



# 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

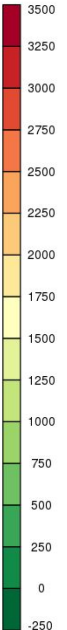
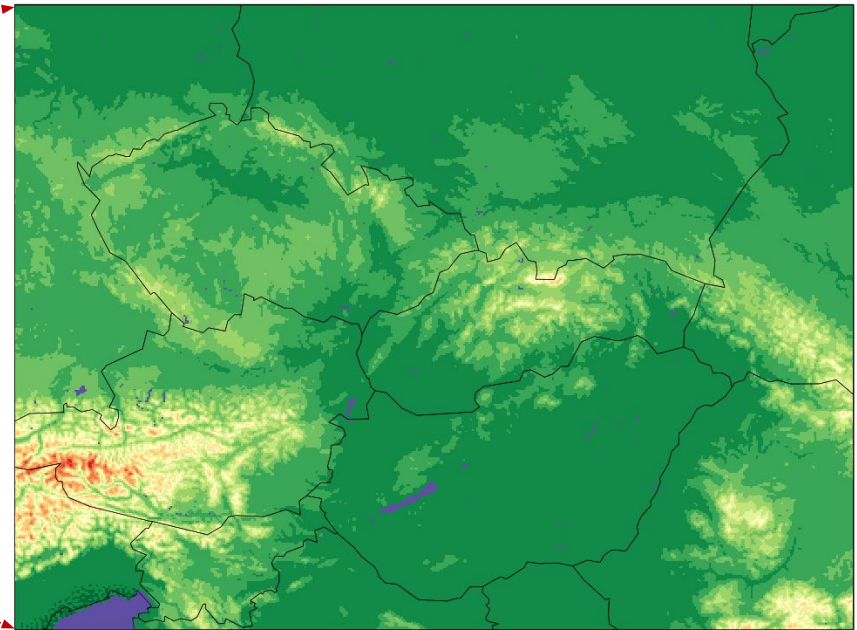
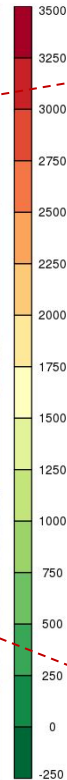
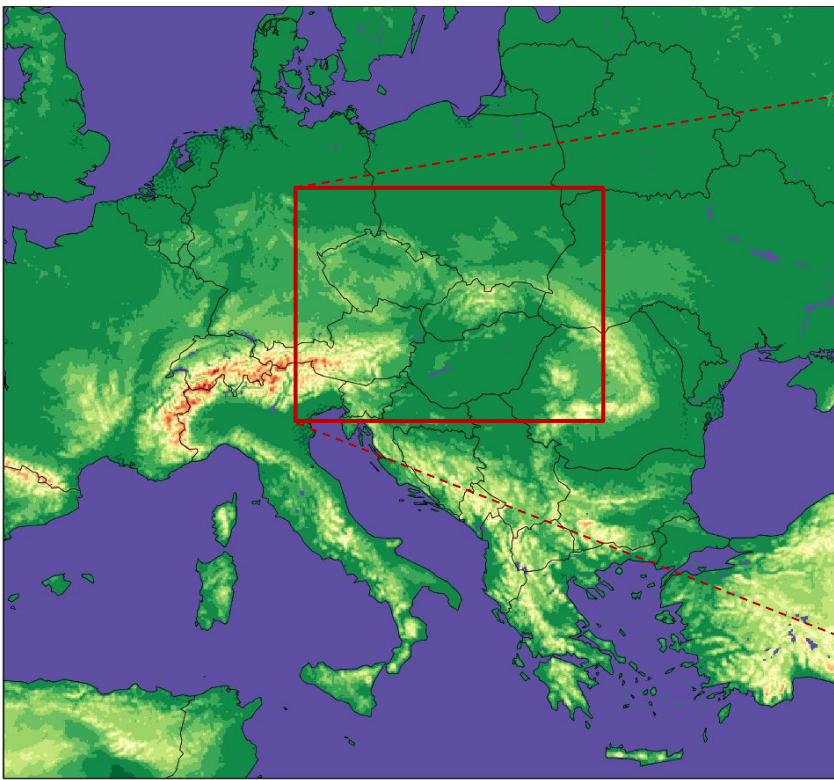
# ALADIN/SHMU systems

