The Assimilation of Clear-Sky Infrared Radiances in the HIRLAM Model

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Abstract

The potential use of spatially and temporal high resolved SEVIRI observations in the HIRLAM model VAR analysis is currently investigated at SMHI. Especially, the extended utilization of the time dimension in HIRLAM 4D-Var is appropriate to make full use of SEVIRI's fast imaging cycle. Currently, we carry out observation impact studies in a pre-operational environment using the two water vapour channels (WV6.2,WV7.3), located at 6.2µm and 7.3µm, to find an optimal assimilation setup. Firstly, the data preparation steps as well as the impact on the analysis are illustrated for one case study. Secondly, we present on this poster two impact studies, which show a positive impact of SEVIRI observations on the upper air parameters during the summer period. In the winter period, the impact on moisture is less pronounced and rather neutral for the other variables.

Data Preparation

The SEVIRI observations undergo various data preparation steps which are listed below. Usually 500 to 1200 pixels (two observations each) at approx. 90km resolution are then kept in each observation window. (6 obs.-windows per 4D-Var analysis)

- Processing of BTs and PGEs using the SAF NWC software (for SEVIRI-segments 7 and 8)
- Selecting 1 pixel out of a 10x10 pixel box
- Rejecting out-of-domain pixels (and scan angles .gt. 70°)
- Rejecting cloudy pixels (PGE01/CMa, cloud mask)
- Applying flat BIAS correction to WV6.2 obs. (2.6K)
- First guess check
- Spatial thinning (thinning box size = 90km)

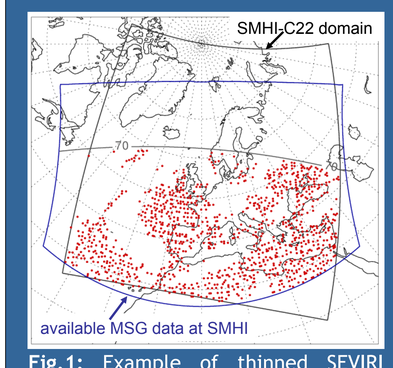

Fig.1: Example of thinned SEVIRI observations (red dots) after applying all data preparation steps.

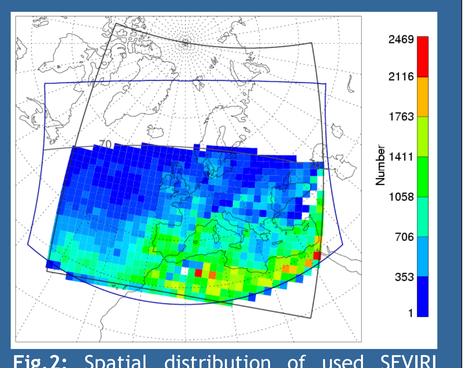

Fig.2: Spatial distribution of used SEVIRI pixels for a one month period with 4D-Var.

Impact on HIRLAM 4D-Var Analysis - Case Study

As demonstrated in this case study, the impact of assimilated SEVIRI radiances is mainly in the moisture fields of the middle and upper troposphere (Figure 3). The large-scale drying in the upper-tropospheric layers, which can be seen here, is due to a systematic deviation in the background minus observation departures (Figure 4).

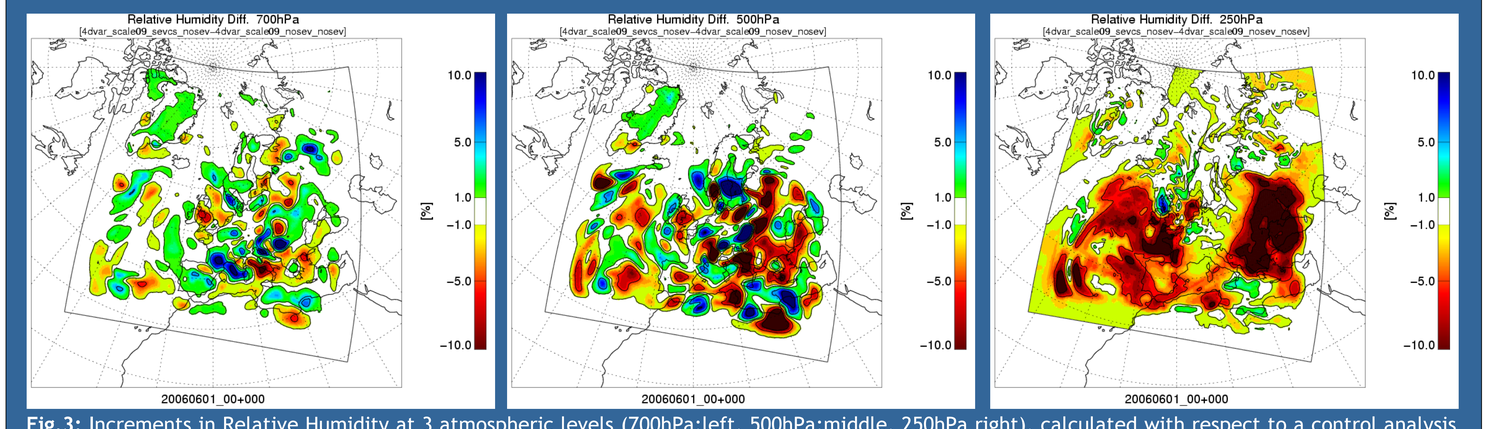

Fig.3: Increments in Relative Humidity at 3 atmospheric levels (700hPa:left, 500hPa:middle, 250hPa right), calculated with respect to a control analysis with conventional observations only.

