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Adaptive Fusion of Multi-sensor Precipitation Observations using Gaussian Scale Mixtures in the Wavelet Domain

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Optimal Integration of multi-sensor multi-scale precipitation data promises a posteriori estimates of precipitation with increased accuracy and resolution that can potentially lead to more accurate hydro-meteorological forecasts and impact assessments. Precipitation fields exhibit remarkable non-Gaussian structure with isolated high intensity cells which often contain a large portion of the storm energy. By encoding these features in the wavelet domain using scale mixtures of Gaussian random variables, an adaptive filtering method is introduced which provides a basis to optimally fuse multi-sensor precipitation data, i.e. data from rain gauges, ground based and space-born radars, and microwave sensors. Exploiting the decorrelation properties of the wavelet expansion, the optimal estimation process ends up being a local operation that uses a modulated version of the local spatial covariance of generalized neighborhoods of the wavelet coefficients to efficiently capture the high frequency non-Gaussian parts of the rainfall images. This study uses a dataset of coincidental observations of precipitation events by the space born precipitation radar on the Tropical Rainfall Measurement Mission (TRMM) satellite and ground based weather surveillance Doppler radars to demonstrate the potential of the proposed methodology for precipitation downscaling and multi-sensor data fusion.