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Ensemble conditional precipitation simulation from spatiotemporally heterogeneous multiplatform satellite data sets.

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Precipitation may be estimated using a variety of satellite sensors. Geostationary infra-red imagery provides information on cloud morphology at relatively high spatial and temporal resolutions, but is unable to resolve precipitation processes directly. Passive and active microwave sensors are more directly sensitive to precipitation-related hydrometeors, but are restricted to Low Earth Orbiting (LEO) platforms necessarily associated with low temporal sampling. LEO platforms typically visit a given location twice a day although, as proposed by the GPM mission, data from multiple platforms may be aggregated to yield higher effective sampling frequencies (∼3-hour for GPM). Datasets from multiple platforms and sensors may be combined to yield composite products that take advantage of their respective strengths. However, such products display extremely complicated uncertainty structures, with error fields that change discontinuously in space and time according to satellite data availability.

This paper describes the development of a new high resolution precipitation simulation technique, conditioned on multiplatform satellite data incorporating both geostationary and LEO elements. The conditional simulation generates rainfall fields consistent with all available satellite data while incorporating a stochastic element representative of precipitation uncertainty. Spatial and temporal dependencies in the precipitation field are modelled within the rainfall generator. This means that any given product point is conditioned on satellite measurements separated from it in both space and time, not just on coincident observations. It is also possible to incorporate error models for different input sensors into the conditional ensemble product.

Temporal dependencies in the precipitation field are modelled using Markov processes running along Lagrangian streamlines while spatial dependencies are modelled using Transiograms (transition probabilities expressed as functions of spatial separation). If reasonable assumptions are made concerning conditional independence between satellite measurements, this formulation allows the conditional sequential simulation of realistic precipitation fields from input data combinations with discontinuous error characteristics. Such a product provides a powerful tool to identify and characterise the uncertainty in multi-satellite products and (though ensemble hydrological modelling) the associated uncertainties in hydrological response.