Developments in the context of the Concordiasi project in Antarctica for the International Polar Year (IPY)

Florence Rabier, Aurélie Bouchard, Vincent Guidard, Fatima Karbou, Stéphanie Guedj

CNRM-GAME, Météo-France and CNRS
42 av Coriolis, 31057 Toulouse, France
Florence.Rabier@meteo.fr

Within the framework of the IPY, the Concordiasi project (http://www.cnrm.meteo.fr/concordiasi/) will make innovative observations of the atmosphere above Antarctica in order to
* Enhance the accuracy of weather prediction and climate records in Antarctica through the assimilation of in-situ and satellite data
* Improve our understanding of microphysical and dynamical processes controlling the ozone content of the polar air masses, by providing the first quasi-Lagrangian observations of ozone and particle content, in addition to an improved characterization of the polar vortex dynamics.

A major Concordiasi component is a field experiment during the Austral springs of 2008 and 2009. The field activities are based on a constellation of up to eighteen long duration stratospheric balloons deployed from the McMurdo station. Six of these balloons will carry GPS receivers and in-situ instruments measuring temperature, pressure, ozone, and particles. All the balloons are capable of releasing dropsondes on demand for measuring atmospheric parameters. Finally, radiosounding measurements are collected at various sites, including the Concordia station.

Studies have been performed on how to improve the estimation of microwave emissivity over Antarctica, following the approach developed in Karbou et al. (2006). Feasibility studies have also been undertaken to improve our knowledge of the variability of surface emissivity over Antarctica. Surface emissivity retrievals in these studies make several assumptions about surface conditions. For example, the land surface emissivity is usually derived from satellite observations assuming that the surface is flat and specular. In fact, snow significantly scatters microwaves, and a specular assumption for the surface may introduce biases for observations from scan-track instruments such as AMSU-A and AMSU-B. To study the sensitivity of surface properties in retrievals, land surface emissivities at AMSU window frequencies have been calculated using specular, lambertian, and intermediate surface reflectivities. It has been found that emissivities derived at 50 GHz and from observations close to nadir are rather sensitive to assumptions about the surface. Simulations of brightness temperatures at sounding channels have been made and have been compared with observations. For the simulations, the land surface emissivity at the closest window channel, in frequency, has been assigned to each sounding channel. For instance, emissivities derived at 50 GHz have been assigned to AMSU-A temperature channels (50-60 GHz) and emissivities derived at 89 GHz have been assigned to AMSU-B humidity channels. It has been found that the best results are obtained when the surface is assumed to have 50% specular reflection and 50% lambertian reflection. Figure 1 shows the correlations between observations and simulations for AMSU-A channel 4 (52.3 GHz). Results are plotted for a control experiment, for an experiment that uses land surface emissivities assuming the surface to have specular reflection and for an experiment that uses land surface emissivities assuming the surface to have specular reflection and lambertian reflections (50% each). In the control experiment, the land surface emissivity was estimated using the empirical version of Grody (1988) and Weng et al. (2001) models for AMSU-B and AMSU-A observations respectively. Observations and simulations correlate much better after inclusion of a surface emissivity that varies in space and time. More in depth studies are planned in order to examine the impact of even more realistic descriptions of Antarctica surface emissivity on analysis and forecast skill.

As far as the assimilation of advanced infrared sounders is concerned, cloud detection is also an issue. The cloud detection scheme (McNally and Watts, 2003) used operationally at Météo-France, was validated with respect to MODIS information over Antarctica and sea ice. Then channels peaking in the stratosphere and upper troposphere were selected for assimilation over land and sea-ice, in addition to channels being used over open sea.

To take advantage of these microwave developments, a new assimilation suite, using additional AMSU-A and AMSU-B data, and also more AIRS and IASI channels over land and sea-ice, has been tested. Scores over the Southern Hemisphere show a better model performance (Figure 2).

Developments will continue and in-situ data obtained from September to November 2009 will be most helpful to validate our satellite data assimilation over these regions.

