Representation of precipitation across spatial and temporal scales

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The estimation of global precipitation is crucial for many applications and is only truly possible from satellite sensors. Collecting regular and frequent satellite observations is key to for generating precipitation products. A sampling frequency of 3-hours is often quoted, based upon a number of factors including the traditional (sub-)synoptic reporting times and the need to represent the diurnal cycle. However, to properly represent precipitation it is critical to consider not only the temporal sampling, but also the spatial resolution of the observations/retrievals since these are intrinsically related to each other. This has become increasingly important as the spatial resolutions of the satellite observations and their associated products has improved over time.

This work presents the results of a study into the auto-correlation of precipitation at various temporal and spatial resolutions. A number of surface radar based case studies over both the US and Europe are used to investigate how the correlation of precipitation varies over time away from the time of observation. Although passive microwave observations are instantaneous, they represent a temporal aggregation of precipitation from the depth of the hydrometeors within the atmospheric column being observed. Using a correlation threshold of 0.8, the full resolution data (instantaneous, 1x1 km) falls below this threshold after just 2 minutes, while an equivalent 'high-resolution' product (instantaneous, 10x10 km) extends this to just 6 minutes. Increasing the temporal aggregation periods, the auto-correlation length greatly extends the temporal auto-correlation at the fine resolution sampling, although the increases are negligible at the coarse spatial and temporal resolutions. However, even at moderate resolutions (20x20 km), the auto-correlation falls below the 0.8 threshold beyond 20 minutes from the observation, and attains a correlation of just 0.3 at the extremes of the 3-hour sampling window.

The results of this study highlights the importance of considering the temporal and spatial resolution in any precipitation study, including any intercomparison of precipitation from different sensors. It also demonstrates that increasing the spatial resolution also requires increasing temporal sampling to maintain the same fidelity in the precipitation products.