Data assimilation activities@SHMU

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RC LACE DA videoconference working days, 14-16/09/2020

Outline

- Operational and experimental setups of ALADIN systems
- Upgrade to CY43t2
- Scientific work
  - Katka: two individual presentations
    - Comparison of Mode-S EHS vs. MRAR
    - Assimilation of radial winds from radars
  - Imro (Martin): BLENDVAR e-suite, STD
  - MiNe: A-LAEF based QC, highres CANARI
- Future plans

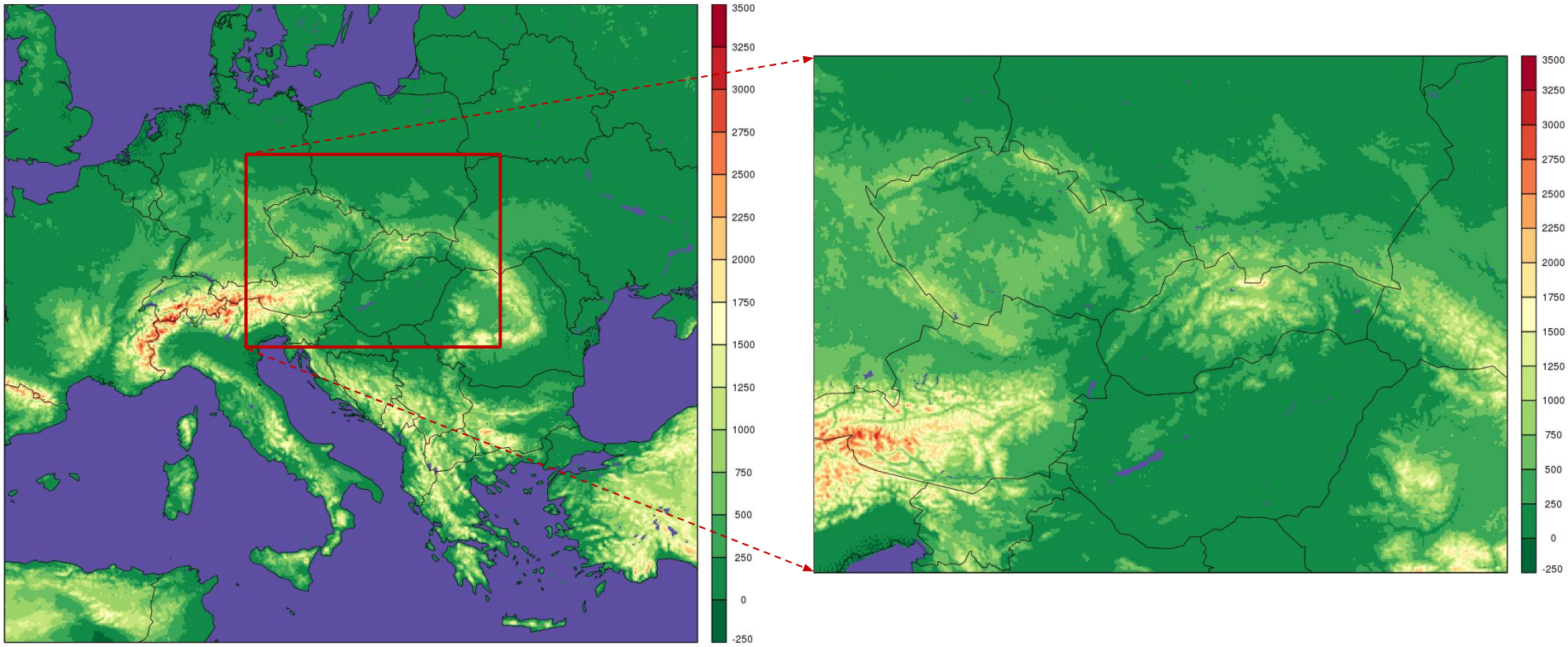
ALADIN/SHMU systems

CMC	ALARO/SHMU
status	operational
code version	CY40T1bf07_export
physics	ALARO-1vB
dx	4.5 km
pts	625 x 576
vertical levels	63
tstep	180 s
forecast ranges	78/72/72/60 (a' 1h)
coupling model	ARPEGE (long- & short cut off), 3h
assimilation	upper air spectral blending by DFI & CANARI surface assimilation
initialization	no initialization
HPC	IBM Flex System p460, linux

ALADIN/SHMU systems

CMC	**ALARO/SHMU**	**ALARO/2km**	**AROME/2km**
status	operational	experimental	
code version	CY40T1bf07_export	CY43T2_bf11	CY40T1bf07_export
physics	ALARO-1vB	ALARO-1vB	AROME-FRANCE
dx	4.5 km	2.0 km	
pts	625 x 576	512 x 384	
vertical levels	63	87	73
tstep	180 s	120 s	144 s
forecast ranges	78/72/72/60 (a' 1h)	78/72/72/60 (a' 1h)	-
coupling model	ARPEGE (long- & short cut off), 3h	ARPEGE, 1h	ALARO-1vB (4.5 km), 1h
assimilation	upper air spectral blending by DFI & CANARI surface assimilation	downscaling	
initialization	no initialization	DFI	no initialization
HPC	IBM Flex System p460, linux	IBM p755 running with IBM Flex System p460, linux	

