COP21 Climate Negotiators' Responses to Climate Model Forecasts

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Policymakers involved in climate change negotiations are key users of climate science. It is therefore vital to understand how to communicate scientific information most effectively to this group. We tested how a unique sample of policymakers and negotiators at the Paris COP21 conference update their beliefs on year 2100 global mean temperature increases in response to a statistical summary of climate models' forecasts. We randomized the way information was provided across participants using three different formats similar to those used in Intergovernmental Panel on Climate Change (IPCC) reports. In spite of having received all available relevant scientific information, policymakers adopted such information very conservatively, assigning it less weight than their own prior beliefs. However, providing individual model estimates in addition to the statistical range was more effective in mitigating such inertia. The experiment was repeated with a population of European MBA students who, despite starting from similar priors, reported conditional probabilities closer to the provided models' forecasts than policymakers. There was also no effect of presentation format in the MBA sample. These results highlight the importance of testing visualization tools directly on the population of interest.

Climate change policy whether at a local, national or international scale requires dealing with the presence of uncertainty on many dimensions[3]. These uncertainties may be grouped into two broad categories: (a) those associated with socio-economic, demographic, geo-political, and technological drivers, and (b) those associated with the science of climate itself and, in particular, the response of the climate system to increases in CO2 concentration in the atmosphere. Scientists and advisory bodies like the IPCC handle and report these uncertainties in different ways. Uncertainties about both categories are typically dealt with by means of multi-model ensembles, either of integrated assessment models[4] or of climate models[5]. These comparison exercises generate distributions of variables of interest, which incorporate model and parametric uncertainty. They are routinely represented and summarized in reports like the ones produced by the IPCC (see Figure S4 for examples of formats used to represent these uncertainties).

Studies that examine people's response to, and use of, probabilistic information suggest that individuals may treat uncertainty from distinct sources differently[6], and that the communication format can affect how they use this information[7,8]. Concerns have been raised about the implications of uncertainty and its presentation format on their use in climate change decisions[3–8]. However, little is known about the way policymakers, directly involved in climate negotiations, process and react to the data and projections presented in written discussion and graphical displays (as, for example, in the IPCC summaries for policymakers).

Our goal in this experiment is to investigate climate negotiators' reactions to climate scientific uncertainty and the way it is presented. We address this problem by centering the experiment on a focal point in climate change policy making: global climate model projections of global temperatures increase by the year 2100 as a result of current and future GHG emissions. To make our experiment relevant to the policy debate, we use an emission scenario which builds upon the pledged "nationally determined contribution" (NDC). Our respondents are a unique sample of 217 policymakers attending the Paris COP21 conference, more than half of them being active negotiators (including eight heads of delegations). To investigate the specificities of this population, we compare policymakers' responses to those of 140 European MBA students, trained to play a country role in a climate negotiation simulation.

Our results provide insights into climate negotiators' expectations of future global warming and their reaction to scientific forecasts. Specifically, our experiment enables us to answer four research questions in a real world setting: (1) What are climate policymakers' expectations of future temperature increases? (2) How do climate model predictions change their expectations? (3) How is the effectiveness of climate model predictions affected by the way model information and its uncertainty is presented? and (4) Are climate policymakers different (in their beliefs and use of model predictions) from informed members of the general public?

Related to the first question, Figure 1 depicts policymakers' ex-ante beliefs (or priors) about the effects of NDCs on long-term global temperature increase, elicited for four (mutually exclusive and exhaustive) temperature increase intervals . Only 18% of respondents reported probabilities for the four ranges of temperature increases that summed up to 100%. For the remaining analyses we normalized subjective probabilities so that the four estimates given by each individual add up to 100.[13] Our main findings are robust to the exclusion of subadditive observations for either priors or conditional probabilities. For more information, see SI.4. It is important to notice that respondents were not given any information about the emission pathway in the period 2030-2100. Thus, they were free to report probabilities that reflected both their beliefs about future emissions and about the resulting evolution of the temperature. The future deemed most likely is that of 2100 temperature increases of 2-3°C, followed closely by the 3-4 °C scenario. These scenarios are in line with the debate preceding the Paris conference, with estimates ranging between 2.7°C and 3.5°C, as provided by the UNFCCC[a] and Climate Interactive[b] respectively. The median judged probability of 2100 temperature increase below 2°C is 8%. Although the distribution of probability assigned to this scenario is wide, most respondents did not assign more than a 20% probability to this event. This low probability assigned to the <2°C scenario is in stark contrast with the outcome of the Paris agreement that emphasized the need to limit temperature increases to be "well below 2°C". MBA students (Figure S5) reported similar prior distributions.

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[a] See http://unfccc.int/resource/docs/2015/cop21/eng/07.pdf

[b] https://www.climateinteractive.org/tools/scoreboard/

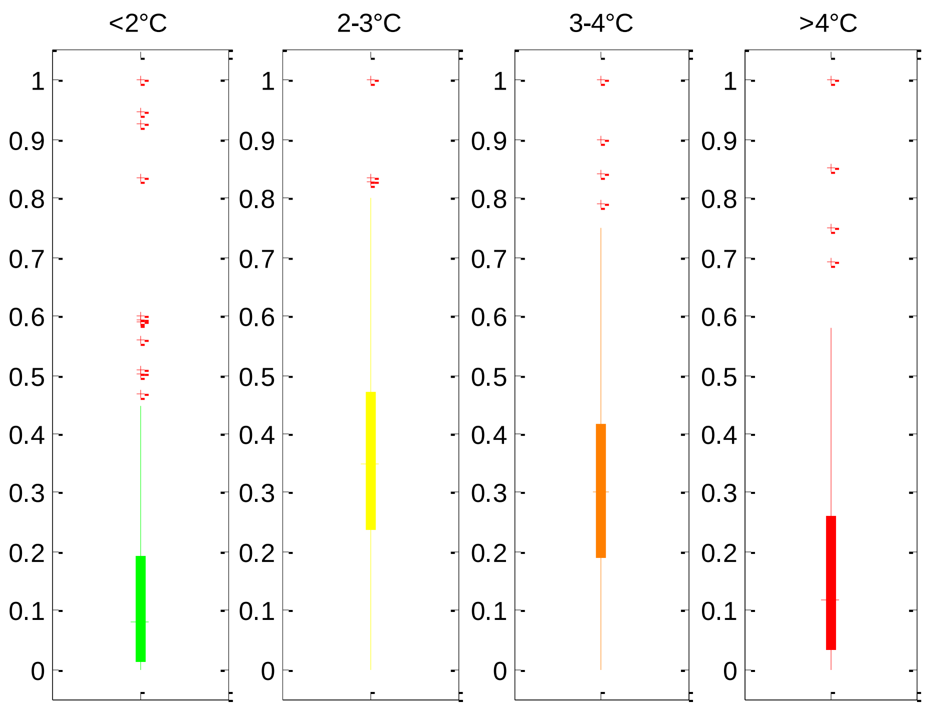


Figure 1: Distribution of prior probabilities across temperature bins. The box line shows the median, the edges are the 25th and 75th percentiles of the sample. Whiskers are 1.5 times the interquartile range away from the top or bottom of the box (covering 99% of the data if normally distributed). Outliers are displayed with a red + sign. See Supplementary Information Figure S5 for the same Figure for the Student sample.

The prior beliefs do not differ for climate negotiators directly involved in the negotiation process vs. non-negotiator policymakers present at the Paris conference, and are not associated with other individual characteristics such as age or gender. However, there is evidence of regional differences. We classified respondents into five groups of countries (not mutually exclusive) that are relevant to climate negotiations: Vulnerable (countries/regions vulnerable to consequences of climate changes); Emerging Economy (countries/regions experiencing economy booming); Energy Exporter (countries/regions that are major exporters of fossil fuels); high Emitters (seven highest GHGs emitters), and OECD members (See SI.2 for a detailed description of country clusters). Representatives of vulnerable and emerging economies assign a lower probability to the 2-3 °C bin, and a higher one to the high temperature outcome of >4° (see Table S1).

To answer our second question, we assess how COP21 policymakers use climate models predictions when being asked for the probability distribution of 2100 global temperature increase based on a *specific* emission pathway. Before answering the question, policymakers received the range of predictions made by major climate models associated with this specific emission pathway. The projected temperature was shown by means of boxplot, displayed in three different formats (see methods for details). Reported conditional probabilities move clearly in the direction of the climate model forecasts (19% of the COP21 sample adopt the provided forecasts, almost exactly, while 61% move in the direction of that information). However, policymakers’ probability estimates of temperature increases conditional on the specific emission pathway adhere more closely to their unconditional priors than to the forecasts provided (see SI.3*).*

Figure 2 shows the joint distributions of priors and probabilities conditional on the given emission pathway. An observation along the horizontal black line represents an individual who reacted to the scientific information by fully adopting it as her conditional probability. It should be noted that, unless the respondent is a climate scientist or possesses private information on the validity of alternative climate model projections, reporting the provided model forecast as one’s conditional probability is the rational thing to do. Conversely, observations along the diagonal line represent individuals who did not move from their priors at all (respectively 28%, 20%, 24% and 30% of respondents for the four temperature categories, and 18% for all four of them). These figures include those respondents whose prior was right on the mark (1 in the <2°C scenario and 3 in the >4°C scenario), hence they had no reason to change their prior. Confirming previous research[14], more than 80% of respondents did not treat the scientific information as a posterior probability, but rather used it as additional information to update their prior beliefs, mostly in a very conservative fashion (see Table S4 and Table S5 in SI.4 and discussion). Interestingly, in the follow-up experiment with MBA students’ conditional probabilities are much less close to prior beliefs on average, 25% of the sample almost exactly reporting the provided information (see Figure S6).

Different mechanisms might make respondents anchor on their unconditional priors, when being asked to report the probabilities of the given emission scenario. These mechanisms might furthermore have different impact on different individuals.

The first mechanism relates to the confidence respondents have in their priors. We find that reported confidence in the prior (on a 7-pt scale) for policymakers (median=5.00, iqr=1.75) is higher (Wilcoxon p-value=0.02) than for MBA students (median=4.0, iqr=2), with active negotiators and other COP21 participants reporting similar levels of confidence (p=0.82, Wilcoxon test). The difference in confidence could be the result of different perceptions of expertise and power, and confidence in one’s own judgment has been shown to negatively affect advice taking[15,16]. For COP21 non-negotiator policymakers, high confidence in the prior is associated with large distances between their reported conditional probabilities and the provided scientific information. In contrast, active negotiators’ and MBA students’ distance between conditional probabilities and scientific information is independent of their confidence level (see Figure S1).

