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 coarser 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 1. Mode of GINA-WRF Run

Mode/Analysis Time	T-12 Z	T-6 Z	T Z
CNTL	Cold start	Cycle	Cycle
AIRS	Cold start	Cycle AIRS DA	Cycle AIRS DA
CRIS	Cold start	Cycle CRIS DA	Cycle CRIS DA

Forecasts for Nov., 2012 are produced for this study. Results from three 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 2012110500 is picked as case study. Normalized standard deviation, RMSE, and correlation coefficient are calculated to quantitative analysis the impact of data assimilation.

Results

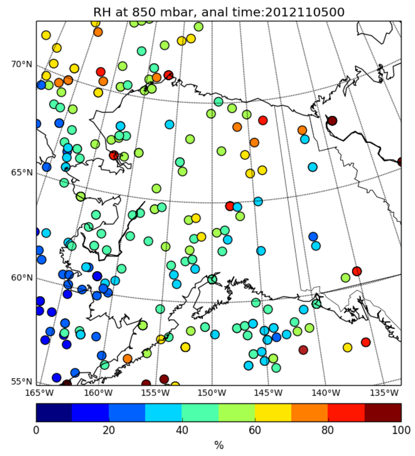

Fig.1 AIRS RH Data at 850 mbar

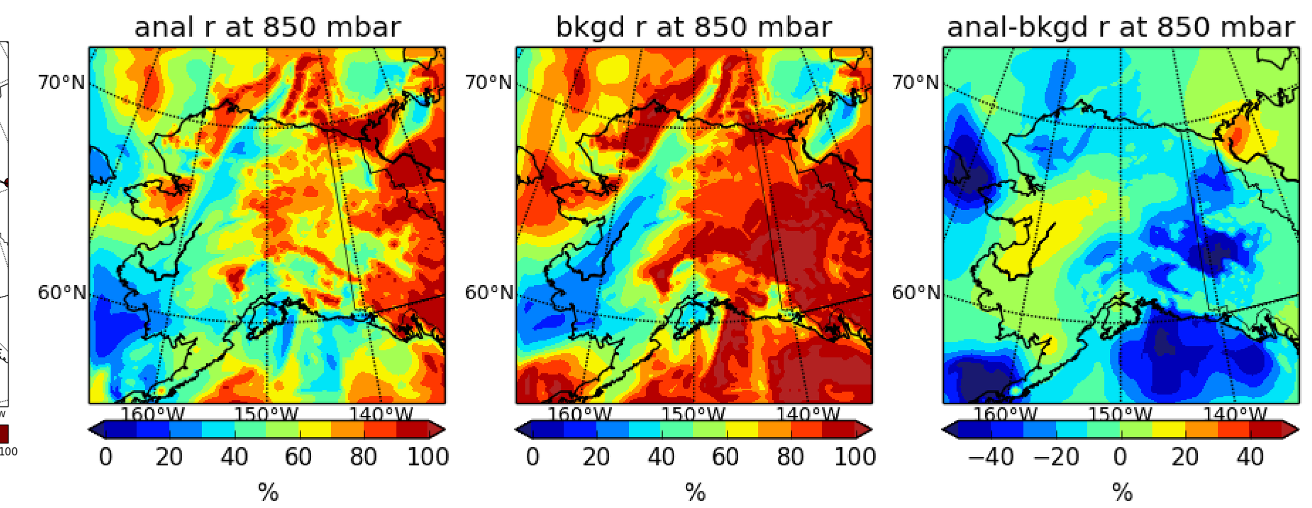

Fig.2 RH analysis and background at 850 mbar

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 modify the initial condition in many areas. For example, RH at 850 mbar above Barrow (70026) is adjusted and is picked as the case study.

