



Norwegian
Meteorological
Institute



Recent progress in HIRLAM upper-air data assimilation

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with contribution from HIRLAM colleagues

EWGLAM, 2019, Sofia, Bulgaria

outline



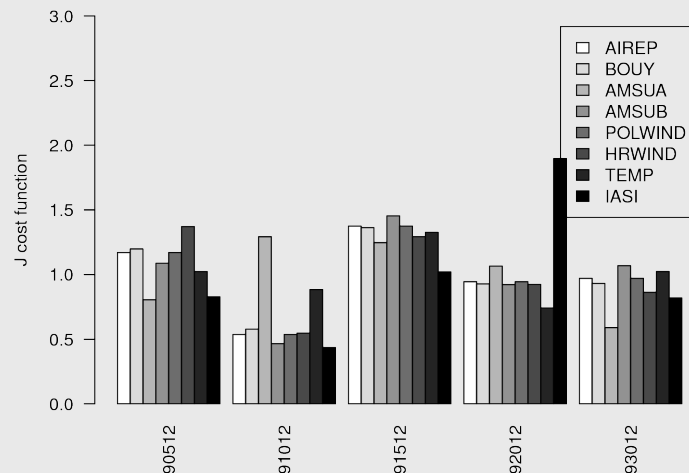
- Operational upper air data assimilation (UA-DA) systems in HIRLAM
- Algorithmic development
- Improving the use of observations
- Concluding remarks and further plan

Operational upper air data assimilation (UA-DA) systems



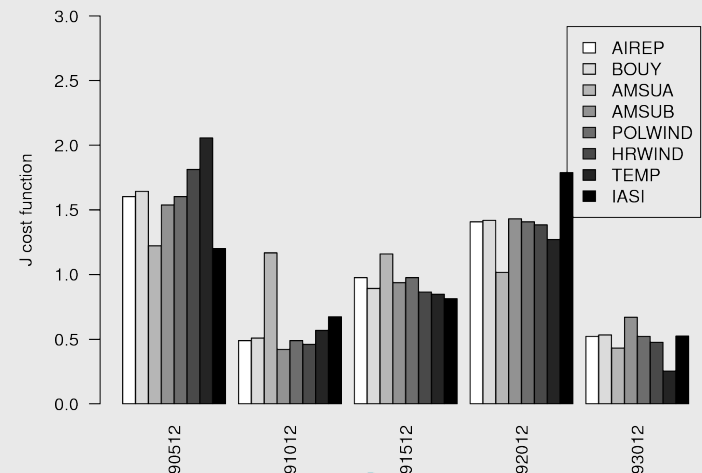
- **Assimilation scheme:** 3D-VAR;
- **Cycling Strategy:** 3 hourly;
- **Conventional observations:** SYNOP, SHIP, BUOY, AMDAR, AIREP, ACARS, ModeS EHS, Pilots, TEMP;
- **Satellite radiances:** AMSU-A, AMSU-B/MHS, ATMS, IASI;
- **Satellite retrievals:** Scatterometer, GNSS ZTD, GPS RO, AMV;
- **Radar observations:** Reflectivity;
- **Bias correction scheme:** Variational (VarBC)
- **Blacklisting of conventional observations:** IFS decision

Normalized variability of the cost function over different dates
Forecast: 6 hours, Total Norm



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

Normalised variability of the cost function over different dates
Forecast: 48 hours, Total Norm



Progress with 4D-Var

N Gustafsson, J Barkmeijer, M Lindskog, J Bojarova, Eoin Whelan, Isabel Monteiro

Experiments:

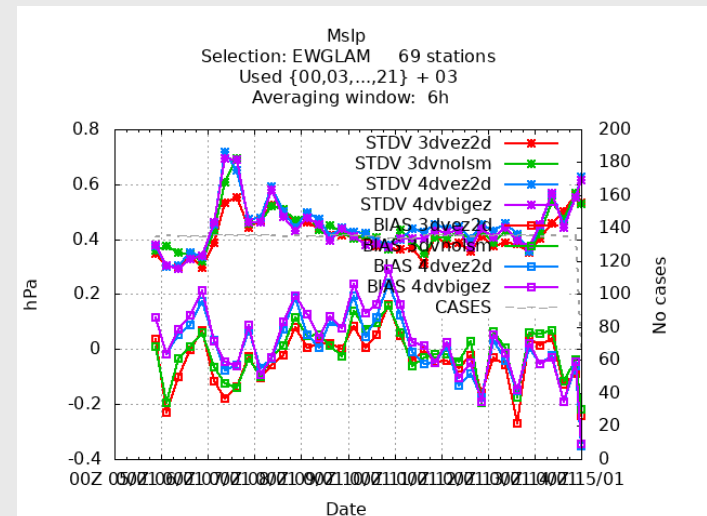
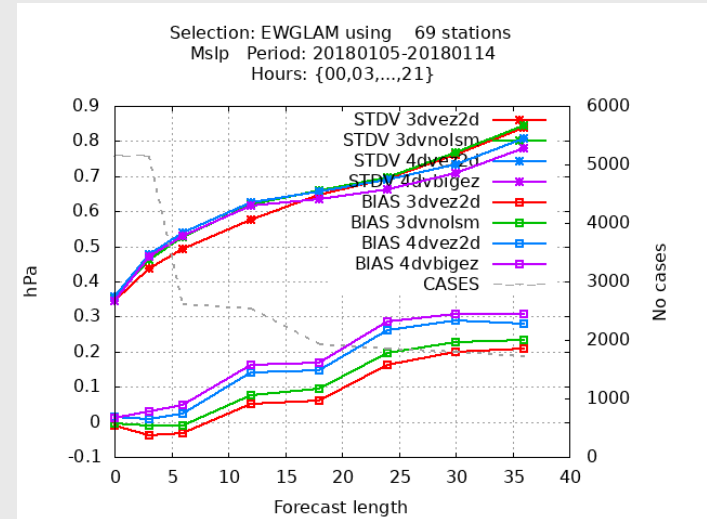
3dvez2d : 3D-Var, ez=11, LSM,
Redzone = 120 km

3dvnolsm : 3D-Var, ez=11, no LSM
Redzone = 120 km

4dvex2d : 4D-Var, ez=23, no LSM,
6x, 3x increments
Redzone = 120 km

4dvbigesz : 4D-Var, ez=11 in model,
ez=191/131 in minim.
No LSM, 6x, 3x,
Redzone = 10 km

Coordinated test runs with 4D-Var:
SMHI, KNMI, Met Éireann, IPMA



4D-Var and LBCs

Nils Gustafsson

3D-Var: The analysis is influenced by observations all the way to the Lbs and the analysis is used as the first LBC

4D-Var: The TL increment is relaxed to zero in the forward run and the AD (dJ/dx) is also relaxed to zero.
(+ forecast LBC in the middle of the window)

How to cure this?

(1) Use the increment at the start of the window (analysis increment) as first LBC (quite simple)

(2) Control LBCs at the end of the window (requires one more control vector)

Single observation in 4D-Var

R. Azad, N. Gustafsson, J. Barmeijer, M. Mile

Many tested the 4D-Var scheme with single observation. Expected behaviour was found: good evolution of the increment.



Single obs of specific humidity at 850 hPa and for 12 UTC at the middle of the window

Shown is the linear evolution of the increment

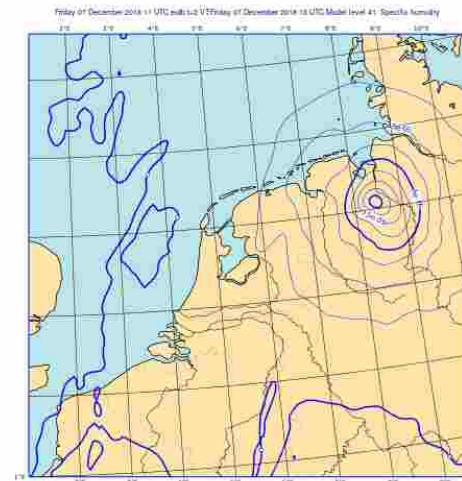
11 UTC



12 UTC



13 UTC



Other development on algorithm ...

LETKF (*P. Escriba*): Further tuning of the scheme showed very promising results. Porting of the code to higher model version demands resources.

Hybrid and EnVar scheme (*J. Bojarova*): Further testing and tuning of scheme is needed. Similarly, here as well we need to port the code to higher model version.

Estimation of the background error statistics (*J. Bojarova, X. Yang*): Different techniques (downsc/EDA/Brand) were compared in frame of a reanalysis project (Copernicus Arctic Reanalysis project).

Accounting for large scale information (*J. Bojarova, M. Dahlbom*): Spectral blending vs Jk.

Nowcasting-related dev: From development to operational implementation and testing (MetCoOp and DMI).