Given that negotiators reported conditional probabilities further from scientific information than non-negotiator policymakers in Paris (this is a result robust to the different tests presented in SI.4) as well as than MBA students (Table S9), a second possible mechanism might be at play. Negotiators (consciously and/or unconsciously) may be more cautious in reporting conditional probabilities that differ from their country’s (or block of countries’) negotiation position which is in turn possibly reflected in their priors.

A third mechanism is known as *substitution bia*s, where a hard question is addressed by answering a (unconsciously substituted) simpler question. We can here not dismiss the possibility that, although our objective was to elicit probabilities conditional on the given emission scenario (see the Methods section for details), respondents did not consider the emission profile as given. Conditional probabilities would then also reflect their judged likelihood of the provided emission profile. Given their expertise, negotiators and non-negotiator policymakers at COP21 might have felt compelled to use this knowledge, justifying a greater occurrence of substitution bias than among the MBA students.

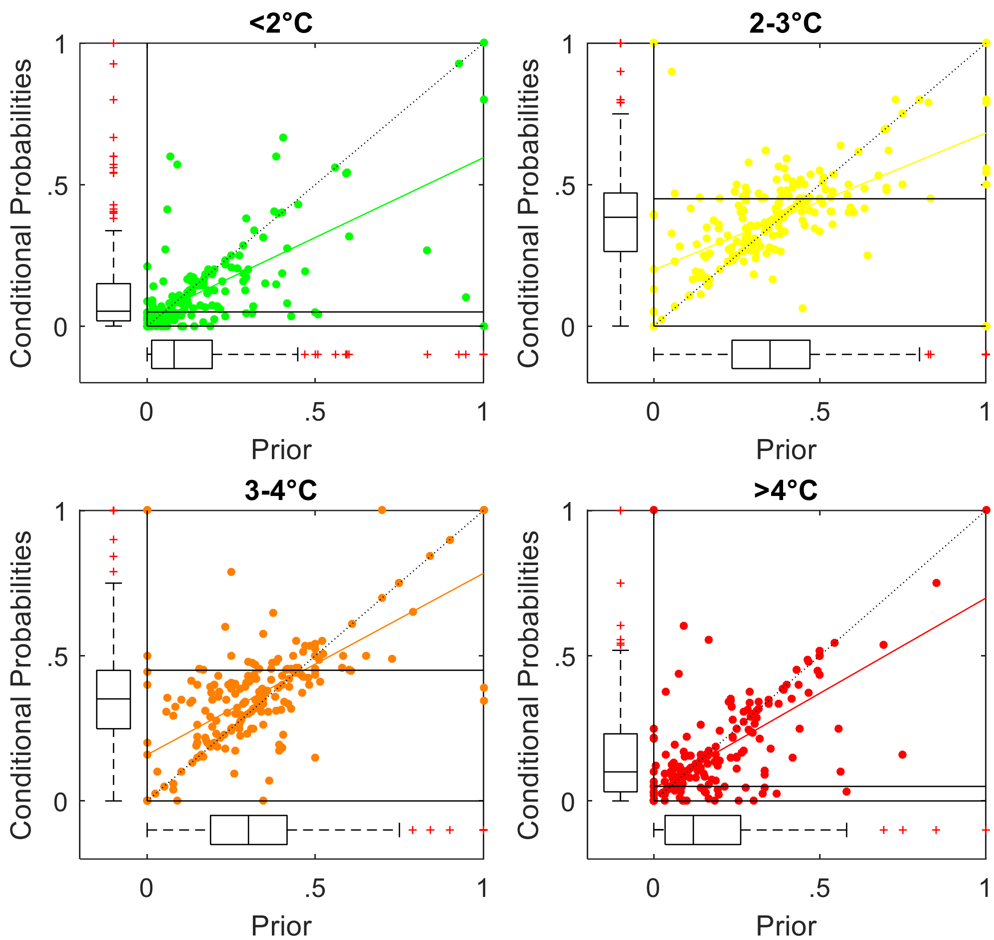


Figure 2: Scatter plot of the prior and conditional probabilities across temperature bins. Each dot is an observation, the colored lines represent a linear fit to the data and the black lines represent the scientific information. The bisector line is in dashed. Boxplots show the distribution of the prior and conditional probabilities, as in Figure 1. See Supplementary Information Figure S6 for the same Figure for the Student sample.

In summary, our data show that, in answer to the second question posed, the policymakers' reported conditional probabilities fail to fully incorporate the scientific information they received. Future research is needed to be able to disentangle the alternative mechanisms at play.

Our third question addresses the way uncertain forecasts extracted from scientific models are interpreted as a function of the presentation format. Figure 3 shows different ways of communicating the uncertainty in predictions across climate models. The formats were randomized between subjects. This provides greater accuracy but lower treatment effects than a within subjects design. Format 1 presents the mean and the central 90% of the predictions across scientific models and is the format used in the WGI IPCC 5th AR report. Formats 2 and 3 provide additional information about model uncertainty, i.e., the fact that different models generate different estimates. Format 2 highlights those models whose estimates fall outside the 90%

uncertainty range, while Format 3 presents all models' estimates. These formats thus provide information on similarities between models, clustering of predictions, and outliers.

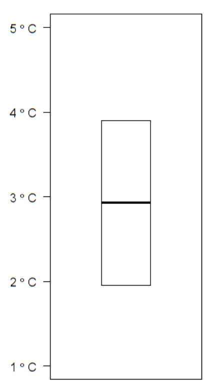
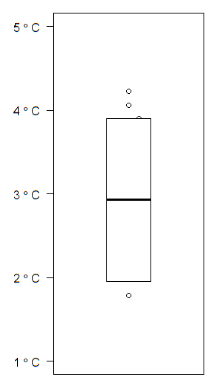
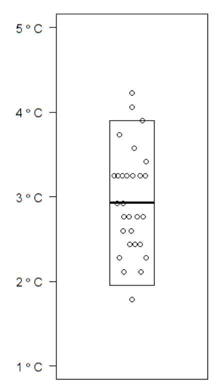
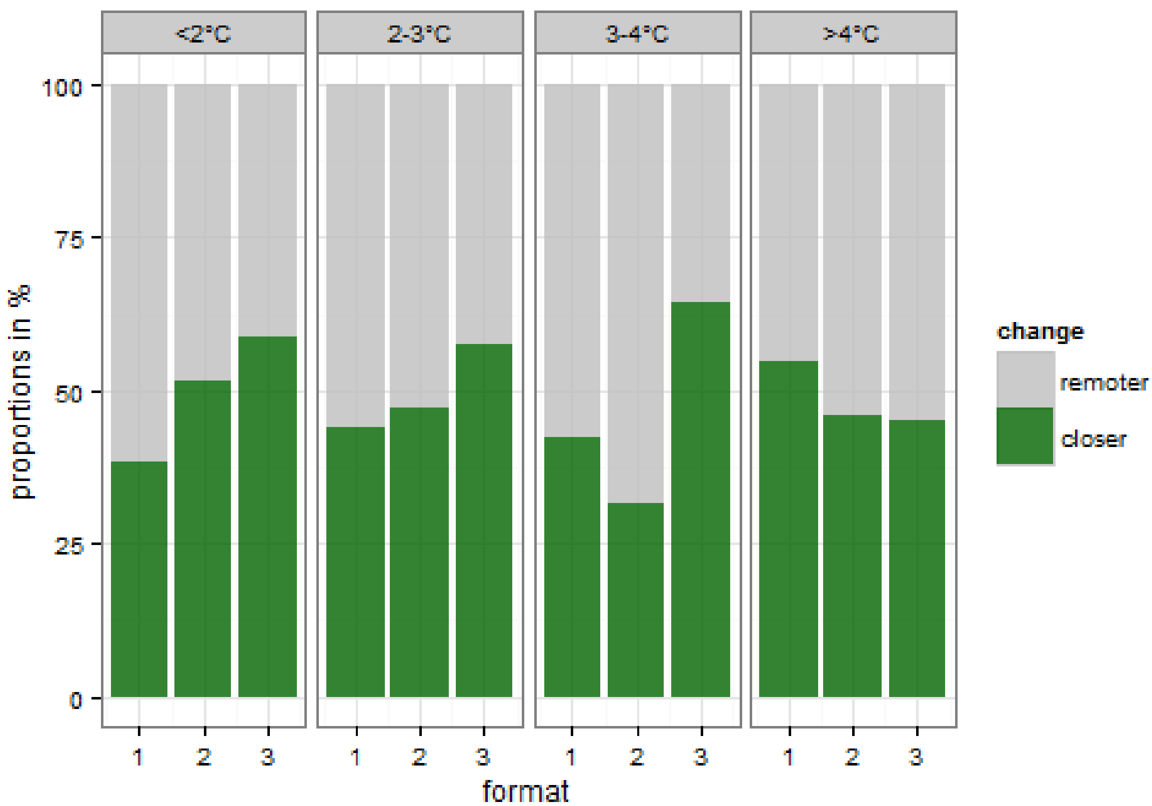
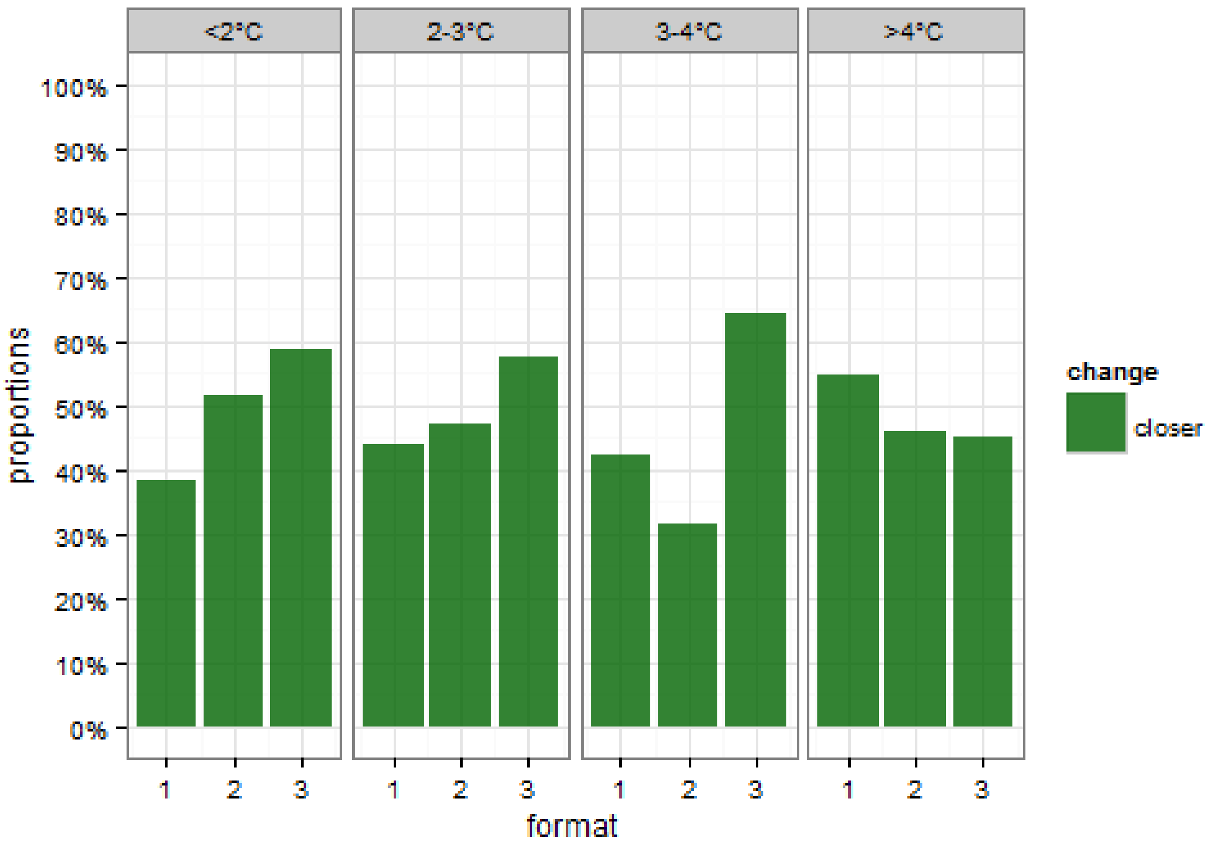
Predicted 2100 Temperature Increase over Pre-industrial Level		
		
