Norwegian Meteorological Institute

HIRLAM upper-air data assimilation

Roger Randriamampianina

27th ALADIN Workshop & HIRLAM All Staff Meeting 03/04/17, Helsinki

outline

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

- Some development works related to UA-DA;

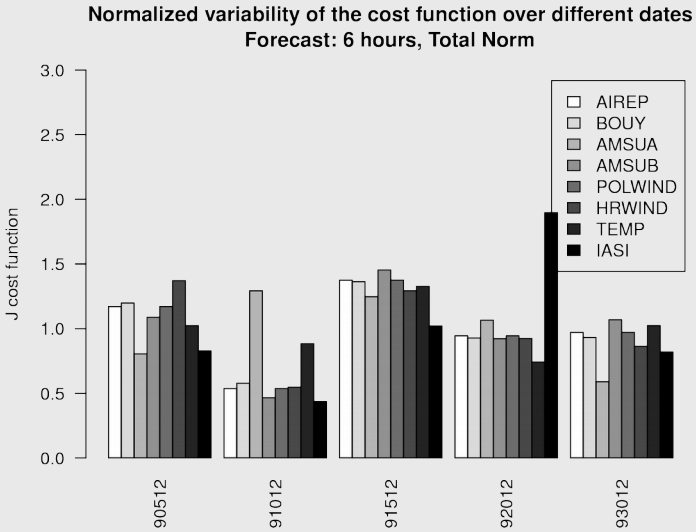
- Local implementation;

- Data assimilation events – video meetings.

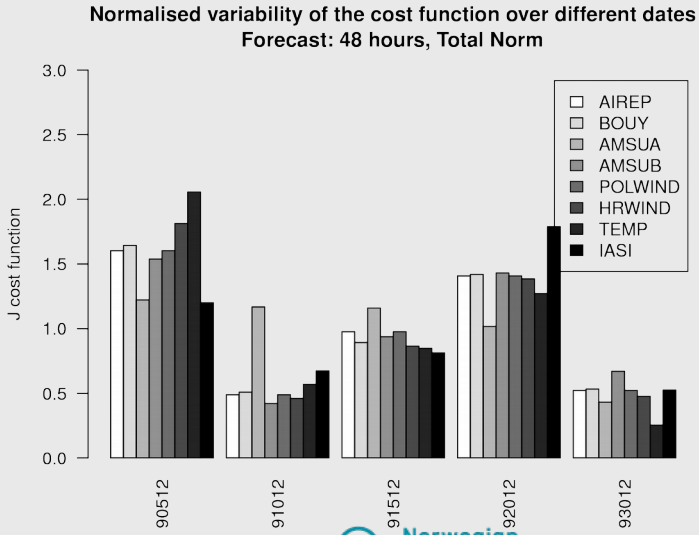
- Outlook

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, **ATMS**, IASI;
– **Satellite retrievals:** Scatterometer, **GNSS ZTD**, **GPS RO**, (geo)AMV;
– **Radar observations:** Reflectivity;
– **Bias correction scheme:** Variational (VarBC).



Experiment run with AROME-MetCoOp Sensitivity of the forecast model to different observations



Highlight of the progress – initialisation

– Cloud initialisation: flexible solution ready for operational implementation by **E. Gregow**, M. Lindskog, T. Landelius, S. Van de Veen & T Moene in CY38h1.2

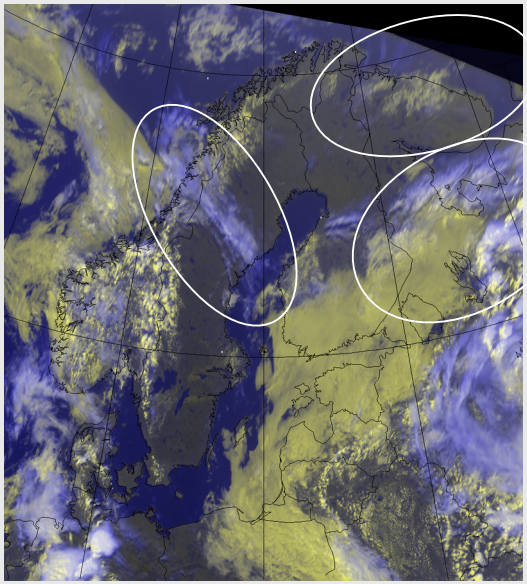
- Input from NWCSAF Cloud-Type classes: Gives too much clouds (especially high-clouds)

- Saturation water vapor only to water: Related to too much high-clouds
  New code to calculate saturation water vapor for ice (upper levels)

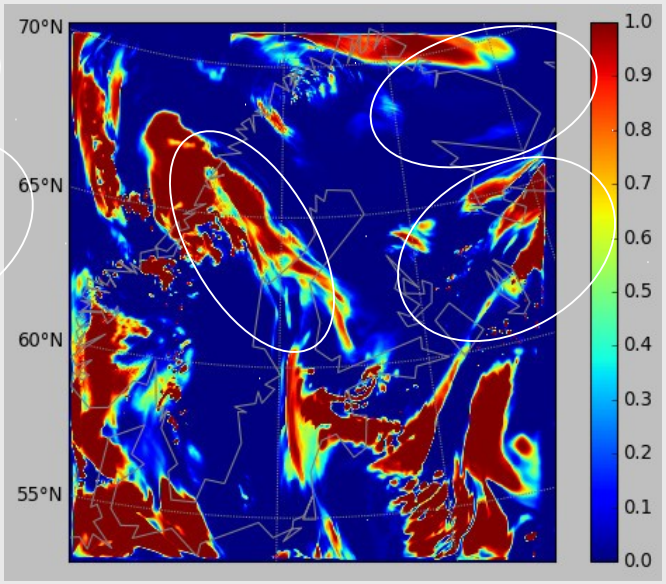
- Cloud-base estimation: Related to low-clouds
  MSG – Synop based
  MSG_SWE – Climatological estimates, “first-guess”

- Thresholds effecting the humidity profiles: Related to whole vertical profile of cloud

