Improving GOES-R IR-based Precipitation Products using NEXRAD Radar Network and OK MESONET Observations

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One of the GOES-R goals is to improve operational satellite-based cloud and precipitation products to enhance short-term heavy rainfall and flood forecast, as well as long-term assessments concerning agriculture and water resources management. Most of heavy precipitation are associated with deep convective systems (DCSs) whose large-scale morphologic feature of cold cloud shield at the tropopause-level and cloud microphysical properties (phase, size, LWP, etc.) near cloud top can be monitored by the GOES-R. It is difficult, however, to separate precipitating portions of DCS from non-precipitating anvils from the GOES-R observations due to their similar cloud-top temperatures, which leads to large uncertainties in satellite IR-based precipitation retrievals. This key limitation can be improved by using a newly developed automatic 3-D radar (NEXRAD) classification technique to identify the convective and stratiform rain region (precipitation) and cirrus anvil region (non-precipitating) from midlatitude DCSs.

In the recent study (Stenz et al. 2013), the performance of the National Mosaic and Multi-sensor Quantitative Precipitation Estimation System (NMQ) Q2, and a simplified version of the GOES-R Rainfall Rate algorithm (also known as the Self-Calibrating Multivariate Precipitation Retrieval, or SCaMPR) was assessed over the state of Oklahoma (OK) using OK MESONET observations as ground truth. Q2 pixel-level estimates were directly compared to the collocated OK MESONET observations from 2010-2012. While the average annual Q2 precipitation estimates were about 35% higher than MESONET observations (~690 mm), there were very strong correlations between these two data sets for multiple temporal and spatial scales. SCaMPR retrievals were typically three to four times higher than the collocated MESONET observations, with relatively weak correlations to OK MESONET observations during 2012. Further analysis of the SCaMPR retrievals revealed that the probability of detection (POD) for precipitation of all amounts was only slightly lower than radar based estimates, but large false alarm rates (FAR) existed because of cold cloud-top temperatures in non-precipitating regions of DCSs. By incorporating cloud optical depth into satellite IR-based QPEs such as SCaMPR, FARs can be significantly reduced while maintaining high PODs. To accomplish this, an algorithm has been developed to identify the precipitating area in a GOES image using both retrieved cloud optical depth and cloud-top temperatures. Preliminary testing of this algorithm has shown significant reduction of the SCaMPR FAR, with the precipitating area retrieved from GOES data becoming much closer to the precipitating area estimated by radar.

Reference:

Ronald Stenz, Xiquan Dong, and Baike Xi, and Robert J. Kuligowski, 2013: Assessment of SCaMPR and NEXRAD Q2 precipitation estimates using Oklahoma MESONET observations. Submitted to J. Hydrometeorology.