Norwegian Meteorological Institute

Progress in Hirlam upper-air data assimilation

Roger Randriamampianina

30th ALADIN Workshop & HIRLAM All Staff Meeting 30.03-3.04.2020

outline

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

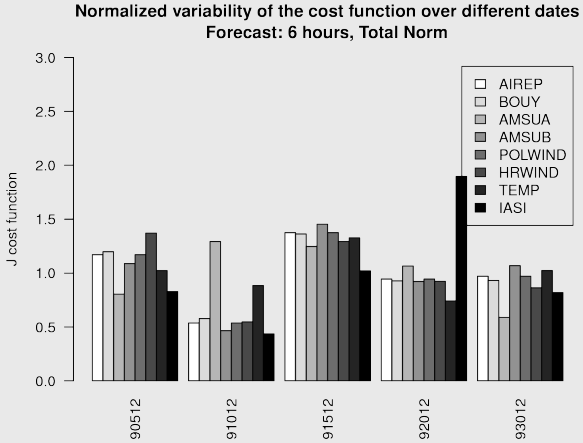
- Local implementation

- Some development works related to UA-DA

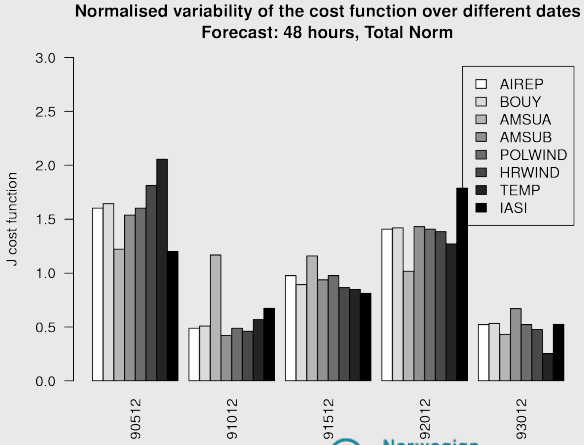
- Data assimilation meetings (working weeks and video)

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/MRAR, Pilots, TEMP (High-Res);
– **Satellite radiances:** AMSU-A, MHS, ATMS, IASI;
– **Satellite retrievals:** Scatterometer, GNSS ZTD, GPS RO, (geo and polar) 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 – towards improved tools

SAPP: Scalable Acquisition and Pre-Processing system
(Eoin Whelan, Ronan Darcy)

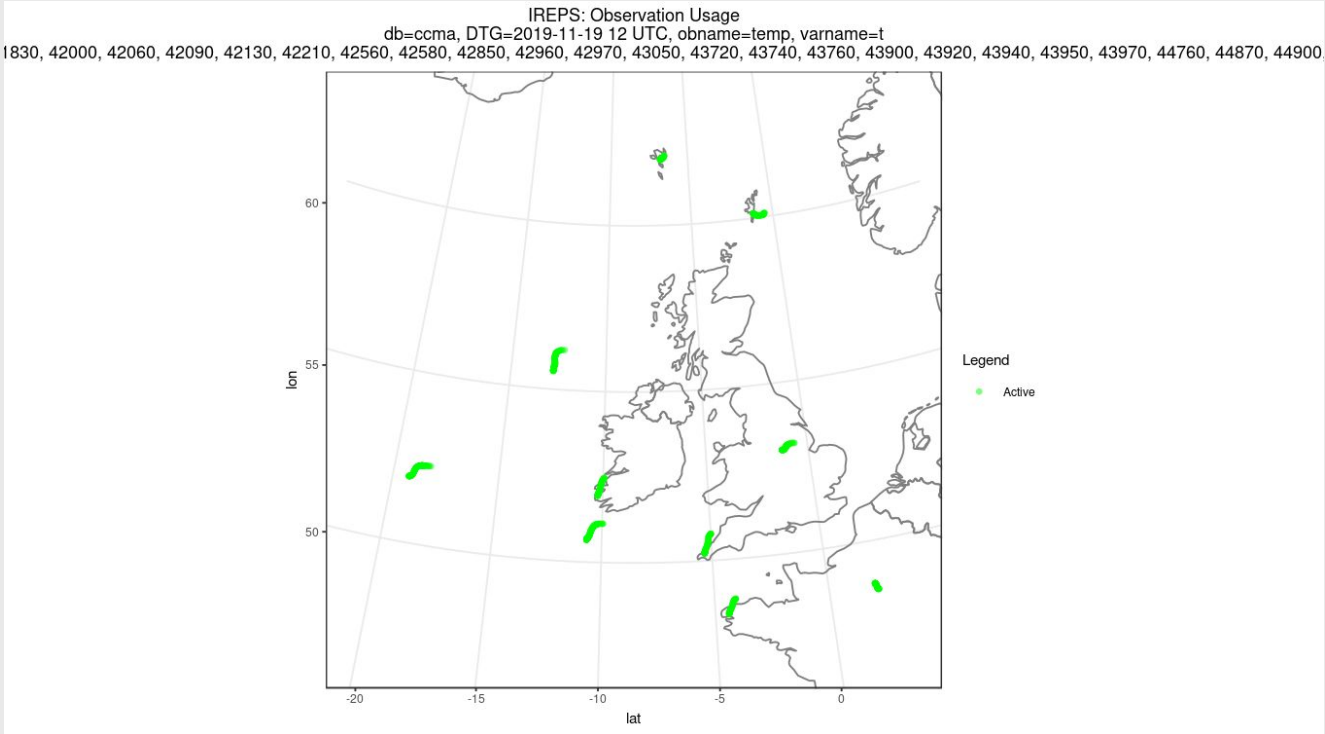
- SAPP Optional Programme up and running
- Started 1st 2019 supporting provision of the SAPP
- Collaboration and support via Confluence wiki
- Operational in Met Éireann since November 2019
- Minor (Bator) updates required for cy40h1.1
- cy43h2 ready for SAPP BUFR

