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The global space-time cascade structure of Precipitation: gauges, reanalyses, and satellite radar data: weather and climate scales

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There have been surprisingly few studies of the global space-time scaling properties of rain. One of the reasons is the difficulty in obtaining appropriate areal rainfall estimates: global gauge networks are sparse whereas individual land based radar measure effective reflectivity factors (not rain rates) and –except for the TRMM satellite radar - are limited to regions of only several hundred kilometres. Both radar and in situ measurements have difficulty distinguishing between low and zero rain rates. In comparison, meteorological reanalyses are on regular grids the result of using data assimilation algorithms. These are sophisticated model/data products but the assumptions needed to obtain rainfields are particularly questionable. In order to overcome these difficulties, it is therefore important to quantitatively compare the space-time scaling properties of data of each type (gauges, reanalyses, satellite radar). In this talk, we use 1) a unique in situ, precipitation product: the CPC gridded (hourly, 29 year long, 13x21 grid boxes, resolution roughly 200 km), 2) the state of the art ECMWF interim reanalysis "stratiform rain" product (3 hourly over 3 months, 1.5o resolution), as well as 3) 5300 orbits (1 year) of TRMM precipitation radar data gridded at 100x100 km, 4 day resolution.

All three data sets were systematically analyzed in space (both east-west, and north-south), weak and strong events, collectively spanning scales a hundred kilometres to planetary and in time from hours to 30 years. This allowed us to determine their cascade structures and to make detailed scale by scale intercomparisons. In space, the cascades all had similar effective outer scales (around 30,000 km), with the east-west value a bit higher than the north-south value. In time both the CPC and the reanalyses had outer scales of about 50 days; however the TRMM radar data had an outer scale closer to 500, and larger than observed for other atmospheric fields. By quantitative comparison of exponents for low and high moments we showed that linear space-time transformations worked well for TRMM and the ECMWF reanalysis, less well for the CPC gauge data. We also could use this the analyses to statistically calibrate the TRMM radar.