IOMASA deliverable 2.3
Assimilation of Total Water Vapor Retrievals at SMHI

Per Dahlgren Tomas Landelius
SMHI
Swedish Meteorological and Hydrological Institute

1 Introduction

Technically, it is quite straight forward to assimilate TWV retrievals into the HIRLAM analysis code HIRVDA. HIRVDA is already prepared to handle other types of observations of integrated water vapor. So much of that code can used again. This report will describe how data is collected, preprocessed and then used in the analysis.

2 Data Collection and Preprocessing

Collection of TIWV retrievals is done via ftp from DTU, Danish Technical University. The data is then in ASCII format with one file containing all data from one day. At SMHI the HIRLAM model is usually run at 00,06,12 and 18 UTC, and so will the experiments with the TWV retrieval data. Therefore, all observations within a file from DTU must be sorted according to time. Thereafter we only use data above 75 deg north. This is because we are only interested in data over the Arctic region, since that is what IOMASA is all about. It is also because the $(\mathbf{y} - \mathbf{H}\mathbf{x}_b)$ statistics looks better over ice than over sea, figure 2, which indicates that we can expect a better impact of the data over ice. The data is also *thinned*, which means that we increase the horizontal distance between observations to meet the length-scales of the background errors in the analysis. Figure 1 shows the preprocessing chain for one example file from 20:th of Jan 2005. Figure 3 shows the effect of the latitude selection and especially the thinning of the data.

3 Technical Check of the Assimilation Code

To test that the TWV retrievals are coming into the HIRVDA code correctly, we have done a single obs experiment. This means that only one observation has been assimilated, and the reason is to check the assimilation increments and verify that it looks as expected. Figure 4 shows how the information from one TWV observation is spread horizontally. It is the background statistics that spreads the information in the horizontal since the observation itself does not

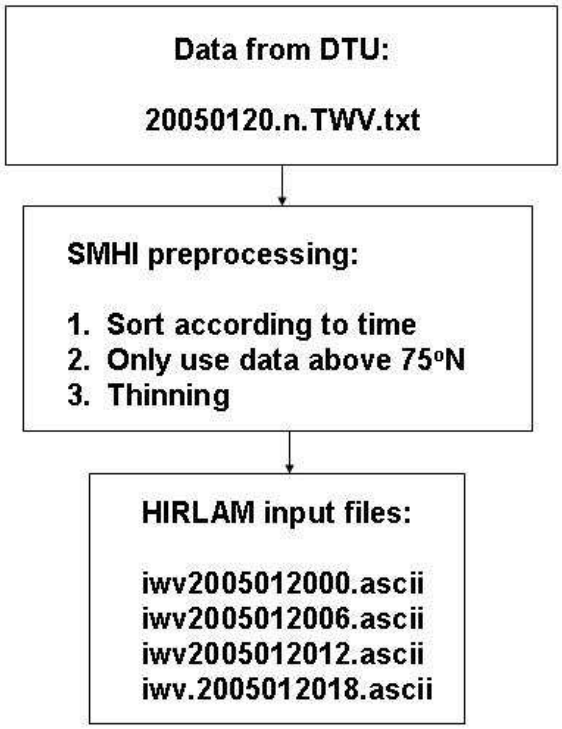

Figure 1: *Processing of TWV files at SMHI. The example shows a file with data from 20:th Jan 2005. The date standard is year-month-day-hour.*

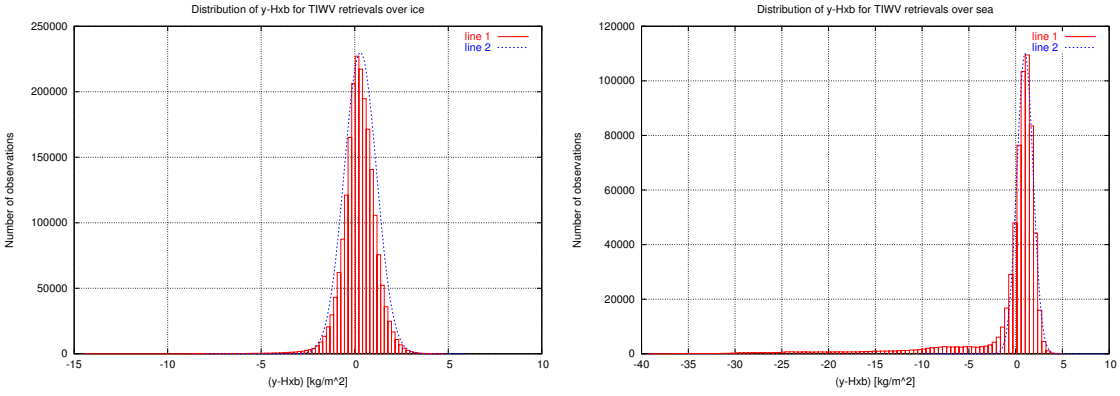

Figure 2: *Distribution of innovations for TWV retrievals. Blue curve is a fitted Gauss function*

