Investigating the assimilation of IASI data in a limited area model

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Introduction

Assimilation and impact assessment of the Infrared Atmospheric Sounding Interferometer (IASI) data at the Norwegian Meteorological Institute (Met.no) is defined in one of the working packages of the Norwegian international Polar Year project (THORPEX-IPY/Norway). ALADIN-HARMONIE assimilation and forecasting system have been chosen for this study. Since at Met.no the operational model is the HIRLAM, the ALADIN-HARMONIE system had to be implemented first.

This poster describes the implementation of the IASI data in the ALADIN/HARMONIE-Norway assimilation system. The importance of the bias correction in the assimilation of satellite radiances is well known. In the IFS/ARPEGE/ALADIN codes, the correction of radiance biases can be done in two different ways: Bias can be estimated in off-line regime (*Harris and Kelly, 2001 - off-line bcor*) or adaptively using variational technique (*Auligné et al., 2007 - VarBC*). The power of both techniques will be discussed in this poster to approve our decision on using the variational bias correction technique to correct the bias of the IASI data.

Monitoring of the IASI data

A set of 366 channels, provided by Andrew Collard from the ECMWF was used in this study. One FOV of four of each FOR's is extracted guaranteeing one IASI FOV for each AMSU-A FOV. FOVs corresponding to 3 AMSU-A FOVs (FOV with number less than 12 and bigger than 109) on both edges of the satellite track are rejected to avoid large bias.
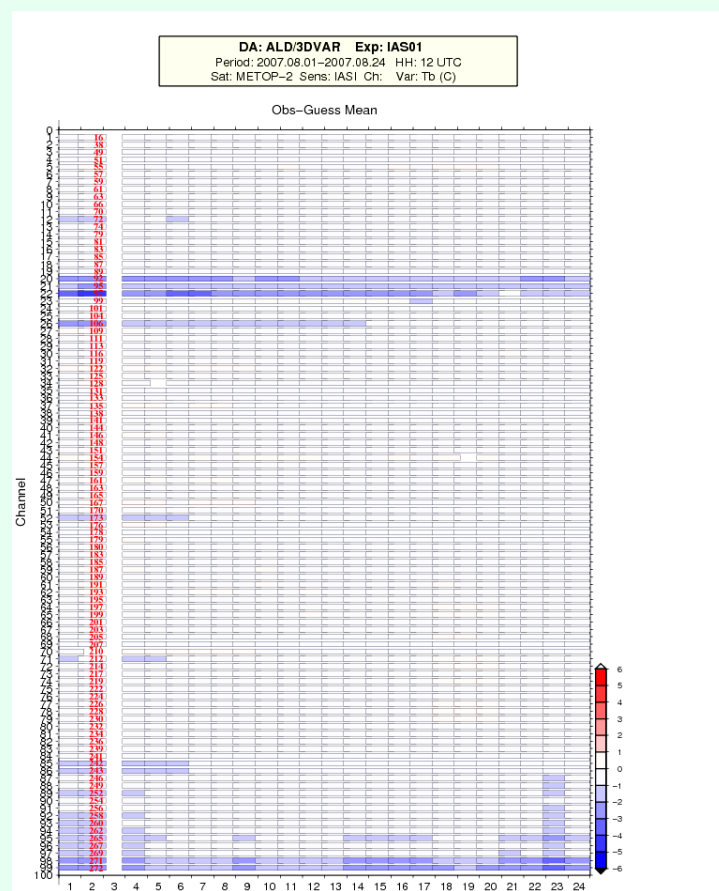

Fig. 8. *Channels "obeying" the variational bias correction were privileged during the selection of channels to be used.*
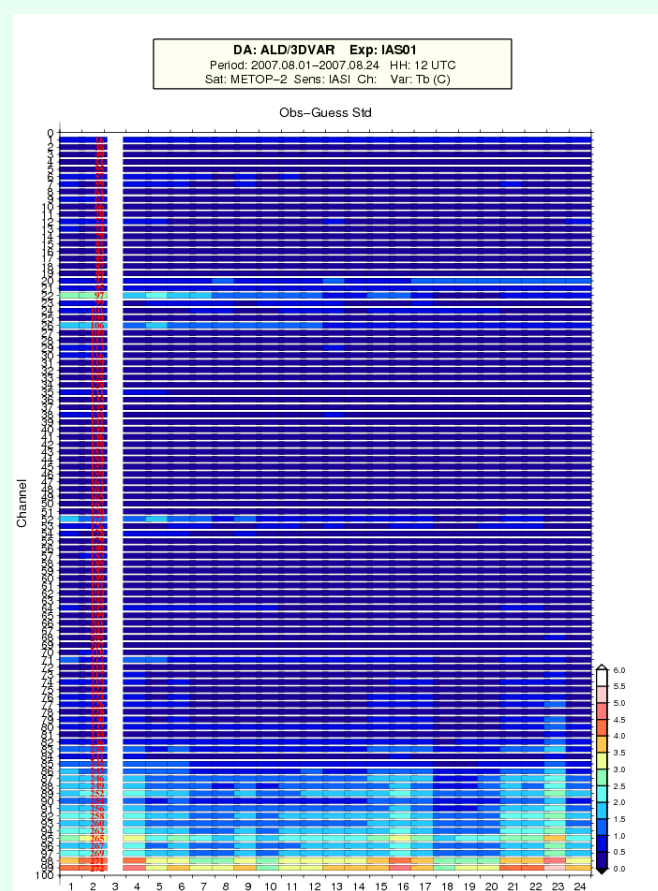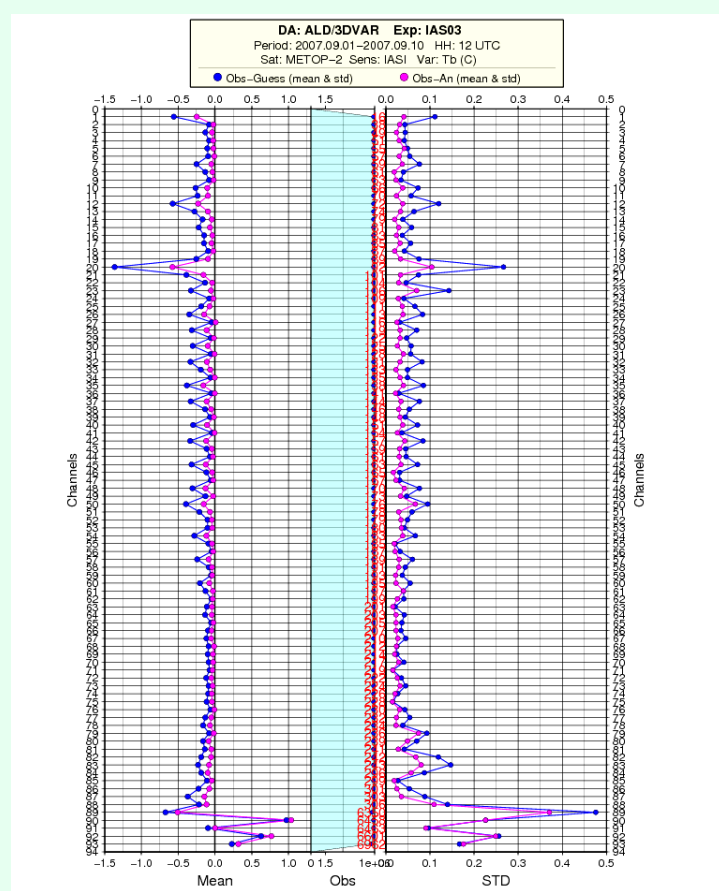
Fig. 9. *Bias and standard deviation of the chosen 93 channels.*

