Norwegian Meteorological Institute

Hirlam upper-air data assimilation: progress and plan

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26th ALADIN Workshop & HIRLAM All Staff Meeting 04/04/16

outline

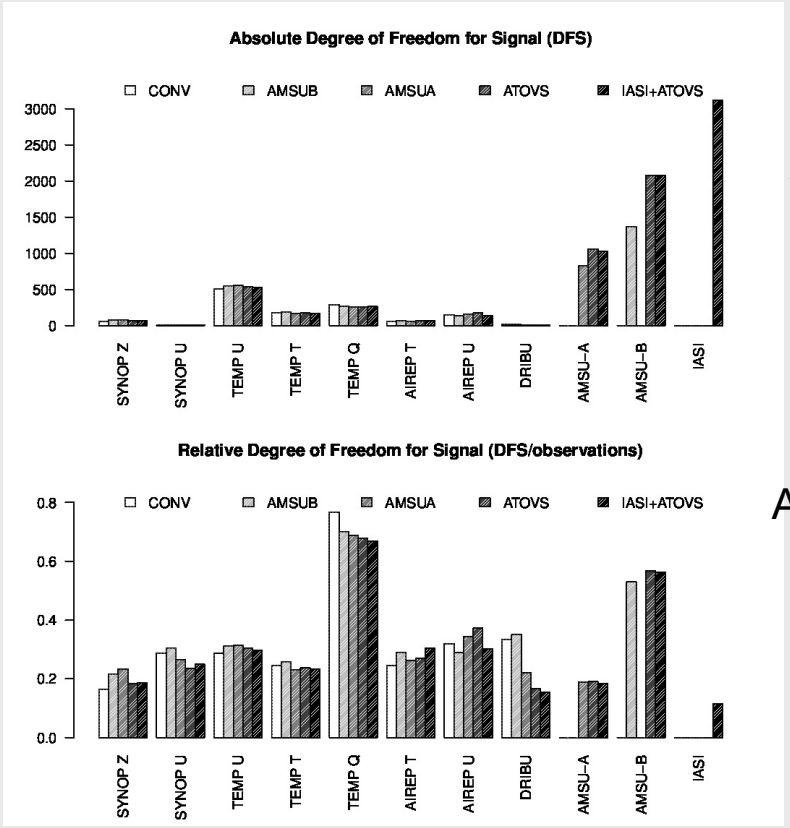
- Operational upper air data assimilation (UA-DA) systems in HIRLAM;

- Highlight of the progress in UA-DA;

- Data assimilation events.

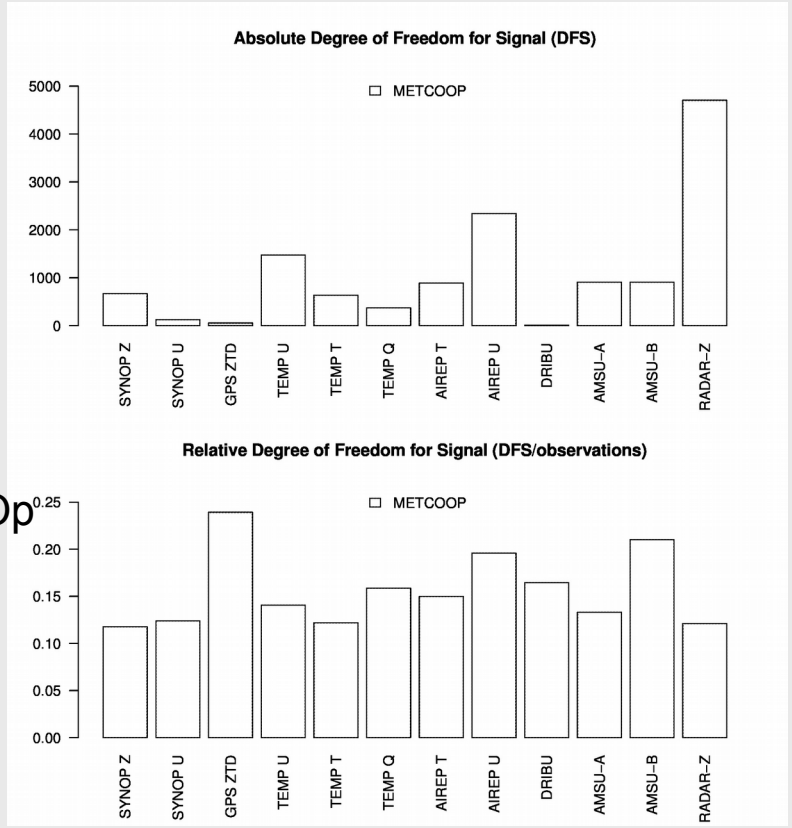
Operational upper air data assimilation (UA-DA) systems