Format 1	**Format 2**	**Format 3**
The box covers 90% of the estimated temperatures (box edges represent the 5th and 95th percentiles) with the central line marking the mean.	*The box covers 90% of the estimated temperatures (box edges represent the 5th and 95th percentiles) with the central line marking the mean. Each dot represents the temperature projection of a climate models that falls outside the box edges*	*The box covers 90% of the estimated temperatures (box edges represent the 5th and 95th percentiles) with the central line marking the mean. Each dot represents the temperature projection of a climate model.*

Figure 3: ***Different formats employed across subjects in the presentation of model forecasts.***

Since the three formats (which are similar to the ones used by the IPCC) provide increasing details about the underlying scientific uncertainty, we are interested in their relative effectiveness in influencing reported conditional probabilities. Figure 4 shows the proportion of respondents whose conditional probability is closer to scientific information across the four temperature bins for each of the three presentation formats. Providing policymakers with the individual model estimates in addition to the statistical range (Format 3) increases the likelihood of reporting conditional probabilities closer to the scientific information (further analysis is provided in Table S8). The >4°C scenario is the only one where Format 3 is not outperforming the other formats. The respondents judged the three formats to be equally credible (on average 4.6 on a 1-7 scale). However, scientific information provided using Format 3 was perceived as marginally more informative than Format 1 (see Table S7 for details). Interestingly, the effect of format is not significant in the MBA student sample (See Table S9). These results highlight the importance of testing visualization tools directly on the population of interest.





<2°C
2-3°C
3-4°C
>4°C
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
proportions
1
2
3
format
change
closer

1

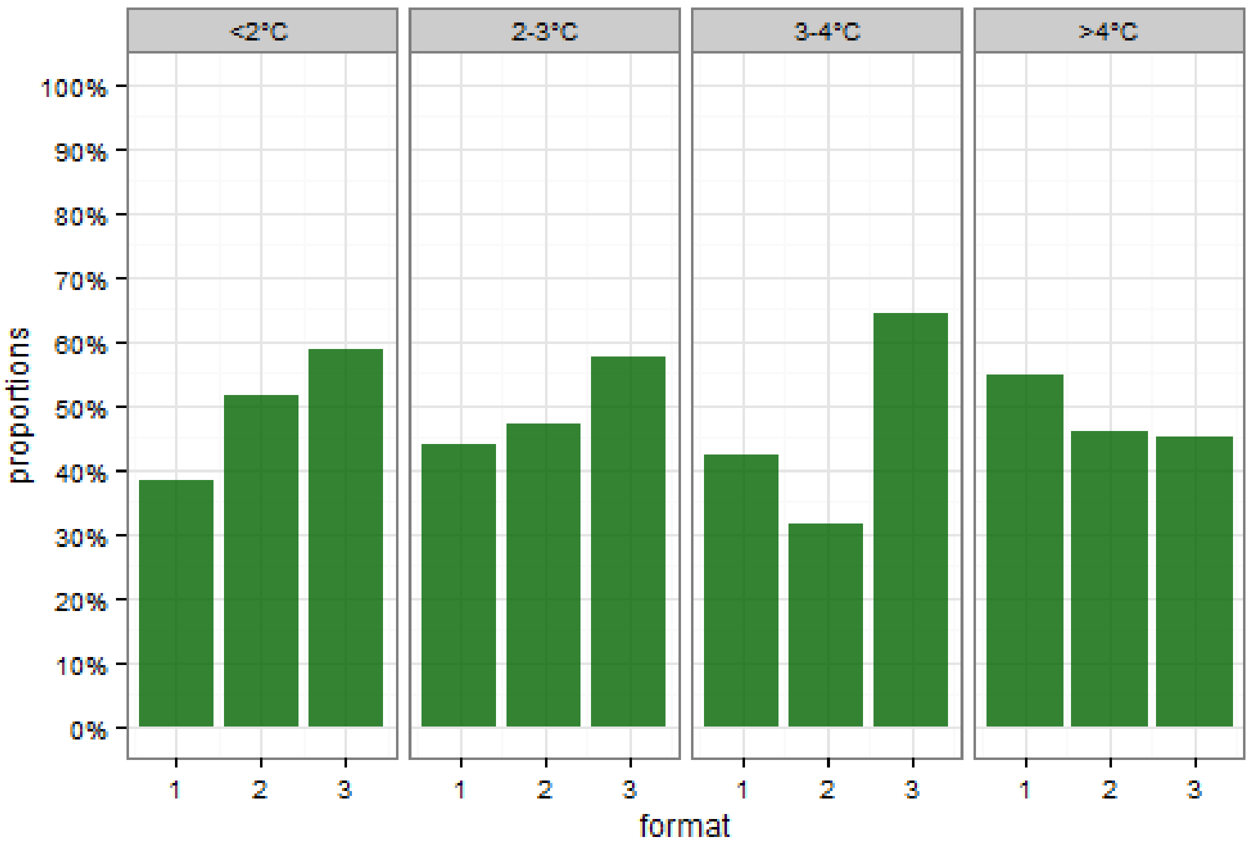


Figure 4: Proportion of respondents whose conditional probability is closer to scientific information. See Supplementary Information Figure S7 for the same Figure for the Student sample.

Although the scientific understanding of the response of the climate system to increases in CO2 concentration will improve over time, significant uncertainty and disagreements across climate and economic models are likely to persist[17]. Science communication (and particularly uncertainty communication) will be increasingly relevant in climate change and science-based policy-making. Greater efforts therefore need to be devoted to the understanding of how policymakers perceive and react to scientific uncertainty and how they are affected by the way it is presented[18]. Our results point to the importance of testing behavioral effects in the population of interest.

Our study provides a unique glimpse at COP21 policymakers' beliefs and responses to climate model forecasts. The comparison between their responses and those of a climate-educated MBA student population answers our fourth question and reveals two striking behavioral phenomena. The first is a notable anchoring effect of prior beliefs, which is much more pronounced for policymakers. Policymakers, though not distinguishable in their priors from the student sample, were less likely to revise their conditional probabilities in the direction of the model forecasts (Figure S5 and Table S9). The second result, particularly important for future communication of uncertainty to key users, is that the gap between initial beliefs and scientific evidence can be partially mitigated by using an adequate presentation format (See Table S8). Our results reinforce recent calls for the incorporation of behavioral (in addition to normative) models of judgment and choice into public policy[19] and suggest a more effective, and relatively easy to implement, format to visually communicate scientific information to policymakers. In that sense, application of our results could naturally take place for example in the next assessment report of the IPCC.

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Author contributions: All authors were involved in planning the research and designing the experiments. VB, EW, LB and MT carried out the experiment. VB, MT and NL analyzed the results. All authors contributed to the writing of the paper.

Methods

We conducted a framed field experiment[20] at the 2015 United Nations Climate Change Conference, COP21, held in Paris. We recruited 217 participants, representing more than 100 countries (the sample composition is described in Table S10) and elicited their expectations for global temperature increases by 2100 before testing their responses to climate model projections. More than half of our respondents were climate negotiators, including eight heads of delegations. The others were non-negotiator policymakers from different communities.

In individual in-person interviews, we prompted policymakers for their prior probability distribution of four different intervals of Year 2100 global temperature increases (<2°, 2-3°, 3-4°, >4° C), following implementation of current NDCs. We provided policymakers with response scales that used the IPCC numeric-verbal format (see SI.8).

After eliciting policymakers' prior distributions, we presented them with a specific extrapolation of the NDCs beyond 2030, where global emissions remained roughly constant throughout the century. We then presented policymakers with predicted 2100 temperature increases given that specific emission trajectory that were based on the transient climate response of all 30 climate models included in the 5th Assessment Report of the IPCC, WGI (Table 9.5)[21]. We presented policymakers with the results, shown in either one of the three boxplot formats in Figure 3. These were introduced as follows: "*the projections (in °C) as estimated by all climate models whose results on transient climate response are reported in the IPCC latest assessment report*". We then elicited the policymakers' projections of long-term temperature conditional on the specified emission scenario ("***Based on the projections we have just shown you****, and for each of the 4 ranges presented in the table below, could you please indicate* ***the probability (or probabilities) that the temperature will be in that range****.").* For this second round, we used again the response template shown in SI.1 (in SI.8 we report the full survey).