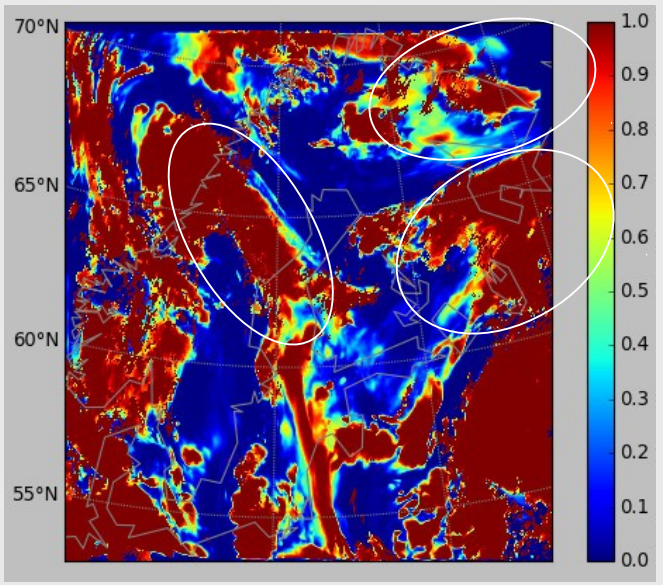
Satellite



Har. Reference



Har. MSG-NWCSAF



Highlight of the progress – initialisation

– Back and forth nudging scheme implementation: Ole Vignes

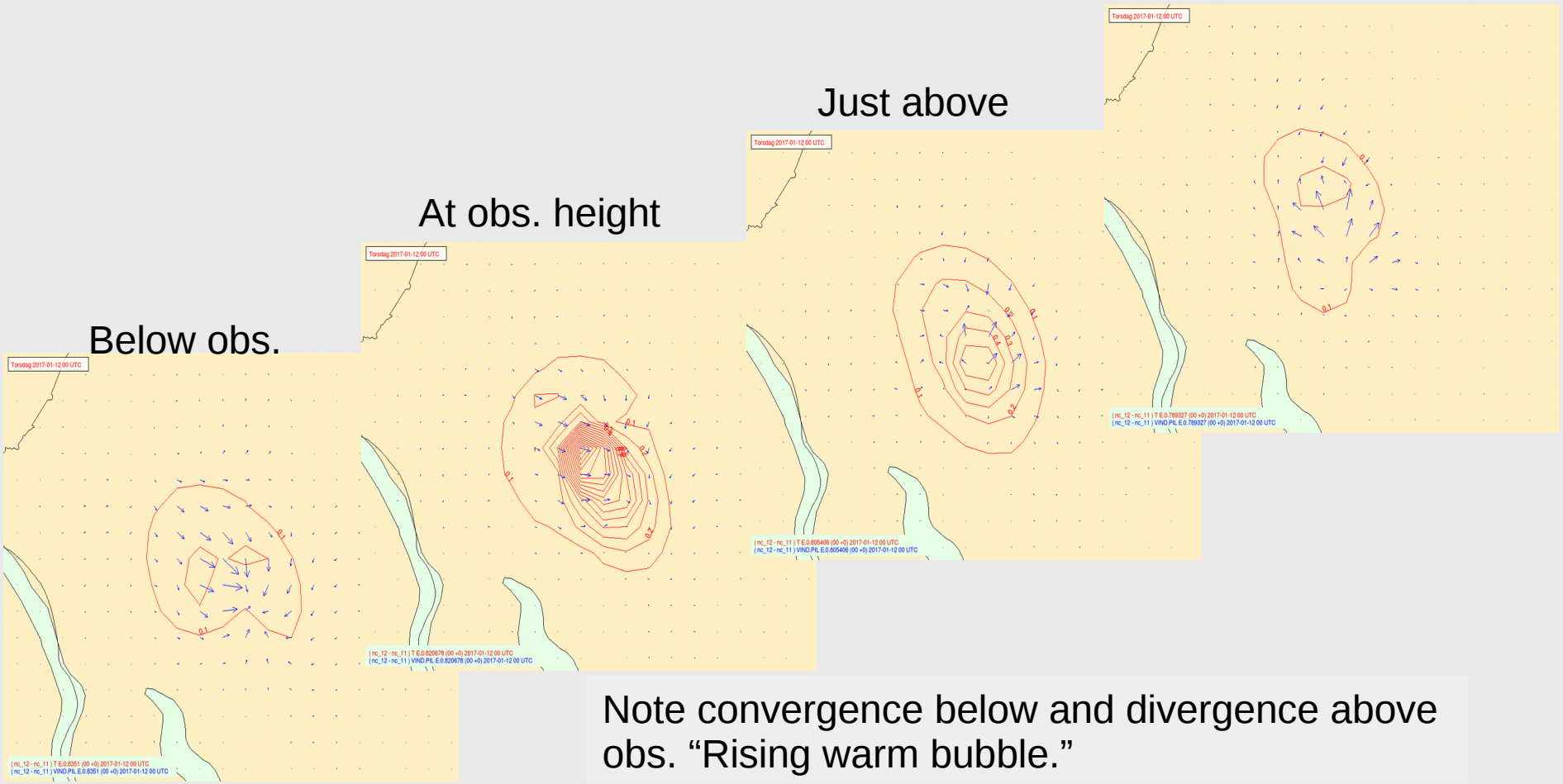
Implemented in context of digital filter initialization (but only single obs. so far).
Have been studying the effect of a single temperature observation, effect of multiple back and forth passes and length of time action (at a single point).
Examples of increments produced (certainly not geostrophic!):

Even higher

Just above

At obs. height

Below obs.



Note convergence below and divergence above obs. “Rising warm bubble.”

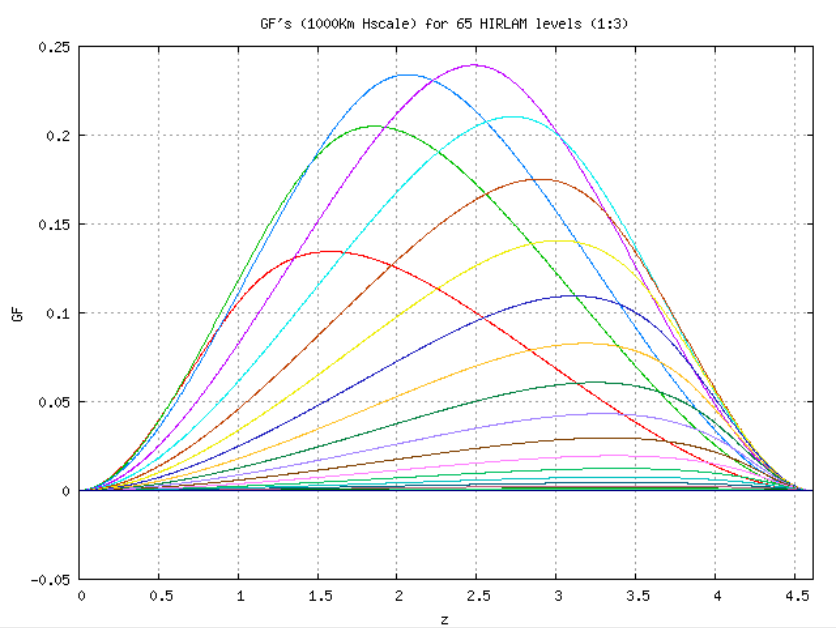
Highlight of the progress – initialisation

