9th International Conference on Fog, Fog Collection, and Dew

FOGDEW2023

July 23-28, 2023

Fort Collins, Colorado USA

FOGDEW

2023

Fort Collins, USA

Conference Ice-Breaker Reception and Registration

17:00 - 19:00 Sunday, 23rd July, 2023
CSU Canvas Stadium OCR Sideline Field Club

Enter on the west side of Canvas Stadium. Join us for the conference opening reception. Pick up your registration materials, connect with old and new colleagues, and enjoy drinks and light refreshments.

Conference opening

09:00 - 09:30 Monday, 24th July, 2023
CSU Lory Student Center Ballroom C+D

Conference opening session (Jeff Collett, Chair, Conference Organizing Committee; Genki Katata, Chair, Conference Scientific Committee)

Session 1 - Fog Impacts on Transportation

09:30 - 10:15 Monday, 24th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Melina Sol Yabra, Otto Klemm

09:30 - 09:45

1A AVIATION ACCIDENTS WITH FOG INVOLVED: KOBE BRYANT

Michael R. Witiw[1], Steve LaDochy[2]

[1]Certified Consulting Meteorologist, Sammamish, WA, USA. [2]California State University at Los Angeles, Los Angeles, CA, USA

09:45 - 10:00

1B CLIMATOLOGICAL ASPECTS OF THE OCCURRENCE OF FOG OVER 13 AIRPORTS IN ARGENTINA USING HOURLY METAR AND SYNOP DATA

Melina Sol Yabra[1,2,3], Ramón de Elía[2], Luciano Vidal[2], Matilde Nicolini[4,1,5]

[1]Departamento de Ciencias de la Atmósfera y los Océanos (UBA-FCEN-DCAO), Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Buenos Aires, C.A.B.A., Argentina. [2]Servicio Meteorológico Nacional, Buenos Aires, C.A.B.A., Argentina. [3]Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Buenos Aires, C.A.B.A., Argentina. [4]Centro de Investigaciones del Mar y la Atmósfera (CIMA)de Buenos Aires, Buenos Aires, C.A.B.A., Argentina. [5]Instituto Franco Argentino Sobre Estudios de Clima y Sus Impactos (UMI-IFAECI/CNRS-CONICET-UBA), Buenos Aires, C.A.B.A., Argentina

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10:00 - 10:15

1C BETTER REPRESENTATION OF ACTIVATION IN FOG USING UK MET OFFICE UNIFIED MODEL

Pratapaditya Ghosh[1], Hamish Gordon[1], Paul Field[2,3], Adrian Hill[4], Katherine Evans[5], Salil Mahajan[5], Wei Zhang[5], Min Xu[5], Marie Mazoyer[6]

[1]Carnegie Mellon University, Pittsburgh, PA, USA. [2]UK Met Office, Exeter, United Kingdom. [3]University of Leeds, Leeds, United Kingdom. [4]European Centre for Medium-Range Weather Forecasts, Reading, United Kingdom. [5]Oak Ridge National Laboratory, Oak Ridge, TN, USA. [6]Météo-France, Paris, France

Group photograph - instructions will be provided by Jeff Collett and I-Ting Ku

10:15 - 10:30 Monday, 24th July, 2023

Refreshment Break

10:30 - 11:00 Monday, 24th July, 2023
CSU Lory Student Center Ballroom C+D

Featured Presentation A - Fog as an Urban Water Resource

11:00 - 11:30 Monday, 24th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Genki Katata

Feature A ALLEVIATING THE PRESSURE ON THE CONVENTIONAL WATER SUPPLY NETWORK IN URBAN AREAS THROUGH BUILDING-INTEGRATED FOG COLLECTORS (BFC)

Nathalie Verbrugghe, Ahmed Z. Khan

Building, Architecture and Town Planning Department (BATir), Université Libre de Bruxelles (ULB), Brussels, Belgium

Session 2 - Fog and Dew as Water Resources I

11:30 - 12:30 Monday, 24th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Nurit Agam, Camilo del Rio

11:30 - 11:45

2A FOG MONITORING NETWORK ALONG THE CENTRAL AND NORTHERN CHILEAN COAST: ANTHROPIC, CLIMATIC AND ECOLOGICAL IMPLICATIONS

Camilo del Río[1,2], Fernando Alfaro[3], Alexander Siegmund[4], Constanza Vargas[1], Pablo Osses[1,2], Juan Carlos Pastene[4], Patricio Pliscoff[1], Sebastián Vicuña[5], Francisco Suárez[5], Jörg Bendix[6], Patrick Jung[7], Michael Lakatos[7]

[1]Centro UC Desierto de Atacama, Pontificia Universidad Católica de Chile, Santiago, Chile. [2]Instituto de Geografía, Pontificia Universidad Catolica de Chile, Santiago, Chile. [3]GEMA Center for Genomics, Ecology and Environment, Universidad Mayor, Santiago, Chile. [4]Research Group for Earth Observation (rgeo), Department of Geography, Heidelberg University of Education, Heidelberg, Germany. [5]Departamento de Ingeniería Hidraúlica, Pontificia

Universidad Católica de Chile, Santiago, Chile. [6]Laboratory for Climatology and Remote Sensing, Department of Geography, University of Marburg, Marburg, Germany. [7]Integrative Biotechnology, University of Applied Sciences, Kaiserslautern, Germany

11:45 - 12:00

2B NEOTROPICAL MONTANE CLOUD FORESTS AND CLIMATE CHANGE

Eileen Helmer, Juan Cordova-Rodriguez

International Institute of Tropical Forestry, USDA Forest Service, San Juan, Puerto Rico, USA

12:00 - 12:15

2C LONG-TERM MONITORING OF COASTAL FOG AND BETTER UTILIZATION IN THE JIZAN REGION, SAUDI ARABIA

Aleksandar Valjarević[1], Salem Algarni[2], Ismail Gultepe[3], Cezar Morar[4]

[1]University of Belgrade, Faculty of Geography, Beograd, Serbia, Serbia. [2]Department of Mechanical Engineering, King Khalid University, Abha, Saudi Arabia. [3]Faculty of Eng . and Appl. Sci., Ontario Technical University, Oshawa, ON, Canada, Oshawa, Canada. [4]Department of Geography, Tourism and Territorial planning, University of Oradea, Oradea, Romania

12:15 - 12:30

2D BIOMIMICKING NATURE FOR EFFECTIVE FOG WATER AND ENERGY HARVESTING WITH ELECTROSPUN POLYMER FIBERS

Joanna Knapczyk-Korczak, Urszula Stachewicz

AGH University of Science and Technology, Krakow, Poland

Lunch (provided)

12:30 - 14:00 Monday, 24th July, 2023
CSU Lory Student Center Ballroom C+D

Session 3 - Fog and Dew as Water Resources II

14:00 - 15:15 Monday, 24th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Pablo Osses, Maria Giovanna Di Bitonto

14:00 - 14:15

3A PERSPECTIVES OF FOG WATER AS COMPLIMENTARY SUPPLY SOURCE FOR THE FUTURE.COASTAL ATACAMA DESERT, CHILE

Pablo Osses[1,2,3], Jazmine Calabrese[1], Alexander Siegmund[4,5], Constanza Vargas[2,3,1], Camilo del Rio[1,2], Vicente Espinoza[1,2]

[1]Pontificia Universidad Catolica de Chile, Santiago, Chile. [2]Centro Desierto Atacama UC, Santiago, Chile. [3]Estación Atacama UC-Alto Patache, Iquique, Chile. [4]Department of Geography-Research Gropu for Earth Observation (rgeo) UNESCO Chair on Observation and -Education of World Heritage and Biosphere Reserve, Heidelber University of Education, Heidelberg, Germany. [5]Heidelberg Center for Environment (HCE) - Institute of Geography, Heidelberg University, Heidelberg, Germany

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14:15 - 14:30

3B INTER-COMPARISON OF COMMERCIAL MESHES BASED ON FOG HARVESTING EFFICIENCY THROUGH LAB TEST CAMPAIGNS

Maria Giovanna Di Bitonto[1], Nathaly Michelle Rodriguez Torres[2], Roberta Caruana[1], Manfredo Guilizzoni[1], Adriana Angelotti[1], Alessandra Zanelli[1]

[1]Politecnico di Milano, Milano, italy, Italy. [2]politecnico di milano, milano, italy, Italy

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14:30 - 14:45

3C SPEED AND VOLUME MEASUREMENTS OF DROPLETS SLIDING ON VERTICAL FIBERS

Matteo Léonard, Josephine Van Hulle, Nicolas Vandewalle

GRASP, Université de Liège (ULIEGE), Liège, Belgium

14:45 - 15:00

3D Capillary transport on spines, grooves, fibers and strips for water collection

Nicolas Vandewalle[1], Josephine Van Hulle[1], Matteo Leonard[1], Pierre-Brice Bintein[2], Denis Terwagne[2]

[1]GRASP, University of Liege, Liege, Belgium. [2]Frugal Lab, University of Brussels, Brussels, Belgium

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15:00 - 15:15

3E MICRO-GROOVED PLASTIC FOIL ENHANCES DEW COLLECTION AND PREVENT AGING

Nicolas Lavielle[1,2], Anne Mongruel[1], Tarik Bourouina[2], Daniel Beysens[1,3]

[1]Physique et Mécanique des Milieux Hétérogènes, CNRS, ESPCI, PSL Research University, Sorbonne Université, Sorbonne Paris Cité, Paris, France. [2]ESYCOM lab, UMR 9007 CNRS, Univ Gustave Eiffel, Marne-la-Vallée, France. [3]OPUR, Paris, France

Refreshment Break

15:15 - 15:45 Monday, 24th July, 2023
CSU Lory Student Center Ballroom C+D

Session 4 - Fog and Cloud Chemistry I

15:45 - 17:00 Monday, 24th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Martha Scholl, Dominik van Pinxteren

15:45 - 16:00

4A CHARACTERIZATION OF CHEMICAL COMPOSITION IN SIZE-RESOLVED MARINE AEROSOL DURING FOG FORMATION EVENTS OVER THE NORTHWEST ATLANTIC OCEAN DURING FATIMA 2022

Leyla Salehpoor[1], Leigh R Crilley[1], Cora J Young[1], Gianina Giacosa[2], Lauren Robinson[2], Phillipe Gauvin-Bourdon[2], Rachel Chang[2], Ed Creegan[3], Harindra J Fernando[4], Trevor C VandenBoer[1]

[1]York University, Toronto, ON, Canada. [2]Dalhousie University, Halifax, NS, Canada. [3]US Army Research Laboratory, White Sandss, NM, USA. [4]University of Notre Dame, South Bend, Indiana, USA

16:00 - 16:15

4B THE SCHMÜCKE CLOUD OBSERVATORY (SCO) AND THE CENTRE FOR CLOUD WATER CHEMISTRY (CCWaC) AS NEW FACILITIES IN THE EUROPEAN RESEARCH INFRASTRUCTURE ‘ACTRIS’

Dominik van Pinxteren, Uwe Käfer, Hartmut Herrmann

TROPOS, Leipzig, Germany

16:15 - 16:30

4C CHEMICAL COMPOSITION OF FOG WATER COLLECTED AT FOUR SITES IN NORTH- AND MONT-LEBANON DURING 2021

Dani KHOURY[1,2], Yasmine JABALY[2], Maurice MILLET[1], Olivier DELHOMME[3,1]

[1]University of Strasbourg-ICPEES (UMR 7515 CNRS), Strasbourg, France. [2]University of Balamand, Tripoli, Lebanon. [3]University of Lorraine, Metz, France

16:30 - 16:45

4D FOG, DRIZZLE, AND MIST IN YOKOHAMA AND IN MT. OYAMA, JAPAN

Manabu Igawa

Kanagawa University, Yokohama, Kanagawa-Pref., Japan

16:45 - 17:00

4E MICROORGANISIMS IN FOG AND THEIR ABILITY TO DRIVE FORMALDEHYDE CONCENTRATIONS

Thuong Cao[1], Pierre Herckes[1], Ferran Garcia-Pichel[1], Derek Straub[2]

[1]Arizona State University, Tempe, AZ, USA. [2]Susquehanna University, Selinsgrove, PA, USA

Featured Presentation B - Fog Trends in East China

09:00 - 09:30 Tuesday, 25th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Genki Katata

09:00 - 09:30

Feature B LONG-TERM FOG VARIATION AND ITS IMPACT FACTORS OVER EAST CHINA

Shuqi Yan[1,2], Bin Zhu[2], Tong Zhu[3], Chune Shi[4], Duanyang Liu[1], Hanqing Kang[2], Wen Lu[2], Chunsong Lu[2]

[1]Key Laboratory of Transportation Meteorology of China Meteorological Administration, Nanjing Joint Institute for Atmospheric Sciences, Nanjing, Jiangsu, China. [2]Nanjing University of Information Science and Technology, Nanjing, Jiangsu, China. [3]IMSG at NOAA, NESDIS/STAR, 5830 University Research Ct., Maryland, Maryland, USA. [4]Key Laboratory of Atmospheric Sciences and Satellite Remote Sensing of Anhui Province, Anhui Institute of Meteorological Sciences, Hefei, Anhui, China

Session 5 - Fog and Cloud Chemistry II

09:30 - 10:30 Tuesday, 25th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Pierre Herckes, Taehyoung Lee

09:30 - 09:45

5A ORGANIC CARBON IN CLOUD WATER: THE NEW CHEMICAL REGIME AT WHITEFACE MOUNTAIN

Christopher E Lawrence[1], Mary Barth[2], Archana Tripathy[1], Paul Casson[1], Richard Brandt[1], James Schwab[1], Phil Snyder[3], Daniel Kelting[4], Elizabeth Yerger[4], Haider Khwaja[5], Mirza Hussain[5], Sara Lance[1]

[1]University of Albany, Albany, NY, USA. [2]National Center for Atmospheric Research, Boulder, CO, USA. [3]Adirondack Lake Survey Corp, Ray Brook, NY, USA. [4]Adirondack Watershed Institute, Paul Smiths, NY, USA. [5]Wadsworth Center, NY Department of Health, Albany, NY, USA

09:45 - 10:00

5B MODELING THE MULTIPHASE AEROSOL AND CLOUD CHEMISTRY OF ISOPRENE-RELATED ORGANIC HYDROXY HYDROPEROXIDES AND EPOXIDES WITH MCM/CAPRAM

Andreas Tilgner, Erik H. Hoffmann, Marvel B. E. Aiyuk, Hartmut Herrmann

Leibniz Institute for Tropospheric Research (TROPOS), Atmospheric Chemistry Department (ACD), Leipzig, Germany

10:00 - 10:15

5C CHARACTERIZATION OF CHEMICAL AND PHYSICAL CHANGES IN ATMOSPHERIC AEROSOLS DURING FOG PROCESSING AT BAENGNYEONG ISLAND, SOUTH KOREA

Taehyoung Lee[1], Alexandra J Boris[2,3], Taehyun Park[1], Jeffrey L Collett Jr[2]

[1]Hankuk University of Foreign Studies, Seoul, Korea, Republic of. [2]Colorado State University, Fort Collins, CO, USA. [3]California Air Resources Board, Sacramento, CA, USA

10:15 - 10:30

5D OVERVIEW AND FIRST RESULTS OF THE FOG AND AEROSOL INTERACTION RESEARCH ITALY CAMPAIGN (FAIRARI) 2021/22

Almuth Neuberger[1,2], Fredrik Mattsson[1,2], Yvette Gramlich[1,2], Sophie Haslett[1,2], Liine Heikkinen[1,2], Anilbhai Patel[1,2], Sarah Steimer[1], Stefano Decesari[3], Marco Paglione[3], Claudia Mohr[1,2], Ilona Riipinen[1,2], Paul Zieger[1,2]

[1]Department of Environmental Science, Stockholm University, Stockholm, Sweden. [2]Bolin Centre for Climate Research, Stockholm, Sweden. [3]Institute of Atmospheric Sciences and Climate, National Research Council, Bologna, Italy

Refreshment Break

10:30 - 11:00 Tuesday, 25th July, 2023
CSU Lory Student Center Ballroom C+D

Session 6 - Fog and Dew Ecosystem Interactions

11:00 - 12:30 Tuesday, 25th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Glenda Garcia-Santos, Lixin Wang

11:00 - 11:15

6A THE IMPORTANCE OF FOG AND DEW IN DRYLAND DYNAMICS

Lixin Wang[1], Na Qiao[1], Kudzai Farai Kaseke[1], Eugene Marais[2], Gillian Maggs-Kölling[2]

[1]Indiana University-Purdue University Indianapolis, Indianapolis, IN, USA. [2]Gobabeb – Namib Research Institute, Walvis Bay, Namibia

11:15 - 11:30

6B IMPORTANCE OF DEW AND FOG AT MICROHABITATS FOR BIODIVERSITY AND FUNCTIONAL ECOLOGY OF NON-VASCULAR PLANTS

Michael Lakatos[1], Patrick Jung[1], Lukas Lehnert[2], Fernando Daniel Alfaro[3], Camilo del Río[4], Tanja Lakatos[1], Jörg Bendix[5]

[1]University of Applied Sciences Kaiserslautern, Kaiserslautern, Rhine-Palatinate, Germany. [2]Ludwig-Maximilians-University Munich, Munich, Bavaria, Germany. [3]Universidad Mayor,, Huechuraba, Chile. [4]ontificia Universidad Católica de Chile, Santiago de Chile, Chile. [5]University of Marburg, Marburg, Hessen, Germany

11:30 - 11:45

6C PRESENCE AND IMPORTANCE OF FOG IN FOREST ECOSYSTEMS OF A PROTECTED FOREST LOCATED IN THE ALPINE REGION

Glenda Garcia-Santos[1], Nikolaus Obojes[2], Leonardo Montagnani[3]

[1]University of Klagenfurt, Klagenfurt, Austria. [2]EURAC, Bozen, Italy. [3]University of Bozen, Bozen, Italy

11:45 - 12:00

6D DRY DESERT SOILS AS A SINK FOR CO_2 - THE THUS-FAR NEGLECTED EFFECT OF NON-RAINFALL WATER INPUTS

Nadav Bekin, Nurit Agam

Jacob Blaustein Institutes for Desert Research Ben-Gurion University of the Negev, Midreshet Ben-Gurion, Israel

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12:00 - 12:15

6E DOES THE TRUE ROSE OF JERICHO CAPTURE DEW? TRICHOMES AND PLANT ORIENTATION AS THERMAL AND STRUCTURAL MECHANISMS FOR DEW CAPTURING.

Yuval Siboni, Merav Seifan, Nurit Agam

The Jacob Blaustein Institutes for Desert Research Ben Gurion University, Midreshet Ben Gurion, Israel

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12:15 - 12:30

6F INVISIBLE DEW FORMATION BY ATMOSPHERIC AEROSOLS AND ITS ROLE FOR NOCTURNAL TRANSPIRATION OF POPLARS

Chia-Ju Ellen Chi[1], Clara Vega[2], Victoria Fernández[2], Juergen Burkhardt[1]

[1]University of Bonn, Bonn, Germany. [2]Universidad Politécnica de Madrid, Madrid, Spain

Lunch (on your own) + IFDA Board Meeting (LSC322)

12:30 - 14:00 Tuesday, 25th July, 2023

Poster Session A

14:00 - 16:00 Tuesday, 25th July, 2023
CSU Lory Student Center Ballroom B
Presentation type Poster

Posters and refreshments

A2 COMPARATIVE MESH MEASUREMENTS OF FOG WATER COLLECTION

Hayli Stewart, Danijela Jozinovic, Daniel M Fernandez

California State University, Monterey Bay, Seaside, CA, USA

A3 FIELD-TESTING FOG HARPS

Jimmy K. Kaindu[1], Kevin R. Murphy[1], Alexandra N. Jones[1], Daniel M. Fernandez[2], Brook S. Kennedy[1], Jonathan B. Boreyko[1]

[1]Virginia Tech, Blacksburg, VA, USA. [2]California State University Monterey Bay, Seaside, CA, USA

A4 FOG WATER COLLECTION AT THE UC SANTA CRUZ CASFS FARM

Phillip T Grote

UC Santa Cruz, Santa Cruz, CA, USA

A6 SPATIAL MODELLING OF NEAR-SURFACE FOG WATER VARIABILITY AND ITS RELATIONSHIP WITH LOCAL TOPOGRAPHY IN NORTHERN CHILEAN ATACAMA DESERT

Juan Carlos Pastene[1,2], Alexander Siegmund[1,2], Camilo del Río[3], Pablo Osses[3]

[1]Department of Geography – Research Group for Earth Observation (rgeo), UNESCO Chair on Observation and Education of World Heritage and Biosphere Reserve, Heidelberg University of Education, Heidelberg, Germany.
[2]Heidelberg Center for Environment (HCE) & Institute of Geography, Heidelberg University, Heidelberg, Germany.
[3]Instituto de Geografía & Centro UC Desierto de Atacama, Pontificia Universidad Católica de Chile, Santiago, Chile

A8 SMALL-SCALE VARIABILITY IN FOG WATER COLLECTION AT A LOCATION ALONG CALIFORNIA'S CENTRAL COAST

Kathleen Krasinski, Tianyi Luo, Daniel M Fernandez

California State University, Monterey Bay, Seaside, CA, USA

A9 LARGE-SCALE VARIABILITY IN FOG WATER COLLECTION ACROSS AN ARRAY OF STANDARD FOG COLLECTOR ALONG COASTAL CALIFORNIA

Crystelle Vargas, Olivia Equinoa, Cone Michelle, Kathleen Krasinski, Hayli Stewart, Danijela Jozinovic, Daniel M Fernandez

California State University, Monterey Bay, Seaside, CA, USA

A11 IMPLEMENTATION OF BIOPHILIC URBAN PLANNING BASED ON THE USE OF FOG AS A COMPLEMENTARY WATER RESOURCE IN DESERT CITIES

Virginia V Carter

Pontificia Universidad Católica de Chile, Santiago, Chile

A13 INTERMEDIATE-SCALE VARIABILITY IN FOG WATER COLLECTION ACROSS AN ARRAY IN A CALIFORNIA COASTAL ENVIRONMENT, THE FORT ORD NATURAL RESERVE

Olivia Equinoa[1], Crystelle Vargas[1], Daniel M Fernandez[1], Jon Detka[2,1], Joe Miller[2]

[1]California State University, Monterey Bay, Seaside, CA, USA. [2]University of California, Santa Cruz, Santa Cruz, CA, USA

A14 MEASUREMENTS OF STANDARD FOG COLLECTOR EFFICIENCIES USING FM-120 SPECTROMETERS

Daniel M Fernandez, Steven KIm, Theodore Robinson

California State University, Monterey Bay, Seaside, CA, USA

A15 PROPOSING A STANDARD: CALIBRATION OF FOG GAUGE MEASUREMENTS FOR CROSS-SITE COMPARISONS

Han Tseng[1], Thomas Giambelluca[1,2]

[1]Water Resources Research Center, University of Hawai‘i at Mānoa, Honolulu, Hawaii, USA. [2]Geography and Environment Department, University of Hawai‘i at Mānoa, Honolulu, Hawaii, USA

A16 INTEGRATION OF FOG HARVESTING TECHNIQUE IN GREEN WALLS DESIGN

Maria Giovanna G Di Bitonto[1], Lujain Hadba[2], Lígia Maria Marques Oliveira Torres Silva[2], Paulo Jorge Figueira Almeida Urbano Mendonça[2], Alessandra Zanelli[1]

[1]Politecnico di Milano, Milano, Italy, Italy. [2]UMinho, Guimaraes, Portugal, Portugal

A17 INTEGRATION OF THE FOG WATER HARVESTING SYSTEM IN LIGHTWEIGHT STRUCTURE DESIGN FOR EMERGENCY CAMPS

maria giovanna G di bitonto, Nathaly Michelle Rodriguez Torres, Nicolò Elio Giorgetti, Alara Kutlu, Alessandra Zanelli

Politecnico di Milano, Milano, Italy, Italy

A20 FIRST RESULTS FROM THE GROUNDBASED FOG AND AEROSOL SPECTROMETER

Dagen Hughes[1], Darrel Baumgardner[1], Almuth Neuberger[2], Paul Zieger[2]

[1]Droplet Measurement Technologies LLC, Longmont, CO, USA. [2]University of Stockholm, Stockholm, Sweden

A21 INTERCOMPARISON STUDY OF CLOUD-INSITU MEASUREMENT PROBES AT SONNBLICK OBSERVATORY, AUSTRIA

Christian Maier, Elke Ludewig

Geosphere Austria, Salzburg, Austria

A22 PROTOTYPING AN IMAGE-BASED COASTAL FOG DETECTION NETWORK USING SEVEN RGB CAMERAS ALONG THE OREGON COAST

Sonya Rauschenbach[1], John Kim[2], Alex Dye[3]

[1]Department of Land Air and Water Resources, University of California, Davis, Davis, CA, USA. [2]Forest Service, U.S. Department of Agriculture, Corvallis, OR, USA. [3]Department of Forest Ecosystems & Society, Oregon State University, Corvallis, OR, USA

A23 MODIFYING THE CALTECH ACTIVE STRAND CLOUDWATER COLLECTOR FOR APPLICATION IN COMPLEX TERRAIN

Ajinkya G Deshpande[1], Christine F Braban[1], Eiko Nemitz[1], Rob Kinnersley[2], Robert Nicoll[1], Duncan Harvey[1], Matthew R Jones[1]

[1]UK Centre for Ecology and Hydrology, Edinburgh, United Kingdom. [2]Environment Agency, Bristol, United Kingdom

A24 FOG: A NEW TOOL AND GAME CHANGER IN ALGAL BIOTECHNOLOGY

Tanja Lakatos[1], Patrick Jung[1], Felix Harion[2], Laura Briegel-Williams[2], Timo Schmidt[3], Michael Wahl[4], Michael Lakatos[1]

[1]University of Applied Sciences Kaiserslautern, Kaiserslautern, Rhine-Palatinate, Germany. [2]University of Applied Sciences Kaiserslautern, Kaiserslautern, Germany. [3]University of Applied Sciences Augsburg, Augsburg, Bavaria, Germany. [4]University of Applied Sciences Trier, Birkenfeld, Germany

A25 NUMERICAL STUDY OF A PLANE DEW CONDENSER

PEDRO FLORES-CASTILLO[1], DANIEL BEYSENS[2]

[1]Harvard University, Cambridge, Massachussetts, USA. [2]ESPCI, Physique et Mécanique des Milieux Hétérogènes, CNRS, ESPCI Paris-PSL University, Sorbonne Université, Sorbonne Paris Cité, Paris, France

A26 THE EMISSIVITY OF A CONDENSING SURFACE IS DOMINATED BY WATER

Daniel Beysens[1,2], Joachim Trosseille[1], Laurent Royon[3], Anne Mongruel[1]

[1]ESPCI, Physique et Mécanique des Milieux Hétérogènes, CNRS, ESPCI Paris-PSL University, Sorbonne Université, Sorbonne Paris Cité, Paris, France. [2]OPUR, Paris, France. [3]Université de Paris, LIED, UMR 8236 CNRS, Paris, France

A27 LARGE ENHANCEMENT OF DEW WATER CONDENSATION ON SELF-LUBRICATED SILICONE

Nicolas Lavielle[1], Daniel Beysens[1,2], Anne Mongruel[1]

[1]Physique et Mécanique des Milieux Hétérogènes, CNRS, ESPCI, PSL Research University, Sorbonne Université, Sorbonne Paris Cité, Paris, France. [2]OPUR, Paris, France

A29 A SINGLE COLUMN STUDY OF MARINE FOG FORMATION THROUGH CLOUD BASE LOWERING

Nathan H Pope[1], Adele L Igel[2]

[1]University of California, Davis, Davis, California, USA. [2]University of California, Davis, Davis, CA, USA

A30 POINT REYES AS A MICROCOSM: INITIAL RESULTS FROM A FOG-DEPENDENT ECOSYSTEM WARMING EXPERIMENT

Paul O Seibert, Cynthia Gerlein-Safdi

University of California, Berkeley, Berkeley, California, USA

A31 INTERANNUAL VARIATIONS IN FOG COLLECTION IN THE EASTERN IBERIAN PENINSULA AND FORCING MECHANISMS OF THE LARGE ATMOSPHERIC SCALE

Eduardo Agosta[1,2], David Corell[3], María J. Estrela[3]

[1]Consejo Nacional de Investigaciones Científicas y Técnicas, Buenos Aires, Argentina. [2]Universidad de La Plata, Buenos Aires, Argentina. [3]University of Valencia, Valencia, Spain

A32 MAPPING PAST AND FUTURE DEW, RAIN AND EVAPOTRANSPIRATION EVOLUTIONS IN NORTH-WEST AFRICA (2005–2100) ACCORDING TO MEASURED DATA AND CLIMATE SCENARIOS

Daniel Beysens[1,2], Marc Muselli[3,2]

[1]ESPCI, Physique et Mécanique des Milieux Hétérogènes, CNRS, ESPCI Paris-PSL University, Sorbonne Université, Sorbonne Paris Cité, Paris, France. [2]OPUR, Paris, France. [3]University of Corsica, Corte, France

A33 OBSERVATIONS OF FOG CHEMICAL COMPOSITION OVER A 15 YEAR PERIOD

Derek Straub

Susquehanna University, Selinsgrove, PA, USA

A34 MAPPING FOG OCCURRENCE AND FOG COLLECTION POTENTIAL FOR FOOD SECURITY IN SOUTHERN BOLIVIA

Giulio Castelli[1], Aida Cuni Sanchez[2], Teresa Lopez de Armentia[3], Fabio Salbitano[1], Elena Bresci[1]

[1]University of Florence, Florence, Italy. [2]Norwegian University of Life Sciences (NMBU), Oslo, Norway. [3]Zabalketa, Getxo, Bizkaia, Spain

A35 MARINE FOG MICROPHYSICS DURING FATIMA: TURBULENCE IMPACT ON FOG LIFE CYCLE

Ismail Gultepe[1,2], Harindra J.S. Fernando[3], Qing Wang[4], Eric Pardyjak[5], Sebastian W, Hoch[5], Alexei Perelet[5], jesus R.P. Carte[6], Sen Wang[3], John Komar[7], Eric Villeneuve[7], Martin Agelin-Chaab[7]

[1]ACE CWT, Ontario Tech University, Oshawa, Ontario, Canada. [2]Faculty of Engineering and Applied Science, Ontario Tech University, Oshawa, Ontario, Canada. [3]University of Notre Dame, South Bend, IN, USA. [4]NPS, Monterey, CA, USA. [5]University of Utah, Salt Lake City, Utah, USA. [6]NPS, Montery, CA, USA. [7]Ontario Tech University, Oshawa, Ontario, Canada

A36 THE ENSO RELATION IN THE SPATIAL DISTRIBUTION OF FOG AND LOW CLOUDS (1995-2022) IN THE ATACAMA DESERT (18°S-35°S)

Vicente Espinoza[1,2,3], Klaus Keim[1,2,3], Nicolás Valdivia[1,2,3], Constanza Vargas[1,2,3], Diego Rivera[1,2,3], Pablo Osses[1,2,3], Camilo del Río[1,2,3]

[1]Pontificia Universidad Católica de Chile, Santiago, Chile. [2]Instituto de Geografía UC, Santiago, Chile. [3]Centro UC Desierto de Atacama, Santiago, Chile

1C BETTER REPRESENTATION OF ACTIVATION IN FOG USING UK MET OFFICE UNIFIED MODEL

Pratapaditya Ghosh[1], Hamish Gordon[1], Paul Field[2,3], Adrian Hill[4], Katherine Evans[5], Salil Mahajan[5], Wei Zhang[5], Min Xu[5], Marie Mazoyer[6]

[1]Carnegie Mellon University, Pittsburgh, PA, USA. [2]UK Met Office, Exeter, United Kingdom. [3]University of Leeds, Leeds, United Kingdom. [4]European Centre for Medium-Range Weather Forecasts, Reading, United Kingdom. [5]Oak Ridge National Laboratory, Oak Ridge, TN, USA. [6]Météo-France, Paris, France

A39 $\sum 10^6 = 1$ HIGH YIELD ZERO-CARBON COALESCENCE OF ATMOSPHERIC LIQUID MICR-DROPLETS

Mansur Mohammed Abahusayn, Yoonjin Won

UCI, Irvine, California, USA

A40 CHARACTERISTICS OF THE MACRO- AND MICRO-STRUCTURES OF THE DIFFERENT GRADES FOG IN JIANGSU , CHINA

Hongbin Wang, Duanyang Liu, Zhiwei Zhang

Key Laboratory of Transportation Meteorology of China Meteorological Administration, Nanjing Joint Institute for Atmospheric Sciences, Nanjing, China

A41 A YELLOW SEA FOG OBSERVATIONS AND MODELING USING THE SOCHEONGCHO OCEAN RESEARCH STATION

Hojin Kim, Ki-Young Heo, Jin-Yong Jeong

KIOST, Busan, Korea, Republic of

A43 PERFORMANCE COMPARISON OF SEVERAL NUMERICAL WEATHER PREDICTION MODELS IN THE FATIMA 2022 CAMPAIGN PERIOD

Zheqi Chen[1], Sasa Gabersek[2], Reneta Dimitrova[3], Yongsheng Chen[1], Peter Taylor[1]

[1]York University, Toronto, Canada. [2]U.S. Naval Research Laboratory, Washington, USA. [3]Notre Dame University, Notre Dame, USA

A45 ANALYSIS OF A SEA FOG EVENT IN YELLOW SEA BESIDES THE CENTER OF TYPHOON LEKIMA (1909)

Qian Wang[1,2], Xiaomeng Shi[1,2]

[1]Key Laboratoray for Meteorological Disaster Prevention and Mitigation of Shandong, Jinan, Shandong, China. [2]Qingdao Meteorological Observatory, Qingdao, Shandong, China

A46 SPRINGTIME SEA FOG PENETRATION IN QINGDAO: ANOMALOUS MOISTENING AND DIURNAL COOLING

Shutong Song[1], Xiaomeng Shi[2], Li Yi[1]

[1]Ocean University of China, Qingdao, China. [2]Qingdao Meteorological Bureau, Qingdao, China

A47 OBSERVATIONAL ANALYSIS OF A FOG EVENT IN THE OYASHIO EXTENSION AREA

Suping Zhang[1], Xin Zhang[1], Xiaomeng Shi[2]

[1]College of Oceanic and Atmospheric Sciences, Ocean University of China,, Qingdao, China. [2]Qingdao Meteorological Observatory, Qingdao, China

A48 ATMOSPHERIC CONDITIONS CONDUCIVE TO MARINE FOG OVER THE NORTHEAST PACIFIC IN WINTERS 1979-2019

Xinbei Li[1], Suping Zhang[1], Darko Koračin[2,3], Li Yi[1], Xin Zhang[1]

[1]Ocean University of China, Qingdao, China. [2]Physics Department, Faculty of Science, University of Split, Split, Croatia. [3]Division of Atmospheric Sciences, Desert Research Institute, Reno, Nevada, USA

A49 EXAMINATION OF A FOG EVENT RELATED TO A LARGE-SCALE CYCLONE AT SABLE ISLAND DURING FATIMA CAMPAIGN

Clive E Dorman[1], Darko Koračin[2,3], Ismail Gultepe[4,5]

[1]Scripps Institution of Oceanography, UCSD, La Jolla, CA, USA. [2]Desert Research Institute, UNV, Reno, NV, USA. [3]University of Split, Split, Croatia. [4]Ontario Tech University, Oshawa, Ontario, Canada. [5]University of Notre Dame, Notre Dame, IN, USA

A51 AN UNUSUAL STORY BEHIND THE SCIENTIFIC BOOK SEA FOG

Gang Fu, Pengyuan Li, Suping Zhang, Shanhong Gao, Lijia Chen

Department of Marine Meteorology, Lab of Ocean-Atmosphere Interaction and Climate, Lab of Physical Oceanography, Ocean University of China, Qingdao, Shandong, China

A53 DENSE FOG BURST REINFORCEMENT OVER EASTERN CHINA UNDER THE INFLUENCE OF COMPLEX ENVIRONMENT

Duanyang Liu[1,2], Zihua Li[3], Shengjie Niu[4], Wenlian Yan[5], Shuqi Yan[6], Fan Zu[6], Hongbin Wang[6], Chengying Zhu[6]

[1]Nanjing Joint Institute for Atmospheric Sciences, Nanjing, Jiangsu, China. [2]Key Laboratory of Transportation Meteorology of China Meteorological Administration, Nanjing, Jiangsu, China. [3]Nanjing University of Information Science and Technology, Nanjing, Jiangsu, China. [4]Nanjing Tech University, Nanjing, China. [5]Jiangsu Meteorological Observatory, Nanjing, China. [6]Nanjing Joint Institute for Atmospheric Sciences, Nanjing, China

A55 SIMULATING AEROSOL ACTIVATION IN STRATUS LOWERING FOG OBSERVED DURING C-FOG

Noah Asch[1], Hamish Gordon[1], Pratapaditya Ghosh[1], Salil Mahajan[2], Wei Zhang[2], Hyun Kang[2], Katherine Evans[2]

[1]Carnegie Mellon University, Pittsburgh, PA, USA. [2]Oak Ridge National Laboratory, Oak Ridge, TN, USA

Session 7 - Fog and Dew Deposition and Measurement

16:00 - 17:15 Tuesday, 25th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Kathleen Weathers, Dilia Kool

15:45 - 16:00

7A SIMULATION OF AVAILABLE WATER CONTENT FROM FOG EVENTS IN THE COAST OF SEMI-ARID REGION OF CHILE AND ITS CONTRIBUTION IN MAINTAINING LOCAL VEGETATION

Valentina Pacheco, Sebastián Vicuña, Francisco Suarez, Felipe Lobos, Aurora Gaxiola, Camilo Del Rio

Pontificia Universidad Católica de Chile, Santiago, Chile

16:00 - 16:15

7B FOG AND DEW AS CONTROLLING FORCES FOR THE BIOSPHERE-ATMOSPHERE INTERACTION IN THE ATACAMA DESERT – CONCEPT AND RESULTS OF AN INNOVATIVE MEASUREMENT AND OBSERVATION NETWORK IN NORTHERN CHILE

Alexander Siegmund[1,2], Camilo del Río[3], Pablo Osses[3], Juan Carlos Pastene[1,2]

[1]Department of Geography – Research Group for Earth Observation (rgeo), UNESCO Chair on Observation and Education of World Heritage and Biosphere Reserve, Heidelberg University of Education, Heidelberg, Germany.
[2]Heidelberg Center for Environment (HCE) & Institute of Geography, Heidelberg University, Heidelberg, Germany.
[3]Instituto de Geografía & Centro UC Desierto de Atacama, Pontificia Universidad Católica de Chile, Santiago, Chile

16:15 - 16:30

7C FOG OCCURENCE AND FOG DEPOSITION: A NEW APPROACH TO ESTIMATE THE SPATIO-TEMPORAL OCCURRENCE OF FOG AND THE AMOUNT OF FOG DEPOSITION

Philipp Körner[1,2], Christian Bernhofer[1]

[1]TU Dresden, Dresden, Germany. [2]iamk GmbH, Dresden, Germany

16:30 - 16:45

7D PROJECT FOR A DEW CONDENSATION STANDARD

Daniel Beysens[1,2], Laurent Royon[3], Sylvain Lefavrais[1,2], Marc Muselli[4,2]

[1]ESPCI, Physique et Mécanique des Milieux Hétérogènes, CNRS, ESPCI Paris-PSL University, Sorbonne Université, Sorbonne Paris Cité, Paris, France. [2]OPUR, Paris, France. [3]Université de Paris, LIED, UMR 8236 CNRS, Paris, France. [4]University of Corsica,, Corte, France

16:45 - 17:00

7E WATER DYNAMICS IN DRY SOILS – USING RELATIVE HUMIDITY SENSORS TO MEASURE WATER VAPOR ADSORPTION IN DESERT SOILS

Dilia Kool[1], Nurit Agam[2]

[1]Department of Environmental, Geoinformatic and Urban Planning Sciences, Ben-Gurion University of the Negev, Beer Sheva, Israel. [2]Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, Midreshet Ben Gurion, Israel

Technical Excursion (separate ticket required for all participants)

07:45 - 17:00 Wednesday, 26th July, 2023

Join us for a fun and educational trip into Rocky Mountain National Park. We will travel by bus from Fort Collins up through Big Thompson Canyon, into the national park, and across the continental divide. Lunch will be provided in the town of Grand Lake, before we return back through Rocky Mountain National Park to Fort Collins. Along the way we will learn about alpine ecosystems, air pollution and haze, nitrogen deposition, water resources, and impacts of wildfires.

Buses will load at 7:45 AM just north of the Lory Student Center and the CSU Transit Center on Plum Street. Please bring comfortable clothes and dress in layers; a light rain jacket is suggested. It will likely be very warm at lower elevations but could be cold and maybe even snow at our stop at the Alpine Visitor Center atop Rocky Mountain NP and thunderstorms are a possibility. Bring water to stay hydrated and sunscreen and sunglasses to prepare for high altitude sun exposure.