MET éireann

Highlight of the progress – towards improved use of observations

SAPP: Scalable Acquisition and Pre-Processing system

(Eoin Whelan, Ronan Darcy)

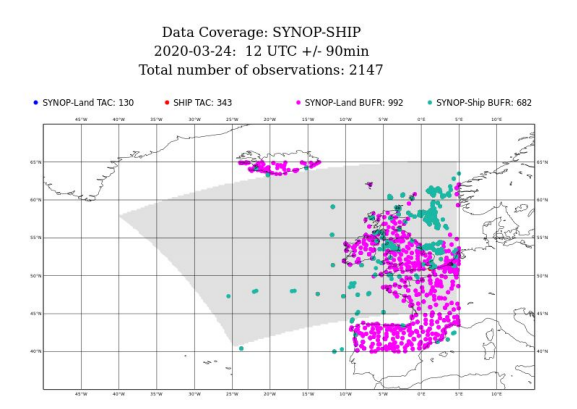


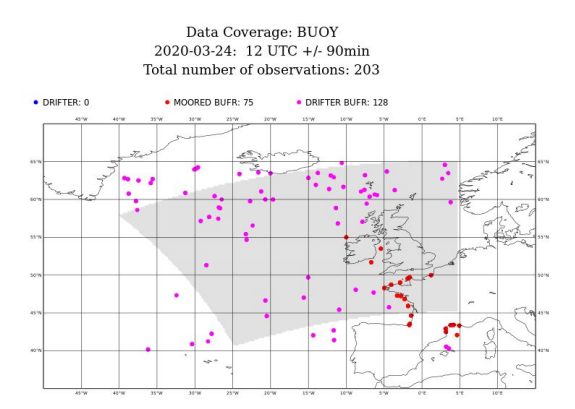
First operational assimilation of hi-res TEMP

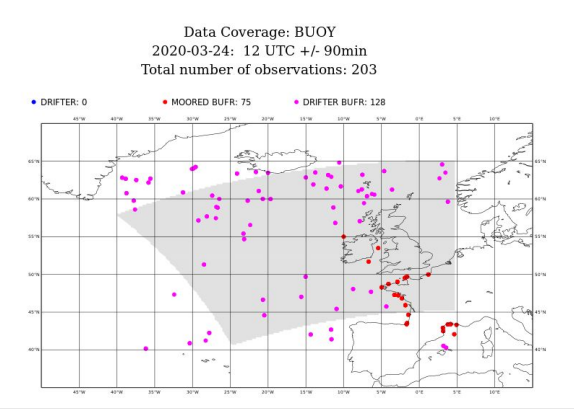
Highlight of the progress – towards improved use of observations

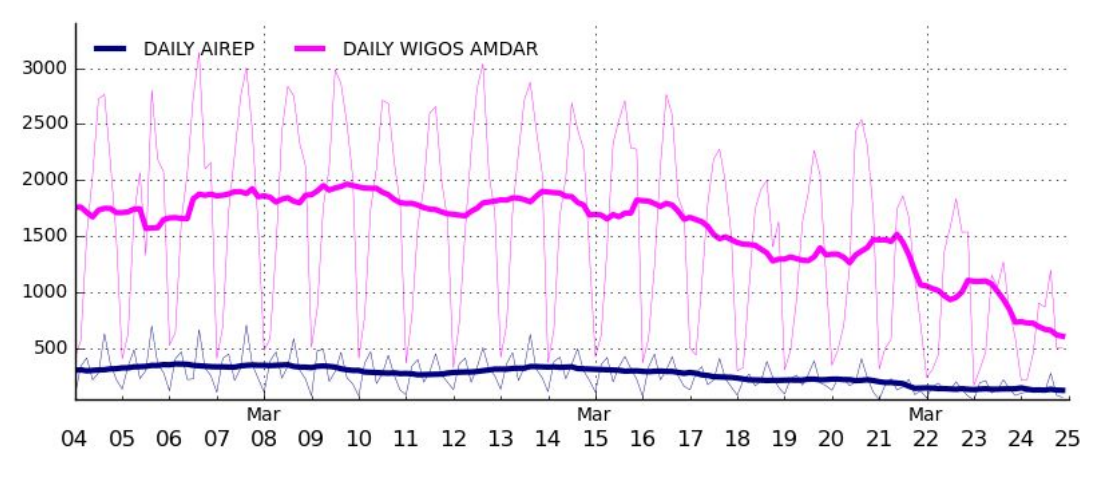
SAPP: Scalable Acquisition and Pre-Processing system

