Assimilation of Precipitation Measurement Missions Microwave Radiance Observations With GEOS-5

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1. Assimilation Procedure and Quality Control

In GEOS-5 ADAS, GMI data are thinned before these observations are screened. GEOS-5 only assimilates data over the ocean with skin temperature above 275 K (Fig 2). Data are not used if the observations suggest there is rain or thick clouds. These threshold vary by channels. The difference between GMI observations (O) and those model produced (forecasts, F) are adjusted through cloud and other bias correction processes (BC), in GSI (Fig 3).

GMI level 1C-R and TMI 1B radiance data are investigated. However, channels 1 and 2, 10 GHz, are not actively used in atmospheric data assimilation because of the biased background departure (Fig 4).

2. Assimilate GMI Radiance Observations With GEOS-5

The experiments are conducted with 0.5° x 0.5° (latitude by longitude) grid resolution. The control experiment is conducted with the full observation data set used for GEOS-5 operational processing. GMI data are added in the Experiment. Both experiments are conducted between mid-April and May 2014.

Fig 5. Histograms of GMI observations departures (O−F) and analysis departures (O−A) in the GMI experiment result in May 2014. Orange curves demonstrate O−F before BC.

3. Assimilate TMI Observations –

Bridge the Microwave Image Data Gap in GEOS-5 Reanalysis

In GEOS-5 reanalysis, there is a microwave imager radiance data gap between November 2009 – April 2014 after SSMI (F13) data set was lost and before GMI observation started.

- Experiment period: mid Nov 2004 – Jan 2005 when there was no major observation system change in GEOS-5 reanalysis.

Investigation 1: TMI data’s impact during the SSMI/TMI overlap period 1998-2009.

Fig 8. Tropical (30 °S – 30 °N) mean (shaded) and standard deviation (STD, contour) of analysis specific humidity tendencies in (left) control and (middle) TMI experiments and (right) their differences. The figure shows that TMI data dehydrate the surface atmosphere and hydrate the lower troposphere with a large variance.

Investigation 2: The potential impact of TMI data in the next analysis during the period 2009 – 2014.

Fig 9. Specific humidity tendencies in (left) control experiment and (middle) TMI experiment at 850 hPa in January 2005. Right panel shows a comparison of the absolute specific humidity differences between GEOS-5 analyses and ECMWF Interim data set. Red and green colors suggest control and TMI experiments are close to Interim data set, respectively. The right panel demonstrates TMI observations make GEOS-5 specific analysis closer to ECMWF Interim data set.

4. Summary and ongoing work

- Improvement in GEOS-5 forecasts is neutral after GMI data are assimilated in clear-sky conditions. We are testing all-sky microwave radiance data assimilation framework using these data.
- TMI observations can bridge the microwave imager data gap between 2009 – 2014 in GEOS-5 reanalysis.
- GMAO is also developing a sea surface temperature assimilation methodology using buoy observations and space-borne infrared data. TMI and GMI 10.6 GHz radiance data are being investigated for this purpose.