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

# ALADIN/SHMU systems

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

# Operational & HR models domains



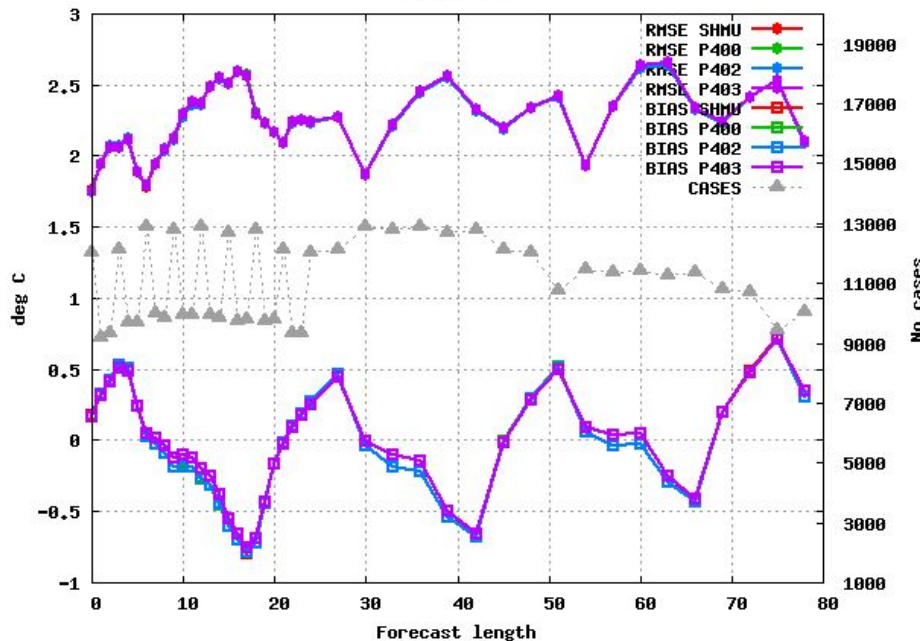
ALARO 4.5 km/L63

ALARO 2.0 km/L87  
AROME 2.0 km/L73

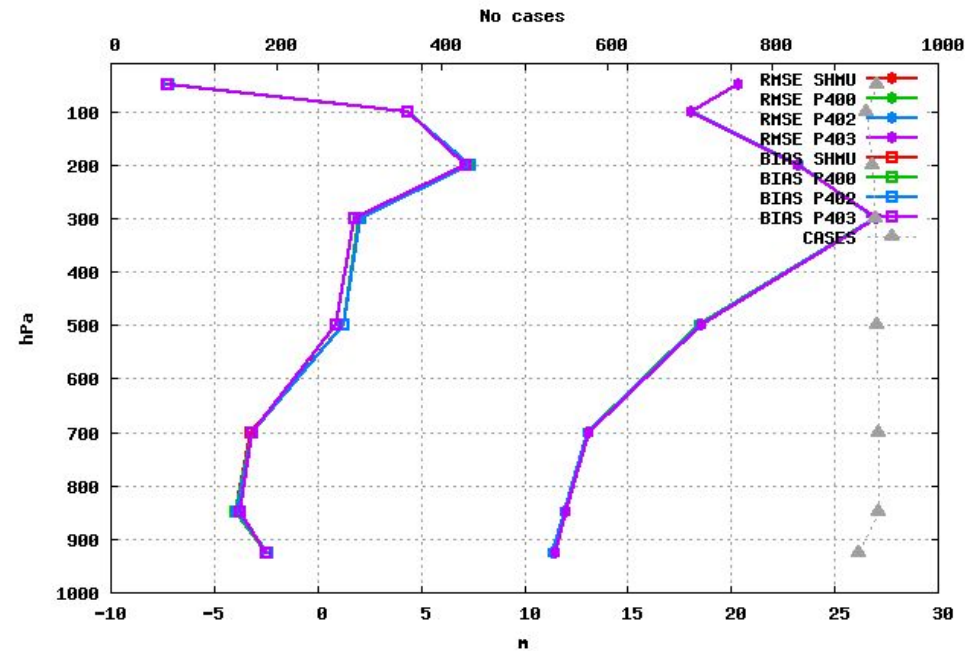
# Upgrade to CY43T2bf10 - direct model

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

Selection: ALL using 1452 stations  
T2m Period: 20200519-20200527  
Hours: {00}



40 stations Selection: ALL  
Height Period: 20200519-20200527  
Statistics at 00 UTC Used {00} + 24 48 72