Operational & HR models domains

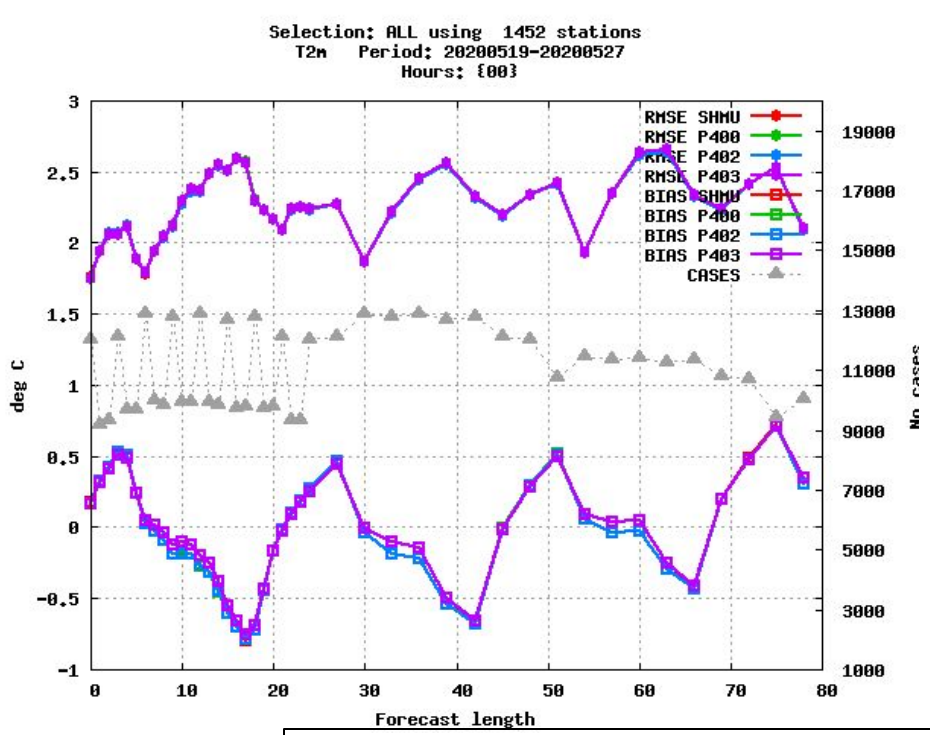


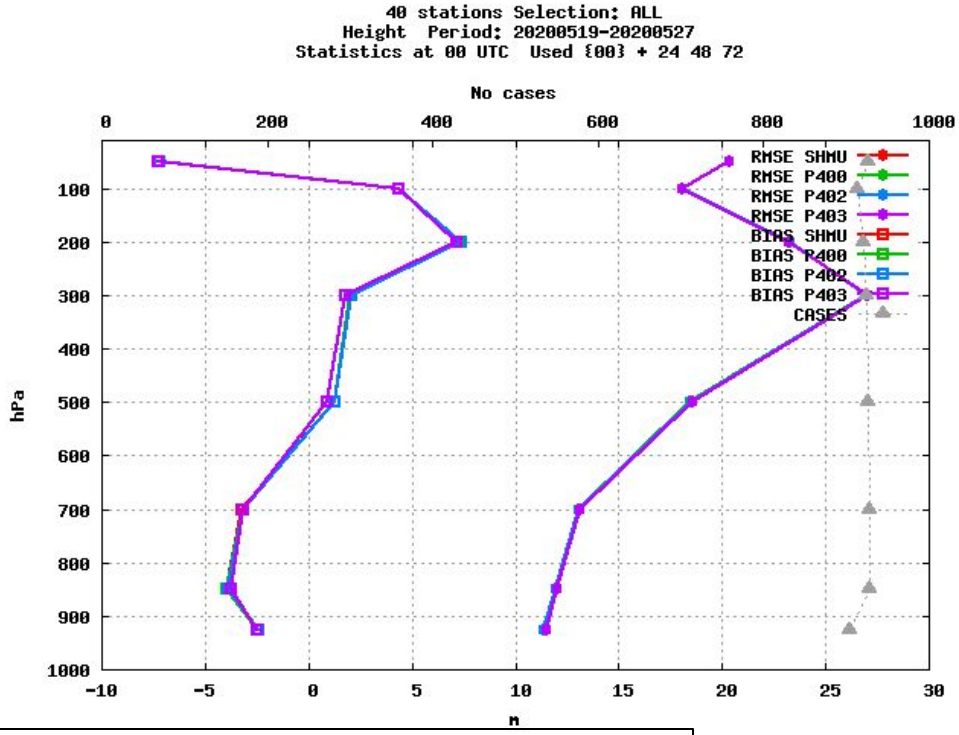
ALARO 4.5 km/L63

ALARO 2.0 km/L87
AROME 2.0 km/L73

Upgrade to CY43T2bf10 - direct model

- Originally not planned -> only for new HPC, that is heavily delayed
- ee927, e001, DF BLENDING - no particular problems, scores neutral



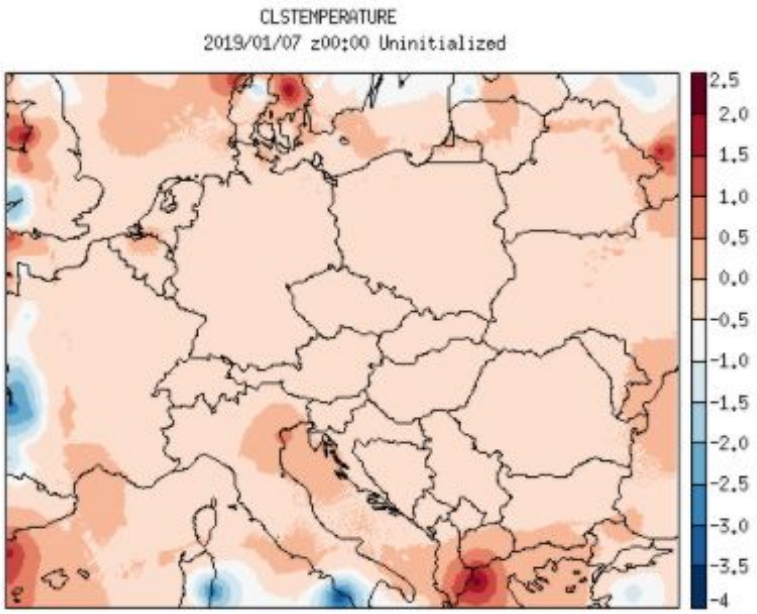


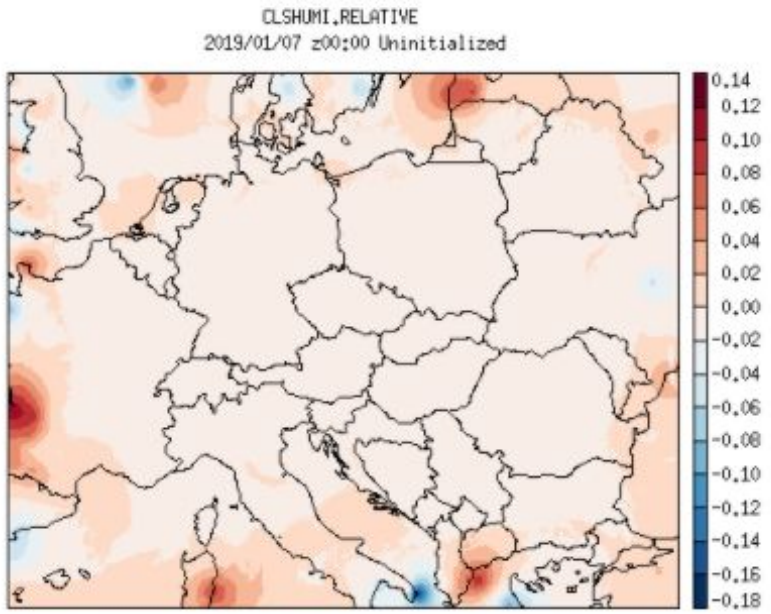
SHMU oper vs **P403: CY43t2, but CANARI on CY40t1**

Upgrade to CY43T2bf10 - CANARI

- Many changes in CANARI CY43t2 (OOPS)
- Changed LSREJ switch functionality - CHMI solution of local blacklisting of stations surrounded by sea was adopted

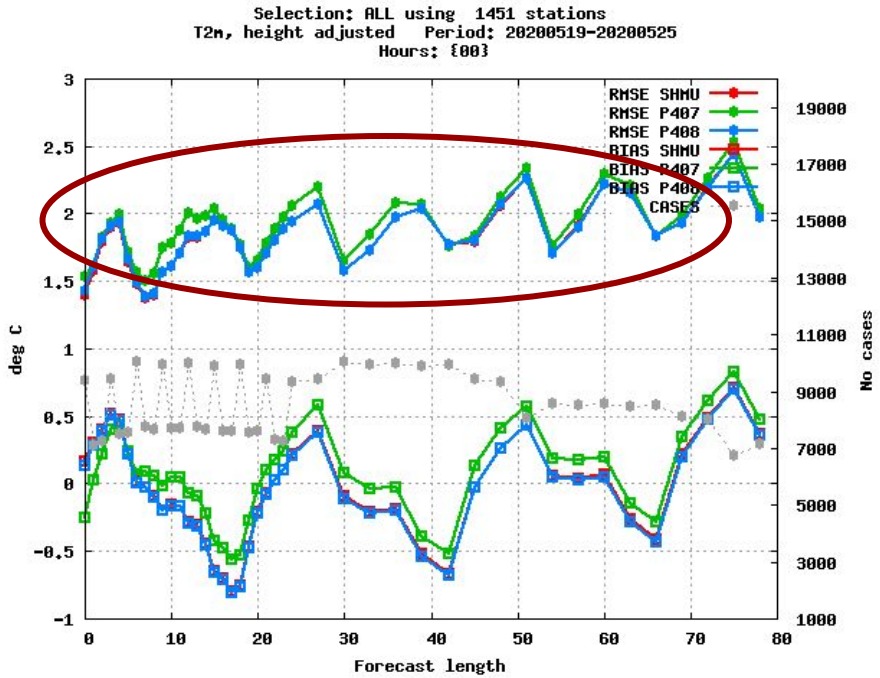
The analysis differences: CY40t1 vs. CY43t2:

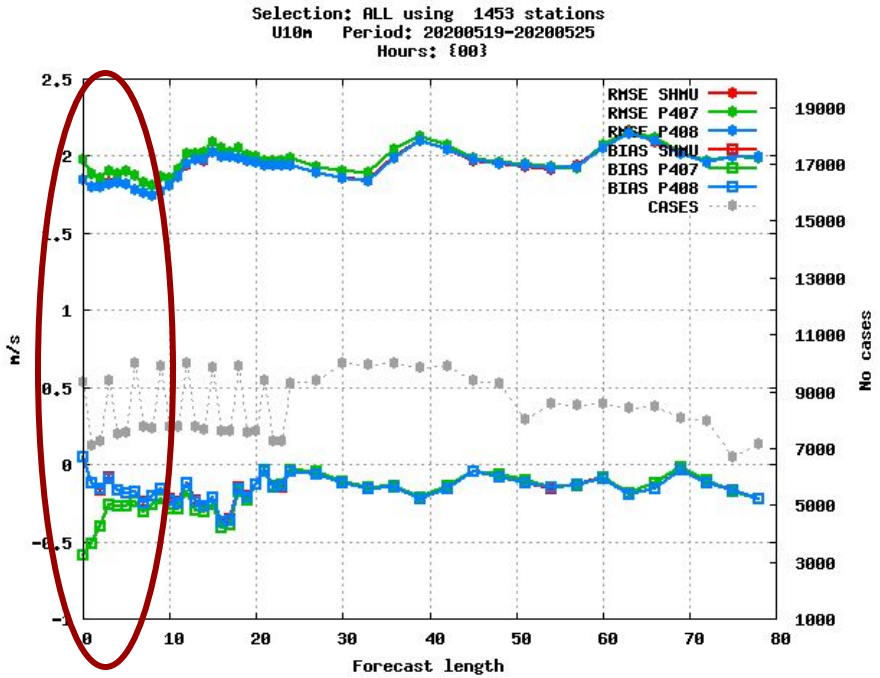




Upgrade to CY43T2bf10 - surface DA

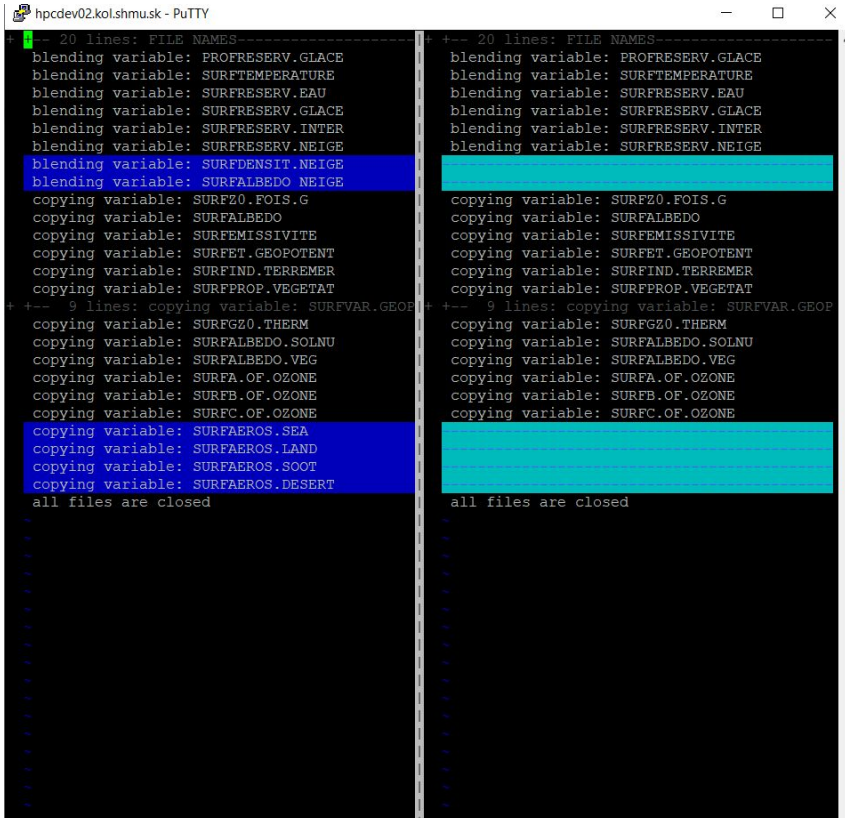
- BLENDSUR is used to get SST from Arpege analysis
- Scores problem in e-suite (**P407**) with surface DA on CY43t2, the rest of suite as in operations on CY40t1
- **P408** with corrected BLENDSUR - scores wrt **SHMU** operational OK