- **Assimilation scheme:** 3D-VAR;
- **Cycling Strategy:** 3 hourly;
- **Conventional observations:** SYNOP, SHIP, BUOY, AMDAR, AIREP, ACARS, ModeS EHS, Pilots, TEMP;
- **Satellite radiances:** AMSU-A, AMSU-B/MHS, IASI. obs from NOAA, and Metop satellites;
- **Satellite retrievals:** Scatterometer, GNSS ZTD, (geo)AMV;
- **Radar observations:** Reflectivity;
- **Bias correction scheme:** Variational (VarBC).



AROME-Arctic (left) old results on four different days

AROME-MetCoOp (right) old results on one case



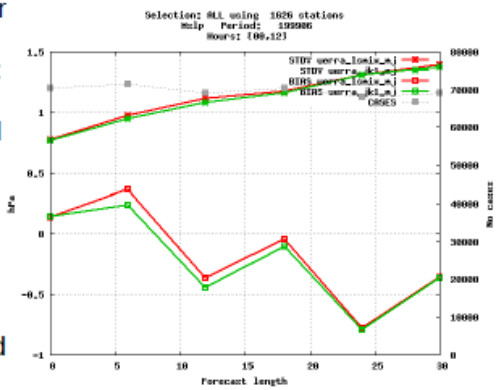
Highlight of the progress – initialisation

– Jk against large scale mixing (LSM) with the Aladin model

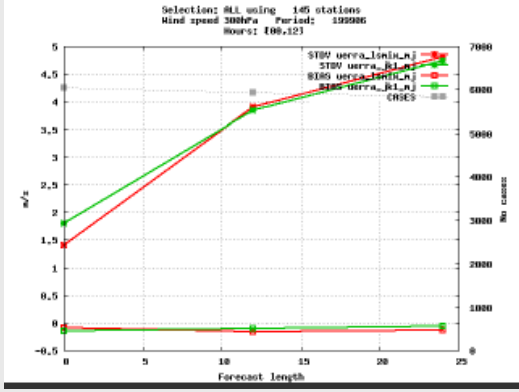
Jelena Bojarova
study performed
in frame of
UERRA project

As one could expect, neither LSM nor Jk constraint are able to correct ALADIN model for systematic deficiencies which became more and more pronounced during longer forecasts : a too low pressure with too warm air in the lower troposphere over land. Both Jk term and particularly LSM overshoots surface pressure (positive bias) trying to resist this systematic deficiency. One can see that Jk term keeps model state further away from observations at analysis time, improving forecast quality for longer forecast lengths. The possible overfit of observations in a standard configuration should be considered.