The preliminary assimilation trails

IAS01 – analysis using IASI data without cycling for updating the VarBC tables

IAS03 – first trial of IASI data assimilation using temperature channels without using humidity surface or column channels over sea only. The observation errors were set as follows: 0.2K for CO2 band, 1K for window channels, 2K for water vapour channels

IAS04 – run without IASI data where bias correction for radiances is corrected using off-line bcor

IAS07 – as IAS03, but observation error for CO2 band, water vapour channels were set as 0.5K and 4K, respectively. The cloud detection scheme was improved. Stratospheric channels were used over sea and land
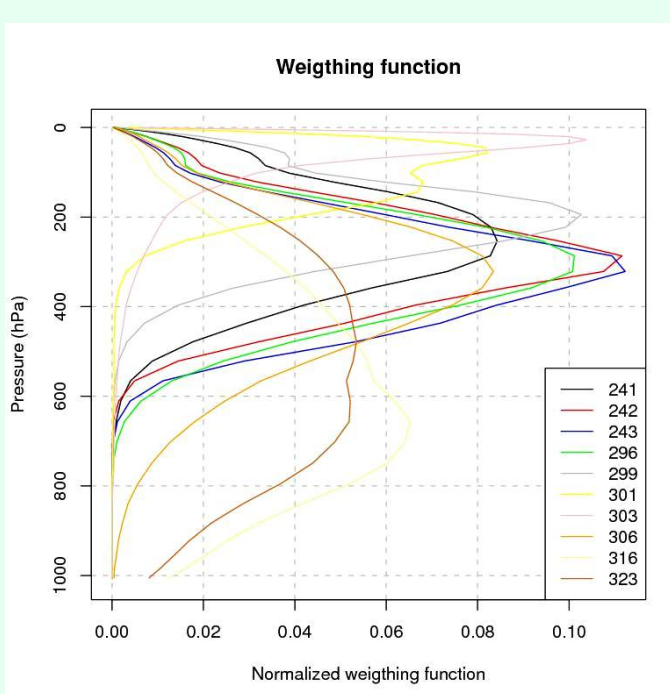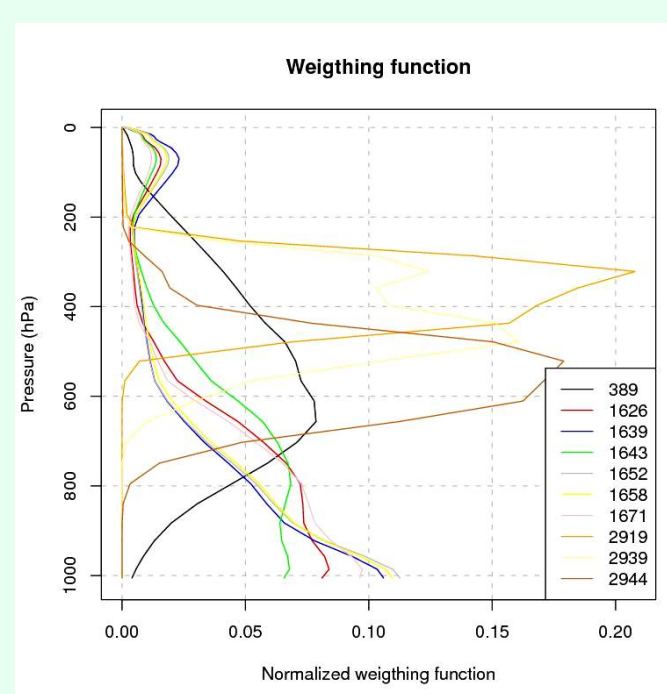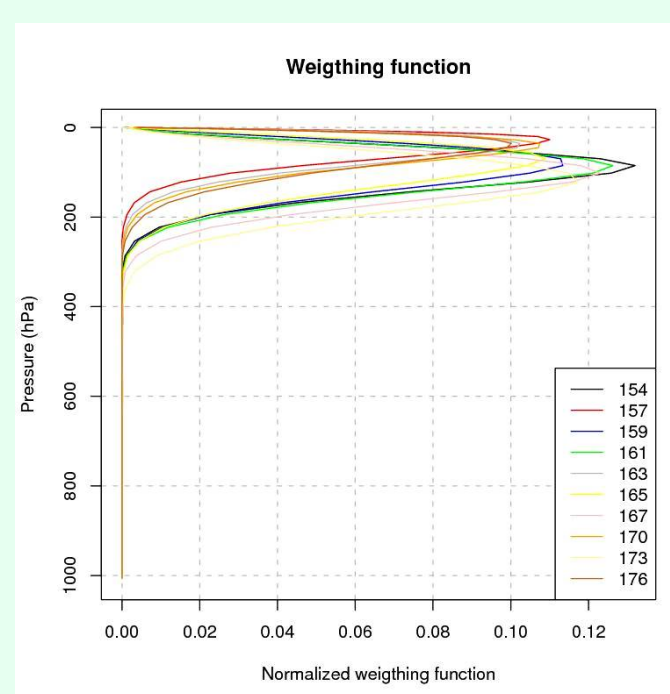
IAS09 – run without IASI data