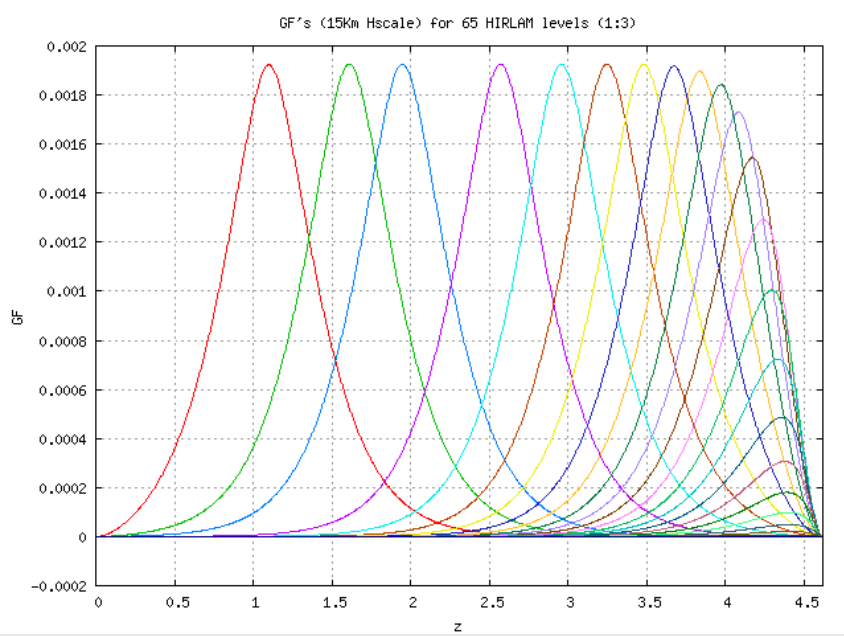
– Considering the variational constraints encoded in an operator M
M: Non-hydrostatic semi-implicit system: **Carlos Geijog**

$$2J(x^k) = \int_o^{\tau_n} w_o^k \left\| x^k - x_o^k \right\|^2 + w_c^k \left\| Mx^k - x_\bullet^k \right\|^2$$

– Search for a solution in the vicinity of the background;
– using Green's Functions to find scale dependent balance operator;
– focusing mainly on wind analysis;
– to be coupled with field alignment scheme.

==> **It's a work in progress!**





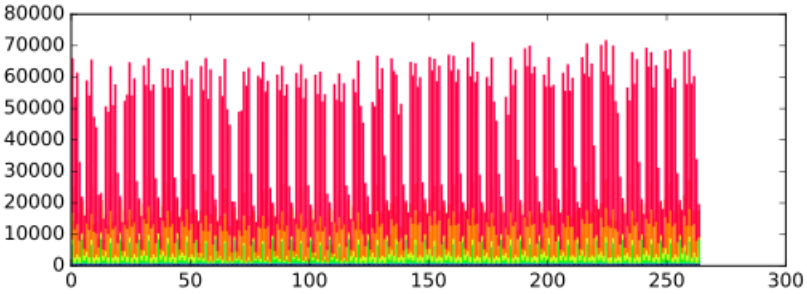
Highlight of the progress – Implementation of new obs type

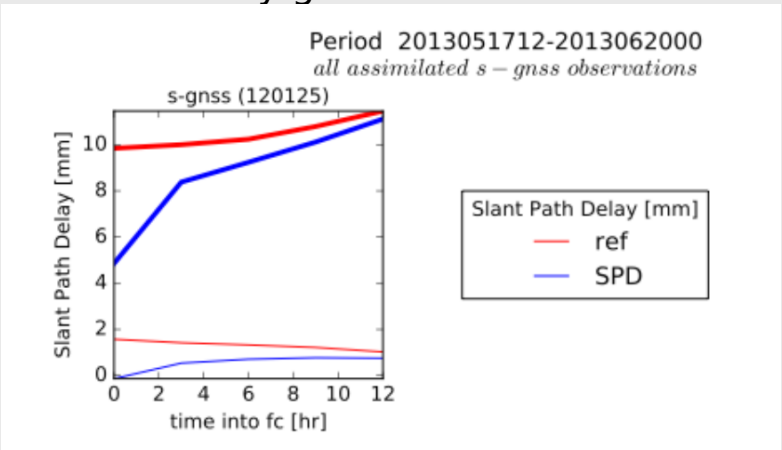
Implement GNSS slant delay observation in HARMONIE-AROME DA

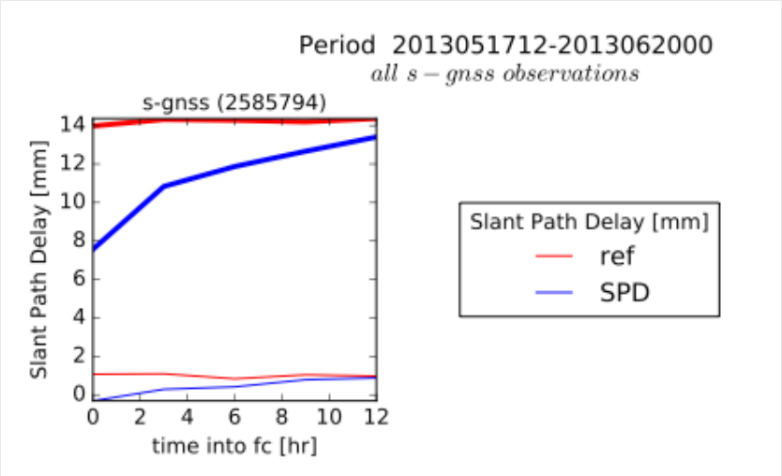
Siebren de Haan (Comprehensive presentation can be found on Hirlam wiki page)

Data assimilated
- STD : 5%
- TEMP
- AMDAR
- Mode-S EHS

STD
- positive impact over whole forecast
- bias correction works sub-optimal
- too short time window?
- all observations show very good statistics







Highlight of the progress – towards improved tools and schemes

Improved pre-processing tools: use of Bator alone to read all observations
==> see Eoin's Talk

Development of 4D-Var: more issues and solutions discussed during the last video meeting (see the minutes)
Nils Gustafsson, Jan Barkmeijer, Magnus Lindskog, Martin Ridal, and more …

Modular B: Jelena Bojarova
– Control of different balance is now available through namelist
Modset submitted to the Harmonie trunk.

Development of EnVar: Jelena Bojarova
– Codes necessary for extension of control vectors submitted to the Harmonie trunk. Modifications are based on square-root B transform.
==>**BUT,** no plan to have the square-root B in OOPS in the near future!!