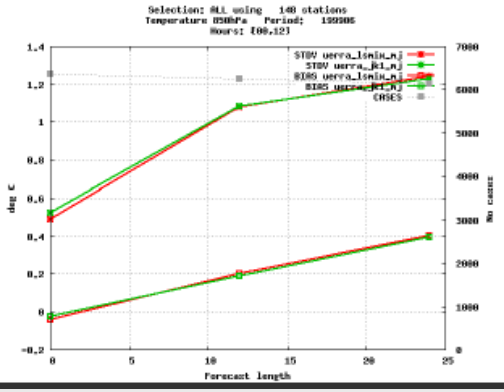
Surface pressure



Wind Speed 300hPa



Temperature 850hPa



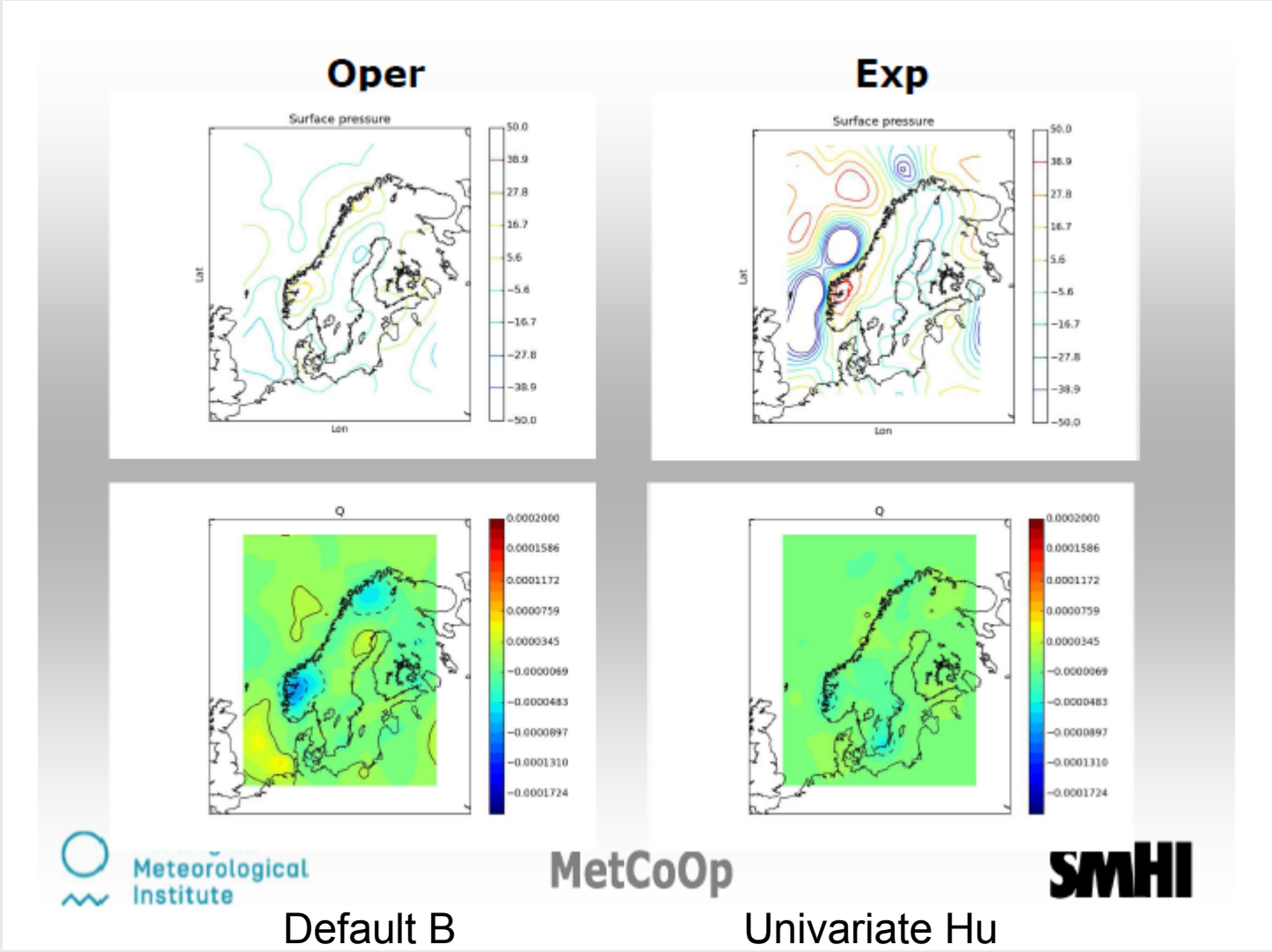
See link below
for more
details

https://hirlam.org/trac/attachment/wiki/HarmonieVideoMeetings/etkf_4dvar_3dvar_oops_meeting/Jk_LSM.pdf

– Cloud initialisation: flexible solution ready for operational implementation by M. Lindskog & Toon Moene in CY38h1.2

Highlight of the progress – 3D-VAR (Ps & Hu balance)

Magnus Lindskog, METCOOP drying effect of surface Z assimilation over mountainous regions in Norway

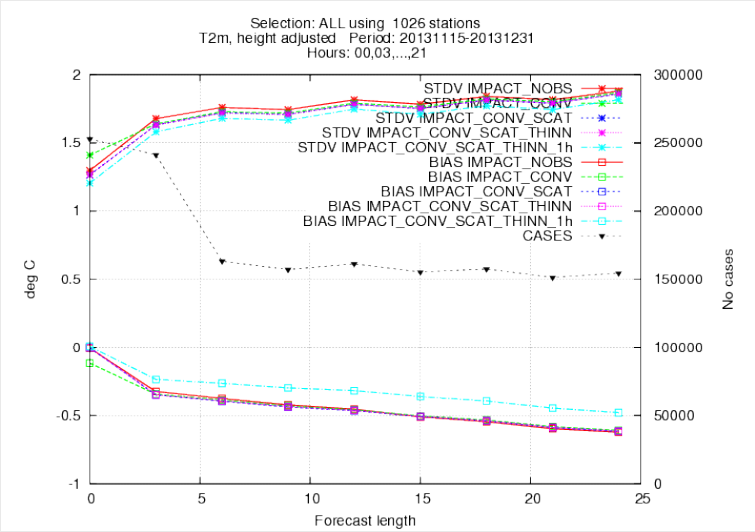


Highlight of the progress – 3D-VAR studies

– 1h versus 3h cycling with ASCAT data

Gert-Jan Marseille, Jan Barkmeijer, Siebren de Haan and Wim Verkley; see also Jan Barkmeijer's presentation.