Fig. 10. *Examples of weighting functions of IASI channels.*
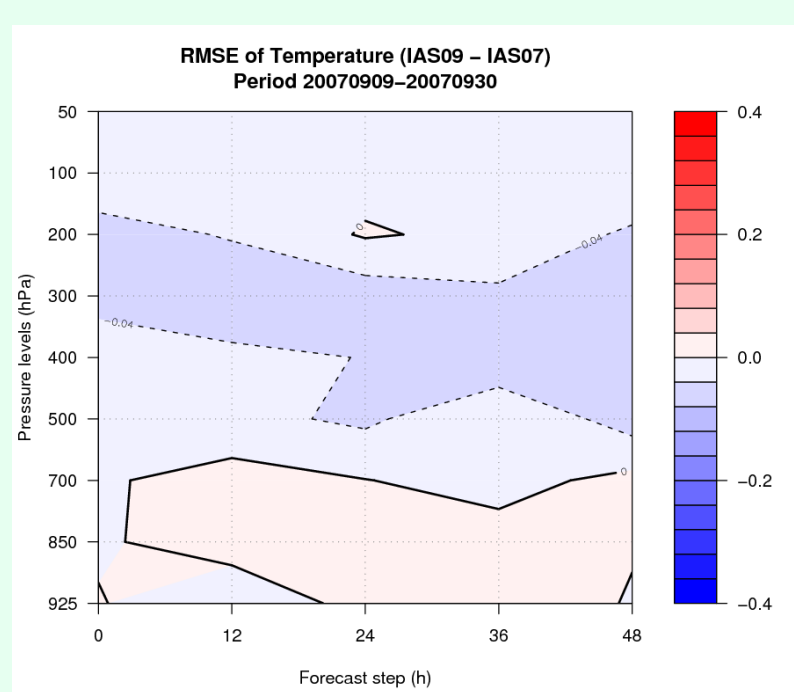
Verification against observations