Highlight of the progress – 3D-VAR: local implementation

Task: Implement 3D-VAR DA with 3-hourly cycling

Spain: Use conventional, ATOVS and GNSS ZTD observations

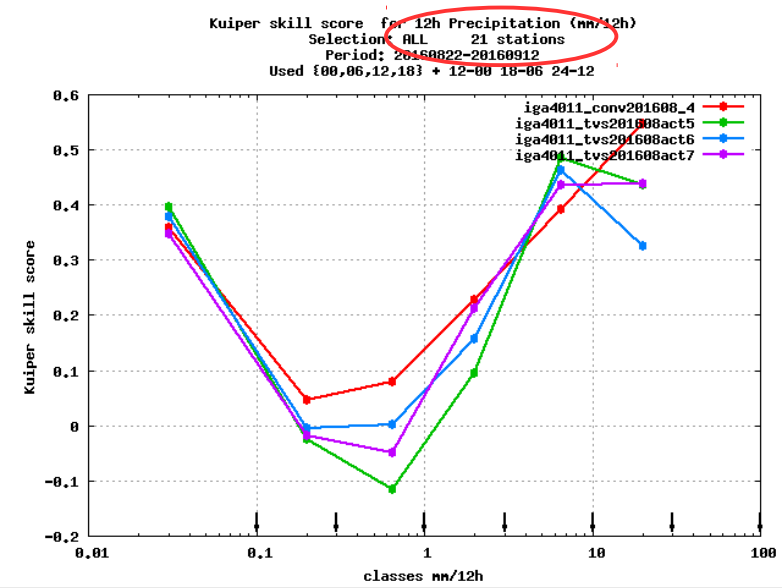
Maria V Diez M, Jana S Arriola and Joan Campins

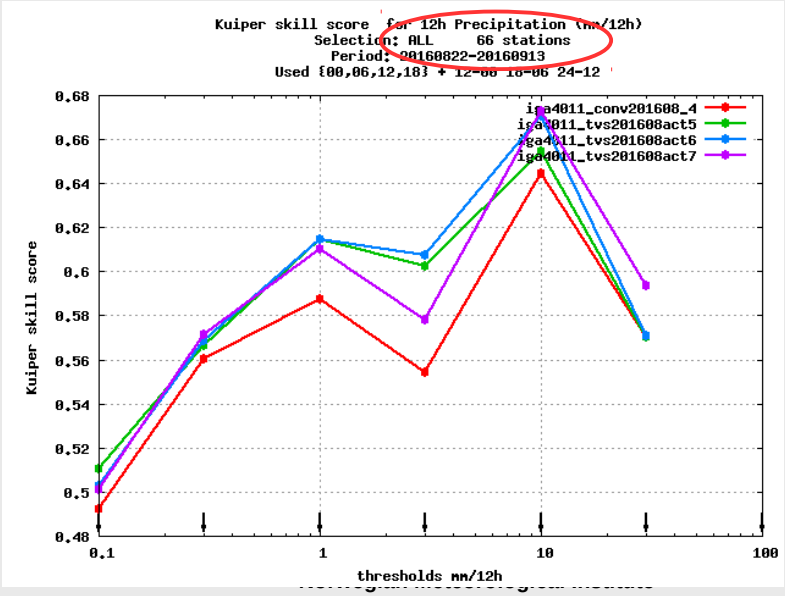
==> ***see Jana's presentation***

Iceland: Use conventional and ATOVS observations

Sigurdur Thorsteinsson and Roger Randriamampianina

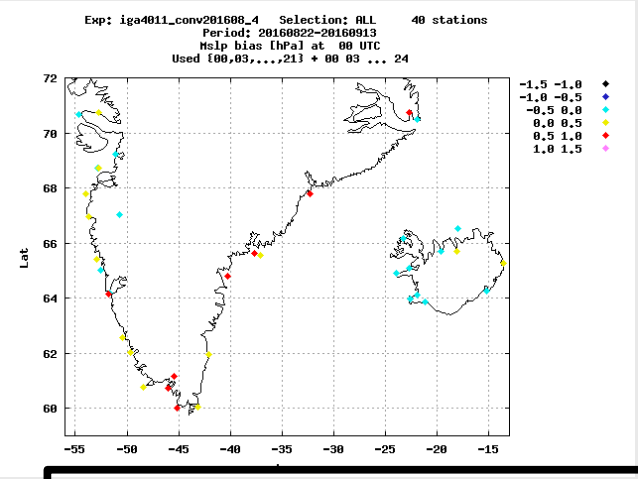
ATOVS configuration: AMSU-A (ch: 5 – 10); AMSU-B (ch 3 - 5)