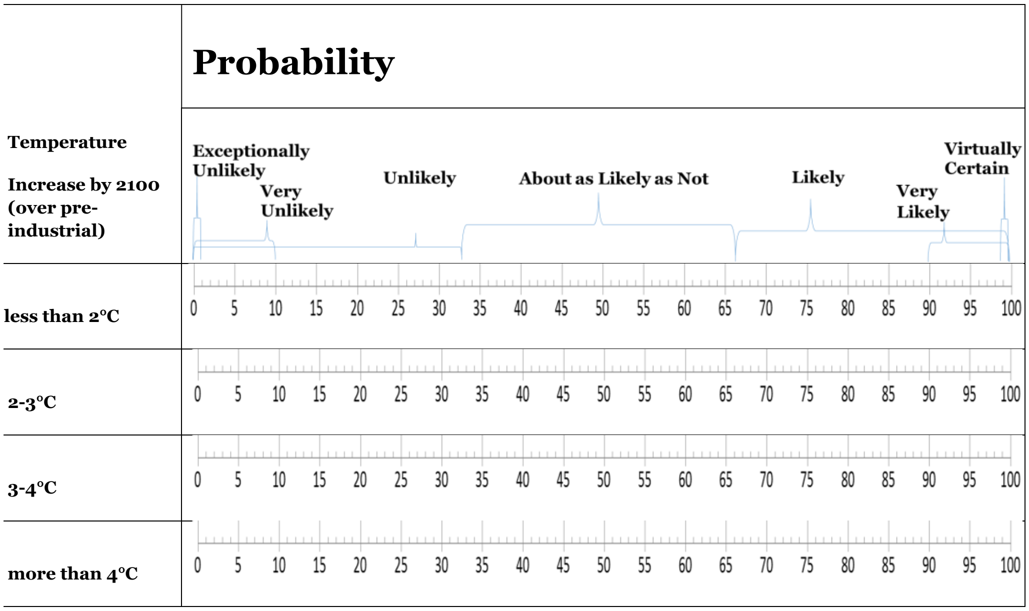
Figure 3 shows different ways of communicating the uncertainty in predictions across climate models. The formats were randomized between subjects. This provides greater accuracy but lower treatment effects than a within subjects design. Format 1 presents the mean and the central 90% of the predictions across scientific models and is the format used in the WGI IPCC 5th AR report. Formats 2 and 3 provide additional information about model uncertainty, i.e., the fact that different models generate different estimates. Format 2 highlights those models whose estimates fall outside the 90% uncertainty range, while Format 3 presents all models' estimates. These formats thus provide information on similarities between models, clustering of predictions, and outliers. When we asked policymakers for the second round of estimates of the probability distribution over possible 2100 temperature increases, we instructed them to consider the specified emission pathway as given, in order to isolate the impact of climate uncertainty alone. In both rounds of probability elicitation, we asked policymakers to report their level of confidence in their estimates.

In May 2016, a 2-day simulation of a post-COP21 climate change negotiation (Model UNFCCC) took place in Erasmus University Rotterdam. This event involved MBA students from 7 major European business schools who had received briefings in climate change science and UNFCCC climate negotiations. MBA students were playing the role of delegates to the COP21 process for a representative set of countries. These students have been preparing for this event for several months with documents including detailed background papers. We replicated the key portions of the experiment with a sample of 113 respondents. This MBA student sample is far more knowledgeable, in the content matter of the study, than any usual sample of students, or online survey subjects (because of their selection and preparation for the meeting). However, the students are less driven/influenced in their beliefs by national needs/agendas than actual climate negotiators, as they only play/act or simulate national roles.

For both the Rotterdam and Paris experiments, informed consent was obtained from participants, consistent with procedures of a protocol approved by the Institutional Review Board at Columbia University.

Supplementary Online Material

SI.1: Response scale for judging probabilities of global temperature increases by 2100



SI.2: Determinants *of Priors*

Table S1 Results of Seemingly Unrelated Regression on COP21 policymakers' prior probabilities for each temperature bin.

VARIABLES	<2°C	2-3°C	3-4°C	>4°C	<2°C	2-3°C	3-4°C	>4°C
Negotiator	-0.00	0.04	-0.03	-0.00	-0.02	0.04	-0.02	0.00
	(0.04)	(0.05)	(0.04)	(0.03)	(0.05)	(0.05)	(0.05)	(0.03)
Vulnerable[f]	0.06	-0.14**	0.01	0.07*	0.06	-0.15***	0.01	0.08**
	(0.05)	(0.05)	(0.05)	(0.04)	(0.06)	(0.06)	(0.06)	(0.04)
Emerging	0.02	-0.14**	0.01	0.10***	0.06	-0.14**	-0.01	0.09**
	(0.05)	(0.05)	(0.05)	(0.04)	(0.06)	(0.06)	(0.06)	(0.04)
Exporter	-0.06	-0.03	0.05	0.04	-0.03	-0.07	0.06	0.04
	(0.05)	(0.05)	(0.05)	(0.03)	(0.05)	(0.05)	(0.05)	(0.04)
Emitters	0.02	0.03	-0.06	0.01	0.04	0.01	-0.07	0.03
	(0.05)	(0.05)	(0.05)	(0.04)	(0.06)	(0.06)	(0.06)	(0.04)
Confidence in Prior	0.02	-0.02	0.02	-0.01	0.01	-0.02	0.02	-0.01
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	0.07	0.51***	0.27***	0.15**	0.09	0.43**	0.23	0.25*
	(0.08)	(0.09)	(0.08)	(0.06)	(0.19)	(0.19)	(0.19)	(0.14)
Demographic controls[g]	No	No	No	No	Yes	Yes	Yes	Yes
Observations[h]	144	144	144	144	134	134	134	134
R-squared	0.04	0.13	0.03	0.08	0.09	0.20	0.11	0.12

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Negotiators do not possess different priors from non-negotiator policymakers. Policymakers (including negotiators) from vulnerable and emerging countries are more pessimistic than their counterparts of the OECD countries, having lower prior for the 2-3°C bin and higher prior for the >4°C bin.

Regional Coding:

The coding of country/region clusters is based, primarily, on self-reported country represented. 84 out of 217 subjects did not provide enough information to allow us to code the country they represent, reporting "None", "UN", "University" or simply nothing. We coded those who did not fill in information according to their reported nationality. In this way, we coded the country/region cluster for 21 more observations. Demographic controls include respondents' age, gender, education level and number of children.

The sample size is smaller than the total sample as some respondents did not fill either the country they represented or their demographic information.

Vulnerable countries/regions in our sample are: Afghanistan, Antigua & Barbuda, Bangladesh, Barbados, Bhutan, Burkina Faso, Central African Republic, Chad, Comoros, Congo RDC, Equatorial Guinea, Ethiopia, Fiji, Gabon, Ghana, Guatemala, Kenya, Latvia, Lebanon, Maldives, Marshall Islands, Mongolia, Morocco, Mozambique, Myanmar, Nepal, Pakistan, Palau, Panama, Papua New Guinea, Philippines, Somali, Salvador, Sudan, Swaziland, Tunisia, Togo, Tonga, Uganda, Vanuatu, Vietnam, and Zambia.

Emerging economy countries/regions in our sample are: Argentina, Bangladesh, Brazil, Chile, China, Colombia, Hungary, India, Indonesian, Malaysia, Mexico, Pakistan, Panama, Peru, Philippines, and Poland.

Energy **exporter** countries/regions in our sample are: Algeria, Australia, Brazil, Canada, China, Colombia, Georgia, Iraq, Latvia, Lebanon, Mongolia, Norway, Netherlands, Qatar, Russia, South Africa, Vietnam, and United States of America.

High **emitter** countries/regions in our sample are: Brazil, China, European Union, India, Japan, Russia and United States of America.

OECD members in our sample are: Australia, Austria, Belgium, Canada, Chile, Denmark, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Japan, Korea, Luxemburg, Mexico, Netherlands, New Zealand, Norway, Poland, Switzerland, United Kingdom, and United States of America.

SI.3: Tests of the overall differences between Priors, Scientific Information and Conditional Probabilities

Table S2. Means and medians of the Euclidean distance between the three distributions of interest.

	Overall Distance (Prior-Information)	Overall Distance (Prior- Conditional Probability)	Overall Distance (Conditional Probability-Information)	Prior- Conditional Probability vs. Conditional Probability-Information
Mean	0.41	0.21	0.32	P= 0.00
Median	0.37	0.14	0.29	

Note: The metric used to calculate the distance between pairs of the three distributions of probabilities is the Euclidean distance. The conditional probability is closer to prior than to the scientific information provided (i.e. distance Prior-Conditional Probability is smaller than distance Conditional Probability-Information).

SI.4: Tests of Difference between Scientific Information and Conditional Probabilities

We consider four metrics to quantify the difference between reported conditional probabilities and the scientific information. These metrics can be organized using the matrix below to distinguish whether they provide information on the differences bin by bin or aggregated across the four temperature bins; and whether they measure the magnitude of change or its direction.

Table S3 Overview of the four metrics used as dependent variables in the regressions.

Metrics	**Overall**	**Bin by bin**
Continuous	Euclidean Distance (Overall_dis)	Bin by bin Distance (Bin_dis)
Dichotomous	Overall conditional probability is closer to information than prior is (Overall_closer)	Bin by bin conditional probability is closer to information than prior is (Bin_closer)

Table S4 Results of basic models on COP21 policymakers' four metrics based on normalized priors and conditional probabilities.

VARIABLES	Bin_dis	Bin_dis	Bin_closer	Bin_closer	Overall_dis	Overall_dis	Overall_closer	Overal_closer
Negotiator	0.02**	0.02*	-0.13***	-0.11**	0.04*	0.04	-0.11	-0.12
	(0.01)	(0.01)	(0.05)	(0.05)	(0.02)	(0.02)	(0.07)	(0.07)
Confidence Prior	0.01***	0.01***	-0.04**	-0.04**	0.03***	0.02***	-0.06**	-0.06**
	(0.00)	(0.00)	(0.02)	(0.02)	(0.01)	(0.01)	(0.03)	(0.03)
Bin_prior_info[i]	0.61***	0.58***	0.66***	0.81***				
	(0.05)	(0.06)	(0.15)	(0.15)				
Overall_prior_info[j]					0.70***	0.61***	-0.02	0.24
					(0.05)	(0.06)	(0.16)	(0.18)
Constant	-0.05***	-0.01			-0.11**	-0.01		
	(0.02)	(0.03)			(0.05)	(0.11)		
Bin index[k]	Yes	Yes	Yes	Yes	No	No	No	No
Demographic Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	820	768	820	768	205	192	206	193
(Pseudo) R-squared	0.478	0.510	(0.052)	(0.093)	0.497	0.546	(0.033)	(0.119)
Prob > chi2	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Overall, being a negotiator and having higher confidence in one's prior result in conditional probabilities that deviate more from the provided information, indicated by the positive (negative) coefficients in regressions with continuous (dichotomous) metrics. For regressions on bin-by-bin metrics, standard errors are clustered at the individual level. Bin_prior_info is the absolute distance between the prior and the provided information in the corresponding temperature bin. Overall_prior_info is the Euclidean distance between the prior and the provided information. The Bin index indicates the temperature bin (<2°C, 2-3°C, 3-4°C, or >4°C) for which the bin-by-bin metrics are calculated.