Featured Presentation C - The Winter Fog Experiment in India

09:00 - 09:30 Thursday, 27th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Genki Katata

09:00 - 09:30

Feature C WIFEX: WALK INTO THE WARM FOG OVER INDO GANGETIC PLAIN REGION

Sachin Ghude[1], R. K. Jenamani[2], Rachana Kulkarni[3], Sandeep Wagh[1], Narendra G. Dhangar[1], Avinash N. Parde[1], Prodip Acharja[1], Prasanna Lonkar[1], Gaurav Govardhan[1], Prafull Yadav[1], Akash Vispute[1], Sreyashi Debnath[1]

et al

[1]Indian Institute of Tropical Meteorology, Pune, India. [2]India Meteorological Department, Delhi, India. [3]University of Pune, Pune, India

Session 8 - Fog and Cloud Dynamics and Trends

09:30 - 10:30 Thursday, 27th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Eleonora Forzini, Jan Cermak

09:30 - 09:45

8A ANALYSIS OF FOG DYNAMICS IN THE NAMIB DESERT AND IMPACTS ON NATURAL AND ARTIFICIAL FOG COLLECTION

Eleonora Forzini[1], Aida Cunì-Sanchez[2], Giulio Castelli[1], Elena Bresci[1]

[1]University of Florence, Florence, Italy. [2]Norwegian University of Life Sciences, Ås, Norway

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09:45 - 10:00

8B MOUNTAIN CLOUD DYNAMICS DEPEND ON RECYCLED WATER VAPOR AND FOREST COVER

Martha A. Scholl[1], Maoya Bassiouni[2], Sheila F. Murphy[3]

[1]U.S. Geological Survey, Water Resources, Reston, VA, USA. [2]University of California Berkeley, Berkeley, CA, USA. [3]U.S. Geological Survey, Water Resources, Boulder, CO, USA

10:00 - 10:15

12A COLD-FOG MICROPHYSICS DURING CFACT CAMPAIGN

Ismail Gultepe[1,2], Eric Pardyjak[3], Sebastian W. Hoch[3], Anna G. Hallar[3], Zhaoxia Pu[3], Alexei Perelet[3], Martin Agelin-Chaab[4], John Komar[1], Eric Villeneuve[1]

[1]Ontario Tech University, Oshawa, ON, Canada. [2]University of Notre Dame, South Bend, IN, USA. [3]University of Utah, Salt Lake City, UT, USA. [4]Ontario Tech University, Oshawa, Ontario, Canada

10:15 - 10:30

8D TRENDS OF FOG TREND RESEARCH

Otto Klemm

University of Münster, Münster, Germany

Refreshment Break

10:30 - 11:00 Thursday, 27th July, 2023
CSU Lory Student Center Ballroom C+D

Session 9 - Fog and Cloud Physics

11:00 - 12:30 Thursday, 27th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Ismail Gultepe, Pratapaditya Ghosh

11:00 - 11:15

9A HIGHLIGHTS OF 'FOG AND TURBULENCE IN THE MARINE ATMOSPHERE (FATIMA)' 2022 FIELD CAMPAIGN

Harindra Joseph Fernando[1], Edward Creegan[2], Clive Dorman[3], Sasa Gabersek[4], Ismail Gultepe[5], Luc Lenain[3], Eric Pardyjak[6], Qing Wang[7]

[1]University of Notre Dame, Notre Dame, IN, USA. [2]US Army Research Laboratory, White Sands Missile Range, NM, USA. [3]Scripps Institution of Oceanography, San Diego, CA, USA. [4]Naval Research Laboratory, Monterey, CA, USA. [5]Ontario Tech University, Oshawa, ON, Canada. [6]University of Utah, Salt Lake City, UT, USA. [7]Naval Postgraduate School, Monterey, CA, USA

11:15 - 11:30

9B OBSERVATIONS OF THERMODYNAMIC PROFILES IN FOG AND FOG-AEROSOL INTERACTIONS

David D Turner[1], Heather Guy[2], Ian Brook[2], Chris Cox[3], Penny Rowe[4], Matt Shupe[3], Von Walden[5], Ryan Neely III[2]

[1]NOAA / Global Systems Lab, Boulder, CO, USA. [2]Univ of Leeds, Leeds, United Kingdom. [3]NOAA / Physical Sciences Lab, Boulder, CO, USA. [4]Northwest Research Associates, Seattle, WA, USA. [5]Washington State Univ, Pullman, WA, USA

11:30 - 11:45

9C MARINE STRATUS AND FOG - BOUNDARY LAYER MIXING AND A WATER DROPLET SINK.

Peter A Taylor

York University, Toronto, Ontario, Canada

11:45 - 12:00

9D PHYSICAL-BASED MODEL FOR ESTIMATING FOG WATER POTENTIAL IN (SEMI-)ARID REGIONS

Felipe Lobos-Roco[1,2], Camilo del Rio[1]

[1]Centro UC Desierto de Atacama, Pontificia Universidad Católica de Chile, Santiago, Chile. [2]Departamento de Ingeniería Hidráulica y Ambiental, Pontificia Universidad Católica de Chile, Santiago, Chile

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12:00 - 12:15

9E SIMULTANEOUS, MULTI-SITE AND VERTICAL MEASUREMENTS OF FOG DROPLET SPECTRA IN CONJUNCTION WITH STANDARD FOG COLLECTORS IN THE MONTEREY BAY (CA) REGION

Daniel M Fernandez[1], Jesus Ruiz-Placarte[2], Ryan Yamaguchi[2], Qing Wang[2]

[1]CSU Monterey Bay, Seaside, CA, USA. [2]Naval Postgraduate School, Monterey, CA, USA

12:15 - 12:30

9F FOG FORECAST AT MEXICO CITY INTERNATIONAL AIRPORT: A THERMODYNAMIC APPROACH

Fernando García-García, Pohema J. González-Viveros, Ernesto Caetano

Universidad Nacional Autónoma de México, Coyoacán, CDMX, Mexico

Lunch (on your own)

12:30 - 14:00 Thursday, 27th July, 2023

Poster Session B

14:00 - 16:00 Thursday, 27th July, 2023
CSU Lory Student Center Ballroom B
Presentation type Poster

Posters and refreshments

B1 VERTICAL CHARACTERISTICS OF VOCs DURING FOG, HAZE DAYS IN THE LOWER TROPOSPHERE OVER THE EASTERN CHINA: BASED ON UAV OBSERVATION

Ruolan Liu[1,2], Duanyang Liu[2], Shujie Yuan[1], Fan Zu[2], Hong Wu[2], Ruixiang Liu[2,3]

[1]Chengdu University of Information Technology, Chengdu, China. [2]Nanjing Joint Institute for Atmospheric Sciences, Nanjing, Nanjing, China. [3]Lianyungang Meteorological Bureau of Jiangsu Province, Lianyungang, China

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B4 WHAT IS THE ROLE OF ORGANIC COMPOUNDS DISSOLVED IN LEAF WETNESS IN INDUCING NON-STOMATAL OZONE UPTAKE?

Rachele Ossola, Mj Riches, Rose Rossell, Cameron Osburn, Delphine Farmer

Colorado State University, Fort Collins, Colorado, USA

B5 CHEMICAL EVOLUTION OF FOG WATER IN FOUR CONTRASTED SITES IN NORTHERN FRANCE (ALSACE) BETWEEN 2015 AND 2021

Dani KHOURY[1,2], Yamine JABALI[2], Maurice MILLET[1], Olivier DELHOMME[3,1]

[1]University of Strasbourg-ICPEES (UMR 7515 CNRS), Strasbourg, France. [2]University of Balamand, Tripoli, Lebanon. [3]University of Lorraine, Metz, France

B6 COMPARISON OF CONCENTRATIONS OF GAS-DERIVED CONSTUITUENTS IN DEW BETWEEN 20 YEARS AGO AND RECENT YEARS AND CHANGES IN ATMOSPHERIC CONCENTRATIONS OF GAS-DERIVED CONSTUITUENTS ASSOCIATED WITH DEW FORMATION AND DISAPPEARANCE AT SAKAI, OSAKA, JAPAN

Norimichi Takenaka[1], Yuma Otagaki[2], Yusuke Fujii[1]

[1]Osaka Metropolitan University, Sakai, Osaka, Japan. [2]Osaka Prefecture University, Sakai, Osaka, Japan

B9 INVESTIGATING AMAZON RAINFOREST FOG AS AN AEROSOL PROCESSOR

Bruna G Sebben[1], Fabio L Teixeira[2], Swarup China[3], Christopher Pöhlker[4], Nurun Nahar[3], Rodolfo D Piazza[5], Rodrigo F Marques[5], Glaucio Valdameri[1], Emerson Hara[1], Ricardo H Godoi[1]

[1]Federal University of Paraná, Curitiba, Brazil. [2]University of São Paulo, São Paulo, Brazil. [3]Pacific Northeast Nacional Laboratory, Richland, USA. [4]Max Planck Institute for Chemistry, Mainz, Germany. [5]São Paulo State University, Araraquara, Brazil

B10 RAPID POST-FOG GROWTH OF AITKEN MODE PARTICLES INTO CCN SIZES THROUGH MULTIPHASE CHEMICAL FOG PROCESSES

Erik H. Hoffmann[1], Andreas Tilgner[1], Simonas Kecorius[1,2], Hartmut Herrmann[1]

[1]Leibniz Institute for Tropospheric Research (TROPOS), Atmospheric Chemistry Department (ACD), Leipzig, Germany. [2]Institute of Epidemiology, Helmholtz Zentrum München - German Research Center for Environmental Health, München, Germany

B11 MODELING THE CHEMICAL MULTIPHASE PROCESSING OF BIOMASS BURNING TRACE COMPOUNDS WITH CAPRAM-BBM1.0

Andreas Tilgner, Lin He, Erik H. Hoffmann, Hartmut Herrmann

Leibniz Institute for Tropospheric Research (TROPOS), Atmospheric Chemistry Department (ACD), Leipzig, Germany

B13 ESTIMATES OF CLOUD WATER DEPOSITION AT MOUNTAIN FOREST SITES IN JAPAN

Yize WANG[1], Hiroshi OKOCHI[1], Manabu IGAWA[2], Hiroaki YAGOH[3], Yoshiyuki TAKAHASHI[4], Masatoshi KURIBAYASHI[5], Yuri KANNO[6], Kyohei NITTA[7]

[1]Graduate School of Creative Science and Engineering, Waseda University, Tokyo, Japan. [2]Department of Materials and Life Chemistry, Kanagawa University, Yokohama, Japan. [3]Niigata Prefectural Institute of Public Health and Environmental Sciences, Niigata, Japan. [4]National Institute for Environmental Studies, Tsukuba, Japan. [5]Nagano Environmental Conservation Research Institute, Nagano, Japan. [6]Field Science Center for Northern Biosphere, Hokkaido University, Horonobe, Japan. [7]Akita Prefecture Agriculture, Forestry and Fisheries Research Center Forest Technology Center, Akita, Japan

B15 OCCURRENCE, BEHAVIOR, FATE, AND HEALTH IMPACT OF AIRBORNE MICROPLASTICS (AMPS) (4): CHARACTERISTICS OF AMPS IN CLOUD, SNOW, AND AEROSOL AT THE SUMMIT OF MT. FUJI IN THE FREE TROPOSPHERE

HIROSHI OKOCHI[1], Yize Wang[1], Yuto Tani[1], Yosuke Onozuka[1], Hiroshi Hayami[1], Yasuhiro Niida[2]

[1]Waseda University, Shinjuku, Tokyo, Japan. [2]PerkinElmer Japan, Yokohama, Kanagawa, Japan

B16 TRACE METALS IN FOGS: WHAT HAVE WE LEARNED OVER THE YEARS?

Pierre Herckes, Aurelie Marcotte, Denise Napolitano, Youliang Wang, Thuong Cao

Arizona State University, Tempe, AZ, USA

B17 SPATIAL VARIATION IN FOG CHEMISTRY ALONG AN ARID GRADIENT IN THE ATACAMA DESERT

Constanza Vargas[1,2,3], Fernando D Alfaro[4], Vicente Espinoza[1,2,3], Diego Rivera[1,2,3], Pablo Osses[1,2,3], Klaus Keim[1,2,3], Nicolas Valdivia[1,2,3], Camilo del Rio[1,2,3]

[1]Pontificia Universidad Católica de Chile, Santiago, Chile. [2]Instituto de Geografía UC, Santiago, Chile. [3]Centro UC Desierto de Atacama, Santiago, Chile. [4]Universidad Mayor, Santiago, Chile

B18 FOGWATER ORGANIC MATERIAL AT A WESTERN NORTH PACIFIC TERRESTRIAL BACKGROUND SITE

Stephen M Griffith[1], Bettina Breuer[2], Minh Tri Truong[3], Ying-Chieh Chen[3], Shantanu Kumar Pani[3], Chang-Feng Ou-Yang[3], Sheng-Hsiang Wang[3], Chung-Te Lee[4], Ying I Tsai[5], Otto Klemm[2], Neng-Huei Lin[3,6]

[1]Department of Atmospheric Sciences, National Taiwan University, Taipei, Taiwan. [2]Climatology Research Group, University of Muenster, Muenster, Germany. [3]Department of Atmospheric Sciences, National Central University, Taoyuan, Taiwan. [4]Graduate Institute of Environmental Engineering, National Central University, Taoyuan, Taiwan. [5]Department of Environmental Engineering and Science, Chia Nan University of Pharmacy and Science, Tainan, Taiwan. [6]Center for Environmental Monitoring and Technology, National Central University, Taoyuan, Taiwan

B22 EFFECTS OF pH, EXPOSURE TO LIGHT AND HYDROXYL (OH) RADICALS ON LIVE BACTERIA UNDER CLOUD-LIKE CONDITIONS: INSIGHTS INTO THE PRODUCTION AND TRANSFORMATION OF BIOLOGICAL AND ORGANIC MATTER IN CLOUD WATER

Theodora Nah[1,2,3], Yushuo Liu[1,2], Chee Kent Lim[1], Zhiyong Shen[1], Patrick K.H. Lee[1,3]

[1]School of Energy and Environment, City University of Hong Kong, Hong Kong SAR, China. [2]City University of Hong Kong Shenzhen Research Institute, Shenzhen, China. [3]State Key Laboratory of Marine Pollution, City University of Hong Kong, Hong Kong SAR, China

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B23 ANALYTICAL PROCEDURE FOR THE CONCOMITANT ANALYSIS OF 242 POLAR AND NON-POLAR ORGANIC COMPOUNDS OF DIFFERENT FUNCTIONAL GROUPS IN FOG WATER

Dani KHOURY[1,2], Yasmine JABALY[2], Olivier DELHOMME[3,1], Maurice MILLET[1]

[1]University of Strasbourg-ICPEES (UMR 7515 CNRS), Strasbourg, France. [2]University of Balamand, Tripoli, Lebanon. [3]University of Lorraine, Metz, France

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B24 STANDARDIZATION OF THE ANALYTICAL PROCESS FOR CLOUD WATER CHEMICAL ANALYSIS WITHIN ACTRIS - RESULTS FROM A PILOT INTERCOMPARISON CAMPAIGN

Uwe Käfer[1], Dominik van Pinxteren[1], Elke Ludewig[2], Anne Kasper-Giebl[3], Laurent Deguillaume[4], Paul Zieger[5], Hartmut Herrmann[1]

[1]Leibniz Institute for Tropospheric Research (TROPOS), Atmospheric Chemistry Department (ACD), 04318 Leipzig, Germany. [2]GeoSphere Austria, Sonnblick Observatory, 5020 Salzburg, Austria. [3]TU Wien, Institute of Chemical Technologies and Analytics, 1060 Vienna, Austria. [4]CNRS, SIGMA Clermont, Institut de Chimie de Clermont-Ferrand, Université Clermont Auvergne, F-63000 Clermont-Ferrand, France. [5]Stockholm University, Department of Environmental Science, Stockholm, Sweden

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B26 APPROACH TO GROWTH PROCESS OF CLOUD DROPLETS BY QUANTITATIVE DETERMINATION OF SULFATE IN SINGLE RAINDROPS

Ben Nanzai[1], Masaki Shirakura[2]

[1]Shizuoka Institute of Science and Technology, Fukuroi, Shizuoka, Japan. [2]Shizuoka Institute of Science and Technology, Fukuroi, Japan

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B27 ANALYSIS OF TRENDS OF WET DEPOSITION AND BACKWARD TRAJECTORIES IN SOUTHEAST ASIA.

SNEHAL SURENDRA PUJARI, Hiroshi Hayami

WASEDA UNIVERSITY, SHINJUKU, TOKYO, Japan

B28 CLOUD MICROPHYSICS AND CHEMISTRY CHARACTERIZATION FROM ULTRALIGHT AIRCRAFT FLIGHTS IN ARDÈCHE-FRANCE

Jim Grisillon[1], Sylvain Ravier[1], Amandine Durand[1], Anne Monod[1], Daniele Zannoni[2], Harald Sodemann[2], Patrick Chazette[3], Guy Febvre[4], Christophe Gourbeyre[4], Jean-Luc Jaffrezo[5], Rhabira Elazzouzi[5], Christophe Berthod[6]

[1]Laboratoire de Chimie de l’Environnement (LCE), UMR 7376, Aix-Marseille Université, Marseille, France. [2]Geophysical Institute, University of Bergen and Bjerknes Centre for Climate Research, Bergen, Norway. [3]Laboratoire des Sciences du Climat et de l’Environnement (LSCE), UMR 8212, Université Paris-Saclay, Gif sur Yvettes, France. [4]Laboratoire de Météorologie Physique (LaMP), UMR 6016, Université Clermont Auvergne (UCA), Clermont-Ferrand, France. [5]Institut des Géosciences de l’Environnement (IGE), UMR 5001, Université Grenoble Alpes, Saint Martin d'Hères, France. [6]Division Technique UAR 855, INSU CNRS, Meudon, France

B29 FOG BOUNDARY-LAYER FEATURES AND THEIR RELATIONSHIPS WITH AIR POLLUTION BASED ON UNMANNED AERIAL VEHICLS CASES IN LIANYUNGANG, CHIAN

Shujie Yuan[1], Ruolan Liu[1,2], Duanyang Liu[2], Fan Zu[2], Hong Wu[2], Ruixiang Liu[2,3]

[1]Chengdu University of Information Technology, Chengdu, China. [2]Nanjing Joint Institute for Atmospheric Sciences, Nanjing, China. [3]Lianyungang Meteorological Bureau of Jiangsu Province, Lianyungang, China

B31 HOW DIFFERENCES IN ALTITUDE CAN HAVE INFLUENCE ON FOG COLLECTION: A CASE STUDY IN THE WESTERN MEDITERRANEAN BASIN

David Corell, María J. Estrela

University of Valencia, Valencia, Spain

B32 PHYSICOCHEMICAL CHARACTERISTICS OF FOG IN AN AGRICULTURAL CITY IN EASTERN CHINA

Haopeng Wu[1], Shengjie Niu[1,2]

[1]Nanjing University of Information Science and Technology, Nanjing, Jiangsu, China. [2]Nanjing Tech University, Nanjing, Jiangsu, China

B33 RADIATION FOG EVOLUTION FROM THIN TO THICK PHASE: EVIDENCE FROM WIFEX OBSERVATIONS

Narendra Gokul Dhangar, Avinash N. Parde, Sachin D. Ghude

Indian Institute of Tropical Meteorology, Pune, Maharashtra, India

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B35 THE FOG ISOTOPIC VARIATIONS IN GOBABEB, NAMIBIA BETWEEN 2014 AND 2020

Yue Li[1], Lixin Wang[1], Carlynn Joe Diersing[1], Gillian Maggs-Kölling[2], Eugene Marais[2]

[1]Indiana University-Purdue University Indianapolis, Indianapolis, Indiana, USA. [2]Gobabeb Namib Research Institute, Walvis Bay, Namibia

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B36 THE POTENTIAL STORAGE EFFECTS ON THE ISOTOPIC COMPOSITIONS OF FOG AND DEW WATERS

Carlynn J Diersing[1], Yue Li[1], Gillian Maggs-Kölling[2], Eugene Marais[2], Lixin Wang[1]

[1]Department of Earth Sciences, Indiana University-Purdue University Indianapolis (IUPUI), Indianapolis, IN, USA. [2]Gobabeb – Namib Research Institute, Walvis Bay, Namibia

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B37 NAMIB FOG AND LOW CLOUD LIFE CYCLES AND THEIR INTERACTION WITH BIOMASS BURNING AEROSOLS

Hendrik Andersen, Alexandre Mass, Jan Cermak

Karlsruhe Institute of Technology, Karlsruhe, Germany

B38 NET PRECIPITATION IN A CANARIAN FOG LAUREL FOREST: RESULTS FROM A THIRTY- YEAR MONITORING PERIOD

Luis A. Gómez-González[1], Ángel B. Fernández-López[2]

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B41 ENHANCED WATER AND LIGHT-USE EFFICIENCY UNDER SUMMER COASTAL FOG IN A CALIFORNIA AGRICULTURAL SYSTEM

Sara A Baguskas[1], Andrew J Oliphant[1], Rachel E.S. Clemesha[2], Michael E Loik[3]

[1]San Francisco State University, San Francisco, CA, USA. [2]Institution of Oceanography, University of California-San Diego, La Jolla, CA, USA. [3]University of California Santa Cruz, Santa Cruz, CA, USA

B42 MODELING CLOUD WATER INTERCEPTION FOR HAWAII USING CLOUD LIQUID WATER CONTENT, WIND SPEED, CANOPY HEIGHT, AND LEAF AREA INDEX

Han Tseng[1], Thomas Giambelluca[1,2]

[1]Water Resources Research Center, University of Hawaiʻi at Mānoa, Honolulu, Hawaii, USA. [2]Geography and Environment Department, Water Resources Research Center, University of Hawaiʻi at Mānoa, Honolulu, Hawaii, USA

B43 PHOTOSYNTHETIC GAS EXCHANGE OF BROADLEAF TREES ON CLOUDY AND FOGGY DAYS

Yongjiang Zhang

University of Maine, Orono, ME, USA

B45 ARE ALL DESERTS ALIKE? WATER VAPOR ADSORPTION IN THE NAMIB AND NEGEV DESERTS

Nurit Agam[1], Dilia Kool[2]

[1]Blaustein institutes for Desert Research, Ben-Gurion University of the Negev, Midreshet Ben Gurion, Israel. [2]Department of Environmental, Geoinformatic and Urban Planning Sciences, Ben-Gurion University of the Negev, Beer-Sheva, Israel

B47 OASIS SPATIAL RESPONSES TO ATMOSPHERIC WATER INPUTS IN THE ATACAMA DESERT USING A HYBRID MODEL BASED ON RADAR AND SOLAR DOMAIN SATELLITE IMAGES

Diego E. Rivera[1,2], Camilo del Río[1], Fernando D. Alfaro[3], Felipe Lobos-Roco[1], Constanza Vargas[1], Francisco Abarca[1]

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B48 FOG TYPES FREQUENCY AND THEIR WATER POTENTIAL IN THE COASTAL ATACAMA DESERT

Klaus Keim Vera[1,2], Felipe Lobos Roco[1,2]

[1]Instituto de Geografía, Pontificia Universidad Católica de Chile, Santiago, Chile. [2]Centro UC Desierto de Atacama, Santiago, Chile

B49 SATELLITE OBSERVED POSITIVE IMPACTS OF FOG ON VEGETATION AND FOG RETRIEVAL USING CALIPSO LIDAR OBSERVATIONS

Na Qiao[1], Lixin Wang[1], Eugene Marais[2], Gillian Maggs-Kölling[2], Feng Li[3]

[1]Department of Earth Sciences, Indiana University-Purdue University Indianapolis (IUPUI), Indianapolis, IN, USA. [2]Gobabeb – Namib Research Institute, Walvis Bay, Namibia. [3]Department of Computer and Information Science, Indiana University-Purdue University Indianapolis (IUPUI), Indianapolis, IN, USA

B50 DETECTION OF DAWN SEA FOG/LOW STRATUS USING GEOSTATIONARY SATELLITE IMAGERY

LI YI

Ocean University of China, qingdao, shandong, China

B51 DETERMINANTS OF FOG AND LOW STRATUS OCCURRENCE AND LIFE CYCLE OVER CENTRAL EUROPE

Eva Pauli, Jan Cermak, Hendrik Andersen

Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

B52 ON THE PHYSICAL CAUSES AND POTENTIAL IMPLICATIONS OF SATELLITE-BASED FALSE-DETECTIONS IN NOCTURNAL MARITIME LOW CLOUDS AND FOG

Jesse D Turner[1], Steven D Miller[1,2], Yoo-Jeong Noh[2], Bill Line[3,2]

[1]Colorado State University, Fort Collins, CO, USA. [2]Cooperative Institute for Research in the Atmosphere (CIRA), Fort Collins, CO, USA. [3]NOAA, Denver/Boulder, CO, USA

B53 HIGH-RESOLUTION SATELLITE-BASED CLOUD DETECTION FOR THE ANALYSIS OF LAND SURFACE EFFECTS ON BOUNDARY LAYER CLOUDS

Julia Fuchs[1], Hendrik Andersen[1], Jan Cermak[1], Eva Pauli[1], Rob Roebeling[2]

[1]Karlsruhe Institute of Technology, Karlsruhe, Germany. [2]European Organisation for the Exploitation of Meteorological Satellites, Darmstadt, Germany

B54 MACHINE-LEARNING ALGORITHM FOR 24H DETECTION OF FOG AND LOW STRATUS OVER EUROPE BASED ON METEOSAT-SEVIRI INFRARED BANDS

Babak Jahani[1,2], Julia Fuchs[1,2], Jan Cermak[1,2], Marina Zara[1,2]

[1]Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research (IMK), Karlsruhe, Germany. [2]Karlsruhe Institute of Technology (KIT), Institute of Photogrammetry and Remote Sensing (IPF), Karlsruhe, Germany

B55 ESTIMATING UNCERTAINTY FOR FOG DETECTION AND VISIBILITY ESTIMATION USING SATELLITE OBSERVATIONS

Prasad J Deshpande[1], Shivam Tripathi[1], Arnab Bhattacharya[2]

[1]Dept. of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, Uttar Pradesh, India. [2]Dept. of Computer Science and Engineering, Indian Institute of Technology Kanpur, Kanpur, Uttar Pradesh, India

B56 SPATIOTEMPORAL DISTRIBUTIONS OF CLOUD COVER IN TAIWAN

Yen-Jen Lai

1. Experimental Forest, College of Bio-Resources and Agriculture, National Taiwan University, Zhushan, Taiwan

B57 GROUND TRUTHING OF MODIS GA V6 SATELLITE FOG DATA WITH STANDARD FOG COLLECTORS ALONG THE CENTRAL CALIFORNIA COAST

Michelle Cone, Daniel M Fernandez

California State University, Monterey Bay, Seaside, CA, USA

Session 10 - Fog Modeling + Human Dimensions of Fog

16:00 - 17:00 Thursday, 27th July, 2023
CSU Lory Student Center Ballroom C+D

Presentation type Oral
Session Chairs Laura Lisbon, Lixin Wang

16:00 - 16:15

10A POINTWISE MACHINE LEARNING BASED RADIATION FOG FORECAST WITH STATION DATA IN GERMANY

Michaela Vorndran, Adrian Schütz, Jörg Bendix, Boris Thies

University of Marburg, Marburg, Germany

16:15 - 16:30

10B ARTIFICIAL INTELLIGENCE ANALYSIS OF MARINE FOG VISIBILITY USING ATLANTIC CONDOR SHIP MEASUREMENTS FROM FATIMA

Eren Gultepe[1], Sen Wang[2], Harindra J. S. Fernando[3], ismail Gultepe[4], Byron Blomquist[5]

[1]Southern Illinois University, Edwardsville, IL, USA. [2]University of Notre Dame, South Bend, IN, USA. [3]University of Notre Dame University, South Bend, IN, USA. [4]Ontario Technical University, Oshawa, Ontario, Canada. [5]NOAA, Boulder, CO, USA

16:30 - 16:45

10D THE SOCIO-POLITICAL DIMENSIONS OF FOG. AN ETHNOGRAPHY OF FOG CATCHERS IN PEÑA BLANCA, NORTHERN CHILE

Viola Di Tullio

IUSS, Pavia, Italy. LUISS, Roma, Italy

16:45 - 17:00

10E PARALLELS OF FOG HARVESTING AND PAINTING (OR, TRACING FOG THROUGH ATOMIZING PAINT)

Laura N. Lisbon

The Ohio State University, Columbus, OH, USA

Conference Banquet

18:30 - 21:30 Thursday, 27th July, 2023
CSU Canvas Stadium 4th Floor Stadium Club

Join us for dinner and live Bluegrass music from the Hummin'Birds. Ticket (included with conference registration; extra tickets can be purchased in advance for guests) required for entry.

Featured Presentation D - Fog Life Cycles from a Satellite Perspective

09:00 - 09:30 Friday, 28th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Otto Klemm

09:00 - 09:30

Feature D FOG LIFE CYCLES FROM THE SATELLITE PERSPECTIVE: RECENT PROGRESS AND COMING CHALLENGES

Jan Cermak, Hendrik Andersen, Julia Fuchs, Babak Jahani, Alexandre Mass, Eva Pauli, Jutta Vüllers, Marina Zara

Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Session 11 - Remote Sensing of Fog and Low Clouds

09:30 - 10:15 Friday, 28th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Li Yi, Michelle Cone

09:30 - 09:45

11A A DATA-DRIVEN APPROACH TO EXPLOIT SPATIAL AND SPECTRAL STRUCTURES IN GEOSTATIONARY SATELLITE DATA FOR REMOTE SENSING OF FOG TESTED FOR THE ATACAMA DESERT

Christoph Böhm, Jan Schween, Simon Matthias May, Dwaipayan Chatterjee, Ulrich Löhnert, Susanne Crewell

University of Cologne, Cologne, Germany

09:45 - 10:00

11B GENERATION OF A HARMONIZED TIME SERIES CROSS-CALIBRATING TWO METEOSAT GENERATIONS TO GENERATE A LONG TERM FOG TIME SERIES FOR EUROPE

Sheetabh Gaurav, Boris Thies, Sebastian Egli, Jörg Bendix

Laboratory of Climatology and Remote Sensing, Faculty of Geography, University of Marburg, Marburg, Hesse, Germany

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10:00 - 10:15

11C Fog-low stratus (FLS) occurrence under increasing Amazon drought conditions supports the formation of climate change refugia in concave

Jörg Bendix[1], Marius Pohl[1], Boris Thies[1], Maaike Bader[1], Lukas Lehnert[2]

[1]University of Marburg, Department of Geography, Marburg, Germany. [2]University of Munich (LMU), Department of Geography, Munich, Germany

Refreshment Break

10:15 - 10:45 Friday, 28th July, 2023
CSU Lory Student Center Ballroom C+D

Session 12 - The Physics of Warm and Cold Fogs

10:45 - 12:00 Friday, 28th July, 2023
CSU Lory Student Center Ballroom C+D
Presentation type Oral
Session Chairs Zheqi Chen, Maroua Fathalli

8C EFFECTS OF SYNOPTIC FORCING ON FORMATION OF MARINE FOG AT SABLE ISLAND, NOVA SCOTIA DURING JULY 2019.

Darko Koračin[1,2], Clive E Dorman[3]

[1]Desert Research Institute, UNV, Reno, NV, USA. [2]University of Split, Split, Croatia. [3]Scripps Institution of Oceanography, UCSD, La Jolla, CA, USA

12B SOME RESULTS FROM THE SOUTH WEST FOGS 3D EXPERIMENT FOR PROCESSES STUDY (SOFOG3D) PROJECT

Frédéric Burnet[1], Christine Lac[1], Pauline Martinet[1], Martial Haeffelin[2], Julien Delanoë[3], Jeremy Price[4], Salomé Antoine[1], Alistair Bell[1], Théophane Costabloz[1], Maroua Fathalli[1], Marie Taufour[1], Guillaume Thomas[1]

[1]CNRM, Université de Toulouse, Météo-France, CNRS, Toulouse, France. [2]IPSL/LMD - Ecole Polytechnique, Palaiseau, France. [3]LATMOS/IPSL/UVSQ, Guyancourt, France. [4]Met Office, Exeter, United Kingdom

12C FOG MICROPHYSICAL PROPERTIES AND EXPERIMENTAL STUDY OF THIN TO THICK FOG TRANSITION DURING THE SOFOG3D CAMPAIGN.

Théophane Costabloz, Frédéric Burnet, Christine Lac, Pauline Martinet

CNRM, Université de Toulouse, Méteo France, CNRS, Toulouse, France

12D RELATING FOG DROPLET SIZES TO SOURCES IN ATLANTIC CANADA

Rachel Y Chang[1], Joelle Dionne[1], Baban Nagare[1], Gianina Giacosa Massa[1], Cameron Power[2], Aldona Wiacek[2], Cora J Young[3], Wanmin Gong[4], Leyla Salehpoor[3], Trevor C VandenBoer[3], Ed Creegan[5], Harindra Joseph S Fernando[6]

[1]Dalhousie University, Halifax, Nova Scotia, Canada. [2]St. Mary's University, Halifax, Nova Scotia, Canada. [3]York University, Toronto, Ontario, Canada. [4]Environment and Climate Change Canada, Toronto, Ontario, Canada. [5]US Army Research Laboratory, White Sands Missile Range, New Mexico, USA. [6]University of Notre Dame, South Bend, Indiana, USA

12E FOG FORMED BY STRATUS LOWERING: OBSERVATIONAL AND MODELING OF TWO CASE STUDIES

Maroua Fathalli, Christine Lac, Frédéric Burnet, Pauline Martinet

CNRM, Université de Toulouse, Méteo France, CNRS, Toulouse, France

Conference closing session

12:00 - 12:45 Friday, 28th July, 2023
CSU Lory Student Center Ballroom C+D
Session Chairs Jeff Collett

IFDA Board Meeting (lunch provided)

13:00 - 15:00 Friday, 28th July, 2023
CSU Lory Student Center Room 322

ABSTRACTS

Feature A

ALLEVIATING THE PRESSURE ON THE CONVENTIONAL WATER SUPPLY NETWORK IN URBAN AREAS THROUGH BUILDING-INTEGRATED FOG COLLECTORS (BFC)

Nathalie Verbrugghe, Ahmed Z. Khan

Building, Architecture and Town Planning Department (BATir), Université Libre de Bruxelles (ULB), Brussels, Belgium

Abstract

Water stress is a rising concern in rapidly expanding cities and is predicted to exacerbate by 2050. Climate change is imposing nations to implement mitigation and adaptation strategies to achieve sustainable development. Population growth along with the decreasing availability of fresh water puts pressure on the conventional supply network and severely affects the urban metabolism in terms of economy and environment. It is therefore urgent to explore alternative freshwater sources. Atmospheric moisture is a viable resource, and through a simple design comprising a mesh that intercepts droplets, this already serves as an alternative for various rural communities living in fog-prone, (semi-)arid regions. However, the integration of fog collectors in a metropolitan context remains highly unexplored, highlighting the need for investigation. As a field of research, fog harvesting is multidisciplinary addressing several United Nations (UN) Sustainable Development Goals (SDGs) such as SDG 9, industry innovation and infrastructure, and SDG 11, sustainable cities and communities, but specifically SDG 6, clean water and sanitation. This study explores and proposes a conceptual building-integrated prototype that collects water from humid air to deal with existing water shortages in built-up areas. This is particularly important for vulnerable metropolitan regions where the water distribution infrastructure is inaccessible or in poor conditions because of inadequate regulations by local governments. However, urban fog collectors can also serve to avoid potential drought spells, to augment urban regeneration, and to alter the population's attitude in terms of water management. This research is twofold, first, design parameters are identified through a systematic literature review of existing fog collecting mechanisms and a brief elaboration on rainwater collection systems in urban areas and second, a building-integrated fog collector or BFC is developed through Research by Design (RbD). This methodology enables the assessment of the most efficient prototypes through altering the design in conjunction with estimating the water yield by using the results from Small Fog Collector projects from Chile, Morocco and Nepal. The result is a conceptually functioning fog harvester integrated into the existing roof structure delivering water passively. To conclude, this is theoretically implemented in a fog-prone area of the Chilean city Alto Hospicio to evaluate the collector's aesthetic value. This research is confined to theoretically analysing and quantifying the prototype's water harvesting potential to provide a framework and ultimately facilitate further advancements. Future research in an urban area, both theoretically and experimentally by using physical prototypes, as well as an assessment of the fog water quality are the subsequent steps to advance the development of this sustainable technology. Lastly, important to convey is that it is beneficial for countries where fog is feasible to integrate atmospheric moisture as a national water policy to alleviate the stress on overexploited freshwater resources.

Feature B

LONG-TERM FOG VARIATION AND ITS IMPACT FACTORS OVER EAST CHINA

Shuqi Yan[1,2], Bin Zhu[2], Tong Zhu[3], Chune Shi[4], Duanyang Liu[1], Hanqing Kang[2], Wen Lu[2], Chunsong Lu[2]

[1]Key Laboratory of Transportation Meteorology of China Meteorological Administration, Nanjing Joint Institute for Atmospheric Sciences, Nanjing, Jiangsu, China. [2]Nanjing University of Information Science and Technology, Nanjing, Jiangsu, China. [3]IMSG at NOAA, NESDIS/STAR, 5830 University Research Ct., Maryland, Maryland, USA. [4]Key Laboratory of Atmospheric Sciences and Satellite Remote Sensing of Anhui Province, Anhui Institute of Meteorological Sciences, Hefei, Anhui, China

Abstract

Fog is a kind of hazardous low-visibility weather phenomenon. Its long-term variation includes two aspects, fog frequency (fog days) and fog lifetime (fog duration). Previous studies have demonstrated that long-term fog variation over East China is controlled by three impact factors, climate change, urbanization and aerosols. In this work, we aims to quantitatively separate the contributions of three factors to fog variation by observation and numerical simulations.

The long-term variation of fog days over three major city clusters of East China are revealed by ground meteorological observation data from 1960 to 2012. Fog days increase first and then decrease, with the turning point occurring at 1980~1990s. The turning point occurs 5~15 years earlier in large cities than in small cities. Furthermore, the respective contributions of climate change, urbanization and aerosols are quantitatively calculated. During the initial urban development stage (1960-1985), the increase in fog days is dominantly contributed by the promoting effects of increasing aerosols (45~85%). During the fast urban development stage (1986-2012), the promoting effect of aerosols weakens, while the inhibiting effect of urbanization strengthens and becomes the dominant factor (53~60%). During the overall period (1960-2012), the contribution of urbanization and aerosols is at least 1.6 times higher than that of climate change.

The trend of fog duration is analyzed by using manually-recorded weather phenomenon data from 1960 to 2010. More than 90% of stations witness an increase in fog duration and the delay in fog dissipation time. By comparing background and non-background stations, we find that the increase in fog duration is caused by the increase in aerosol pollution. The promoting effect of aerosols is contributed by aerosol-radiation interaction (ARI; also aerosol direct effect) and aerosol-cloud interaction (ACI; also aerosol indirect effect). Moreover, the separate effects of ARI and ACI on fog lifetime are quantitatively revealed by WRF-Chem simulations on a fog event. ACI advances fog formation, delays fog dissipation and increases fog duration by about one hour. In contrast, ARI effect is quite weak, which increases fog duration only by 3 min. It is because that the more but smaller fog droplets produced under polluted conditions can inhibit sedimentation and favors fog maintenance. In addition, fog droplets have a much stronger extinction ability than unactivated aerosols, which can block substantial solar radiation and lead to delayed dissipation. Further experiments show that ACI effect on fog duration overweighs ARI effect under different moisture and pollution conditions.

From above, we can infer the future fog change in urban regions of China. Supposing that urban areas keep expanding and air quality keeps deteriorating, fog frequency will decrease but fog duration will increase. Effectively emission control be taken to shorten fog duration and reduce the hazards of fog weather.

Feature C

WIFEX: WALK INTO THE WARM FOG OVER INDO GANGETIC PLAIN REGION

Sachin Ghude[1], R. K. Jenamani[2], Rachana Kulkarni[3], Sandeep Wagh[1], Narendra G. Dhangar[1], Avinash N. Parde[1], Prodip Acharja[1], Prasanna Lonkar[1], Gaurav Govardhan[1], Prafull Yadav[1], Akash Vispute[1], Sreyashi Debnath[1]

et al

[1]Indian Institute of Tropical Meteorology, Pune, India. [2]India Meteorological Department, Delhi, India. [3]University of Pune, Pune, India

Abstract

The presence of persistent heavy fog in northern India during winter creates hazardous situations for transportation systems and disrupts the lives of about 400 million people. The meteorological factors responsible for its genesis and predictability are not yet completely understood in this region. Given its high potential for socio-economic impact, there is a pressing need for extensive research that understands the inherently complex nature of the phenomena through field observations and modeling exercises. WiFEX is a first-of-its-kind multi-institutional initiative dealing with intensive ground-based measurement campaigns for developing a suitable fog forecasting capability under the aegis of the smart cities mission of India. Between the 2015–2020 winters, measurement campaigns were conducted at the Indira Gandhi International Airport, New Delhi, covering more than 90 dense fog events. The field experiments involved extensive suites of in-situ instruments and gathered simultaneous observations of micro-meteorological conditions, radiative fluxes, turbulence, droplet/aerosols microphysics, aerosol optical properties, fog water-chemistry, and vertical thermodynamical structure to describe the environmental stability in which fog develops. An operational modeling framework, the WRF model, was set up to provide fog predictions during the measurement campaign. These field observations helped to interpret the strengths and deficiencies in the numerical modeling framework. Four scientific objectives were pursued: (a) life cycle of optically thin and thick fog, (b) microphysical properties in the polluted boundary layer, (c) fog water chemistry, gas/aerosol partitioning during fog life-cycle, and (d) numerical prediction of fog. This paper presents an overview of WiFEX and a synthesis of selected observational and modeling analyses/findings related to the above mentioned scientific topics.

Feature D

FOG LIFE CYCLES FROM THE SATELLITE PERSPECTIVE: RECENT PROGRESS AND COMING CHALLENGES

Jan Cermak, Hendrik Andersen, Julia Fuchs, Babak Jahani, Alexandre Mass, Eva Pauli, Jutta Vüllers, Marina Zara

Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Abstract

This contribution presents recent progress in understanding temporal and spatial patterns of coastal and continental fog based on satellite observations. Fog is a spatial phenomenon with distinct temporal dynamics. This life cycle (i.e. the onset, persistence and dissipation of fog), directly determines the impact of fog on human systems (e.g. traffic), and natural systems (e.g. arid-region vegetation). In turn, the life cycle is determined by meteorological conditions and properties of the land surface. In the following, progress is presented on the continual and consistent monitoring of fog across the day/night transition as a basis for further analysis, the evaluation of formation and dissipation patterns in Europe and Namibia, and the quantitative analysis of meteorological and land-surface impacts on fog life cycles.

