ITSC-XVII Conference 2010

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Abstract Title: Use of Quality Controlled AIRS Temperature Soundings to Improve Forecast Skill

Preferred Presentation Type: oral

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Abstract: AIRS was launched on EOS Aqua on May 4, 2002, together with AMSU-A and HSB, to form a next generation polar orbiting infrared and microwave atmospheric sounding system. The primary products of AIRS/AMSU-A are twice daily global fields of atmospheric temperature-humidity profiles, ozone profiles, sea/land surface skin temperature, and cloud related parameters including OLR. Also included are the clear column radiances used to derive these products which are representative of the radiances AIRS would have seen if there were no clouds in the field of view. All products also have error estimates. The sounding goals of AIRS are to produce 1 km tropospheric layer mean temperatures with an rms error of 1K, and layer precipitable water with an rms error of 20 percent, in cases with up to 90 percent effective cloud cover. The products are designed for data assimilation purposes for the improvement of numerical weather prediction, as well as for the study of climate and meteorological processes. With regard to data assimilation, one can use either the products themselves or the clear column radiances from which the products were derived.

The AIRS Version 5 retrieval algorithm is now being used operationally at the Goddard DISC in the routine generation of geophysical parameters derived from AIRS/AMSU data. A major innovation in Version 5 is the ability to generate case-by-case level-by-level error estimates for retrieved quantities and clear column radiances, and the use of these error estimates for Quality Control. The temperature profile error estimates are used to determine a case-by-case characteristic pressure p_{best}, down to which the profile is considered acceptable for data assimilation purposes. The characteristic pressure p_{best} is determined by comparing the case dependent error estimate $\delta T(p)$ to the threshold values $\Delta T(p)$. The AIRS Version 5 data set provides error estimates of T(p) at all levels, and also profile dependent values of pbest based on use of a “Standard” profile dependent threshold $\Delta T(p)$. These “Standard” thresholds were designed as a compromise between optimal use for data assimilation purposes, which requires highest accuracy (tighter Quality Control), and climate purposes, which requires more spatial coverage (looser Quality Control). Subsequent research using Version 5 sounding and error estimates showed that tighter Quality Control performs better for data assimilation proposes, while looser Quality Control

(better spatial coverage) performs better for climate purposes.

We conducted a number of data assimilation experiments using the NASA GEOS-5 Data Assimilation System as a step toward finding an optimum balance of spatial coverage and sounding accuracy with regard to improving forecast skill. The model was run at a horizontal resolution of 0.5 degree latitude x 0.67 degree longitude with 72 vertical levels. These experiments were run during four different seasons, each using a different year. The AIRS temperature profiles were presented to the GEOS-5 analysis as rawinsonde profiles, and the profile error estimates $\delta T(p)$ were used as the uncertainty for each measurement in the data assimilation process.

We compared forecasts generated from the analyses done by assimilation of AIRS temperature profiles with three different sets of thresholds $\Delta T(p)$; Standard, Medium, and Tight. We compared the results of these forecasts to those generated from a “Control” analysis, in which all the data used operationally by NCEP in 2003 was assimilated, but no AIRS data was assimilated. Radiances from the Aqua AMSU-A instrument were assimilated operationally by NCEP and are included in the “Control”. No AIRS data was assimilated operationally at that time. An additional set of data assimilation experiments was also performed in which all data used in the Control, as well as observed AIRS radiances, were assimilated as is now done operationally by NCEP and ECMWF. These experiments are referred to as Radiance Assimilation.

Assimilation of Quality Controlled AIRS temperature profiles significantly improve 5-7 day forecast skill compared to that obtained without the benefit of AIRS data in all of the cases studied. In addition, assimilation of Quality Controlled AIRS temperature soundings performs better than assimilation of AIRS observed radiances. Tight Quality Control of AIRS temperature profile performs best on the average from the perspective of improving Global 7 day forecast skill.