[c] Bin_prior_info is the absolute distance between the prior and the provided information in the corresponding temperature bin.
[d] Overall_prior_info is the Euclidean distance between the prior and the provided information.
[e] This index indicates the temperature bin (<2°C, 2-3°C, 3-4°C, or >4°C) for which the bin-by-bin metrics are calculated.

A large literature has studied "binary additivity", i.e. testing whether P(Event) +P(Not Event) = 1. In most cases, and on average, this condition is satisfied. However, studies that have looked at partitions of discrete distributions with more than two outcomes, as in our case, all find a different behavior. Indeed, results from Tversky and Koehelr[22] show that additivity in such cases is much harder to achieve and in fact quite rare, while subadditivity is more common. Macchi et al[23] and Redelmeier et al[24] find evidence of superadditivity and subadditivity, respectively, in judgments made by doctors. Fox & Birke[25] showed it on lawyers. Fox, Rogers & Tversky[26], on option traders. Finding that n>2 events sum to a probability>1 may be driven by a bias toward the "case partition" ignorance prior of 1/2 for each event (cf. Fox & Rottenstreich[27]).

We found no significant differences between the COP21 and MBA students' samples in terms of the additivity of their probability estimates of either distributions (priors and conditional probabilities).

Below we test the robustness of results presented in Table S4 to the use of raw data rather than normalized data.

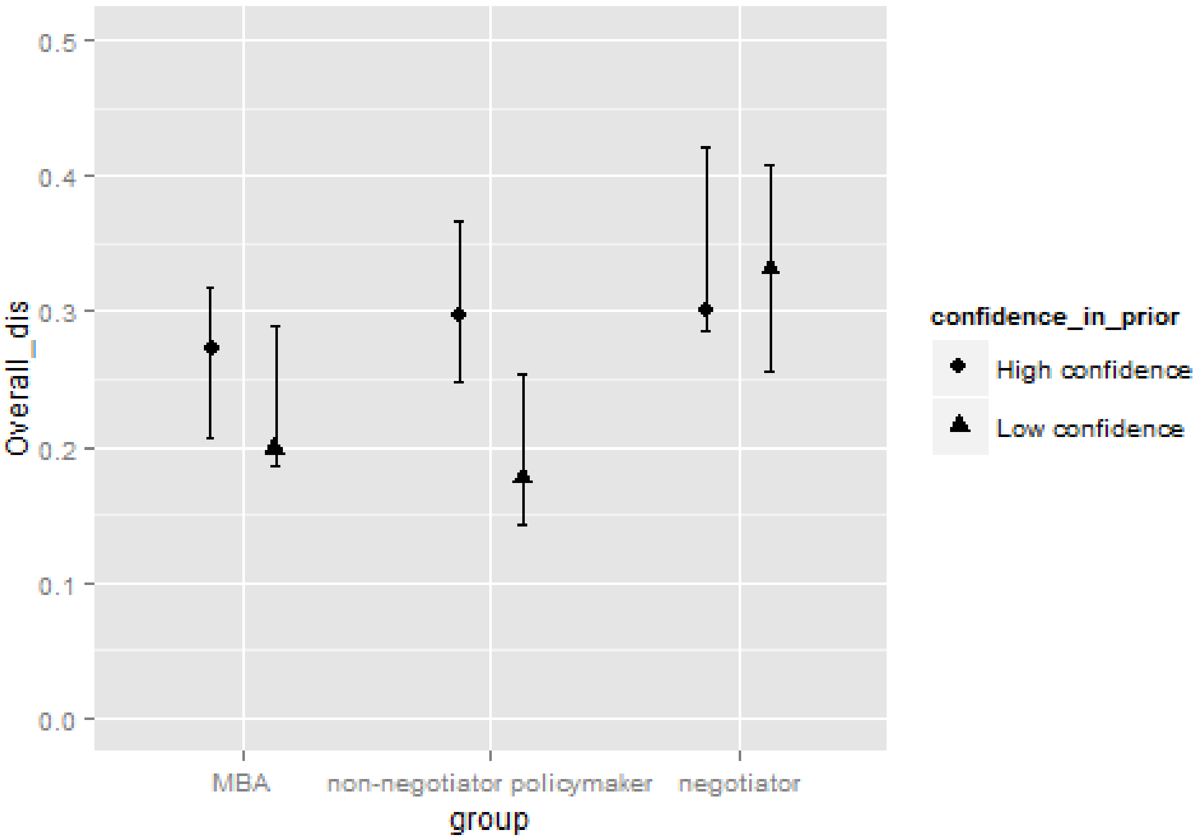
Table S5: Results of basic models on COP21 policymakers' four metrics based on raw priors and conditional probabilities.

VARIABLES	Bin_dis	Bin_dis	Bin_closer	Bin_closer	Overall_dis	Overall_dis	Overall_closer	Overal_closer
Negotiator	0.03***	0.03***	-0.10**	-0.09*	0.06**	0.06**	-0.16**	-0.15**
	(0.01)	(0.01)	(0.04)	(0.05)	(0.03)	(0.03)	(0.07)	(0.07)
Confidence Prior	0.01**	0.01**	-0.02	-0.02	0.01	0.01	-0.03	-0.03
	(0.00)	(0.00)	(0.02)	(0.02)	(0.01)	(0.01)	(0.03)	(0.03)
Bin_prior_info	0.62***	0.61***	0.72***	0.81***				
	(0.04)	(0.05)	(0.10)	(0.11)				
Overall_prior_info					0.80***	0.80***	0.10	0.10
					(0.06)	(0.06)	(0.15)	(0.17)
Constant	-0.04*	-0.03			-0.08	-0.12		
	(0.02)	(0.03)			(0.05)	(0.12)		
Bin index	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	820	768	820	768	205	192	206	193
(Pseudo) R-squared	0.47	0.47	(0.07)	(0.070)	0.55	0.574	(0.02)	(0.06)
Prob > chi2	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.16

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Overall, being a negotiator and having higher confidence in prior result in conditional probabilities deviating more from the scientific information, indicated by the positive (negative) coefficients in regressions with continuous (dichotomous) metrics. For regressions on bin-by-bin metrics, standard errors are clustered at the individual level.

Figure S1 Median (with 95% Wilcoxon confidence interval) distance between conditional probabilities and scientific information for different sub-samples of the population by hign/low confidence in priors.



Note: Respondents are coded as having low (high) confidence in prior if their confidence (on a scale from 1 to 7) is smaller than (larger or equal to) five. High confidence accounts for 56.0% of the sample. MBA students, negotiators and non-negotiator policymakers with high confidence are not differentiable in terms of overall distance between conditional probability and scientific information. For respondents with low confidence, however, negotiators have larger overall distance than MBA students and non-negotiator policymakers. Across high and low confidence samples, only non-negotiator policymakers show lower overall distance when confidence in prior is low.

Table S6 Results of models of regional effects on COP21 policymakers' four metrics based on normalized priors and conditional probabilities.

VARIABLES	Bin_dis	Bin_dis	Bin_closer	Bin_closer	Overall_dis	Overall_dis	Overall_cl
Negotiator	0.08***	0.05**	-0.32***	-0.23*	0.19**	0.14	-1.92
	(0.02)	(0.02)	(0.11)	(0.13)	(0.08)	(0.08)	(99.79
Vulnerable	0.06***	0.05***	-0.24*	-0.24	0.17*	0.16*	-1.75
	(0.02)	(0.02)	(0.15)	(0.14)	(0.09)	(0.09)	(101.15
Emerging	0.06**	0.04*	-0.22**	-0.22*	0.22**	0.20**	-0.08
	(0.03)	(0.02)	(0.10)	(0.11)	(0.09)	(0.09)	(0.72)
Exporter	0.02	0.01	-0.03	-0.04	0.04	0.03	-0.09
	(0.02)	(0.02)	(0.09)	(0.09)	(0.06)	(0.06)	(0.79)
Emitter	0.04**	0.03*	-0.17*	-0.14	0.11	0.09	-1.89
	(0.02)	(0.02)	(0.09)	(0.10)	(0.07)	(0.07)	(100.00
Neg_Vul[f]	-0.06**	-0.05*	0.21	0.17	-0.16	-0.14	1.78
	(0.03)	(0.03)	(0.17)	(0.17)	(0.10)	(0.10)	(100.93
Neg_Eme[f]	-0.06	-0.03	0.14	0.11	-0.22**	-0.17*	0.02
	(0.03)	(0.03)	(0.14)	(0.14)	(0.10)	(0.10)	(0.32)
Neg_Exp[f]	-0.02	-0.01	0.18	0.17	-0.06	-0.03	0.19
	(0.03)	(0.03)	(0.13)	(0.14)	(0.08)	(0.08)	(1.56)
Neg_Emit[f]	-0.07**	-0.05*	0.20	0.15	-0.16*	-0.13	1.92
	(0.03)	(0.03)	(0.14)	(0.16)	(0.09)	(0.09)	(99.73
Bin_prior_info	0.58***	0.54***	0.65***	0.80***			
	(0.06)	(0.07)	(0.16)	(0.16)			
Overall_prior_info					0.60***	0.50***	-0.08
					(0.07)	(0.08)	(0.67)
Constant	-0.04*	-0.02			-0.08	-0.03	
	(0.02)	(0.02)			(0.07)	(0.15)	
Bin index	yes	yes	yes	yes	no	no	no
Demographic Controls	No	Yes	No	Yes	No	Yes	No
Observations	676	616	676	616	153	141	154
(Pseudo) R-squared	0.45	0.47	(0.06)	(0.11)	0.48	0.51	(0.06
Prob > chi2	0.00	0.00	0.00	0.00	0.00	0.00	0.30

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Compared to the baseline, which is non-negotiator policymakers from the OECD countries, negotiators (from all countries included), policymakers (negotiators and non-negotiator policymakers alike) from vulnerable, emerging and emitter countries/regions report conditional probabilities farther away from the scientific information. Negotiators from vulnerable, emerging and emitter countries/regions do not report conditional probabilities farther away from the scientific information than their non-negotiator counterparts. This is revealed by the significant coefficients of interaction terms

[f]Neg_X, is the interaction term between Negotiators and country group X.

(Neg_Vul, Neg_Eme, and Neg_Emi), which have similar size but the opposite sign as the negotiator coefficient. Neg_X, is the interaction term between Negotiators and country group X.

