Bias Correction for Assimilation of Retrieved AIRS Profiles of Temperature and Humidity

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Abstract

The Atmospheric Infrared Sounder (AIRS) is a hyperspectral radiometer aboard NASA’s Aqua satellite designed to measure atmospheric profiles of temperature and humidity. AIRS retrievals are assimilated into the Weather Research and Forecasting (WRF) model over the North Pacific for some cases modeling “atmospheric rivers.” These events bring a large flux of water vapor to the west coast of North America and often lead to extreme precipitation in the coastal mountain ranges. An advantage of assimilating retrievals rather than radiances is that information in partially cloudy fields of view can be used.

Two different Level 2 AIRS retrieval products are compared: the Version 6 AIRS Science Team standard retrievals and a neural net retrieval from MIT. Before assimilation, a bias correction is applied to adjust each layer of retrieved temperature and humidity so the layer mean values agree with a short-term model climatology. WRF runs assimilating each of the products are compared against each other and against a control run with no assimilation. Forecasts are against ERA-Interim.

Bias for Assimilation Profiles

Temperature and Humidity

Background and Motivation

Operational GSI assimilates AIRS radiances but excludes cloudy areas. AIRS profiles (JPL) are assimilated in the form of left-conserve profiles of temperature and moisture via the atmosphere (as a secondary feature, but there was an overall negative during the peak of the analysis using AIRS).

It was difficult to validate the impact of AIRS profile assimilation due to biases between the profiles and model humidity in upper levels. Also, validation against a CDA Total Precipitable Water product was complicated by biases between the model and the TPW product.

AIRS profiles are retrieved for a specific lat/lon grid. The aim is to ensure that satellite observations to not, on average, change the model climatology of temperature and moisture. Data assimilation algorithms are generally designed for use with unbiased observations (Joseffson).

Experiment

- Atmospheric River on XX date
- WRF domain in eastern North Pacific and western North America at XX resolution
- WRF 48-hr forecast initialized on XX
- Initial and boundary conditions come from GFS, which incorporates assimilation of various observation types including AIRS radiances (but not in cloudy areas)
- Data assimilation using Gridpoint Statistical Interpolation (GSI)
- Model runs:
  - No GSI (control)
  - AIRS V6 profile assimilation
  - Bias-corrected AIRS V6 profile assimilation

Results—Stats

Taylor Diagrams and Tables

Ongoing Work

- Test robustness of correction from day to day and season to season, investigate proper timescale to update correction
- Do a cycling model run for a period of weeks to the impact of continued assimilation
- Further validation, including against rainfall analyses on the west coast.
- Perhaps validation of forecast cloud cover vs. satellite observations.

References


Blankenship, C. et al., 2014: High-resolution spaceborne observation of atmospheric column and evaluation of reanalysis product. American Geophysical Union Fall Meeting 2013, Abstract 4A-B.

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