Fig. 11. *RMSE difference between IAS07 (run with IASI data) and IAS09 (run without IASI data) runs*
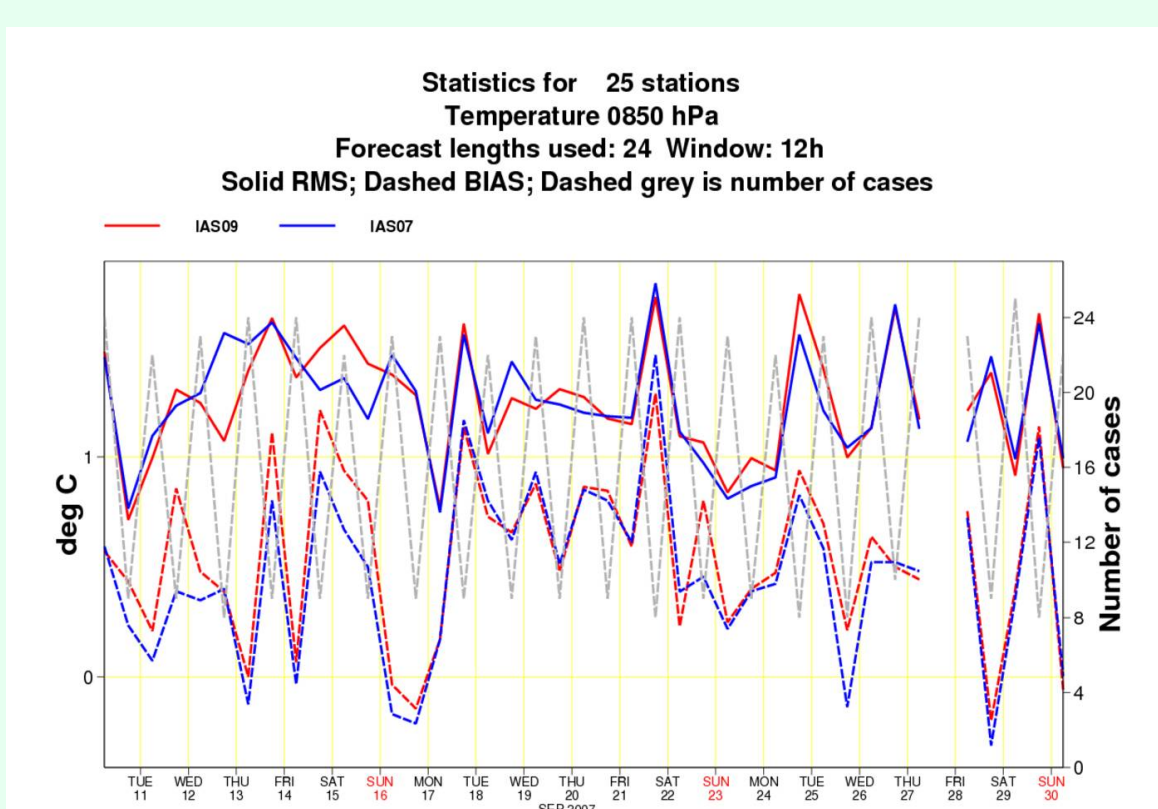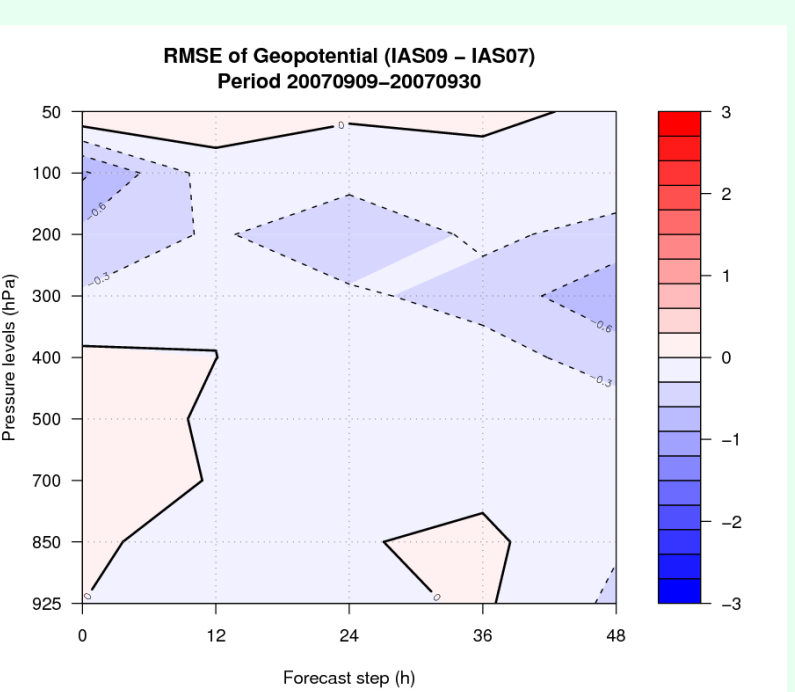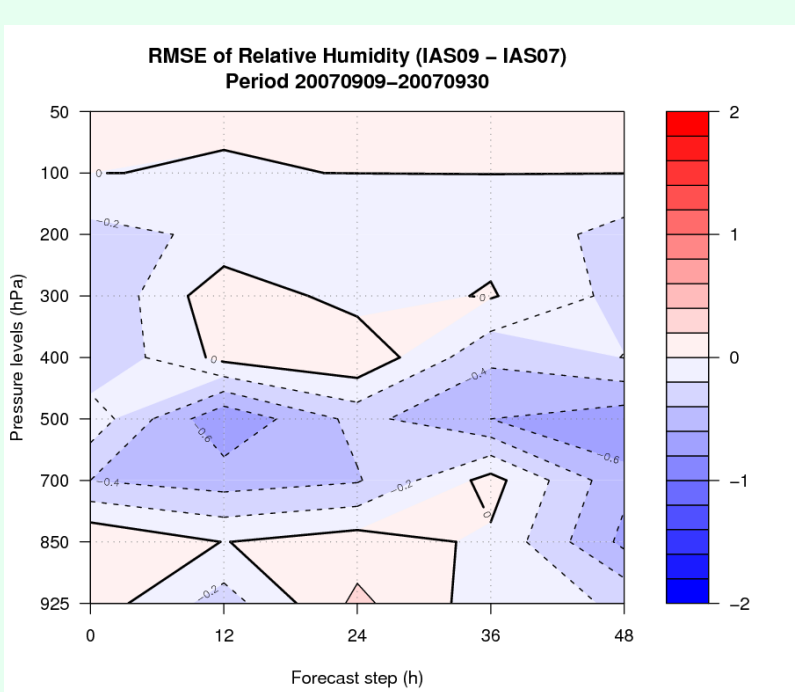