SI.5: Formats to present uncertain scientific information

Figure S2 presents an example of Format 1 coming from the Summary for Policymakers of the WGI AR5th in which the median and uncertainty range are visible.

Figure S2: Replication of a figure found in Summary for Policymakers of WGI AR5th IPCC, 2013.

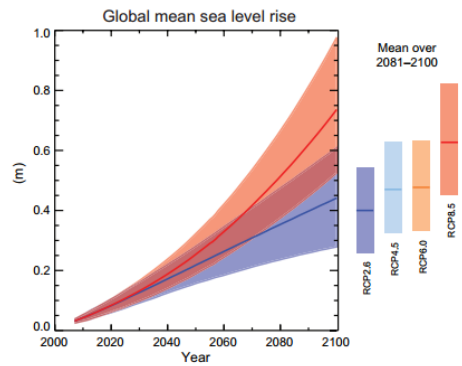


Figure SPM.9 | Projections of global mean sea level rise over the 21st century relative to 1986–2005 from the combination of the CMIP5 ensemble with process-based models, for RCP2.6 and RCP8.5. The assessed *likely* range is shown as a shaded band. The assessed *likely* ranges for the mean over the period 2081–2100 for all RCP scenarios are given as coloured vertical bars, with the corresponding median value given as a horizontal line. For further technical details see the Technical Summary Supplementary Material {Table 13.5, Figures 13.10 and 13.11; Figures TS.21 and TS.22}

Figure S3 presents an example of Format 2 coming from the WGIII AR5th in which the median, the uncertainty range, and the outliers are visible.

Figure S3: Replication of typical figures found in: Chapter 6 of WGIII AR5th IPCC, 2014.

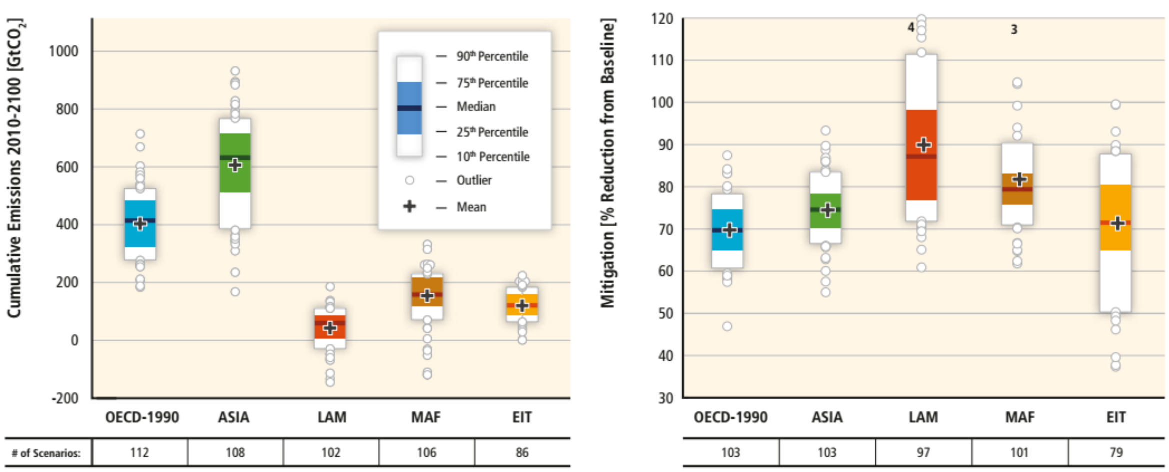
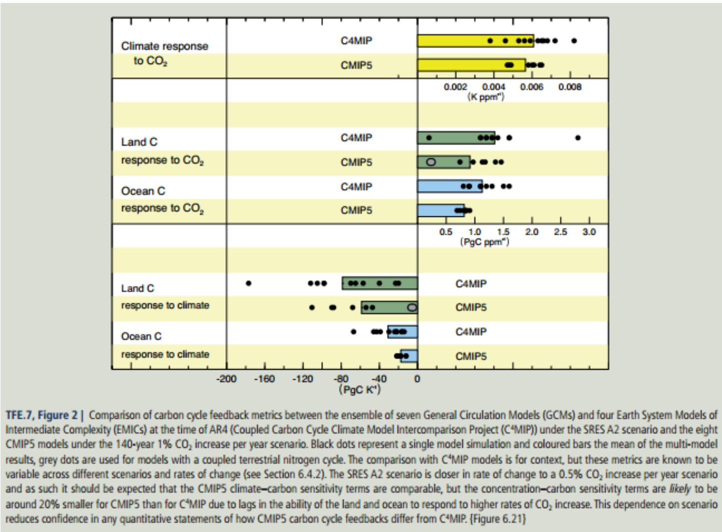


Figure 6.9 | Regional carbon budget (left panel) and relative mitigation effort (right panel) for mitigation scenarios reaching 430–530 ppm CO_2eq in 2100, based on cumulative CO_2 emissions from 2010 to 2100. Carbon budgets below 0 and relative mitigation above 100 % can be achieved via negative emissions. The number of scenarios is reported below the regional acronyms. The number of scenarios outside the figure range is noted at the top. Source: WG III AR5 Scenario Database (Annex II.10), idealized implementation and default technology cases.

Figure S4 presents an example of Format 3 coming from the WGI AR5th in which the median is visible, and black dot represent single model simulation.

Figure S4: Replication of typical figures found in the Technical Summary of WGI AR5th IPCC, 2013.



TFE.7, Figure 2 | Comparison of carbon cycle feedback metrics between the ensemble of seven General Circulation Models (GCMs) and four Earth System Models of Intermediate Complexity (EMICs) at the time of AR4 (Coupled Carbon Cycle Climate Model Intercomparison Project (C^4MIP)) under the SRES A2 scenario and the eight CMIP5 models under the 140-year 1% CO_2 increase per year scenario. Black dots represent a single model simulation and coloured bars the mean of the multi-model results, grey dots are used for models with a coupled terrestrial nitrogen cycle. The comparison with C^4MIP models is for context, but these metrics are known to be variable across different scenarios and rates of change (see Section 6.4.2). The SRES A2 scenario is closer in rate of change to a 0.5% CO_2 increase per year scenario and as such it should be expected that the CMIP5 climate–carbon sensitivity terms are comparable, but the concentration–carbon sensitivity terms are *likely* to be around 20% smaller for CMIP5 than for C^4MIP due to lags in the ability of the land and ocean to respond to higher rates of CO_2 increase. This dependence on scenario reduces confidence in any quantitative statements of how CMIP5 carbon cycle feedbacks differ from C^4MIP. {Figure 6.21}

The range of scales for both variables *credibility* and *informativeness* associated with each format is from 1 to7. There is no difference in credibility across formats (Kruskal-Wallis $\chi^2 = 2.99$, df = 2, p-value = 0.22). Informativeness, however, is marginally different across the formats (Kruskal-Wallis $\chi^2= 5.00$, df = 2, p-value = 0.08). Post hoc Dunn's test with Bonferroni-correction for two tests reveals that Format 3 is marginally more informative than Format 1 (p=0.08) but there is no difference between Format 1 and Format 2 (p=1.00) or between Format 2 and Format 3 (p=0.16). Note that credibility and informativeness are measured in a between-subject design, so the identified difference in perceptions across formats could be bigger had the subjects been able to see multiple formats.

Table S7. Means and standard deviations of perceived credibility and informativeness by COP21 policymakers across formats.

	Sample size	Credibility	Informativeness
Format 1	72	4.6 (1.3)	4.6 (1.2)
Format 2	69	4.5 (1.3)	4.6 (1.3)
Format 3	73	4.8 (1.6)	5.0 (1.6)

Table S8 Results of models of format effects on COP21 policymakers' Bin_closer metric based on normalized and raw priors and conditional probabilities

VARIABLES	Bin_closer (Normalized)	Bin_closer (Normalized)	Bin_closer (Raw Data)	Bin_closer (Raw Data=)
Format2	-0.01	0.00	0.01	0.00
	(0.06)	(0.07)	(0.06)	(0.06)
Format3	0.16***	0.19***	0.13**	0.12**
	(0.06)	(0.06)	(0.05)	(0.05)
Negotiator	-0.14***	-0.13**	-0.11**	-0.10**
	(0.05)	(0.05)	(0.04)	(0.05)
Confidence in Priors	-0.04**	-0.04**	-0.02	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)
Bin_prior_info	0.71***	0.86***	0.74***	0.83***
	(0.15)	(0.15)	(0.10)	(0.11)
Bin index	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	No	Yes
Observations	820	768	820	768
Pseudo R-square	0.07	0.11	0.08	0.11
Prob >chi-square	0.00	0.00	0.00	0.00

Standard errors clustered by subject ID in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Overall Format 3 increases the likelihood for policymakers to report conditional probabilities which are closer to the scientific information than their corresponding priors. The better performance of Format 3 fails to be statistically significant when measured with other metrics (as for example the Euclidean distance aggregated over all bins).

SI.6: Results of the experiment with the MBA student population

Figure S5. Replication of Figure1 with the MBA student sample.

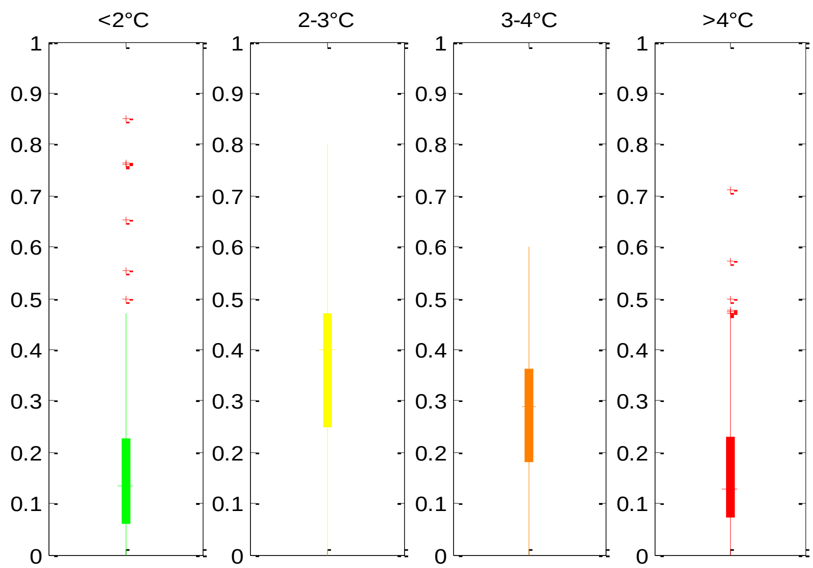


Figure S6. Replication of Figure 2 with the MBA student sample.