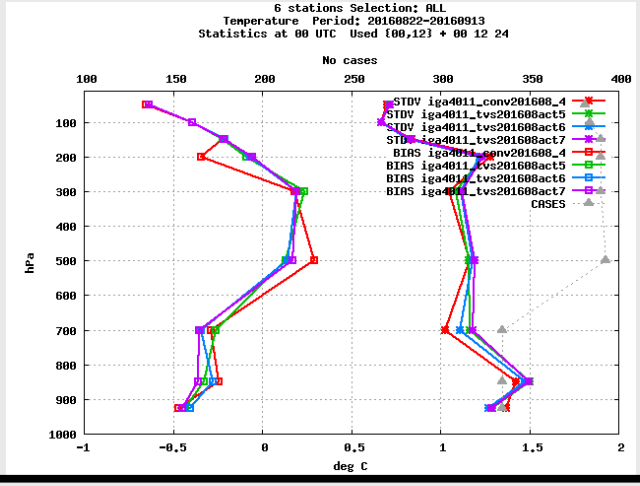


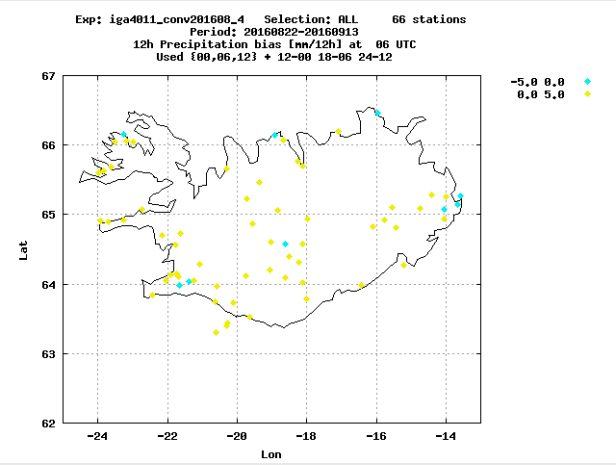


Highlight of the progress – 3D-VAR: local implementation

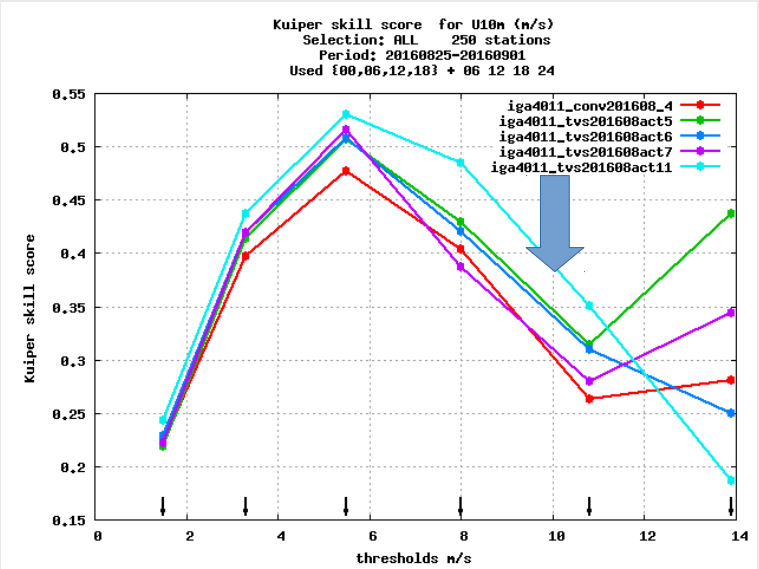
Upper-air still negative impact expect for humidity



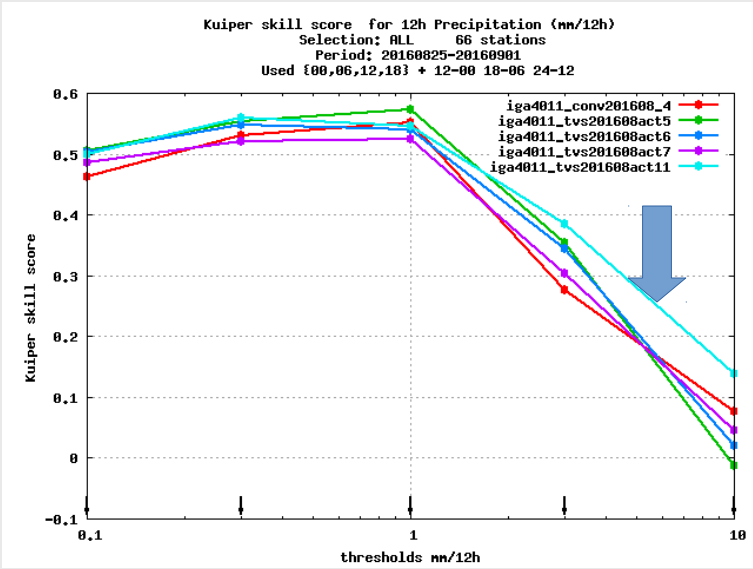




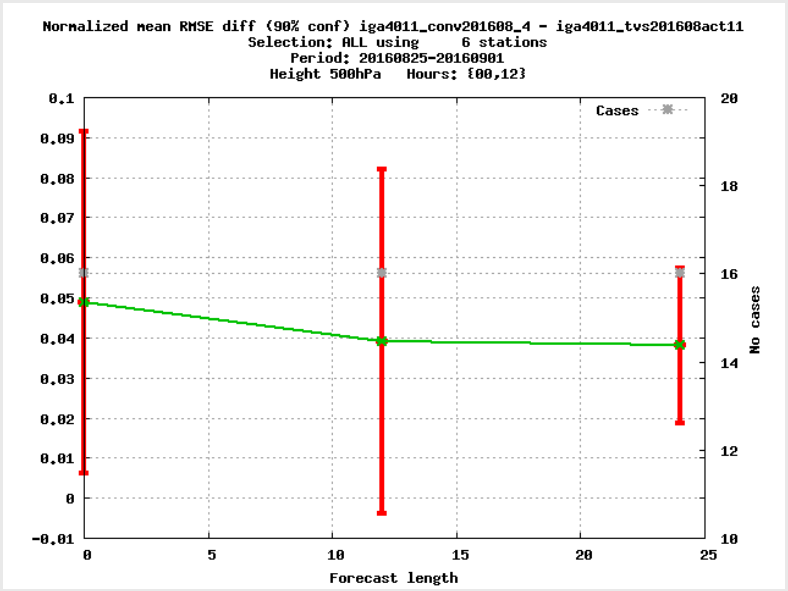
After careful check of the quality of T2m and Ps diagnostics through obsmon and blacklisting of bad stations, we got the light blue line