Fig. 12. *Time series representing RMSE (solid lines) and bias (dashed lines) of runs with (IAS07) and without (IAS09) IASI data*
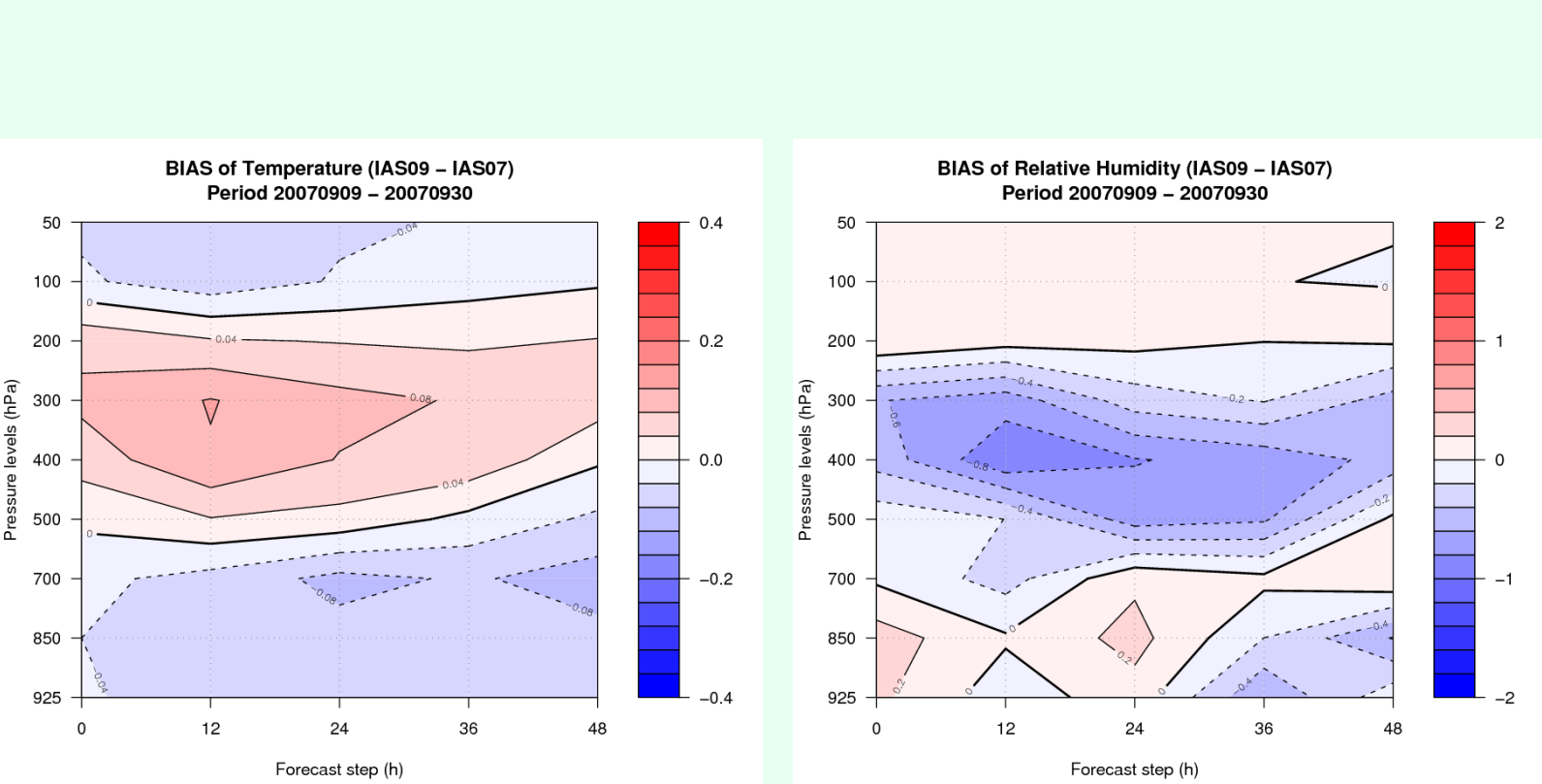
Fig. 13. *BIAS difference between IAS07 (run with IASI data) and