To fully understand the life cycles of fog situations, spatially and temporally continual observations are needed. With distinct daytime and nighttime algorithms, geostationary satellite products were not usable for this purpose. A 24-hour technique has been introduced for the Namib-region fog that makes use of infrared channels only, together with structural features of the observed surfaces. This proved unsuitable for more varied terrain, as found e.g. in Europe. Instead, a machine learning-based technique has been developed there, also based on infrared information only, and thus applicable 24 hours a day. Validation against in-situ measurements shows a performance superior to the previous standard threshold-based daytime approach. In addition, a high-resolution fog product has been specifically developed for daytime use in and around cities, where fog is likely to be impacted by the urban heat and pollution islands.

On the basis of satellite fog products, logistic regression has been used to identify the timing of fog formation and fog dissipation at each location covered in the satellite view, for both Europe and the Namib region. The patterns found reveal distinct spatial regimes of fog life cycles that can be linked to terrain features as well as meteorological factors in both regions. In Namibia, position relative to the coastline is also important.

With products on the distribution and timing of fog occurrence available, a quantitative analysis of the factors driving the life cycles has become possible. In Namibia, coastal and large-scale atmospheric dynamics have been found to dominate fog occurrence both spatially and temporally, as quantified using statistical modeling. In Europe, meteorological controls are also prevalent, but land surface has been shown to modulate this effect markedly in a machine-learning approach. This is likely related to water cycle modifications as well as the release of condensation nuclei.

The insights gained in these analyses are currently being put to use in a range of applications: A technique for the short-term forecasting (nowcasting) of fog dissipation is under development with partners from the energy sector to improve photovoltaics forecasts. Process studies will be enhanced by ground-based remote sensing observations at the new Karlsruhe Low-Cloud Exploratory Platform (KLOCX) facility. And finally, insights into the processes driving the fog life cycle together with climate-model output will enable us to project future changes in fog.

1A

AVIATION ACCIDENTS WITH FOG INVOLVED: KOBE BRYANT

Michael R. Witiw[1], Steve LaDochy[2]

[1]Certified Consulting Meteorologist, Sammamish, WA, USA. [2]California State University at Los Angeles, Los Angeles, CA, USA

Abstract

On January 26, 2020, at 0945 Pacific Standard Time (PST) a helicopter carrying Kobe Bryant, a retired National Basketball Association star, crashed killing all nine abord. The crash occurred at an altitude of 1100 feet above mean sea level in coastal mountains near Calabasas, California. Widespread fog was reported in the vicinity of the accident. Although fog does not cause accidents, it is often a contributing factor. The greatest aviation accident in history- the Pan Am- KLM catastrophe that took place on Tenerife in the Canary Islands occurred under foggy conditions on March 27, 1977. With 583 fatalities, it remains the single deadliest aviation accident ever. On January 18, 2023, a helicopter crash occurred east of the city of Kyiv in foggy conditions. There were 14 fatalities. These are just a few examples of the thousands of aviation accidents chronicled in the National Transportation Safety Board's database. We will examine these accidents with a focus on the Kobe Bryant crash on January 26, 2020, and the weather conditions that led up to the accident. There were several reporting stations close to the accident location, as well as satellite imagery, radar data, and a 1200 UTC (0400 PST) atmospheric sounding. A broader look at the impacts of fog in the region on transportation and the frequency of accidents both on the ground and in the air will be investigated. Climate change influences on fog frequencies appear to favor less dense fog in the coastal area, however the Kobe Bryant accident points to the need for aviators to be aware of, and educated to, the hazard that fog presents.

1B

CLIMATOLOGICAL ASPECTS OF THE OCCURRENCE OF FOG OVER 13 AIRPORTS IN ARGENTINA USING HOURLY METAR AND SYNOP DATA

Melina Sol Yabra[1,2,3], Ramón de Elía[2], Luciano Vidal[2], Matilde Nicolini[4,1,5]

[1]Departamento de Ciencias de la Atmósfera y los Océanos (UBA-FCEN-DCAO), Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Buenos Aires, C.A.B.A., Argentina. [2]Servicio Meteorológico Nacional, Buenos Aires, C.A.B.A., Argentina. [3]Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Buenos Aires, C.A.B.A., Argentina. [4]Centro de Investigaciones del Mar y la Atmósfera (CIMA)de Buenos Aires, Buenos Aires, C.A.B.A., Argentina. [5]Instituto Franco Argentino Sobre Estudios de Clima y Sus Impactos (UMI-IFAECI/CNRS-CONICET-UBA), Buenos Aires, C.A.B.A., Argentina

Abstract

Fog plays a critical role in the aviation industry, as reduced visibility can close airports, delay operations, and increase costs. The first objective of this work is to present a climatological characterization of fog over Argentinian airports having different geographical environments. For the 20-year period from 2000 to 2019, hourly METARs from 13 airports are used. Consideration was given to annual and diurnal cycles, prevailing wind direction and intensity, consistency concerning Landing Instrument System (ILS) settings, number of days with fog, and number of days for which alternate airports for the most common flight plans are simultaneously affected by fog. These results place some of the busiest local airports among the most affected in the world, with fog frequencies higher than those of the New York region, the coasts of Portugal, southeastern Australia, and the west coast of the United States, among others.

The lack of robustness and completeness of the METAR database at some airports led the authors to use SYNOP data as an alternative. Although obtaining identical values was not expected, due to subtle and not-so-subtle differences in definitions, some of the variables are in fact not comparable. The most problematic category is "present weather", which uses a different coding scheme in each of the messages and does not allow a one-to-one transformation or "translation" between the codes. The use of "present weather" precludes convergence between METAR and SYNOP fog climatology. The difference found between the METAR and SYNOP observations and their respective fog climatologies suggests that the values obtained should not be taken in a strictly quantitative way. The comparison between these two types of weather reports also highlights the importance of defining the nature of the study in terms of purely meteorological or aeronautical issues. The description of complex phenomena in a few simple subjective categories, although helpful in many respects, needs to be translated into robust, representative statistics of the phenomena.

1C

BETTER REPRESENTATION OF ACTIVATION IN FOG USING UK MET OFFICE UNIFIED MODEL

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Abstract

Fog, like all low clouds, can be affected by aerosol concentrations. Aerosol-cloud interactions are responsible for significant uncertainties in future climate change projections. Fog is not an extreme weather condition, but it is associated with low visibility. It causes disruptions and losses to transportation, especially the aviation industry. Aerosols play an important role in the formation and lifetime of fog. Activation of fog droplets depends on the availability of aerosols, their size distributions, and chemical characteristics. Hence, it is important to accurately represent aerosols and their interaction with fog in the numerical weather prediction models.

In this work, we use the UK Met Office Unified Model to simulate fog over the Instrumented Site for Atmospheric Remote Sensing Research (SIRTA) observatory near Paris during November 2011. Observations from the measurements at the SIRTA observatory are used to evaluate the model performance. Temperature and relative humidity near the surface are accurately reproduced. The aerosol number concentration is also in good agreement with the observations. However, the default simulation over-predicts the fog droplet concentrations during most of the fog events.

We increased the sedimentation rate at the bottom most model level to represent interception of fog by trees and buildings. We have suppressed activation by updrafts in temperature inversions to account for entrainment of warm air. We have also added radiative cooling as a source of supersaturation, in the model. Some models have a lower threshold of updraft velocity as a kind of proxy for radiative cooling and sometimes also sub-grid turbulence. However, we found that radiative cooling rate varies with time during the fog life-cycle and hence using a proxy fixed cooling rate is not ideal. Significant improvement in the model performance was observed with the new parameterization.

The droplet concentration in the UM with CASIM microphysics is prognostic, and depends on the supersaturation at all previous times during the evolution of the fog (the ‘history’). In practice, this means the droplet concentration is determined by the highest updraft speed since the time of formation of the fog. We performed sensitivity studies to examine the impact of this history. We have modified the model activation scheme to adjust to higher supersaturations over a certain number of timesteps, by using a linearly decaying memory of 10 minutes. With this tuning also, we get a decent agreement of droplet concentration with the observation.

Radiative cooling was found to be extremely important in simulating fog lifecycle. However, contribution from adiabatic cooling was also significant on some days. Future work involves a closer examination of the scale dependence of the aerosol activation scheme.

2A

FOG MONITORING NETWORK ALONG THE CENTRAL AND NORTHERN CHILEAN COAST: ANTHROPIC, CLIMATIC AND ECOLOGICAL IMPLICATIONS

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Abstract

The study of fog in Chile is vast. This research has been historically developed at the coast of the Atacama Desert. Here, fog presence is frequent, making it a major feature of the local climate, providing humidity and atmospheric water to this arid environment supporting highly endemic ecosystems. Such studies have contributed to describe fog climatology, its interactions with ecosystems and fog water potential resources. However, research on the distribution and variability of fog and its water potential has been discontinuous in time and space and from different methodological approaches. Thus, we still have a limited comprehensive understanding of the fog along the Atacama for the same period of time, under the same synoptic or regional conditions and with comparable technologies. Furthermore, beyond the Atacama Desert boundaries the study of fog has been very scarce, limiting our understanding of fog water supply in regions that are recently affected by a severe drought, like central Chile. We expand our network from 4 to 20 fog monitoring stations. Each monitoring station is composed of meteorological stations that measure radiation, temperature, relative humidity, wind speed and direction, and fog water yields (by SFCs). This extended network covers from hyperarid environments (18°S) to Mediterranean ones (32°S). The stations are located along the Coastal Cordillera at representative sites with diverse ecosystems. The in-situ measurements are complemented with GOES satellite time series of fog and low cloud data for the period 1995-2022. Our preliminary results show variations in the seasonal cycles of fog, with picks of fog presence in winter and spring (austral) seasons in the extreme north of the network (18° - 23°S), and transiting to maxima in spring and summer in central Chile (30°-32°S). Likewise, stations located to the north of 25° S show a higher seasonal variability than those located to the south of such latitude. This is reflected in the fact that the stations to the north present marked seasons of high and low fog presence, in relation to those located to the south which are more regular. The collected fog water shows a similar seasonal pattern, but with significant variations in volumes influenced by local geographic factors. For example, the highest fog water yields annual average occurs in Alto Patache (20°S) and El Boldo (32°S) with 7 and 4.4 L/m2/day respectively. Conversely, the lowest fog water yield is measured at La Chimba station (23°S) with 0.15 L/m2/day. Fog water yields allow us to understand the relevance of fog water for each ecosystem, contextualizing its dependence on other atmospheric water inputs (precipitation and dew). The network of fog monitoring stations contributes bringing in-situ observations that will allow us to a better understanding of fog latitudinal variations, as well as the regional and local factors that produce it. This knowledge is presented as a key component to understanding the changes in fog under climate change, its implications for the environment, and the necessity to generate conservation strategies for the ecosystems it supports

2B

NEOTROPICAL MONTANE CLOUD FORESTS AND CLIMATE CHANGE

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Abstract

For a 2019 study, we mapped the extent of Neotropical montane cloud forest and páramo ecological zones with climate maps and climate station data and a simple model. We estimated metrics for cloud immersion empirically, from sea-level relative humidity, relative humidity and mountain sizes. We assumed that the presence of cloud forests, as indicated in the literature, implied the presence of persistent fog and mist. We present methods and results from that study and a potential approach for expanding this study beyond the Neotropical realm.

2C

LONG-TERM MONITORING OF COASTAL FOG AND BETTER UTILIZATION IN THE JIZAN REGION, SAUDI ARABIA

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Abstract

The phenomenon of fog occurs in many regions of the world and varies from place to place. Saudi Arabia occupies almost 80% of the area of the Arabian Peninsula. The current climate has seen a 30% increase in temperature and a 20% decrease in precipitation over the period from 1979 to 2019. Saudi Arabia needs to use water from alternative sources. Fog and dew can be used for this purpose.

In this study, the occurrence of fog in the Jizan region of Saudi Arabia (SA) was analyzed. The methodology is based on remote sensing (RS) retrievals, geographic information systems (GIS), and statistical approaches. The Jizan region is located in the southeast of SA, near the border with Yemen and is wide open to the Red Sea in the south. The Jizan region has an average elevation of 550 m, with the highest mountains Jabal Dukhaum (2,630 m), Jabal Idgis (2,160 m), and Jabal Zalma (1,258 m). The probability of fog formation is high, especially at altitudes above 2,000 m and in coastal regions. The results of remote sensing and analysis from GIS show that the number of foggy days is not uniform and can be divided into three major groups. The group I is between (1991-2003), the group II is between (2004-2015), and the group III is between (2016-2022).

The area of Saudi Arabia is located in arid and semi-arid regions, and the use of drinking water from this region can be of great importance. It is estimated that an annual average of 8×10^{13} liters (80 km^3) of freshwater from the fog could be used for drinking purposes and partly for agriculture. This amount of water fluctuates over time. Results suggested that average days with fog was about 24 days in the period of observation (1992-2012 year) and covered area of 1755.5 km^2 with a maximum 30 L per month per m^2. It is concluded that fog water collection can be used for operational applications in the rural regions.

Key words. Saudi Arabia, Jizan region, Remote Sensing, Geographical Information Systems, fog, utilization of fog.

2D

BIOMIMICKING NATURE FOR EFFECTIVE FOG WATER AND ENERGY HARVESTING WITH ELECTROSPUN POLYMER FIBERS

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Abstract

Many effective water harvesting methods are inspired by nature, and this is the case also for large and nanoscale meshes. One of the methods to produce polymer fibers and meshes at the nanoscale is electrospinning. This method gives many opportunities to create composite fibers by selecting co-axial or side-by-side nozzles or meshes by using two nozzles at the same time or in the layer-by-layer approach. Eventually, various strategies were applied to create electrospun fibers with the desired mechanical and surface properties, such as surface potential, roughness, and wettability by combing hydrophobic and hydrophilic polymers for fog water collectors and energy harvesting.

Nanoscale materials are able to enhance the perforce of many designed systems in water harvesting by incorporating them in fog water collectors. It gives the highest chances to capture smaller droplets present in the typical fog by increasing the shade coefficient in the meshes and also attracting water by implanting the hydrophilic properties and positively charged surface.

We developed electrospun polymer fibers, which successfully imitate many fascinating natural materials, for instance, spider webs. Highly porous fibrous meshes were obtained from hydrophobic and hydrophilic polymers. Randomly oriented and aligned fibers with an average diameter from 150 nm to a few microns were analyzed in terms of their surface and bulk properties, including water collection rate. Electrospun fibers can also be integrated into existing collectors, such as Raschel mesh. We showed how fiber morphology and wetting properties could increase the fog collection rate. Additionally, electrospun fibers have tunable surface potential that can be controlled by applying positive and negative voltage polarities during electrospinning. The surface charges of electrospun fibers are able to attract water droplets but also generate triboelectric energy. The effectiveness and perspective of using electrospun polymer fibers as fog water collectors are analyzed, indicating the best water collection approaches based on electrospun polymer fibers.

Acknowledgments

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3A

PERSPECTIVES OF FOG WATER AS COMPLIMENTARY SUPPLY SOURCE FOR THE FUTURE.COASTAL ATACAMA DESERT, CHILE

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Abstract

The use of fog water as a complementary water source has been widely demonstrated. Several research and practical approaches reinforce that fact. But there is a question remaining, why is it not full of fog collectors everywhere. We propose to analyze the perspective of fog harvesting as a complementary water resource for local communities. We state that fog harvesting can diversify the water sources as photovoltaic energy has revolutionized the energy ones.

This work considers two main approaches:

1. To model how much water the local geographical conditions can produce considering topography, climatology, plus data from a network of 5 Standard Fog Collectors (SFCs) connected each one with a dedicated meteorological station. In addition, GOES satellite images were used to model the spatial and temporal distribution of fog presence. As last, an assumption of technology of 9 Large Fog Collector (LFCs) installed in a standard but efficient manner over every hectare of surface previously classified as suitable for fog water production.

2. In the social side, resident population was identified under census 2017 data and considered under the criteria of the Sustainable Development Objectives (SDO) number #6 in water safety, two thresholds based in WHO, 50 and 100 liters person day was considered as a minimum volume reasonable to be satisfied. Is relevant to don´t forget we are in a rural area of a developing country in the driest desert on earth. With this data a network of water needs was configured.

As results, fog water production and social water requirements were contrasted with the aim of understand if the estimated water from fog combined with the considered LFCs technology, can support totally or partially the basic water needs of the resident population, or even more, there is water remaining to improve their quality of life or start thinking in new uses of the key resource.

3B

INTER-COMPARISON OF COMMERCIAL MESHES BASED ON FOG HARVESTING EFFICIENCY THROUGH LAB TEST CAMPAIGNS

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Abstract

Fog harvesting is a procedure to extract water from atmospheric moist air. It is an ancient technique, but in the last century, a specific device named Fog Water Collector (FWC) has been introduced. It is composed of a mesh and a supporting structure, which may vary in shape and dimensions. Usually, fog harvesting projects imply the use of the Raschel mesh. The concern these days focuses on a major water collection by improving the fog collector. Regarding the mesh efficiency, in literature, experiments carried out under laboratory conditions, mainly focus on coating applications on the Raschel mesh. Nevertheless, the aim of this paper is to explore, through laboratory tests, the performance of some alternative meshes and to identify those with the highest efficiency. The meshes have been selected based on thickness, material, pore geometry, pore scale, and filament shape, those meshes are available on the market and used in different fields, like agriculture, industry, and building. This paper explores the possibility of increasing the mesh efficiency, with respect to the application of the traditional Raschel mesh, by analyzing the features that characterize a mesh. After an analysis of the state of the art of fog harvesting laboratory experiments, two different methods have been developed to further assess the reliability of the findings. Based on the results, the investigated meshes could be divided into two groups: the two-dimensional and the three-dimensional meshes, being the last ones the most performative.

3C

SPEED AND VOLUME MEASUREMENTS OF DROPLETS SLIDING ON VERTICAL FIBERS

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Abstract

Water is a major issue of this century. In situations where water is scarce, Nature surprises us with the diversity of solutions it implements. In particular, spider silks and cactus spines inspired scientists for developing solutions like cloud nets.

In our study, we investigate the dynamics of gravity driven droplets sliding along fiber bundles. This problem is more complex than it seems since the droplet is losing volume and speed as it goes down. With the help of an original setup, we solve this problem by tracking in real time droplet characteristics and dynamics. We observe that droplet speed and volume decay exponentially since the droplet leaves behind a thin liquid film that exerts a capillary force capable of stopping the droplet motion before it is completely consumed. Our findings also reveal that using bundle of fibers and thus creating grooves in between them enhances droplet speed while increasing liquid loss.

This research has important applications in the field of droplet collection as well as the development of new instruments. Indeed, this study shows that existing cloud nets can be improved at low cost by simply changing the structure and number of the used fibers.

3D

Capillary transport on spines, grooves, fibers and strips for water collection

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Abstract

As scarcity of water is expected to intensify with global warming, unconventional water sources such as advective fogs may become essential. In numerous arid regions, nets are used to harvest such water droplets. Of course, natural systems such as cactus spines or grooves on plant leaves are known to favor the capillary transport of droplets. Different experiments are presented in order to emphasize the role played by capillary transport in the complex process of water collection. Different synthetic model systems will be studied such as grooves, spines, fibers and strips. They will reveal some key geometrical elements for designing future efficient fog nets.

3E

MICRO-GROOVED PLASTIC FOIL ENHANCES DEW COLLECTION AND PREVENT AGING

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Abstract

Although thousands of papers have been devoted to date to micro-patterned surfaces in view of enhancing heat transfer and condensation, there is up to now no industrial use of these surfaces. These materials remain indeed mechanically fragile and submitted to aging effects by sun exposure, dust abrasion and unavoidable pollution (e.g. fatty acids). Microgrooves have recently been shown to efficiently collect condensed dew drops [1] by enhancing the growth of some droplets and their shedding by gravity. Droplets first condense on the plateaus, coalesce with the channels filled with condensed water and with other droplets connected with the same channels.

In this context, we present here a study of a micro-grooved foil surface which, in contrast with the same smooth surface, does not present aging effects even after 6 months of functioning in a harsh outdoor environment. Such micro-grooved foils are low cost and can be manufactured on a large scale. The foil is made of low density polyethylene, 0.3 mm thickness, in which microbeads of Ti02 and BaSO4 have been incorporated to increase the emissivity in the atmospheric window and reflect the sun light (OPUR foil [2,3]). A food-proof surfactant is also added. The surfactant is insoluble with water and migrates to the surface to promote rapid droplet shedding. The studied surfaces are squares of 9´9 cm2. Microgrooves, of 50 µm thickness and depth and separated by 50 µm width plateaus, are obtained by the techniques of hot embossing from a circular micro-grooved aluminum surface of 13 cm diameter. Hot embossing is a cheap and versatile technique that can be used on a larger scale if needed.

The study consisted in comparing a smooth and a micro-grooved foil. Both were set on a 30° tilted planar support oriented SW on a terrace, about 20 m elevation, in Paris (5th arrondissement). The overall test duration was 6 months, between 17/02/2022 and 17/08/2022. Outside temperatures were measured between 0.2°C and 39.7°C, with several heat waves. The wind speed was measured between 0 and 20.5 m/s, with several episodes of storm, of which one sandstorm.

The foils were periodically tested, initially before being positioned outside, then after one week, one month, three months and 6 months. The tests consisted in condensation and collection in a vertical position in a climatic chamber with air temperature 30°C and relative humidity 50, 60 or 70 %. The condensing surface was cooled at 16°C by a Peltier element. Water was collected at the bottom of the plate by a tissue placed at 0.1 mm from the surface and connected to a balance. Two parameters were deduced from the evolution of the collected mass, the time lag where the first drop reaches the tissue and the collection rate.

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4A

CHARACTERIZATION OF CHEMICAL COMPOSITION IN SIZE-RESOLVED MARINE AEROSOL DURING FOG FORMATION EVENTS OVER THE NORTHWEST ATLANTIC OCEAN DURING FATIMA 2022

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Abstract

Aerosols play an important role in regulating the Earth's energy balance and climate change by impacting radiative forcing (directly) and cloud condensation nuclei (indirectly). Fog formation results from radiative, thermodynamic, microphysical, dynamical, chemical, surface conditions, and meteorological interactions. Aerosols can promote fog formation as condensation nuclei when the relative humidity exceeds 100%. There is an intricate relationship between aerosol and fog characteristics; physico-chemical characteristics of aerosol change by the occurrence of fog, and aerosol properties directly impact the life cycle of a fog layer. Aerosol-fog interaction is an essential process in understanding and forecasting fog formation events. Previous studies have focused on aerosol-fog interaction on land, with fewer studies in the marine environment. Sea fog can be hazardous by reducing visibility, which causes disturbance in aviation and marine transportation. Therefore, sea fog study is critical in understanding fog formation, development, and dissipation to enable accurate forecasting and improve safe marine activities and transportation. During the Fog and Turbulence Interactions in the Marine Atmosphere (FaTIMA) project, we explored the initiation and persistence of marine fog events. The current study aimed to determine the chemical composition of aerosols during fog and non-fog episodes to better understand how aerosol chemistry affects fog formation. Size-resolved aerosol samples were collected with a Micro Orifice Uniform Deposit Impactor (16 fog samples) and a nano Micro Orifice Uniform Deposit Impactor (13 non-fog samples) on the Atlantic Condor research cruise in the northwest Atlantic Ocean off the coast of Eastern Canada from July 3 to August 1, 2022. Major water-soluble cations and anions, $DEAH^+$+$TMAH^+$ (diethylamine + trimethylamine), and MSA^- (methane sulfonic acid) were analyzed in aerosols by ion chromatography coupled to a conductivity detector. In the coarse mode, the dominant ions were Na^+ and Cl^- in both fog and non-fog periods, with similar contributions as expected for sea salt. In some fog events, the concentration of sea salt ions like Na^+, Mg^{2+}, and Cl^- from the coarse mode increased before the fog formation and then decreased over the fog; this suggests that sea salt aerosols may act as the fog condensation nuclei. In the fine mode, Na^+ was the dominant cation in non-fog samples; however, NH_4^+ was the main cation during fog events, and nss-SO_4^{2-} was the most abundant anion in both fog and non-fog aerosols. An increased sum of total concentration (neq m^{-3}) of NH_4^+, $DEAH^+$+$TMAH^+$, MSA^-, and nss-SO_4^{2-} was observed in fine mode aerosols during the fog vs. non-fog periods. The average concentration of NH_4^+, $DEAH^+$+$TMAH^+$, MSA^-, and nss-SO_4^{2-} during fog events were 5.47 neq m^{-3}, 2.14 neq m^{-3}, 0.81 neq m^{-3}, and 8.51 neq m^{-3}, respectively, while during non-fog periods, they deceased to 2.84 neq m^{-3}, 0.76 neq m^{-3}, 0.17 neq m^{-3}, and 5.73 neq m^{-3}, respectively. The results indicate that the aerosol chemistry varied in the fine mode between fog and non-fog events, and this will be used to better understand how the chemical composition of size-resolved aerosol governs the presence and/or absence of fog as well as its lifetime.

4B

THE SCHMÜCKE CLOUD OBSERVATORY (SCO) AND THE CENTRE FOR CLOUD WATER CHEMISTRY (CCWaC) AS NEW FACILITIES IN THE EUROPEAN RESEARCH INFRASTRUCTURE 'ACTRIS'

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TROPOS, Leipzig, Germany

Abstract

The Aerosols, Clouds and Trace Gases Research Infrastructure ACTRIS is currently being implemented throughout Europe, with field observatories for long-term monitoring, exploratory platforms for process studies, and topical centers (TCs) for operational support and quality assurance.

Within the ACTRIS cloud in-situ (CIS) component, TROPOS is establishing the Schmücke Cloud Observatory (SCO) as a national facility (NF) for long-term cloud monitoring and research, as well as the Centre for Cloud Water Chemistry (CCWaC) as a CIS TC unit for defining guidelines, standard operation procedures and quality assurance measures to determine the chemical composition of cloud water within ACTRIS.

In this presentation, a brief history of Lagrange-type cloud experiments will first be given, highlighting some major findings from those and then introducing the SCO as a new and unique infrastructure for continuous Lagrange-type experiments.

The SCO is planned with a main site on the summit of Mount Schmücke in the Thuringian forest in Central Germany, where a measurement tower will be constructed to host a suite of continuous and discontinuous instrumentation, including aerosol chemical speciation monitors (ACSMs), a proton-transfer-reaction mass spectrometer (PTR-MS), mobility particle size spectrometers (MPSSs), aethalometers, trace gas monitors, cloud water collectors, filter samples, and others.

This in-cloud station will be complemented by two valley sites upwind and downwind of the Schmücke, close to the villages of Goldlauter and Gehlberg, respectively. They will be equipped with similar instrumentation as the main station to enable Lagrange-type cloud experiments and study changes of clouds, aerosols, and cloud processing of aerosols under a changing climate.

The SCO will be one of a several cloud observatories across Europe, where aerosol and cloud properties will be monitored within ACTRIS. At some of those, chemical analysis of cloud water composition will be performed on a regular basis. To establish common or comparable procedures for sampling, sample handling, and laboratory analysis across these sites, the CCWaC unit within the CIS TC has started to conduct intercomparison campaigns and will develop guidelines and QA/QC for cloud water chemical measurements. These activities will be outlined as well and first results be presented.

4C

CHEMICAL COMPOSITION OF FOG WATER COLLECTED AT FOUR SITES IN NORTH-AND MONT-LEBANON DURING 2021

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Abstract

The consistent occurrence of organic chemicals in fog water suggests that it is an excellent scavenger of organic chemicals from the atmosphere. Among the different pollutants that are scavenged by fog water are the pesticides, PAHs, PCBs, phenols and acids. Lebanon is mainly known for its dense valley fog during which the visibility is extremely low (<10 m). To my knowledge, to date, no research studies were carried out. For this reason, fog samples are collected from Akkar and Mont-Lebanon districts during 2021 (February to June) using the Caltech Active Strand Cloud Collector (CASCC). Overall, 14 fog samples are taken, 5 samples from Fnaideq (suburban site), 5 samples from Beit Younes (urban site), 1 sample from Qamouaa (rural site) and 4 samples from Bzomar (suburban site). Once collected, fog samples are filtered on a Borosilicate glass microfiber filter with a porosity of 0.45 micron and analyzed for their physical properties (pH, liquid water content and conductivity). Then their ionic composition (Cl^-,NO_3^-, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+} and Ca^{2+}) is analyzed using IC and their heavy metal composition (Pb, Hg, Mn, Zn, Cd, Al, Ni, Cu, As and Fe) is analyzed using ICP. Organics are extracted by LLE on the XTR Chromabond column, evaporated to 1 mL and derivatized with 50 µL of MtBSTFA. Their analysis is carried out using GC/MS, GC-MS/MS and LC-MS/MS.

The results show that the mean pH at Fnaideq, Qamouaa, Beit Younes and Bzomar is respectively 7.2 ± 0.3, 7.44, 7 ± 0.3 and 6.8 ± 0.3. Their mean LWC is respectively 0.0075, 0.022, 0.03 and 0.018 g/m^3. Their mean conductivity values are respectively 1322 ± 344, 324, 411 ± 305 and 932 ± 926 µS/cm. Their mean average TIC values are respectively 3106.9, 4112.2, 4972.4 and 5969.1 µEq/L. The main anion found in fog water at all sites is , while the two dominant cations are and . The contribution of to sea-salt is found to be negligible, whereas, the contribution of to sea salt is important. Moreover, the cations such as , and   highly neutralize the acidic constituents such as and .

Zn and Ni are the most abundant heavy metals at all sampling sites. Their average concentrations vary respectively in the range of 137.6–349.7 µg L^{-1} and 38.2–585.5 µg L^{-1}. The highest total metal concentration is found at Bzomar (1174.7 µg L^{-1}), followed by Fnaideq (802.6 µg L^{-1}), Qamouaa (343.31 µg L^{-1}) and Beit Younes (335.7 µg L^{-1}). The enrichment factors show that their source is a mixture between anthropogenic and crustal origins.

Moreover, the organic analysis presents some variabilities depending on the site. The highest concentrations are mainly found at the two suburban sites, Bzomar and Fnaideq. All sites are found to be contaminated by many organic compounds from all families. Their sources differ from one region to another depending on the site and meteorological conditions. 72-hr backward trajectories show that a part of the air masses passed over the Mediterranean Sea, while others originate from Turkey, Syria and Europe.

4D

FOG, DRIZZLE, AND MIST IN YOKOHAMA AND IN MT. OYAMA, JAPAN

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Abstract

My group had observed fog and other wet and dry deposition in Yokohama and in Mt. Oyama from 1988 to 2019. Fog water was collected with an active collector and passive collectors in Mt. Oyama. Fog water collected with an active collector had high acidity and high ion concentration, while the water collected with passive collectors had lower acidity and ion concentration than that collected with an active collector. The sample collected with passive collectors was identified to be not only fog water but also drizzle. The throughfall at the summit of Mt. Oyama had about the same components as the sample collected with passive collectors. The drizzle is important for the plant at high mountain, because precipitation of throughfall increases with the altitude and becomes much larger than that of rain mainly for the contribution of drizzle. The drizzle and fog contribute little to the vertical precipitation, but they contribute significantly to throughfall as the lateral precipitation for the efficient capacity of canopy to capture small droplets driven on the wind. In Yokohama, fog events rarely occurred but a passive fog collector often collected samples of drizzle. The samples in Yokohama had about the same components of those in Mt. Oyama, although the acidity of the samples in Mt Oyama was higher than that in Yokohama for the acid fog. In Yokohama, my group identified the characteristics of mist. Mist is formed on aerosol with small amount of water, and its pH is not low. Therefore, the order of liquid water content (LWC) is mist << fog < drizzle < rain, and the order of the ion concentration is the reverse of the order of LWC. However, the order of the acidity is much different from the order above and the acidity of fog is the highest. The reason may be the difference of the relative amount of aerosol components, gaseous components, and LWC. For fog, acid gas is readily dissolved in water phase and not too much diluted.

In the period of our observation, air pollution in Japan had been improved and severe acid fog events decreased. Forest decline in the Tanzawa Mountains including Mt. Oyama occurred, but the air pollution improvement will prevent the further declining of the forest damaged by severely acidic fog. Fog and drizzle are blessed water input to forest ecosystem, but trace amount contaminants are concentrated in small droplets such as fog and drizzle. Therefore, the investigation on these droplets remains important to preserve forest ecosystem.

4E

MICROORGANISIMS IN FOG AND THEIR ABILITY TO DRIVE FORMALDEHYDE CONCENTRATIONS

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Abstract

Research on conversion of organic compounds by microorganisms in atmospheric water (clouds and fog) has recently gained interest in the bioaerosol community. Most existing work has addressed remote environments (mainly Puy de Dôme, France) but few observations exist on bacteria and their biotransformation in the United States. In this study, we investigated paired fog and aerosol samples collected recurrently in Selinsgrove (Pennsylvania, USA) from June, 2021 to November, 2022. Using 16S rRNA gene sequencing, we found that the bacterial community of fogs differs consistently from that found in paired aerosol samples. Proteobacteria (Alpha-, and Beta-) dominated fog, while Alphaproteobacteria, Firmicutes, and Actinobacteria were abundant in aerosols. Fog DNA concentrations tended to increase with liquid water content (LWC), which contrasts with the opposite trend observed between ionic content and LWC. Additionally, formaldehyde biodegradation capacity by the fog microbiome was determined at 10°C in collected samples. We found that degradation rates of formaldehyde in fog are measurable. This study provides a better estimation of how active bacteria in fog contribute to the organic carbon transformation processes.

5A

ORGANIC CARBON IN CLOUD WATER: THE NEW CHEMICAL REGIME AT WHITEFACE MOUNTAIN

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Abstract

Whiteface Mountain (WFM) in the Adirondack Mountains in upstate New York is home to an historic cloud water monitoring site, with measurements at the site dating as far back as the 1970s. This site was largely founded to investigate the role of cloud droplets on the formation of SO_4^{2-}, the environmental impacts of acid deposition, and monitor the progress of the Clean Air Act Amendments of the 1990s. Work at sites like WFM discovered that sulfur dioxide (SO_2) can dissolve into cloud and fog droplets, oxidizing to form SO_4^{2-}. Considerable progress has been made in the United States related to the reduction of acid deposition, with steady decreases in SO_4^{2-} from 1994 to 2022. However, as SO_4^{2-} and to a lesser extent, nitrate (NO_3^-) have decreased in overall importance, other constituents are emerging in the chemical system. Organic carbon is ubiquitous throughout the atmosphere, existing in the gas, particle and aqueous phases. In many regions of the world, organic carbon is becoming the dominant constituent within aerosol. Research in the past two decades has revealed a significant role for aqueous chemistry in the processing of organic carbon in the atmosphere with fog and cloud droplets serving as chemical reactors, a process similar to SO_4^{2-} production. In particular, volatile but highly water-soluble organic gases such as glyoxal and methylglyoxal can dissolve into cloud and fog droplets and oxidize into less volatile compounds like oxalic acid, contributing to aerosol growth since they remain in condensed form when the droplets evaporate. As organic carbon becomes a more important fraction of the aerosol, further research, including in cloud and fog droplets, are required to properly constrain aerosol mass and composition.

In WFM cloud water, there has been a clear increase in total organic carbon concentrations (TOC) since measurements began in 2009, but the underlying causes remain unclear. Additionally, there is a growing inorganic cation/anion imbalance that correlates strongly with TOC, indicating a growing role of organic anions in the chemical system. To help constrain the TOC and the growing ion imbalance, a set of organic acids were added to suite of measurements including formic acid, acetic acid, oxalic acid, pyruvic acid, and glyoxylic acid. Similar to the increase in TOC, the underlying sources of the missing anions remain unclear. This work will investigate the growing role of TOC and the important chemistry impacting it, with an emphasis on organic acids. Statistical analysis will be used to investigate the trends in TOC and organic acids and how they relate to other ions in the system. Additionally, chemical modeling techniques in both the gas and aqueous phases will be discussed to show the major chemical pathways that impact organic acids, and how these results compare to observations.

5B

MODELING THE MULTIPHASE AEROSOL AND CLOUD CHEMISTRY OF ISOPRENE-RELATED ORGANIC HYDROXY HYDROPEROXIDES AND EPOXIDES WITH MCM/CAPRAM

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Abstract

Tropospheric gas-phase oxidation of isoprene under low NO_x conditions yields oxygenated organic hydroperoxides, ISOPOOHs and $ISOP(OOH)_2$, and epoxides (IEPOX) which can undergo phase transfer and then undergo chemical conversions in deliquesced particles and fog or clouds. Recent CAPRAM mechanism modules developments focused mainly on the multiphase chemistry of isoprene-related hydroperoxides. Subsequent model investigations were intended to study the multiphase chemistry of isoprene-related organic compounds focusing on their potential to act as oxidants sources (e.g. for aqueous OH) and aqSOA precursors. The developed ISOPOOH/$ISOP(OOH)_2$ module contains the gaseous $ISOP(OOH)_2$ formation, the phase transfer of organic hydroperoxides, their aqueous photolysis, thermal decomposition, S(IV) oxidation pathway and the OH oxidation as well as subsequent chemistry of ISOPOOH/ $ISOP(OOH)_2$ products mainly based on recent laboratory data. In the base mechanism, no Fenton-like reactions for ISOPOOH/$ISOP(OOH)_2$ are considered in the mechanism because of potentially uncertain reaction rate coefficients. But for sensitivity studies, recently published constants were tested. In the IEPOX scheme, the measured OH oxidation rates of IEPOX and its reaction products were included. In total, the developed ISOPOOH/$ISOPOOH_2$ reaction module contains 12 additional gas-phase and 142 aqueous-phase reactions as well as 20 phase transfer processes. The developed module has been finally coupled to the existing multiphase mechanism MCMv3.3.1/CAPRAM4.0. Subsequently, detailed SPACCIM process model studies were performed for remote non-permanent cloud scenarios investigating the chemistry under deliquesced particles and clouds conditions.

Model simulations showed that multiphase chemistry in clouds and, to some extent, under aerosol conditions can act as a potential sink for ISOPOOH and $ISOP(OOH)_2$. Moreover, the ISOPOOH and IEPOX chemistry can contribute to substantially aqSOA formation under remote continental conditions. The model runs revealed that the ISOPOOH chemistry can alter the gas-phase OVOC composition. Performed sensitivity studies demonstrate that the effect on the aqueous-phase HO_x strongly depends on the Fenton-like chemistry of ISOPOOH. Consequently, modelled aqSOA yield under remote conditions strongly depends on multiphase chemistry of isoprene oxidation products and the Fenton-like chemistry. The studies exhibit the need for more kinetic and mechanistic process knowledge to build more sophisticated mechanisms.

5C

CHARACTERIZATION OF CHEMICAL AND PHYSICAL CHANGES IN ATMOSPHERIC AEROSOLS DURING FOG PROCESSING AT BAENGNYEONG ISLAND, SOUTH KOREA

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Abstract

Fog acts as a processor of atmospheric aerosol particles and trace gases by aqueous oxidation of gas phase precursors, the interaction of aerosols with atmospheric water, and cleansing the atmosphere by scavenging and removing atmospheric particles. In addition to playing a central role in the hydrologic cycle and influencing atmospheric radiative transfer, clouds interact with various chemical species.

To understand the interaction of aerosol with fog better, we conducted a fog sampling campaign and physical and chemical measurements of aerosols at the Baengyeong Island Intensive Air Quality Monitoring Station, South Korea, from June 25th – July 21st, 2014, using a compact version of the Caltech Active Strand Cloudwater Collector known as the CASCC2 and a two-stage fog/cloud water collector that collects “small” and “large” drops. The chemical composition and physical properties of aerosol particles were characterized by a High Resolution Time of Flight Aerosol Mass Spectrometer (HR-ToF-AMS, Aerodyne), an Aerodynamic Particle Sizer (APS, TSI), and a Scanning Mobility Particle Sizer (SMPS, TSI).

To investigate wet scavenging by fog, aerosols were characterized by HR-ToF-AMS before, during, and after five fog events. Total non-refractory PM1 mass decreased by an average of 22.8% with the onset of fog. The scavenging efficiency (η) of organics was 7–34%, where lower η was associated with lower organic oxidation state and hygroscopicity. The variation in scavenging was size-dependent for both organics and nitrate. Both organic mass and the $SO_2^+/H_2SO_4^+$ ratio were used to indicate the prevalence of hydroxymethanesulfonate (HMS), an aqueous secondary organic aerosol (aqSOA) formation marker, which increased after the 7/18 fog episode. The aerosol carbon oxidation state decreased toward the end of all fog episodes suggesting possible molecular fragmentation and loss of highly oxidized functional groups. This study explores relatively rare time-resolved aerosol fog processing measurements. The presentation will provide an overview of the chemical composition of fog samples and examine changes in particle chemical composition and microphysics associated with fog processing in the boundary layer.

5D

OVERVIEW AND FIRST RESULTS OF THE FOG AND AEROSOL INTERACTION RESEARCH ITALY CAMPAIGN (FAIRARI) 2021/22

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Abstract

The Italian Po Valley is one of the most polluted regions in Europe. Under the influence of meteorologically stable conditions, clear skies, and high humidity, this often causes long-lasting and dense fog events. These wintertime events have been studied since the 1980s, showing that the frequency of fog events has decreased over time. However, the processes involved in the fog evolution are not yet fully understood. Therefore, Stockholm University's new mobile atmospheric laboratory, equipped with state-of-the-art atmospheric sampling techniques, was installed in San Pietro Capofiume for two months, measuring aerosol, fog droplets, and hydrometeors as part of the FAIRARI campaign (Fog and Aerosol InteRAction Research Italy 2021/22).

The two inlet system used (a whole-air inlet and a ground-based counterflow virtual impactor, CVI, inlet) allowed a comparison of the microphysical and chemical properties of the dried fog droplets (fog residuals measured behind the CVI inlet) with the dried total aerosol (measured behind the whole-air inlet). The dry size distribution (using two Differential Mobility Particle Sizers, DMPS) as well as the droplet activation (using two Cloud Condensation Nuclei Counters, CCNC) were measured behind both inlets simultaneously. In addition, the chemical properties of the fog residuals (using a Soot Particle Aerosol Mass Spectrometer, SP-AMS) and the absorption properties of the total aerosol (using a Multi-Angle Absorption Photometer, MAAP) were recorded. Aerosol molecular composition and trace gases were measured behind a whole-air inlet, using a proton-transfer reaction (VOCUS) and a chemical ionization mass spectrometer with filter inlet for gases and aerosols (FIGAERO-CIMS). On the roof of the mobile laboratory, aerosol and fog microphysical parameters (such as the fog droplet size distribution and the polarization ratio) and meteorological parameters were measured in parallel. Offline chemical analysis of the aerosol and fog water was done by analyzing filter samples.