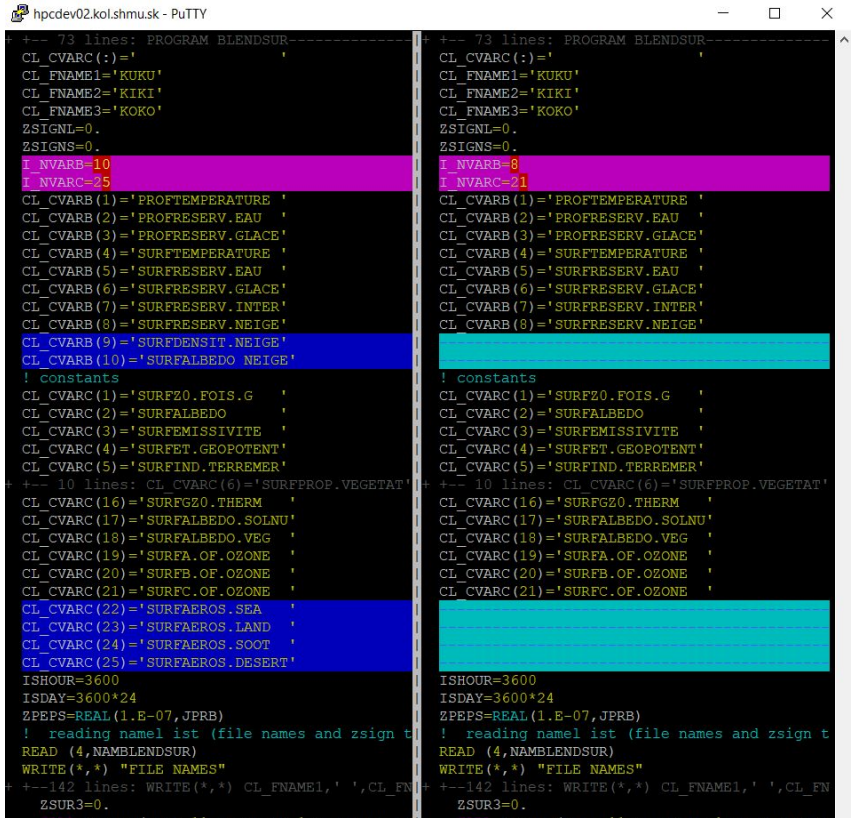




Upgrade to CY43T2bf10 - surface DA

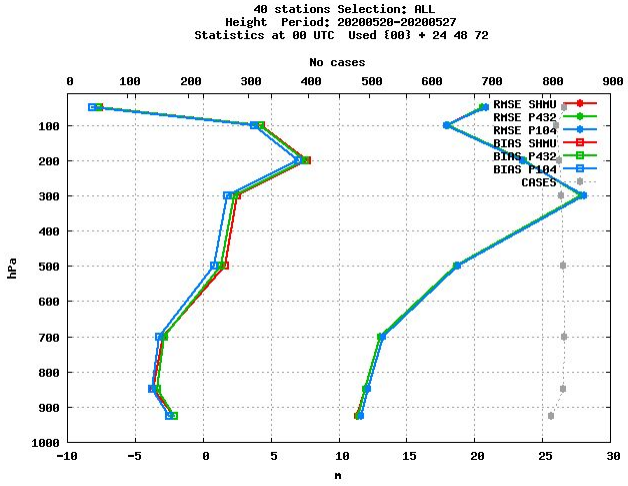
blendsur.F90: the fields to be copied are hardcoded. Differences between local and export versions were not checked => stupid bug contaminated whole assimilation (didactic warning: cycle with caution!)

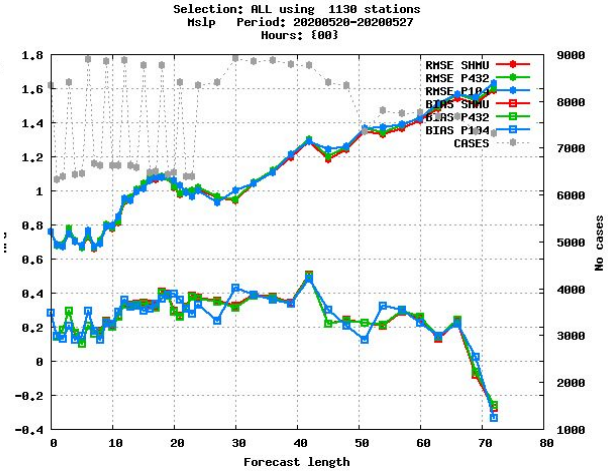


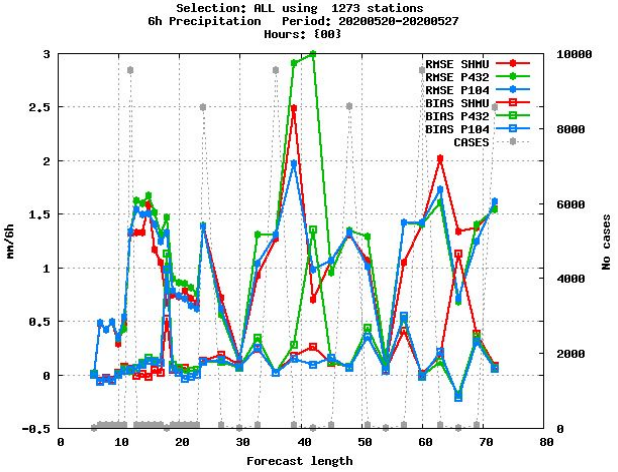


Short experiment with hourly coupling

- 20.-27.05.2020, downscaling mode, hourly LBC in production
- Mixed results - scores mostly neutral
- ?? geopotential, MSLP; messy precipitation scores
- No improvement in two realized case studies: overestimated wind gust, underestimated morning freezing temperatures







SHMU - **P432**: CY43T2_bf10 in e001 - **P104**: CY43T2_bf10 in e001 + 1h LBC

3D-Var on CY43T2bf10 for ALARO 4.5 km

- Till 2020 all 3D-Var experiments @SHMU (ZTD, Mode-S) have been run on AROME 2 km/L73 domain with CY40T1
- Early 2020: DA configurations for conventional observations (blending, bator, e002, e701, e131) have been ported/upgraded and validated for operational ALARO 4.5 km/L63 domain with CY43t2
- Reference = Alena's script on beaufix (many thanks!)
- Several local problems linked to the (old version of) gcc compiler on the IBM platform had been identified and solved in close collaboration with RC LACE ASC (Olda). Some of the fixes have been promoted for CY43t2bf11. OMP issue in shuffle still open.
- B-matrix - downscaled ARPEGE EPS
- 3D-Var scripts were adapted for operational environment (run_app in perl) => milestone for SHMU 3D-Var

CY43T2bf10 BLENDVAR e-suite

SYNOP
TEMP
AMDAR

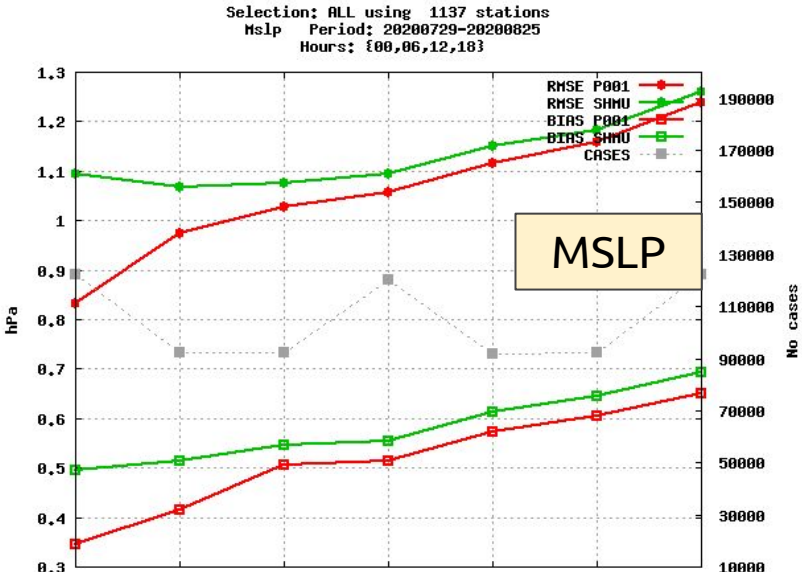
RAW (=no tuning) e-suite 29/07-25/08

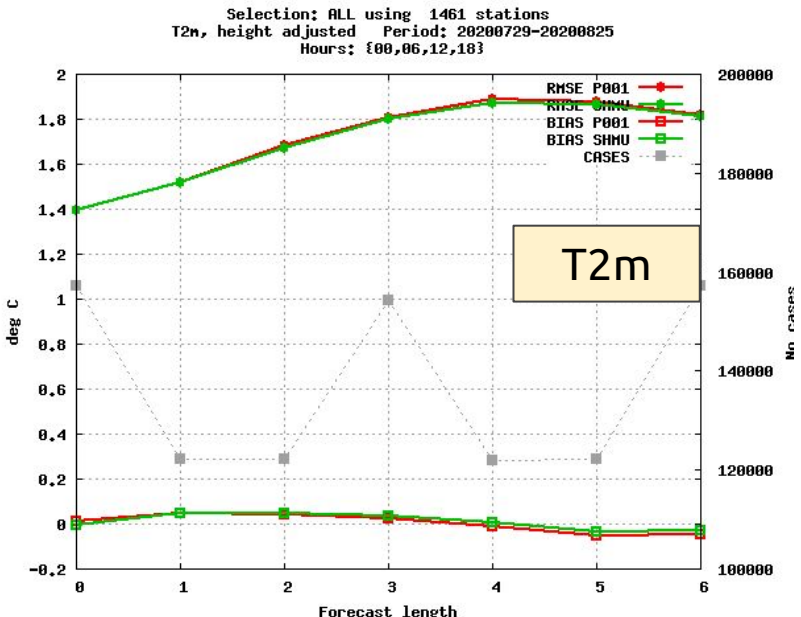
SHMU operational BLENDING CY40t1
P001 BLENDVAR CY43t2