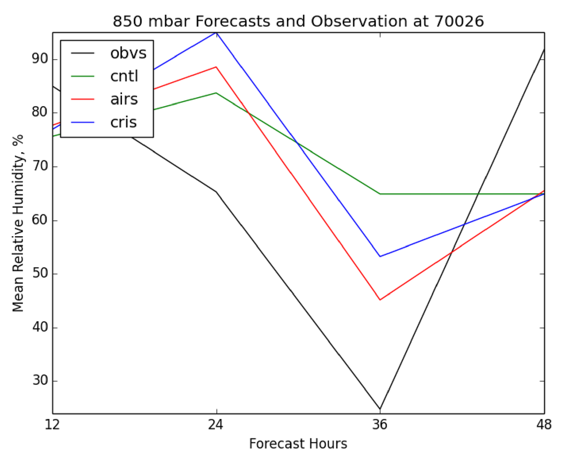

Fig.3. Comparison of 48 hours forecasts of RH with different DA and Observation

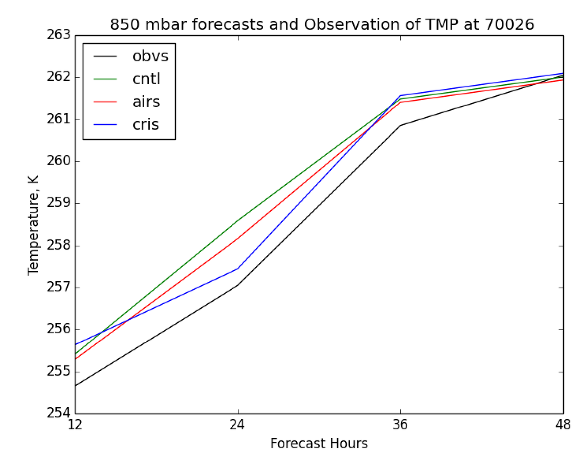

Fig.4. Comparison of 48 hours forecasts of TMP with different DA and Observation

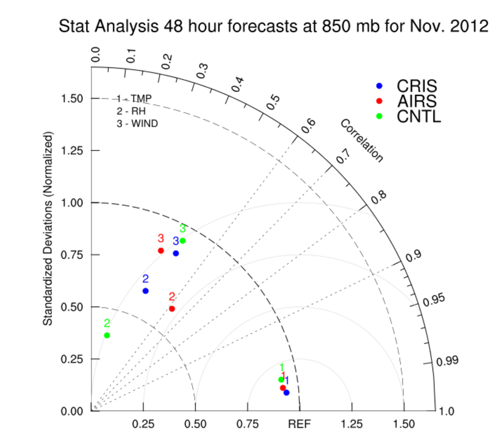

Fig.5. Statistic Analysis of 48 hours forecasts

48-hour forecasts l are shown in Figures 3 and 4. Relative humidity and temperature are compared with observation, respectively. Figure 3 shows the 48-hour forecasts from both 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 closes to the observation values than those from CNTL run. Statistic analysis for the case is shown in Figure 5. Three 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.

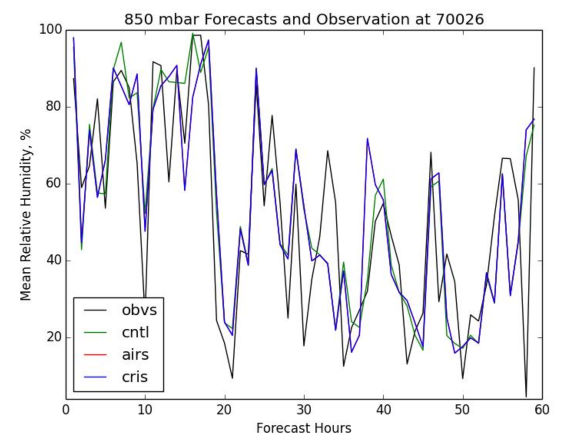

Fig.6. Monthly 24-hour forecasts for RH

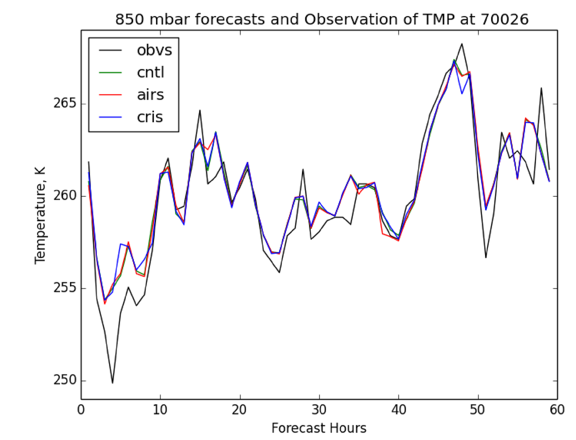

Fig. 7. Monthly 24-hour forecast for TMP

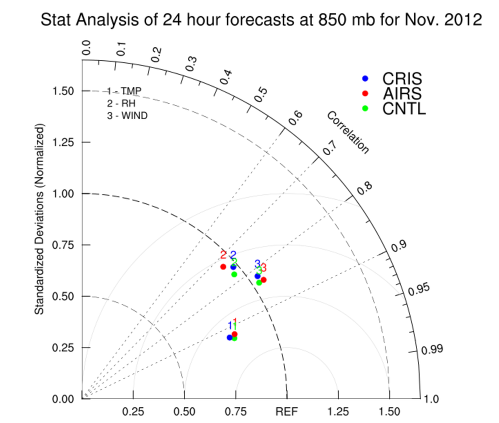

Fig.8. Statistics results of monthly 24-hour forecasts

The modification of data assimilation against background varies with location and analysis time. Figures 6 and 7 give out the 24-hour forecasts over one month of relative humidity and temperature, respectively. They demonstrate that AIRS/CRIS forecasts at some analysis times are improved significantly, but some times are not and AIRS and CRIS forecasts are very similar. Figure 8 verifies that AIRS/CRIS forecasts do not introduce systematic errors but improve the forecasts where and when the AIRS/CRIS data are different from background fields.

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

1. Bradly Zavodsky, Jayanthi Srikishen, Gary Jedlovec, Evaluation of the Impact of AIRS Radiance and Profile Data Assimilation in Partly Cloudy Regions
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."

Acknowledgements

This work is supported by grants NOAA GOESR G336393 and NOAA-NPP/JPSS G337844.

Further information

1.Testify if we can pick some reanalysis data as "ground true" to evaluate the forecasts to overcome the problem of very coarser 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.