More about impact of observations with 3D-VAR, see R. Randriamampianina's poster



https://hirlam.org/portal/validation/38h1/IMPACT5

– Accounting for observation footprint in model space – "supermoding"

u/v (m^2s^{-2})	variance (o-b)	variance (o-<b>$|_{footprint}$)
ASCAT	2.75/3.31	2.46/2.99
OSCAT	1.93/2.86	1.51/2.31

averaging in model domain improves (o-b) statistics substantially (10-20%)

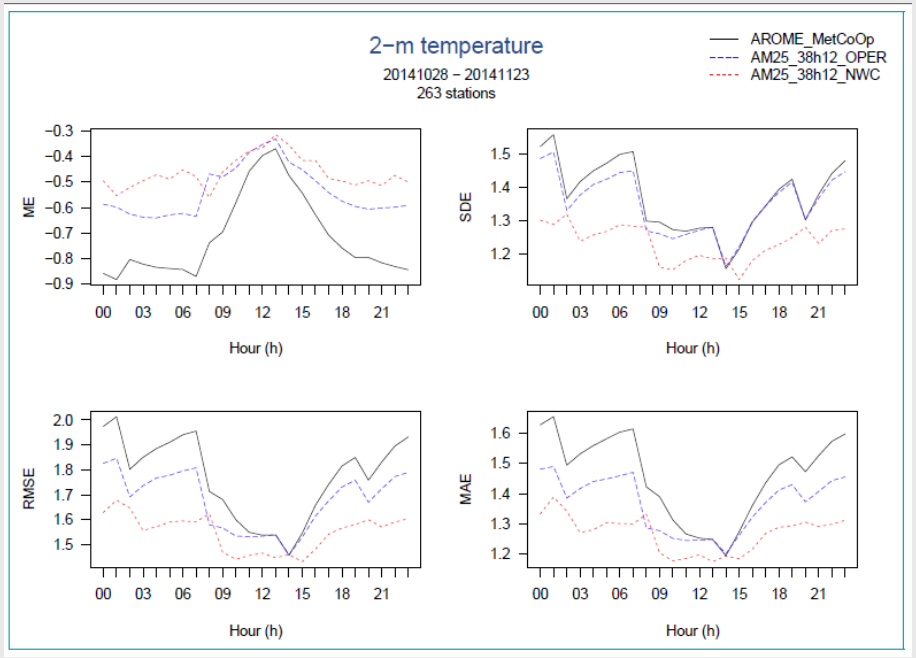
Recommendation: HARMONIE observation operator to take into account observations footprint

Highlight of the progress – RUC, nowcasting

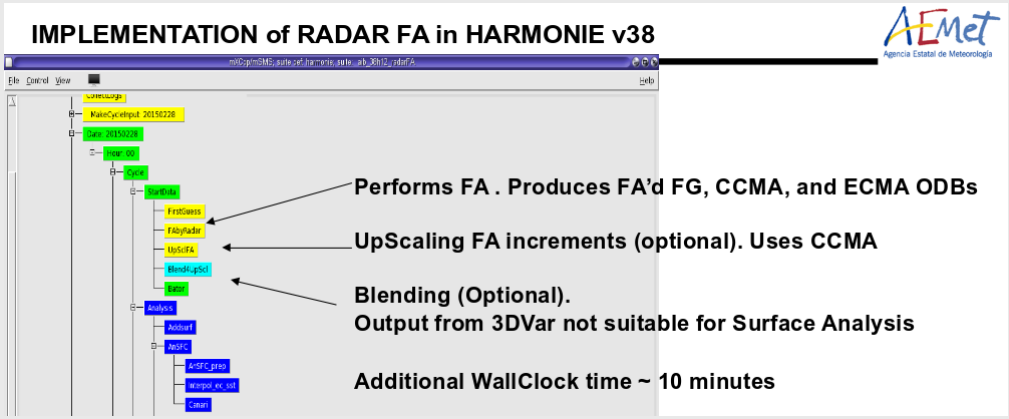
– 1h 3D-VAR rapid refresh using MetCoOp model, conventional and ATOVS data
Lise Graff, R. Randriamampianina, M. Müller

