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On the need for sub-daily data to study changes in extreme rainfall.

Daniel Argüeso[1] and Alejandro Di Luca[2]
[1]Physics Department, University of the Balearic Islands, Palma de Mallorca, Spain (d.argueso@uib.es)
[2]Département des Sciences de la Terre et de l'Atmosphère, Université du Québec à Montréal, Montreal, Canada

Heavy rainfall is among the most impactful natural events. Our understanding of such events has improved significantly in the last decades, but large uncertainties remain around their recent and future response to a changing climate. At global scales, the frequency and intensity of daily extreme precipitation has increased, the hydrological cycle is becoming faster. However, the response at regional scales and shorter timescales is much more complex. The study of sub-daily or even sub-hourly data has been explored to some extent only, mostly due to the limited availability of data. When using high-resolution models to explore rainfall changes, it is possible to examine much higher frequencies, yet most studies focus on daily rainfall changes.

Here, we demonstrate inherent limitations of daily data to study present and future precipitation extremes. Limitations that are not purely a matter of refining our sampling, but do have a physical background because outstanding rainfall rates rarely occur over the course of a day. Our results show that fundamental aspects of rainfall changes are not described with daily data, and the assessment of future changes in daily precipitation likely leads to misrepresentation of causes and impacts. We show that the short-lived and intermittent nature of most rainfall extremes need at least hourly data to be properly characterized, otherwise heavy rainfall is poorly detected. Analyzing higher frequencies also reveals aspects of extremes that cannot be addressed with daily data, such as changes in their intensity and duration. This is particularly relevant for risk and impact assessment studies because a significant part of changes in extremes occur at sub-daily scales. Such changes go unnoticed or, even worse, are misrepresented by daily rainfall amounts.