During the main period of the campaign, 21 events with a visibility between 20 and 1000 m were measured, summing up to about 80 h of in-fog data with a mean visibility of 185 m. Here, we will present our experimental setup as well as first highlights of aerosol-fog interactions observed during the FAIRARI 2021/22 campaign.

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6A

THE IMPORTANCE OF FOG AND DEW IN DRYLAND DYNAMICS

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Abstract

Fog and dew are the least studied hydrological components in most ecosystems. There are growing interests to study the role of fog and dew in ecosystem dynamics particularly in water-limited systems. However, key knowledge gaps exist such as the mechanisms of fog and dew alleviating vegetation water stress, water sources of the fog and dew, and their quantitative contributions to ecosystem functions. In this study, using isotopes, remote sensing, and modeling techniques, we demonstrated the diverse sources of fog and dew in the Namib Desert. We also demonstrated the important role of fog on soil water dynamics during rainless periods. We also quantified the role fog/dew plays in vegetation water status from both ground observations and satellite observations. The results highlight the important but often neglected role of fog and dew in dryland ecosystem dynamics. The results indicate that to better predict the ecosystem responses to climate change, especially in drylands, a better understanding and quantification of fog and dew contributions is essential.

6B

IMPORTANCE OF DEW AND FOG AT MICROHABITATS FOR BIODIVERSITY AND FUNCTIONAL ECOLOGY OF NON-VASCULAR PLANTS

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Abstract

Microclimate and structural parameters of micro-habitats impact a variety of animals, plants and microbes -sometimes more than macro- conditions. Examples of micro-scale impacts are: microstructures of ground vegetation reducing soil evaporation, epiphylls and microbes infesting tree leafs and influencing forest productivity; or micro structures of plants trapping dew or fog and delivering considerable amount of water to animals and plants in xeric environments.

The presentation highlights the current discussion of connecting the micro- with the macro-level in the context of e.g. dew condensation at microstructures, phyllospheric islands and broader impacts of the micro-scaled organisms of non-vascular plants, such as cyanobacteria, algae, lichens and bryophytes. The focus is on novel patterns, functions and mechanisms which are based on micro-levels and cause biotic responses on the macro-level. The presentation covers topics from tropical biodiversity from the lowland cloud forest of French Guiana to arid ecosystem functioning in the xeric Atacama desert of Chile and will present up-scaling from cells to organisms, from species to communities and from microhabitats to landscapes.

6C

PRESENCE AND IMPORTANCE OF FOG IN FOREST ECOSYSTEMS OF A PROTECTED FOREST LOCATED IN THE ALPINE REGION

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Abstract

Recent studies in south Tyrol (Alpine region) confirmed that these ecosystems are influenced by convective clouds appearing over mountain peaks in the summer, and thermal inversions, leading to higher fog occurrence in valleys, in the winter. This is relevant because fog provides additional moisture to the ecosystem as well as influence other water components of the water balance like for example evaporation, transpiration and amount of throughfall.

It is known that there are high variations in cloudiness at small scales, therefore affecting the estimation of evaporation fluxes, which include large uncertainties, difficult to assess and interpret. The frequency of fog has been recently quantified by analyzing digital cameras but nothing is known about the amount of water being provided by fog to the ecosystem as throughfall or transpired during fog days. We present a first estimation of the water partition and balance of an alpine forest ecosystem.

6D

DRY DESERT SOILS AS A SINK FOR CO_2 - THE THUS-FAR NEGLECTED EFFECT OF NON-RAINFALL WATER INPUTS

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Abstract

The soil CO_2 efflux is primarily attributed to the metabolic activity of soil organisms and is the largest terrestrial source of CO_2 to the atmosphere. However, it is considered to be low to negligible during desiccation periods in desert soils. In the last two decades, studies across Earth's deserts have challenged this paradigm, reporting a diel trend of CO_2 exchange in dry periods, consisting of nocturnal CO_2 uptake and daytime efflux. Authors often explain this diel cycle by the increased dissolution of gaseous CO^2 in soil water, which decreases CO_2 concentration in the soil pores, forming an atmosphere-to-soil concentration gradient and CO_2 diffusion into the soil. In the morning, CO_2 is outgassed from water films, rapidly increasing CO_2 efflux. However, nocturnal CO_2 uptake occurs even in the driest soil conditions when no apparent water is available to drive the process, and hence, this explanation is controversial. We hypothesize that atmospheric water capture by the soil, i.e., non-rainfall water inputs, provides the water supply to drive nocturnal CO_2 uptake in dry, desert soils. To test our hypothesis, we conducted field measurements of concurrent water vapor adsorption and CO_2 fluxes in loess soil in the northern Negev Desert, Israel during the summer seasons of 2021 and 2022 . Nocturnal water vapor and CO_2 uptake occurred throughout the season with a mean daily peak of -0.15 mmol m^{-2} s^{-1} and -0.4 µmol m^{-2} s^{-1}, respectively, followed by a daytime efflux that peaked at a mean rate of 0.17 mmol m^{-2} s^{-1} and 0.7 µmol m^{-2} s^{-1}. The fluxes were coupled over the daily cycle, but the soil CO_2 flux lagged after the water vapor flux, resulting in a diel hysteresis relationship. This implies that atmospheric water adsorbed to the soil particles may serve as a solvent for soil CO^2, driving nocturnal uptake of atmospheric CO^2. After sunrise, water evaporates, followed by CO_2 outgassing. However, the daily CO^2 cycle was unbalanced, with a ney uptake of 0.12 g m^{-2}, implying that the soil in our study site acts as a small carbon sink. Considering that arid and semi-arid regions occupy 40% of Earth's terrestrial surface and that models predict a global decrease in soil moisture in many regions of the world, the effect of atmospheric water capture by desert soils on CO^2 exchange may have a significantly larger role in the global carbon balance albeit currently completely ignored.

6E

DOES THE TRUE ROSE OF JERICHO CAPTURE DEW? TRICHOMES AND PLANT ORIENTATION AS THERMAL AND STRUCTURAL MECHANISMS FOR DEW CAPTURING.

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Abstract

Water scarcity in desert environments shapes plants' characteristics, some of which develop strategies like utilizing non-rainfall water inputs (NRWIs) such as dew and fog. Unique physical properties that promote dew condensation can act to lower the leaf temperature by modifying the leaf orientation to maximize radiative cooling. Surface microstructures affecting the boundary layer conductance or radiative heat loss can also promote dew by reducing leaf temperatures. Properties can also be retention related, like capillary microstructures, roughness, and the surface's wettability. Plants trichomes can function as a thermal or structural property enhancing dew formation. Here we examine whether *Anastatica hierochuntica*, an annual desert extremophyte, obtains the ability to harvest dew, focusing on the role of trichomes and the leaves' orientation. Specifically, we aim to identify whether the trichomes' role is temperature-related or retention-related.

We planted 20 pots with *Anastatica hierochuntica* and removed the trichomes from half of them (hereafter referred to as hairy and non-hairy plants). 24-h campaigns were conducted, during which measurements were done every 2 hours. Changes in the pots water content were determined by monitoring their mass, thermal images of the plants were acquired to reveal spatial patterns of leaf surface cooling, and specific leaf water content was measured from sample leaves. In addition to the 24-h campaigns, measurements were conducted several times before sunset (minimum water content) and before sunrise (maximum water content).

Changes in water content in the pots deferred between the hairy and non-hairy plants only during the plants' active hours, while during the night, when transpiration is minimal, no differences were observed. This indicates that the trichomes affect the transpiration rate. The higher increase in specific leaf water content for the hairy plants indicates that the trichomes assist in either capturing or keeping the water in the leaf. These findings imply that *Anastatica hierochuntica* captures dew water, and that the trichomes affect water status, therefore providing a partial overview that will be completed with further investigation.

6F

INVISIBLE DEW FORMATION BY ATMOSPHERIC AEROSOLS AND ITS ROLE FOR NOCTURNAL TRANSPIRATION OF POPLARS

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Abstract

Major parts of anthropogenic and natural aerosols are hygroscopic and deliquesce at high humidity, particularly when depositing on leaf surfaces close to transpiring stomata. This condensation already starts at the deliquescence humidity of salts (e.g., 75% for NaCl) and this type of dew formation often remains invisible, with the minute amounts of liquid water having negligible hydrological relevance. However, they can be important for transport processes between the leaf surface and the neighboring compartments, i.e., the atmosphere (e.g., trace gas fluxes) and the interior of the leaf (e.g., foliar water uptake), respectively (Burkhardt, 2010). That is to say, invisible dew may significantly affect diverse physiological functions such as plant-water relations, nutrient uptake and transport (Burkhardt and Grantz, 2016; Chi *et al.*, 2022; Vega *et al.*, 2023). This study further investigates the connections between invisible dew and nocturnal transpiration, a broadly observed phenomenon of unclear functional relevance, by which non-CAM plants open stomata at night and lose water without carbon gain.

In a greenhouse ventilated with aerosol-free air, poplar seedlings (*Populus maxim. x nigra*) were grown in hydroponic solutions, which were either fully-nourished or with one nutrient deficient, respectively. After applying various solutions on leaf surfaces, the stomatal conductance was measured overnight, representing the behavior of nocturnal transpiration under the effects of invisible dew.

Nocturnal stomatal conductance of deficient poplar leaves only increased for those leaf surface solutions contained the nutrient which was missing in the root zone, suggesting that nocturnal stomatal conductance may be regulated by the corresponding nutrient availability on leaf surfaces. Our findings contribute to reveal the connections between nocturnal stomatal conductance and invisible dew, shedding light on possible interactions between aerosol deposition and the water and nutrient relations of plants.

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7A

SIMULATION OF AVAILABLE WATER CONTENT FROM FOG EVENTS IN THE COAST OF SEMI-ARID REGION OF CHILE AND ITS CONTRIBUTION IN MAINTAINING LOCAL VEGETATION

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Abstract

The permanent marine fog presence along the western coast of the semi-arid and mediterranean region of Chile shows a relationship with coastal vegetation patterns and seems to be a sub-estimated water input for basins water balance. Several studies suggest that marine fog inland transport on south-westerly winds are a major water source for the maintenance of coastal vegetation, and relict forests. Despite the importance of fog-inputs for coastal ecosystems dynamics, our knowledge is limited regarding fog temporal and spatial dynamics in the coastal landscape. Specifically, in how much water from the fog is being used by relict forests and what is the contribution of fog into the basins water balance. Therefore, the aim of this study is to analyze coastal fog in the coast of the semi-arid and mediterrenean region in Chile addressing the spatial and temporal distribution of its frequency, liquid water content and water collection. This study is centered in the border between the regions of Coquimbo and Valparaiso in Chile, with a special interest in a relict forest present uphill 3.5 km far from the coast with an altitude of 650 meters (lat: -32.2°/long: -71.5°). We focused on relict temperate forests (Valdivian forests) dominated by Aextoxicon punctatum and individuals that can reach up to 15 m. tall. These forests are surrounded by a semi-arid matrix and currently survive with less than 200 mm annual precipitation. Our methodological approach is a combination of a thermodynamic model and satellite imagery analysis that result in spatiotemporal simulations of fog to obtain the water content available from fog in the basin. For this study we gathered data from in-situ standard fog collectors, simple meteorological stations, and soil water content sensors at different depths. To complement observations, we use GOES-16 satellite images to characterize the spatial fog patterns and its relation with vegetation. Finally, we extrapolate the results of the thermodynamic model and satellite analysis into a digital elevation model to identify with precision the places where fog occurs in the study area. Our preliminary results show that fog presence is higher between the months of September to December, with collection values around 200 L m-2 monthly. Over the study catchment, modeling results show that fog is present from 300 m to 800 m in height. Moreover, our observations show that water infiltrates during fog events, evidencing the contribution of fog to plant roots. Our research contributes to quantifying the fog water supply for ecosystems and its role in the water balance of semi-arid basins. This novel knowledge will contribute to bringing precise information to stakeholders in water management matters in territories affected by droughts.

7B

FOG AND DEW AS CONTROLLING FORCES FOR THE BIOSPHERE-ATMOSPHERE INTERACTION IN THE ATACAMA DESERT – CONCEPT AND RESULTS OF AN INNOVATIVE MEASUREMENT AND OBSERVATION NETWORK IN NORTHERN CHILE

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Abstract

In the hyperarid part of the Atacama Coastal Desert in northern Chile, highly specialized fog ecosystems are widespread, which meet their water and nutrients requirements directly from atmospheric sources. The water requirements of the endemic Tillandsia landbeckii that predominate there are essentially covered by regularly occurring fog, which the plants absorb through their leaves. In addition, according to previous results, the dew also seems to be an additional, important source of water, especially in the summer months with low presence of fog. Due to the close dependence of these ecosystems on the availability of fog and dew, they act as a bioindicator of climate change as well as to analyze optimal locations for using the fog as a sustainable water source – in a region that averages only 1 mm of precipitation per year and the is suffering from increasing water shortages due to the growing, water-intensive mining of raw materials such as copper and lithium.

However, the distribution and intensity of the fog occurrences is spatially and temporally very variable and depends on various atmospheric factors and processes. In order to be able to systematically record and analyze both the characteristics of the foggy climate and the factors that control it at different scales, a regional climate measurement network has been set up and expanded step by step since 2014. It includes a total of 8 full-fledged climate stations in the investigation area, at which, in addition to classic parameters such as temperature, relative humidity, wind direction and wind speed, above all, fog water quantities are measured by standard fog collectors (SFC), 360-degree fog collector, dew, leaf moisture, etc. according to international standards and all corresponding data be saved for 10 minutes. The climate stations cover a gradient from 518 m about 2 km from the coast to 1,354 m about 11 km inland.

On an area of approx. 3 x 3 km in the core of the investigation area, in which fog ecosystems with Tillandsia landbeckii are widespread, fog measurements are also carried out at 15 locations on the basis of specially developed "Mini SFCs" (50 x 50 cm collection area) near the ground. At 7 of these stations, the fog water volume is measured in addition to water tanks with water level sensors with a time resolution of 10 minutes. In addition, a ground-based, visual observation system GOFOS (“Ground Oriented Fog Observation System”) was developed, which is used to analyze the spatial and vertical distribution of local fog occurrences – both during the day and at night (due to light sources).

On the one hand, the talk will present the concept and implementation of the extensive regional climate and fog measurement and observation network in the study area. In addition, the first results of the spatial and temporal analysis especially based on the SFC, 360-degree fog and dew collector data, are presented, which can also be called up "live" via a specially set up Internet platform.

7C

FOG OCCURENCE AND FOG DEPOSITION: A NEW APPROACH TO ESTIMATE THE SPATIO-TEMPORAL OCCURRENCE OF FOG AND THE AMOUNT OF FOG DEPOSITION

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Abstract

The presented method aims to determine the presence or absence of fog (yes/no) and the liquid water content (mg/m^3) with high spatial and temporal resolution. By utilizing a digital elevation model and hourly (or 10-minute) temperature and humidity data, the method is capable of accurately determining the fog and liquid water content at a resolution of 100 meters and one hour or 10 minutes, respectively. The results of the liquid water content and fog deposition are then validated using measured data.

In addition to the determination of the liquid water content, the method also takes into consideration the impact of vegetation on fog deposition through the use of vegetation data and Katata's deposition velocity model. This enhances the accuracy of the results, allowing for a more comprehensive understanding of the fog and liquid water content.

The methods, results, and an outlook for the improvement of the model and its operational use are presented for a 70-year period in Germany. The results indicate that the method is effective in determining the presence and density of fog, as well as the amount of liquid water content in the atmosphere. The outlook for the future improvement of the model highlights the potential for further refinement and optimization, leading to even more accurate and reliable results.

In conclusion, the presented method is a valuable tool for the study of fog and liquid water content, providing a high level of resolution and accuracy. The methods, results, and outlook for improvement offer valuable insights into the potential for operational use of the model, making it a valuable resource for those interested in atmospheric studies.

7D

PROJECT FOR A DEW CONDENSATION STANDARD

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Abstract

In contrast to evaporation, there is up to now no internationally recognized standard for dew condensation measurements. According to the countries and research groups, different measurement techniques and various surfaces are used, such as cloths, PTFE (Teflon), PMMA (plexiglass), dedicated foils (OPUR), nylon mesh (Hiltner balance), paint (Duvdedani plate) resistive or capacitive surfaces (leaf-wetness sensors), etc. These surfaces exhibit various emissivities and more important, have different sizes and are implemented under different conditions.

In order to define a dew standard measuring process, the different factors that controls dew formation must be identified. In addition to the characteristics of the surrounding humid air, should be considered (i) radiative cooling (substrate emissivity toward the sky), (ii) heat exchange with the supporting device and (iii) heat and mass exchange with air. Concerning point (i), although a high emissivity is desirable, the value is not so critical because the substrate is quickly wet and water emissivity soon dominates (0.96; 0.98 in the atmospheric window; see [1]). Point (ii) can be lowered by choosing a material with low thermal capacity and thermal conductivity. Point (iii) is more difficult to assess because the air flow along the surface changes the characteristics of the hydrodynamic, thermal and diffusive boundary layers.

When defining a standard, one has thus to ensure that the air flow along the condensing substrate is controlled at best. In order to be insensitive to the wind direction and avoid creating an obstacle in the air flow, the substrate has to be symmetrical and parallel to the wind, which leads to the design of a horizontal circular surface. Because a flat and uniform boundary layer cannot be obtained at the periphery of this substrate due to edge effects, the condensing surface must be surrounded by similar, larger circular surfaces (see [2]). In order to remove the influence of humidity and inhomogeneities of the ground, such a substrate should be placed at a certain height above the ground, e.g. 1 m, in an open area that ensures both uniform air flow and efficient radiative cooling.

In order to define the geometry of such a dew standard, 3D and 2D Computational Fluid Dynamics simulations for turbulent air flows have been carried out at different windspeeds ranging from 1 to 10 $m.s^{-1}$. Good results were obtained with a circular substrate of 357 mm diameter (0.1 m^2) at the upper surface of a circular box of 1 m diameter and 280 mm thickness with rounded edges of 70 mm radius.

Such a dew standard will continuously measure dew at the meteo station of the Ajaccio airport (Corsica island, France) by weighing, using an electronic balance having 0.1 g accuracy (10^{-4} mm). We expect having data to show by the conference time.

[1] Beysens, D., Trosseille, J., Mongruel, A. The emissivity of a condensing surface is dominated by water. (In this conference).

[2] Beysens, D. (2018). Dew Water. Rivers Publisher (Gistrup).

7E

WATER DYNAMICS IN DRY SOILS – USING RELATIVE HUMIDITY SENSORS TO MEASURE WATER VAPOR ADSORPTION IN DESERT SOILS

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Abstract

Atmospheric water, or non-rainfall water inputs (NRWIs) are a critical, albeit largely overlooked, component of the global hydrological cycle. Water vapor adsorption specifically, is not only the least studied form of NRWI but likely the most common one in arid areas.

Lysimeter measurements in the Negev desert during the summers of 2019-2022 indicate that water vapor adsorption in loess soil amounts to at least 33 mm when looked at cumulatively over the summer (0.3-0.5 mm night^{-1}): about ~30% of annual rainfall (116 mm). Given the challenges using lysimeter measurements, attempts to quantify NRWI amounts and duration have generally been limited to short time periods at point or local scales. Determining the true importance of NRWIs in arid and extremely arid environments, which comprise 20% of the terrestrial surface, requires new approaches to measure water content in the 0.5-5% range.

Using weighing lysimeters as a reference, we tested of-the-shelf temperature and relative humidity sensors to assess changes in water content with high temporal resolution over longer periods of time for sand and loess soils. Relative humidity was converted to water potential (Kelvin equation). The water content was then determined using a water retention curve measured with a vapor sorption analyzer. Results showed diurnal patterns in water content consistent with lysimeter measurements. Maximum increase in water content correlated well with lysimeter measured NRWIs. While not all issues are yet resolved, this direction opens possibilities to expand our measurement capacity over longer periods of time and increase the number of measurement locations at relatively low cost. This provides one step forward in trying to understand the magnitude of NRWIs in arid environments across the globe.

8A

ANALYSIS OF FOG DYNAMICS IN THE NAMIB DESERT AND IMPACTS ON NATURAL AND ARTIFICIAL FOG COLLECTION

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Abstract

Over the last years, several studies evidenced changes in fog occurrence timing and patterns in different areas of the world, including the Namib Desert. Here, advection fog moving from the Atlantic Ocean towards the South-West African coast, represents the main water input for local flora and fauna, contributing to offset the rather scarce and erratic rainwater inputs.

Some spatiotemporal characterizations of fog in the Namib Desert have been proposed mainly for climatological and meteorological purposes, but little is known about how these changes can affect the fog water quantity that can be naturally and artificially harvested in this area. Thus, the aim of this work is to analyse climate change's potential impact on fog collection in the Namib Desert.

We set up and statistically analysed an 8-year dataset of daily collected fog water amounts in 13 ground stations along Angola (n=1), Namibia (n=9), and South Africa's (n=3) coasts extracted from meteorological data collections made available by the Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL). In each study site, fog data were collected with cylindrical, aluminium fog collectors conveying water in a covered rain gauge.

Overall collected fog water rates are lower with respect to those recorded in other areas, moreover, considerable variability both interannual and intra-annual in fog water amounts was found in all sites. The relation between rainfall and fog was also very mutable, with fog water averages doubling rainwater ones in some stations or vice-versa and equalling in some other sites. Mean annual fog water ranged from 7.8 to 70.9mm at Garnet Koppie and Vandersterrberg stations. In Namibe station, the mean annual fog water amount compares to 20% of the yearly rainfall quantity, while in Vogelferderberg it is 229%.

High interannual variation was observed in all sites (average standard deviation 111mm), with the annual highest fog water quantity ranging from 156.1 to 1533.7mm and the minimum amount ranging from 0.3 to 338mm in Namibe and Vandersterrberg stations, respectively. Almost all the sites reported 2015-2016 as the years yielding more fog water and 2020-2021 yielding the lowest amounts, possibly due to El Niño Southern Oscillation's different phases. The results also show a significant intra-annual variability of collected fog water (average standard deviation 22.2mm); however, some similar seasonal patterns could be identified across the observed stations. Concerning temporal trends, 7-out-of-13 time series reported a $P<0.05$ level statistically significant decreasing trend (-2.21mm per year on average) in fog water yields. Furthermore, in three sites, topographical obstacles to fog flow such as higher mountains surrounding the stations were found, which limited the real quantification of fog collection potential there.

Despite the short data timespan available, results suggest that climatic changes such as increased temperatures are affecting fog formation, and therefore, the potential for fog water collection. Further analyses, possibly including remote sensing or reanalysis datasets aiming to increase the available data timespan, are envisioned to understand to what extent fog collection in the Namib Desert will be affected in future by climate change.

8B

MOUNTAIN CLOUD DYNAMICS DEPEND ON RECYCLED WATER VAPOR AND FOREST COVER

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Abstract

In many regions, prevailing winds generate upslope (orographic) clouds and fog on a near-daily basis, contributing unmeasured precipitation and suppressing evapotranspiration in the forest water budget. The role of forest cover in the hydrometeorology of these processes is not well understood. Theory and models suggest that regional deforestation can cause changes in cloud frequency and cloud formation altitude, but few studies have quantified the response of an orographic cloud system to land cover change. Our previous work in Puerto Rico established that orographic precipitation (including rain, drizzle, and cloud droplets deposited on vegetation) was a significant source of streamflow. We measured cloud immersion, temperature, relative humidity and rainfall within the Luquillo Experimental Forest in eastern Puerto Rico during a 4.5-year study period that included a severe drought and a category-4 hurricane impact. The hurricane resulted in major canopy loss (defoliation) that instantaneously decreased rainfall interception, shading, and transpiration. Cloud base height and frequency were measured at 2 sites near the coast with ceilometers, while cloud immersion, temperature and relative humidity were measured below canopy in the forest at 5 elevations from 617 to 1006 m. Cloud layer thickness and immersion frequency on the mountain slope correlated with antecedent rainfall, linking recycled terrestrial moisture to the formation of mountain clouds; and cloud base altitude rose during drought stress and post-hurricane defoliation, indicating the condition of the forest also played a role in orographic cloud generation. Temperature and water vapor anomalies along the mountain slope persisted for at least 12 months post-hurricane, while cloud base altitude returned to previous levels after about 10 weeks. Because changes in temperature, atmospheric moisture and orographic cloud condensation can be driven by land-cover change, it is important that these interactive processes are included in regional-scale land/atmosphere model predictions for water availability. Projected future increases in atmospheric warming, severe drought and wildfire have the potential to affect mountain precipitation in similar settings worldwide.

8C

EFFECTS OF SYNOPTIC FORCING ON FORMATION OF MARINE FOG AT SABLE ISLAND, NOVA SCOTIA DURING JULY 2019.

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Abstract

Sable Island, a low sand strip 20 km long, 1 km wide, and 180 km SE of Nova Scotia is representative of the open ocean marine fog conditions along Atlantic Canada with the benefit of a RAOB station and a 1st order surface observation station. A study of 2019 July found that the mean fog occurrence was 32 % and revealed that fog occurred in 16 events that were an extended low cloud base with low visibility and one or more fog events that were closely related to synoptic forcing. This study confirms the essential role of synoptic structure to fog here and not just from a favorable surface advection direction, which occurs most of the time. The bulk of the events were under cyclonic conditions and a minority were anticyclonic types. The cyclonic fog cases are observed during a rapid movement of frequent cyclones to the east across Canada and also along the coast. With these there is a strong perturbation of the marine layer and fog layers can form and extend several hundred meters aloft. Fog occurs west of the highest winds and unstable cloud conditions. An example is shown for 2019 July 13-14 which is an eastward moving coastal low. Less frequently occurring are a rapidly developing and eastward moving ridge along the Canadian coast. These increase the subsidence capping the moist marine layer, the reduction of its depth and fog formation. An anticyclonic case is shown for July 25-27.

8D

TRENDS OF FOG TREND RESEARCH

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Abstract

Temporal trends of the intensity and frequency of fog over the past tens of years have been studied at many sites worldwide. In most cases, observations are made with visibility meters. The vast majority of publications show decreases of fog, although regional specifics lead to opposite (increasing) trends in some cases. Most negative trends have been associated either with increasing temperature and the resulting increase of capacity of the air to contain water vapor, or with a decrease of air pollution, specifically the cloud condensation nuclei (CCN) concentration, which alters fog microphysics and increases the visibility.

A more detailed analysis of trends and their causes needs to refer to additional data such as the liquid water content (LWC) of fog, the absolute and relative humidity of the air mass, the fog droplet size distribution (DSD), the concentrations, chemical compositions and sizes of CCN. There is extremely limited data available for any of these parameters over longer time periods. For example, trend data of "ion loads", which are the masses of ions dissolved in fog water per volume of air, are rarely available.

This contribution will present examples of trend analyses that go beyond traditional evaluation of visibility. Specifically, ion load data will be presented, ion concentration ratios (e.g., sulfate / nitrate ratios). A specific view will be oriented at the activation status of fog droplets: We expect to see stronger dependency of fog trends on temperature and humidity whenever the CCN concentrations are high, because low-visibility events will occur also at relative humidity (rH) below 100 % and in presence of non-activated, yet deliquesced particles. On the other hand, whenever the aerosol and CCN concentrations are low, fog forms not before rH reaches 100 %, which likely favors a dependency of fog trends on rH and thus on temperature.

9A

HIGHLIGHTS OF 'FOG AND TURBULENCE IN THE MARINE ATMOSPHERE (FATIMA)' 2022 FIELD CAMPAIGN

Harindra Joseph Fernando[1], Edward Creegan[2], Clive Dorman[3], Sasa Gabersek[4], Ismail Gultepe[5], Luc Lenain[3], Eric Pardyjak[6], Qing Wang[7]

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Abstract

In a comprehensive field campaign conducted during 01-31 July 2022, the key drivers for the formation, maturation, and dissipation (i.e., lifecycle) of marine fog were studied, focusing particularly on the role of atmospheric turbulence. Momentum, temperature, humidity, and aerosol inhomogeneities of large-scale weather systems cascade down to the smallest (Kolmogorov) scale of atmospheric turbulence (~ 1mm), and the fog droplets form around hygroscopic aerosols of size ~ 100 nm embedded therein, physicochemical properties of which also play an important role. The dissipation of temperature inhomogeneities occur on the Obukhov-Kolmogorov scale, which is of the same order as the Kolmogorov scale. The massive Fatima field campaign was based on data from (i) an isolated narrow (1km x 40km) island – Sable Island - located in the North Atlantic Ocean south of Grand Banks and proximity to continental shelf break in a region where cold Labrador and warm Gulf Stream waters osculate, (ii) the research vessel R/V Atlantic Condor that traversed the area, which also deployed a suite of autonomous surface crafts, and (iii) Hibernia oil platform where a limited amount of instruments were deployed. The first two measurement platforms were instrumented in unprecedented proportions by dozens of investigators, with novel and conventional instruments that probed from ~ 1000 km synoptic to ~ 100 nm microphysical scales of the atmosphere, the upper ~ 250 m of ocean as well as air-sea fluxes. Novel instruments were developed to probe the smallest scales of turbulence. Concurrent studies included bio-chemo-physical properties of aerosol nuclei and their evolution. A brief overview of the Fatima-2022 field campaign as well as some salient results will be given in this presentation [funded by the Grant N00014-21-1-2296 of the Office of Naval Research, administered by the Marine Meteorology and Space Program]

9B

OBSERVATIONS OF THERMODYNAMIC PROFILES IN FOG AND FOG-AEROSOL INTERACTIONS

David D Turner[1], Heather Guy[2], Ian Brook[2], Chris Cox[3], Penny Rowe[4], Matt Shupe[3], Von Walden[5], Ryan Neely III[2]

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Abstract

Supercooled fogs can have an important radiative impact at the surface of the Greenland Ice Sheet, but they are difficult to detect and our understanding of the factors that control their lifetime and radiative properties is limited by a lack of observations. This study demonstrates that ground-based spectrally-resolved measurements of downwelling longwave radiation can be used to generate retrievals of thermodynamic profiles in optically thin fog layers (optical depth less than 5) and microphysical properties of the fog (phase and particle effective radius) when the fog optical depth is greater than ~0.25. The retrieved thermodynamic profiles from infrared spectrometers (IRS) are shown to be more accurate than from multi-channel microwave radiometers (MWR), based upon comparisons with in-situ observations on a 10-m tower and from a limited number of collocated radiosondes. Additionally, due to the high sensitivity of the IRS to liquid water, retrievals based on IRS observations detect fog onset (defined by a threshold in liquid water path) earlier than those based on MWR observations by 25 to 185 minutes. Selecting 12 cases of fog under otherwise clear skies between June and September 2019 at Summit Station in central Greenland, the mean ice particle (optically-equivalent sphere) effective radius was 24.0 ± 7.8 µm, and the mean liquid droplet effective radius was 14.0 ± 2.7 µm. These results, combined with measurements of aerosol particle number concentrations, provide observational evidence supporting the hypotheses that (a) low surface aerosol particle number concentrations can limit fog liquid water path, (b) fog can act to increase near-surface aerosol particle number concentrations through enhanced mixing, and (c) multiple fog events in quiescent periods gradually deplete near-surface aerosol particle number concentrations.

9C

MARINE STRATUS AND FOG - BOUNDARY LAYER MIXING AND A WATER DROPLET SINK.

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Abstract

A simple 1-D RANS model of the time evolution of the Planetary Boundary Layer is extended to include water vapor and cloud droplets plus transfers between them. An underlying ocean surface is treated as a source of water vapor, and as a sink for cloud or fog droplets. With the model we can simulate conditions reported in G.I. Taylor's classic 1917 paper "The formation of fog and mist". With a constant sea surface temperature and a steady wind, initially dry or relatively dry air will moisten, starting at the surface. Turbulent boundary layer mixing will then lead towards a layer with well-mixed potential temperature (and so temperature decreasing with height) and well mixed water vapor mixing ratio. As a result the air will, sooner or later, become saturated at some level and stratus cloud will form. If that air is later advected over colder water the air will cool and the base of the stratus cloud will lower. Fog may then extend down to the surface.

Our main assertion is that for marine fog the underlying water surface can be a source for the water vapor but is a sink for water droplets. The liquid water mixing ratio is then essentially zero at the surface but will increase with height to a maximum, typically in the lowest 100- 500 m height range, depending on conditions. Relative humidity is 100% throughout this layer and is what is typically observed, e.g. by G.I. Taylor in 1915. There are however no published observations that we know of, that provide the variations of liquid water mixing ratio with height in marine fog. I am hoping that the FATIMA program may provide these critical measurements.

9D

PHYSICAL-BASED MODEL FOR ESTIMATING FOG WATER POTENTIAL IN (SEMI-)ARID REGIONS

Felipe Lobos-Roco[1,2], Camilo del Rio[1]

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Abstract

Water resources in arid and semi-arid regions, such as the Atacama Desert, are fundamental for social, economic, and natural development. In recent decades, climate change has decreased precipitation rates in most semi-arid regions of the north and central Chile, producing a decrease in water supply, which threatens available water resources. Under these water stress conditions, diversifying water resources becomes imperative. In this context, fog harvesting arises as a complementary water source to tackle water scarcity, especially in the coastal Atacama Desert, where it is abundant and virtually untapped. However, our limited understanding of the physical processes that control fog formation, the lack of observations, and the complex topography where fog occurs, make it difficult to estimate where, when and how much water can be harvested from clouds. Based on recent studies that have unraveled several physical processes of fog formation and dissipation, this research proposes to build a physical model based on the thermodynamics of the marine boundary layer to estimate the fog water potential in the arid and semi-arid region of the coastal Atacama Desert. This model is theoretically based on the mix-layer theory during advective fog events, where an air parcel is forced to lift due to the topography resulting in thermodynamic changes in the air parcel. With this model, we aim to determine the main physical characteristics of the marine cloud that produces inland fog in the Atacama using widely available meteorological data. Such characteristics are fog frequency, cloud base and top level, liquid water content, and collectible water with unprecedented spatiotemporal accuracy. Likewise, through this model, we propose studying climate change's impact on these potentially available water resources. The expected results will advance our understanding of the physical processes that influence fog harvesting. Moreover, this model will contribute to providing continuous data where observations are lacking. As fog is a global meteorological phenomenon, this model might be applicable worldwide, contributing to bridging the data gap in regions where fog harvesting is a viable water source, especially in underdeveloped countries. We expect this research to have a high social impact by providing valuable information about new water sources to decision-makers to mitigate the effects of climate change.

9E

SIMULTANEOUS, MULTI-SITE AND VERTICAL MEASUREMENTS OF FOG DROPLET SPECTRA IN CONJUNCTION WITH STANDARD FOG COLLECTORS IN THE MONTEREY BAY (CA) REGION

Daniel M Fernandez[1], Jesus Ruiz-Placarte[2], Ryan Yamaguchi[2], Qing Wang[2]

[1]CSU Monterey Bay, Seaside, CA, USA. [2]Naval Postgraduate School, Monterey, CA, USA

Abstract

During the Summer of 2021, two locations separated by about 15 km along Monterey Bay had several weeks of simultaneous deployments of FM-120 droplet spectrometers, standard meteorological instrumentation, and standard fog collectors. One of the locations, Moss Landing Marine Lab, is at the center of Monterey Bay at the mouth of the Salinas Valley. This location typically experiences a diurnal ebb and flow of fog associated with the thermal-driven wind circulation up and down the Salinas Valley. The second location, about 15 km south and 2 km inland, is located slightly above sea level at a site known as Fritzsche Field, near the Marina Airport between the cities of Salinas and Monterey. This site, slightly further from the coast and out of the fog corridor, experiences different fog patterns than the location at Moss Landing. This presentation juxtaposes the data collected concurrently from the two locations from the FM-120 units, the standard fog collectors and the meteorological measurements.

The latter half of the deployment in early Fall 2021 featured two FM-120 instruments 5 and 10 m heights above the surface on a meteorological tower at Moss Landing Marine Lab, along with a standard fog collector mounted on the ground and the standard suite of meteorological instruments. During this period, the FM-120 instruments yielded a significant increase in LWC over the short vertical intervals over which it was measured. This could have important implications associated with optimal placement of fog collectors to maximize water volumes collected and attests to the strong vertical gradient associated with the fog patterns at this location at this time.

9F

FOG FORECAST AT MEXICO CITY INTERNATIONAL AIRPORT: A THERMODYNAMIC APPROACH

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Abstract

Fog occurs when the ambient temperature and dew point become nearly identical in an air mass. This can be achieved through cooling or by adding moisture until reaching supersaturation. This phenomenon occurs under conditions that include complex interactions between thermodynamic, dynamic, and microphysical processes at various spatial and temporal scales, which are also associated with great variability of the surface-atmosphere interface and topographic effects. Because of this, a good understanding of the physical mechanisms of fog formation is required to develop suitable modeling and forecasting tools.

The most widely used fog classification system, which is based on the prevailing synoptic conditions and the main physical processes responsible for the formation of the phenomenon, considers three main types: radiation, advection and frontal fog. In particular, radiation fog occurs when nighttime radiation cooling reduces air temperatures below its dew point, typically under clear-sky, light-wind conditions. This allows to abstract the thermodynamic processes, since the dynamic processes are of minor importance.

In the present work the results of a study for the forecast of the temperature of formation of radiation by fog are presented using the equations of thermodynamics for humid air. The method was evaluated with historical events that occurred at the Mexico City International Airport (AICM) between 2003 and 2012, using the corresponding reports from the Météorologique Aviation Régulière (METAR). Likewise, the results were compared with those obtained through simulations carried out with the Weather Research and Forecasting (WRF) model. It is concluded that, for radiation fogs, the thermodynamic approach gives satisfactory results and even superior to those obtained with the WRF.

10A

POINTWISE MACHINE LEARNING BASED RADIATION FOG FORECAST WITH STATION DATA IN GERMANY

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Abstract

There are many uncertainties in radiation fog forecast. Continuous effort is being made to improve the forecast. A supplementary and increasingly popular approach to numerical weather forecast is the forecast with machine learning (ML) algorithms. While numerical weather forecast is based on mathematical models with partial differential equations, ML algorithms take a more heuristic approach. The latter strategy calls for three steps.

Precise data preprocessing is the initial step. This implies that after preprocessing, the dataset must contain the forecast-relevant information in a way that the algorithm can learn from it. This is not a trivial step because it necessitates a thorough understanding of the fundamental principles underlying radiation fog. Even when the relevant information is contained in the data, it is not always evident, especially in severely unbalanced fog datasets. The best strategy to achieve a pleasing result may therefore not be to simply feed the algorithm all the data and variables that are available. So that the appropriate dynamics may be detected by the algorithm, the data and information should be adjusted accordingly.

The second step is the data splitting into training, validation and test datasets. The ability to predict fog is driven by the temporally linked process that describes the ongoing change in atmospheric state but in order to guarantee constant independence between the training, validation and test dataset, the data splitting method must consider this temporally linked information between the individual datapoints. Otherwise, the algorithm's forecast accuracy can be based on the temporally correlated information content of the individual data points.

The third step is the interpretation of the model scores. When looking at the forecast score alone, it is a very abstract number that does not directly allow a statement about the forecast performance of the model. In order to evaluate the model performance, two baselines are of relevance: algorithm complexity and dataset complexity. A baseline for algorithm complexity justifies the chosen algorithm and also classifies the model performance. A baseline for dataset complexity also classifies the model performance and enables a better comparability of different datasets.

Following these principles, our current objective is to improve the ML based fog forecast with XGBoost for a forecasting period up to four hours for the station in Linden-Leihgestern (Germany). The training and evaluation are based on the Expanding Window Approach (Vorndran et al. 2022) that considers the autocorrelation of a fog time series and maintains the temporal order during both training and evaluation. The evaluation is based on a score for each of the following categories: Overall performance, fog formation, and fog dissipation. The results are set in relation to different baselines to evaluate the performance and the dataset complexity. Building on this scheme, newly preprocessed data led to an improvement in the prediction of radiation fog for the station in Linden-Leihgestern. We will present the most recent findings from our research.

10B

ARTIFICIAL INTELLIGENCE ANALYSIS OF MARINE FOG VISIBILITY USING ATLANTIC CONDOR SHIP MEASUREMENTS FROM FATIMA

Eren Gultepe[1], Sen Wang[2], Harindra J. S. Fernando[3], ismail Gultepe[4], Byron Blomquist[5]

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Abstract

The objective of this study is to investigate marine fog visibility (Vis) as a function of meteorological parameters obtained from instrumentations mounted on the Canadian research vessel Atlantic Condor during the first FATIMA (Fog and turbulence in the marine atmosphere) field campaign. The project took place in July 2022 on and nearby the Sable Island and the Grand Banks area of the NW Atlantic Ocean. The Condor sailed from the port of Halifax to a location near Sable Island, and then to the Hibernia Oil Rigs region in the 500 km north. After a stopover near the Hibernia rig, the ship reversed its path. An extensive suite of instruments on the ship collected marine fog microphysics measurements, visibility, and meteorological parameters such as the droplet size distribution (DSD), relative humidity (RH), air temperature (Ta), dew point T (Td), wind speed (Uh) and direction (ϴ), as well as precipitation rate (PR) and wind speed variability (UHsd), which were used in a machine learning (ML) algorithm for the prediction of visibility (Vis).