IAS09 (run without IASI data) runs*
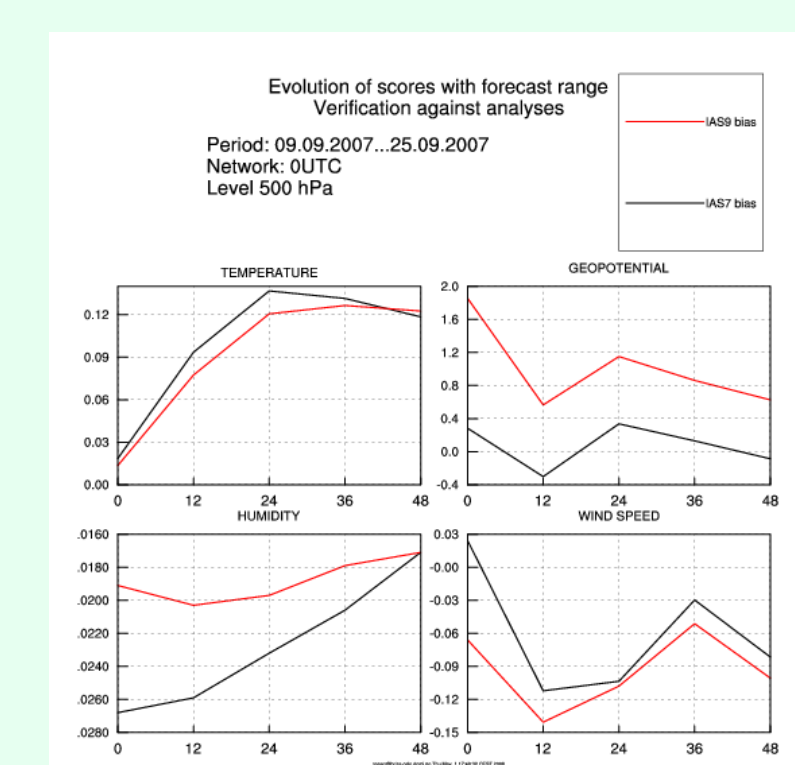
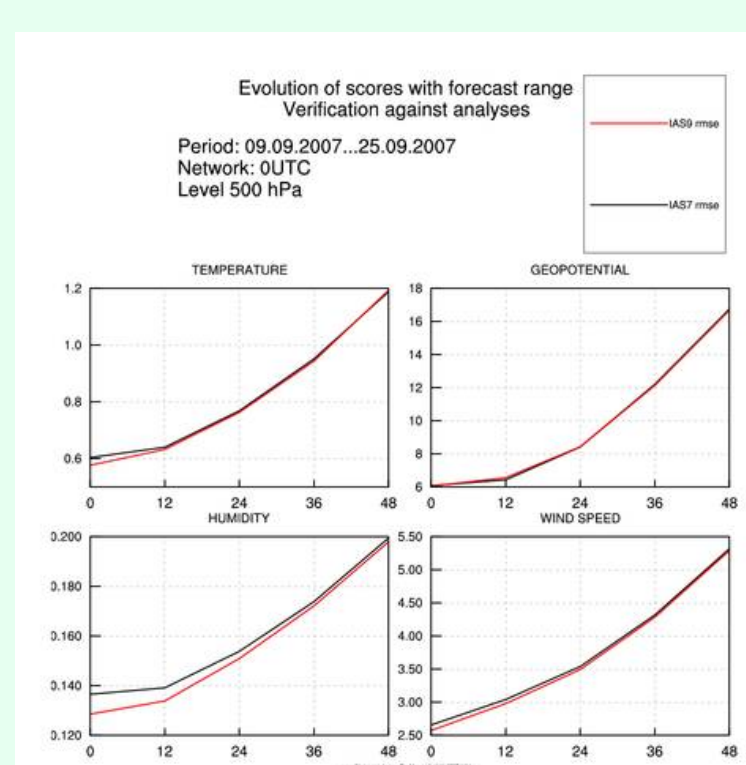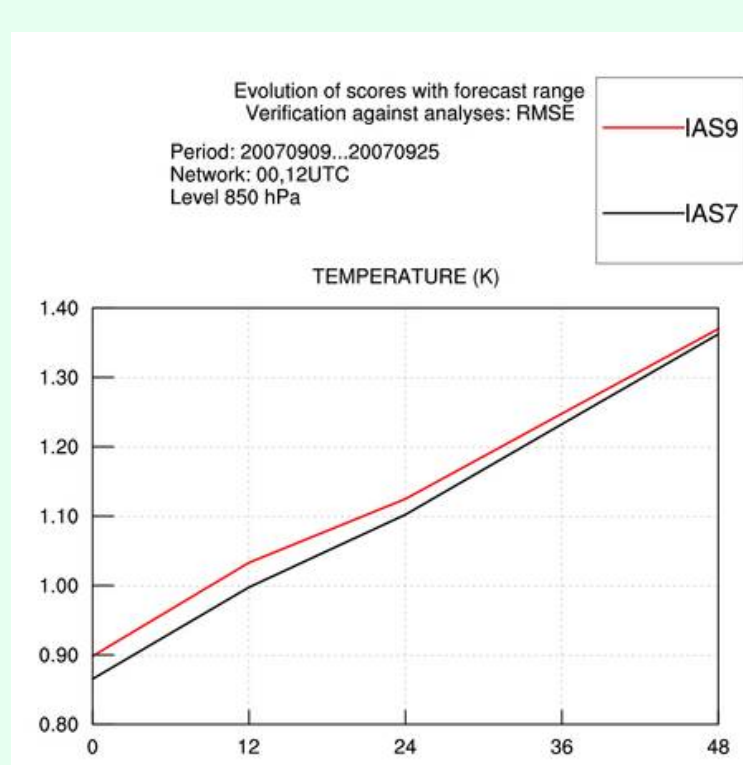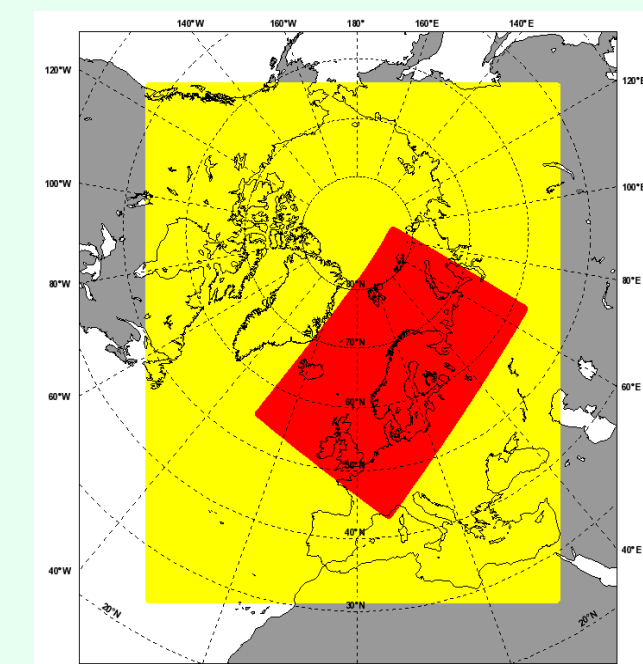## Verification against ECMWF analyses