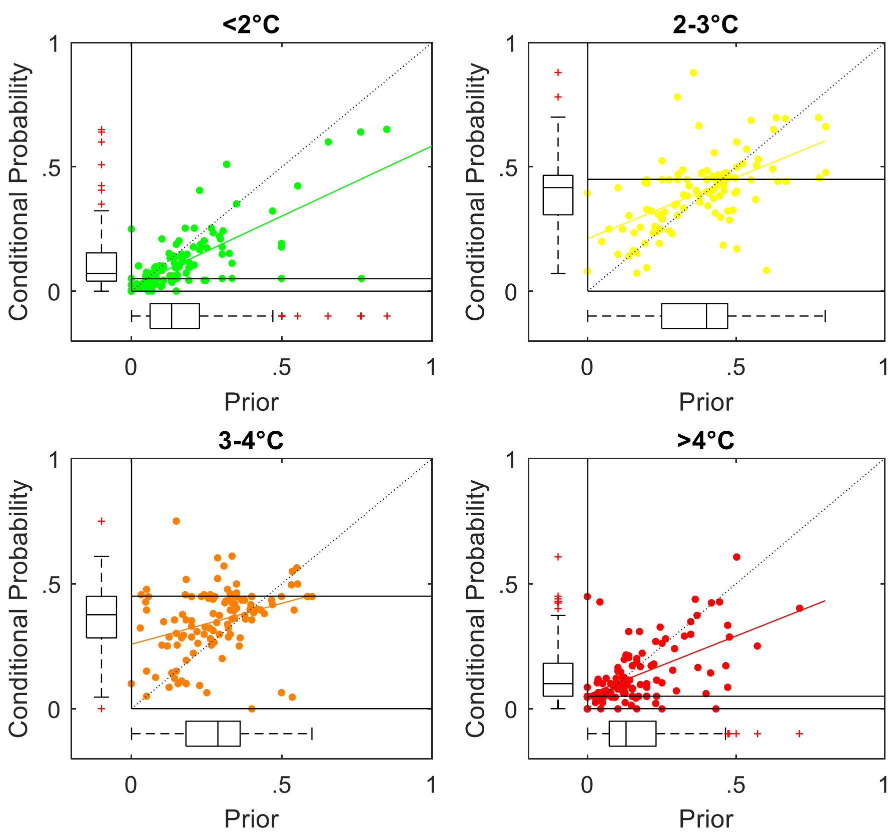
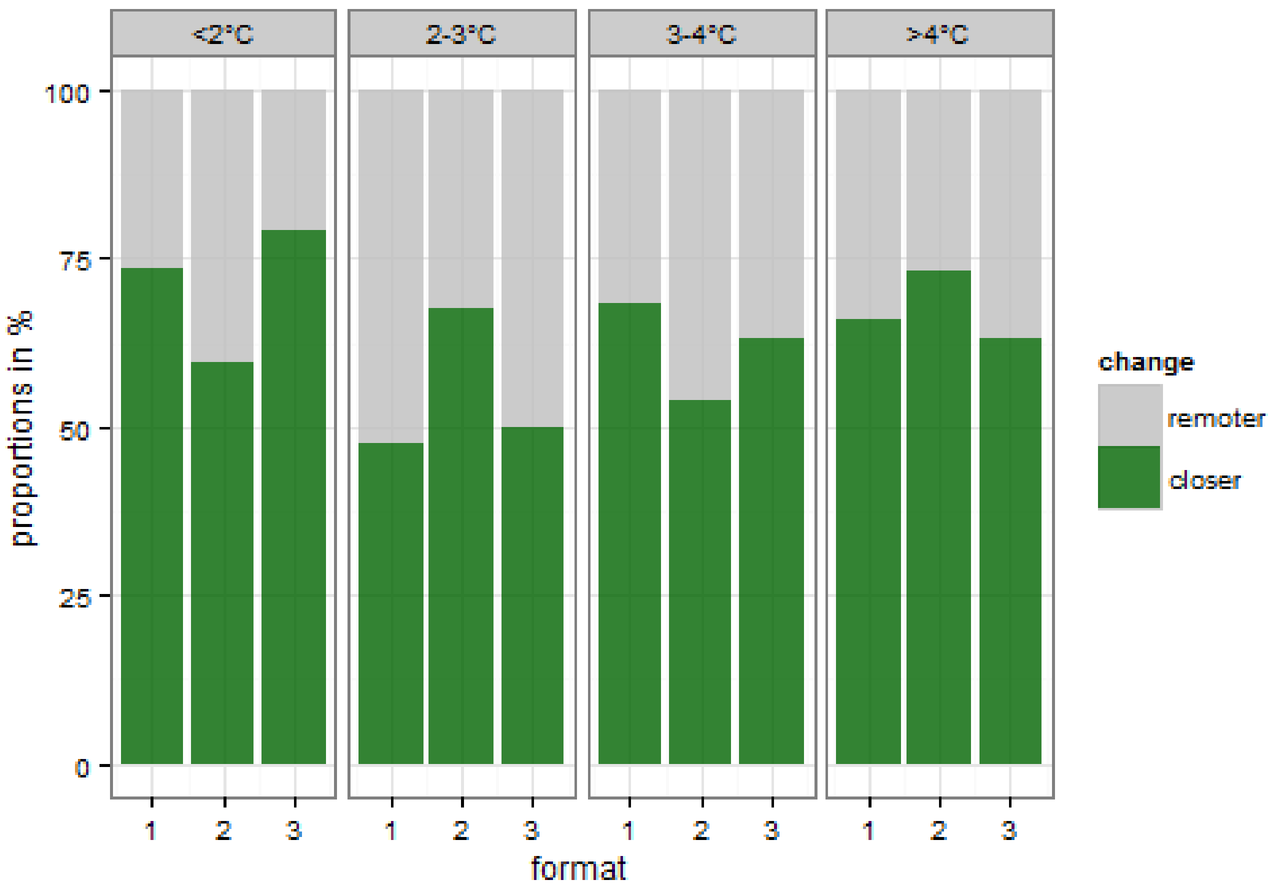
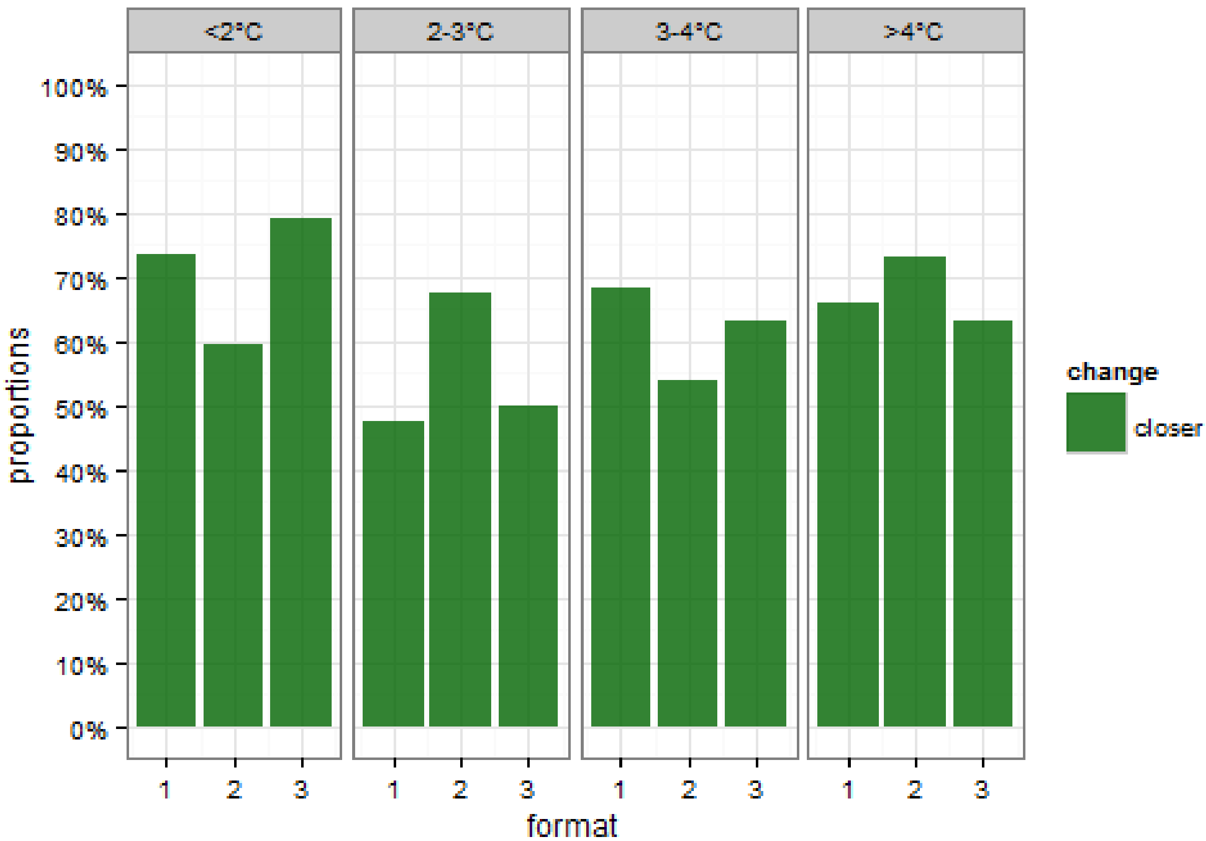


