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Probabilistic Quantitative Precipitation Estimates with Ground- and Space-based Remote Sensing

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The uncertainty structure of ground- and space-based radar quantitative precipitation estimation (QPE) is largely unknown at fine spatiotemporal scales near the radar measurement scale (e.g. 1-km/5-min for ground-based radars, 5-km/instantaneous for space-based radars). Applications such as hydrological modeling, storm prediction, and flash flood monitoring require more than just one deterministic "best estimate" to adequately cope with the intermittent, highly skewed distribution that characterizes precipitation. To advance the use of uncertainty as an integral part of QPE for ground-based and space-borne sensors, an investigation has been carried out across the conterminous US on the NOAA/NSSL Multi-Radar/Multi-Sensor and on the NASA/JAXA TRMM and GPM space-based radars. Extension to satellite-based infrared passive sensors is demonstrated. Probability distributions of precipitation rates are computed instead of deterministic values using models quantifying the relation between radar reflectivity and the corresponding "true" precipitation. This approach conditions probabilistic quantitative precipitation estimates (PQPE) on factors such as the precipitation rate and typology. It preserves the fine space/time sampling properties of the sensor, and integrates sources of error in QPE and the impacts of algorithms assumptions. Precipitation probability maps compare favorably to the deterministic QPE. The PQPE approach is shown to mitigate systematic biases from deterministic retrievals, quantify uncertainty, and advance the monitoring of precipitation extremes. It provides the basis for precipitation probability maps, radar and satellite precipitation ensembles needed for multisensor merging of precipitation, early warning and mitigation of hydrometeorological hazards, and hydrological modeling.