The visibility was predicted by a regression model using an ensemble of bagged random forests (EBRF). The collected data was filtered only to contain observations with a rain intensity <0.05 mm hr^{-1}. Further filtering was applied to create four datasets that contained observations at each of the following Vis thresholds: (i) <1 km, (ii) <5 km, (iii) <10 km, and (iv) <20 km. For each of these four threshold levels, a separate model was developed. Prior to training the models, 80% (training split) of all collected data was randomly held-out for training and the remaining 20% (testing split) was used for reporting final model performance. To train and determine the optimal hyper-parameters for the models, 10-fold cross validation technique was used on the 80% held-out training datasets. The final testing model performance at each Vis threshold was obtained as: (i) Vis<1 km: RMSE = 87.56 m, R^2 = 0.774; (ii) Vis<5 km: RMSE = 449 m, R^2 = 0.789; (iii) Vis<10 km: RMSE = 915.3 m, R^2 = 0.873; and (iv) Vis<20 km: RMSE = 1576.8 m, R^2 = 0.930. Across the models, at the shorter visibility ranges of 1 km and 5 km, Ta-Td, Uh, and ϴ, as well as PR were important predictors. However, Vis>10 km, RH had a much more important role as a predictor.

The success of the analysis indicated that this work can be extended to include Sable Island observations, as well as liquid water content (LWC), droplet number concentration (Nd), and aerosol number concentration (Na). In the presentation, issues and challenges faced during the ML application will be summarized and future simulations will be discussed.

This work was funded by the Grant N00014-21-1-2296 (Fatima Multidisciplinary University Research Initiative) of the Office of Naval Research, administered by the Marine Meteorology and Space Program.

10D

THE SOCIO-POLITICAL DIMENSIONS OF FOG. AN ETHNOGRAPHY OF FOG CATCHERS IN PEÑA BLANCA, NORTHERN CHILE

Viola Di Tullio

IUSS, Pavia, Italy. LUISS, Roma, Italy

Abstract

In Northern Chile's internal areas, climate change has taken the form of a severe drought and has caused a drastic reduction in rainwater. Water scarcity led to an environmental and social crisis with a major impact on intensive grain cultivation (the main source of local income), pastoralism (drastically reducing the number of livestock), and the migration of young people to urban centers. However, in these areas fog is often present, allowing the construction of several projects on fog harvesting. In Peña Blanca (a small Comunidad Agrícola in the Coquimbo region) the Atrapanieblas Comuneros were constructed in 2005 by the Fuad, a local NGO. Today they catch around 571.590 L (2.190 L/m2) per year.

Based on two months of ethnographic fieldwork in Peña my research explores, through an anthropological lens, the positive and negative social impacts of the Atrapanieblas Comuneros, observing community engagement and participatory practices, and considering the environmental crisis in its multiple dimensions. Furthermore, drawing on environmental anthropology the research investigates humans, nonhumans, and the multiple relations that have developed around fog and fog nets. Fog is understood as an actor that shapes the stories within the community and the atrapanieblas as a conceptual space in which different interests and actors (animals, community, NGOs, students, national and international stakeholders) engage with each other.

The NGO aims to slow down desertification and soil degradation through a reforestation project using collected water. Yet, the local's main interest lies in the use of fog water for animals or fields. While large national and international companies see it as a project to invest in and create profit. It became evident that eventually, the atrapanieblas trap not only the fog but also multiple interests and wills of different social actors. From a social point of view, these infrastructures become a privileged place to observe "entanglements" (Tsing 2015), relations, and encounters, adopting the role of connectors of subjectivities. The observation of their impacts must consider the long-term history of vulnerability produced by Chile's political and economic history, including water distribution policies. In this sense, water emerges in its multi-dimensionality and relationality as a subject of history.

The environmental crisis, therefore, locally turned into a creative space that allowed the community to re-signify traditional practices and relations with water and fog. In this sense, the atrapanieblas, among other alternative water management practices, are also understood locally as acts of silent resistance, bottom-up initiatives that render the community independent of state services, bringing to light the history of marginalization of these valleys. The research shows to what extent fog hunting becomes a connecting action. It implies new knowledge models in which the interdependence between multiple social actors (animals, climate elements, individuals, and local, national, and international stakeholders) enables mutual sustenance.

10E

PARALLELS OF FOG HARVESTING AND PAINTING (OR, TRACING FOG THROUGH ATOMIZING PAINT)

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Abstract

I am interested in what the lens of "fog" reveals in relation to the discipline of painting, to my painting process of atomizing paint, and to the conditioning of edges that I take painting to be. Furthermore, as I become more aware of fog harvesting, I have come to think about the capturing of fog on a surface to release water as parallel – or at least adjacent to – the capturing of atomized paint on a surface to construct a painting. What are the parallels of fog harvesting and a process of painting through atomization? Furthermore, what does each process of controlling, tracking, and tracing fog illuminate in relation to each other?

I will use my own work and references to other contemporary artists to provide examples of the relevance of fog to artists who wish to produce work that provides an atmospheric or auratic experience. For example, the work of Fujiko Nakaya is a prominent example of an artist using actual fog as a medium to set up ways in which we can experience different environments.

In the discipline of painting, painters depict spatial conditions by controlling edges for purposes of illusion. Atmospheric perspective is a tool for creating the illusion of depth in which objects in the distance appear less distinct. I will introduce color field painters like Helen Frankenthaler or Sam Gilliam who refuse to work with illusion to create spatial experiences but rather work with applications of paint to create an experience of envelopment, particularly at a large scale. Katharina Grosse is a contemporary example of a painter working with atomized paint at a large scale to reorient spatial orientation.

The experience of being in fog and the relation to painting–particularly painting which aims to explore spatial conditions that reframe our perceptions and understanding–is inspiring me to develop more explicit connections in my atomization "set-ups" with the way fog moves and is captured on surfaces, like those being developed and used to harvest fog. In my own painting process, in which I atomize paint and capture it on surfaces, atomizing paint is a process of suspending pigment in a liquid and adding air to move the pigment, much like the wind moves droplets of water in fog. I build these set-ups or "apparatuses" to control the drift of the atomized paint. Surfaces ultimately capture the trace of the paint, not unlike the harvesters that capture fog.

Finally, the question remains how painting–or, more broadly, art–relates to the practices of scientific communities involved in fog research. More specifically, how might my engagement with the tracery of atomized paint, orchestrated through apparatuses of interference toward and onto a surface, share and illuminate structural aspects of and with fog? As traces of atomized material construct my painting through a blend of distinct and indistinct edges, they set up an experience much like that of experiencing fog.

11A

A DATA-DRIVEN APPROACH TO EXPLOIT SPATIAL AND SPECTRAL STRUCTURES IN GEOSTATIONARY SATELLITE DATA FOR REMOTE SENSING OF FOG TESTED FOR THE ATACAMA DESERT

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Abstract

Accurate and efficient satellite-based fog detection is desired for various research and operational applications. However, conventional retrievals still suffer from limited detection skill and require expert knowledge to interpret available products. They typically rely on sequential thresholds tests applied to individual spectral bands or band combinations without considering all available spectral information from satellite observations. First approaches using more data-driven methodologies and adding hand-designed variables to consider spatial structures have shown promising improvements. Here, we apply a fully convolutional artificial neural network architecture to exploit available spatial and spectral information to segment satellite images into fog and no-fog pixels. We use cropped images from the Geostationary Operational Environmental Satellite - 3rd generation (GOES-16) with a focus on the Atacama Desert. By choosing this study region, algorithm development and testing benefit from a rather homogeneous surface in time and space, excluding substantial seasonal effects on reflection and emission due to a vegetation cycle. Additionally, the variety of fog types is limited and spatially constraint. The coastal region is affected by advected stratocumulus which forms fog when it intercepts with the coastal mountain range and sustains fog-dependent ecosystems whereas further inland conditions are more conducive to formation of radiation fog. On the eastern margin of the desert, orographic up-slope fog occurs when humid air is advected and cools upon forced ascent at the slope of the Andes. By investigating and explaining how the neural network derives its decision, we identify unique spatial and spectral fog signatures and relate them to the distribution of the specific fog types. This way, scientific consistency can be established and our understanding about specific fog structures and related mechanisms can be improved. For training and validation of the neural network, we created a novel ground-based reference fog data set which is based on in-situ leaf wetness sensor measurements refined with additional meteorological station data. These data were obtained from a station network deployed across the Atacama Desert by the Collaborative Research Center "Earth – Evolution at the Dry Limit" (https://sfb1211.uni-koeln.de/) of the German Science Foundation (DFG SFB1211).

11B

GENERATION OF A HARMONIZED TIME SERIES CROSS-CALIBRATING TWO METEOSAT GENERATIONS TO GENERATE A LONG TERM FOG TIME SERIES FOR EUROPE

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Abstract

Fog is a meteorological phenomenon that reduces horizontal visibility to less than 1000 meters and has a serious socioeconomic and environmental consequences. It influences the earth's radiation budget by reflecting incoming solar radiation. Current long-term research on the fog occurrence based on station data have indicated that the frequency of fog has decreased over Europe since the 1960s. However, due to a limited number of ground-based observations from SYNOP stations and airports, primarily in low-altitude areas, there is insufficient evidence to support the hypothesis that fog and low stratus (FLS) are decreasing across Europe. In order to scientifically investigate different factors which might be responsible in influencing fog formation over the years over space and time, there is a need of long term consistent satellite data time series to analyze FLS distribution. The European Meteosat program generally delivers suitable data since 1977. However, due to the different spatial, spectral and radiometric resolution of the individual satellites including early-years calibration uncertainties makes homogenization necessary to finally derive products such as FLS occurrence. In this study, a machine learning based approach has been developed to harmonize the two generation Meteosat datasets to generate a long-term consisent dataset (1991-2020) which can be further used to classify fog over the European domain (WMO region VI). A Random Forest (RF) based model is trained during the overlap period (2004-2006) of Meteosat First Generation (MFG) and Meteosat Second Generation (MSG), to synthesize MFG data from MSG data to generate a consistent MFG time series which can be later used for fog classification. Due to the 24-hours availability of WV and IR channels and their significance in FLS detection, the focus has been put on synthesizing these two MFG channels in this study. The results of this model indicated a good match of synthesized MFG datasets with the original MFG datasets during the overlap period with mean absolute error (MAE) of 0.7 K for the WV model and 1.6 K for the IR model and out-of-bag (OOB) R^2 score of 0.98 for both models. The synthesized MFG WV and IR channels are combined with cloud base altitude (CBA) and visibility information from Meteorological Aviation Routine Weather Reports (METAR) and synoptic weather observations (SYNOP) in a machine learning based model to classify the fog occurrences, and finally derive a continuous long-term fog time series. In the talk, we will present the progress in generating a 30 years fog climatology (1991-2020) for Europe with a temporal resolution of 30 minutes using this dataset.

11C

Fog-low stratus (FLS) occurrence under increasing Amazon drought conditions supports the formation of climate change refugia in concave

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Abstract

The Amazon rainforest harbors an immense biodiversity and has so far functioned as an important terrestrial carbon sink. However, climate and land use changes are causing the lowland rainforest to become increasingly dry, threatening biodiversity and functionality (e.g. climate regulation). Epiphytes, for example, which are particularly species-rich and abundant in the canopy of the lowland forest and supply themselves with water directly from rain and nocturnal fog, are among the primary groups of organisms at risk. Under climate change conditions, many of these organisms can therefore only survive in hygric climate-change refugia. Based on a novel remote sensing FLS product, we will show that suitable refugial spaces with high fog frequency exist throughout the Amazon, especially in concave topography. Analysis of recent droughts reveals that under severe drought intensities sufficiently high FLS frequencies are only maintained in steep river valleys. We therefore strongly recommend that such forests must be protected as a climate change adaptation measure.

12A

COLD-FOG MICROPHYSICS DURING CFACT CAMPAIGN

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Abstract

The objective of this study is to characterize the microphysics of cold-fog conditions during the Cold Fog Amongst Complex Terrain (CFACT) which was conducted in Heber Valley, Utah from 7 January to 24 February 2022. The field campaign was supported by the NSF Lower Atmospheric Observing Facilities (LAOF) managed by NCAR's Earth Observing Laboratory (EOL), as well as the University of Utah and Ontario Technical University. Heber Valley is situated at approximately 1650 m above sea level (ASL) and is surrounded by canyons, mountains and irregular topography. The Provo River flows from north to south along the valley floor from Jordanelle Reservoir to Deer Creek (DC) Reservoir. The highest peaks surrounding the valley are about 3500 m ASL and located to the west and southwest of the project area.

The DC supersite had extensive ice and droplet microphysical as well as precipitation measurements that were obtained using a custom-built Gondola (comprised of a DMT CDP and BCP), a DMT FM120, a MesaPhotonics CDMS, a DMT GCIP, a Vaisala PWD52, and an OTT ParSiVel. During the project, aerosol measurements were performed using a GRIMM, SMPS, and CCN instruments as well as filter samplers. These instruments covered a size range from 8 nm up to 1 cm, representing aerosols, fog particles, and precipitation. Measurements from a Doppler Lidar and Vaisala CL61 ceilometer, a tethered balloon system (TBS), and a 32-m turbulence tower were used to characterize vertical profile of fog microphysics, aerosols, and thermodynamic structure. The 11 significant weather events during CFACT had freezing fog, ice fog (IF), and light ice crystal precipitation, and total precipitation at 10%, 20%, 15%, and 25% of the days, respectively, when Vis<5 km. In the presentation, IF events will be discussed with respect to ice-crystal particle spectra and habit. Furthermore, physical parameterizations related to aerosols and turbulence will be summarized within the context of the field program along with challenges related to these parameterizations.

12B

SOME RESULTS FROM THE SOUTH WEST FOGS 3D EXPERIMENT FOR PROCESSES STUDY (SOFOG3D) PROJECT

Frédéric Burnet[1], Christine Lac[1], Pauline Martinet[1], Martial Haeffelin[2], Julien Delanoë[3], Jeremy Price[4], Salomé Antoine[1], Alistair Bell[1], Théophane Costabloz[1], Maroua Fathalli[1], Marie Taufour[1], Guillaume Thomas[1]

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Abstract

The primary objective of SOFOG3D, funded by Météo-France and ANR (French National Research Agency), is to advance our understanding of fog processes at the smallest scale to improve forecasts of fog events by numerical weather prediction (NWP) models.

A six months field experiment has been conducted from October 2019 to March 2020 in the South-West of France to provide 3D mapping of the boundary layer during fog events. Three nested domains have been instrumented to collect observations from regional scale (300x200 km²) down to local scale on the super-site (10x6 km²). Detailed measurements of meteorological conditions, aerosol properties, fog microphysics, water deposition, radiation budget, heat and momentum fluxes on flux-masts, were performed on the super-site selected in an agricultural exploitation to contrast large open area with pine forest slots. Two 94 GHz cloud radars were operated, and the combination with microwave radiometer (MWR) measurements allowed optimal retrieval of temperature, humidity and liquid water content profiles. In addition in situ measurements of turbulence and droplet size distribution were performed under a tethered balloon. During intensive observation periods, 15 fog events were sampled with the tethered balloon and 180 radiosoundings were launched. A network of 17 observation sites located in forests or crops, has been deployed over a 70x20 km² area to explore the impact of surface heterogeneities on the fog life cycle.

A new configuration of the operational NWP model AROME was run with 500 m horizontal resolution, 156 vertical levels and the 2-moment microphysical scheme LIMA. A network of 8 MWR on 6 sites was deployed on the larger domain to evaluate this new configuration and to investigate how better initial conditions of the model can improve fog forecasts through assimilation using an innovative ensemble-based variational data assimilation scheme.

High resolution simulations of the three deeper fog layers sampled during the campaign have been performed with the Meso-NH model to assess recent advances in parametrizations and to provide spatio-temporal turbulence and microphysical characteristics of the fog layer and the atmosphere above. Both observations and simulations allowed to better understand the impact of surface heterogeneities (forest vs. non forest) on the fog life cycle.

We will present the instrumental set-up and discuss the main results of the project. An overview of the 34 sampled fog events will be given. We will show that the new AROME configuration improves the number of predicted fog cases and reduces the overestimation of thick fog in the current operational configuration, and that the assimilation in the 3D-VAR system of AROME-France of the temperature profiles provided by the MWR network is promising. The data analysis of 17 measurement sites reveals a tendency for a slightly late formation in the forest compared to the crop, related to the shelter effect. The synergy between remote sensing and in situ measurements under the tethered balloon, allowed to document the evolution of thermodynamic and microphysical profiles during the fog life cycle and to study thin to thick fog transition and processes occurring at fog top.

12C

FOG MICROPHYSICAL PROPERTIES AND EXPERIMENTAL STUDY OF THIN TO THICK FOG TRANSITION DURING THE SOFOG3D CAMPAIGN.

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Abstract

The SOuthwest FOGs 3D experiment for processes study (SOFOG3D) project focused on fog processes at the smallest scale. A six months field experiment has been conducted from October 2019 to March 2020 in the South-West of France to provide 3D mapping of the boundary layer during fog events by combining remote sensing instruments (microwave radiometer, Doppler cloud radar and Doppler lidars), balloon-borne in-situ measurements and detailed measurements of meteorological conditions, aerosol properties, fog microphysics, water deposition, radiation budget, heat and momentum fluxes on flux-masts.

During the 15 Intensive Observation Periods (IOP) of the campaign, a tethered balloon was operated at the super site with an innovative payload composed of a turbulence probe and a cloud droplet probe (CDP) measuring the size distribution of water droplets within a diameter range from 2 to 50 µm. These measurements allow us to document the temporal evolution of the vertical profile of the microphysical and thermodynamic properties for 8 thin fogs (thickness <50m) and 7 developed layers including 3 episodes exceeding 200m thick. These data are analysed here to study the transition from thin to optically thick fog which is a key step in the fog life cycle but remains poorly understood due to lack of in situ observations.

Ground-based microphysical measurements performed on the different sites by different instruments such as the Fog Monitor (FM120), visibilimeters (PWD22 and Young) and Gerber (PVM100) are analysed to document the spatial heterogeneity of the microphysics during fog life cycle. A strong variability, in terms of extinction and size distribution, can sometimes be noticed between sites about 1km apart. These data are also used to validate measurements derived from the CDP operated under the tethered balloon.

When fog becomes optically thick, the downwelling infrared radiation is getting very close to the upwelling one and the turbulent kinetic energy increases suddenly. Such features are observed for the three episodes that exceeded 200m in thickness.

The CDP measurements below the tethered balloon reveal that liquid water content (LWC) profiles reverse during the transition from thin to thick fog. During the mature phase, when the fog is vertically developed and until the dissipation into stratus, the temperature profile is neutral and LWC increases with altitude, except near the fog top due to mixing processes. In contrast, at the beginning of the episode, in stable conditions, LWC is maximum near the ground and decreases with height. On the basis of these observations, we analyse the temporal evolution of the temperature and LWC vertical gradients for the 10 most documented IOPs. We show that the transition between the fog formation in stable conditions ($d\theta/dZ > 0$ and $dLWC/dZ < 0$) and the developed phase which is more adiabatic ($d\theta/dZ \sim 0$ and $dLWC/dZ > 0$) is not continuous over the fog life cycle.

These measurements highlight a contrasting evolution of the microphysical and thermodynamic profiles during the transition from thin to thick fog.

12D

RELATING FOG DROPLET SIZES TO SOURCES IN ATLANTIC CANADA

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Abstract

Fog droplet size distributions on or near the coast of Atlantic Canada are often bimodal, with modes present at approximately 5 and 25 microns. The origin of these two modes, as well as their ability to coexist, is still under investigation. As part of the Halifax Fog and Air Quality Study (HaliFAQS), measurements of fog droplet size distribution were conducted in the eastern Canadian coastal city Halifax, Nova Scotia from May to August 2019 using a fog droplet monitor (FM-120, Droplet Measurement Technologies). During this study, a strong seasonal difference was observed in the droplet size distribution: during spring (May & June) fog events, the smaller droplet mode dominated resulting in lower liquid water content; while during summer (July & August), the larger droplet mode dominated, resulting in a higher liquid water content and lower visibility. Footprint analysis using the Lagrangian particle dispersion model FLEXPART revealed that fog events when the larger droplet mode dominated originated from local (continental) sources and were likely strongly influenced by radiative fog formation processes. By contrast, the fog events in which the smaller droplet mode dominated were more influenced by marine sources and coincided with local precipitation.

These results will be compared to fog droplet and aerosol size distributions and chemical composition measured off the coast of Atlantic Canada as part of the Fog and Turbulence Interactions in the Marine Atmosphere (FATIMA) that took place in July 2022. These measurements will provide additional constraints on the contribution of aerosols to fog droplet size distributions and provide primarily marine-influenced fog cases compared to the results from HaliFAQS, where the urban setting and emissions appear to contribute strongly to the observed droplet distribution. Overall, our findings suggest that the visibility in coastal urban fogs is highly dependent on air mass history and require different considerations in models.

12E

FOG FORMED BY STRATUS LOWERING: OBSERVATIONAL AND MODELING OF TWO CASE STUDIES

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Abstract

Fog is a difficult meteorological phenomenon to predict due to its high spatial and temporal variability and the complexity of physical processes and their interplay. Improving fog forecast is essential to limit the impact on transportation. Fog formed by stratus lowering remains especially difficult to forecast by the numerical weather prediction (NWP) model. Two cases of fog events, sampled during two field campaigns, are analyzed here based on ground and upper air observations and high-resolution simulations with the Meso-NH model to better understand the key processes driving stratus lowering up to fog formation.

The first fog event was sampled on December 1-2, 2016 in the North-East of France,(Fathalli et al, 2022). The budget analysis of thermodynamical and microphysical variables shows that the advection of cloud water in the stratus and at its top is a major process driving the stratus lowering. This promotes the settling of droplets by generating cooling and moistening of the sub-cloud layer by evaporation. The other non-local process, which completes the stratus lowering until the fog formation, is the advection of cold air towards the base and under the stratus, induced by fine-scale orographic circulations and which confers a spatio-temporal variability to the occurrence of fog due to the hilly terrain.

The second case study was sampled between 28 and 30 December 2019, during the SOFOG3D campaign in the South-West of France. We analyze in situ and remote sensing measurements, such as microwave radiometer and 94 GHz cloud radar, from two different sites about 100 km apart. On the super-site in the Landes forest, a radiative fog occurred the first night, lifted into a stratus in the morning, remained all day long, and lowered in the afternoon to form a new fog by stratus lowering during the second night. In contrast at the Agen site in the Garonne valley, the stratus completely dissipated and a radiative fog formed during the second night. The widespread radiative fog over the entire domain (200 x 300 km^2) during the first night developed due to cold air advection from the East. We analyze data from many stations to study why the stratus lowering is generalized over the northern part of the domain, while the stratus completely dissipates over the southern part of the domain.

This data analysis is complemented by a 3D numerical simulation with the Meso-NH model at 100 m resolution with a downscaling approach from the operational NWP model AROME, using the LIMA 2-moment microphysical scheme. Preliminary results show that for the second night, the simulation well reproduces the contrasting fog life cycle for both sites with radiative fog on Agen and stratus lowering on the super-site, but forming earlier fog on the former. A budget analysis is conducted to investigate the spatial heterogeneity at the regional scale and to study the physical mechanisms involved in fog formed by stratus lowering.

We will present the two case studies and discuss the main results of our analysis.

A2

COMPARATIVE MESH MEASUREMENTS OF FOG WATER COLLECTION

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Abstract

Several locations on or near the campus of California State University, Monterey Bay serve as excellent test locations for field-based, comparative studies of fog collecting devices. These sites provide easy access to the instrumentation, different levels of security, as needed, and they are in a zone that experiences coastal (advective) fog during the summer and fall seasons.

As such, comparisons have been underway for several years that include comparisons between standard raschel 35% shade coefficient double-layer mesh made by Marienberg and other types of materials, including German FogHaTin mesh, single layer Marienberg 35% shade coefficient raschel mesh, triple layer Marienberg 35% shade coefficient raschel mesh, and a denser raschel weave obtained locally. Additionally, we have had the opportunity to compare with several spacings of wire harp.

The results of these comparisons do yield some differences, sometimes on the order of +/-10% in water volumes collected for these different types of materials considered. This paper will examine some of these comparisons and attempt to qualify some of the conditions that affect the relative efficiencies of these different materials in terms of the overall water collection rates that they experience. Such conditions include the wind speed and wind direction and the fog droplet sizes.

This work is significant in that it may affect the choice of fog collecting mesh used in different circumstances based on not only the efficiency of the mesh, but its cost and general availability and the associated tradeoffs therein.

A3

FIELD-TESTING FOG HARPS

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Abstract

Responding to global water shortages, fog harvesting is emerging as a viable and useful technique for collecting fresh water. We recently developed an anti-tangling and anti-clogging Fog Harp that increased the fog harvesting efficiency by a factor of 3-7X compared to a conventional Raschel mesh. However, these results were for scale-model harvesters under laboratory conditions of very dense fog. Here, we fabricate large-scale (0.5 m x 0.5 m) Fog Harps by adapting a pre-existing manufacturing process for harp screens and test their outdoor performance at Monterey Bay, California. Comparisons were made between a single-layer Fog Harp (50% shade coefficient) and a double-layer, 35% shade coefficient Raschel mesh. The performance multiplier in water yield for the Fog Harp versus Raschel mesh was found to vary widely, depending on the day-to-day fog conditions and even local variability on the test platform. Overall, the yield multipliers were lower than those of the lab tests, likely due to the lighter droplet density of natural fog compared to lab fog. These results indicate that the fog harvesting efficiency is not fixed for a given harvester type, as it additionally depends on the fog conditions and harvester area.

A4

FOG WATER COLLECTION AT THE UC SANTA CRUZ CASFS FARM

Phillip T Grote

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Abstract

This paper will delve into the topic of fog collection technology and its potential for use in agriculture. A literature review will be presented, covering existing large-scale fog collection systems and their successes. Additionally, the paper includes specific research conducted by students at the CASFS Farm at the University of California, Santa Cruz. The focus of the research conducted was to design and build a low-cost fog collector as a proof-of-concept for agricultural use. Collection was done in the summer months, a period of little rainfall in this area. The primary research question of this study is to investigate if any local weather conditions have a significant impact on the efficiency of atmospheric moisture harvesters. The results of this study can demonstrate the feasibility of using low-cost fog collectors in small-scale agriculture. In three example fog events in the month of August, we collected 3.58 Liters, 4.45 Liters, and up to 5.17 Liters. Over the 83 days in which we had our collector up, we collected 113 Liters of water, for a rate of 0.0814 Liters per Meter squared per Day. So far, we have not shown any significant correlation between collection rate and wind speed, but continue to research the significance of factors like wind direction and temperature. Future research will aim to place collectors in different geographic settings to see differences, and to investigate the use of biomimicry in the design process, while still keeping the focus on small-scale agriculture.

A6

SPATIAL MODELLING OF NEAR-SURFACE FOG WATER VARIABILITY AND ITS RELATIONSHIP WITH LOCAL TOPOGRAPHY IN NORTHERN CHILEAN ATACAMA DESERT

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Abstract

In the coastal Atacama Desert of northern Chile, the advective fog reachess the ca. 1,200 masl in a site called "Oyarbide Field" on an area of approx. 3 km^2 with an altitudinal gradient of ca. 100 m, a place with a complex terrain and where one of the greatest Tillandsia landbeckii field is located. It is at this scale where research on fog variability and its interaction with local topography is still limited. This study aimed to determine the spatial association between near-surface fog water variability (50 cm from the ground) and topographical parameters, which can contribute to the study of the development and pattern of Tillandsia landbeckii at the site.

Fifteen Mini Standard Fog Collectors (Mini SFCs of 50 x 50 cm) have been installed in Oyarbide Field from February 2019 and they have been measured monthly up to the present. Five potential topographical predictors of near-surface fog water variability from a Digital Elevation Model (DEM) were analyzed in the Oyarbide Field using Ordinary Least Squares (OLS) and Geographically Weighted Regression (GWR). The global pattern and spatial variability between near-surface fog water variability and the selected potential topographical parameters was analyzed and evaluated.

Topographical parameters influence for near-surface fog water variability was exposed at global and local level in Oyarbide Field. Altitude has a direct correlation with areas of large collection of near-surface fog water with large collection towards the highest zones (SE) of the site. The explanatory variables slope and scope in global OLS were significantly associated with areas of large collection. Local GWR model shows the relationship between near-surface fog water variability and the roughness of the terrain in agreement with recent studies on patterns and variability of Tillandsia landbeckii in Oyarbide. The GWR model is widely better at explaining the near-surface fog water and topography relationship than the OLS model with a great improvement in R^2.

Developing spatial modelling of near-surface fog water variability is useful for a better understanding of local topographical parameters influencing fog water variability but can also improve the knowledge about the geo-ecological niche of fog ecosystems of Tillandsia landbeckii and so to better understand the biosphere-atmosphere interactions in hyper-arid environments.

A8

SMALL-SCALE VARIABILITY IN FOG WATER COLLECTION AT A LOCATION ALONG CALIFORNIA'S CENTRAL COAST

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Abstract

In April, 2018, ten fog collectors, each with an area of 2.25 m2, were deployed in a clearing within an area of approximately one acre in a coastal region in Seaside, CA on the campus of California State University, Monterey Bay. Their primary purpose was to provide moisture and some protection for sapling oak trees that we are attempting to re-establish in this formerly disturbed region. Each fog collector is equipped with a rain gauge, so nearly continuous records from many of these devices are available for analysis. Both total water collected and data consisting of “pure fog” (following the removal of likely rain signatures) will be presented.

Data collected from over the past five years illustrates high consistency between fog collectors in registering fog events, but significant differences between fog collectors in the volumes of water collected during a given fog event. These differences are fairly consistent across the entire time period and may be associated with local variations in wind patterns associated with eddies generated by nearby buildings. A short period during which local winds were monitored at three different locations within the fog array during the latter part of this deployment provides some justification for this claim.

This study is significant in that it points out the potential variability in fog collector water captured as a result of nearby natural obstructions and how some of these variabilities may, at first, appear to be in contradiction to what might be expected at first glance.

A9

LARGE-SCALE VARIABILITY IN FOG WATER COLLECTION ACROSS AN ARRAY OF STANDARD FOG COLLECTOR ALONG COASTAL CALIFORNIA

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Abstract

Since 2009, a growing array of standard fog collectors has been established along coastal California, centered and focused in the Monterey area. For instance, currently there exist close to 30 fog collectors as part of the network within 5 km of the campus of California State University, Monterey Bay, and over 40 if the window is extended to a 150 km radius from campus.

This array has yielded insights on the patterns of both fog occurrence and fog abundance at various locations along California's sometimes-foggy coastline and serves as a unique testbed for long-term studies of fog variability.

This presentation addresses some fog measurements made across the array on scales of 100+ kilometers. Particularly, over this past year, a new set of standard fog collectors deployed in extremely foggy Pacifica, California exhibit a marked contrast in fog water captured, averaging, in some cases, close to 4 L/m2/day as compared, for instance, to many locations near Monterey, CA, about 150 km south, that yield collection averages less than 0.2 L/m2/day.

Similarly, this presentation examines fog occurrence and variability along transects and locations within central California that stretch inland from the mouth of the Salinas Valley at Moss Landing, CA eastward to hotter and dryer Carmel Valley as well as southward, toward Monterey and Big Sur.

As expected, fog occurrence and abundance is much greater at the coastal locations, but the seasonal patterns of fog events inland versus at coastal locations leads to some interesting insights on seasonal and longer-term fog generation at multiple locations.

A11

IMPLEMENTATION OF BIOPHILIC URBAN PLANNING BASED ON THE USE OF FOG AS A COMPLEMENTARY WATER RESOURCE IN DESERT CITIES

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Abstract

The lack and reduction of natural habitats and green spaces, recognized as multifunctional areas to increase the health and well-being of people, and the unequal access to them, is one of the main challenges cities around the world face due to its expansion, and recently, given the COVID-19 crisis. In this context, biophilic urbanism emerges as a comprehensive approach that seeks to integrate nature into the planning and design of urban spaces. Even when approaches of this type are necessary to make cities greener and improve the health and well-being of their inhabitants, their implementation is usually affected by the availability of a permanent water resource that allows their development, especially in arid and semi-arid environments, and, given the scenarios affecting water availability associated with climate change. In this regard, the cities of Chile present a significant lack of urban green areas, considering the standards suggested by the World Health Organization, of a minimum of 9m 2 for each inhabitant living in a city. The country registers an average of 4.15 m2 per inhabitant, which is decreasing towards the north. Paradoxically, the northern zone of Chile has the presence of a permanent alternative water resource, known as mist or "camanchaca." This research project is carried out in the city of Alto Hospicio, characterized by high vulnerability in terms of the well-being of its population, and, at the same time, located in an area recognized for the volumes of available fog water. The research seeks to generate knowledge about the real volumes of potentially collectable fog water in the city, through the use of Fog Collectors (locally named Atrapanieblas), with the aim of implementing the biophilic urbanism approach. Additionally, it intends to identify and analyze the preferences of the population of Alto Hospicio, regarding urban planning initiatives to integrate in the city, contributing to the integration of scientific knowledge with dialogues and decision-making processes. The research will include four analyses: first, to determine volumes of collectible fog water in different places in the city of Alto Hospicio to implement biophilic urban planning initiatives. Second, to identify the population's preferences regarding biophilic initiatives to implement. Third, to determine which native species commonly exist in the study area, which could be considered within biophilic urban planning initiatives, and finally, to identify potential sectors of the city of Alto Hospicio to implement biophilic urban planning initiatives and a system of associated fog collectors, for irrigation. The expected results are an estimate of collectable fog water (L/m 2 /day) in the city of Alto Hospicio, a classification of the most and least preferred initiatives to be implemented by the population, and zoning of the most appropriate places to implement biophilic initiatives and Atrapanieblas, having as a basic context the characterization of the population and the existing public green infrastructure

A13

INTERMEDIATE-SCALE VARIABILITY IN FOG WATER COLLECTION ACROSS AN ARRAY IN A CALIFORNIA COASTAL ENVIRONMENT, THE FORT ORD NATURAL RESERVE

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Abstract

In 2019, ten standard fog collectors (with accompanying rain gauges) were deployed across an approximately 600-acre reserve managed by the University of California. It is known as the Fort Ord Natural Reserve (FONR) and it is located in Marina, California, just several kilometers from the campus of California State University, Monterey Bay. The purpose of this deployment is to observe the spatial variability of fog deposition, particularly as it impacts the local coastal chaparral ecosystem. Significant variability exists in the presence of species across the reserve, as well as the impacts of moisture-induced plant disease within this diverse space.

As expected, significant variability in fog water collection is seen throughout the reserve, with fog collectors located further from the coast observing lesser fog. In conjunction with the fog collectors, data from leaf moisture sensors located at various points along the transect will be related to the presence or absence of fog along the reserve.

This presentation will examine some of the fog measurements collected during this time period to assess the spatial variability in the context of the distance from the coast and typical wind patterns. We will also assess the impact that the fog patterns may be having on the local flora.

A14

MEASUREMENTS OF STANDARD FOG COLLECTOR EFFICIENCIES USING FM-120 SPECTROMETERS

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Abstract

Measurements of collection efficiencies of standard fog collectors are critical in determining optimal methods to harvest water from fog at different locations. The collection efficiency is a measure of the percentage of the total amount of water available that a fog water collection device captures. In order to estimate collection efficiencies, knowledge of the liquid water content (LWC) associated with the airborne fog droplets on the windward side of the fog collector is needed as are measurements of associated water retrieved in conjunction with the standard fog collector devices. LWC measurements associated with fog are obtained through the use of a device known as an FM-120 droplet spectrometer.

We were also able to measure other efficiencies associated with water collection from fog, notably the drainage efficiency and the interception efficiency, which are related to the percentage of the water that effectively enter the final collection vessel after being collected and the percentage of the fog that is initially intercepted by the mesh, respectively. In order to accomplish this, another measurement of the fog's liquid water content is needed directly behind the fog collector, through the use of an additional FM-120 device.

In between July and November, 2020, at one of the fog collection sites in Marina, CA, near the campus of California State University, Monterey Bay, three standard fog collectors, two with double-layered raschel and one with German FogHaTin mesh, were deployed at one of the field sites. In front of these fog collectors, an FM-120 fog droplet spectrometer was deployed and directly behind one of the double-layered SFC's, an additional FM-120 instrument was deployed. All told, some fraction of the above instrumentation observed 70 fog events during this period of time. We calculated collection efficiencies for all of the events and, for the first time we are aware of, from field measurements, we were able to determine both the drainage and the interception efficiencies for the double-layered SFC for most of the events over an extended time period.

This presentation will describe the ranges of efficiencies we observed and will relate these efficiencies to several parameters, including the fog liquid water content, the wind speed and wind direction, the duration of the fog event, and the mean fog droplet size. In addition, coupled with meteorological instrumentation, we have parsed out pure fog events from mixed fog/drizzle and rain events and have assessed the impact of the drizzle events on the fog collection efficiency.

A15

PROPOSING A STANDARD: CALIBRATION OF FOG GAUGE MEASUREMENTS FOR CROSS-SITE COMPARISONS

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Abstract

Fog is highly variable across space and time. Studying the influences of fog on ecohydrological processes and water resources relies on characterizing its spatial variability over the landscape through site comparisons. Fog gauges are widely used to quantify fog in remote sites because of their simplicity and low cost to operate; however, fog gauge measurements are inherently biased due to the measurement principle and the characteristics of the instrument. Previous studies also reported data in units that are hard to interpret. Therefore, fog gauge data must be calibrated and presented in a standard unit to make meaningful, quantitative comparisons.

This study demonstrates a method for fog gauge calibration and highlights the importance of presenting fog gauge data in units that allow meaningful comparisons. We propose that fog gauges should measure cloud liquid water content (cLWC) as the standard unit for studies of fog and cloud water interception. The calibration process includes removing rainwater contamination and adjusting for the fog gauge efficiency (FGE). Rain and fog often occur simultaneously on tropical mountains, and preventing rainwater from entering the fog gauge under wind-driven rain conditions is very difficult. To exclude rain effects, the amount of rainwater captured by the fog gauge, including that from wind-driven rain, must be estimated and subtracted from the total water collection. Fog gauge performance also varies with the gauge design, particularly with the interceptor shape and the screen material. We define the FGE as the ratio of the cLWC detected by the fog gauge to the true ambient cLWC, which reflects the aggregated effects of the instrumental characteristics on the capture, collection, and measurement of fog water.

We used a shielded passive Juvik-type fog gauge in this study; however, the calibration principles apply to all fog gauge types. We estimated fog gauge rainwater collection based on raindrop terminal velocity and the raindrop size distribution using only observational data from an anemometer and a tipping-bucket rain gauge. Next, the FGE was estimated by comparing the fog gauge to a reference, which is a collocated, highly accurate cloud droplet sensor. The raw fog gauge data was first converted to cLWC without adjustment for FGE, then compared to the cLWC measured by the reference sensor. The calibration experiments show that rainwater contamination can cause significant overestimates of cLWC. The ratio of annual rainwater to total water collection by the fog gauge ranged from 7.6% to 58% across five sites. The FGE for the Juvik gauge was estimated to be about 12%, much lower than previously thought. Wind speed and cloud droplet size seem to have little influence on FGE, although more data are needed to confirm this finding. We compared field measurements at two climatically contrasting sites as an example of the calibration effects. Before and after calibration, the fog gauge data can give conflicting impressions of the "fogginess" at the two sites, which may lead to misinterpretation. This highlights the impacts of the units in which the data is presented and the importance of fog gauge calibration.

A16

INTEGRATION OF FOG HARVESTING TECHNIQUE IN GREEN WALLS DESIGN

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Abstract

Fog harvesting projects are generally developed in rural areas for agricultural purposes; instead, the potential of the fog collector could be explored to integrate water supply also for the urban environment. The aim is to meet buildings' requirements, in particular internal comfort and water demand, proposing a new architectural system that can at the same time encourage the growth of vegetation and collect water from fog. For this reason, the study is mainly divided into two parts, in the first the fog collector is presented, analyzing its components, structure and fabric, to identify its development margins in the construction industry; the second part focuses on the green facades, referring to thermal comfort, pollution absorption and vegetation analysis. The proposed investigation is useful for the development of a device integrated into the design of green facades for making them water self-sufficient and at the same time purifying the air.

A17

INTEGRATION OF THE FOG WATER HARVESTING SYSTEM IN LIGHTWEIGHT STRUCTURE DESIGN FOR EMERGENCY CAMPS

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Abstract

Growing concerns over water scarcity worldwide have led to research about technologies that have the potential to obtain water from nontraditional sources, implementing water collectors as alternative infrastructure to supply water in territories where the fog phenomenon is recurring (Schemenauer and Cereceda, 1994). The Large Fog Collector, a device commonly used for fog harvesting, is a textile-tensile structure composed of a mesh, two poles, and cables. The paper aims to integrate this technology in the lightweight structure design, for its application in emergency camps. Taking advantage of the vertical development of the device, this tensile structure shall be integrated into shelter envelopes, in order to promote resilient installations and make the structured water self-sufficient. The paper explores the design criteria for the development of a novel concept of a Smart Water Collecting Envelope (SWCE) integrated into an emergency shelter. Firstly, the SWCE is thought of as a possible add-on of two emergency shelters: (a) the “Multipurpose Shelter” (MP), designed by PoliMi with the collaboration of IFRC and produced by Ferrino; and (b) the “Cocoon Textile Unit”, designed by PoliMi with the collaboration of Sioen. Both shelters are the results of the European project S(p)eedkits (Zanelli 2016, Viscuso et al 2019, Ferrino 2023). Depending on the Fog Liquid Water Content (Klemm et al., 2012), the water can be used for basic human needs or in an optimal scenario also for domestic uses. Starting from the SWCE concept, the authors evaluate the opportunities and the limits of integrating similar devices to other family tents available on the market and study the applicability of the SWCE concept to a wider scale of the emergency camp.

A20

FIRST RESULTS FROM THE GROUNDBASED FOG AND AEROSOL SPECTROMETER

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Abstract

Except for the most pristine, warm environments, fog can be a mixture not only of liquid water droplets, but will often be mixed with dust, ash, unactivated, hydrophobic aerosol particles and ice crystals in sub-zero temperatures. In addition, the fog droplets mixed with pollution particles (smog) will have optical properties different than more pristine fog. Hence, there has long been a need to measure the properties of these types of complex fog/smog particles to better understand their composition and forecast their occurrence.

