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Assimilating All-Sky Infrared Brightness Temperatures in an Ensemble Data Assimilation System using a Nonlinear Bias Correction Method

Ensemble data assimilation experiments were used to assess the ability of satellite all-sky infrared brightness temperatures and a nonlinear bias correction (BC) method to improve the accuracy of short-range model forecasts. Infrared brightness temperatures from the SEVIRI sensor that are sensitive to clouds and water vapor in the upper troposphere were assimilated at hourly intervals during a 3-day period using a regional-scale assimilation system. Linear and nonlinear conditional biases were removed from the all-sky satellite observations using a Taylor series polynomial expansion of the observation-minus-background departures and BC predictors sensitive to clouds and water vapor. Assimilating all-sky infrared brightness temperatures without BC degraded the forecast accuracy based on comparisons to radiosonde observations. Removal of the linear and nonlinear conditional biases from the satellite observations substantially improved the results, with predictors sensitive to the location of the cloud top height having the largest positive impact, especially when higher order nonlinear BC terms were used. Overall, experiments employing the observed cloud top height or observed brightness temperature as the bias predictor had the smallest water vapor, cloud, and wind speed errors, while also having less degradation to temperatures than occurred when using other predictors. The forecast errors were smaller during these experiments because the cloud-height-sensitive BC predictors were able to effectively remove the large conditional biases from lower brightness temperatures associated with a deficiency in upper-level clouds in the model background.

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