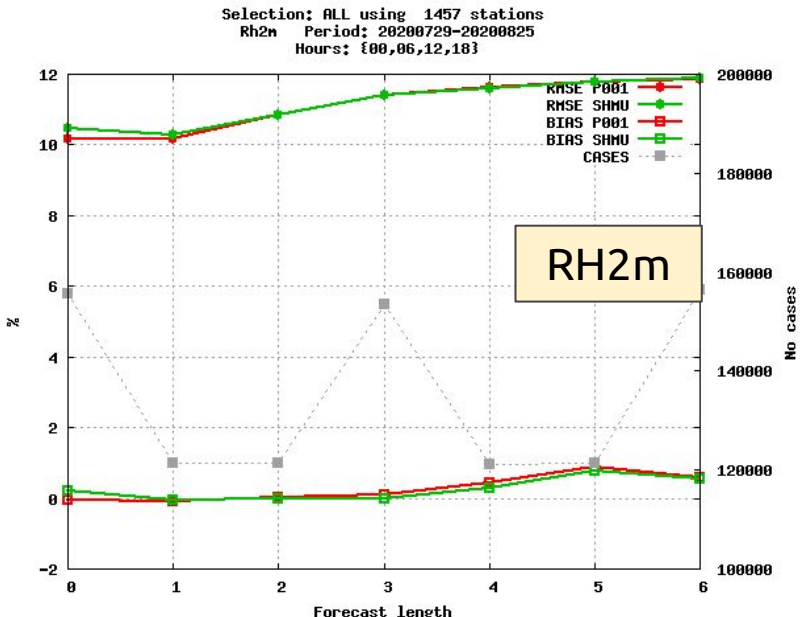
LS parameters improved

2m thermodynamic params. “neutral”