(Eoin Whelan, Ronan Darcy)









Aircraft count recently for Irish domain

High Resolution Hirlam Limited Area Model

MET éireann

Assimilation of Mode-S data in MetCoOp

(Magnus Lindskog)

Three parallel data assimilation experiments run on supercomputer Bi from 20191211 to 20201010:

CRL: Copy of cy 40 pre-op + pre-operationally used observations over MetCoOp C domain. Only aircraft based observations (ABO) used are AMDAR.

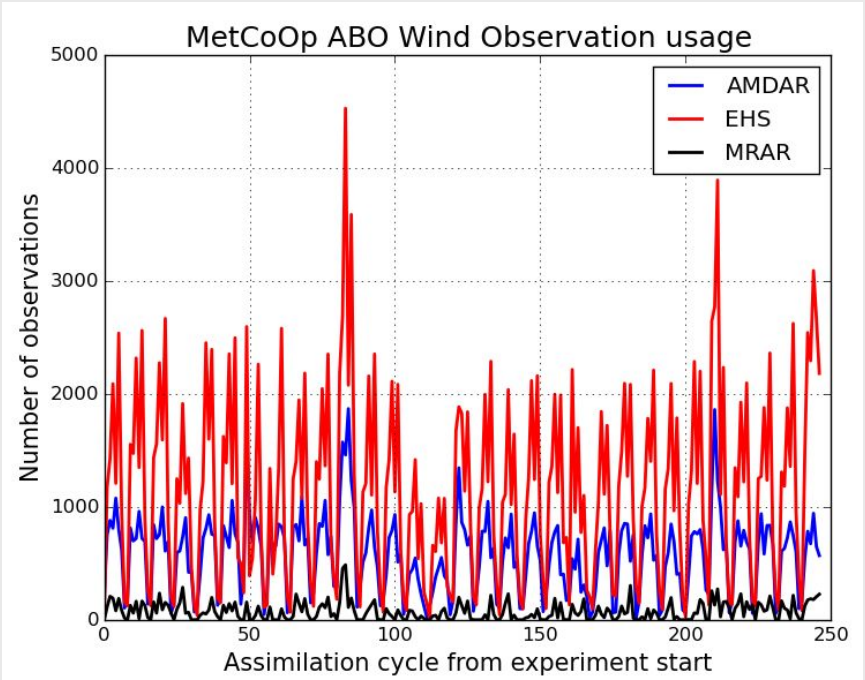
MOD: As in CRL + assimilation of MODES EHS and MRAR) from Denmark and MODES EHS from Denmark and MUAC (but few or no data from MUAC). Observation errors for MRAR and EHS T/u/v as assigned for AMDAR.

EHS: As in MOD but no MRAR used, only EHS. In addition Mode-S EHS winds were used with an observation error systematically increased with 1 m/s for u/v as compared to AMDAR and Modes-S EHS temperatures were assigned very large observation error standard deviations.

Assimilation of Mode-S data in MetCoOp

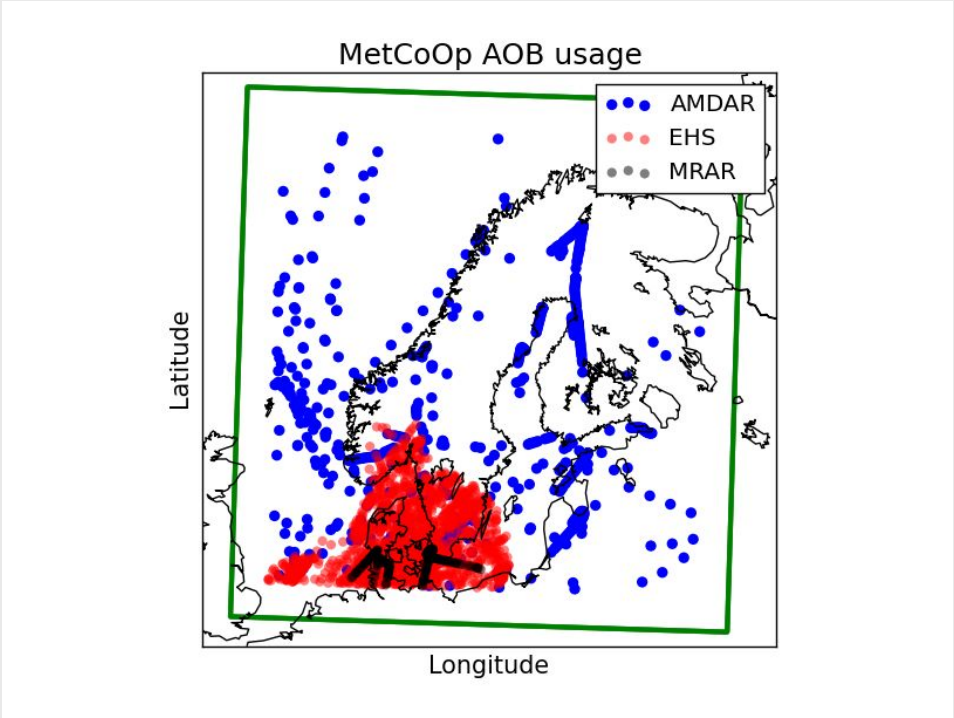
Norwegian Meteorological Institute FMI SMHI

(Magnus Lindskog)



Time-series of wind observations used in data assimilation minimization

Spatial coverage ABO
20191213 12 UTC



A lot of Mode-S EHS and not so many MRAR. Large variation in observation availability between day and night.

