Satellite Sounder Data Assimilation for Improving Alaska Region Weather Forecast

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Introduction
Data assimilation has been demonstrated very useful in improving both global and regional numerical weather prediction. Alaska has very coarse surface observation sites. On the other hand, it gets much more satellite overpass than lower 48 states. How to utilize satellite data to improve numerical prediction is one of hot topics among weather forecast community in Alaska. The Geographic Information Network of Alaska (GINA) at University of Alaska is conducting study on satellite data assimilation for WRF model. AIRS/CRIS sounder profile data are used to assimilate the initial condition for the customized regional WRF model (GINA-WRF model). Normalized standard deviation, RMSE, and correlation statistic analysis methods are applied to analyze one case of 48 hours forecasts and one month of 24-hour forecasts in order to evaluate the improvement of regional numerical model from data assimilation. The final goal of the research is to provide improved real-time short-time forecast for Alaska regions.

Data and methods
GINA-WRF with Alaska domain is set up for the study. A set of optimal physical parameters specific suitable for Alaska region is introduced in the model. Model is initialized with GFS data GDAS convention observation data plus best quality AIRS/CRIS sounder profile data are used as inputs of GSI data assimilation scheme. Each forecast runs WRF model in three modes: Control (CNTL), AIRS data assimilation (AIRS), and CRIS data assimilation (CRIS). Each mode run actually executes WRF model three times.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Spin-up Time</th>
<th>Simulation Time</th>
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<tbody>
<tr>
<td>CNTL</td>
<td>00 Z</td>
<td>00 Z, 12 Z, 24 Z</td>
</tr>
<tr>
<td>AIRS</td>
<td>00 Z</td>
<td>00 Z, 12 Z, 24 Z</td>
</tr>
<tr>
<td>CRIS</td>
<td>00 Z</td>
<td>00 Z, 12 Z, 24 Z</td>
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Forecasts for Nov., 2012 are produced for this study. Results from these different runs are compared with point observation data. Matched pairs of forecast and observation are selected by MET Tools. One 48-hour forecasts at analysis time 2012110800 is picked as case study. Normalized standard deviation, RMSE, and correlation coefficient are calculated to quantitative analysis the impact of data assimilation.

Results
AIRS/CRIS sounder data are filtered with best quality for data assimilation purpose. The number of best quality data changes with altitude. In the case of Nov. 5, 2012, 00 Z, enough high quality AIRS data at 850 mbar are used to adjust the background field (Fig.1). Analysis, background, and the difference in Figure 2 testifies that AIRS data modifies the initial condition in many areas. For example, RH at 850 mbar above Barrow (70026) is adjusted and is picked as the case study. 48-hour forecasts are shown in Figures 3 and 4. Relative humidity and temperature are compared with observation, respectively. Figure 4 tells us that 48-hour temperature forecasts from AIRS and CRIS runs are more close to observation than forecasts from CNTL run in terms of the variation pattern. Figure 4 tells us that 48-hour temperature forecasts from AIRS and CRIS runs are more close to the observation values than those from CNTL run. Statistic analysis for the case is shown in Figure 5. There statistic analysis reveals out that relative humidity forecast is improved significantly. The case study testifies significant improvement of forecast only occurs at where the different between analysis and background is large.

Conclusions
1. Both AIRS and CRIS sounder profile data assimilation improve the WRF model forecast. The improvement is localized and time-dependent.
2. Different weather variables experience different degree of improvement by data assimilation. Relative humidity presents more improvement than temperature.
3. AIRS and CRIS sounder data assimilation scheme have similar performance in terms of improvement of forecast.

Literature cited
2. Model Evaluation Tools Version 4.1 (METv4.1) User’s Guide 4.1. Model Evaluation Tools was developed at the National Center for Atmospheric Research (NCAR) through grants from the United States Air Force Weather Agency (AFWA) and the National Oceanic and Atmospheric Administration (NOAA). NCAR is sponsored by the United States National Science Foundation.

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Further information
1. Testify if we can pick some reanalysis data as “ground true” to evaluate the forecasts to overcome the problem of very coarse observation in Alaska.
2. Conduct statistic analysis for forecasts over one year to evaluate how satellite sounder data assimilation impact the accuracy of regional weather forecast model.