Droplet Measurement Technologies LLC (Droplet) has recently developed a single particle optical spectrometer that is a ground-based version of Droplet's airborne Cloud and Aerosol Spectrometer with Polarization (Baumgardner et al., 2001,2014). The Ground-based Fog and Aerosol Spectrometer (GFAS) measures directly, or derives:

- Equivalent optical diameter (EOD) of particles 0.5 – 60 µm.
- Number and volume concentrations > 3000 cm^{-3}
- Shape factor using polarization detection.
- Complex refractive index

The shape factor is used to differentiate liquid droplets from ice crystals, dust particles or ash from biomass burning. The complex refractive index determines if fog droplets are mixed with either dissolved or insoluble material. In addition to its unique measurements of polarized, scattered light from individual particles, the integrated wind sensor detects the direction and velocity of the mean wind and this direction is used to rotate the GFAS on its base to point into the wind and avoid inertial separation and bias.

A GFAS was deployed by the University of Stockholm in the Po Valley, Italy, as part of an international project to characterize wintertime fog in this region in 2022. This presentation will use data from this project to highlight the unique features of the GFAS, including auto-calibration, extraction of index of refraction and auto pointing into the wind.

A21

INTERCOMPARISON STUDY OF CLOUD-INSITU MEASUREMENT PROBES AT SONNBLICK OBSERVATORY, AUSTRIA

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Abstract

Under the framework of the ACTRIS (Aerosols, Clouds and Trace gases Research Infrastructure) Topical Center CIS (Cloud In-Situ) a monitoring network of cloud in-situ parameters will be set up in Europe. Cloud-In-situ monitoring has gone through a long scientific history. Several instrument developments have been made since the early 1980’s (Gerber, 1984; Cerni, 1983) in order to quantify cloud microphysical properties. Past studies found discrepancies between measurement principals and the main describing cloud parameters Cloud Liquid Water Content (LWC) and Cloud effective Radius (Reff) (Guyot, 2015). Dependencies of wind direction/speed and total number concentrations (Doulgeris, 2020) lead to further research needs.

Upon new measurement techniques and several new instruments on the market (Kaikkonen, 2020; Tiitta, 2022) an intercomparison of 15 optical and offline instruments took place at Sonnblick Observatory, Austria. During this campaign a set of integrating probes, forward scattering spectrometers and Cloud water samplers was measuring continuously for a period of 2 weeks from 21st November to 5th December 2022. 5 Particle Volume Monitors (PVM), 1 Vaisala PWD52, 2 Cloud Droplet Analyzers (CDA), 3 Fog Monitors (FM120), 2 Ground based Fog & Aerosol Spectrometers (GFAS-DPOL), 1 ICEMET, and 1 Optical Particle Counter (Promo 3000) were installed on the roof terrace of the station. The initial instrument setup contained 3 measurement sites divided by the instrument’s measurement principals. During the campaign, the setup was modified in order to investigate possible side effects (Location, wind direction/speed).

The main objectives of this field campaign were (1) to analyze and quantify discrepancies of integrating probes and forward scattering spectrometers and (2) the reliability of the out coming results with focus on the two basic parameters LWC and Reff. Under the framework of a 24/7 monitoring network the suitability for high alpine conditions (icing/hoar frost) and dependencies on wind speed/direction of all participating instruments (3) were analyzed. The general outline of the intercomparison and first results will be presented.

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A22

PROTOTYPING AN IMAGE-BASED COASTAL FOG DETECTION NETWORK USING SEVEN RGB CAMERAS ALONG THE OREGON COAST

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Abstract

In Pacific coast Mediterranean climates, where summers are characterized by high temperatures and low precipitation, summertime coastal fog provides moisture and shading to the local ecosystems. Marine fog off the Pacific coast is primarily driven by subsidence of high pressure air over relatively colder ocean waters. As marine fog moves towards the coast, the complex topography of the Pacific coast impacts air movement, resulting in hyper-local fog occurrence. Due to the complex and dynamic nature of coastal fog formation, a quantification of fog's role in local weather and water cycles requires a high spatial resolution dataset. Image data from cameras capturing the visible spectrum in red, green and blue bands are common along the coast, for example camera networks that monitor surfing conditions, such as Surfline (www.surfline.com) and traffic cameras that look over coastal highways. The images from cameras present an opportunity to analyze spatial patterns of fog formation, however, there first needs to be a reliable methodology for fog detection using image data. We propose testing two different machine learning methodologies, an unlabeled clustering model and a labeled deep learning model to determine the accuracy and scalability of an image-based fog detection network.

We have collected a database of ~75,000 images at seven locations along the Oregon coast, six of which have data for the summer of 2022 and one that has data from 1992-2019. They come from two sources, (1) images saved from Surfline's webpage after getting written permission from Surfline employees and (2) images provided by Dr. Rob Holman's lab. The background images in each of these seven sites range from partially to completely overlooking the ocean. This presents a unique challenge: there are few background objects which could be obscured by fog, which reduces the presence of a key signal that the image contains fog. We will test a Gaussian Mixed Model, unsupervised clustering method, on each site separately to see if the model makes distinct clusters between foggy and not-foggy images. We will compare these results to a Convolutional Neural Network, which we will train on labeled images from all the sites to see if the model can detect the fog in images with different backgrounds. This study provides insight on which methodology can reliably detect fog and be applied to webcams globally.

A23

MODIFYING THE CALTECH ACTIVE STRAND CLOUDWATER COLLECTOR FOR APPLICATION IN COMPLEX TERRAIN

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Abstract

Global atmospheric nitrogen deposition is known to drive detrimental impacts including biodiversity loss, changes in plant community composition and water quality degradation. Evidence from environmental physics research has shown that nitrogen deposition over complex terrain and surfaces is enhanced as compared to that in flat terrain. By overlaying two simple categories of terrain complexity on modelled UK reactive nitrogen (Nr) deposition estimates, we show that this enhancement could be 20-50% higher than in flat terrain. In high-elevation environments, cloud and fog water samples are typically 5-20 times more concentrated in pollutants than rainwater. Deposition from fog and cloudwater can therefore account for a significant uncertainty in Nr deposition estimates in complex terrain. Fog and cloudwater collection for chemical analysis is challenging at complex terrain sites due to conditions such as high winds, availability of continuous power supply and contamination from rainwater. This study shows the scale of fog at a northern European site and progresses a conditional sampling strategy with automated modifications to the size-fractionating Caltech Active Strand Cloudwater Collector (CASCC). The CASCC was interfaced with a Biral VPF-750 Present Weather. Only upon detection of fog by the Present Weather Sensor, the CASCC begins sampling by activation of a 12V DC axial fan, which is switched on by a signal from a data logger. This ensures minimal power consumption by the CASCC and prevents contamination of the sample during rain and snow events. An additional automated lid was fitted on the inlet of the CASCC to avoid further contamination when sampling is deactivated. During activation of the fan, a signal is also sent to a linear actuator which opens the lid. In this study, we provide the design and working of the modified CASCC. We also present initial estimates of capture efficiency and fog chemical composition by comparing the automated collector against, theory, a passive fog collector and a non-automated CASCC.

A24

FOG: A NEW TOOL AND GAME CHANGER IN ALGAL BIOTECHNOLOGY

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Abstract

For several decades, upscaling in algae bioengineering has focused on submersed aquatic culture conditions in suspensions with water-controlled ponds or photobioreactors. New biotechnological developments use immobilised microalgae that grow air exposed (emersed) as biofilms on carriers wetted with artificial fog. In combination with the use of terrestrial microalgae as production strains, their desiccation tolerance also eliminates the need for permanent overlaying with water films and the cultivation process can be implemented with nutrient-rich aerosols in a way that saves both resources and weight. This offers new vertical and decentralised perspectives for upscaling from the laboratory to the technical plant and makes it possible, for example, to open up facades as new biotechnological production areas. Some recent developments regarding fog-applications in algal biotechnology are presented.

A25

NUMERICAL STUDY OF A PLANE DEW CONDENSER

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Abstract

Dew water, whose condensation and collection needs only passive radiative energy, is an attractive solution to obtain water from the atmosphere. Dew could, at least partially, counterbalance the climate change's effects. The simplest dew condensers are planes thermally isolated from below and tilted with horizontal. This work addresses how the characteristics of such planar condensers and the climatological conditions affect the yield of condensed water. The results obtained can accurately predict water condensation on a plane surface for different locations around the world using meteorological data, allowing the water condensation potential to be estimated. This tool can also calculate how water condensation could look in the future within a set of evolving meteorological conditions in the context of global warming.

We present the main results obtained from a comprehensive numerical study of the functioning of such a condenser with 1 m typical length under the assumption of laminar airflow [1]. The mathematical and computational framework uses Mathematica in a finite element analysis for estimating and increasing water condensation using actual meteorological data and transient analyses. Wind speed and condenser tilt angle with horizontal are varied. A 2D numerical analysis of the water condensation process driven by the thermodynamical phenomena of convection, radiation, condensation, and evaporation and its interaction with a fluid (humid air) is made using the Navier-Stokes-Equation and an energy balance Equation. The 2D analysis reduces the complexity of the solution domain; a 3D analysis was however carried out to compare air velocity results. The angular variation of the sky radiation is taken into account. The emissivity of the condenser surface is taken to unity, close to that of a wet substrate dominated by water emissivity (0.95; 0.98 in the atmospheric window). Windspeed and condenser tilt angle with horizontal is varied.

The simulation results give values of the heat and mass transfer coefficients (they are proportional) with respect to windspeed, validating a variation with the windspeed root square. Water condensation can also vary as the unit per length of the condenser because the heat transfer coefficient varies over the condenser distance. The most optimal value is around 0.75 m in length. The value of the condensed water is also obtained. Using Mirleft (Morocco) meteorological inputs for September 28th-29th, 2007, to solve multiple results, the maximum water condensation occurs when the tilt angle is between 10° and 15°. With respect to windspeed, the highest water condensation occurs when the wind velocity is below 0.66 $m.s^{-1}$ (at 10 m from the ground), and the heat transfer coefficient is around 5 $W.m^{-2}.K^{-1}$. The dew yield is also seen to compare well with the experimental data from different locations and time frames, validating the model's accuracy.

[1] Flores-Castillo, P., 2022. Computational Analysis of Water Condensation for Passive Dew Condensers to Optimize Water Condensation (Master dissertation, Harvard University).

A26

THE EMISSIVITY OF A CONDENSING SURFACE IS DOMINATED BY WATER

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Abstract

Condensation of dew water involves primarily radiative cooling. A substrate of high emissivity in the atmospheric window is thus quite generally looked for. In this work, we show that, after a transient, it is the emissivity of condensed water (0.96 and 0.98 in the atmospheric window) which controls the radiative cooling in the steady state. A very large substrate emissivity is therefore not a necessary condition for enhanced dew recovery. This result is of conceptual and practical importance and can be generalized to any process involving water vapor condensation induced by radiative cooling.

One first develops an optical model to determine the normal emissivity of a pattern of sessile water drops. This model reveals first a threshold for the thickness of the water slab above which its emissivity is a constant equal to the emissivity of water. For non-emissive substrate, a water layer thickness larger than 20 µm is needed to reach an emissivity of 0.98 in the atmospheric window, and 12 µm to reach 0.96 in the whole wavelength range.

Coming now to a pattern of sessile water drops, the fraction of wet surface during condensation is a key parameter to determine an effective emissivity. During dropwise condensation, the surface fraction wet by the drops increases with time and the effective substrate emissivity stabilizes to a value close to the water emissivity. It follows that the effective emissivity of high or low emissivity substrates reach similar values when wet after a time that depends on the condensation rate.

In order to illustrate this point, experiments using an IR camera are performed with substrates of same wetting properties (contact angle 66°) but different emissivities, with low (0.05) and high (0.88) values. The effective emissivity of the wet substrate can be deduced from the measured sample temperature and the IR radiance averaged on the camera pixels. After a short time (~ 1000 s in the conditions of the experiments), an asymptotic value of ~ 0.98 is obtained for the high emissive substrate. The low emissive surface reaches later an asymptotic value of ~0.94 after a time of ~ 5000 s. Interestingly, the optical model gives nearly the same asymptotic values than measured, that is 0.975 (high emissivity substrate) and 0.934 (low emissivity substrate).

In the steady state of condensation, substrates with moderate emissivity will therefore have condensation yields comparable to a substrate with very high emissivity. This result is interesting for many applications.

[1] Effective substrate emissivity during dropwise condensation. J. Trosseille, A. Mongruel, L. Royon and D. Beysens, Int. J. Heat and Mass Transfer 183 (2022) 122078.

A27

LARGE ENHANCEMENT OF DEW WATER CONDENSATION ON SELF-LUBRICATED SILICONE

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Abstract

Condensation of water vapor from humid air is driven by a vapor concentration gradient at the vicinity of the liquid-air interface. This gradient otherwise gives a limit to the condensation rate. We show in this work that this limit can be significantly surpassed and condensation greatly enhanced by the continuous refreshment of the condensation surface leading to continuous nucleation, a process which does not involve the presence of a steady limiting diffusion layer.

For this purpose, we use a Polydimethylsiloxane (PDMS) gel swollen in a silicone oil. The resulting material is an oil-imbibed PDMS gel (iPDMS), or self-lubricated silicone. The silicon oil migrates at the surface to form a thin layer whose thickness increases slowly with time as a result of the restructuration of the PDMS gel [1]. If depleted, this oil layer is spontaneously renewed thanks to the reservoir of oil in the cross-linked matrix. The thickness of the oil layer can be tuned and measured as a function of time.

In this study, water condenses on iPDMS with different oil layer thickness ranging from 0.02 to 4 m. During condensation, new physical mechanisms are at play compared to condensation on non-infused PDMS. Because oil spreads on water, the water droplets of nm scale that nucleate at the oil-air interface are immediately engulfed within the oil film. The oil-air interface is thus continuously refreshed for new nucleation and engulfment of water droplets. Droplets in oil grow by coalescence until they become sufficiently large to emerge from the oil layer. Upon emergence, water droplets are cloaked with a thin oil film. Then, they continue to grow by the incorporation at their surface of water molecules that have permeated through the oil film. Growth thus proceeds from the classical mode limited by a diffuse gradient. In addition, an oil meniscus present at the drop perimeter causes attractive capillary interactions between distant droplets. The growth of droplets by coalescence is thus enhanced. Finally, drop shedding on inclined surfaces is facilitated because of the very low hysteresis inherent to the water-oil interface. Altogether, drop engulfment, meniscus-induced coalescences and fast shedding continuously refresh the oil surface and permits new nucleation to continuously take place.

On a vertical surface, when the oil layer thickness is increased from 0.25 mm to 4 mm, the latency time for droplet shedding is reduced from 1 h. to 5 min. and the amount of collected water is increased by 50% after 4h of condensation. The cost for this enhanced condensation and collection of water drops is, however, the presence of a very slight fraction of silicone oil in the collected water (less than 0.1%). This oil, nevertheless, simply separates from water, the two being immiscible.

[1] Lavielle, N., Asker, D. & Hatton, B. D. Lubrication dynamics of swollen silicones to limit long term fouling and microbial biofilms. Soft Matter 17, 936–946 (2021).

A29

A SINGLE COLUMN STUDY OF MARINE FOG FORMATION THROUGH CLOUD BASE LOWERING

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Abstract

Marine fog is a major hazard to maritime navigation. Marine fog can form through a variety of physical mechanisms, each with different sensitivities to synoptic and microphysical conditions. One of the most common types of marine fog is cloud base or stratus lowering fog, which forms as a low stratus deck that is capped by an inversion grows downward until it reaches the surface. This type of fog in most ocean regions known for their fogginess. Cloud base lowering (CBL) fog is Lagrangian from a column perspective, making it ideal to simulate with a single-column model (SCM). In this study, we use the PAFOG SCM developed by Bott et al. We initialize typical CBL setups, with a shallow, cloudy marine boundary layer capped by a strong inversion, that consistently forms fog. We then test the sensitivity of the timing of fog development and fog properties to the droplet concentration and droplet distribution width of the initial cloud deck. These properties were shown to exert a strong control on fog formation in our previous study of marine fog. Initial results from this new study will be presented.

A30

POINT REYES AS A MICROCOSM: INITIAL RESULTS FROM A FOG-DEPENDENT ECOSYSTEM WARMING EXPERIMENT

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Abstract

Warming temperatures from global climate change are contributing to a steady decline in fog occurrence in the San Francisco Bay Area. Coastal grasslands in Point Reyes rely on fog to survive through the dry season when meteoric precipitation is rare, but fog is present most mornings. Point Reyes Field Station in Olema Valley, California is a heavily sensed perennial grassland where the Lawrence Berkeley National Laboratory soil warming project will take place to simulate the effects of climate change on soils, with a specific emphasis on soil microbial populations. This presents the unique opportunity to quantify the response of grassland water uptake to warming soil temperatures and to untangle the effects of the expected increase in nitrogen availability as a consequence of enhanced microbial activity and the decrease in soil moisture availability.

Here, we will present the results of a characterization study conducted on greenhouse-grown Colonial Bentgrass (*Agrostis capillaris*) and Fawn Tall Fescue (*Festuca arundinacea*), two of the three dominant species at the site. The grasses were grown in controlled greenhouse conditions, where we then conducted a tracer experiment in which the plants were misted using water enriched in ^{18}O with the soil protected and unprotected. The water in the roots of the plants was extracted and analyzed to determine whether the two species uptake fog water through foliar uptake or through stemflow combined with root uptake.

A31

INTERANNUAL VARIATIONS IN FOG COLLECTION IN THE EASTERN IBERIAN PENINSULA AND FORCING MECHANISMS OF THE LARGE ATMOSPHERIC SCALE

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Abstract

The interannual variability of the monthly accumulated and monthly daily frequency of fog-water collected in the east of the Iberian Peninsula in the period of available data, 2003-2012, is studied. We objectively characterize its variations in space and time throughout the annual cycle, with emphasis on the wet phase where the highest frequency of occurrence and the highest monthly volumes of fog-water collected are recorded. This allows the identification of two independent regions of variability: northern region (NR), represented by the Colomer collector, and southern region (SR), represented by the collectors of Mondúver, Montgó and Mariola. Previous works showed that locally, sea breeze, seasonality, elevation, surrounding topography and distance to the sea are differentiating factors. In synoptic terms, moisture transport from the Mediterranean and cyclonic tropospheric circulations favors the collection of fog, while anticyclonic tropospheric conditions favor an increase in the frequency of foggy days, although with less significant fog-water volumes. The synoptic variability of the tropospheric circulation in the western Mediterranean basin explains much of the occurrence and intensity of collected fog-water. The tropospheric climatic circulation over Europe that determines the predominant monthly meteorological conditions for the monthly accumulated fog-water collected in the NR is defined by a cyclonic anomaly centered on the southwest coasts of the Iberian Peninsula and northwest Africa, and an anticyclonic anomaly centered over the Baltic region; in the SR, the anomalous structure is similar, although with a more intense SW-NE gradient. The latter favors an anomalous westward mass flow over the Iberian Peninsula, being more intense for the SR, accompanied by intense anomalies of specific humidity at lower tropospheric levels in eastern Peninsula Ibérica. There appears to be large-scale forcings that modulate the interannual tropospheric circulation variability linked to collected fog-water associated with hemispheric and regional quasi-stationary wave activities, particularly in the wet season, from October to May. This study would provide predictive indicators of the climate system in the context of climate change and low-frequency variability to understand the climatic conditions that favor the availability of fog-water collected in the long term.

A32

MAPPING PAST AND FUTURE DEW, RAIN AND EVAPOTRANSPIRATION EVOLUTIONS IN NORTH-WEST AFRICA (2005–2100) ACCORDING TO MEASURED DATA AND CLIMATE SCENARIOS

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Abstract

Global warming and reduction in fresh water availability are often related. This is especially the case for North Africa (Morocco, the Canary Islands, West Algeria), which is considered a hot spot where the combination of climate change and strong population growth is very likely to further aggravate the already scarce water situation. In this context, the present study addresses the evolution of dew, rain and evapotranspiration in W-Africa from meteo data. Measurements have been collected for the period 2005–2020. The other data for the period 2020–2100 are concerned with the low and high emissions representative concentration pathway scenarios RCP 2.6/8.5 from the coordinated regional climate downscaling experiment database.

Meteo data are used for rain and evapotranspiration. Dew was calculated from a formulation which needs only a few meteo data in a calculation based on an energy balance [1]. Already measured meteo data are downloaded from several sites. Predicted data correspond to the climate simulations from the Météo-France model CM5-ALADIN63. The files are downloaded from the Coordinated Regional Climate Downscaling Experiment (Cordex) database.

The results are presented and discussed with maps giving the volume and the frequency of dew and rain events. Evapotranspiration is also analyzed together with its evolution. One notes than the relative contribution of dew with respect to rain can reach 12% in the coastal and near coastal regions of SW Morocco (Agadir/Casablanca/Marrakech/Oujda) and NW regions of Algeria (Oran/Tlemcen). For desert sites (Béchar, Tindouf) the cumulative dew/rain ratio presents values in the range 4 to 8%.

The evolution in the studied is characterized by a notable continuous decrease in rain precipitation. In particular, for the RCP 8.5 scenario, the decrease is about −14 mm.decade−1, the more credible scenario because the decrease is already observed since 2000. The decrease is maximum on the coast and on the foothills of Atlas. Only the extreme south of the country (Mauritanian border) could experience a significant increase in rainfall.

One also observes a diminution in dew yields along a NW/SE axis, strongly correlated with a decrease in relative humidity (up to 7%). The areas from the Atlantic coast to the Sahara Desert are gradually impacted by this reduction. Sahara also experiences a decrease in dew yields, especially from the highlands (Atlas Mountains) towards SW. There is a general tendency to see a reduction with increasing distance from the sea, located W and N, correlated with a diminution in nocturnal relative humidity from NW to SE.

Concerning evapotranspirations, the potential evapotranspiration should display an increase over the century, weak for the scenario RCP 2.6 (+4.0 mm.decade−1), larger for the scenario RCP 8.5 (+7.4 mm.decade^{-1}). This increase is related to the expected rise in ambient temperature. The actual evapotranspiration is lower in 2100 than in 2006, with −15.8 mm.decade^{-1} for RCP 2.6.

[1] Beysens, D., 2016. Estimating dew yield worldwide from a few meteo data. Atmospheric Research 167, 146–155.

A33

OBSERVATIONS OF FOG CHEMICAL COMPOSITION OVER A 15 YEAR PERIOD

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Abstract

Fog samples have been collected over a period of 15 years, from 2008 through 2022, at a rural location in Pennsylvania, USA. This long-term field study was designed to document the fog chemical composition in the region, to evaluate changes in composition over time, to shed light on emission sources, and to support a variety of shorter-term investigations such as ammonia partitioning and, most recently, the identification of bacteria present in fog water. The study location experiences radiation fog between May and November, though the highest frequency of fog events occurs in September and October. An automated Caltech Heated Rod Cloudwater Collector (CHRCC) was used to collect a single bulk sample per fog event. Samples were collected and analyzed for pH, major inorganic ions, and low molecular weight organic acids. A subset of samples was also analyzed for total organic carbon (TOC), total nitrogen (TN), bacteria, and N-nitrosodimethylamine (NDMA). Ammonium, sulfate, calcium, and nitrate were the most abundant major ions and formate and acetate were the most abundant organic acids. The concentrations of major ions, inorganic acids, and TOC were found to be on the lower end of values reported in the literature from similar studies around the world. Statistically significant decreasing trends were observed over the duration of the project for sulfate, nitrate, ammonium, and chloride. Sulfate concentrations decreased more rapidly than nitrate, such that the ratio of sulfate to nitrate decreased from approximately 4 at the beginning of the study to 0.7 by the end of the study. Annual average pH increased during the length of the study, though the lowest pH samples were typically associated with high concentrations of organic acids. Finally, ion concentrations in fog were observed to be higher than those in dew, based on two shorter duration dew studies conducted at the same site.

A34

MAPPING FOG OCCURRENCE AND FOG COLLECTION POTENTIAL FOR FOOD SECURITY IN SOUTHERN BOLIVIA

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Abstract

The rural area of “Valles Cruceños”, Bolivia, is characterized by water scarcity and increasing pressure for food production by the neighbouring of Santa Cruz de la Sierra. Here, orographic fog is a phenomenon occurring all year round, representing a sustainable water resource for improving farmers' resilience to dry spells and for promoting food sovereignty. This research aims to first assess the potential of fog collection in the area by a 1-year experimental analysis made through 1-m2 fog collectors placed in 10 different locations. Starting from the collected data, we design under safe assumptions (including sensitivity analysis) a fog water irrigation system providing water for a standard theoretical field with local crops in the dry season. Results showed an average of 6.01 l/m2/d can be obtained from most productive areas, with peaks up to 8.93 l/m2/d. The present paper represents the first study on fog collection in Bolivia. Moreover, to the best of our knowledge, the work represents one of the first consistent studies on the productive use of orographic fog, while a large part of the literature focuses on advection fog, mostly occurring on the Pacific Coast of South America.

A35

MARINE FOG MICROPHYSICS DURING FATIMA: TURBULENCE IMPACT ON FOG LIFE CYCLE

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Abstract

The goal of this work is to compare microphysical parameters obtained from various fog measurement devices including FM120, CDP, and BCP probes of DMT (Droplet Measurement Technologies) Inc., and a low-cost Alphasense optical particle counter (OPC-N3). The impact of marine-fog microphysical properties and turbulence on the life cycle of fog is also investigated. Measurements were collected during July 2022 as part of the FATIMA (Fog and turbulence in the marine atmosphere) field campaign that took place over and nearby Sable Island and Grand Banks. The measurements were gathered on the Atlantic Condor ship by a Gondola (a combined CDP and BCP system) and an FM120 mounted on the deck and a CDP mounted on a crane, as well as by an FM120 and OPCs on Sable Island that include OPCs mounted on a UAV (unmanned aerial vehicle) and a tethered balloon system (TBS). Horizontal wind speed (Uh) and direction, as well as ship heading, are considered in the analysis of droplet counts. The OPC-N3 had 24 bins from 0.3 µm to 40 µm, while the FM120 and CDP had 30 bins from 1-50 micron, and the BCP had 30 bins from 5-75 µm size range. Turbulence fluctuations obtained from 3D sonic anemometers, that likely impacted particle size distributions (PSDs), are also considered in the calculations. In the analysis, various parameters such as liquid water content (LWC), droplet number concentration (Nd), and mean volume diameter (MVD) are analyzed to recognize the issues related to measurements and developing parameterizations. In the presentation, visibility (Vis) values, representing marine fog conditions, calculated from the PSDs and visibility sensors will be evaluated for marine fog predictions and physical parameterizations with respect to wind speed and turbulence effects.

This work was funded by the Grant N00014-21-1-2296 (Fatima Multidisciplinary University Research Initiative) of the Office of Naval Research, administered by the Marine Meteorology and Space Program.

A36

THE ENSO RELATION IN THE SPATIAL DISTRIBUTION OF FOG AND LOW CLOUDS (1995-2022) IN THE ATACAMA DESERT (18°S-35°S)

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Abstract

A semi-permanent stratocumulus cloud deck is constantly present in the coastal Atacama Desert producing a regular fog belt, which represents a complementary water resource to supply several locations in Chile. As a spatial and temporally extended phenomenon, understanding its inter-annual variability, and long-term relationship with global phenomenon such as ENSO, represents a scientific challenge since this variability has been observed only locally. We propose to analyze the spatiotemporal variability of fog and low clouds (FLCs) in the coastal Atacama Desert of Chile (18°S-35°S) and the influence that ENSO has on this phenomenon. We analyze the last twenty-seven years (1995-2022) of GOES satellite images to identify monthly averages of day and night fog and low clouds based on thermal differences and temperature filters. We validate our results with visual cloud cover data (oktas) obtained from six airports in the study area. For determine the ENSO-fog relationship, we use the oceanic El Niño index, analyzing 3-month averages of anomalies in the Pacific 3.4 zone (5°N-5°S; 120°W-170°W). Our results show that the spatiotemporal variability of FLCs has a marked seasonal cycle and the observed trends show that there are no important changes in the presence of FLCs in the different latitudes during the study period. Only some weak positive trends are observed during cold seasons which may be related to the predominance of La Niña-Like decades. Usually, in the north (south) there is a higher (lower) frequency in the spring (summer) months, while the minimum frequency in the north (south) is in the summer (winter) months. Moreover, our findings show that ENSO has a potential connection with low clouds and fog frequency, which present a marked latitudinal difference with a breakpoint around ~25°S, verifying the above described spatially. In the northern area (~20°S) warm phases of ENSO (El Niño) in summer (winter) increases (decreases), while in the cold phases (La Niña), occurs inversely. Conversely, in the south (~30°S), its behavior is reversed, warm phases of ENSO (El Niño) in summer (winter) decreases (increases) the low clouds, while in the cold phases (La Niña), occurs oppositely. Our research will help us to understand present and future distribution of fog and low clouds, as well as the long-term use of fog water.

A39

∑ 10^6 = 1 HIGH YIELD ZERO-CARBON COALESCENCE OF ATMOSPHERIC LIQUID MICR-DROPLETS

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Abstract

Water scarcity and climate change necessitate exploring additional water resources including unconventional sources of zero-carbon water such as the hydrologic cycle. Liquid water of fog and clouds that do not rain is a valuable source of water if it could be extracted efficiently, economically and without carbon footprint. Many scarce water locations possess liquid water resources in the form of frequent dense fog and clouds that do not rain to their potential. Research to collect atmospheric liquid water in the form of fog using fog water collectors has benefited many communities around the world since the 1960s. Commercial applications, however, require a significant increase of water yield. A new technology, called Atmospheric Aerostat Coalescer (AAC), uses a process that first isolates the water micro-droplets of fog and clouds from the air then coalesces them to large drops that fall for collection. It takes on average, one million micro-droplets of cloud water to coalesce to one large drop to fall as rain. The yield was 250 grams/square meter of coalescers per day. The technology may commercialize water collection from fog and clouds pending favorable field pilot testing. The research used high-speed and high-resolution cameras to study fog water collection of Rachel mesh and other configurations. It showed micro-droplets growing to big drops or break up and then fly away carried by the increased air speed and drop in pressure between the filaments as predicted by Bernoulli principle. Collection efficiency of Rachel mesh was 3-5%, compared to 71% by AAC.

Attempts to collect micro-water droplets on solid or semi-solid and liquid surfaces are challenging due to the complexity of liquid-solid and liquid-liquid interactions. Recent research shows the interaction is influenced by complex mechanisms including surface hydrophobicity, its wettability, topography, interfacial tensions, droplet/air/vapor deformations and other factors. However, the rapid development of nano imaging technology, high-speed video measurement technology, surface processing technology has provided researchers with better tools for details. Some of these advances were employed in the presented research such as hydrophobicity, topography and orientation in addition to high speed and high-resolution camera. Maximum water collection of Rachel mesh of 3-5% was at 4 m/s.

A40

CHARACTERISTICS OF THE MACRO- AND MICRO-STRUCTURES OF THE DIFFERENT GRADES FOG IN JIANGSU , CHINA

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Abstract

Based on the minute-resolution meteorological elements data observed at 70 automatic weather stations in Jiangsu, the second-resolution sounding data of 3 sounding stations and the fog droplet spectrum data of 21 dense fog events, from January 1, 2013 to December 31, 2018, the spatial and temporal distribution, boundary layer structure and microphysical structure characteristics of the fog at different grades in Jiangsu were analyzed. The results show that in recent years, the number of fog hours in Jiangsu are distributed along the Yangtze River and to the north along the Huaihe River. The average annual fogging time at each station is 318.5h, the strong dense fog and extremely dense fog were mainly concentrated along the Huaihe River and its north, accounting for 16.4% of the total fog hours. The probability of occurrence of fog in Jiangsu is the highest at 05:50, and the probability of occurrence of fog in winter, spring, summer and autumn is the highest at 07:10, 05:50, 05:20 and 05:50, respectively. The temperature structure of fog at different grades between 0 and 1500 m has inversion layer, and with the increase of fog intensity, the inversion intensity increases. And the relative humidity is saturated in the lower layer, but with the increase of fog intensity, the relative humidity of upper layer decreases. With the increase of fog intensity, the number of fog drops of different sizes all increase, and the spectrum of fog drops expands obviously when strong dense fog or extremely dense fog occurs.

A41

A YELLOW SEA FOG OBSERVATIONS AND MODELING USING THE SOCHEONGCHO OCEAN RESEARCH STATION

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Abstract

Sea fog can impact coastal regions by increasing the risk of maritime accidents. It can also affect the local weather and climate by reducing incoming solar radiation and modifying atmospheric temperature and moisture. The Yellow Sea is the most frequently foggy area along the Korean coast. In the Yellow sea, sea fog often contributes to serious transport accidents in the open sea and coastal regions. Therefore, accurately predicting sea fog in the Yellow Sea is imperative. The Socheongcho Ocean Research Station (SORS) is a steel-framed tower-type platform located at 37°25’ N, 124°44’ E over the Yellow Sea and designed to monitor long-term oceanic variance, enabling interdisciplinary scientific investigation. In this presentation, we summarized sea fog observations at SORS and applied them to the numerical study. Accurate sea fog simulation and prediction remain challenging for numerical models. The Weather Research and Forecasting (WRF) and Parameterized Fog model (PAFOG) were selected for the numerical study. The fog cases were collected with a present weather detector to monitor visibility. Turbulent fluxes have been observed by an open-path eddy covariance system composed of a sonic anemometer and an open-path infrared gas analyzer. The sonic anemometer is installed on the intermediate deck at the height of 7m and 10m from the mean sea level to obtain a direct air-sea interaction process. All data were subject to quality control to detect any unrealistic value checks before analysis using EasyFlux. The ceilometer measured the backscatter profiles of the range corrected signals. From this, the heights of cloud bases, inversion bases, and PBL heights can be determined over time. Radiosonde observation was also conducted for detailed profiles that show the evolution of the lower atmospheric structure and sea fog layer with air temperature, dew point and wind speed profiles. Along with the analysis of SORS observations, sensitivity tests for vertical initial conditions of the PAFOG model were compared SORS observations and reanalysis data. Turbulent fluxes and PBL height simulation results were also verified with observations.

A43

PERFORMANCE COMPARISON OF SEVERAL NUMERICAL WEATHER PREDICTION MODELS IN THE FATIMA 2022 CAMPAIGN PERIOD

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Abstract

The FATIMA (Fog and turbulence interactions in the marine atmosphere) project is a multi-year project seeking advance leaps in the fundamental understanding of the marine-fog life cycle via a cross-disciplinary approach. In July 2022, a field campaign was conducted on Sable Island (offshore from Nova Scotia, Canada) as well as over the Grand Banks area in the North Atlantic. Grand Banks is one of the foggiest locations, with 45% occurrence during June-July-August. Sable Island is a narrow and long island, with significant amount of fog during the summer. Thanks to the land, various sets of equipmentequipment can be set up for observations. ECCC (Environment and Climate Change Canada) also has a weather station on the island.

During the campaign, there were daily weather briefing meetings where the weather conditions in the next 1-2 days were forecasted and discussed, as a guide to the crews on the field for equipment set-ups. Some regional scale NWP (numerical weather prediction) models were used to forecast the period. They were the COAMPS (Coupled Ocean/Atmosphere Mesoscale Prediction System) model from the U.S. Navy, and two WRF (Weather Research and Forecasting) models with different settings. The models are high-resolution so that the relatively narrow (~ 1km) sand bar land of Sable Island can be seen in the domains. The results of the models are compared to the ECCC observations, including temperature, dew point, wind speed, wind direction, and fog periods. It is found that different models can give similarly good results of temperature, dew point and wind. However, fog period prediction is not as accurate as other variables, and the models performs differently.

A45

ANALYSIS OF A SEA FOG EVENT IN YELLOW SEA BESIDES THE CENTER OF TYPHOON LEKIMA (1909)

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Abstract

This study focuses on the physical process of a sea fog event during Typhoon Lekima(1909) in the Northern Yellow Sea by using observation data, reanalysis data and backward trajectory model. The analysis indicates that the typhoon circulation was the decisive factor determining whether fog formed offshore and developed inland. The warm and humid southerlies from the south Yellow Sea condensed into fog on the colder sea surface besides the typhoon center, which not only provided sufficient moisture for the formation and development of the sea fog but also formed a significant inversion layer over the fog area with the downdraft in the center of the typhoon. The "stable up and turbulent down" structure in the boundary layer improved the development of sea fog on the coast and inland area. However, the horizontal wind steering and the strengthening wind speed behind the typhoon strengthened the wind shear in the boundary layer, resulting in the enhanced turbulent mixing and the decrease of the stability in the bottom boundary layer, which was the main cause of the fog dissipation.

A46

SPRINGTIME SEA FOG PENETRATION IN QINGDAO: ANOMALOUS MOISTENING AND DIURNAL COOLING

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Abstract

Sea fog often penetrates adjacent coastal areas, a process called sea fog penetration (SFP). SFP can cause traffic accidents and other economic losses. Qingdao, an international port city with a dense population, suffers from SFP originated over the Yellow Sea in the boreal spring (March-May); the process, however, is not well studied. Based on hourly observations from buoys and automatic weather stations distributed in Qingdao and its adjacent islands, we composite SFP events to reveal their spatiotemporal features and to investigate mechanisms involved. Results show that these SFP events often penetrate inland areas from southeast to northwest and last 5-8 hours at night. We further use reanalysis data to reveal that during the daytime before SFP, strong moisture advection at 925-975 hPa brings sufficient water vapor from Yellow Sea to Qingdao; the water vapor then transfers downward to the surface via background descending motion and turbulent mixing. The daytime anomalous moistening, together with the following diurnal cooling at night, saturates the surface atmosphere and hence facilitates SFP. The strength of the SFP depends on the strength of daytime anomalous moistening. Considering the moistening leads SFP by about a day, we use this relationship to predict the intensity of SFP. The accuracy of predicting SFP events could reach 50%~80%, which highlights the predictability of intensity of SFP in Qingdao.

A47

OBSERVATIONAL ANALYSIS OF A FOG EVENT IN THE OYASHIO EXTENSION AREA

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Abstract

The northwest Pacific is the most foggy oceanic area in the world. Low visibility in fogaffects navigation heavily, yet the synoptic processes of sea fog formation over open oceans remain unclear due to the lack of in-situ observations so far. In September 12-14, 2019, a Chinese arctic research vessel, XiangYanghong 01, captured a fog event in the cold Oyashio Extension (OE) area. The mechanism of the fog formation and maintenance is investigated in the present study based on the in-situ observations. The results show that the fog formation was influenced by both a synoptic-scale warm front in a mid-latitude cyclone system and a local SST front (sea surface temperature front). Warm humid air was transported from south to north along with the warm front, which resulted in the near surface air becoming warmer and wetter in the OE area. The fact that the moistening effect was greater than the heating one led to the relative humidity increasing and close to saturation. On the other hand, the northward warmer air climbed upward when met the colder air mass over the OE water, thus forming a large-scale frontal temperature inversion. The bottom of the inversion dropped further affected by a sinking branch from a vertical circulation in the marine atmospheric boundary layer, and this vertical circulation was very likely to be induced by the local SST front. The lowered inversion was conducive to fog droplets, once formed, to be confined near the sea surface. The fog layer was formed in the warm moist air on the cold flank of the SST front. The contributions of the background atmospheric warm front and the local SST front to fog formation is clarified and a relevant conceptual model is proposed, which are helpful for understanding of the physical processes in the formation of marine fog and for fog forecast in open oceanic area.

A48

ATMOSPHERIC CONDITIONS CONDUCIVE TO MARINE FOG OVER THE NORTHEAST PACIFIC IN WINTERS 1979-2019

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Abstract

Observations show that the northeast Pacific (NEP) is a fog-prone area in winter, compared with the northwest and central Pacific where fog rarely occurs in winter. By synthesizing observations and reanalysis results from 1979 to 2019, this study investigates the atmospheric circulation and marine atmospheric boundary layer (MABL) structure associated with marine fog over the NEP in winter. The composite analysis shows that the eastern flank of the Aleutian low and the northwestern flank of the Pacific subtropical high jointly contribute to a northward air flow over the NEP. Under such conditions, warm and moist air flows through a cooler sea surface and facilitates the formation of advection-cooling fog. The air near the sea surface in foggy areas is cooled by the downward sensible heat flux. The smaller upward latent heat flux (10 W·m-2) compared to the surrounding area (60 W·m-2) demonstrates that the moisture originates from the advection instead of local evaporation. The lower (at 925 to 875 hPa) and stronger (up to 0.08 K·hPa-1) inversion layer, compared with cloudy cases and the turbulence in the lower atmosphere (below 975 hPa), also promotes fog formation and evolution. About 68% of all fog cases (42242) show positive differences between surface air temperature (SAT) and sea surface temperature (SST), while 32% are negative, both during southerly winds. Composite analysis of the latter shows lower specific humidity above the inversion bottom compared to the former. The dry air enhances longwave radiative cooling from the fog top, favoring cooling of fog layer, gradually causing SAT to fall below SST.