Assimilation of Mode-S data in MetCoOp

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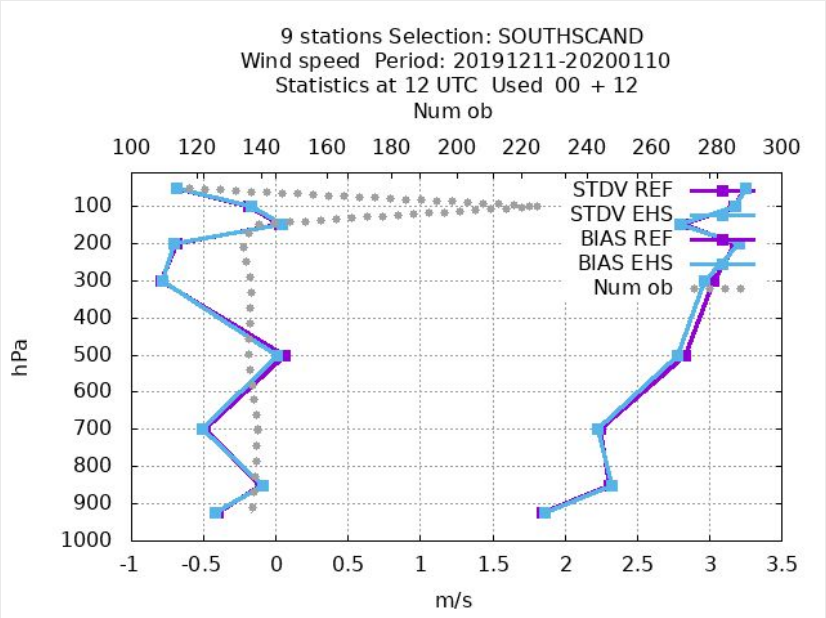
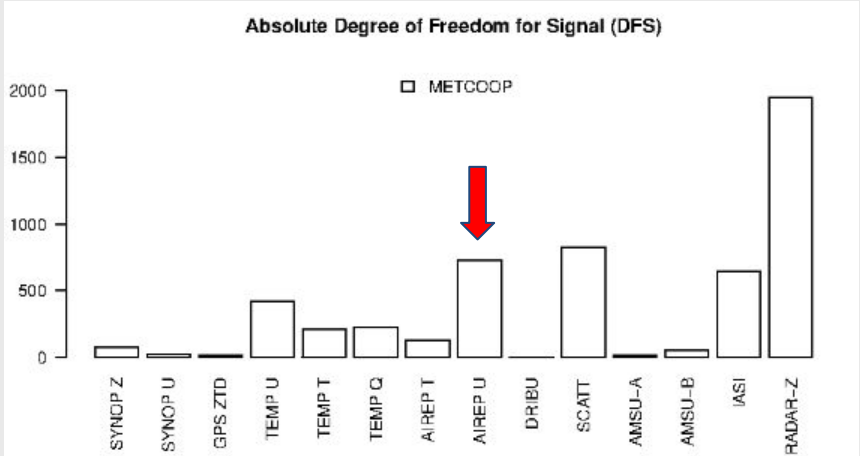
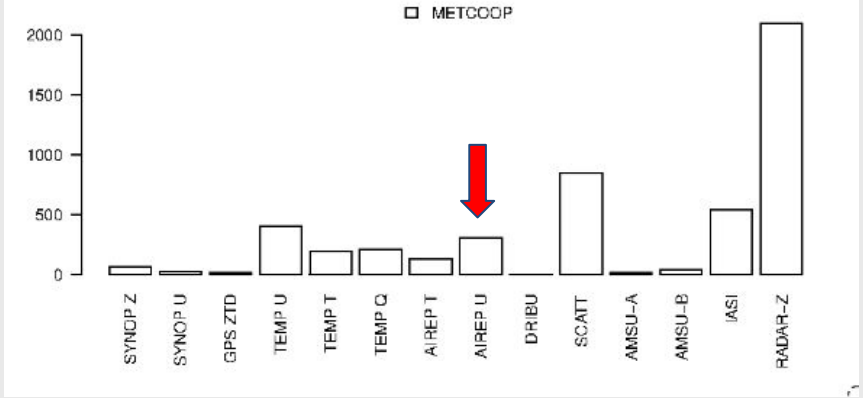


EHS:



CRL:



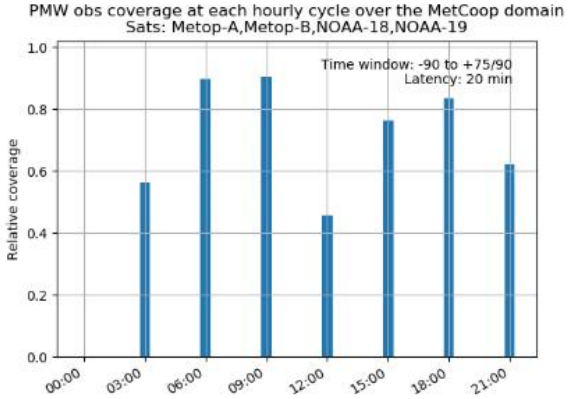
Positive impact on wind-speed forecasts.
Rather neutral for wind direction.

Microwave radiances from METOP-C, FY3C, FY3D
(Magnus Lindskog)

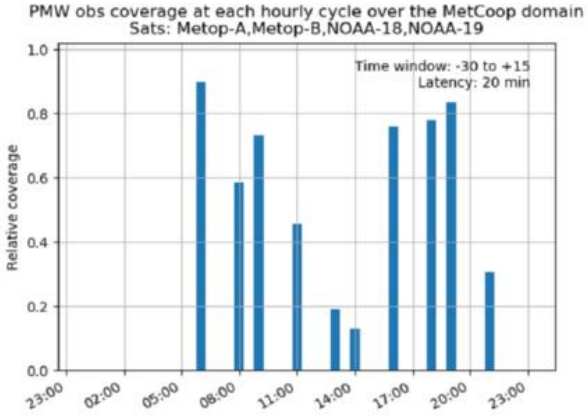
Microwave radiances from METOP-C, FY3C, FY3D

SMHI

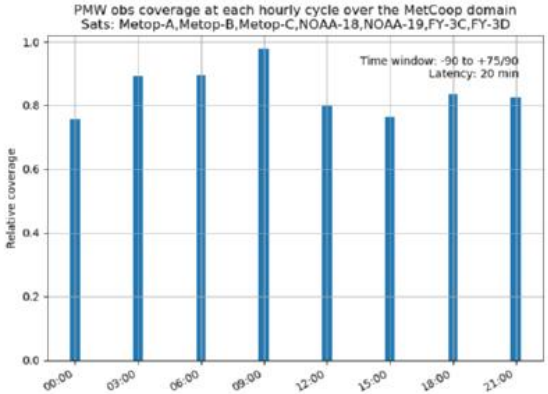
Availability with Current use in MEPS



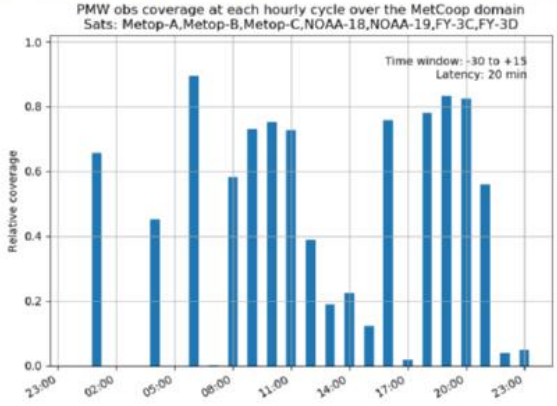
Availability with Current use in Nowcasting



Availability with Enhanced use in MEPS



Availability with Enhanced use in Nowcasting



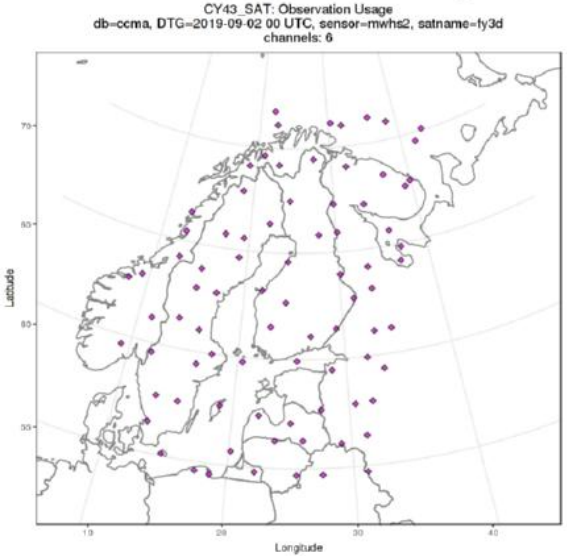
Microwave radiances from METOP-C, FY3C, FY3D
(Magnus Lindskog)