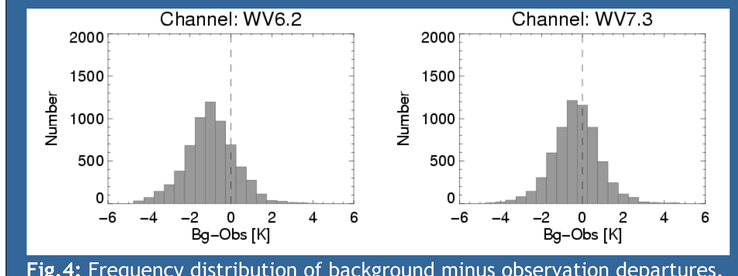

Fig.4: Frequency distribution of background minus observation departures.

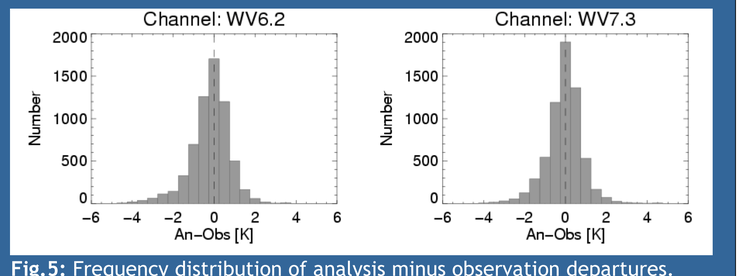

Fig.5: Frequency distribution of analysis minus observation departures.

Observation Impact Study I – Summer Period

Experiment description

- Time period : 06/24/2005 – 07/21/2005
- Control run (CTRL4D) : 4D-Var analysis with conventional observations only
- Experiment (SEV4D) : 4D-Var analysis with conventional and SEVIRI observations; SEVIRI observations are taken from six time slots (the slot closest to the respective observation window centre)
- Cycle : 6 hour assimilation cycle / forecast up to 48 hours
- Verification : EWGLAM radiosondes and synops

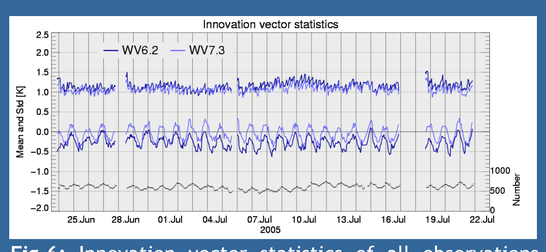

Fig.6: Innovation vector statistics of all observations used in the cost function.

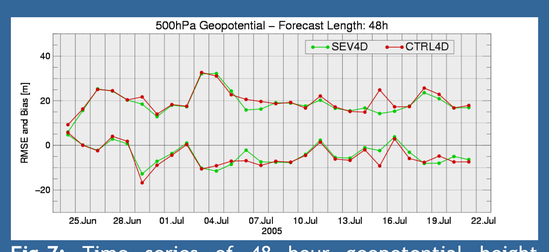

Fig.7: Time series of 48 hour geopotential height forecast error. Shown are daily means of RMSE and Bias.

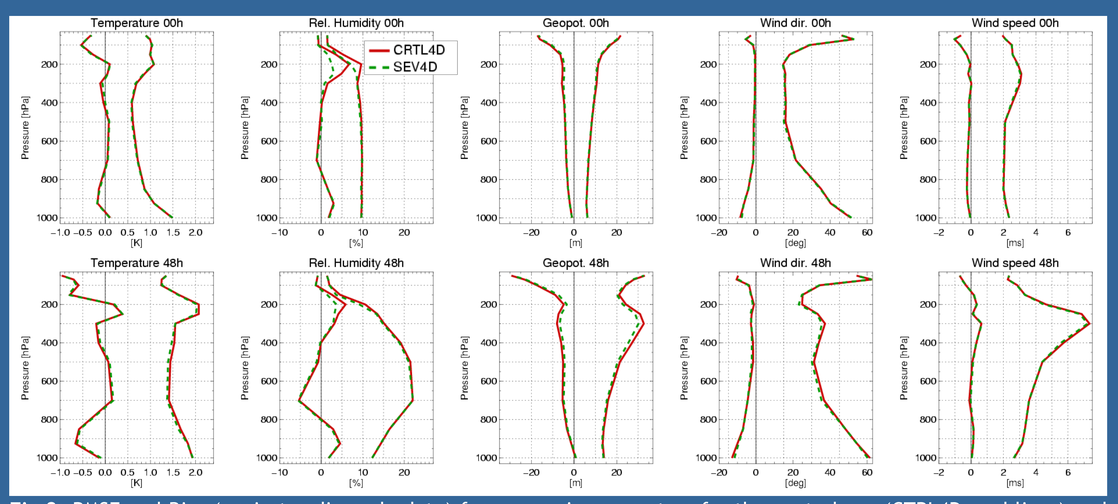

Fig.8: RMSE and Bias (against radiosonde data) for upper air parameters for the control run (CTRL4D, red lines) and SEVIRI experiment (SEV4D, dashed green lines). First row: at analysis time; second row: after 48 hours forecast.