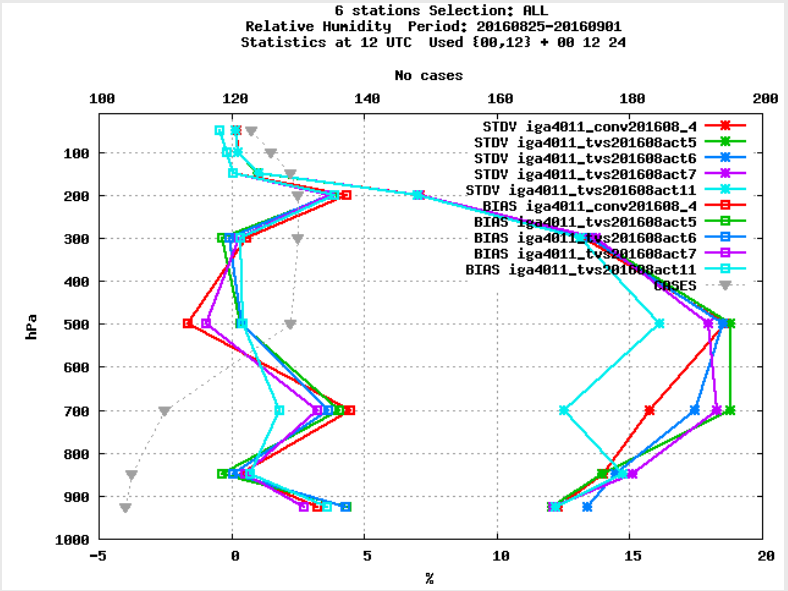


Light blue exp is still running

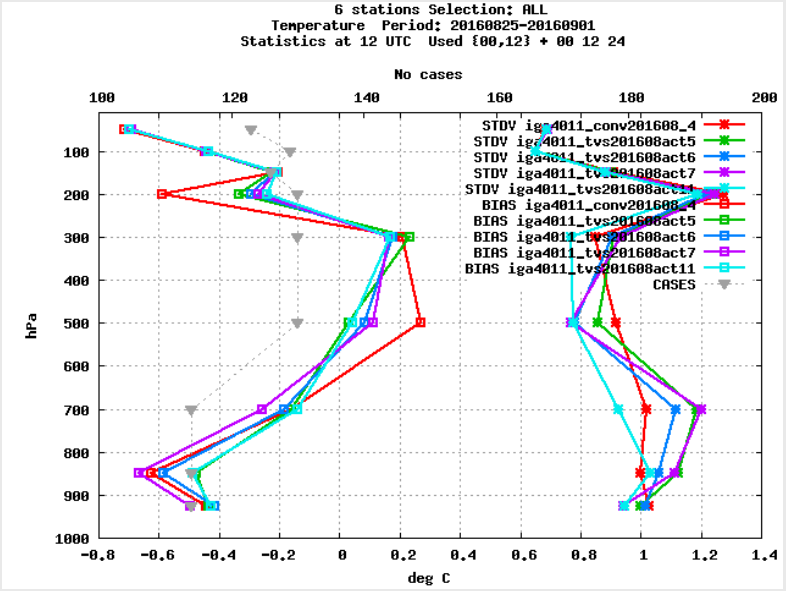


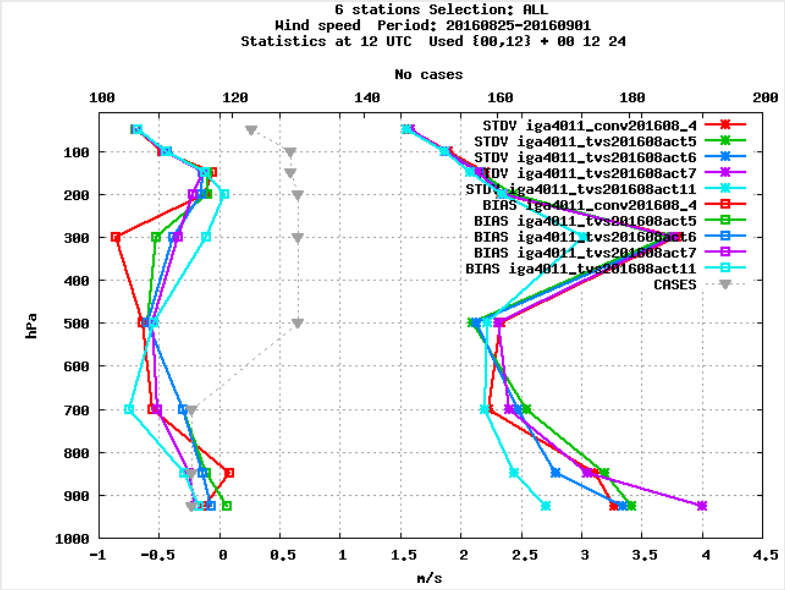
Highlight of the progress – 3D-VAR: local implementation





The problem was in the surface observations in this case





Highlight of the progress – Rapid Refresh: local implementation

Task: Development of 1-hour non-cycling DA – Rapid Refresh

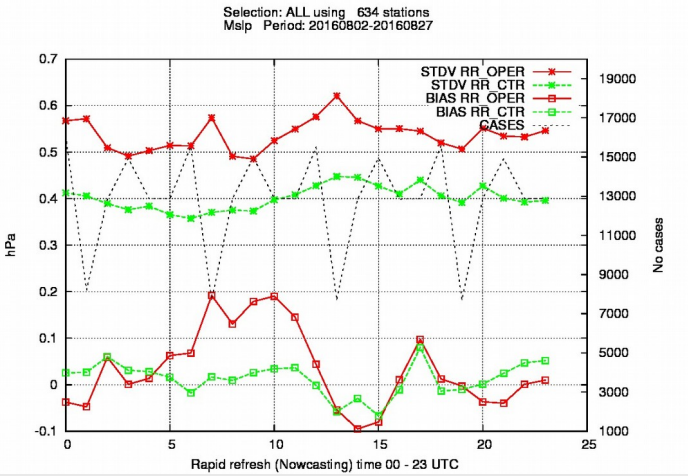
Roger Randriamampianina, SAWIRA2 project

Tested observations on top of conventional observations:

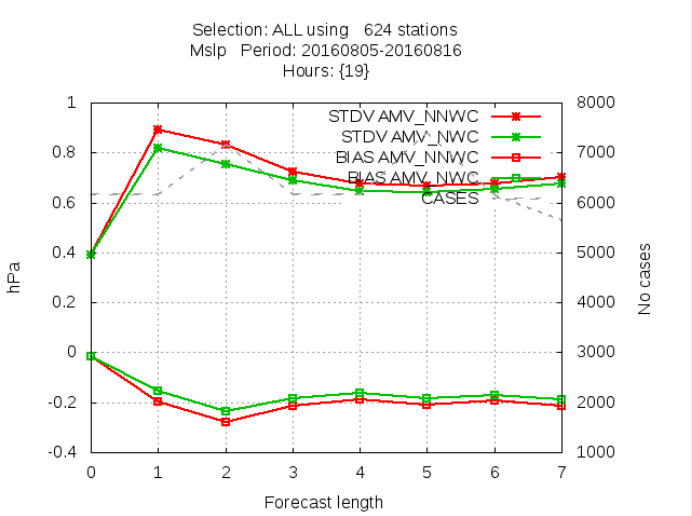
- Atmospheric Motion Vectors (AMV), ATOVS (AMSU-A, AMSU-B/MHS), IASI

Short-range(red) vs nowcast (green)

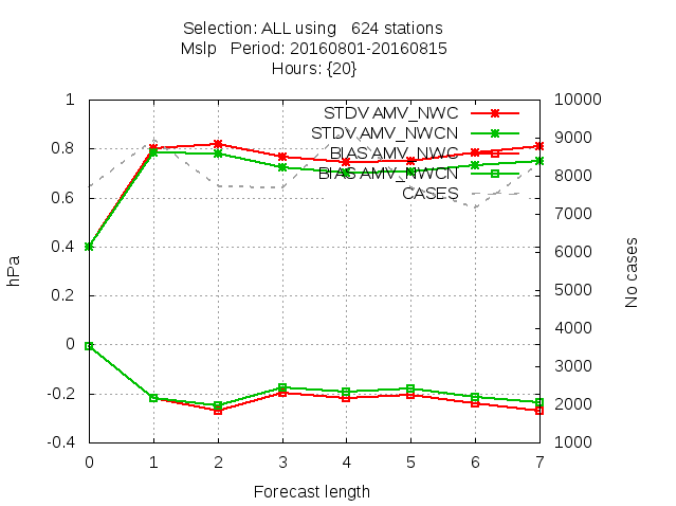
Similar impact for T2m and Hu2m except V10m is neutral