Parallel data assimilation experiment

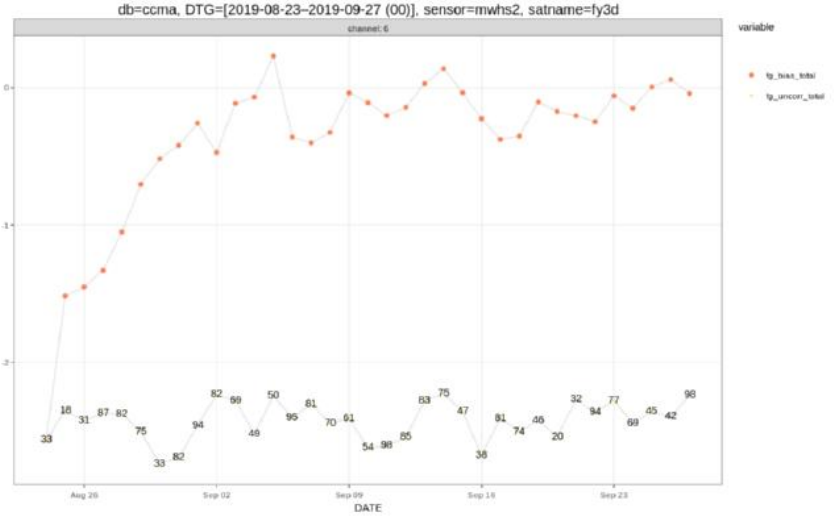
SMHI

Functionality demonstration

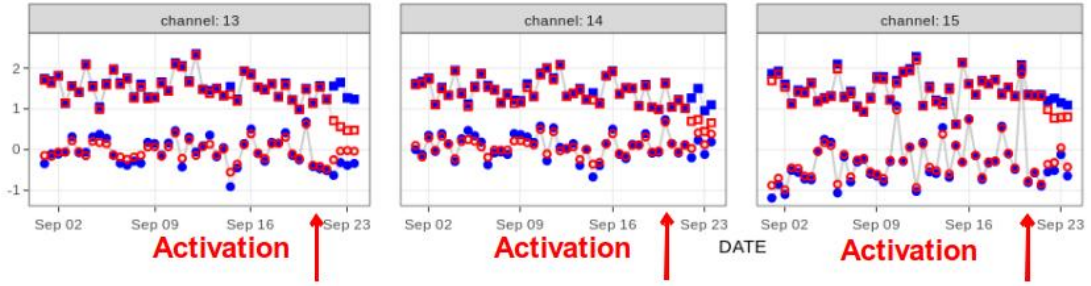
FY3D MWHS-2 ch 6 obs usage



Spin-up VARBC FY3D MWHS-2 ch 6, 00 UTC



FY3D MWHS-2 ch 11-12 time serie ob-fit statistics 00,12 UTC



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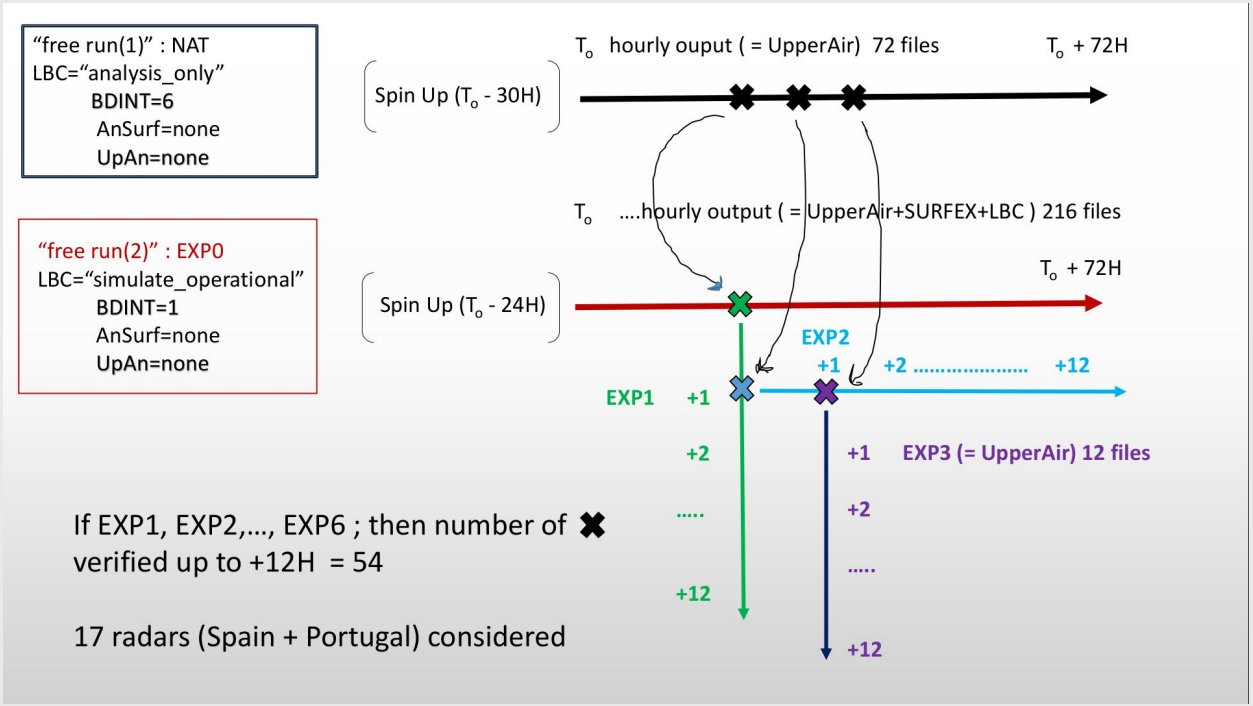
Highlight of the progress – initialisation

Filed alignment (FA) -- An OSSE study (Carlos Geijo)

More about the method can be found in (Geijo 2011: ASM presentation) using Brewster K.A (2003).