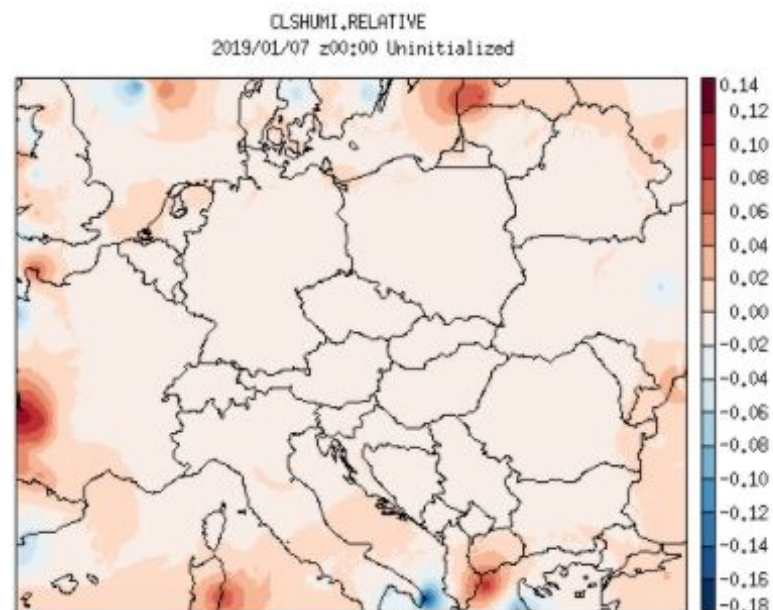
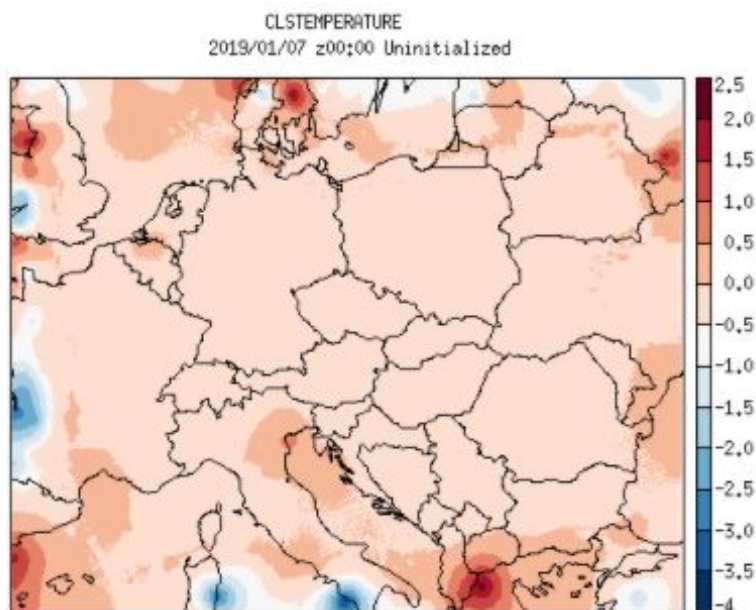
**SHMU oper** vs **P403: CY43t2**, but **CANARI on CY40t1**



