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Quantifying how the full local distribution of daily precipitation is changing and its uncertainties

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The study of the consequences of global warming would benefit from quantification of geographical patterns of change at specific thresholds or quantiles, and better understandings of the intrinsic uncertainties in such quantities. For precipitation a range of indices have been developed which focus on high percentiles (e.g. rainfall falling on days above the 99th percentile) and on absolute extremes (e.g. maximum annual one day precipitation) but scientific assessments are best undertaken in the context of changes in the whole climatic distribution. Furthermore, the relevant thresholds for climate-vulnerable policy decisions, adaptation planning and impact assessments, vary according to the specific sector and location of interest.

We present a methodology which maintains the flexibility to provide information at different thresholds for different downstream users, both scientists and decision makers. We develop a method[1,2] for analysing local climatic timeseries to assess which quantiles of the local climatic distribution show the greatest and most robust changes in daily precipitation data. We extract from the data quantities that characterize the changes in time of the likelihood of daily precipitation above a threshold and of the amount of precipitation on those days. Our method is a simple mathematical deconstruction of how the difference between two observations from two different time periods can be assigned to the combination of natural statistical variability and/or the consequences of secular climate change. This deconstruction facilitates an assessment of how fast different quantiles of precipitation distributions are changing. This involves not only determining which quantiles and geographical locations show the greatest and smallest changes, but also those at which uncertainty undermines the ability to make confident statements about any change there may be. We demonstrate this approach using E-OBS gridded data[3] which are timeseries of local daily precipitation across Europe over the last 60+ years.

We treat geographical location and precipitation as independent variables and thus obtain as outputs the geographical pattern of change at given thresholds of precipitation. This information is model- independent, thus providing data of direct value in model calibration and assessment.

[1] S C Chapman, D A Stainforth, N W Watkins, 2013, On Estimating Local Long Term Climate Trends, Phil. Trans. R. Soc. A, 371 20120287; D. A. Stainforth, 2013

[2] S C Chapman, D A Stainforth, N W Watkins, 2015 Limits to the quantification of local climate change, ERL,10, 094018 (2015), ERL,10, 094018

[3] M R Haylock et al . 2008: A European daily high-resolution gridded dataset of surface temperature and precipitation. J. Geophys. Res (Atmospheres), 113, D20119