R. Azad (MET Norway), *E. Gregow*, *D. Schönach* (FMI), *X. Yang* (DMI)

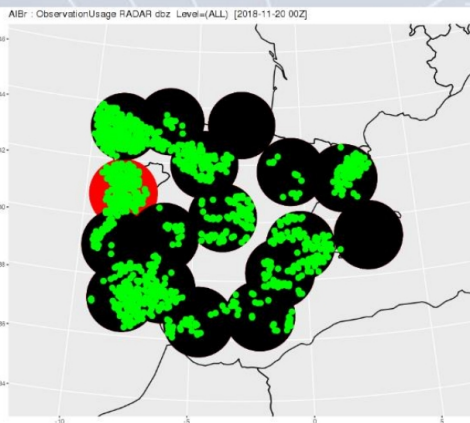
Use of more observations in operational DA

Observations added since last EWGLAM meeting:

- At Met Éireann (E Whelan): ASCAT, AMSU-A, MHS, IASI
- At KNMI (J Barkmeijer): MODE-S, ASCAT
- At AEMET (J Sanchez, M Diez, P Escriba): Radar RFL, RH2m and T2m

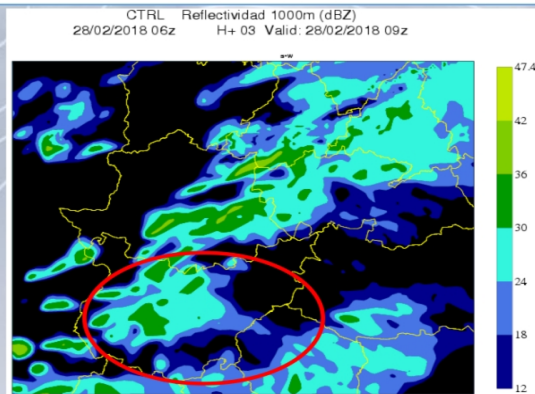
(J Sanchez & co.)

Radar Reflectivity 18 radars (ES+ PT)