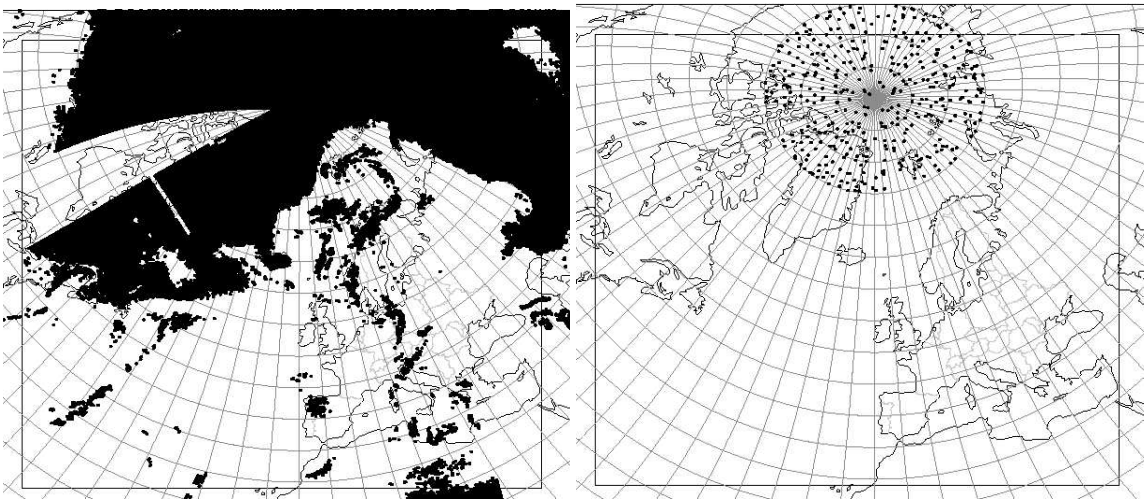

Figure 3: *The effect of the SMHI preprocessing of data. The example is from 20050120, and the data is for the 06 UTC analysis. The HIRLAM domain used for this study is also shown in the figures.*

have any information about that. This looks good and is also what could be expected. Figure 5 shows how the information is distributed in the vertical. Again it is the background statistics (left figure) that determines that because the observations are an integrated quantity. The example if from 20041210 at 18 UTC, these results are also presented in the deliverable 2.2.1.

4 Experiment Setup and First Results

We have chosen to run Jan 2005 for the impact experiments and with a model resolution of 33km. The domain is shown in figure 3. The observation errors for the TWV observations are set to 0.3 $[kg/m^2]$ which is about the same as the background error in observation space for integrated water vapor at high

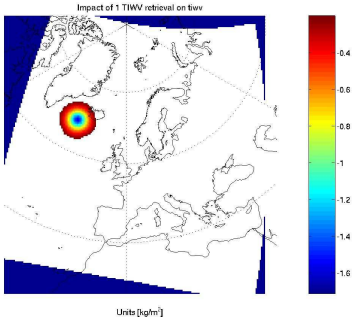

Figure 4: *The impact of one TWV retrieval on total integrated water vapor amount*

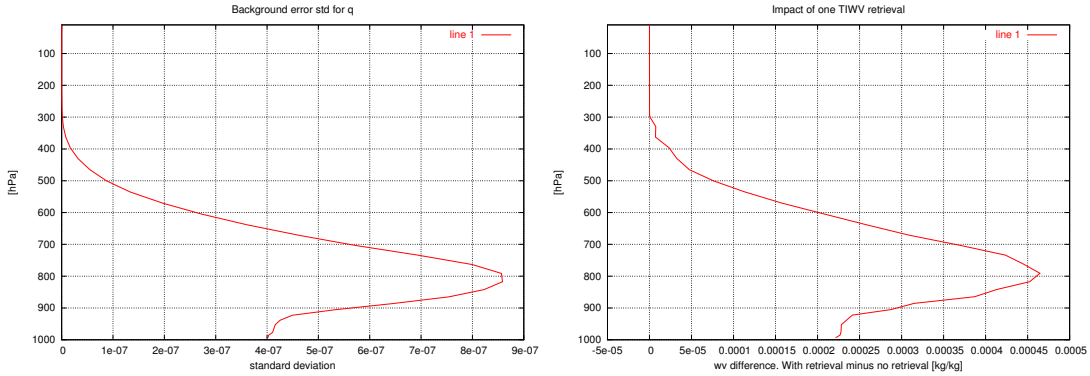

Figure 5: *The impact of one TWV retrieval on a vertical column at the observation point*

latitudes.

