



Developments on assimilation of IASI in the Norwegian HARMONIE regional NWP model

- HARMONIE will become the main operational model of the joint operational NWP runs of Norway and Sweden (MetCOOP) planned to be operational from the start of 2014.
- A polar low case study showing forecast improvements from IASI assimilation
- A first impact study with IASI moisture channel assimilation showing a slight positive impact
- Ongoing work and plans for future

Developments on assimilation of IASI in the Norwegian HARMONIE regional NWP model


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The Norwegian HARMONIE 5.5 km model

The Norwegian Meteorological Institute... met.no operational forecasting system for the synoptic scale is HIRLAM, but present developments focus on a version of the HARMONIE (Meten Alain Regional/Meso-scale Operational NWP in Europe) model system.

The domain of the model implementation used in the present study is shown to the right, and this pre-operational model is now run routinely and is available to the forecasters.

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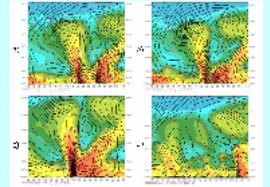
Assimilation system and IASI data

HARMONIE is run with a 3D-Var assimilation scheme.

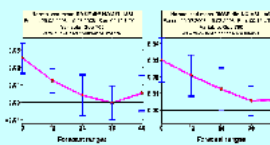
The Norwegian Meteorological Institute receives the 3461 METOP-A IASI channels from CLM3E/ISL41 a near-real-time observation service (SINERG/Ciel). Of these a subset of 3906 channels were selected for further monitoring and potential use in HARMONIE. 3D-Var in the selection of the 3906 channels for monitoring, we followed the choice for channels done by Colford and McNally (2005).

Vertical bias correction is applied to the Metop-A IASI channels. In this approach the coefficients are put into the control vector and updated during the assimilation. The same coefficients are used as a starting value for the next day analysis at the same time, which means that the coefficients are updated once per day (Randriamampianina et al. 2011).

Previous trials with temperature assimilation in polar low situations



The panels show the cross-section of the wind u-component (bold lines), and of the relative humidity for the respective 24-hour forecasts. The cross-section lines were taken through the forecasted polar low of run with (left panels) and without (right panels) the assimilation of IASI radiances, and with (upper panels) and without (lower panels) additional 875 MHz/CHIRP campaign observations. One can see that the run without additional campaign observations, but with IASI radiances (panel c) succeed pretty well the polar low both the near surface cyclone (the shallow low, and an expected synoptic-scale system) (Randriamampianina et al. 2011).

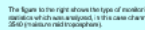
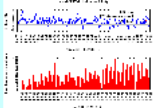


The relative impact of the IASI data on the forecasts is smaller when they were assimilated together with the additional campaign observations (Ciel). The assimilation of the observations, targeted by purpose to sensitive regions, produced much better forecasts. These results confirmed our recent findings on the sensitivity of the HARMONIE-Norway forecasts to the implemented observations, which showed that the radiances are superior to the other observations, especially for the shorter range (1-day) forecasts (Storto and Randriamampianina, 2010). While the significant positive impact of IASI observations in runs with Cielco lasted up to 12-hour, it lasted up to 24-hour forecast for the runs without Cielco. (Randriamampianina et al. 2011)

Addition of moisture channels

Moisture channels for assimilation were selected manually from the 3906 pre-selected channels. The selection was based on analysis of observation error statistics (observed - model first guess). A conservative choice where channels which were well described by the NWP model were selected, mostly upper tropospheric channels.

In total 15 moisture channels were selected for assimilation. The channel selection is slightly different for the 4 cycles (00, 06, 12, 18 UTC), and is separate for land and sea with separate subsets of these 15 channels used for each case.

The figure to the right shows the type of monitoring stations which was employed, in this case channel 3461 (met.no/IASI/temperature).

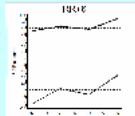
The table to the left shows the IASI moisture channels selected for the assimilation run.

Channel	Band	Wavenumber	Wavenumber
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15

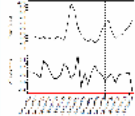
A first impact trial:

In this experiment a parallel impact trial with moisture channels was set up for a late summer experimental period covering 15 Aug - 15 Sep 2011. The reference run assimilated conventional observations and satellite data including IASI temperature channels, while the experiment also assimilated the selected moisture channels.

Verification versus SYNOP surface observations was performed. The difference in verification scores between the reference and moisture channel run were very small for wind and mean field parameters. The only parameter where differences were seen was in the precipitation verification, where some positive impact was seen. Some results are shown below.



The figure shows verification scores (observed deviation and bias) for 6-hour accumulated precipitation versus SYNOP observations with the model domain of the IASI experiment with water vapor channels (dashed) compared to a reference run without water vapor channels (solid).



The figure shows the time contribution to the RMSE of the precipitation error computed for all forecasts. The lower RMSE for the IASI experiment is positive, and it is not null so that the difference is positive when the IASI water vapor experiment scores better than the reference experiment.

Future plans

A slight net positive impact from IASI moisture channels is seen in the precipitation verification, but the impact is highly variable and situation dependent.

So far only a first trial has been done, and further work is planned on optimizing the moisture channel usage, also including mid-tropospheric channels.

In parallel, work on improving the background error constraint for moisture will be undertaken, applying an Ensemble Data Assimilation approach towards non-dependent assimilation structure functions with particular emphasis on moist processes.

References:
 Storto A and Randriamampianina R. 2010. The status in past of meteorological observations in the Norwegian regional model as demonstrated in a series of test experiments. Atmos. Sci. Lett. 7: 11-14.
 Randriamampianina R, Tvetter and Storto. 2011. Exploring the Assimilation of IASI Radiances in Forecasting Polar Low Quality Journal of Research. Vol. 12(1): 170-175.