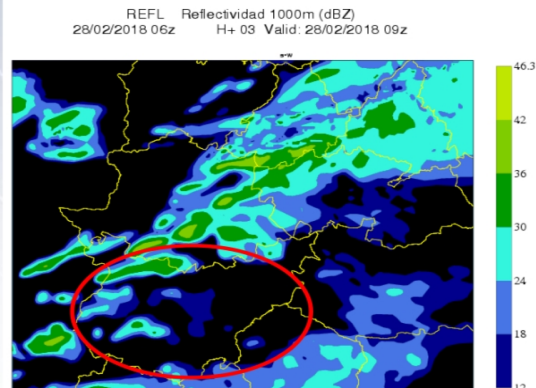


5. Results: verification and case study

CTRL



REFL

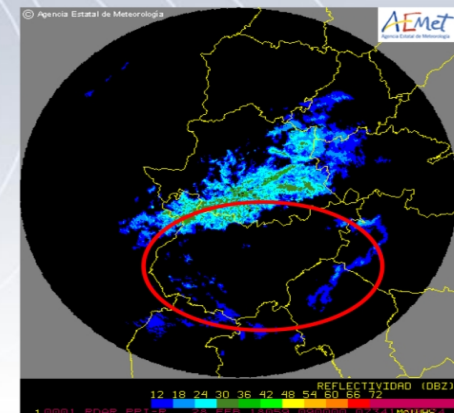


CASE STUDY



ZOOM CASE STUDY: 28 feb 2018, 09Z

OBS



Alertness Better use of observations in DA

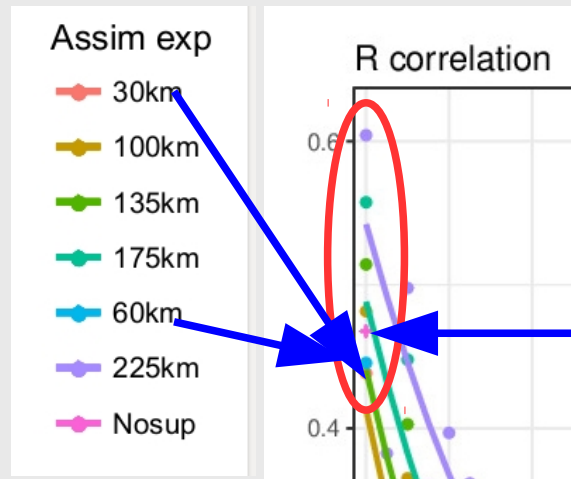
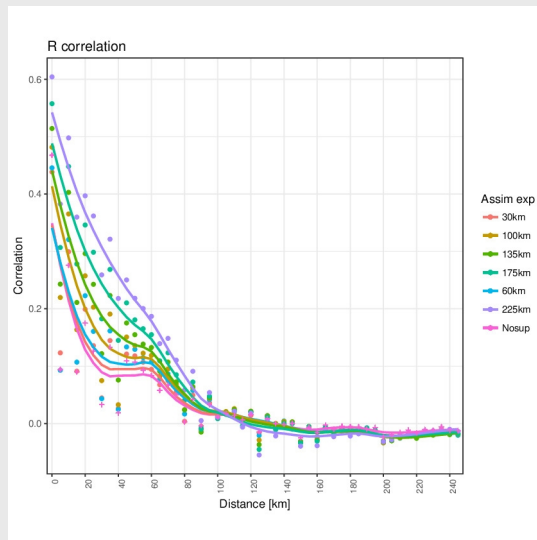
Implementation of supermodding technique for ASCAT

M Mile, PhD work

observation effective resolution < model effective resolution: superobbing
observation effective resolution > model effective resolution: supermodding



– The task is to reduce the representativeness error in DA



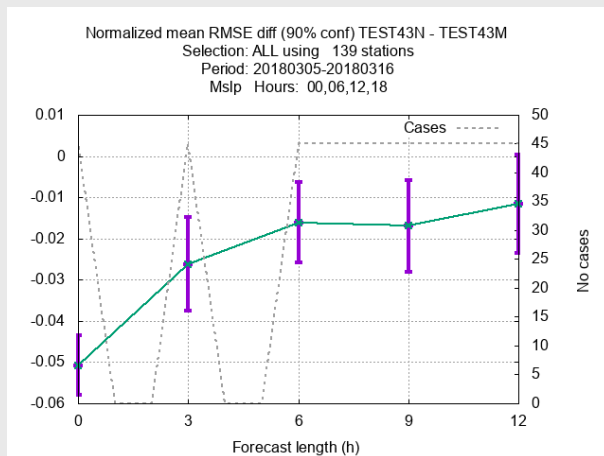
Using Desroziers et al. 2005:
Overall error reduction with supermodding size 30-60 km and increase from 100km and above. We observe also increase of correlation.

No supermodding

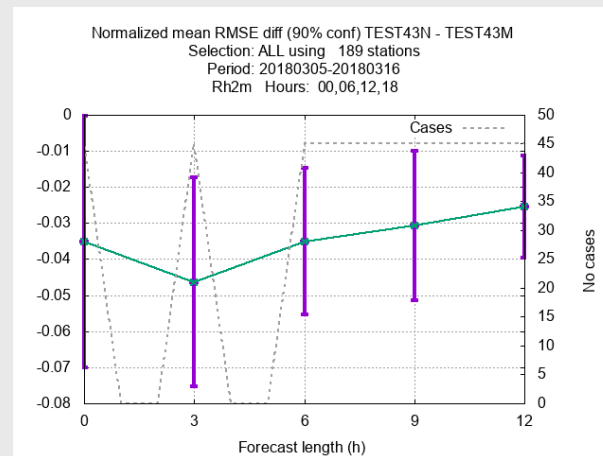
– Case study: Applying the supermodding technique in ASCAT DA improves the forecast of wind speed and direction.
Paper on this work will be submitted soon...

IFS blacklisting decision in Harmonie-Arome DA (CY43)

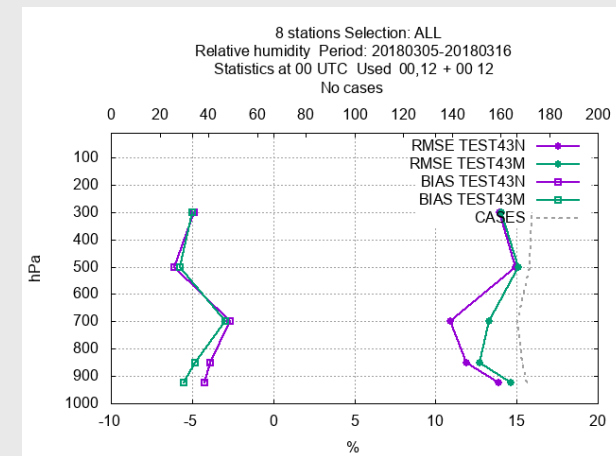
- In Harmonie DA, we use an old-dated blacklisting file from Meteo France.
- Versions of the IFS blacklisting decision were used in OSEs and reanalysis systems.
- We receive regularly the updated list of blacklisted conventional observations (stations IDs with bad parameters/instruments).
- The implementation is not one-by-one, because we kept the selection of active observations as for ARPEGE/ALADIN/AROME DA. So, mainly the adopted solution concerns only the blacklisting of conventional observations.