Cut-off time: 15 min

We succeed to reduce the production of real-time very short-range forecast to 2-7 hours



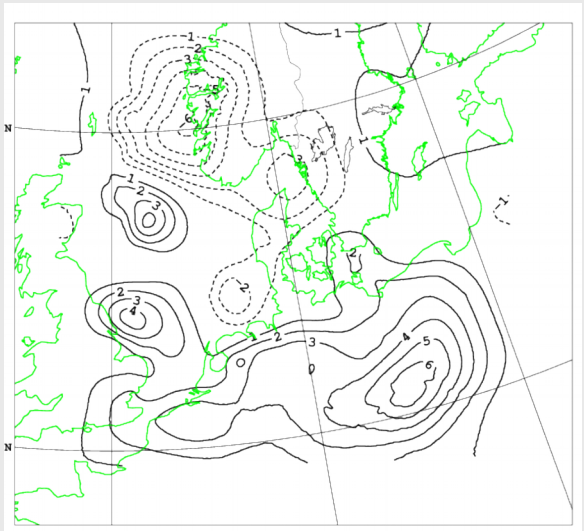
– Carlos Geijo: Field alignment with radar winds



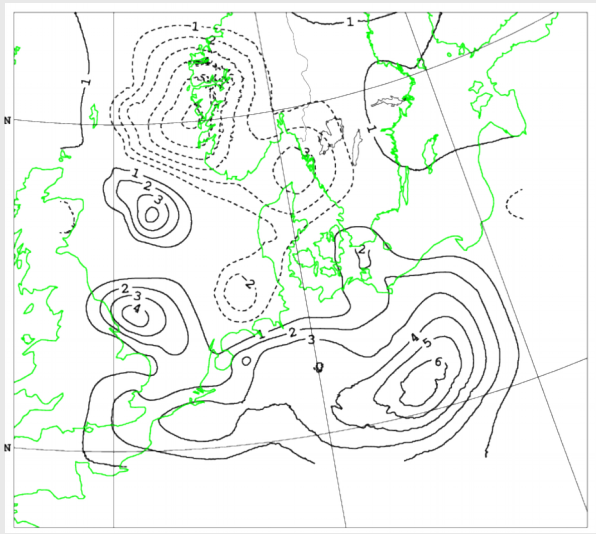
Highlight of the progress – algorithm development

–Nils Gustafsson:

1) Jc-DFI implementation (technically working);
2) better handling of change of resolution in spectral space (done);
3) run outer loop with update in ODB;



low resolution Ps increment



Ps increment

– More results on 4D-VAR performance, see Jan Barkmeijer's presentation;

– Pau Escriba: LETKF is proven to be better than 3D-VAR (38h1.2) for Spanish domain. He is working with Harmonie CY40;

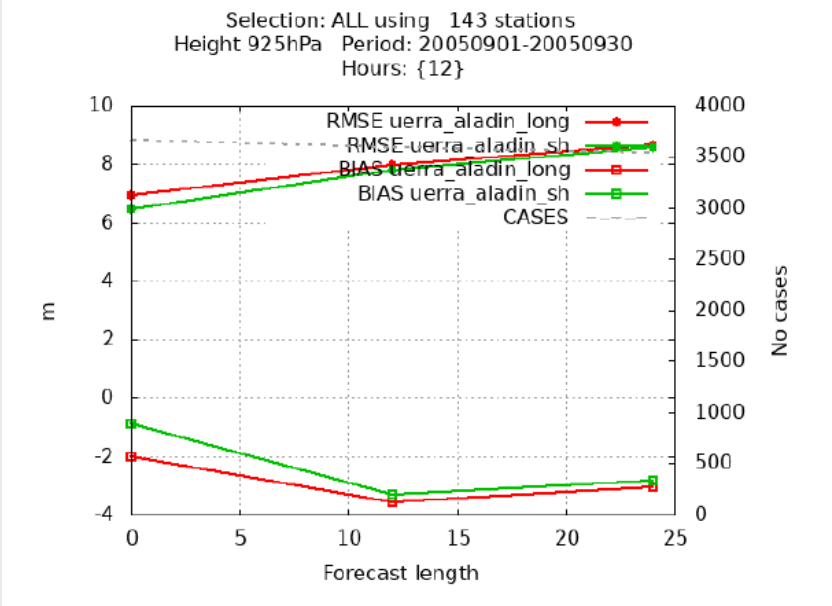
– Roel Stappers: Developed a matrix free linear algebra (MFLA), which will simplify further the OOPS programming framework. See his presentation for more details.