The experiments are up and running but are not completed yet. We will therefore only show some output from the runs conducted so far. The example shows how the information from the TWV observation evolves in the model as it is integrated forward in time. Figure 6 shows the MSLP for the 20050101 00 UTC run integrated 12h, i.e. it is valid at Sat 1 Jan 2005. A ridge, from a high pressure west of Greenland, dominate the north pole area. North east of Greenland is a trough. Figure 7 shows that after 18h there is less difference between the two experiments than in the beginning. This is expected because the water vapor field in a NWP model is much driven by the dynamics. New information added by observations is therefore overrun by the dynamic tendencies as the model is integraget forward. Assmimilation of water vapor information can therefore mostly improve short range forecasts.

5 Discussion

This report shows that SMHI have prepared the HIRLAM analysis code HIRVDA to assimilate TWV retrievals. A processing chain of the observations has been setup, and the data is used in an experiment that is not completed yet. Some output from the experiments are shown in the report, mostly to verify that the experiments are running correctly.

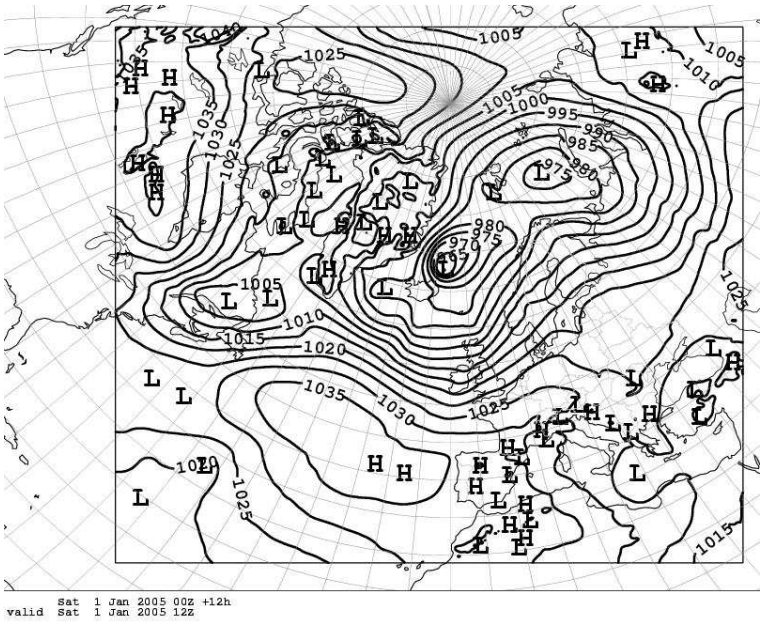

Figure 6: *The synoptic situation 20050101 00 + 12h.*

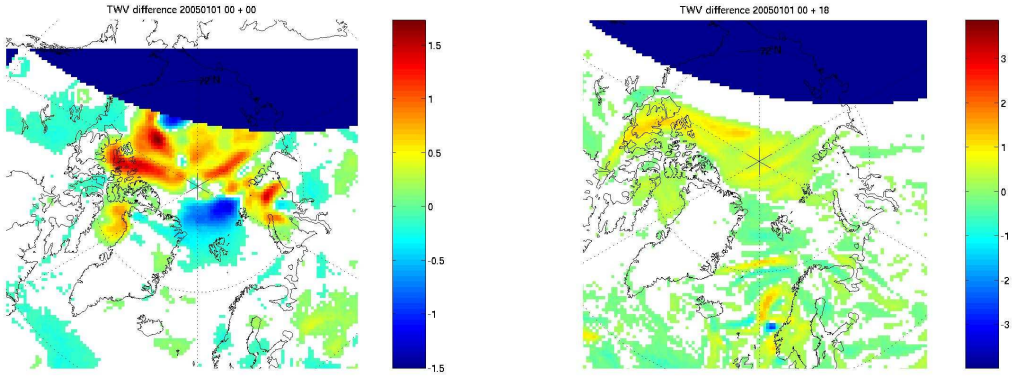

Figure 7: *Difference in total water vapor between reference run and experiment run. Reference run has not assimilated the TWV observations while the experiment run has. The left figure shows the difference at the analysis time. The right figure shows the difference after the model has been integrated 18h forward in time.*