Error reduction: MSLP



RH2m



New blacklisting
Old blacklisting

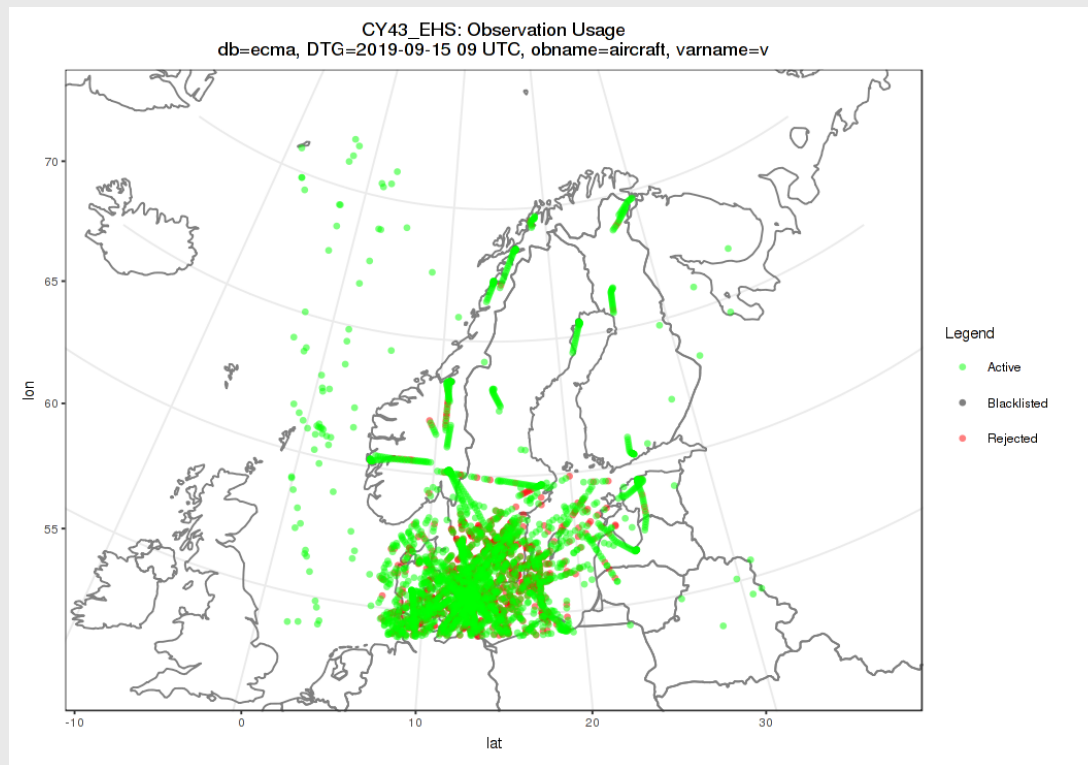
Note the relatively short period.

Preparation for operational implementation

- Metop-C observations: The Harmonie system was updated to use AMSU-A, MHS, ASCAT;
- To close some gaps with respect to satellite radiances: MWHS-2 from FY-3C/3D are now under test.

Collecting more (Nordic) Aircraft Based Observations (ABO)

- MET Norway, SMHI, and FMI are collecting the Mode-S data from the available antennas



Mode-S EHS collected by SMHI
plus DMI and KNMI data

Magnus Lindskog

Concluding remarks and outlook

- Continue to add more observations in local operational systems. This depends on the willingness of the local team, but needs also help from experts.
So, it's common task...
- Explore the potential that the crowdsourced observations can give to nowcasting and high resolution NWP applications
- We hope to have 4D-VAR in operational soon
- The Harmonie-Arome is already an ensemble system
 - to have it tuned to use the different recently (or planned) developed DA elements (nowcasting, LETKF and hybrid EnVar schemes) and talk about that at next meeting
- Regular video meetings help a lot to share experiences and avoid duplicated works

Thank you