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The Global space-time Cascade structure of precipitation: satellites, gauges and reanalyses

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Cascades have been used as models of precipitation for nearly 25 years yet many basic questions remain unanswered and most applications have been to small or to regional scales. In this paper we revisit some of these issues and present an inter comparison of three global or near global scale data sets: the hourly (and ≈200 km) resolution Climate Prediction Center (CPC) gridded precipitation over the continental US, the three hourly global ECMWF reanalysis stratiform precipitation product at 1.5o resolution and an analysis of 5300 orbits (1 year) of the Tropical Rainfall Measuring Mission (TRMM) satellite rainfall over ±40o latitude. Each data set was analyzed zonally, meridionally and in time. Each showed accurate cascade structures; in space up to planetary scales and in time up to 5 – 10 days. For each we estimated the moment scaling exponent (K(q)) as well as it's characterization near the mean (C1) and the effective outer cascade scales. The comparison of the cascade structures in different directions indicate that although anomalies remain, that the structure is relatively isotropic in (horizontal) space-time. For a given direction, the comparison of the different products indicates very similar but not identical scaling properties. In order to be properly inter calibrated at more than a unique resolution, the different products must have the same exponents so that - while the similarities are encouraging - the remaining anomalies point to needed improvements in techniques for estimating areal rainfall. Our analysis of the CPC data base shows that in time; $H = 0.17 \pm 0.11$ so that rain is apparently not the direct product of a cascade process (which would have H = 0), and we also find power law probability tails with exponent qD ≈3 so that the orders of singularity are apparently not bounded.