Highlight of the progress – High-resolution observations

– Magnus Lindskog: Assimilation of **Seviri radiances** in frame of DNICAST. Implementation based on LACE data pre-processing, but **small difference in handling in VarBC**. More about it see M. Lindskog's presentation;

– Aircraft derived data (ADD): **Mode-S EHS** tested with 4D-VAR at KNMI with good results. See Jan Barkmeijer's presentation;

– **(Near)surface observations**: J. Bojarova and M. Lindskog in frame of UERRA project tested the use of station hight instead of mea-sea-level pressure. Positive impact on geopotential in lower troposphere;

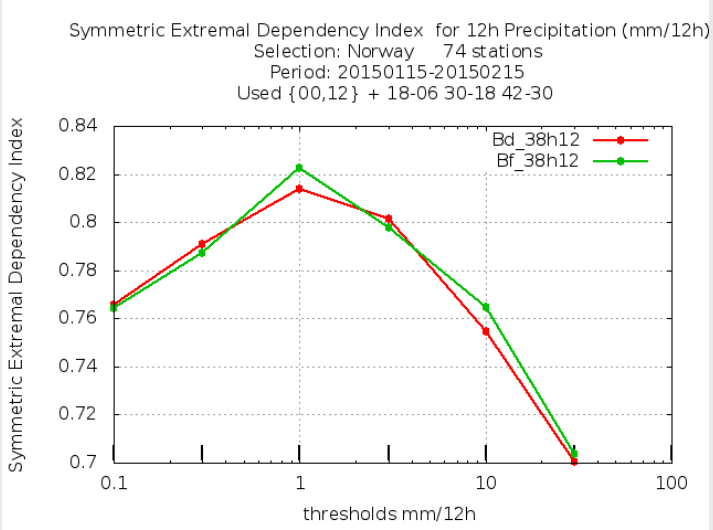


Highlight of the progress – High-resolution observations

– **Radar reflectivity**: Martin Ridal observed too low simulated reflectivities by the observation operator. This was related to fact that the lower limit of the Swedish radars is -30 dBz while in MFBUR data the limit is -10.5 dBz. Code change in “inv_refl1dstat.F90” was needed to handle this properly.
More about this on video-meeting on radar data minutes:
https://hirlam.org/trac/wiki/HarmonieVideoMeetings/Meeting_on_radar_data_processing;

– **Prep-opera toolbox**: Mats Dahlbom built a pre-processing tool that reads and process OPERA radar data. He tested this tool with data of 70 radars from 10 European countries. **Action from video meeting** to test this tool and look it as potential common pre-processing tool for radar data and in particular for those from OPERA;

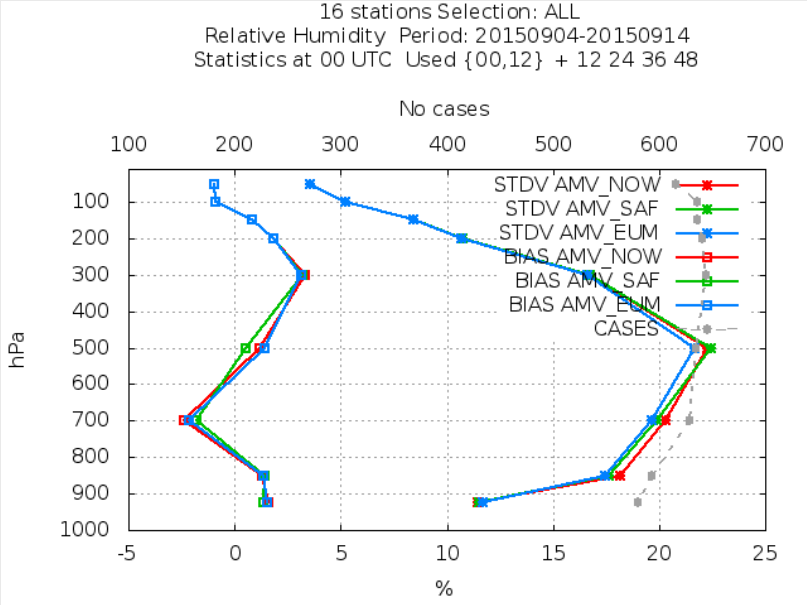
– **Clear echoes and blocked radar data** at MET Norway (R Azad, C Elo and R Randriamampianina).
  –Test on avoiding the use of detected clear echoes shows promising results on humidity and precipitation forecasts;
  – Properly handling blocked data also showed promising results. More about these studies in Roohollah Azad's presentation.



