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Limits of Precipitation Detection from Microwave Radiometers and Sounders

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The Global Precipitation Measurement (GPM) mission will unify and draw from numerous microwave conical scanning imaging radiometers and cross-track sounders, many of which already in operation, to provide near real-time precipitation estimates worldwide at 3-hour intervals. Some of these instruments were designed for primary purposes unrelated to precipitation remote sensing. Therefore it is worthwhile to evaluate the strengths and weaknesses of each set of channels with respect to precipitation detection to fully understand their role in the GPM constellation.

The GPM radiometer algorithm will use an observationally-based Bayesian retrieval with common databases of precipitation profiles for all sensors. Since these databases are still under development and will not be truly complete until the GPM core satellite has completed at least one year of dual-frequency radar observations, a screening method based upon retrieval of non-precipitation parameters related to the surface and atmospheric state is used in this study. A cost function representing the departure of modeled radiances from their observed values plus the departure of surface and atmospheric parameters from the TELSEM emissivity atlas and MERRA reanalysis is used as an indicator of precipitation.

Using this method, two datasets are used to evaluate precipitation detection: One year of matched AMSR-E and AMSU-B/MHS overpasses with CloudSat used as validation globally; and SSMIS overpasses over the United States using the National Mosaic and QPE (NMQ) as validation. The Heidke Skill Score (HSS) is used as a metric to evaluate detection skill over different surfaces, seasons, and across different sensors. Non-frozen oceans give the highest HSS for all sensors, followed by bare land and coasts, then snow-covered land and sea ice. Negligible skill is present over ice sheets. Sounders tend to have higher skill than imagers over complex surfaces (coast, snow, and sea ice), whereas imagers have higher skill over well-understood surfaces such as water and bare land which have relatively few degrees of freedom compared to the number of channels present.

Aside from providing an evaluation of the precipitation detection capabilities of existing sensors, the results of this study may be used to optimize the GMI retrieval by determining channel weights based upon ancillary information regarding surface type and atmospheric state.