TropiDash: a comprehensive open-source dashboard for Tropical Cyclone data visualization and analysis

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Tropical Cyclones (TCs) are synoptic-scale storm systems rapidly rotating around a center of low atmospheric pressure which primarily derive their energy from exchanges of heat and moisture between the air and sea. These cyclones are among the most impactful geophysical phenomena, inflicting substantial economic damages and numerous fatalities. Key hazards associated with TCs include intense winds, extreme rainfall, and storm surges, which frequently result in extensive coastal flooding. Because of the severe consequences of their impacts, precise monitoring of these events and effective preparation for their occurrences are crucial to ensure the safety and resilience of populations and infrastructure.

For successful monitoring and preparation, the access to relevant factors associated with TC forecasts, such as risk projections and impact variables, must be adequate and user-friendly, enabling users to rapidly locate and comprehend the information they seek. To achieve this objective, visual tools and dashboards that concentrate interdisciplinary information and data from diverse sources serve as powerful summarization methods. Summary dashboards and tools facilitate easy access to information for all users ranging from experts and policymakers to common citizens. They consist of a platform offering a comprehensive overview of the situation, supporting informed decision-making. Current open-source tools for consulting TC data have limitations. They tend to be highly specialized, offering a limited selection of maps or graphs that cover only a portion of TC-related information. They also often lack interactivity, which restricts the user experience and the search for specific information. Furthermore, these tools can be complex to use due to inadequate documentation or challenges in presenting multiple pieces of information concurrently.

In this work, we introduce a novel free open-source dashboard designed to surpass the limitations of existing tools, displaying a comprehensive set of information regarding TC hazards. TropiDash presents several strengths that enhance user experience and accessibility. Developed in the widely

recognized Jupyter Notebook programming environment, it is easily accessible either through the installation guide on its GitHub repository or by initiating its Binder environment. The dashboard features a user-friendly interface utilizing Python widgets and the Voilà protocol. It aggregates data from various sources spanning multiple domains: from cyclone properties, such as track forecasts and strike probability maps, to atmospheric variable fields (wind speed and direction, temperature, precipitation), to risk and vulnerability information, such as cyclone risk, coastal flood risk, population density. All this is made available while providing the user with a wide range of interactivity, from choosing the cyclone to selecting the variables of their interest to roam over the interactive maps.

The first version of TropiDash was realized in the context of Code for Earth 2023, a program for the development of open-source software organized by the European Centre for Medium-Range Weather Forecasts. Here we present an improved and optimized version.