# Upgrade to CY43T2bf10 - CANARI

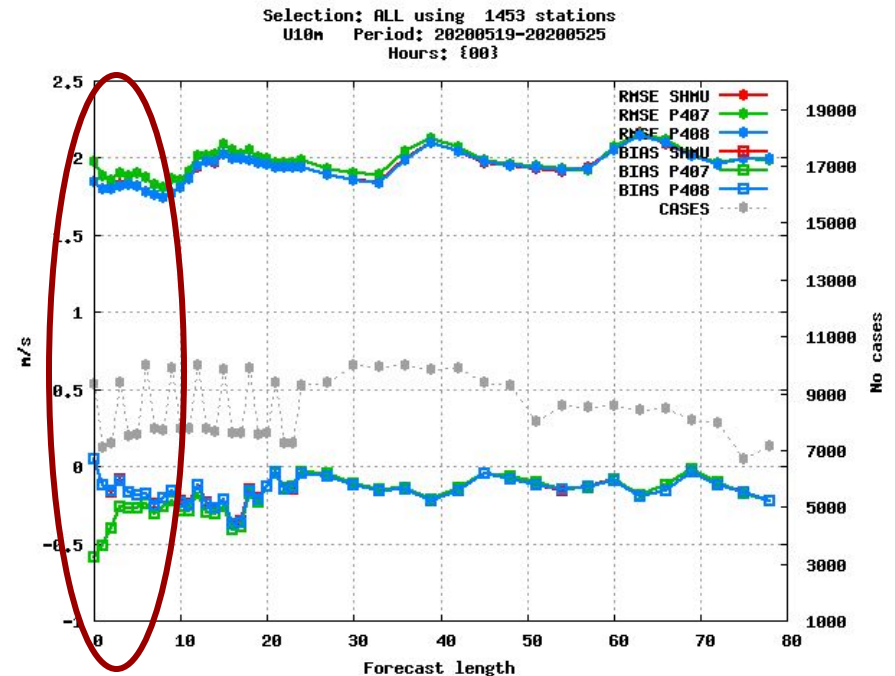
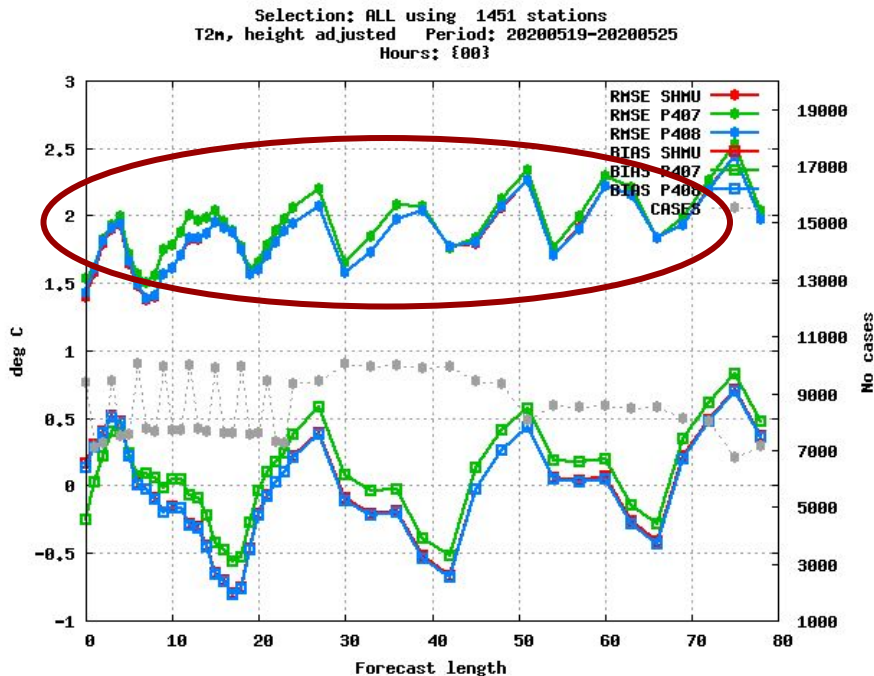
- Many changes in CANARI CY43t2 (OOPS)
- Changed LSREJ switch functionality - CHMI solution of local blacklisting of stations surrounded by sea was adopted

The analysis differences: CY40t1 vs. CY43t2:



# Upgrade to CY43T2bf10 - surface DA

- BLEND SUR 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 BLEND SUR - 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!)