A49

EXAMINATION OF A FOG EVENT RELATED TO A LARGE-SCALE CYCLONE AT SABLE ISLAND DURING FATIMA CAMPAIGN

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Abstract

The Fog And Turbulence In Marine Atmosphere (FATIMA) field project took place during July 01-31 2022 over Sable Island located 300 km SSE of Halifax, Nova Scotia. FATIMA measurements on the island included surface in-situ observations, soundings from UAV, TBS, and Radiosondes and the profiles from remote sensing platforms such as ceilometers, lidars, and radars. The mean July winds are from the SW and usually do not lead to fog. Instead, additional synoptic aspects are necessary to generate fog. One of these reasons is a cyclonic system moving across Canada. A case study on 2022.07.02-2022.07.05 is presented which was characterized by a deep cyclone moving from the west to eastward across Canada to the Labrador Sea. The southerly/SW portion of this low extended over Sable Island and a significant portion of Atlantic Canada. During this event a low cloud base < 914 m and visibility < 4.8 km remained over the Island. Initially, a convergent area with a deep cloud layer, reduced stability and light rain moved eastward across Sable Island. This was followed by two fog periods, lasting 14.3 hrs and 2.7 hrs, that began when the cloud base lowered to the surface. The fog event ended quickly and the cloud base lifted to above 914 m in less than one hour and it was followed by clear sky. Except for the initial low stability period at the leading edge of the cyclonic system, there was a near surface-based air temperature inversion that was saturated during the fog events and unsaturated otherwise. During the fog, the saturated layer extended from 200 m to 1100 m in height. Of the five soundings during fog event, three showed a second saturated inversion layer in the upper portion of the boundary layer. During fog, the Gradient Richardson Number tends to be stable for the surface inversion and unstable in the saturated portion in the fog above. In contrast, during good visibility conditions before and after the event, there was a shallower moist layer with a mostly stable Richardson Number in the layer but weak or unstable above. In the presentation, dynamical and thermodynamical structures of the BL and its impact on fog life cycle related to cyclonic motion will be summarized.

A51

AN UNUSUAL STORY BEHIND THE SCIENTIFIC BOOK SEA FOG

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Abstract

Sea fog refers to one kind of weather phenomena occurred over oceans and coastal regions wherein tiny water/ice droplets sustained in the atmospheric boundary layer and caused the horizontal atmospheric visibility to be less than 1000 m (Wang, 1985). The frequent occurrences of sea fogs over the China Seas were noticed by Chinese scientists very early. Being one of the greatest Chinese meteorologists, Binhua WANG (from 5 March 1914 to 13 April 2011), published his pioneering scientific book SEA FOG in 1985 via China Ocean Press (Beijing) and Springer-Verlag (Berlin, Heidelberg, New York, Tokyo) jointly. As far as our knowing, it was perhaps in the world, the first book which investigated sea fogs systematically.

As indicated by Binhua WANG, his initial idea for sea fog research formed around 1940's when he took part in the World War II in southwest of China working as a weather forecaster for Allied pilots. During his working, he sharply noticed that the low atmospheric visibility associated with sea fogs had a considerable influences on the accuracy of bombing, and then started the compiling and summing up of sea fog information gradually.

After the World War II, for many years, Binhua WANG worked as the director of Qingdao (Tsingtao/Tsingtau) Observatory which was founded by Germany people in 1898. Around 1956, he moved to the Department of Oceanography of Shandong University (in Qingdao) working as a professor of marine meteorology. Later, during his researching and teaching more than several decades, he made great efforts to put sea fog into the teaching course of Marine Meteorology. In 1966, after long-time efforts, he finished a manuscript named as SEA FOG, and was ready to open a lecture to the senior students. Unfortunately, this valuable manuscript was burn away by ignorant young guys during the Cultural Revolution. After the end of Cultural Revolution, he recovered the main structure of this manuscript relying on his tremendous perseverance and significant memory. Later, after organizing of the fragments and references which he could find at that time, in 1983, he published the first book in Chinese named as HAIWU (SEA FOG). Later, with the helps of his colleagues and students, this book was translated into English version SEA FOG, and was published jointly by China Ocean Press and Springer-Verlag company in 1985.

After its publication in 1985, this book got wide positive comments from the world. In 1987, Baines (1987) from Australia, Hasse (1987) from Germany had commented this book in their papers. In 1999, Prof. Ryuji Kimura in University of Tokyo had ever commented that "it was the first, unique and excellent book in the world on sea fog study".

This talk aims to introduce the main structure of this book SEA FOG, as well as a brief history of sea fog research in China. It may provide useful information for those who has great concern and curiosity with the researching history of the sea fog in the world.

A53

DENSE FOG BURST REINFORCEMENT OVER EASTERN CHINA UNDER THE INFLUENCE OF COMPLEX ENVIRONMENT

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Abstract

Fog can be hazardous weather. Dense and polluted fog is especially known to impact transportation, air quality, and public health. Low visibilities on fog days threaten the safety of air, sea and land traffic, especially in strong dense fog (SDF) and extremely dense fog (EDF), which is the most likely to cause accidents such as car rear-end collisions and ship collisions. Throughout more than ten years of observations, strong dense fog (SDF) (visibility less than 200m) and extremely dense fog (EDF) (visibility less than 50m) often occurred in the central and eastern regions of China. This could lead to serious traffic accidents.

This research summarizes the research results of dense fog in Eastern China, including the burst reinforcement features of strong dense fog (SDF) formation, universal feature of SDF, the microphysical process of the fog body enhancement, the causes of burst reinforcement and the characteristics of the boundary layer structure. There are also remarks about fog dissipations. The research results show that there are still many important scientific problems to be solved about dense fog. Future directions for understanding Dense Fog Burst Reinforcement including that: (1) How fog expands to the surrounding areas, and what factors influence the spread of fog? (2) The physical mechanism of dense fog burst reinforcement. (3) It needs to be further observed to study the role of low-level jets in the formation of dense fog. How the low-level jet stream forms? (4) impact of air pollution on the dense fog formation.

A55

SIMULATING AEROSOL ACTIVATION IN STRATUS LOWERING FOG OBSERVED DURING C-FOG

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Abstract

Aerosol particles play a crucial role in determining droplet concentrations in warm clouds and fog. To reach critical supersaturation in stratus or cumulus clouds, parcels adiabatically cool as they rise in updrafts. However, fog has much weaker vertical motion, and relies heavily on radiative cooling processes to reach critical supersaturation. Often in climate models, radiative cooling does not inform aerosol activation, and fog droplet concentrations are generated by adiabatic cooling using a minimum updraft speed, for example 0.1 m/s. This approach systematically overestimates aerosol activation from adiabatic cooling (if the minimum is set too high, as it often is) and neglects spatial or temporal variability in radiative cooling rates. We are investigating the potential importance of radiative cooling in aerosol activation in coastal fog using the UM regional high-resolution model. Through separation of adiabatic (updraft) and non-adiabatic (radiative cooling) supersaturation sources for coastal fog, we aim to improve the representation of aerosol activation in the UK Met Office Unified Model (UM). To compare model performance to measured data, we are simulating case studies from C-FOG, a 2018 field campaign that took place in Newfoundland and Nova Scotia during September and early October. This campaign measured three distinct coastal fog events. Atmospheric measurements such as aerosol/fog droplet size distribution and liquid water content are complemented by in-situ sensing data. Satellite products from GOES and MODIS can be used to retrieve droplet number concentration and liquid water path over a larger geospatial area. Our initial simulation runs indicate that simulated droplet concentrations are overestimated by a factor of 2-3, suggesting that further improvements to the aerosol activation scheme are needed before activation by radiative cooling can be introduced. We outline several possible explanations for the overestimates inspired by complementary work studying urban radiation fog.

B1

VERTICAL CHARACTERISTICS OF VOCs DURING FOG, HAZE DAYS IN THE LOWER TROPOSPHERE OVER THE EASTERN CHINA: BASED ON UAV OBSERVATION

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Abstract

In order to study the temporal and spatial variation characteristics of VOC during fog and haze events, comprehensive field observation experiments were conducted at the Donghai National Meteorological Observing Station (34.54°N, 118.71°E, with an altitude of 32.9 m) in Jiangsu Province, China from November 19, 2020 to January 15, 2021. Three radiation fog events and four haze events were observed by the UAV observation system, during this observation. and more than 100 atmospheric boundary layer profiles were obtained, including air temperature, pressure, relative humidity (RH), wind direction, wind speed, TVOC, NO_2 and O_3. The results show that: During the haze events, the concentration of VOC during the nighttime (0.225-0.253ppm) was significantly higher than that during the daytime (0.191-0.205ppm). The concentration of VOC during the haze events was significantly higher than that in the fog events (0.162-0.191 ppm). The fog layer heights is basically maintained below 200 m, which is consistent with the dramatically changing range of VOC concentration. The VOC concentration in the fog layer (0.172-0.178ppm) decreased significantly during the fog events, which was significantly lower than that before the fog events (0.195-0.240ppm). The VOC concentration changes above the fog top was much smaller than that within the fog layer. It shows that fog has a significant scavenging effect on VOC. The low-level inversions before the fog events weakens the diffusion of VOC, leading the VOC high concentration and tiny changes. The VOC concentrations change with that of fog intensity, and the VOC are removed in fog water. The VOC concentrations in the fog layer (below 200 m) decreased significantly, and the VOC concentrations in the atmospheric boundary layer (200-700 m) changed greatly. This state remained until 1h after the fog dissipation.. The VOC concentration in the near-surface layer tends to be stable after the fog dissipates and no longer changes drastically. The VOC concentration distribution in the atmospheric boundary layer is greatly affected by the inversion intensity.

After the fog events, the concentration of O_3 + NO_2 decreased significantly. The variation trend of the minimum (maximum) concentration of VOC and O_3 + NO_2 in the atmospheric boundary layer is opposite (same). The average concentration of pollutants below 400 m after fog is lower than that in fog, and the higher concentration of VOC can provide favorable conditions for O_3 synthesis. The presence of low-level temperature inversion during the haze events increases the VOC concentration, which is beneficial to the synthesis of O_3. When the concentration of O_3 increases, the concentration of VOC decreases due to reaction consumption. During the fog events, the stable high humidity environment removes the water-soluble pollutants bound to the temperature inversion layer, so that the VOC concentration decreases again. With the continuous decrease of VOC concentration, the formation of O_3 is inhibited, the concentration of O_3 is decreased, and the concentration of O_3 + NO_2 in fog is also decreased. After the fog events, the pollutant concentration was significantly lower than that before the fog.

B4

WHAT IS THE ROLE OF ORGANIC COMPOUNDS DISSOLVED IN LEAF WETNESS IN INDUCING NON-STOMATAL OZONE UPTAKE?

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Abstract

Tropospheric ozone is an anthropogenic pollutant that has significant impacts on human and plant health. Dry deposition is a dominant ozone sink at the Earth's surface and can occur via stomatal and non-stomatal pathways. While the former is a well-known process and is included routinely in ozone deposition models, non-stomatal deposition remains less understood. Cuticular uptake is a non-stomatal uptake mechanism involving the interfacial ozonation of organic compounds present on the surface of leaves. To date, little is known about the origin and chemical nature of these compounds, the environmental variables controlling their occurrence, and the mechanism of these reactions.

In this poster, we describe the development of a robust protocol for collecting water-soluble organics from needles and leaves to be used in laboratory-based ozone uptake measurements. Among the variables, we explored the impact of wetness type (i.e., rain droplet vs. dew), chemistry (i.e., deionized water vs. natural rain), and contact time on the bulk chemistry of the leached material. In addition, we evaluated the variability in collected materials among plant species grown in the same location and the same species in different locations. We characterized leaf wash water samples with a battery of analytical techniques that include total organic carbon, conductivity, pH, and UV-vis spectroscopy. We will soon complement this information with offline aerosol mass spectrometry and ozone uptake measurements performed with a home-built cuvette.

B5

CHEMICAL EVOLUTION OF FOG WATER IN FOUR CONTRASTED SITES IN NORTHERN FRANCE (ALSACE) BETWEEN 2015 AND 2021

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Abstract

Fog water samples are collected between 2015 and 2021 from urban (Strasbourg), suburban (Geispolsheim and Cronenbourg) and rural (Erstein) regions in Alsace. They are analyzed for their inorganic and organic contents in order to investigate the evolution of fog over the sampling years.

The inorganic composition of fog water at Strasbourg had been also previously investigated by Millet et. al in 1996. Current results show that the nature of pH has changed at Strasbourg over time (between 1996 and 2018) from acidic to basic. The current concentrations of ionic species are much lower than those found in 1996. The average pH range has increased from 3.5-4 to 6.1-7.4 indicating that the major cations are currently predominant. There is a sharp decrease in the concentrations (around 20 times). However, concentrations only decreased 3 times. Recently, there is no remarkable yearly variation during the sampling period at all sites, except for a small increase in the pH between 2016 and 2018. Besides, the mean conductivity values at Geispolsheim, Erstein, Strasbourg, and Cronenbourg have slightly increased respectively from 95.1 to 110.69 µS/cm, 106.69 to 122.9 µS/cm, 125.69 to 151.3 µS/cm and 140.3 to 237.1 µS/cm.

The total concentrations of PCBs, PAHs and OCPs have increased from 2015 to 2021 at all sites, despite the decrease in the total PCB and OCP concentrations at Geispolsheim and Erstein between 2015 and 2016. A special case is Geispolsheim which is the only site among all in which the PAH concentrations have slightly decreased from 2015 to 2018. For instance, the total PAH concentrations at Geispolsheim, Erstein, Strasbourg, and Cronenbourg have increased from 2.5 to 3.3 µg L^{-1} , 2.7 to 3.2 µg L^{-1}, 1.7 to 3.1 µg L^{-1} and 1.5 to 3.9 µg L^{-1} . Additionally, the total OCP concentrations have increased from 4.4 to 5.6 µg L^{-1}, 1.8 to 3.6 µg L^{-1}, 0.9 to 2.6 µg L^{-1}, and 2.4 to 5.8 µg L^{-1} respectively at Geispolsheim, Erstein, Strasbourg and Cronenbourg. However, there is a decrease in the OCP concentrations between 2015 and 2016 at Geispolsheim from 4.4 to 1.1 µg L^{-1} and Erstein from 1.8 to 1.2 µg L^{-1}. The total PCB concentrations at Erstein, Strasbourg, and Cronenbourg have increased respectively from 1.5 to 4.5 µg L^{-1}, 7.1 to 10.8 µg L^{-1}, and 2.8 to 4.3 µg L^{-1}. At Geispolsheim, PCB concentrations have decreased from 2015 (7.1 µg L^{-1}) to 2018 (6.1 µg L^{-1}).

The concentrations of total pesticides (non-volatile and volatile) have increased during the sampling period at Strasbourg (from 23.2 to 29.4 µg L^{-1}) and Cronenbourg (from 38.9 to 56.5 µg L^{-1}). In contrast with Erstein and Geispolsheim whose total pesticide concentrations decreased during the sampling period from 44.9 to 30.1µg L^{-1} and 33.9 to 20.6 µg L^{-1}.

The variations of acids and phenols among the sampling years are very negligible, except for Cronenbourg in which the total concentrations of acids have greatly increased during the sampling period from 42.2 to 171.8 µg L^{-1}.

B6

COMPARISON OF CONCENTRATIONS OF GAS-DERIVED CONSTUITUENTS IN DEW BETWEEN 20 YEARS AGO AND RECENT YEARS AND CHANGES IN ATMOSPHERIC CONCENTRATIONS OF GAS-DERIVED CONSTUITUENTS ASSOCIATED WITH DEW FORMATION AND DISAPPEARANCE AT SAKAI, OSAKA, JAPAN

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Abstract

Dew is formed on clear and windless nights. The weather conditions coincide with conditions conducive to the formation of an inversion layer, so the concentration of gaseous substances become high, and they are efficiently incorporated into the dew. Actually, the concentrations of gas-derived constituents in the dew were high. As the amount of dew produced increased, the amounts of gas-derived constituents per unit area increased, while the amounts of particle-derived constituents per unit area remained unchanged. In the presentation, we will show these results. When the dew dries within a few hours after sunrise, the incorporated substances remain as solids or volatilize. As a result, deposition of gaseous substances affects their atmospheric lifetime.

The area around Osaka Metropolitan University in Sakai, Osaka, Japan is dry due to the effects of urbanization, and dew forms only during a short period of time from fall to winter. In this study, gaseous substances incorporated into the dew during this short period and the concentration of substances remaining after drying were measured. The results were compared with those obtained up to 20 years ago, and changes in gaseous substances incorporated into the dew were confirmed. The presentation will report on the concentrations of ammonium ions and other ionic components in the dew 20 years ago and in recent years.

Furthermore, we previously reported that upon drying, high concentrations of nitrite and ammonia react to form nitrogen and water. We showed that this reaction caused the disappearance of both substances and affected the dynamics of these substances, but we suggested that this reaction may have occurred very little in recent years. This could be due to a decrease in the concentration of nitrite ions. There have been no changes that would affect the process of nitrite formation, and the cause of this is unknown. It is possible that the atmosphere is cleaner than it was 20 years ago, but a decrease in the disappearance process of the reaction between nitrite and ammonia would mean an increase in the amount of these substances returning to the atmosphere.

B9

INVESTIGATING AMAZON RAINFOREST FOG AS AN AEROSOL PROCESSOR

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Abstract

Tropical forests have a global importance concerning carbon storage and climatic regulation. The World's largest rainforest, the Amazon, beyond some other significant processes, contributes with water uptake to the atmosphere, which has the ability to promote local cooling, and also take rain to southern regions. In the Amazonian area, the relative humidity frequently reaches 100% during the night, therefore, fog formation before sunrise is a common phenomenon above the canopy. Recent research has shown the ionic composition of fog in several ecosystems, including valleys, mountains, the ocean, and forests. However, we have limited understanding of fog composition in Amazonia. In order to evaluate the role of fog in the Amazon system and whether it has the ability to transfer inorganic and organic compounds as well as biological particles into the open atmosphere, we are conducting an analysis of the fog's composition. A field campaign was carried out in the ATTO site, which comprises a complex of towers placed into the Amazonian rainforest. ATTO site is pristine and there is no significant human influence during the wet season. The goal of the campaign was to investigate the fog's role as an aerosol processor and, by extension, the effects that are involved in the Amazonian atmosphere. The samples were collected using the Caltech Active Strand Cloudwater Collector 2 (CASCC2), which was placed at 42 m AGL, right above the canopy. The sampling period was defined as between 3 and 7 am, based on a previous visibility analysis, on which had been noticed to be the usual fog peak. The liquid fog was collected during the wet season and analyzed with Ion Chromatography for cations, Flow Cytometry for microbiological activity and Zeta Sizer for superficial charges and particle size distribution. The preliminary data indicate that sodium and potassium are the most abundant cationic species, with sodium originating through seawater transport and potassium from the rupture of biological particles. Cytometry results suggest a high number of cells in the fog, up to a maximum of 40,000 cells, which must be thoroughly analyzed for metagenomics to determine which biogenic elements are present. Samples analyzed for Zeta potential ranged between -5.87 and -17.9mV. Despite that, it has been noticed that there was divergence concerning particle size distribution among the different samples, considering that the polydispersity index has reached the maximum of 1.000 and minimum of 0.447. The particle size range including all the samples was 50nm-5000nm. Further investigation will be performed to study single particles, metagenomics, and molecular composition of organic aerosol. These analyses will provide a better understanding of the fog precursors and reveal its overall composition, still not known.

B10

RAPID POST-FOG GROWTH OF AITKEN MODE PARTICLES INTO CCN SIZES THROUGH MULTIPHASE CHEMICAL FOG PROCESSES

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Abstract

In the summertime Arctic, processes leading to more cloud condensation nuclei's (CCNs) are crucial for radiative fog/cloud properties and the Arctic climate. Early growth of newly formed particles into the Aitken mode is an efficient process generating high concentrations of CCN precursors in the Arctic marine boundary layer (AMBL). However, the short lifetime and limited condensable vapors often prevent Aitken-mode particles from growing rapidly into CCN range. Therefore, the growth mechanism of Aitken mode particles into the CCN range under summertime AMBL conditions remains a subject of current research.

During the Arctic cruise field campaign PASCAL in summer 2017, a rapid growth of Aitken mode particles was observed right after long (>4h) fog episodes with growth rates > 20 nm h^{-1} to sizes beyond 80 nm where they are more likely to act as CCN. The observations could not be explained through the field measurements. Thus, process model simulations with the detailed multiphase chemistry mechanism MCM/CAPRAM were performed to investigate and understand the underlying processes. Detailed analyses of both the field and model data indicated a mechanism related to chemical processes within Arctic fog droplets and partitioning processes when the fog dissipates. The simulations showed that semi-volatile acids are formed during long fog episodes through multiphase chemistry. When the fog dissipates, both semi-volatile bases (e.g., ammonia) and acids (e.g., methanesulfonic acid, nitric acid, oxalic acid) redistribute from the activated CCNs to the non-activated particles. For MSA, a mass increase factor of 18 is modeled in the non-activated particles. Overall, the chemical in-fog processes and subsequent post-fog repartitioning are key processes (i) explaining the rapid particle growth of non-CCNs after fog evaporation, (ii) contributing to the increase in the number of CCNs and cloud droplets, and (iii) finally leading to a modification of the physical and radiative properties of AMBL fog and cloud droplets.

B11

MODELING THE CHEMICAL MULTIPHASE PROCESSING OF BIOMASS BURNING TRACE COMPOUNDS WITH CAPRAM-BBM1.0

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Abstract

Biomass burning (BB) is an increasingly important contributor to air pollution on global, regional and local scales affecting air quality, public health and climate. Anhydrosugars and methoxyphenols are key tracers emitted from BB. Once emitted, BB trace compounds can undergo complex multiphase chemistry in tropospheric aerosol particles and fog/cloud droplets. The chemical processing of BB trace compounds can contribute to the formation and modification of the secondary organic aerosol (SOA) composition. However, their chemical multiphase processing is not yet well understood and examined by models. Therefore, the present work aimed at a better understanding of the multiphase chemistry of BB tracers, such as levoglucosan and vanillin, by detailed process model studies with a new developed CAPRAM biomass burning module (CAPRAM-BBM1.0). This reaction module was developed based on the kinetic data from laboratory experiments at TROPOS and other literature studies. The developed CAPRAM-BBM includes 2991 reactions (9 phase transfers and 2982 aqueous-phase reactions) and was coupled with the multiphase chemistry mechanism MCMv3.2/CAPRAM4.0 and the extended CAPRAM aromatics (CAPRAM-AM1.0) and halogen modules (CAPRAM-HM3.0). Then, it was applied for a winter-time residential wood burning scenario in Europe. Our model results show that levoglucosan and vanillin are effectively oxidized under cloud conditions leading to concentration reductions of 30% and 80% on the fourth model day. Furthermore, the results demonstrate that the chemistry of BB tracers can affect the aqueous-phase budgets of key radical oxidants such as OH and NO_3. Moreover, the model runs show that aqueous-phase oxidation of BB compounds contributes significantly to the aqSOA formation and aging, especially to the formation of poly-functionalized organic compounds as well as substituted mono- and dicarboxylic acids. Particularly, the daytime oxidation by OH acts as important sinks for BB tracers. The performed reaction rate analyses revealed that in-cloud oxidation represents the main loss for methoxyphenols but its importance strongly depends on the respective Henry's Law solubilities of the compounds.

B13

ESTIMATES OF CLOUD WATER DEPOSITION AT MOUNTAIN FOREST SITES IN JAPAN

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Abstract

Context/Purpose: The dying of trees in mountainous areas has been reported since the 1960s in Japan, and the effect of air pollution has been pointed out. Although wet and dry deposition has been estimated, cloud deposition has been overlooked. Cloud is a medium that concentrates air pollutants, accelerates chemical reactions, and transports air pollutants to the forest canopy. In Japan, about 70% of the land area is covered by forests, and cloud water deposition is an important pathway. We report on the estimation of cloud water deposition (CWD) in mountain forests in Japan.

Method: Sampling was performed at seven sites; the southeastern foot of Mt. Fuji (1290 m a.s.l., Shizuoka Pref), at the northwest - faced top of Mt. Oyama (1252m a.s.l., Kanagawa Pref.), at mountainside of Mt. Hakkai (1150 m a.s.l., Niigata Pref.), at the north foot of Mt. Fuji (1055 m a.s.l., Yamanashi Pref.), in Mt. Iizuna (1030 m a.s.l., Nagano Pref.), at the foot of Mt. Moriyoshi (750m a.s.l., Akita Pref), and in Teshio (70 m a.s.l., Hokkaido Pref.). Precipitation and throughfall were collected using a filtration-type collector and cloud water using a passive string-type collector for every month at each site. The pH and electric conductivity were measured, and major inorganic ions were measured by ion chromatograph. CWD was estimated by the canopy water balance method.

Results/Interpretation: During the period from August 2019 to December 2022, the estimate of CWP was the largest at Mt. Oyama (9.39 mm/day), followed by 3.13 mm/day at the southeastern foot of Mt. Fuji, 0.99 mm/day at Mt. Hakkai, 0.66 mm/day at the north foot of Mt. Fuji, 0.56 mm/day at Teshio, 0.14 mm/day at Mt. Iizuna, and 0.13 mm/day at Mt. Moriyoshi, and 0.14 mm/day at Mt. Iizuna. The annual frequency of clouds a is estimated to be 30% in Mt. Oyama and 10 % at the southern foot of Mt.Fuji. The higher the frequency of cloud, the resulting in high CWP. CWP increased as the elevation increases. However, at Mt. Iizuna, which is at about the same elevation as the north foot of Mt. Fuji, CWP is rarely detected. This is because Mt. Iizuna is surrounded by the forest canopy coupled with 5% frequency of cloud occurrence during the year. CWD fluxes of SO_4^{2-} and NO_3^- were estimated by multiplying their concentrations by CWP. The deposition flux of SO_4^{2-} (1.6 meq/m^2/day) was higher than that of NO_3^- (1.0 meq/m^2/day) at the top of Mt. Oyama which is probably strongly influenced by SO_2 and sulfate transported by the northwest monsoon from the continent during winter and spring. At the southern foot of Mt. Fuji, located in the atmospheric boundary layer, the deposition flux of NO_3^- (1.6 meq/m^2/day) is larger than that of SO_4^{2-} (1.1 meq/m^2/day), indicating that this area is affected by air pollution from domestic automobile traffic.

B15

OCCURRENCE, BEHAVIOR, FATE, AND HEALTH IMPACT OF AIRBORNE MICROPLASTICS (AMPS) (4): CHARACTERISTICS OF AMPS IN CLOUD, SNOW, AND AEROSOL AT THE SUMMIT OF MT. FUJI IN THE FREE TROPOSPHERE

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Abstract

Context/Purpose: In recent years, microplastics (MPs), plastic fragments smaller than 5 mm, have been detected in human lungs, blood, milk, feces, and the placenta of pregnant women. The most important route by which MPs enter the body is through inhalation. Although there is growing interested in airborne microplastics (AMPs), there is only one report of AMPs in the free troposphere, a long-range transport pathway. This study aims to characterize AMPs (number concentration, polymer type, and shape) in cloud water, snowpack, and aerosols in the free troposphere.

Method: Cloud water was collected by a passive string-type collector at the top of Mt. Fuji (3776 m a.s.l.) in the summer of 2021 (n=11) and 2022 (n=4). We also collected cloud water by an active string-type collector at the foot of Mt. Fuji (1290 m a.s.l.) from October in 2020 to August in 2022 (n=14) and by a passive string-type collector at the top of Mt. Oyama (1251 m a.s.l.) from February to October in 2022 (n=9). PM2.5 was collected on a PTFE-binder glass fiber filter by a high-volume air sampler (Shibata HV-RW) equipped with a PM2.5 cyclone separator only at night (from 6:00 p.m. to 4:00 a.m. the following morning) in 2019 and 2021. In 2022 AMPs in the aerosol were collected using a multi-nozzles cascade impactor (MCI) at three aerodynamic diameters: below 2.5 µm (PM2.5), 2.5-10 µm (PM2.5-10), and above 10 µm (PM10<) on a glass fiber filter with PTFE binding. Pretreatment methods included the removal of organic matter using 30% H2O2, density separation by shaking with 5.3 M NaI, and subsequent centrifuge separation. AMPs were identified by µFTIR ATR imaging at a wavenumber range of 4000 - 695 cm-1. The candidate particles of AMPs were selected by screening the IR peak band of C-H stretching (3000 - 2700 cm-1) and C=O stretching (1740 - 1710 cm-1) and then identified by the score (70 % or more) with library search and visual confirmation of polymer-derived absorption peaks.

Results/Interpretation: Total concentrations of AMPs in PM2.5 in 2021 ranged from 0.06 to 0.19 MP m-3, considerably lower than in 2019 (4.91 ± 0.54 MP m-3), which was affected by Typhoon No. 6 (NARI). AMPs in PM2.5 was not detected in 2022, while AMP in PM10< was 0.01 MP m-3 during the night from July 26 to August 9 and 0.04 and 0.01 MP m-3 during all days from August 9 to 16, respectively. AMPs in cloud water at the summit and southern foot of Mt. Fuji were 6.67 and 13.9 MP/L in 2022, respectively. Polypropylene (PP), polyethylene terephthalate (PET), and propylene/polypropylene copolymer (PE/PP) were found to be significant polymers in both aerosol and cloud water. In addition, 119 MP/L of AMPs were found in the snowpack in the spring of 2022 at the summit of Mt. Fuji. These results indicate that AMPs are important as cloud condensation nuclei (CCNs) and ice nuclei (INs).

B16

TRACE METALS IN FOGS: WHAT HAVE WE LEARNED OVER THE YEARS?

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Abstract

Metals in fogs have been studied over the years for their impact on aqueous phase chemistry such as sulfur oxidation as well as for their potential impacts on environmental and human health. While frequently included in observational studies, trace elements are not always reported or only tangentially discussed. In this presentation we will summarize observations on metals in fog a variety of settings including urban radiation fogs, coastal fogs and intercepted mountain clouds. Fog metal concentrations were highly variable not only between environments but also at each location. While the concentrations are linked to the underlying local particulate matter concentrations and liquid water content, scavenging results show considerable variations (from 10 to 90%) between species and for a same species between events. We will discuss the trace metal occurrence in fogwater, the metal scavenging behavior of fogs and the potential implications on fog chemistry and environmental health.

B17

SPATIAL VARIATION IN FOG CHEMISTRY ALONG AN ARID GRADIENT IN THE ATACAMA DESERT

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Abstract

The coast of the Atacama Desert is characterized by regular presence of fog, which provides water and nutrients to unique ecosystems well-adapted to extreme arid conditions. The spatial variation in the availability of resources transported in fog water and their potential role in terms of well-being in fog ecosystems are poorly known. In this context, our hypothesis is that the resource concentrations vary along the coast, among seasons, and fog water inputs. This study was carried out at three different fog oases in the coastal Atacama Desert, hyper-arid (20°S), arid (26°S), and semi-arid (30°S) to determine differential input of compounds and fog water into ecosystems. Particularly we characterize compounds such as Nitrate (NO3-), Ammonia (NH4+), Nitrite (NO2-), Phosphate (PO4-3), and conditions such as pH, Alkalinity, and Hardness. In addition, we assessed the temporal variability of fog water collection (L/m2) across all sites. Samples were collected by using a CASCC (active strand water collector), and the analysis were in situ. The fog water was collected with a standard fog collector (SFC). Fog water composition showed large spatial variation of Nitrate (3-84ppm), followed by Ammonia (0.1 – 2.8 ppm), Phosphate (0 – 1.2 ppm), and Nitrite (0 – 0.3 ppm). Concerning chemical conditions, fog water was soft (hardness between 6 – 146 ppm), buffer capacity was lower (alkalinity between 5-40ppm), and pH varies from acid to neutral ($4.4<pH<7.2$). Our analysis reveals that pH increases with latitude but PO4-3 and NO3- decreases. Fog water collected indicates the highest collection rate at the hyper-arid site (6 L/m2/día) but more marked temporality (fog presence from May to November) than the other places (26°S and 30°S). The relationship between compounds and fog water collected is negative, the season with more water collected, the nutrient concentrations are lower. In conclusion, the nutrient concentrations are closely related to the latitude and volume of fog water collected. Thus, changes in fog water variability due to global warming may affect nutrient input at fog oases. Finally, this work expands our knowledge of the distribution of nutrients, main chemical characteristics, and the temporal variability of fog water along the coastal Atacama Desert. The latter helps us to understand the impact of fog on the ecosystems and continue to research it as a reservoir and transport vector of nutrients, microorganisms, pollutants, microplastics, and more.

B18

FOGWATER ORGANIC MATERIAL AT A WESTERN NORTH PACIFIC TERRESTRIAL BACKGROUND SITE

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Abstract

Urban and biomass burning (BB) polluted air masses are transported long distances from East Asia and Southeast Asia (SEA) to the western North Pacific and often interact with the mountains of Taiwan. Cloud scavenging and processing of these polluted air masses occurs both before and upon arrival to the mountains, distinctly altering the fog composition and acidity in either case. Characterization of this longer-term or more acute processing has important implications for what could be eventually introduced by wet deposition to the sensitive high-altitude environment of Taiwan. This study examines fog chemical composition and acidity during episodes that occurred in March 2020 at the Lulin Atmospheric Background Station (LABS; 2,862 m) in Taiwan. Inorganic concentrations and organic acid, sugar, and humic-like substances (HULIS) concentrations were all included in the analysis along with permanent gas-phase and particulate measurements, providing a valuable window into the long-range transported components (e.g. BB or otherwise) arriving to the site. Satellite data, ERA-5 and MERRA-2 reanalysis data, and a HYSPLIT back-trajectory analysis were utilized to assess the likelihood of cloud processing before arrival to LABS. We found that the air masses arriving from SEA were associated with higher organic loadings (factor of ~ 2), but a higher pH (~10%) and were likely less impacted by cloud processing en route than air masses arriving from South China; thus highlighting the possible impacts of cloud processing on sensitive downstream environments.

B22

EFFECTS OF pH, EXPOSURE TO LIGHT AND HYDROXYL (OH) RADICALS ON LIVE BACTERIA UNDER CLOUD-LIKE CONDITIONS: INSIGHTS INTO THE PRODUCTION AND TRANSFORMATION OF BIOLOGICAL AND ORGANIC MATTER IN CLOUD WATER

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Abstract

Bacteria in clouds are subjected to a variety of atmospheric stressors, which can adversely affect their survival and energetic metabolism, and consequently their microbial activity. We will present findings from our recent investigations on how cloud water pH (pH 3 to 6), exposure to sunlight and hydroxyl (OH) radicals impact the survival and energetic metabolism, and discuss their implications. Experiments were conducted using four bacterial strains, *B. subtilis*, *P. putida*, *E. hormaechei* B0910, and *E. hormaechei* pf0910, in microcosms comprised of artificial cloud water that mimicked the chemical composition of cloud water in Hong Kong, South China. Our results showed that the energetic metabolism and survival of the bacterial strains strongly depended on the pH. Low survival rates were observed at pH < 4 regardless whether the bacteria were exposed to artificial sunlight. At pH > 4, the bacterial energetic metabolism and survival depended on the strain, exposure to artificial sunlight and OH radicals. Changes in the bacterial energetic metabolism and survival subsequently impacted the ability of the bacteria to biodegrade organic compounds. Exposure to OH radicals under artificial sunlight led to bacterial cell damage and lysis, which released biological and organic compounds with molecular weights that could be as larger as >50 kDa. These released compounds subsequently underwent reactions with OH radicals. Fragmentation reactions were observed to play key roles in transforming the composition of the released compounds, especially during the later stages of the photooxidation. The fragmentation reactions cleaved the C-C bonds of the carbon backbones of high molecular weight proteinaceous-like matter to form a variety of lower molecular weight compounds, including HULIS of molecular weight <3 kDa and highly oxygenated organic compounds of molecular weight <1.2 kDa. Overall, this study provides new insights into how three common atmospheric stressors, cloud water pH, exposure to sunlight and OH radicals, can influence the survival and energetic metabolism of bacteria, and consequently the roles that they play in cloud processes including the production and transformation of organic matter in cloud water.

B23

ANALYTICAL PROCEDURE FOR THE CONCOMITANT ANALYSIS OF 242 POLAR AND NON-POLAR ORGANIC COMPOUNDS OF DIFFERENT FUNCTIONAL GROUPS IN FOG WATER

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Abstract

Fog droplets consist of a mixture of organic and inorganic compounds resulting from scavenging hygroscopic particles and water-soluble trace gases. Organic matter found in fog water can accumulate non-volatile, semi-volatile, and volatile compounds of different chemical structures and properties (different functional groups and chemical properties). However, the extraction and analysis of these compounds from such matrixes are still very limited and infrequent. This study presents a new procedure based on the combination of liquid-liquid extraction (LLE) on solid support (XTR Chromabond cartridge) is developed, optimized and validated for the simultaneous analysis of 38 organic acids, 64 phenols, 55 semi-volatile pesticides, 27 non-volatile pesticides, 16 polycyclic aromatic hydrocarbons (PAHs), 20 organochlorine pesticides (OCPs) and 22 polychlorinated biphenyls (PCBs) residues in fog water. The obtained extract is concentrated, derivatized, and then analyzed with different chromatographic techniques. Phenols and acids are injected into gas chromatography-mass spectrometry (GC-MS) preceded by a derivatization reaction with N-tert-butyldimethylsilyl-N-methyltrifluoroacetamide (MtBSTFA). Semi-volatile pesticides, PAHs, PCBs, and OCPs are injected into gas chromatography-tandem mass spectrometry (GC-MS/MS), while non-volatile pesticides are injected into liquid chromatography-tandem mass spectrometry (LC-MS/MS). The new protocol is validated for its linearity (), recovery (R), precisions (inter and intra-day), limit of detection (LOD), and limit of quantification (LOQ). It shows good linearity (>0.99) in the concentration ranging from 0.05 to 150 ng . The repeatability and reproducibility of measurements expressed as relative standard deviation (% RSD) are found to be satisfactory (% RSD <20%). Furthermore, the detection limits obtained are in the low order of ng L^{-1}.

B24

STANDARDIZATION OF THE ANALYTICAL PROCESS FOR CLOUD WATER CHEMICAL ANALYSIS WITHIN ACTRIS - RESULTS FROM A PILOT INTERCOMPARISON CAMPAIGN

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Abstract

As part of the atmospheric multiphase system, clouds play an important role in several physical and chemical processes influencing climate and air quality e.g. aqueous phase processing of aerosols. For this reason, the pan-European Aerosol, Clouds and Trace gases Research Infrastructure (ACTRIS) aims for the implementation of continuous monitoring and research of cloud water chemical composition at several ground-based observational sites.

Typically, the chemical composition of cloud water is determined from a bulk sample, which is sampled by inertial impaction of cloud droplets. After the collection, the cloud water samples must be delivered to laboratories for offline analysis of chemical constituents (e.g. inorganic ions or organic tracer compounds) with different analytical techniques. In the last decades, several different principles and designs were developed for cloud droplet collection resulting in a wide spectrum of available analytical cloud water samplers. However, very few information is available on the comparability of the different designs and the varying collection efficiencies. In addition, there is currently no standardized procedure regarding sample storage, preparation, and analytical methodology. One of the major goals of ACTRIS is the harmonization of the analytical process between different observatories and laboratories to provide traceable high-quality data sets. Therefore, the Center for Cloud Water Chemistry (CCWaC) was established as part of the Cloud-in-situ topical center to define analytical procedures, support operators, organize intercomparisons, and perform quality assurance for the determination of the cloud water chemical variables.

In this study, we will present results from a first intercomparison campaign of cloud water collectors and sample preservation strategies, which took place in November 2022 on the Sonnblick Observatory. Within this campaign four cloud water collectors with different designs were operated in parallel under alpine conditions. Samples were analyzed for inorganic ions and carboxylates by ion chromatography in order to compare systematic influence of sampler designs on cloud water chemical composition. Depending on meteorological conditions, deviations of varying extend were found in the chemical composition, indicating different collection efficiencies as a function of droplet diameter and contamination by other forms of precipitation. Regarding the sample preservation strategies and storage conditions, different degradation rates for specific organic compounds were found based on the storage time, temperature, and use of biocide. Finally, we will highlight the most critical aspects and potential analytical artefacts, which should be considered in the standardization attempts of cloud water chemical analysis.

B26

APPROACH TO GROWTH PROCESS OF CLOUD DROPLETS BY QUANTITATIVE DETERMINATION OF SULFATE IN SINGLE RAINDROPS

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Abstract

Since the components and concentrations contained in individual raindrops are different, cloud water sampling and analysis methods with higher temporal and spatial resolution are important for elucidating the growth process of cloud condensation nuclei and chemical reactions in the clouds. Several investigations on the analyses of individual rain droplets in terms of particle sizes and elemental components of and the measurement of the droplet diameter were reported, but the direct collection of falling rain and the quantitative analysis was technically difficult and not practical for field work. We have developed a method for easily quantifying the inorganic ion component of a single raindrop by utilizing the crystal formation reaction between the ion contained in the gel thin film and the dissolved ion component in the rain. We prepared a hydrogel thin film containing ion that reacts with the target ion to generate the ionic associate crystal. Then, a drop of simulated rain water was put on the thin film. The ion amount (mol) in the simulated rain water was estimated from the relation between the amount and the total area of the precipitation product. The volume (L) of the simulated rain water droplet was estimated from the relation between the droplet volume and the droplet print diameter. The target ion concentration (mol/L) was calculated from the ion amount and the droplet volume of simulated rain water based on these calibration curves. Based on the earlier studies, the detection sensitivity and analysis accuracy of this method have reached a level that can withstand for analysis of rain droplet. In this study, as the first field measurement of an environment sample using a new sampling tool that is an improvement of the above method, we performed a sampling of individual rain droplet in Shizuoka, Japan, and determined the contained sulfate ion between January 21, 2021 and October 16, 2021. The diameter distribution of the raindrop imprints obtained on the hydrogel showed good agreement with the previously reported raindrop diameters. Different correlations were obtained for each precipitation event between the calculated raindrop volume, sulfate mole number, and sulfate concentration. From each correlation, it can be seen that the precipitation event has a narrow raindrop volume distribution, sulfate mole number distribution, and sulfate concentration distribution, suggesting that it may have information that will lead to the elucidation of the formation and growth process of cloud droplet.

B27

ANALYSIS OF TRENDS OF WET DEPOSITION AND BACKWARD TRAJECTORIES IN SOUTHEAST ASIA.