Fig. 13. *Verification against analyses shows similar results as against observations. IASI warm up the mid-tropospheric layers causing a drying effect. Graphs on the left and in the middle show RMSE and the one in the right shows the bias observed at 500hPa.*

Main characteristics of the ALADIN-HARMONIE/Norway

→ Implemented observations

- Conventional data
  - SYNOP
  - BUOY
  - DRIBU
  - aircraft
  - radiosonde
  - PILOT
  - Wind-profilers
  - AMV

- Satellite data
  - L1C radiances from NOAA-15/16/17/18 and METOP
    - AMSU-A
    - AMSU-B/MHS

→ Observations under implementation
- L1C IASI
- L1D Seviri (See Storto and Randriamampianina, poster)
- GPS Zenith Total Delay (See Storto and Randriamampianina, poster)

Small domain: rotated Lambert pr. Dx=dy= 11 km, 60 vertical levels up to 0.2 hPa

Big domain: polar stereographic pr. Dx=dy= 16 km, 60 vertical levels up to 0.2 hPa

Fig.2. *The chosen two domains*

DFS- Degree of freedom for signal of observations

Variational bias correction setup

We use the CY33T0 for the implementation of the IASI data. After small modification in the code, we could set up the VaBC tables doing 2-months (from 01.07.2007 till 31.08.2007) analysis (screening and minimisation) using on top of all conventional data, the AMSU-A, AMSU-B/MHS and IASI radiances. The setup started with coldstart and zero coefficients.
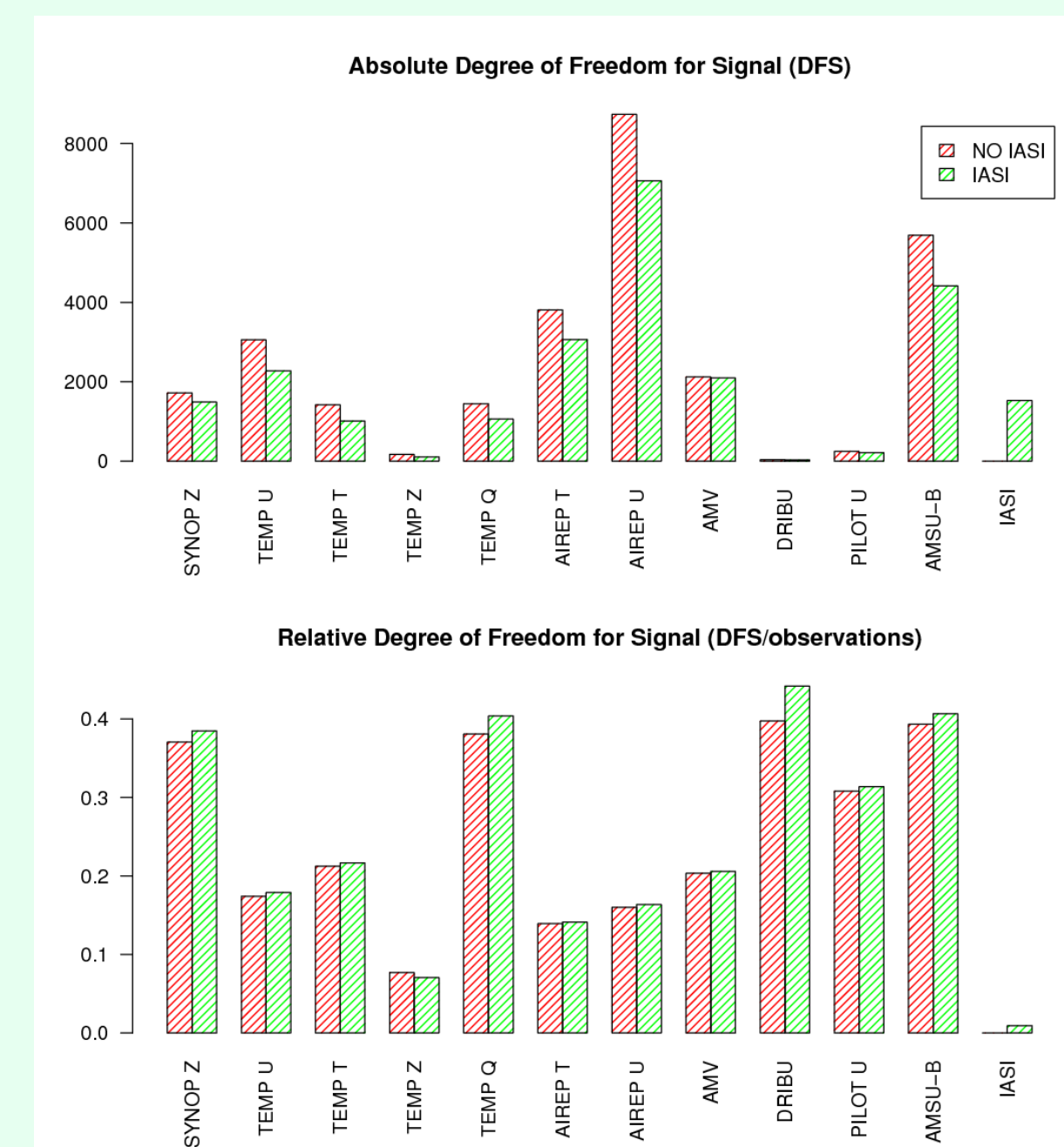

Fig. 4. *Monitoring the channel 13 of the AMSU-A from METOP-2 satellite during the last month of set up time.*