Highlight of the progress – High-resolution observations

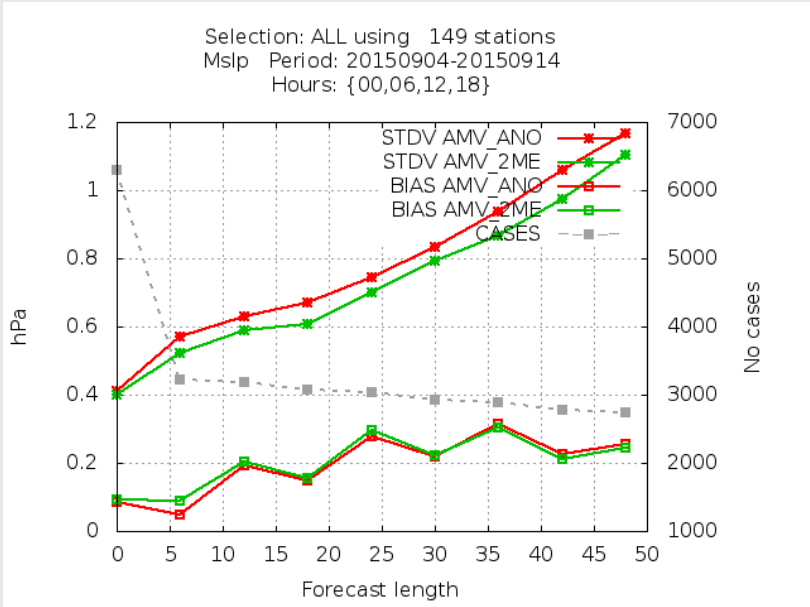
– **High-resolution atmospheric motion vectors** (HRW) from geostationary satellite and **polar winds**: R Randriamampianina and M Mile. In frame of SAWIRA-2 project and OMSZ-MET Norway cooperation, production and pre-processing of HRW is based on Hungarian setup. Bator ischanged to process both EUMETSAT (MPEF) produced wind and locally HRW.
  – next step is to add processing of polar wind in Bator in order use both geostationary and polar winds in MetCoOp.
    – More about this work see Randriamampianina's poster.

Study with AROME-MetCoOp



No AMV – red; EUMETSAT AMV – green; HRW – blue

Study with AROME-Arctic



No polar wind-- red; with polar wind --green

Highlight of the progress – High-resolution observations

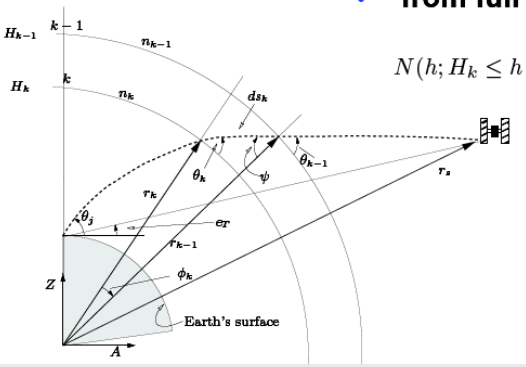
– Siebren de Haan: Observation operator for **GNSS slant total delay (GPS STD)** in Harmonie. The implementation was done with cycle 38h1.2 and was done similarly to the GPS RO, but it is a new and separate operator.

See minutes of video meeting for more details and also:
https://hirlam.org/trac/attachment/wiki/HarmonieVideoMeetings/Meeting_on_conventional_data_and_COPE/STDmarch16.pdf

Implementation

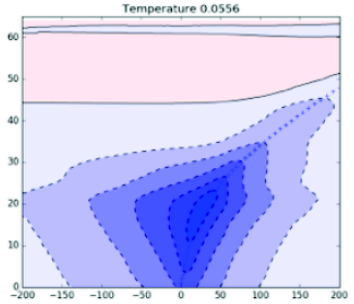
- **Obs operator**
  - **coordinate along signal path in x-z-plane**
  - **from full level to full level:**

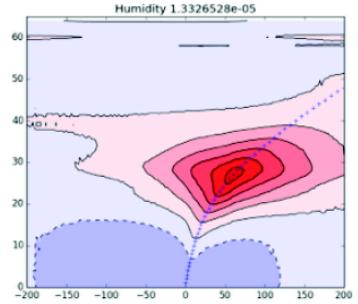
$$N(h; H_k \le h < H_{k-1}) = N_k \left(\frac{N_{k-1}}{N_k} \right)^{\frac{h-H_k}{H_{k-1}-H_k}}$$