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Abstract

Complex chemical reactions take place in the atmosphere and fall to the earth as wet deposition (rain, snow, fog, and dew) or dry deposition (dry particles, gas). The main chemical precursors leading to acidic conditions are sulfur dioxide (SO2) and nitrogen oxides (NOx) (Ecological Society of America). As Asia has the world's highest acid deposition (Vet et al., 2014) it is necessary to analyze the wet deposition parameters to know the trends in past years. The Acid Deposition Monitoring Network in East Asia (EANET) has been working in 13 countries in Asia since 2000. EANET data have been analyzed mainly for Northeast Asian countries (China, Korea, and Japan). In this study, we mainly analyze EANET data in Southeast Asia. It is observed from the analyzed data set that the concentration of non-sea salt (nss) SO42- and NO3- in rainwater are higher in the densely populated urban areas of Indonesia, Vietnam and Thailand. And hence rural sites are specifically selected for trajectories to set aside anthropogenic interference unlike urban sites. In Serpong, a rural site in Indonesia, annual-mean pH in rainwater was around 4.6 from 2001 to 2008 and increased after 2008 with the highest of 5.2 in 2018. Rainwater concentrations of nss-SO42- were stable, and NO3- showed unclear increasing trends. Anthropogenic emissions of SO2 were more rapidly increasing than those of NOx in Indonesia, which is not corresponding to those ions in rainwater. Similar trends to pH were found in nssCa2+ in rainwater. To understand those behaviors, backward trajectories were drawn for every rainy day in Serpong, which will be presented at the conference. Similar results are observed in Pathumthani, a rural site in Thailand, which has shown decreasing trend of (nss) SO42- and an all-time lowest being recorded in 2020 along with Khanchanaburi, a remote site, recording an extremely lower concentrations amongst all the sites.

B28

CLOUD MICROPHYSICS AND CHEMISTRY CHARACTERIZATION FROM ULTRALIGHT AIRCRAFT FLIGHTS IN ARDÈCHE-FRANCE

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Abstract

The collection of cloud water for chemical analysis is usually performed thanks to aircrafts, or on the ground for orographic clouds. However, aircrafts are large CO2 emitters and expensive to charter, and orographic clouds collection is sensitive to meteorological fluctuations. The use of ultralight aircrafts (ULAs) is cheaper, easier to set up, and more environmentally friendly. Moreover, ULAs can carry a large set of instruments and allow detailed scans of individual clouds due to their low speed.

In this study, a new method for cloud water collection based on the use of ULAs is presented. Two modified versions of the Caltech Active Strand Cloudwater Collectors (CASCCs) were mounted on an ULA. One plastic CASCC was used for major ions measurements, and one stainless steel CASCC was dedicated to organic measurements. Nozzles were added to the CASCCs to ensure isokinetic inside the collectors and droplet velocities compatible with CASCC design. A cloud droplet probe (CDP) was used for microphysics measurements, along with a PTU probe for thermodynamic measurements. A total of 12 flights were performed in continental cumuli and stratocumuli from different air mass origins in Ardèche, France. The ULAs enabled to sample clouds located up to 60 km from the aerodrome.

Main chemical analysis were performed, including major ions, organic content, main elements and carboxylic acids. Chemistry concentrations and microphysics measurements were typical for continental cumuli and stratocumuli. The variability in chemical composition was in agreement with the different cloud events. For example, higher concentrations of Ca were found during a Saharan dust event.

The droplet collection efficiencies of the two CASCCs were investigated through comparison between the actual volume of water collected and the volume calculated from microphysical measurements during the flights. Additional wind tunnel experiments and numerical flow modelling were performed to better understand the droplet collection mechanisms. Results from wind tunnel experiments and flow modeling were used to calculate the fifty percent droplet size cuts. Observed instability of droplets due to aerodynamic drag, and effect of wind shear within the clouds may explain the low collection efficiencies. Still, several tens of milliliters were collected each time within 2 h of flights, indicating that this cloud collection method is suitable for most classical chemical analysis.

B29

FOG BOUNDARY-LAYER FEATURES AND THEIR RELATIONSHIPS WITH AIR POLLUTION BASED ON UNMANNED AERIAL VEHICLS CASES IN LIANYUNGANG, CHIAN

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Abstract

During December 10–12, 2020, fog processes occurred in northern Jiangsu, China. Based on the unmanned aerial vehicle (UAV) detection dataset in the boundary layer, ground-based meteorological observations and pollutant datasets, the boundary layer features and influencing factors during these two fog processes were investigated. The results show that: The concentrations of air pollutants during the fog processes are positively correlated with the visibility. During the dissipation stage of fog, the particle mass concentration increased rapidly, which reached the peak when the fog process ended. The double temperature inversion significantly affects the fog processes, where the enhancement of the lower-level temperature inversion corresponds to the explosive growth of the fog, and the dissipation of the upper-level inversion layer indicates the ending of fog processes. The fog layer thicknesses are negatively correlated with the concentrations of air pollutants in the near-surface layer, whose variation is consistent with the change trend of the boundary layer height. The variation of PM10 mass concentrations was related to the wind field in the boundary layer, and the downdraft had a great impact on the mass concentrations of coarse particles. The fogs reached their mature stage when the relative humidity in the fog layers amounts to 90%. The intensity and maintenance time of temperature inversion were important conditions for the occurrence of fog process.The thickening of the inversion layer near the surface corresponds to the increase in the fog layer height. According to the meteorological conditions during the two fog processes, the fog process is maintained when water vapor conditions are favorable enough or when there is a deep near-surface temperature inversion, but the maintenance of the near-surface temperature inversion at an intensity of above 2°C $(100\ m)^{-1}$ mainly contributes to the durations of the two fog processes. The calculation through the trajectory model reveals that the air pollutant source varies during the two processes, which is the main reason for the difference in air pollutant concentrations between two processes (The long-time maintenance of air masses over the surface resulted in higher pollutant concentrations in the second fog process).

B31

HOW DIFFERENCES IN ALTITUDE CAN HAVE INFLUENCE ON FOG COLLECTION: A CASE STUDY IN THE WESTERN MEDITERRANEAN BASIN

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Abstract

At the Mediterranean coast of the Iberian Peninsula, where projections forecast a negative trend in precipitation (less rainfall), it is important to explore new water resources to help mitigate this problem in the future. For this reason, studies have been carried out since 2003 to evaluate the potential for fog collection in this area of the western Mediterranean basin. These studies have revealed that fog-water can be an important water resource in this region. In order to improve the existing knowledge about fog in this area, a study has been carried out to analyze the importance of altitude. For this purpose, it has been evaluated how the altitude at which a fog collector is set up has an impact on both the volume of fog- water collected and the number of days with fog collection. The experiment was conducted during 2010 and 2012 at two different sites: one located in the north of the study area (Mount Montseny) and the other in the south (Mount Muela). At each of these sites, a pair of fog collectors was installed at locations with almost identical geographical conditions, but at different altitudes, so that this was the only factor that could explain the variations. At Mount Montseny the difference in altitude between the two collectors was 398 m, whereas at Mount Muela it was 98 m. The most important results were the following: a) at Mount Montseny, the collector located at the higher altitude collected almost 6 times more water than its pair and collected fog for 73% more days; b) At Mount Muela, the collector located at the higher altitude collected almost twice more water and for 61% more days than its pair.

B32

PHYSICOCHEMICAL CHARACTERISTICS OF FOG IN AN AGRICULTURAL CITY IN EASTERN CHINA

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Abstract

To investigate the relationships among the fog microphysical characteristics, atmospheric pollutants, and the chemical compositions of fog droplets, a 58-day comprehensive field experiment was conducted at the Donghai site in an agricultural city, China, in the winter of 2020, and three studies carried out were listed below: the effect of different sampling frequency fog droplet spectrometers (1Hz and 5Hz) on the observation of fog microstructure; a comparative study of the high-resolution vertical distribution characteristics of meteorological elements and atmospheric pollutants in the boundary layer of radiation fog on clear and foggy days based on UAV observations; and a study of the characteristics of fog water chemistry at three levels of binning in agricultural cities in eastern China.

The main conclusions were as follows:

1)The extremes of fog microphysical quantities were more readily observed by 5Hz than 1Hz. Both of them reflected the relationship between the microphysics at different stages of the fog process, with the main difference occurring in the fog generation phase, probably due to the relatively small number of new droplets of activation and condensation growth observed by 5Hz at this stage.

2) In terms of the vertical distribution of pollutants, TVOC at the same height in the inversion layer is higher in sunny days than in foggy days. Before and during the generation stage of radiation fog, the decrease rate of SO_2 concentration with height was much higher than in the same period of sunny days. The vertical variation of O_3 and NO_2 in sunny and foggy days showed a distinct negative correlation, and the gradient variation of O_3 near the ground in foggy days was significantly greater than that in sunny days. $PM_{1.0}$, $PM_{2.5}$ and PM_{10} in foggy days are more than twice as high as in sunny days. CO is relatively stable and varies less vertically during the radiation fog.

3) The pH, electrical conductivity (EC), total ion concentration (TIC), and chemical compositions of the fog water were all size-dependent. High concentrations of non-sea-salt calcium ($nssCa^{2+}$) and NH4 + led to the alkaline pH of 6.13–7.32. The TIC of fog water was relatively high, especially in small droplets of diameter within 4–16 µm (463527.9 µeq/L). The relatively high NO^{2-} concentration was also found in the fog water, dominated by the non-homogeneous chemical reaction between NO_2 and fog droplets.

B33

RADIATION FOG EVOLUTION FROM THIN TO THICK PHASE: EVIDENCE FROM WIFEX OBSERVATIONS

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Abstract

In optically thin fog phases, the turbulent kinetic energy threshold is approximately 0.1 m^2/s^2, according to our earlier research at the Winter Fog EXperiment (WiFEX), Indira Gandhi International Airport, New Delhi. However, this threshold significantly increases and persists between 0.4 m^2/s^2 and 0.5 m^2/s^2 in the optically thick phase. In the current study, we extended our research on vertical velocity variance during various radiation fog episodes. During night-time, analyzed clear-sky conditions, and thermally stable conditions, three radiation fog episodes, data at the WiFEX site in the current study. Vertical velocity variance at 12.5 m measured in all cases before fog onset was less than 0.05 m^2/s^2. We observed an increase in vertical velocity variance to 0.15 m^2/s^2 as the fog changed from an optically thin to an optically thick phase. In addition, during all fog episodes, soil moisture increased until the fog layer wholly dissipated, and surface warming further dried the soil. It indicates that feedback from the fog layer into the soil layer occurs immediately adjacent to the surface, and evaporation occurs as long as the surface warms. However, we also observed that deeper soil layers below 20 cm (check levels 20, 60 and 90cm) are insignificant. It will be discussed shortly, along with the compressive analysis of the radiation fog episodes.

B35

THE FOG ISOTOPIC VARIATIONS IN GOBABEB, NAMIBIA BETWEEN 2014 AND 2020

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Abstract

In the context of climate change, the intensity, frequency, and duration of drought events have significantly increased, resulting in a profound impact on dryland ecosystems. Over the past 10 years, the Namibian government has declared national emergencies in 2013, 2016, and 2019 due to extreme drought events. Although fog supplies critical amounts of water for dryland ecosystems, they are the least-studied and least-characterized components of the hydrological cycle. In addition, no studies investigate the effect of the extreme drought on the fog origins and formation mechanisms over long time scales. In order to fill these knowledge gaps, we investigated the fog isotope variations (δ^2H, $\delta^{18}O$, and $\delta^{17}O$) in the Namib Desert at Gobabeb-Namib Research Institute during the El Niño drought years (2015, 2016, and 2019) and non-El Niño normal years (2014, 2017, 2018, and 2020). The isotopic compositions (δ^2H, $\delta^{18}O$, and $\delta^{17}O$) of fog in the El Niño drought years were much higher than those in the non-El Niño normal years ($p < 0.05$). Moreover, the slopes of three types of fog line (advection fog, mixed fog and radiation fog) in the El Niño drought years were significantly lower than those in the non-El Niño normal years ($p < 0.05$), indicating a stronger isotope evaporation effect during El Niño droughts. The d-excess of ocean-moisture-derived fog (advection fog) during El Niño droughts is relatively higher compared with non-El Niño normal years, but the d-excess of non-ocean-derived fog is significantly lower in El Niño droughts. This indicated that the local generated fog (mixed and radiation fog) was more susceptible to evaporation effects in El Niño droughts, while the El Niño drought had a less effect on ocean-moisture-derived fog. The d-excess of fog water was positively related to the wind speed in the El Niño drought years but negatively correlated with the wind speed in the non-El Niño normal years ($p < 0.05$). The higher wind speed might reduce the isotopic evaporation effect on fog sources during El Niño droughts, and conversely, it could facilitate the isotope evaporation of fog sources in the non-El Niño normal years. Results showed that total amount of fog during El Niño drought years was significantly higher than the non-El Niño normal years ($p < 0.05$). In addition, the non–ocean-moisture-derived fog (mixed and radiation fog) accounted for 84.3% of the total fog events during El Niño drought years and 70.7% during non-El Niño normal years, suggesting an increasing local-generated fog in the El Niño drought years. These results will assist in predicting dryland responses to global climate change by providing information about fog origins in El Niño droughts and non-El Niño normal years.

B36

THE POTENTIAL STORAGE EFFECTS ON THE ISOTOPIC COMPOSITIONS OF FOG AND DEW WATERS

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Abstract

Fog and dew potentially play an important role in ecosystem dynamics and are particularly important for water-limited systems. To better predict the dryland ecosystem responses to global climate change, a better understanding of long-term isotopic compositions of fog and dew waters is helpful. However, the long-term storage of fog and dew waters have the potential to modify the original isotope composition due to liquid water evaporation and water vapor permeation. In this study, the extent of such changes in the isotopic compositions (δ2H, δ18O, and δ17O) of fog and dew, that is, isotopic differences between original and final measurement values, was investigated under different storage times (over 4.5-9 years) and different bottle volume (0-18 ml). Changes of about +0.65‰ for δ18O ($p < 0.05$) and–2.24‰ for δ17O ($p < 0.01$) have been found for fog water after long-term storage within the glass bottle. Although the δ2H changes of fog water between original and final measurement values varied a lot (ranging from –4.9‰ to 5.5 ‰), no significant difference in δ2H of fog water was observed between original and final measurement values ($p > 0.05$). The fog δ18O changes were negatively correlated with storage volume ($p < 0.01$), but no significant relationship was found between fog δ18O changes and storage time ($p > 0.05$). The δ2H changes of fog and dew water were found to be positively related to the storage time. These results could help maintain the long-term isotopic accuracy and precision of fog and dew waters by providing information of isotopic changes after long-term storage.

B37

NAMIB FOG AND LOW CLOUD LIFE CYCLES AND THEIR INTERACTION WITH BIOMASS BURNING AEROSOLS

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Abstract

This contribution presents ongoing research on the effects of biomass burning aerosols (BBA) on fog and low clouds (FLC) in the Namib, using data from multiple satellite platforms and station measurements.

Fog, which is the most relevant non-rainfall water source for plants and animals in the coastal parts of the Namib Desert, may become increasingly important for local ecosystems as regional climate simulations predict a warmer and drier climate for southern Africa in the future. Previous studies showed the role of BBA on cloud development over the ocean off the Namibian coast. The same processes are likely to influence Namib-region FLC formation and persistence as well. However, the potential effects of aerosols on FLC in the Namib Desert, a direct extension of the South-East Atlantic cloud system have yet to be investigated.

A clear seasonal cycle of FLC dissipation is found in a satellite-based product of FLC formation and dissipation times, with longer FLC persistence during the BBA season. Using a BBA reanalysis product in combination with the satellite data, it is found that during this season, FLC dissipation times are positively correlated to BBA loading (higher aerosol loading coinciding with later FLC dissipation). It is assumed that semi-direct and indirect BBA effects contribute to this pattern. Using a statistical learning technique , potential aerosol effects on FLC dissipation time are isolated from local and large-scale circulation variability, which has been shown to be a main driver of FLC occurrence and life cycles. .

These findings are a first step in a better understanding of the Namib-region FLC system and will help in the development of a statistical model to quantify the sensitivities of FLC lifetime in the region in the next step of the project. An outlook is provided of an upcoming research project in the region, where deep learning will be applied to satellite data to separate fog from low stratus clouds.

B38

NET PRECIPITATION IN A CANARIAN FOG LAUREL FOREST: RESULTS FROM A THIRTY- YEAR MONITORING PERIOD

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Abstract

The Garajonay National Park (Canary Islands, Spain) is well known because of the fog laurel forest, a unique ecosystem that demands high humidity and mild temperatures. Potential distribution of this very special ecosystem is associated with the presence of frequent fogs in the western Islands.

The formation, distribution and incidence of fogs depend greatly on the orography, influenced by the exposure to the trade winds, as well as the altitude. Therefore, fog contributes in an essential way to the environmental heterogeneity and, consequently, to the formation of the complex mosaic of forests that characterizes the Canarian Laurel Forest, at the same time that is a key element in the hydrological cycle.

This work deals with the quantification of the volume of precipitation of Garajonay National Park ecosystems, taking into account the components involved in the process, such as incident precipitation, troughfall and stemflow, and the variation of these components during a long sampling period ranging from 20 to 30 years, depending of the type of recorded rainfall. The study was carried out in a number of plots included in the Ecological Monitoring Program of the Garajonay National Park, with data support from various stations of the Spanish Meteorology Agency.

Throughfall showed the highest values in hillside laurel forest, and especially in the summit heathlands of Erica, with impressive summer values that clearly break with the Mediterranean pattern followed by rainfall in the rest of the locations. The lowest relative values are reached in degraded heath forests and shrubland. In general, stemflow was not significant.

Fog precipitation contributes effectively to net precipitation and is very relevant in the ecological differentiation of Garajonay Ecosystems, favouring the water balance in these areas in higher proportions than in other cloud forests on the planet.

The values of the environmental parameters conditioning the growth of laurel forests, especially precipitation, are reaching critical minimum or extreme levels. There is a clear reduction of normal rainfall in the last three decades. Same happens with forest troughfall, with some remarkable exceptions, like the ridge areas of the Park, where it has hugely increased.

B41

ENHANCED WATER AND LIGHT-USE EFFICIENCY UNDER SUMMER COASTAL FOG IN A CALIFORNIA AGRICULTURAL SYSTEM

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Abstract

In coastal California, the peak growing season of economically important crops, such as strawberries, is concurrent with fog events, which buffer drought stress during the dry season. Understanding how coastal fog impacts crop water demand has implications for sustainable water use practices in an ultimately water-limited ecosystem. We quantified the effects of coastal fog on the energy, water, and carbon fluxes of a strawberry farm located in the fog-belt of the Salinas Valley, California. We used Geostationary Operational Environmental Satellite (GOES) total albedo to detect and quantify large scale patterns of coastal fog. We used eddy covariance (EC) to quantify actual evapotranspiration and gross primary productivity (GPP) at the field scale (approximately 0.5–3 hectares) from June to September 2016. We measured canopy-scale strawberry physiology on foggy and non-foggy days within the measurement footprint of the EC tower. Downwelling longwave radiation ($L\downarrow$), observed by a surface-mounted pyrgeometer, was consistently higher on foggy compared to clear-sky days (regardless of fog-drip), indicating that emission of longwave radiation was derived almost entirely from the cloud base. $L\downarrow$ and total GOES albedo were positively and strongly correlated ($R2 = 0.68$, $P < 0.01$). For both field- and canopy-scales, water-use and light-use efficiency increased by as much as 50% and 70%, respectively, during foggy compared to non-foggy conditions. The initial slope of the curvilinear relationship fit between GPP and photosynthetically active radiation was twice as steep during foggy ($\alpha = 0.0395$) than non-foggy ($\alpha = 0.0210$) conditions, suggesting that the scattering of light during fog events enhances photosynthetic output of whole-plants. Our results suggest that irrigation for these fields could be rescheduled during foggy periods without sacrificing plant productivity. We also demonstrate that $L\downarrow$ can be used to detect low clouds associated with coastal fog events, even when there is no fog-drip. Furthermore, the strong and positive agreement between $L\downarrow$ and satellite-derived indices increases our predictive power of satellite-derived coastal fog indices to estimate surface-atmosphere exchange of carbon, water, and energy fog-influenced agroecosystems.

B42

MODELING CLOUD WATER INTERCEPTION FOR HAWAII USING CLOUD LIQUID WATER CONTENT, WIND SPEED, CANOPY HEIGHT, AND LEAF AREA INDEX

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Abstract

Cloud water interception (CWI), sometimes referred to as fog deposition, is the passive capturing of wind-blown liquid cloud droplets by vegetation. CWI can serve as an important extra water input to the ecosystem in addition to rainfall and has been suggested to increase water resources for human use. Information about CWI amounts and variation over the landscape is necessary to evaluate the influence of CWI on hydrological processes and water resources. However, quantifying CWI at large scales is difficult. CWI can only be measured at the plot scale, and the highly variable nature of CWI makes scaling up plot-based measurements difficult. CWI is controlled by multiple interacting factors including fog occurrence and water content, wind speed and direction, and vegetation characteristics such as exposure, plant height, and leaf area. Because the heterogeneity is a result of individual factors that vary independently across space and time, the spatiotemporal variation of CWI can only be understood and predicted using process-based modeling.

In this study, we used observational data from five tropical montane sites with diverse climates and vegetation types to test a relatively simple model proposed by Katata et al. (2011) that uses only 4 variables. The Katata model predicts CWI as a linear function of cloud water flux (CWF), which is the horizontal throughput of liquid cloud water that passes over the canopy and is proportional to cloud liquid water content times wind speed. The ratio between CWI and CWF, representing the canopy interception efficiency, can be predicted by canopy height and leaf area index. At each site, a meteorological station measured wind speed, rainfall, and variables to estimate potential evaporation. Throughfall and stemflow were measured and canopy parameters, including the canopy storage capacity and free throughfall ratio, were estimated based on the observations. We then ran a canopy water balance model that accounts for the canopy water storage and interception evaporation to estimate CWI. Cloud liquid water content was measured using passive fog gauges that were calibrated for gauge efficiency, and the captured rainwater was estimated and removed. Finally, canopy height and leaf area index were obtained from field surveys or published data.

The result shows that, at the plot scale, CWI varied from 157 to 910 mm annually, and accounted for 2.8% to 33.5% of the total precipitation. The Katata model significantly overestimated the canopy interception efficiency at one out of five sites but predicted the rest reasonably well. The biases of annual CWI predicted by the Katata model based on hourly CWF observations ranged from 24% overestimation to 56% underestimation across the five sites. The largest underestimate was found at the site with discontinuous forest canopy, which also had the highest canopy interception efficiency, likely due to edge effect.

B43

PHOTOSYNTHETIC GAS EXCHANGE OF BROADLEAF TREES ON CLOUDY AND FOGGY DAYS

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Abstract

Photosynthetic gas exchange of broadleaf species has been well-studied, especially on sunny days. Meanwhile, investigations on their photosynthetic gas exchange on cloudy and foggy days are rare due to the limitation of techniques. Understanding the photosynthetic performance of trees on cloudy and foggy days can help understand their overall performance and relative advantages in ecosystems with frequent cloud and fog events. Therefore, we measured the photosynthetic gas exchange of eight deciduous and eight co-occurring evergreen broadleaf species grown in a common open environment in a cloud forest during sunny, cloudy, and foggy days in the summer growing season. The percentage of sunshine hours in the growing season was only 32%. There were distinctly higher numbers of cloudy and foggy days than sunny days. As expected, we found that the photosynthetic rates of all studied trees were distinctly lower on cloudy and foggy days compared to values on sunny days. However, most trees still maintained positive photosynthetic carbon assimilation during foggy days. Interestingly, compared to evergreen trees, deciduous trees showed higher photosynthetic rates on sunny days, but lower values during cloudy and foggy days. This pattern suggests a potential tradeoff between photosynthesis under high direct light conditions and under low and diffuse light conditions.

B45

ARE ALL DESERTS ALIKE? WATER VAPOR ADSORPTION IN THE NAMIB AND NEGEV DESERTS

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Abstract

Atmospheric water, or non-rainfall water inputs (NRWIs) are an important source of water in arid areas. Considering the large surface area of arid and extremely arid regions, NRWIs are a critical, albeit largely overlooked, component of the global hydrological cycle. Water vapor adsorption is not only the least studied form of NRWI but likely the most common one in arid areas. The amount of water vapor adsorption mainly depends on the gradient between water vapor pressure between the air (e_a) and the soil (e_s). Sea breeze, which carries moist air from the sea landward, can result in a significant daily increase in ea in desert areas.

We have examined the diurnal cycle of soil water content derived by water vapor adsorption and evaporation in two very different deserts: the Negev (loess soil, ~100 mm y^{-1}) and the Namib (sand dunes, ~20 mm y^{-1}). Water vapor adsorption into the Negev's loess soil has been established as the dominant NRWI (with 0.3-0.5 mm $night^{-1}$). Even in the Namib, which is known as a fog desert, even on nights with fog, at least half of the water accumulation occurred via water vapor adsorption, before the onset of fog (0.1-0.2 mm $night^{-1}$).

B47

OASIS SPATIAL RESPONSES TO ATMOSPHERIC WATER INPUTS IN THE ATACAMA DESERT USING A HYBRID MODEL BASED ON RADAR AND SOLAR DOMAIN SATELLITE IMAGES

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Abstract

Climate change and human pressures upon traditional water sources provoke decreases in life conditions, especially in areas where the desert is expanding. Despite this, ecosystems supplied by other more subtle water sources, specifically marine fog and dew, are widely recognized. Comprehending the finer hydrological cycle components is fundamental to preserving natural life forms and facing droughts in water stress areas. In this context, oases ecosystems show exceptional adaptive capacities and high efficiency using coastal fog and dew water, giving signals of its variability and distribution. These atmospheric water inputs are an underestimated phenomena due to the difficulty of their detection and quantification, but also the lack of spatially-distributed and long-term observations that allow us to understand their spatio-temporal dynamics. In this research, we developed a methodology with radar and optical satellite systems to provide high spatial and temporal resolution data about the influence of fog and dew on ecosystems. Sentinel-1 C-band data was exploited to describe the dynamics between dry and wet events with a co-polarized radar backscatter (vertical-vertical-VV) change detection approach. In addition, we used the reflectance responses of the multispectral instrument (MSI) over optical and infrared bands provided by the Sentinel-2 satellite to analyze vegetation structure types and dynamics concerning surface moisture. Both data were analyzed to give an approximation of the spatial variability of soil moisture and vegetation responses as proxies for these atmospheric water inputs. We have assembled a satellite-based Fog and Dew Water Index (FDWI) and applied it to the Las Lomitas fog oasis in Pan de Azucar National Park (25ºS-70ºW) from 2022-2023. This location is at 730 m.a.s.l., about 2 km from the sea, and has a regular presence of advective fog throughout the year. To verify the accuracy and sensitivity of outputs obtained for the FDWI, it has correlated with data from a standard fog collector, standard flat dew condenser, leaf wetness, and soil moisture, all provided by a main ground control station. We describe temporal variations of fog and dew in the Oasis and their association with FDWI. The analysis shows that fog is the main driver of the water supply to the Oasis. Furthermore, from a spatial perspective, the FDWI demonstrates the influences of these water inputs have a limited spatial extent, providing a local-scale map of the oasis ecosystem boundaries and gradients. Map of fog and dew water contributions represents an approach to understanding their spatial and temporal dynamics, giving estimations of the potential water use of such ecosystems.

B48

FOG TYPES FREQUENCY AND THEIR WATER POTENTIAL IN THE COASTAL ATACAMA DESERT

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Abstract

In recent decades, fog water has been positioned as a potential and complementary resource for tackling water scarcity in arid regions such as the Atacama Desert. Significant advances have been made in understanding space and time fog cycles, the physical conditions that determine its formation, and the particular geographical setting that allows its presence. However, our knowledge regarding types of fog is limited. Fog types have been identified in the Atacama as orographic, advective, and radiative, but their frequencies have never been quantified before, as well as their physical description or water potential. We propose to bridge this knowledge gap by studying the frequency of fog types, the physical conditions that influence their formation, and their water potential. Our strategy is to use GOES-16 satellite images through the Google Earth Engine platform to define spatial criteria for distinguishing such fog types. As a first step, using these criteria, we develop an algorithm to identify each fog type at high temporal resolution (10 min) in different places of the Atacama Desert, analyzing their frequency. As a second step, we select representative cases of each type and analyze the meteorological, geographical, and oceanic conditions that allow its formation. Finally, we relate such types' frequency with fog water collection measured through standard fog collectors to understand their water potential. Our preliminary findings show that orographic events correspond to 21% of the total days in 2022. Such events occur mainly during summer, showing a low water potential. Conversely, advective events correspond to 43% of the total days concentrated in winter and spring, showing a higher water potential than orographic ones. This research brings us closer to a quantitative understanding of fog nature and its potential as complementary water resources. We expect that improvements in this quantification of fog-type events will contribute to improving fog water predictive models.

B49

SATELLITE OBSERVED POSITIVE IMPACTS OF FOG ON VEGETATION AND FOG RETRIEVAL USING CALIPSO LIDAR OBSERVATIONS

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Abstract

Fog is an important water source for many ecosystems, especially in drylands. Most fog-vegetation studies focus on individual plant scale; the relationship between fog and vegetation function at larger spatial scales remains unclear. This hinders an accurate prediction of climate change impacts on dryland ecosystems. To this end, we examined the effect of fog on vegetation utilizing both optical and microwave remote sensing-derived vegetation proxies and fog observations from two locations at Gobabeb and Marble Koppie within the fog-dominated zone of the Namib Desert. Significantly positive relationships were found between fog and vegetation attributes from optical data at both locations. The positive relationship was also observed for microwave data at Gobabeb. Fog can explain about 10%–30% of the variability in vegetation proxies. These findings suggested that fog impacts on vegetation can be quantitatively evaluated from space using remote sensing data, opening a new window for research on fog-vegetation interactions. In terms of fog retrieval, most fog detection from space cannot differentiate fog and low stratus clouds, and cannot estimate fog deposition. This study assessed the feasibility of using spaceborne lidar observations from the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) in fog detection and estimation. We tested the method in the central Namib Desert, Namibia, where frequent fog events occur and fog observations are available. Results showed the CALIPSO backscatter signal at 532 nm can differentiate low clouds and fog due to its high-resolution vertical profiles. Backscatter signals during fog events were significantly higher than those during non-fog periods. The R2 between backscatter signals and fog observations was 0.85. Moreover, the backscatter signal was also sensitive to relative humidity variation (R2 = 0.66). These results indicate that the CALIPSO data are feasible to estimate fog occurrence and deposition, providing a new perspective for space-based fog studies.

1. Qiao, N., et al., Satellite observed positive impacts of fog on vegetation. Geophysical Research Letters, 2020. 47(12): p. e2020GL088428.

2. Qiao, N., et al., Fog Detection and Estimation Using CALIPSO Lidar Observations. Geophysical Research Letters, 2022. 49(24).

B50

DETECTION OF DAWN SEA FOG/LOW STRATUS USING GEOSTATIONARY SATELLITE IMAGERY

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Abstract

Traditional satellite-based detection of dawn sea fog/low stratus (SFLS) is difficult because of the weak reflectivity in the visible-band at low solar elevation angles and the contamination of the reflected sunlight in the mid-infrared. Here, we propose a dawn SFLS detection algorithm using the joint Fully Convolutional Network and Conditional Random Field (FCN-CRF), which are well known for image semantic segmentation under low contrast conditions. Assuming that the SFLS has long lifetimes over the Yellow Sea, we design a novel SFLS labelling technique using the China's Fengyun 4A (FY-4A) satellite observations before and after dawn to train the FCN-CRF detection for dawn SFLS. A validation using the FY-4A data alone shows that the FCN-CRF detection is able to detect dawn SFLS with satisfactory accuracy, with a probability of detection (POD) of 0.809, a false alarm ratio (FAR) of 0.129, a critical success index (CSI) of 0.727 and a hit rate score (HR) of 0.950. These statistics are further supported by an independent sea fog detecting validation against a buoy's visibility observations, with a POD of 0.849, a FAR of 0.087, a CSI of 0.785, and a HR of 0.874.

B51

DETERMINANTS OF FOG AND LOW STRATUS OCCURRENCE AND LIFE CYCLE OVER CENTRAL EUROPE

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Abstract

This contribution presents the spatiotemporal patterns of fog and low stratus occurrence as well as their life cycle over central Europe, and quantifies sensitivities of both to atmospheric and land-surface conditions from a satellite perspective.

Fog and low stratus (FLS) occurrence, as well as the timing of formation and dissipation (life cycle) have economical and ecological impacts. The occurrence and the life cycle of FLS are influenced by meteorological and land-surface conditions, and their impact varies across temporal and spatial scales. Despite the availability of satellite FLS products, no comprehensive quantitative analysis of the determinants of FLS occurrence and life cycle over a large region exists to date.

In this study, satellite-based data sets and statistical methods, including machine-learning, logistic regression and hierarchical clustering, are used to fill this knowledge gap. While atmospheric drivers are found to be the main determinants of the day to day variability of FLS occurrence, land surface characteristics are shown to impact the long-term spatial distribution of FLS. To analyze FLS life cycle, the timing of FLS formation and dissipation are extracted from a satellite-based FLS data set, revealing spatially well-defined climatological patterns. This new data set is then also linked to environmental conditions quantitatively. Distinct FLS life cycle regimes are identified throughout Europe. A case analysis focussing on the Po valley in northern Italy highlights the influence of atmospheric aerosols on the FLS life cycle.

The data sets and results presented here further provide a basis for future studies focussing in more detail on the processes related to the life cycle of FLS across different geographical regimes and land surface types.

B52

ON THE PHYSICAL CAUSES AND POTENTIAL IMPLICATIONS OF SATELLITE-BASED FALSE-DETECTIONS IN NOCTURNAL MARITIME LOW CLOUDS AND FOG

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Abstract

Climate prediction models are highly sensitive to uncertainties in cloud type, amount, and distribution across space and time. Likewise, clouds play a significant role in operational circles, including aviation. Due to the relative lack of data over the ocean, marine boundary layer (MBL) clouds, including fog, are particularly difficult to measure. Environmental satellites are the best way to collect data on the properties of these low clouds. During the daytime, MBL clouds can be seen in the visible spectrum, but at night, infrared (IR) methods are typically used. These IR methods include a 11-3.9 µm brightness temperature difference (BTD) common to many operational cloud masks. NOAA's GeoColor product uses a similar BTD (10.3-3.9 µm) to identify fog in its displays for National Weather Service users. However, it has recently been demonstrated that under certain conditions, these simple methods can indicate the presence of low cloud when none in fact exists. This false alarm low-cloud issue was first discovered by comparing operational cloud mask products (downstream of the IR methods) to a novel low-light visible imagery of moonlight reflection from the Visible/Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB). This presentation describes the physical basis for these false alarms, along with some examples of regions susceptible to the conditions that create this effect. The findings suggest that regional-scale biases may exist within the products reliant on accurate nighttime cloud masks, foremost among them, the sea-surface temperature climate data record. The magnitude of these inaccuracies are estimated using the VIIRS DNB as a benchmark for truth.

B53

HIGH-RESOLUTION SATELLITE-BASED CLOUD DETECTION FOR THE ANALYSIS OF LAND SURFACE EFFECTS ON BOUNDARY LAYER CLOUDS

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Abstract

In this study, geostationary satellite observations are used to develop and validate two high-resolution cloud-masking approaches for the region of Paris to show and improve applicability for analyses of urban effects on clouds.

Firstly, the Local Empirical Cloud Detection Approach (LECDA) uses an optimised threshold to separate the distribution of visible reflectances into cloudy and clear sky for each individual pixel accounting for its locally specific brightness. Secondly, the Regional Empirical Cloud Detection Approach (RECDA) uses visible reflectance thresholds that are independent of surface reflection at the observed location.

Results show that

1. A decrease of cloud cover during typical fog or low-stratus conditions over the urban area of Paris for the month of November is likely a result of urban effects on cloud dissipation.
2. The regional approach, RECDA, is a more appropriate choice for the high-resolution satellite-based analysis of cloud cover modifications over different surface types than LECDA with regional biases of ±5 %.

This approach can provide comprehensive insights into spatiotemporal patterns of land-surface-driven modification of cloud occurrence and locally induced cloud processes, such as the diurnal variation of the occurrence of fog holes and cloud enhancements attributed to the impact of the urban heat island. Further, it is potentially transferable to other regions and temporal scales for analysing long-term natural and anthropogenic impacts of land cover changes on clouds.

B54

MACHINE-LEARNING ALGORITHM FOR 24H DETECTION OF FOG AND LOW STRATUS OVER EUROPE BASED ON METEOSAT-SEVIRI INFRARED BANDS

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Abstract

In this communication we present a pixel-based algorithm for detection of fog and low stratus (FLS) during the 24H day cycle over land and across Europe, based on geostationary satellite observations.

Fog and low Stratus are both a persistent aggregation of water particles in liquid and/or solid phases (cloud) close to the Earth's surface. As the cloud-base-height is the only real difference between the two (fog: touching the ground; low stratus: above ground), they are frequently treated together as a single category (FLS) from satellite perspective. The study of FLS life cycles requires a consistent around-the-clock product, which has not been available so far. This study presents a pixel-based method for detection of FLS over land across Europe based on Meteosat-11 SEVIRI (Spinning Enhanced Visible and InfraRed Imager) infrared observations. The method is based on a gradient boosted trees (XGBoost) machine learning model that is trained with observations from Meteorological Aviation Routine Weather Reports (METAR) stations. An intensive validation of the product over 356 METAR stations across Europe over five years of daytime winter data revealed that the method proposed is well capable of detecting FLS over land. Specifically, the algorithm is found to detect FLS with probabilities of detection (POD) ranging from 0.79 to 0.86 (for different inter-comparison approaches), and false alarm ratios (FAR) between 0.28 and 0.30. As the algorithm operates based on the SEVIRI infrared observations only, it can be applied over day and night, making it feasible to continuously monitor the FLS status over large areas over the 24H day cycle.

B55

ESTIMATING UNCERTAINTY FOR FOG DETECTION AND VISIBILITY ESTIMATION USING SATELLITE OBSERVATIONS

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Abstract

Fog, a vital component of the water cycle, is commonly observed in different parts of the world, including Northern India. It results in significant financial and health costs. Real-time fog detection and predictions are essential for lowering these losses. To address these issues, the study proposes a methodology for real-time visibility estimation and fog detection using satellite observations. An algorithm is presented to find fog from satellite observations using artificial neural networks. Instead of typical neural networks, which use weights as fixed parameters, the proposed model is based on Bayesian Neural Networks, which utilize weights as probability distributions. The technique also produces prediction uncertainty, which includes data-dependent (epistemic) and model-dependent (aleatoric) uncertainties. This results in the output being the percentage probability of fog, which can be suitably thresholded into fog/no-fog. The input to the model is INSAT-3D geostationary satellite data with a spatial resolution of 4 km. The model is trained and validated using half-hourly data of wintertime *in situ* (METAR) observations collected at airports of 10 cities in North India from 2016 to 2020. The proposed model has better performance as compared to the INSAT-3D fog product developed by ISRO (i.e., baseline) in terms of critical success index (0.45 against 0.13). The characterization of uncertainty indicates that aleatoric uncertainty (ranging up to 0.5) typically exceeds epistemic uncertainty (ranging up to 0.06). The epistemic uncertainty is usually high for observations with higher aleatoric uncertainty, suggesting a positive association. The highest uncertainty typically corresponds to false positives (incorrect fog detection), whereas the least uncertainty corresponds to true negatives (correct no fog detection). The visibility estimation model is under development, and its results will be presented at the conference. This study is a part of the Fog Prediction using Data Science project. The project website (www.fog.iitk.ac.in) provides real-time forecasts that are publicly available.

B56

SPATIOTEMPORAL DISTRIBUTIONS OF CLOUD COVER IN TAIWAN

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Abstract

Solar radiation is the major energy source of the Earth. The amount of solar radiation reaching the ground is significantly affected by the characteristics of clouds. In addition, clouds are one of the most important factors for the interaction of energy, water, and carbon between land and atmosphere. This study explored the long-term, seasonal, and diurnal spatial variation characteristics of island-wide cloud cover in Taiwan based on MODIS cloud product data from 2003 to 2021. The results show that the average cloud top heights of the middle and low clouds are 2,285 m and 4,539 m, respectively, which are the two cloud classes that have a greater impact on Taiwan. Moreover, the cloud cover rate in the afternoon is higher than that of the other three observation periods. Compared to the results of six eco-regions in Taiwan, the cloud cover rate of the three eco-regions in the east is significantly higher than that in the three western eco-regions. The northeast eco-region of Taiwan has the highest cloud shadowing rate, followed by the southeast region. There are 39 and 41 endemic species that can only be found in these two eco-regions and further exploration is suggested.

B57

GROUND TRUTHING OF MODIS GA V6 SATELLITE FOG DATA WITH STANDARD FOG COLLECTORS ALONG THE CENTRAL CALIFORNIA COAST

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Abstract

The MODIS GA V6 satellite sensor aboard a polar orbiter offers relatively high-resolution images (1 km2 pixels) that, on one channel, are believed to be indicators of fog. However, validation of such imagery is difficult due to the challenge of regular surface observations that are collated and available during the times of satellite flyovers. Along the Central California Coast, MODIS has produced imagery every day at 10:30 am since 2000. The network of standard fog collectors that are a part of California State University, Monterey Bay represents a unique opportunity to ground truth the MODIS sensor, since multiple standard fog collectors have been deployed at over a dozen sites across the region and most of these devices record events with a temporal resolution of 5 minutes or less.

There are several challenges associated with this method of ground-truthing the satellite fog imagery. One is that most fog events take place during the evening and early morning hours and, often, by 10:30 AM, had there been a fog event the preceding night, it is likely to have burned off by the time of the flyover. However, this is not always the case.

Another challenge is that there can be a delay of up to 90 minutes between the start of a fog event and the initiation of water collected by a standard fog collector and there can also be a similar delay between the end of a fog event and the cessation of water dripping from the standard fog collector. The length of the latter delay has been less documented, but could be of similar magnitude as the delay of the initiation and is a function of parameters such as the post-fog relative humidity, the wind speed, and the density of the fog event itself.

However, while taking these effects into consideration, this paper demonstrates a unique means of quantifying this comparison with promising results. This is important for potentially providing the ability to more accurately and reliably measure fog occurrence from satellite, allowing an enhanced ability to track fog hot spots, which are useful from a safety perspective and from the perspective of optimal site location for fog water collection.

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