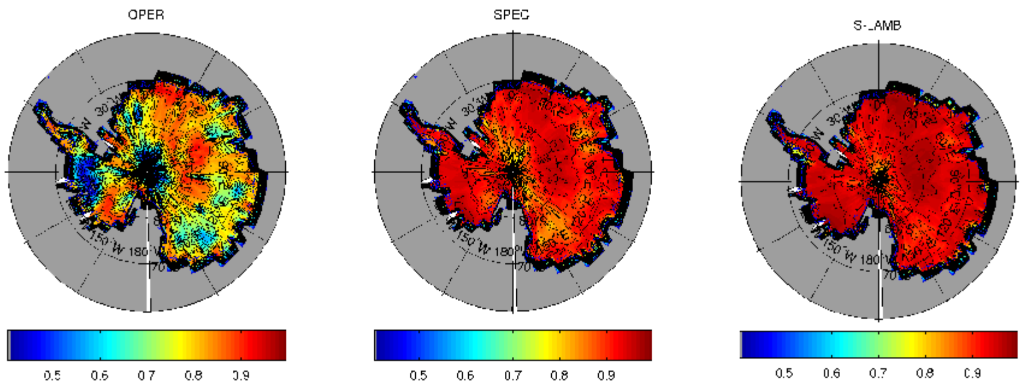

FIG. 1. Map of correlations between observations and simulations of AMSU-A channel 4 (52.3 GHz) for January 2007. Results are shown for a control experiment (left-hand panel), an experiment in which the land surface emissivity has been estimated assuming the surface to have specular reflection (middle panel), and an experiment in which the land surface emissivity has been estimated assuming the surface to have specular and lambertian reflection (50% each) (right-hand panel). The correlations have been computed taking into account data in grid cells of 2°x2° size.

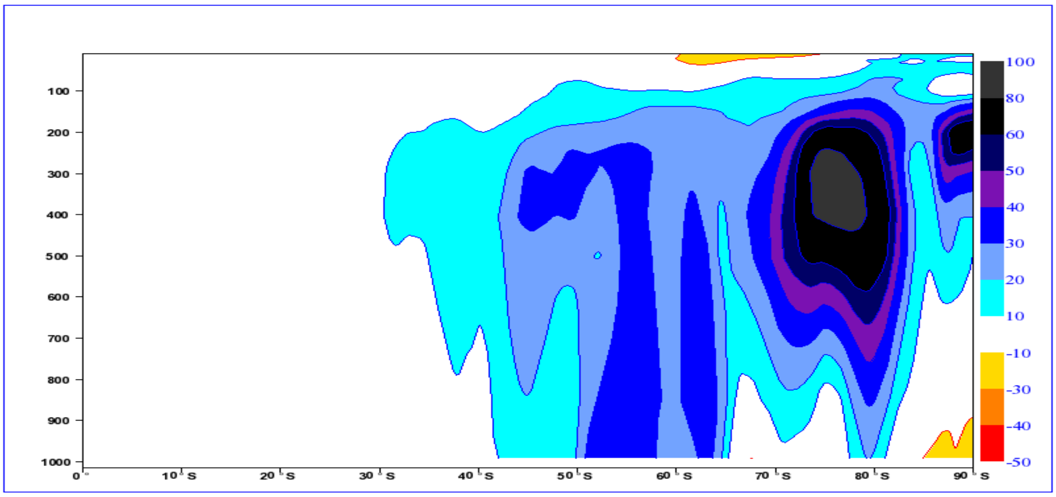

FIG. 2. Statistics of the differences in root-mean-square errors between a version of the ARPEGE model assimilating the same observations as in operations and a version of the model using more satellite data over Antarctica. The statistics are shown for the geopotential errors of the 72-h forecasts over a period of three weeks in July 2007, averaged latitudinally. Blue (resp. yellow) colours indicate that the additional AIRS, IASI and AMSU observations over Antarctica have improved (resp. degraded) the forecasts.