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Space-time macroweather precipitation variability

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In addition to the familiar weather and climate regimes, there is an intermediate "macroweather" regime over the range of time scales from about 10 days to 30–100 years. The three regimes alternate in their basic characters. In the "macroweather" regime, atmospheric fields including precipitation have unique scaling properties characterized by negative temporal fluctuation exponents, which implies – contrary to the weather regime – that fluctuations tend to cancel each other out. This regime is important for seasonal, annual and decadal forecasts, and it is also important for assessing lower frequency anthropogenic effects that can be detected because (in the industrial epoch) they break the scaling. However, in spite of its significance, there is still no coherent picture of the macroweather precipitation space-time variability.

In this presentation, we focus on the macroweather space-time precipitation variability. We systematically study three centennial, global scale precipitation products: one instrument based, one reanalysis based, one satellite and gauge based. We investigate their temporal and spatial statistical variabilities and the outer scale limit where the temporal scaling breaks down (20–40 years depending on the product, depending on the spatial scale). We also analyze the trace moments to directly show the cascade nature of the highly intermittent spatial variability.

Finally, we analyse joint space-time fluctuations using spectra as well as Haar fluctuations and structure functions in order to obtain a complete joint space-time statistical description. Results show that the precipitation field approximately obeys a specific statistical factorization. This is a prediction of a scaling stochastic weather-macroweather and climate model that the joint spectra and structure functions will factor into spatial and temporal terms. This factorization combined with the temporal scaling provides a framework for macroweather models that can make forecasts exploiting the long range temporal memory as well as the strong spatial correlations.