– The method explicitly represents position errors by introducing in the analysis control space a displacement vector field, defined in each analysis grid point, that gives the deformation necessary to minimize the position errors.

– The field alignment (FA) is now implemented in Harmonie-Arome and can be called during minimisation process (conf: 131).



Nature run

X are simulated observations based on long enough forecast (spinup free)

OSSE like experiments to test the concept of Field Alignment

Here, we have hourly application of FA

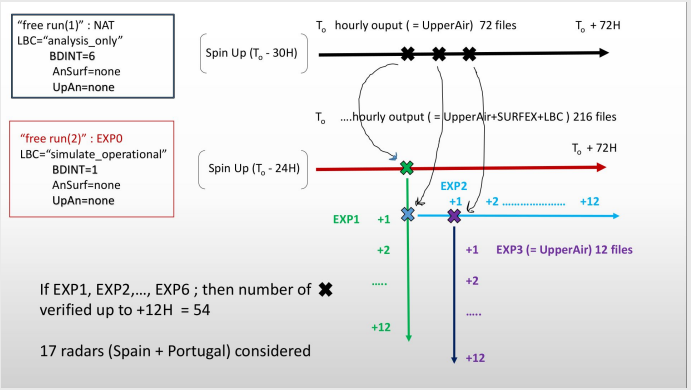
How efficient would be an hourly FA?

AEMet
Agencia Estatal de Meteorología

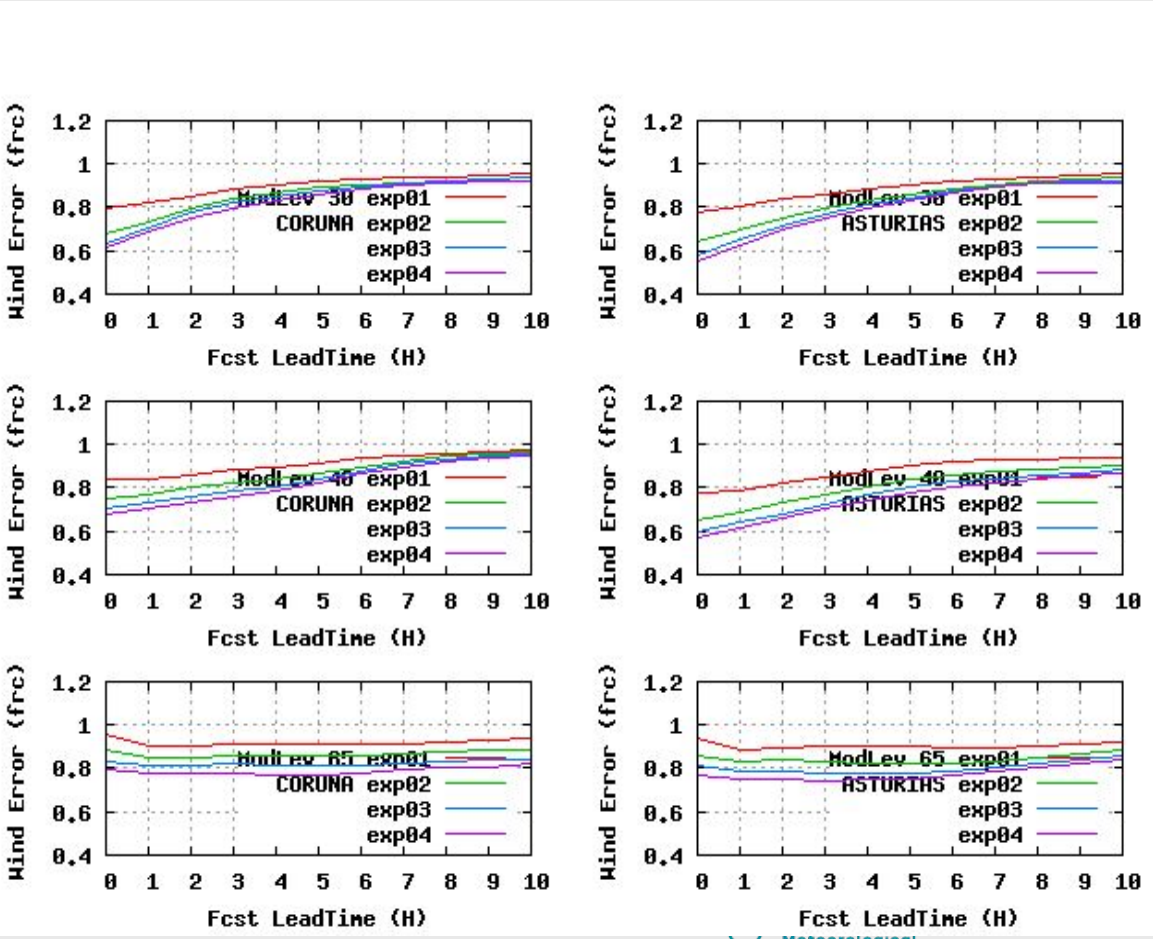
Highlight of the progress – initialisation