Impact lost after 6h

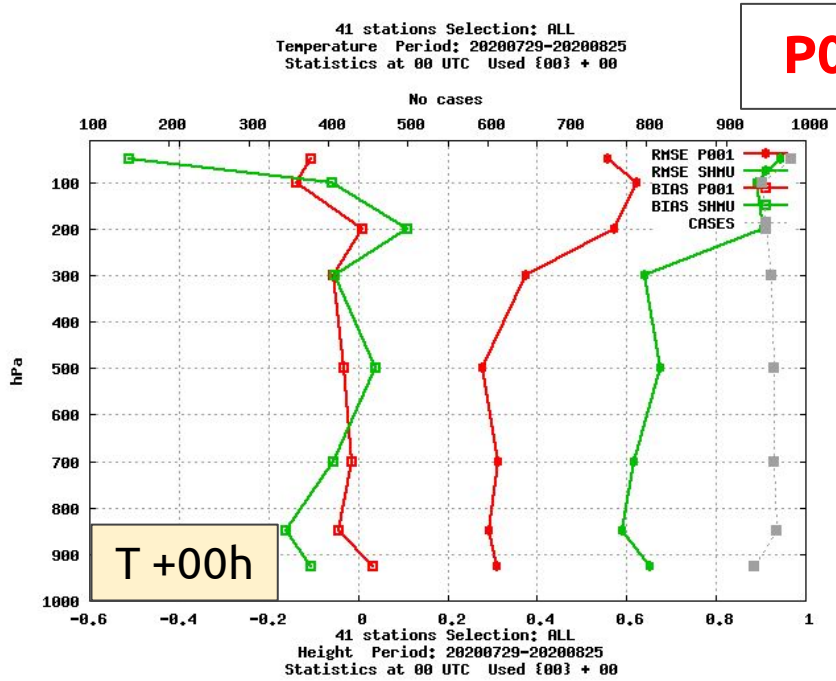


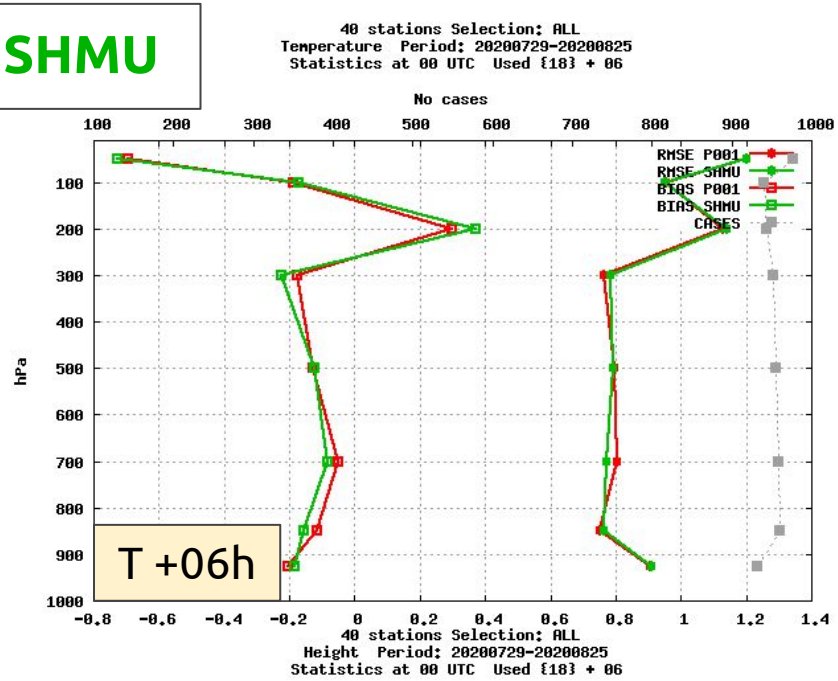


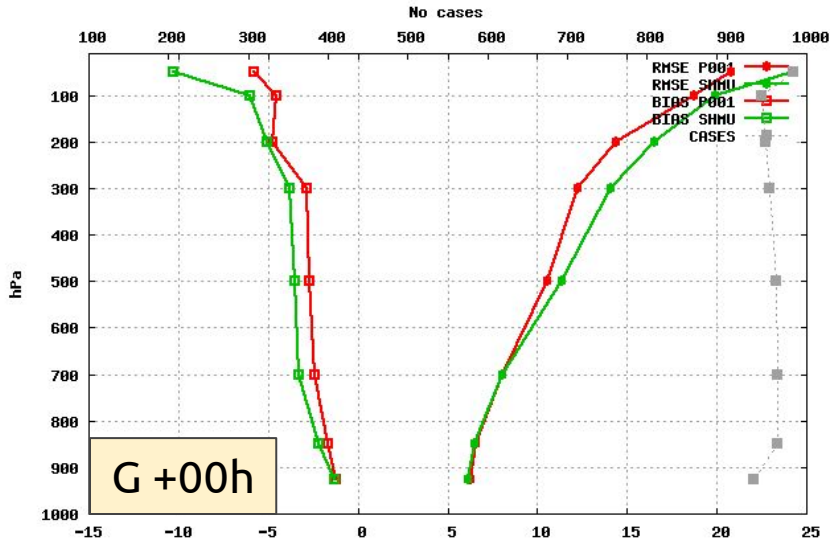


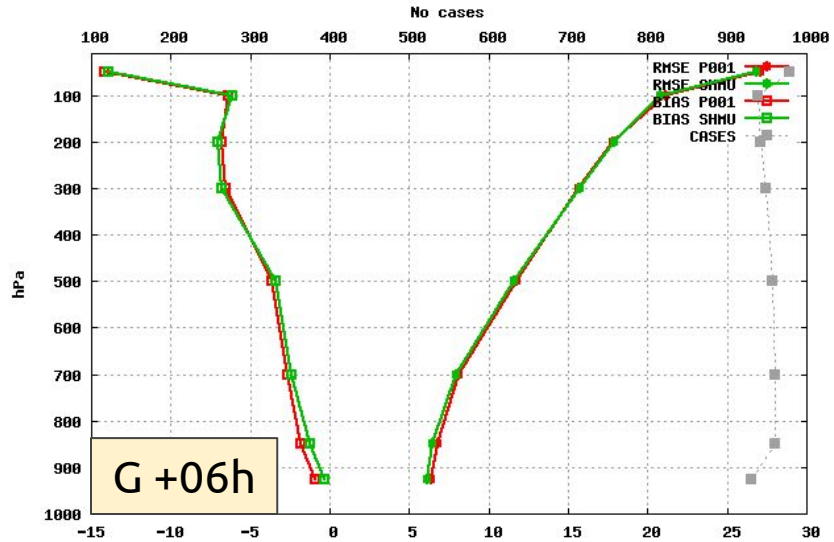
CY43T2bf10 BLENDVAR e-suite

P001- SHMU





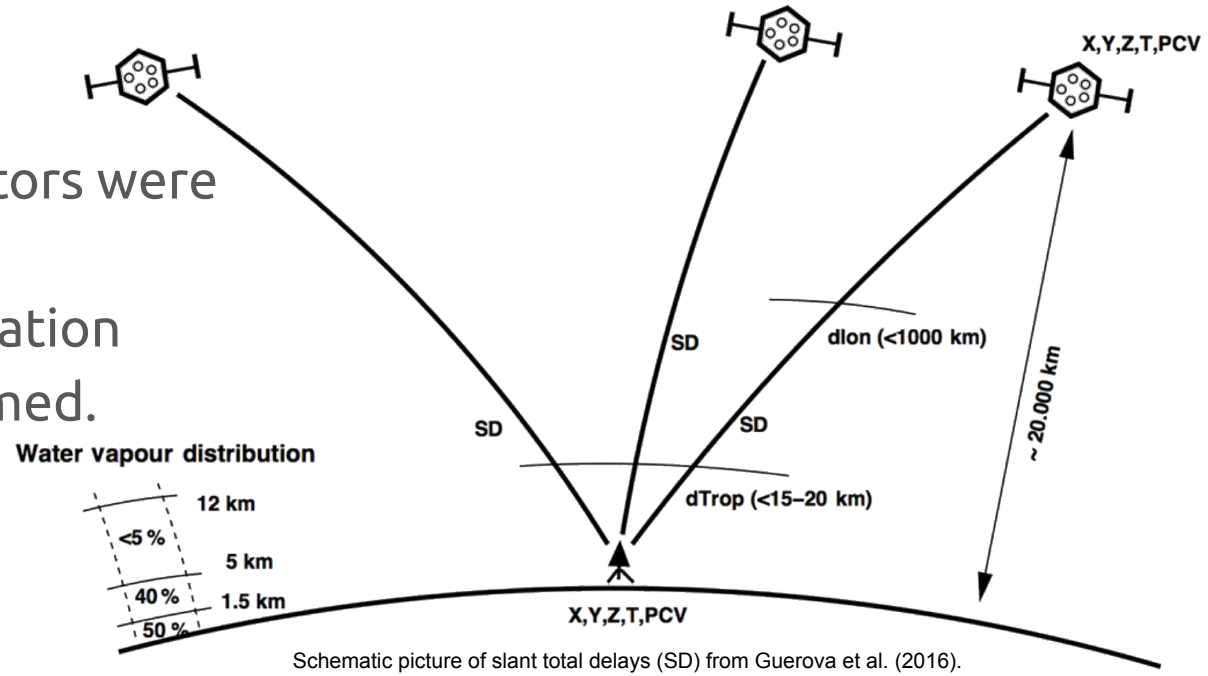




GNSS slant total delays

- Phased from cy40h1 to cy43t2bf10
- Observation type (19) and observation (129) were added.
- Nonlinear, TL, AD observation operators were developed.
- Preliminary assimilation tests were performed.

Financed by RCLACE and C-SRNWP



Schematic picture of slant total delays (SD) from Guerova et al. (2016).

Report available : http://www.rclace.eu/File/Data_Assimilation/2019/repStay_MImrisek_STDphasing_2019.pdf

GNSS slant total delays: BATOR

```
20190824 00
17 19 111 48.751804 19.151007 'BBYSSUT_' 20190824 000000 448.183 1 11111 0
129 165.186112 64.179396 2.681502 1.003

     NSTD                          NCINLV - number of slants/ROBODY-s  NCISTD
NGNSS   |       LAT       LON station id     date  time altitude |  Flag |
    |   |         |         |          |        |     |        | |     | |
17 19 111 48.751804 19.151007 'BBYSSUT_' 20190824 000000 448.183 1 11111 0 -- header
                       satellite number
ASTD   azimuth elevation      STD | error
  |          |         |        | |   |
129 165.186112 64.179396 2.681502 1.003                                  -- body
```

Listing 1: The example of OBSOUL.conv file

New fields added to BODY table:

- MDB_SATID_AT_BODY – Satellite identifier, meant to be used for satellite blacklisting,
- MDB_AZIMUTH_AT_BODY – Azimuth of satellite at GNSS station,
- MDB_ELEVATION_AT_BODY – Elevation angle of satellite at GNSS station,
- MDB_REFCONST_AT_BODY – Refractivity constant at GNSS station.
- MDB_PHI_AT_BODY – geocentric angle between GNSS station and GNSS satellite.

GNSS slant total delays: SCREENING

The number of vertical profiles in model space is set by namelist variable NOBSPROFS:

```
&NAMNPROF
  NOBSPROFS(19)=87,
/
```

- **φ** is the geocentric angle from GNSS station to satellite,
- $\Delta\varphi_k$ s the difference of geocentric angles between two intersections of GNSS signal and model levels,
- h_{top} is the level closest to satellite where the signal is bent for the last time.

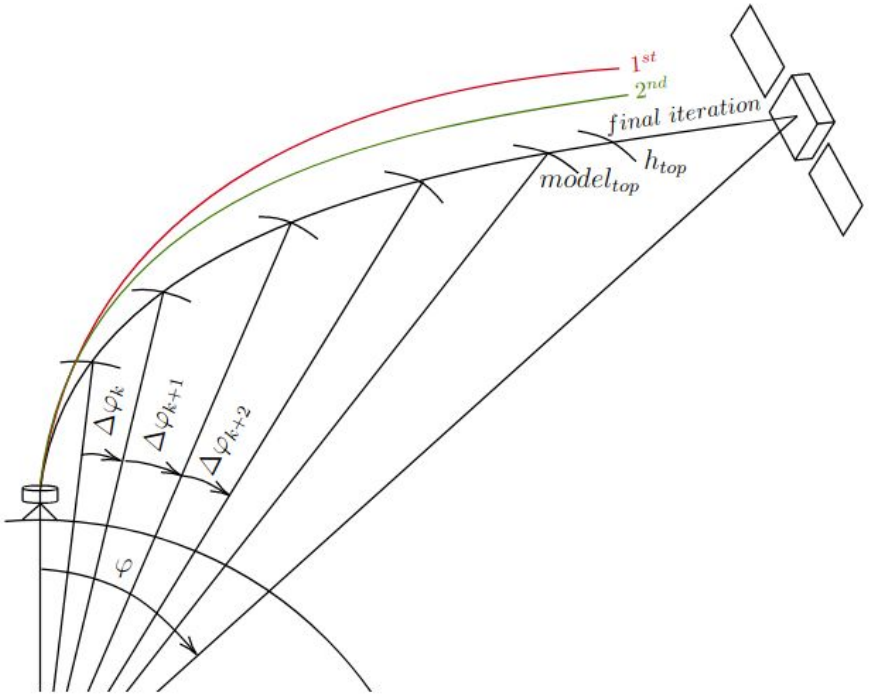


Figure 2: GNSS signal path.

