Development of an Observational System Simulation Experiment (OSSE) for a Geostationary Microwave Imager

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Passive microwave sounding and imaging from geosynchronous orbit was first studied in the mid-1970's, although initial proposals using microwave channels below 220 GHz required prohibitively large antennas. Studies during the early 1990's suggested that antenna size and costs could be significantly reduced while retaining good spatial resolution by using key submillimeter-wavelength water vapor and oxygen bands. The current GEM concept is based on a ~2 meter steerable Cassegrain reflector antenna and fast-scanning subreflector capable of either intensively observing specific areas near severe weather or obtaining synoptic information over an extended environment. A low-mass scanning subreflector provides a means for high-resolution imaging of ~200 km wide swaths on a regional basis, while the main reflector's momentum-compensated steering mechanism provides the ability to scan the swath over the Earth's disk. A total of up to 44 channels within the AMSU-A (50-57 GHz) and AMSU-B (183.310 GHz) bands and near the 118.750-GHz O_2 line, the 340 GHz transmission window, the 380.197 GHz water vapor line, and the 424.763 GHz O_2 line are considered in the baseline system design. The subsatellite spatial resolution at the highest frequency channel is anticipated to be ~12 km after beam deconvolution, with a tradeoff between channel penetration depth and spatial resolution. The GEM system is also the basis for the GOMAS (Geostationary Observatory for Microwave Atmospheric Sounding) sensor being studied within the European community.

An alternate means of geostationary microwave imaging and sounding is based on aperture synthesis. This technique relies on precision measurements of the coherence function in an aperture plane made using a set of receivers and cross correlators, along with subsequent application of a Fourier transform to obtain the angular radiation field. As implemented in geostationary orbit the system would use a Y-shaped array of antenna and receiver elements along with several tens of thousands of one-bit digital correlators to synthesize a full-disk image of the Earth's brightness temperature. The system would require no moving components to provide ~25 km subsatellite spatial resolution at 183 GHz, but impose tradeoffs in sensitivity, spectral coverage, calibration accuracy, and spaceborne hardware complexity. The JPL GeoSTAR concept is based on implementing this technique at the two primary AMSU bands (50-57 and 183 GHz), with possible inclusion of the 89 GHz AMSU window channel.

In order to assess the operational capabilities of each of these systems for forecasting applications a set of observation system simulation experiments (OSSEs) using the two concepts are being conducted. An assessment of the two system concepts requires that the simulated data be considered in the context of severe weather forecasting, and specifically, quantitative precipitation forecasting. To this end the spatial and temporal sampling capabilities of two the candidate systems, along with the spectral and spatial ranges of their data, need to be carefully considered. Since the two system concepts provide distinct types of brightness information the assessment is best carried out in the framework of radiance assimilation into a numerical weather prediction model. In this talk we present the status of the geostationary microwave OSSE effort with a focus on the locking of a high resolution numerical weather prediction model onto microwave brightness imagery from a simulated landfalling hurricane and the impact of the background error covariance matrix on the model update. The ability of the model to be locked onto the data will be discussed, along with the potential for using such imagery to drive regional numerical weather prediction models using direct radiance assimilation.