Observation Impact Study II – Winter Period

Experiment description

- Time period : 12/01/2005 – 12/31/2005
- Control run (CTRL4D) : 4D-Var analysis with conventional observations only
- Experiment (SEV4D) : 4D-Var analysis with conventional and SEVIRI observations; SEVIRI observations are taken from six time slots (the slot closest to the respective observation window centre)
- Cycle : 6 hour assimilation cycle / forecast up to 48 hours
- Verification : EWGLAM radiosondes and synops

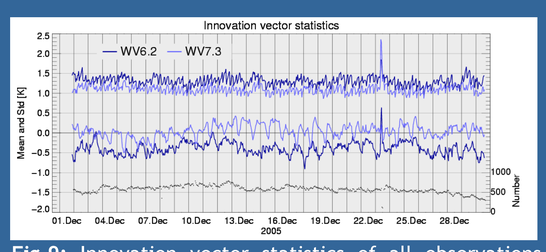

Fig.9: Innovation vector statistics of all observations used in the cost function.

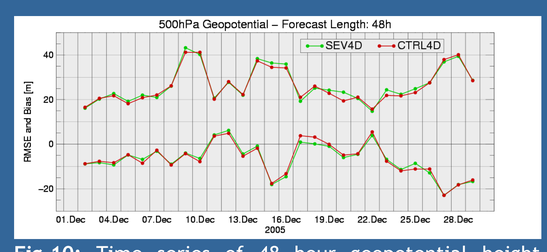

Fig.10: Time series of 48 hour geopotential height forecast error. Shown are daily means of RMSE and Bias.

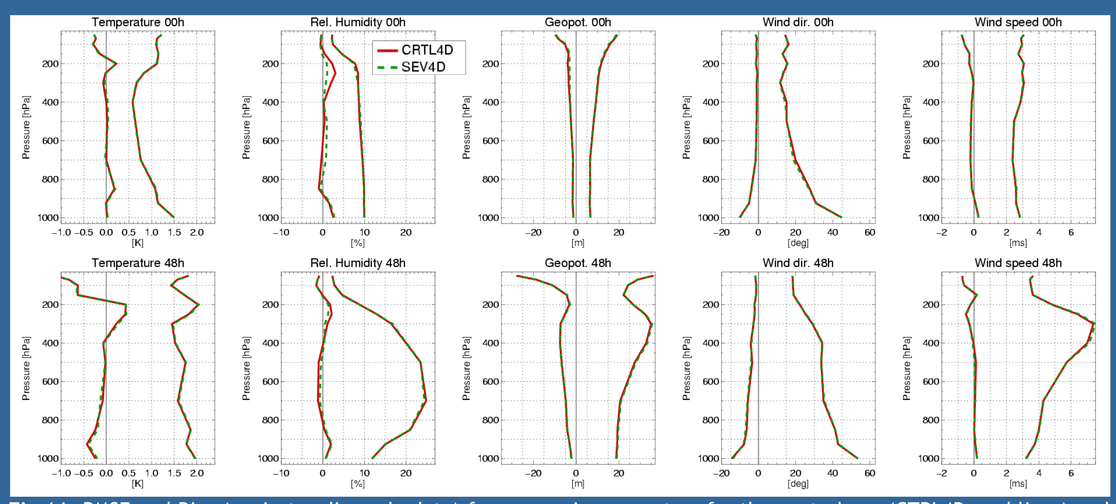

Fig.11: RMSE and Bias (against radiosonde data) for upper air parameters for the control run (CTRL4D, red lines) and SEVIRI experiment (SEV4D, dashed green lines). First row: at analysis time; second row: after 48 hours forecast.

Summary

SEVIRI IR radiances have been introduced successfully as a new observation type in the HIRLAM assimilation system. Assimilation experiments shown in this presentation cover one summer month and one winter month. With the chosen experimental specifications, the assimilation of SEVIRI's water vapour channels primarily affects the analyzed and forecasted mid- and upper-tropospheric humidity fields. A positive impact can be seen in the upper troposphere for all experiments when comparing to radiosondes. This impact is decreasing with forecast length. Small positive effects are also found for the temperature, geopotential height and wind fields after 48 hours in the summer period. The impact on those upper air variables is found to be very small and rather neutral during the winter period. Changes in the data preparation steps, as for example better Bias correction and possibly 'Superobbing', will be addressed in the near future.

Acknowledgements

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