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Autocorrelation – A Simple Diagnostic for Tropical Precipitation in Global Kilometer-Scale Climate Models

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Tropical precipitation is the result of a complex interplay of processes across a wide range of atmospheric scales and is highly variable from place to place. A particularly interesting geographical pattern is obtained for the lag 1 autocorrelation of daily precipitation. Generally, this metric displays a relatively uniform distribution of positive values throughout the tropics. However, certain land regions, such as the Sahel, stand out due to exceptionally low autocorrelation values. These low values correspond to a dominance of high frequency precipitation events in the power spectrum.

In accordance with previous work, we show that CMIP6 climate models struggle to create a similar autocorrelation pattern. Global kilometer-scale models circumvent many of the shortcomings of the conventional coarse models, by resolving deep convection. We find that the two global kilometer-scale models developed as part of the nextGEMS project produce an autocorrelation pattern that is quite similar to the observations. These models also provide an opportunity to study the processes associated with the autocorrelation pattern.

We compare simulations with deep convection parameterization turned on and off to investigate how the parameterization scheme affects the autocorrelation pattern and the underlying power spectrum. Additionally, we perform a precipitation variance analysis based on filtering of convectively coupled equatorial waves to study the genesis of the autocorrelation pattern.