Filed alignment (FA) -- An OSSE study (Carlos Geijo)

Observation levels



Indirect impact



Highlight of the progress – Variational schemes

3D-Var vs 4D-Var in Nowcasting regime

(Jan Barkmeijer, Sisco de Bruijn, Siebren de Haan)

Experiments design:

Update: Regular 3D-Var 3h cycling (KNMI oper)

4D-Var: Regular 4D-Var 3h cycling
Hourly 4D-Var: 4D-Var 1h cycling (overlapping wind)
(one loop at 10km)

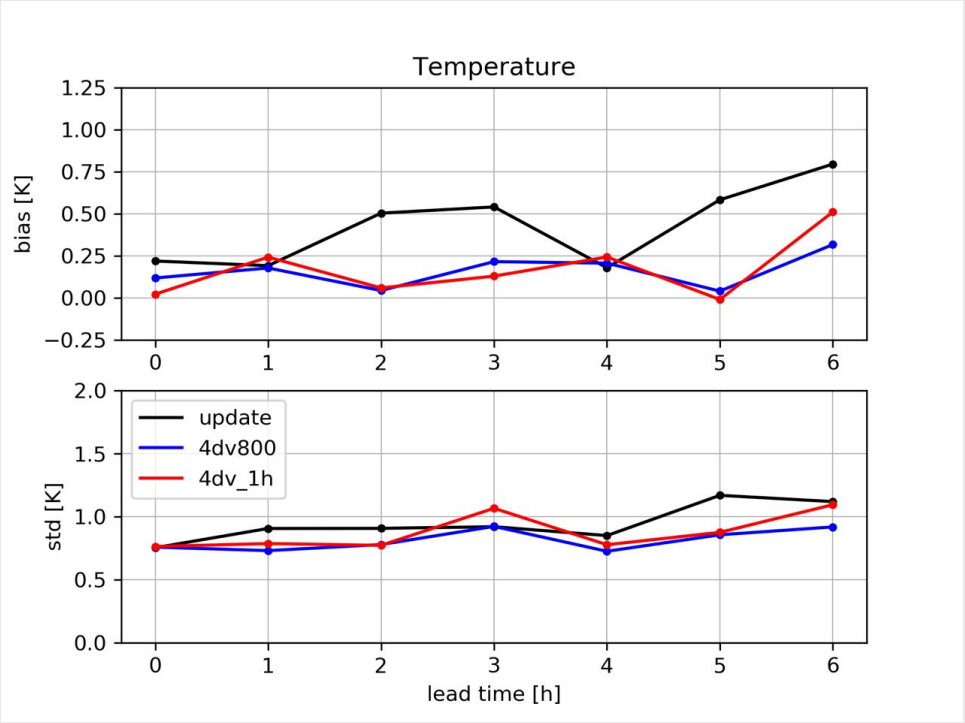
1h 4D: the fc at step=0 of the former cycle
is first guess

Test period: mid Feb. -- Mid Mar. 2020

Domain: Netherlands (800x800)

Same sets of observations, including Mode-S EHS (30 min interval around each hour)

4D-Var observation window: 2 hours



Highlight of the progress – More ongoing development

-- **Assimilation of surface pressure observations:** Group of experts working on this with very good and promising results.

-- **Máté Mile's PhD on supermodding:** Good progress with scatterometer observation.

-- **Assimilation of radar radial winds:** Some good progress achieved.

-- **Common effort on adding more observations in the operational systems !!**

-- **Good (sub-hourly) cycling strategy for nowcasting application.**

-- **Variational constraint approach:** Good progress.

-- **4D-Var:** Goal is to get this scheme operational this year !

-- **Hybrid EnVar:** Good progress. Some scientific issues discovered. Port the development into the common code.

-- **LETKF:** Maintain and further develop

More about most of these topics on the wiki page for working weeks and video meetings:
https://hirlam.org/trac/wiki/Meetings/Data_assimilation/Video_Meetings/2020

Data assimilation meetings

- **Meeting on reanalysis systems** (face to face)

- **Working weeks** (twice per year)
  - Combined meetings on the use of observations & algorithmic issues

- **Video meetings** (two series per year)
  - The use of conventional & crowdsourced observations, COPE and SAPP
  - Radar data (pre-)processing and assimilation
  - Retrievals (observations) assimilation
  - Algorithmic issues: 3DVar, 4DVar, ETKF, etc…
  - Radiance data assimilation

  - Topical meeting: On B matrix computation and use
    Next: On R matrix computation and use; Non-Festat-based B computation and estimation

Wiki page: https://hirlam.org/trac/wiki/Meetings/Data_assimilation
https://hirlam.org/trac/wiki/Meetings/HR/HR_2019_LasPalmas
https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/TrainingCourses

Thank you