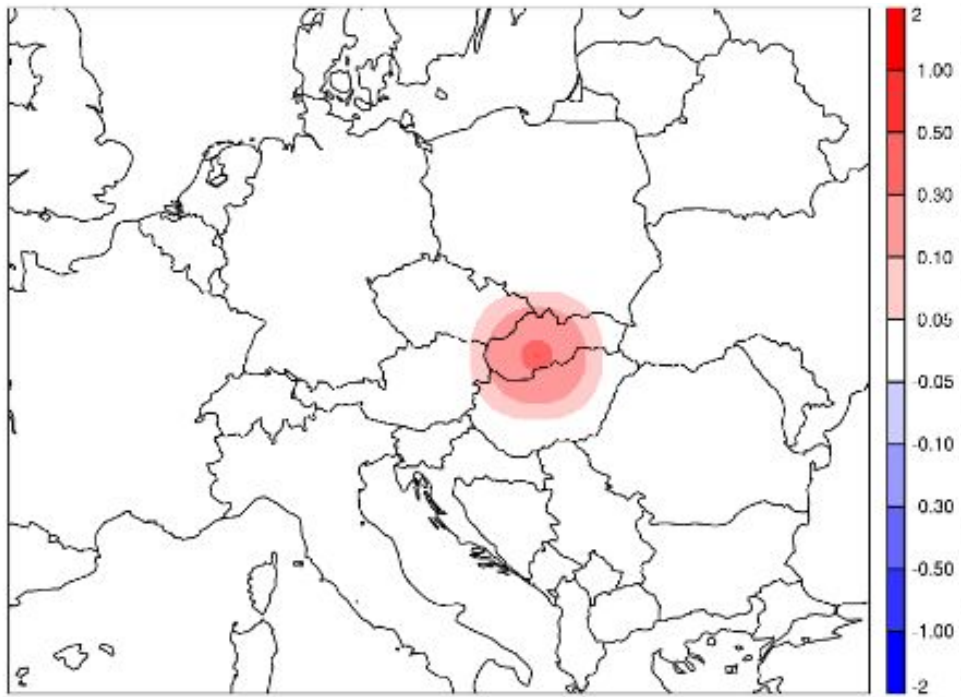
GNSS slant total delays: MINIMISATION

It is mandatory to switch on the use of STD observations in J_o. This is done with NOTVAR variable in minimisation namelist:

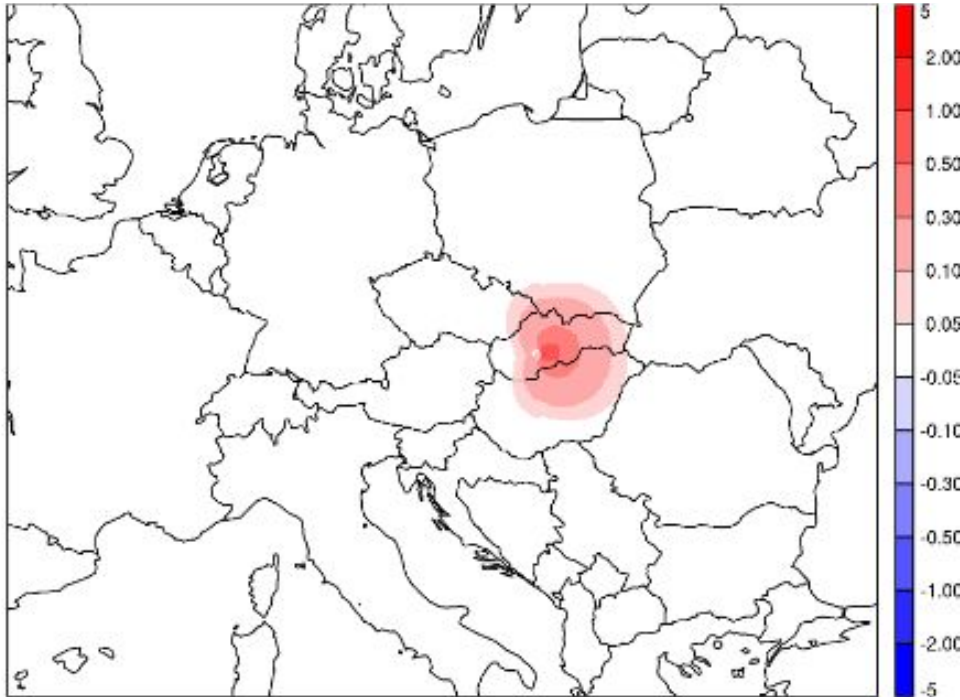
```
&NAMCOSJO
  NOTVAR(1,19)=-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,-1,-1,
/
```

Listing 8: New NOTVAR variable in *fort.4* file for MINIMISATION

Increments of specific humidity of single STD assimilation:



Increments of specific humidity of all STDs assimilation:



GNSS slant total delays: Outlook

- Phase the actual version of the code to higher cycles gradually
- Perform more assimilation studies

