Impact Evaluation of AIRS and SSM/I Assimilation

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A. Motivation

AIRS (Atmospheric Infrared Sounder) is the **first hyper-spectral** infrared instrument designed to observe the earth at very high spectral resolution in the spectral range 3.7 to 15.4 micron. It is onboard AQUA launched in 2002. It has 2378 channels. **A subset of 281 channels is received at CMC**. These channels were carefully selected to provide the maximum information content in terms of atmospheric temperature and humidity as well as surface temperature. AQUA flies in polar orbit at ~650 km altitude, covering the Earth in about one day (swath of about 2000 km, 16 orbits per day). The field of view (FOV) is 13.5 km at nadir and one FOV out of 9 is received at MSC corresponding to an horizontal resolution of ~40 km. AIRS is a research instrument and will not be duplicated. However most weather centers have worked toward the assimilation of AIRS data because it is expected to provide data until 2009 and because it represents a very valuable experience for the upcoming IASI (Infrared Atmospheric Sounding Interferometer) instrument to be launched on METOP in July 2006. IASI will have an operational status guaranteed for at least 25 years, providing 8460 channels. This project aims at assimilating the information from AIRS and later from IASI in CMC operations.

Please have a look at the poster of David Anselmo introduction part. The results presented in this poster are from two experiments: the first tests the impact of Package A in a 4D-Var context, and the second the impact of adding AIRS observations in 3D-Var.

B. Experiments

The experiments discussed in this poster are in **green**.
The experiments discussed in D. Anselmo poster are in **blue**.

4D-Var Cycles:
CONTROL (4D-CNT): current operational system, except
                    with improved GEM forecast model
EXPERIMENT (4D-EXP1): 4D-CNT + Package A

3D-Var/FGAT Cycles:
CONTROL (3D-CNT): 4D-CNT, except with 3D-Var/FGAT
EXPERIMENT (3D-EXP1): 3D-CNT + Package A
EXPERIMENT (3D-EXP2): 3D-CNT + Package A + SSMI
                    obs + removal of AMSU-A CH3
                    + enhanced filtering of AMSU-B
EXPERIMENT (3D-EXP3): 3D-CNT + Package A + AIRS
CONTROL (no AIRS): 3D-Var operational GEM
EXPERIMENT (AIRS): 3D-Var operational GEM + AIRS

Period of Evaluation:
For the 4D-Var experiments presented here, the analyses and forecasts were evaluated over the period December 15, 2004 to January 26, 2005.

C. AIRS cycle

Assimilation :
- 100 possible channels per profile
- 100 000 observations assimilated on average each 6 hours.

System :
- 3Dvar analysis
- current operational model (GEM) at 0.9° resolution,
28 vertical levels and top at 10hPa.

Quality control highlights :
- surface channels assimilated over water only
- Garand and Nadon (1998) algorithm used to detect cloudy or clear profiles.
- Determination of cloud top, cloud cover with CO2-clicing for observation assimilation when jacobian contribution above clouds

Garand, L., and S. Nadon, 1998: **High-Resolution Satellite Analysis and Model Evaluation of Clouds and Radiation over the Mackenzie Basin Using AVHRR Data.** Journal of Climate: Vol. 11, No. 8, pp. 1976–1996
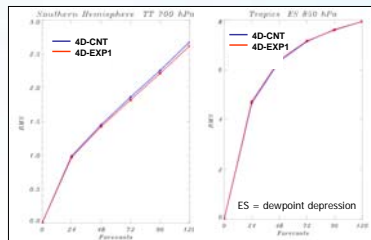
Heilliette, S., and L. Garand, 2006: **Towards variational assimilation of cloudy radiances from hyperspectral infrared sounders.** Proc. 14th Conf. on Sat. Meteor. and Ocean., Atlanta, GA.
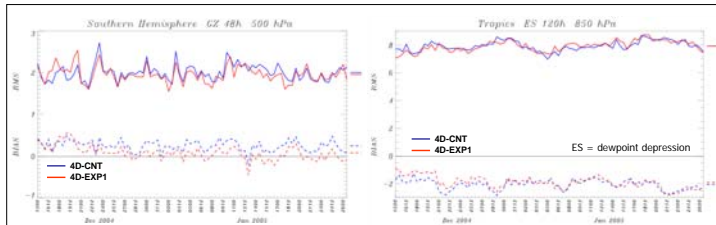
D. Results:
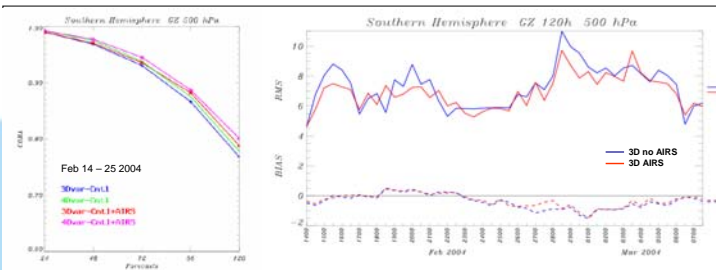
4D-EXP1 vs. 4D-CNT

I. Anomaly Correlation

II. RMS

ES = dewpoint depression

III. Time Series

ES = dewpoint depression

AIRS vs. no AIRS

Feb 14 – 25 2004

Average temperature analysis difference (AIRS – no AIRS)

Adding AIRS data have the effect of changing the atmospheric structure of temperature as can be seen in temperature analysis differences for a 15 days period. While the poles get warmer at 100 hPa, they get colder at 250 hPa. A colder ring around the equator is seen at 500 hPa.

100 hPa
250 hPa
500 hPa
deg K
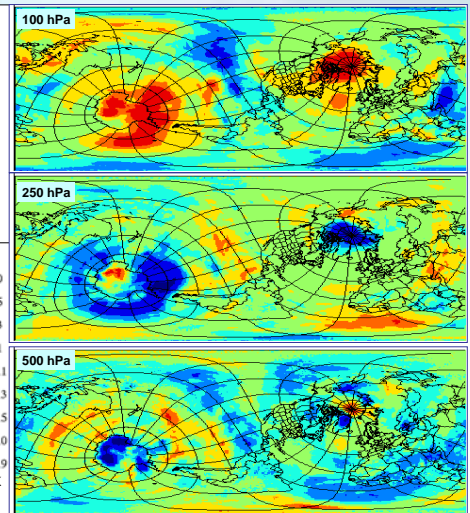
E. Summary

The results presented in this poster indicate a small positive impact after the installation of Package A into the Meteorological Service of Canada's global assimilation system in 4D-Var. With AIRS in 3D-Var, a gain of predictability of 6 hours at day 4 is obtained in the Southern Hemisphere. The gain is even greater with 4D-Var. Results range from neutral to slightly positive in the Northern Hemisphere. Further improvements expected from adjusting parameters such as observation error, data thinning and quality control. In addition a new file providing the warmest pixel among 9 instead of the center one is now available (higher probability of clear pixels). First implementation foreseen for beginning 2007. Promising but very challenging research is also under way to assimilate radiances which are affected by clouds (Heilliette and Garand, 2006).