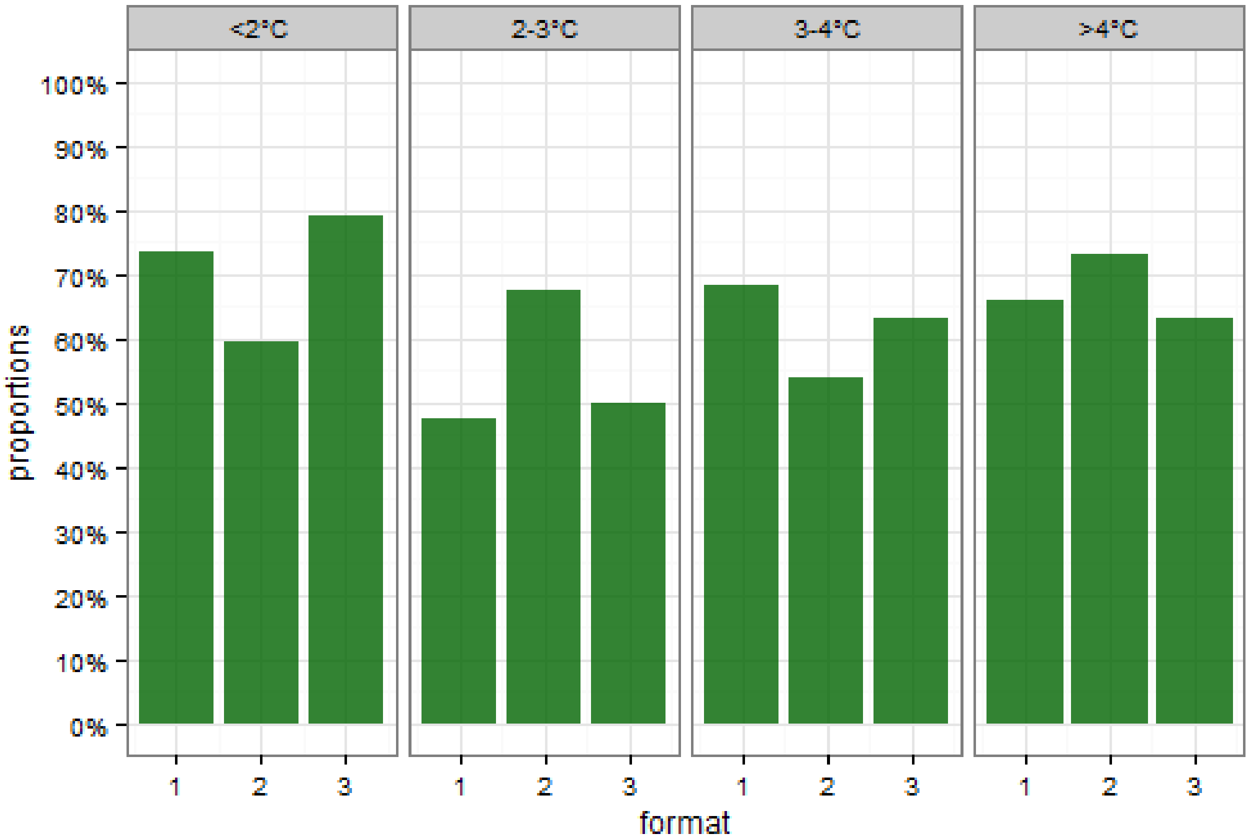
Figure S7. Replication of Figure 4 with the MBA student sample.





<2°C
2-3°C
3-4°C
>4°C
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
proportions
1
2
3
format
change
closer

1



<2°C
2-3°C
3-4°C
>4°C
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
proportions
1
2
3
format

Table S9: Results of models of format effects on the MBA students' and the COP21 policymakers' Bin_closer metric based on normalized and raw priors and conditional probabilities

VARIABLES	Bin_closer (Normalized)	Bin_closer (Normalized)	Bin_closer (Raw Data)	Bin_closer (Raw Data)
MBA	0.21***	0.20**	0.20***	0.22***
	(0.07)	(0.08)	(0.07)	(0.08)
Format2	0.00	0.01	0.02	0.01
	(0.07)	(0.07)	(0.06)	(0.06)
Format3	0.16***	0.17***	0.13**	0.12**
	(0.06)	(0.06)	(0.05)	(0.06)
MBA_F2	0.02	-0.01	-0.12	-0.12
	(0.10)	(0.10)	(0.09)	(0.10)
MBA_F3	-0.16*	-0.17*	-0.18**	-0.14
	(0.09)	(0.09)	(0.09)	(0.09)
Confidence in prior	-0.04***	-0.04**	-0.02	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)
Bin_prior_info	0.89***	1.00***	0.74***	0.82***
	(0.14)	(0.14)	(0.08)	(0.09)
Bin Index	YES	YES	YES	YES
Demographic Controls	No	Yes	No	Yes
Observations	1,268	1,184	1,268	1,184
Pseudo R-square	0.08	0.11	0.07	0.10
Prob >chi-square	0.00	0.00	0.00	0.00

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Overall, the MBA students are more likely than the COP21 policymakers to report conditional probabilities that are closer to the scientific information than their corresponding priors. Format 3 increases such likelihood but only for the COP21 policymakers. This is revealed by the significant interaction term between MBA and Format 3 (MBA_F3), which has similar size but of the opposite sign as the coefficient Format3.

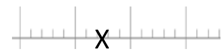
SI.7 Descriptive Statistics

Table S10. Descriptive Statistics of the survey data

	COP21 sample				MBA student sample			
	Obs	Mean	Min	Max	Obs	Mean	Min	Max
Age	208	41.94	21	73	112	24.77	20	47
Children	206	1.33	0	11	106	0.07	0	2
Male	150 (69%)				52 (46%)			
Vulnerable	61				11			
Emerging	29				36			
Exporter	34				25			
Developed	72				32			
Emitter	67				34			
Negotiator	104				NA			
Education	3(Some college)				0(Some college)			
	15(Bachelor)				82(Bachelor)			
	124(Master)				25(Master)			
	21(Professional)				0(Professional)			
	52(Doctor)				4(Doctor)			
Total	217				113			

SI.8: The Questionnaire

A debate on what long-term temperature increase is consistent with the Intended Nationally Determined Contributions (INDCs) has been gaining attention lately. Assume that all the INDCs are implemented as planned. **Based on your knowledge**, and for each of the 4 ranges presented in the table below, could you please put an "x" at the probability that you believe best describes **the 2100 temperature being in that range**?



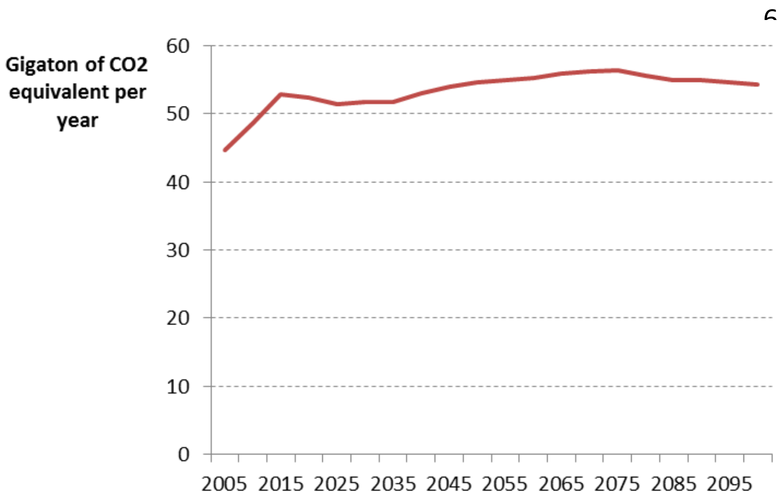
	Probability
Temperature **Increase by 2100** **(over pre-industrial)**	**Exceptionally Unlikely** · **Very Unlikely** · **Unlikely** · **About as Likely as Not** · **Likely** · **Very Likely** · **Virtually Certain**
less than 2°C	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
2-3°C	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
3-4°C	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
more than 4°C	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

How confident do you feel about your assessments of the probabilities of the temperature change by 2100?

(Not at all) **1** **2** **3** **4** **5** **6** **7** **(Extremely)**

The INDCs can be projected beyond 2030. Given a possible global emission pathway (as shown in Figure 1), we compute the greenhouse gasses (GHG) concentrations and radiative forcing in 2100. The associated temperature increase is not known with certainty. We use the transient climate response, as estimated by different IPCC climate models, to predict 2100 temperatures.

Figure 1: Possible projection forward of global emissions consistent with INDCs

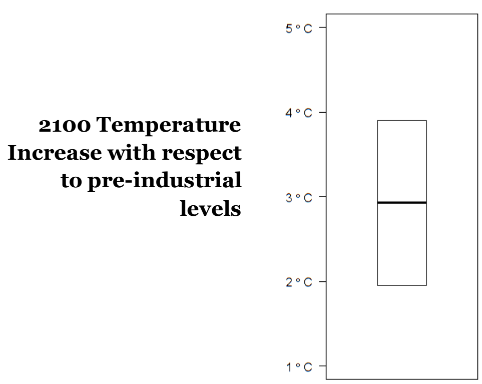


Below you can see the 2100 temperature increase projections (in °C) as estimated by all climate models whose results on transient climate response are reported in the IPCC latest assessment report.

The graph summarizes the distribution of estimates of the temperature increase across climate models.

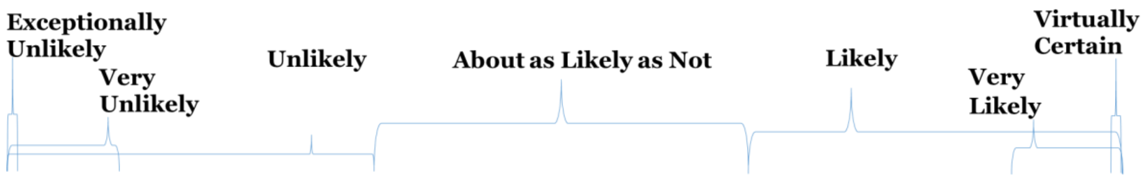
This is the graph for FORMAT 1 that was shown to a third of respondents, whereas others saw the other two formats as in Figure 1.

Distribution of temperature increase across climate models



The box covers 90% of the estimated temperatures (box edges represent the 5th and 95th percentiles) with the central line marking the mean.

Based on the projections we have just shown you, and for each of the 4 ranges presented in the table below, could you please indicate **the probability (or probabilities) that the temperature will be in that range**.

Temperature Increase by 2100 (over pre-industrial)	**Probability** 
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How confident do you feel about your assessments of the probabilities of the temperature change by 2100?

(Not at all) 1 2 3 4 5 6 7 (Extremely)

Think about the information we have given to you to answer the question above

To what extent do you judge the information ***informative***?

(Not at all) 1 2 3 4 5 6 7 (Extremely)

To what extent do you judge the information ***credible***?

(Not at all) 1 2 3 4 5 6 7 (Extremely)

Demographics

1. With which gender do you identify?
    a. Male
    b. Female
    c. No answer

2. Please list your age: ________________

3. How many children do you have? ________________________

4. What is your nationality? ______________________________

5. Which country you are representing? _______________________________

6. What is your role at this Conference of the Parties?
    a. Negotiator
    b. NGO Representative
    c. Private Sector Representative
    d. Researcher/Academic
    e. Journalist
    f. Other, please specify: __________________________________

7. Please indicate the highest level of education you have completed
    a. No degree
    b. High school diploma (or equivalent)
    c. Some college
    d. Bachelor's degree
    e. Master's degree
    f. Professional degree
    g. Doctoral degree