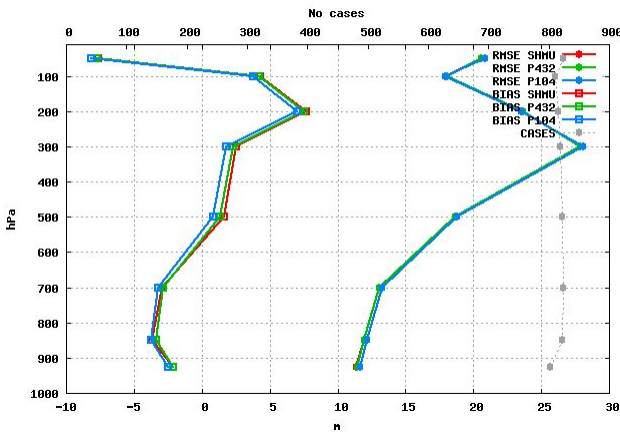
```
hpcdev02.kol.shmusk - PuTTY
+-- 20 lines: FILE NAMES-----
blending variable: PROFRESERV.GLACE
blending variable: SURFTEMPERATURE
blending variable: SURFRESERV.EAU
blending variable: SURFRESERV.GLACE
blending variable: SURFRESERV.INTER
blending variable: SURFRESERV.NEIGE
blending variable: SURFDENSIT.NEIGE
blending variable: SURFALBEDO.NEIGE
copying variable: SURFZ0.FOIS.G
copying variable: SURFALBEDO
copying variable: SURFEMISSIVITE
copying variable: SURFET.GEOPOTENT
copying variable: SURFIND.TERREMER
copying variable: SURFPROP.VEGETAT
+-- 9 lines: copying variable: SURFVAR.GEOP
copying variable: SURFGZ0.THERM
copying variable: SURFALBEDO.SOLNU
copying variable: SURFALBEDO.VEG
copying variable: SURFA.OF.OZONE
copying variable: SURFB.OF.OZONE
copying variable: SURFC.OF.OZONE
copying variable: SURFAEROS.SEA
copying variable: SURFAEROS.LAND
copying variable: SURFAEROS.SOOT
copying variable: SURFAEROS.DESERT
all files are closed
-----
+-- 20 lines: FILE NAMES-----
blending variable: PROFRESERV.GLACE
blending variable: SURFTEMPERATURE
blending variable: SURFRESERV.EAU
blending variable: SURFRESERV.GLACE
blending variable: SURFRESERV.INTER
blending variable: SURFRESERV.NEIGE
copying variable: SURFZ0.FOIS.G
copying variable: SURFALBEDO
copying variable: SURFEMISSIVITE
copying variable: SURFET.GEOPOTENT
copying variable: SURFIND.TERREMER
copying variable: SURFPROP.VEGETAT
+-- 9 lines: copying variable: SURFVAR.GEOP
copying variable: SURFGZ0.THERM
copying variable: SURFALBEDO.SOLNU
copying variable: SURFALBEDO.VEG
copying variable: SURFA.OF.OZONE
copying variable: SURFB.OF.OZONE
copying variable: SURFC.OF.OZONE
all files are closed
```

```
hpcdev02.kol.shmusk - PuTTY
+-- 73 lines: PROGRAM BLENDSUR-----
CL_CVARC(:)='
CL_FNAME1='KUKU'
CL_FNAME2='KIKI'
CL_FNAME3='KOKO'
ZSIGNL=0.
ZSIGNS=0.
I_NVARB=10
I_NVARC=25
CL_CVARB(1)='PROFTEMPERATURE'
CL_CVARB(2)='PROFRESERV.EAU'
CL_CVARB(3)='PROFRESERV.GLACE'
CL_CVARB(4)='SURFTEMPERATURE'
CL_CVARB(5)='SURFRESERV.EAU'
CL_CVARB(6)='SURFRESERV.GLACE'
CL_CVARB(7)='SURFRESERV.INTER'
CL_CVARB(8)='SURFRESERV.NEIGE'
CL_CVARB(9)='SURFDENSIT.NEIGE'
CL_CVARB(10)='SURFALBEDO.NEIGE'
! constants
CL_CVARC(1)='SURFZ0.FOIS.G'
CL_CVARC(2)='SURFALBEDO'
CL_CVARC(3)='SURFEMISSIVITE'
CL_CVARC(4)='SURFET.GEOPOTENT'
CL_CVARC(5)='SURFIND.TERREMER'
+-- 10 lines: CL_CVARC(6)='SURFPROP.VEGETAT'
CL_CVARC(16)='SURFGZ0.THERM'
CL_CVARC(17)='SURFALBEDO.SOLNU'
CL_CVARC(18)='SURFALBEDO.VEG'
CL_CVARC(19)='SURFA.OF.OZONE'
CL_CVARC(20)='SURFB.OF.OZONE'
CL_CVARC(21)='SURFC.OF.OZONE'
CL_CVARC(22)='SURFAEROS.SEA'
CL_CVARC(23)='SURFAEROS.LAND'
CL_CVARC(24)='SURFAEROS.SOOT'
CL_CVARC(25)='SURFAEROS.DESERT'
ISHOUR=3600
ISDAY=3600*24
ZPEPS=REAL(1.E-07,JPRB)
! reading namel ist (file names and zsign t
READ(4,NAMBLENDSUR)
WRITE(*,*) "FILE NAMES"
+--142 lines: WRITE(*,*) CL_FNAME1,' ',CL_FN
ZSUR3=0.
-----
+-- 73 lines: PROGRAM BLENDSUR-----
CL_CVARC(:)='
CL_FNAME1='KUKU'
CL_FNAME2='KIKI'
CL_FNAME3='KOKO'
ZSIGNL=0.
ZSIGNS=0.
I_NVARB=8
I_NVARC=21
CL_CVARB(1)='PROFTEMPERATURE'
CL_CVARB(2)='PROFRESERV.EAU'
CL_CVARB(3)='PROFRESERV.GLACE'
CL_CVARB(4)='SURFTEMPERATURE'
CL_CVARB(5)='SURFRESERV.EAU'
CL_CVARB(6)='SURFRESERV.GLACE'
CL_CVARB(7)='SURFRESERV.INTER'
CL_CVARB(8)='SURFRESERV.NEIGE'
! constants
CL_CVARC(1)='SURFZ0.FOIS.G'
CL_CVARC(2)='SURFALBEDO'
CL_CVARC(3)='SURFEMISSIVITE'
CL_CVARC(4)='SURFET.GEOPOTENT'
CL_CVARC(5)='SURFIND.TERREMER'
+-- 10 lines: CL_CVARC(6)='SURFPROP.VEGETAT'
CL_CVARC(16)='SURFGZ0.THERM'
CL_CVARC(17)='SURFALBEDO.SOLNU'
CL_CVARC(18)='SURFALBEDO.VEG'
CL_CVARC(19)='SURFA.OF.OZONE'
CL_CVARC(20)='SURFB.OF.OZONE'
CL_CVARC(21)='SURFC.OF.OZONE'
ISHOUR=3600
ISDAY=3600*24
ZPEPS=REAL(1.E-07,JPRB)
! reading namel ist (file names and zsign t
READ(4,NAMBLENDSUR)
WRITE(*,*) "FILE NAMES"
+--142 lines: WRITE(*,*) CL_FNAME1,' ',CL_FN
ZSUR3=0.
```