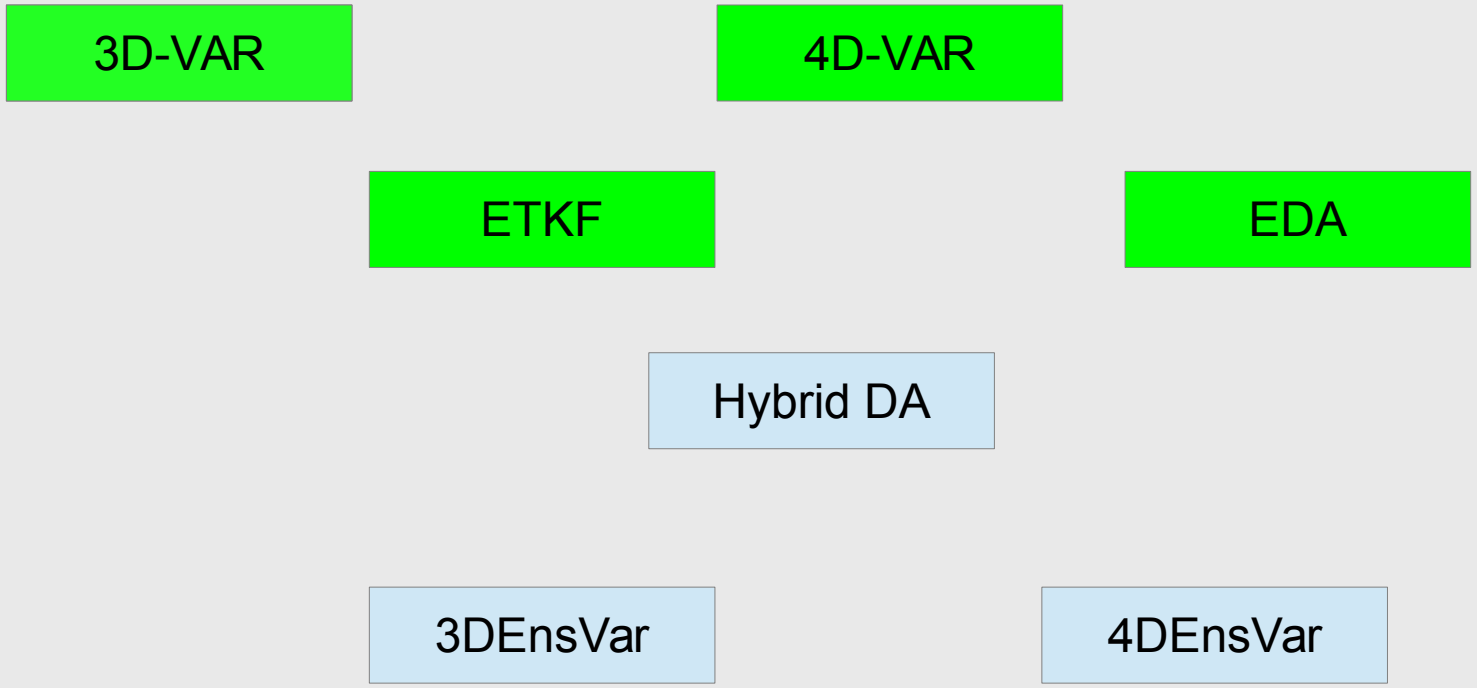
1st result

- **Single Observation:**
  - **azimuth = 0,elevation = 1**
- **Increments (AN-BG) in x-z-plane**





Plan



Goal: to build mesoscale ensemble system with flow-dependent DA

Working organisation

– We built excel sheets describing who is doing or willing to work on which tasks
-- good feed-back from most of experts. The idea is welcomed by most of experts

-- Formation of groups working with the same or similar topics and have regular distant video meetings. Inviting Météo Fance, LACE and other Aladin colleagues;
→ we have 5 video meeting web-rooms on:
radar data processing, conventional data and COPE, Radiance data,
ETKF 3D-VAR 4D-VAR OOPS (algorithm) and retrieval data

– Face-to-face meetings are still needed and we will have min. twice per year
– on use of observations (17-20 May 2016 in Madrid);

– algorithmic issues (30 May – 3 June and in Fall in Norrkoping);
– two meetings in Norrkoping this year.

Thank you