

Atmospheric profile retrievals from IASI in the framework of the Concordiasi campaign

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Introduction

Concordiasi is a multidisciplinary effort jointly operated by France and the United States to study the lower stratosphere and troposphere above Antarctica as well as the land surface of the Antarctic continent. Concordiasi field experiments took place in austral springs 2008, 2009, and 2010. In 2010 an innovative constellation of balloons provided a unique set of measurements covering both volume and time. The balloons, 13 driftsondes and 6 balloons with tethered gondolas dedicated to middle atmosphere measurements, drifted for several months on isopycnic surfaces in the lowermost stratosphere around 18 km, circling over Antarctica in the winter vortex, from the U.S. McMurdo Station, located at 78° south latitude. The balloon flotilla formed a regional observatory of the atmosphere, which provided in situ measurements inside the winter stratospheric polar vortex and allowed the performance, on command, of hundreds of soundings of the troposphere. The in situ measurements included position, temperature, pressure, ozone, and aerosol particles, as well as profiles below the balloonborne gondolas, which included temperature, pressure, humidity, and winds.

In this study, we carry out a first series of **1D-VAR retrievals of temperature and humidity profiles from IASI radiances and compare them to dropsonde measurements.**

1. Selection of IASI pixels and dropsondes

635 dropsondes are available in the Concordiasi dataset. We have selected up to 4 IASI pixels in a vicinity of **50 km and 1 hour** of each dropsonde. After a quality check, we keep 332 dropsondes and 1287 IASI pixels. As dropsondes were released all over Antarctica, surface pressure at the sonde location ranges from ~600 hPa to more than 1000 hPa (cf. distribution and location on Figure 1). When surface pressure is between 700 and 930 hPa, dropsondes mainly are over coastal or mountainous areas, with high orography gradients.

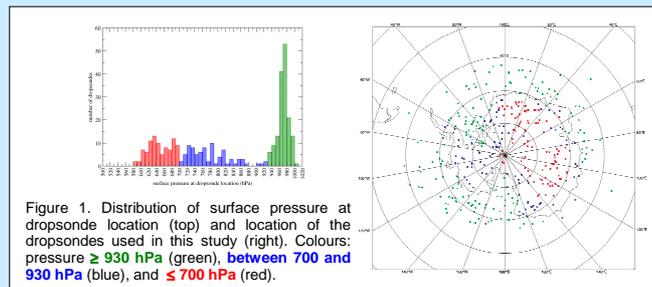


Figure 1. Distribution of surface pressure at dropsonde location (top) and location of the dropsondes used in this study (right). Colours: pressure ≥ 930 hPa (green), between 700 and 930 hPa (blue), and ≤ 700 hPa (red).

2. 1D-VAR retrievals

The 1D-VAR from the NWP-SAF of Eumetsat has been used with IASI brightness temperatures (operational channel selection with 123 channels in LW temperature, window and water vapour) and atmospheric background profiles of temperature and relative humidity from a Concordiasi-dedicated version of the global model ARPEGE. Figure 2 shows averages of these input data for each orography class.

A McNally and Watts cloud detection has been implemented in the 1D-VAR, so that all clear channels are used in each retrieval.

Results of this first series of retrievals are shown in Figure 3. There is hardly no impact on temperature profiles, as they already are of quite good quality (less than 1K in the upper troposphere). Improvements are seen on relative humidity profiles for scenes over the Antarctic Plateau, and also slight improvements in the upper troposphere for the coastal scenes. Slight degradations occur in the lower troposphere for scenes over sea-ice.