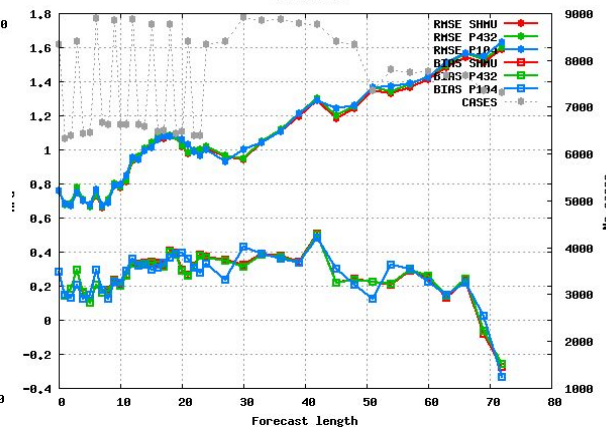
# Short experiment with hourly coupling

- 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

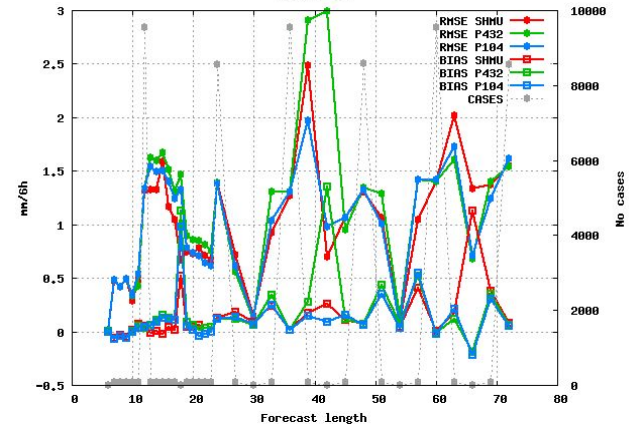
40 stations Selection: ALL  
Height Period: 20200520-20200527  
Statistics at 00 UTC Used {00} + 24 48 72



Selection: ALL using 1130 stations  
Mslp Period: 20200520-20200527  
Hours: {00}



Selection: ALL using 1273 stations  
6h Precipitation Period: 20200520-20200527  
Hours: {00}