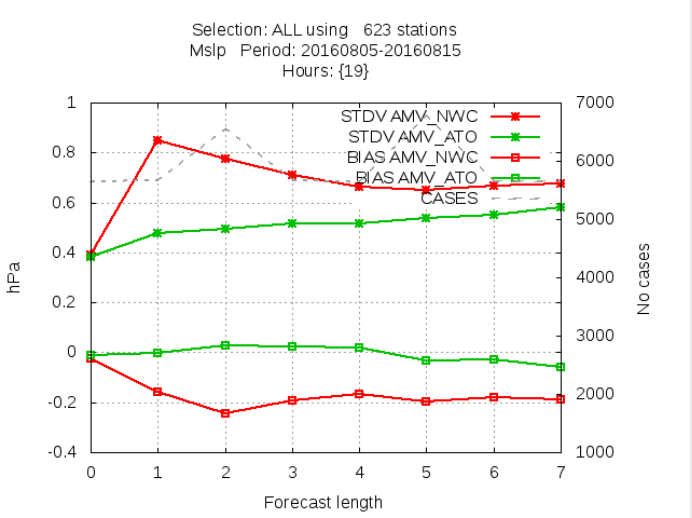
Positive impact of AMV



Positive impact of IASI

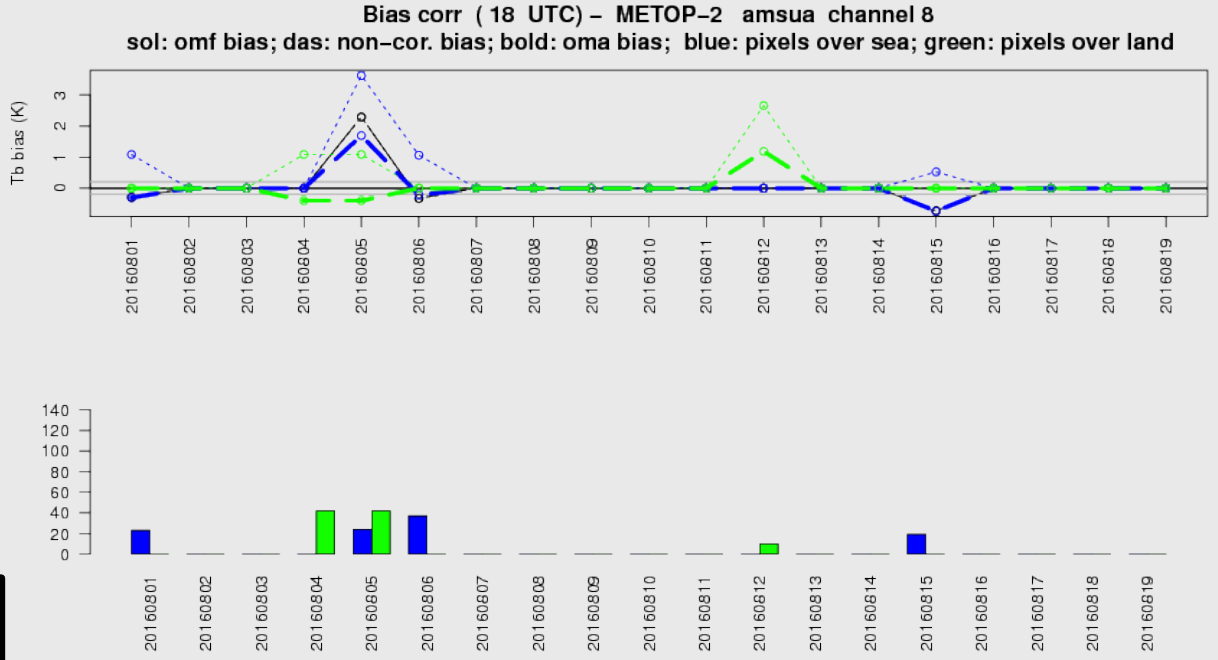


Negative impact of ATOVS



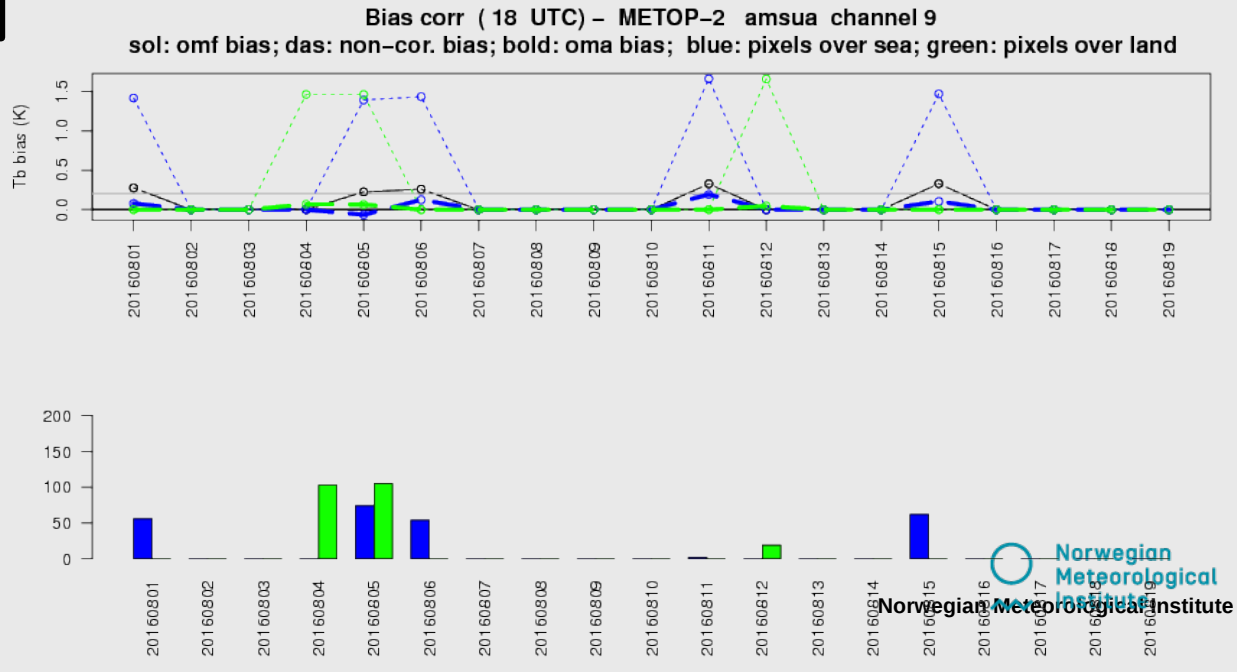
Highlight of the progress – Rapid Refresh: local implementation

