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From Rainfall Downscaling to Rainfall Retrieval: Inverse Problems of Similar Nature

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Satellite-based rainfall estimation offers the possibility of tracking global patterns of rainfall over ocean and land for large-scale hydrologic modeling, and for improved analysis of local and regional rainfall where ground observations are not available. In the past decade, high-resolution retrieval of rainfall from their spaceborne microwave spectral radiative fluxes has been an active area of research in the hydro-meteorological community. However, most current retrieval algorithms cannot properly reproduce low and extreme rainfall intensities and the small-scale precipitation variability, especially over land and coastal areas – important for hydrologic predictions and hazard mitigation. In this research, we introduce a new approach to the spaceborne passive microwave rainfall retrieval problem. The proposed methodology is inspired by the state-of-the-art supervised manifold learning and Bayesian shrinkage estimation paradigms and takes advantage of precipitation sparsity, recently documented and explored by the authors in precipitation downscaling, estimation, and data assimilation. The retrieval methodology relies on a sparsity-promoting search between two dictionaries that encode rainfall intensities and their spectral signatures. The proposed framework is examined using observations of the active precipitation radar (PR) and the passive microwave imager (TMI) on board of the Tropical Rainfall Measuring Mission (TRMM) satellite. The essence of the algorithm is explained and its advantages are highlighted in comparison with the outputs of the currently operational algorithms.