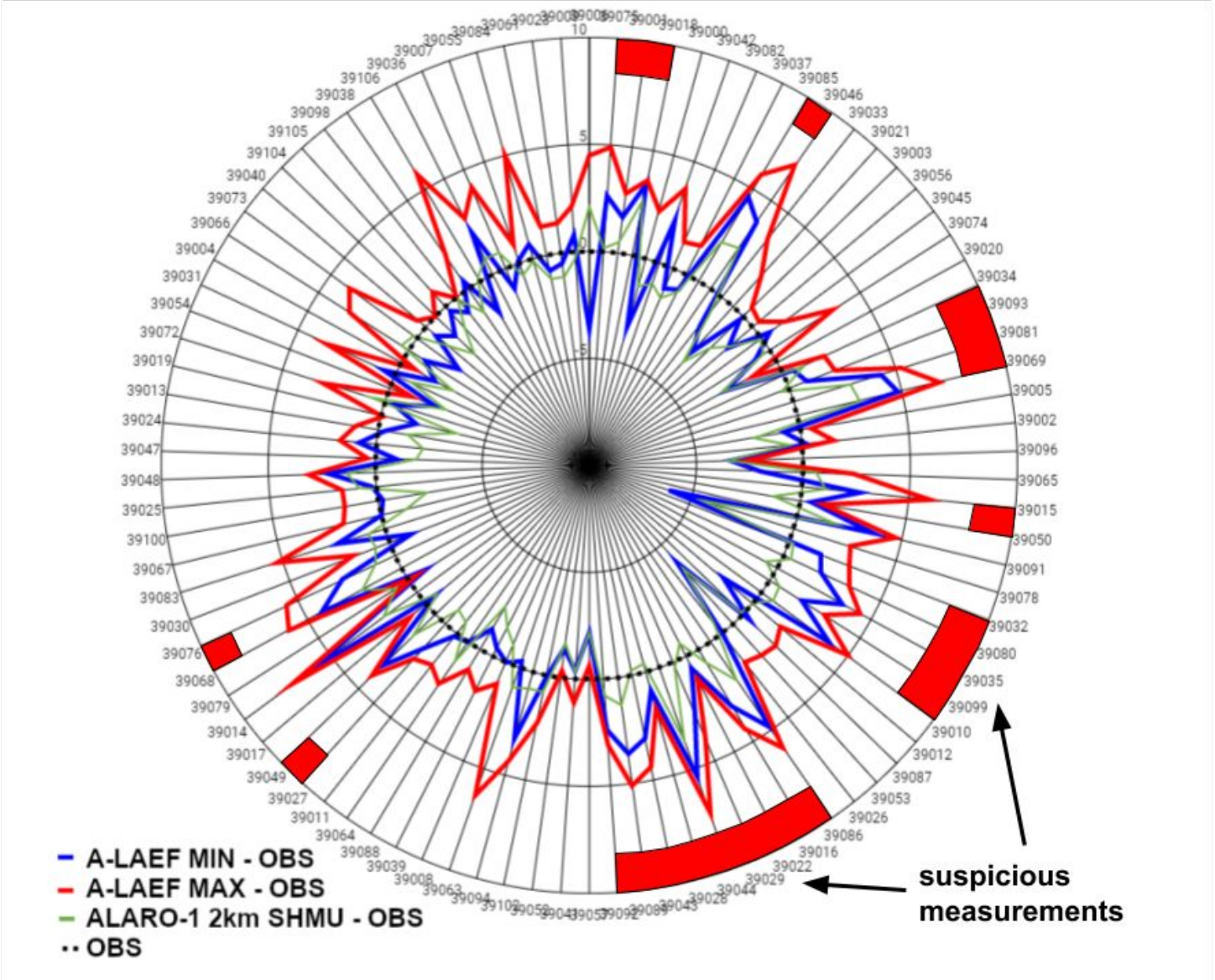
Local QC based on A-LAEF

The experiences gained through INCA nowcasting and high resolution ALARO-1 reanalyses on 1-2 km grids led to a necessity of automatic quality control (QC). Without a proper QC, the automatic weather station (AWS) measurements often brought a spurious signal into the analysis.

A physically consistent spread of the meteorological fields provided by the A-LAEF ensemble was the main motivation for its use in an automatic QC procedure (in a new software level above MySQL database).

As a first attempt the QC of 2m temperature was tested at SHMU. The suspicious AWS measurements with values out of the A-LAEF spread were identified

Local QC based on A-LAEF

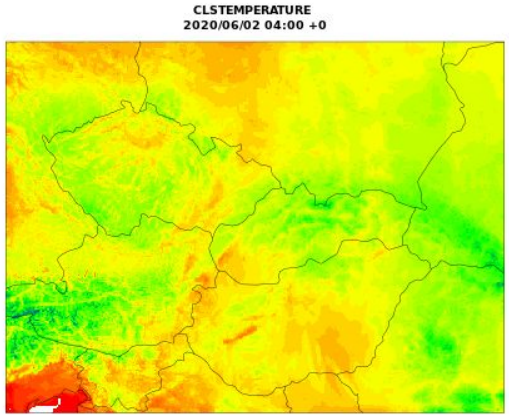


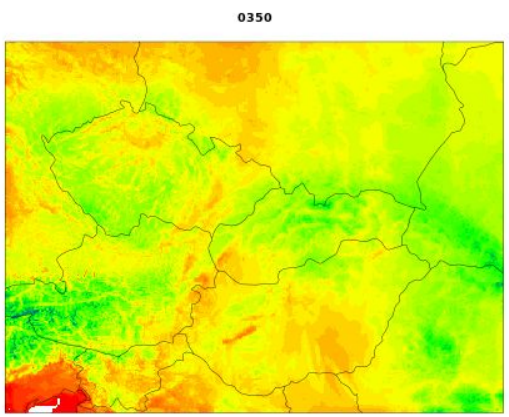
HighRes surface DA

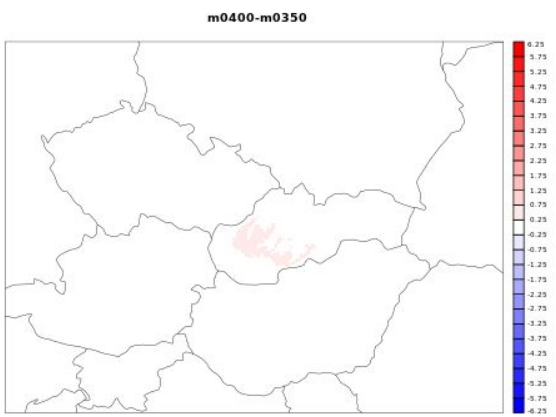
Hourly CANARI/MESCAN analyses (OPLACE + local AWS) were run to assess an impact of 10 minutes time difference in the observations from AWS (HH, 00 min) and SYNOP (HH-1, 50 min. in some countries).

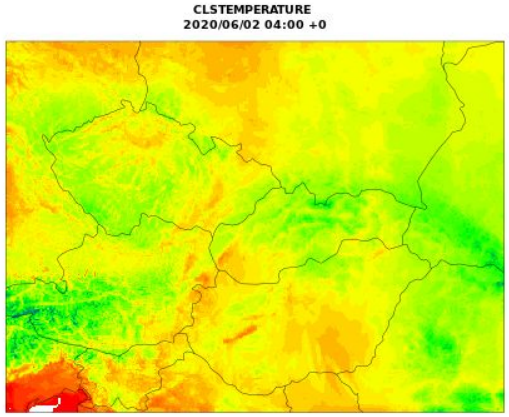
Also, the 10 min gradient in temperature is being checked for potential use in observations QC

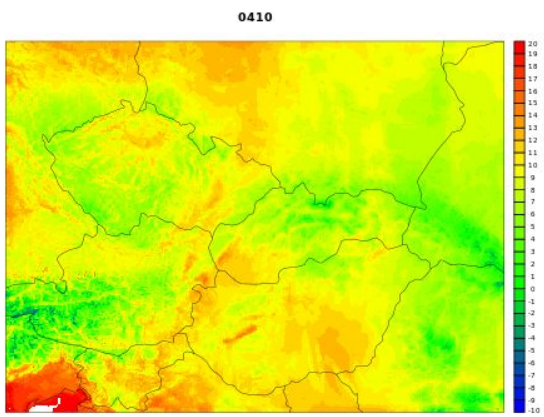
HighRes surface DA

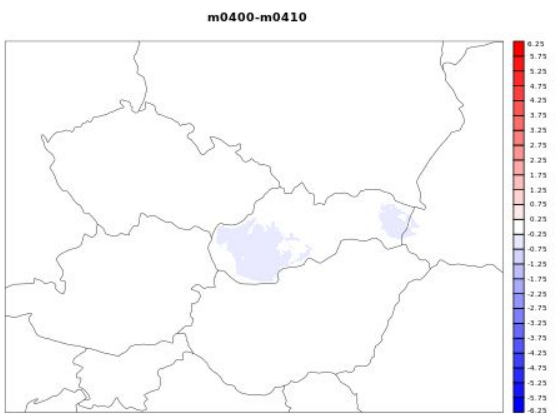












Future plans

- Finishing the upgrade and validation of CY43t2bf11 for DF BLENDING + CANARI for operational ALARO (4.5 km/L63)
- Further validation and tuning of BLENDVAR for ALARO (4.5 km/L63)
- Start observation monitoring
- Resolution increase - pending new HPC