Too high amplitude of bias
Should be blacklisted

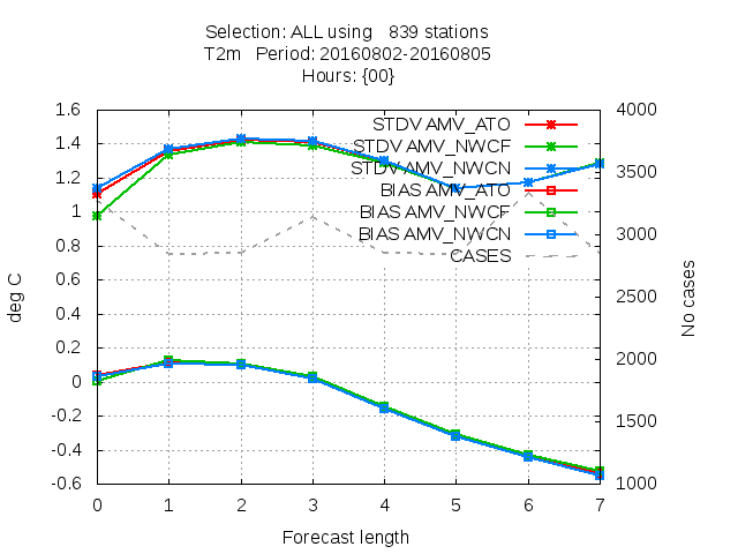


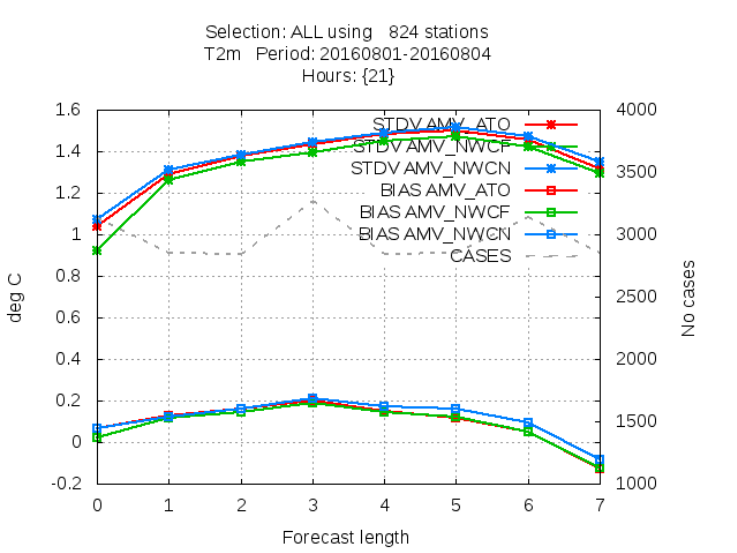
Similar diagnostic is available in obsmon

Normal amplitude of bias

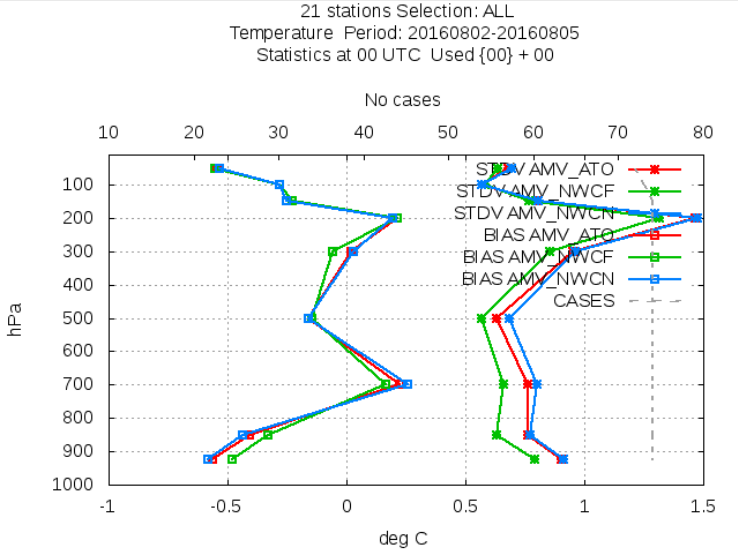


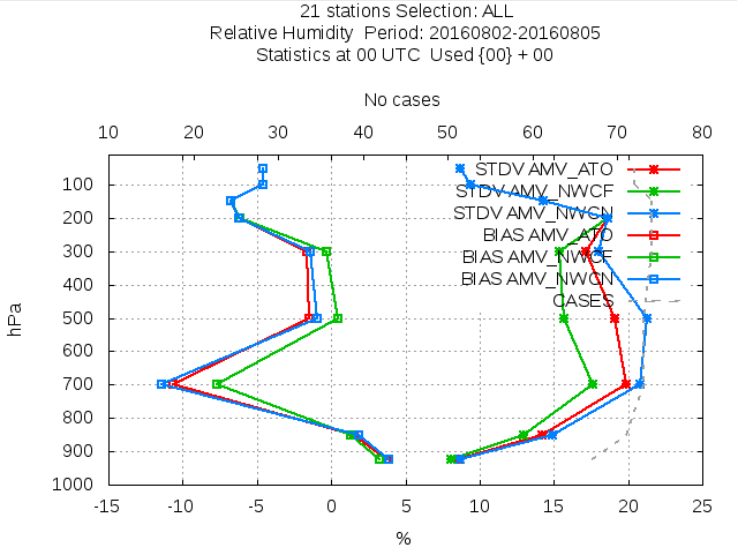
Highlight of the progress – Rapid Refresh: local implementation





The problem seems to be in upper-air observations in this case





Data assimilation events – video meetings

Video meeting on: We just have got our 3rd series of meetings

Conventional observations and COPE: (15 p)
https://hirlam.org/trac/wiki/HarmonieVideoMeetings/Meeting_on_conventional_data_and_COPE

Video Meetings on Radar data processing: (10 p)
https://hirlam.org/trac/wiki/HarmonieVideoMeetings/Meeting_on_radar_data_processing

Video Meetings on Radiance Data Assimilation: (13 p)
https://hirlam.org/trac/wiki/HarmonieVideoMeetings/Radiance_data_assimilation

Video Meetings on retrieval data: (11 p)
https://hirlam.org/trac/wiki/HarmonieVideoMeetings/Retrieval_data_assimilation

Video Meetings on algorithms (ETKF 4DVAR 3DVAR OOPS etc …): (23 p)
https://hirlam.org/trac/wiki/HarmonieVideoMeetings/etkf_4dvar_3dvar_oops_meeting

Outlook – Just few of them ...

– Continue the local implementation of more observations …;

– Testing with 1-h cycling and Rapid refresh;

– Working with initialisation schemes: LHN, back & forth nudging, use of variational constraint, IAU;

– Find solution for the convergence problem in our variational scheme;

– Continue developing the 4D-VAR and EnVar schemes;

– Understand the quality control of radar data – ex. Baltrad vs Prorad tools;

– Bator for all observations and at the same time develop COPE to handle all observations;

– Diagnose B computation by checking Hirlam and MF/Aladin ways of computation;

– Better accounting of large scale information in initialisation and data assimilation;

– ….

Thank you