Detection of forced global and regional changes in the temporal precipitation distribution

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Abstract

Precipitation is one of the societally most relevant aspects of weather, given its role in agriculture, natural disasters and ecosystems. It is a given that climate change will affect and has affected the water cycle. Yet, natural variability and sparse observational records complicate detection and attribution of precipitation changes. We use ridge regression, a statistical learning method, to construct a regularised linear model based on observation-coverage masked data that pins down the locations where simulated changes reflect the forced trend with highest signal-to-noise ratio across the CMIP6 multi-model archive. This yields physically interpretable detection of the forced change pattern of precipitation using only locations on land where observational data is available. The results show a clear signature of climate change in three aspects of the precipitation distribution – mean, extreme and variability – in the GHCNDEX and HadEX3 precipitation observations. Besides global changes, we also detect region- and season-specific changes. The results further suggest that CMIP6 models underestimate observed changes in precipitation, especially for extreme precipitation in boreal winter. If these biases are due to differences between physical process modelling and reality and persist for the future, this questions the reliability of model projections for risk assessment and adaptation.

Keywords: Detection, statistical learning, precipitation

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