Fig. 5. *Monitoring the channel 13 of the AMSU-A from METOP-2 satellite using off-line bcor.*
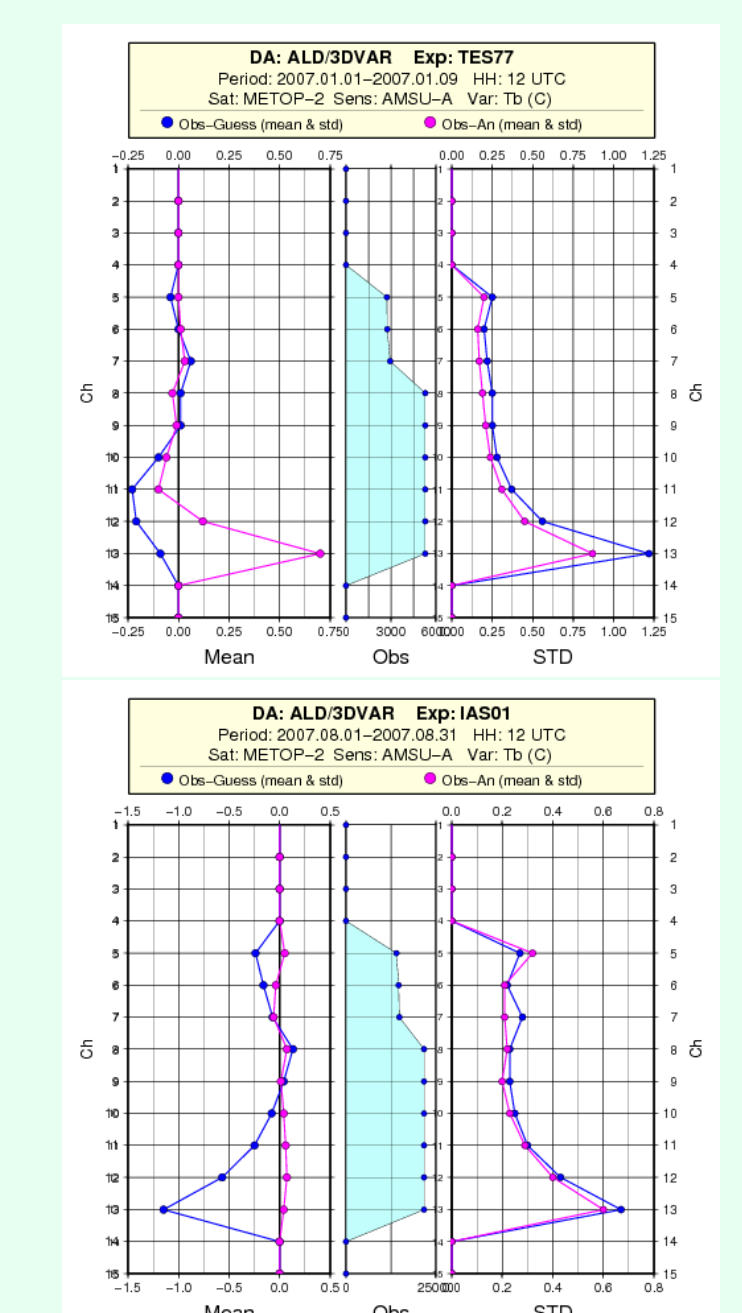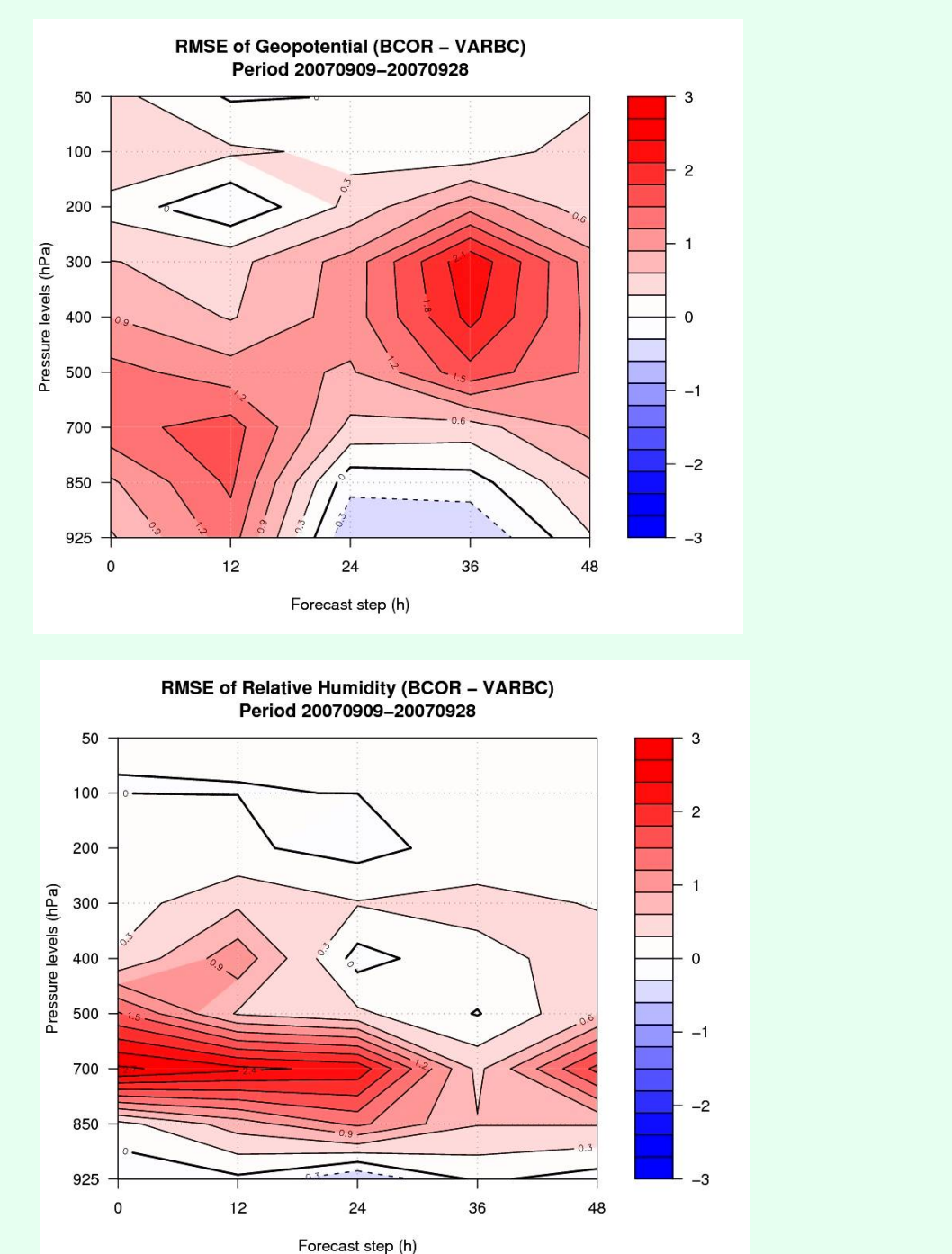
Fig. 6. *The power of off-line bcor (upper case) and VarBC (lower case).*

Fig. 7. *RMSE differences between runs with off-line bcor and variational bias corrections*

Conclusions

Variational bias correction was found to be very efficient in reducing the analysis bias. Compared to the off-line bcor, the variational technique had large positive impact on the analysis and forecast. VarBC tables for satellite radiance assimilation were estimated and tested. Use of stratospheric channels over land and tuning of the cloud detection scheme improved the outcomes of the assimilation of IASI data, even thought the overall impact of the IASI data remained slightly positive than neutral for temperature, especially in lower troposphere. From biases of temperature and humidity, IASI is warming up the mid-trpospheric layers producing drying effect . DFS computation shows that despite a large number of active IASI channels, the relative "contribution" is small. One of reason for this may be the fact that the IASI data are assimilated

We will need to revise the list of active channels before working this humidity or surface channels.