**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

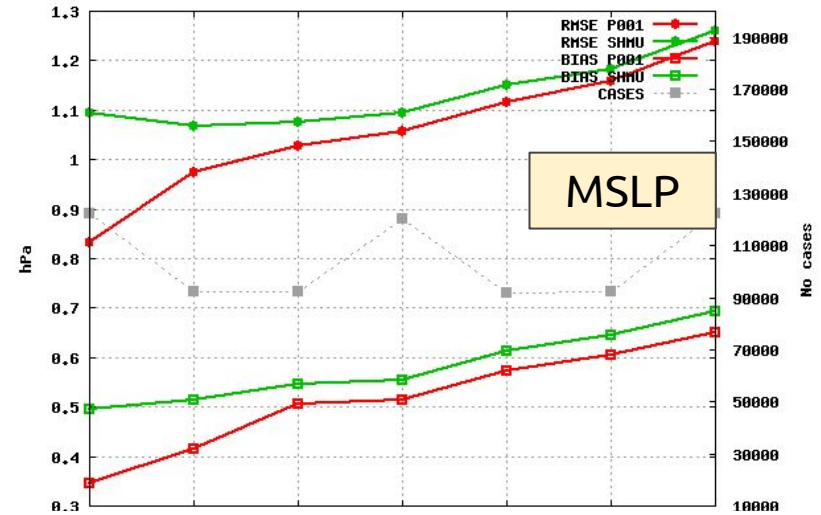
**SHMU** operational BLENDING CY40t1  
**P001** BLENDVAR CY43t2

LS parameters improved

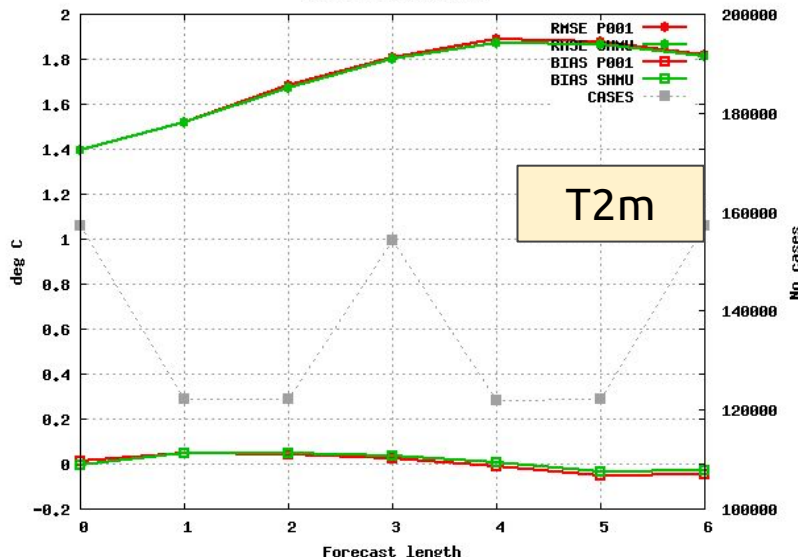
2m thermodynamic params. "neutral"

Impact lost after 6h

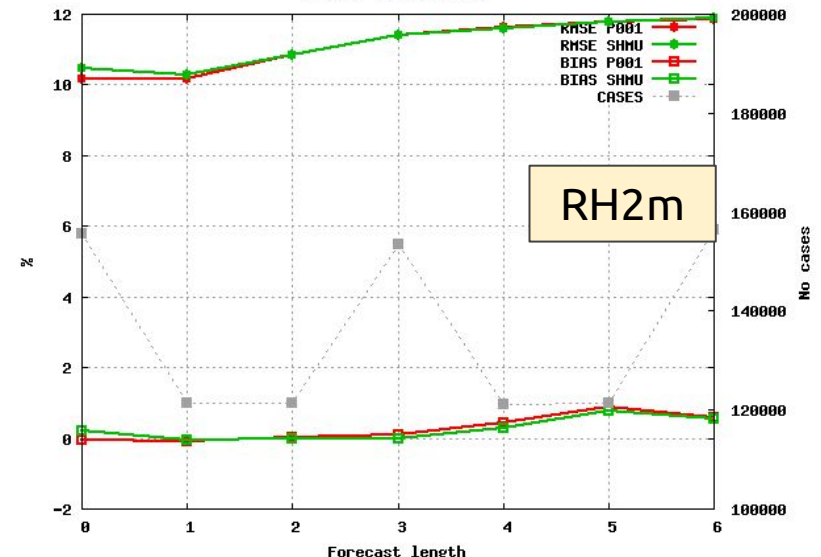
Selection: ALL using 1137 stations  
Mslp Period: 20200729-20200825  
Hours: {00,06,12,18}



Selection: ALL using 1461 stations  
T2m, height adjusted Period: 20200729-20200825  
Hours: {00,06,12,18}



Selection: ALL using 1457 stations  
Rh2m Period: 20200729-20200825  
Hours: {00,06,12,18}