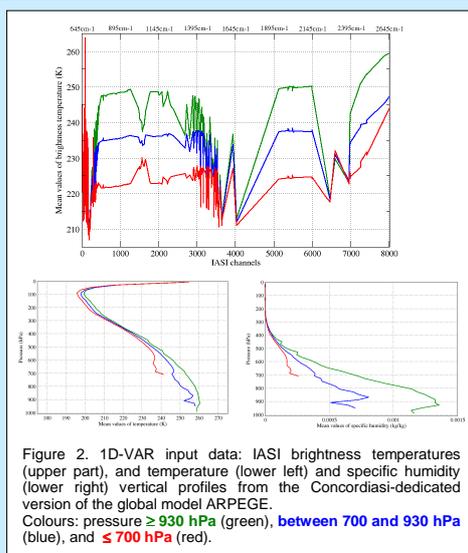


Figure 2. 1D-VAR input data: IASI brightness temperatures (upper part), and temperature (lower left) and specific humidity (lower right) vertical profiles from the Concordiasi-dedicated version of the global model ARPEGE. Colours: pressure ≥ 930 hPa (green), between 700 and 930 hPa (blue), and ≤ 700 hPa (red).

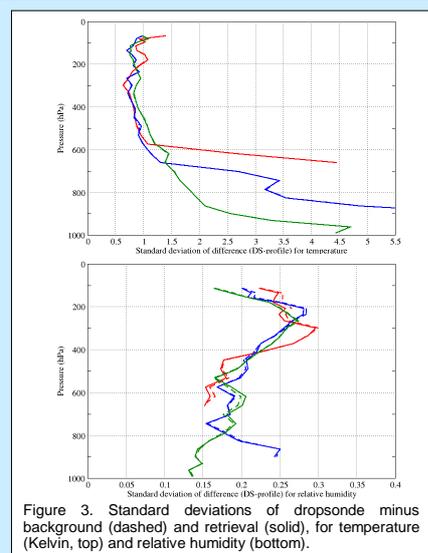


Figure 3. Standard deviations of dropsonde minus background (dashed) and retrieval (solid), for temperature (Kelvin, top) and relative humidity (bottom).

3. Observation error diagnostics

In this first series of retrievals, we used a diagonal observation error covariance matrix (the so-called R matrix), with the same standard deviations as in the operations at Météo-France. A posteriori diagnostic can be calculated after the 1D-VAR, to evaluate the full R matrix. We used the Desroziers method. Results are given in Figure 4.

Observation error standard deviations are over-estimated for stratospheric and upper tropospheric temperature channels (consistent with numerous studies). Diagnosed values for lower tropospheric temperature channels are higher than the ones used for 1D-VAR.

The correlation part of the diagnosed R matrix shows an almost diagonal block for stratospheric and upper tropospheric temperature channels. Correlated parts are present for water vapour channels and also for window and lower tropospheric temperature channels. This may be due to either bad cloud screening or surface parameters, mainly temperature, not accurate enough in input of 1D-VAR.

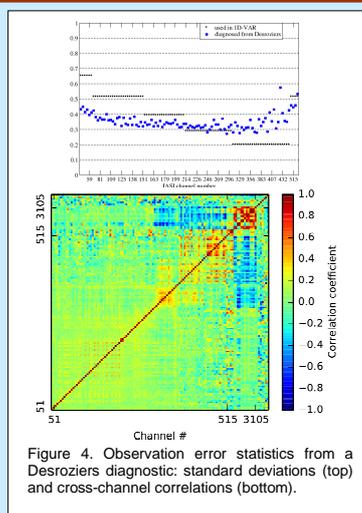


Figure 4. Observation error statistics from a Desroziers diagnostic: standard deviations (top) and cross-channel correlations (bottom).

Conclusion & Future work

A first series of atmospheric profiles has been retrieved from IASI observations using Météo-France fields as background states. Comparison with collocated dropsondes helps to evaluate the quality of the retrievals. Benefits from IASI seem modest in these experiments, as background state already is of good quality.

A posteriori diagnostics suggest that a particular work has to be done on surface properties and cloud screening (which is not obvious in this region).

Channel selection should also be revised to account for the specificities of Antarctica:

highly elevated terrain over the Plateau, very cold and isothermal profiles, cloud screening over sea-ice.

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REFERENCES

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