Use of Radiation and Cloud Observations in Model Diagnosis/Development to Reduce Cloud-Radiation Model Errors from 4-hour to 4-week Forecasts

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ESRL/GSD develops advanced models and data assimilation, including the 3-km High-Resolution Rapid Refresh (HRRR) model and the 13km Rapid Refresh (RAP) model. It also develops advanced global models including coupled models to improve Week 3-4 subseasonal prediction for NOAA.

ESRL/GSD has developed a parameterization suite (turbulent mixing, deep/shallow convection, 9-layer land/snow/vegetation model) to improve planetary boundary layer biases (temperature and moisture) including better representation of clouds and precipitation. This parameterization suite development has been accompanied by an effort for improved data assimilation of clouds, near-surface observations, and radar for the atmosphere-land system. ESRL/GMD has worked with ESRL/GSD in evaluation of the HRRR and RAP models using SURFRAD and other radiation/flux measurements.

Cloud-radiation representation in models for subgrid-scale clouds is a known gap from subseasonal-to-seasonal models down to storm-scale models applied for forecast duration of only a few hours. NOAA/ESRL has been applying these common physical parameterizations for scale-aware deep/shallow convection and boundary-layer mixing over this wide range of time and spatial scales with some progress to be reported in this presentation. SURFRAD/SOLRAD observational data has been critical in evaluation of these models, along with other data from CERES, METAR ceilometer, aircraft, and rawinsondes.

The Grell-Freitas scheme (2014), MYNN boundary-layer Eddy-Diffusivity/ Mass–Flux (EDMF) scheme (Olson / Benjamin et al. 2016), and Rapid Update Cycle (RUC) land-surface model (Smirnova et al. 2016) have been applied and tested extensively for the NOAA hourly updated 3-km HRRR and 13-km RAP model/assimilation systems over the United States and North America, with targeting toward improvement to boundary-layer evolution and cloud-radiation representation in all seasons. This representation is critical for both warm-season severe convective storm forecasting and for winter-storm prediction of snow and mixed precipitation for aviation, severe-storm, hydrology, and energy applications. Improvement of cloud/radiation model representation has been achieved from this ongoing GSD-GMD collaboration.

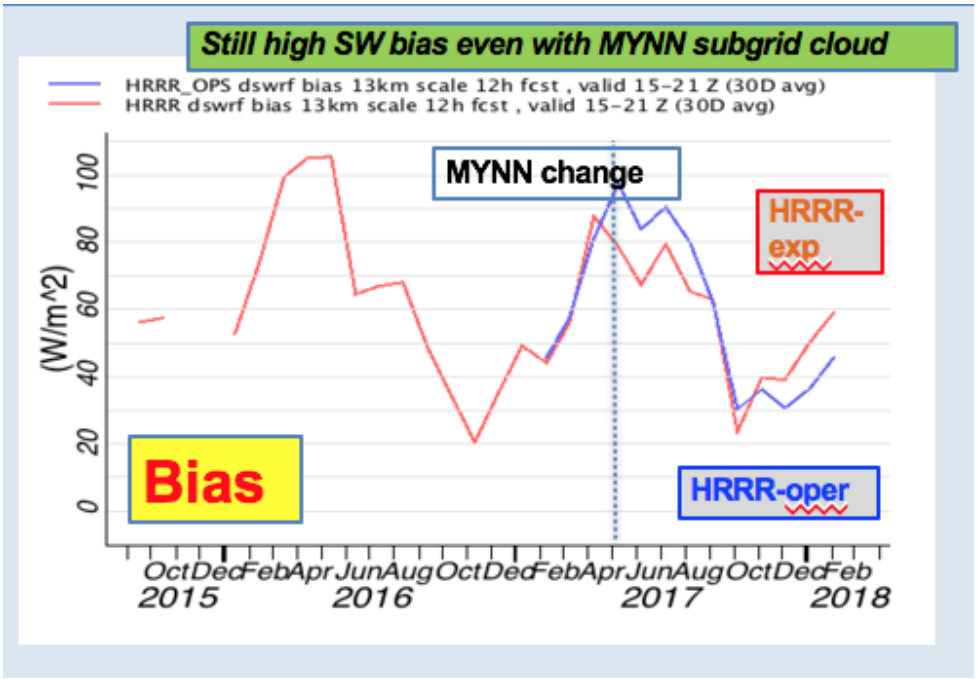

Figure 1. Downward short wave (SW) bias errors from HRRR model vs. SURFRAD observations.