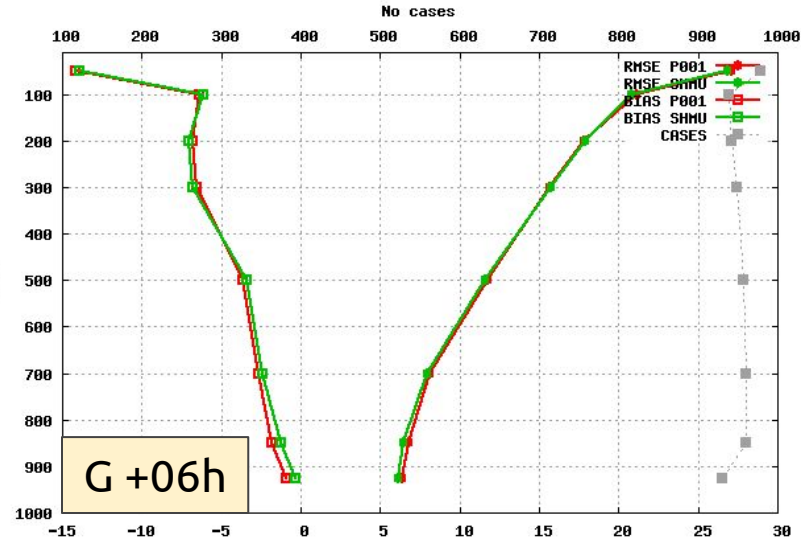
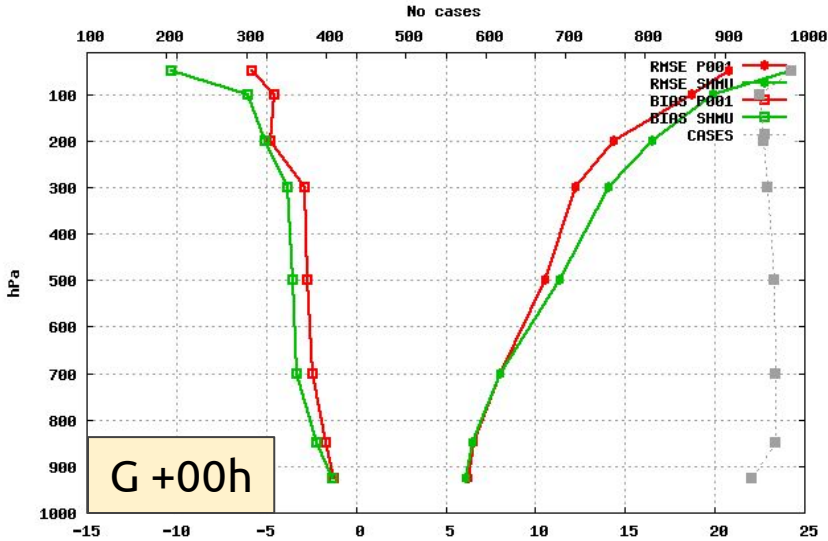
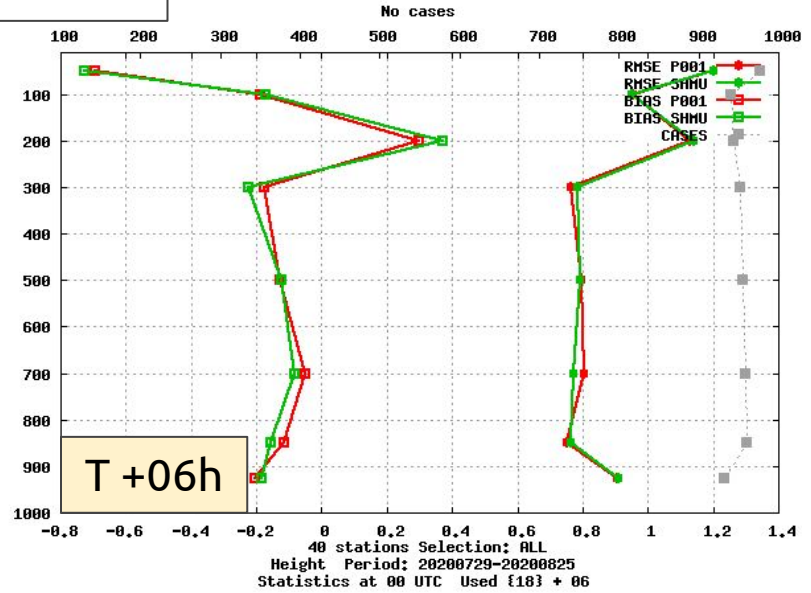
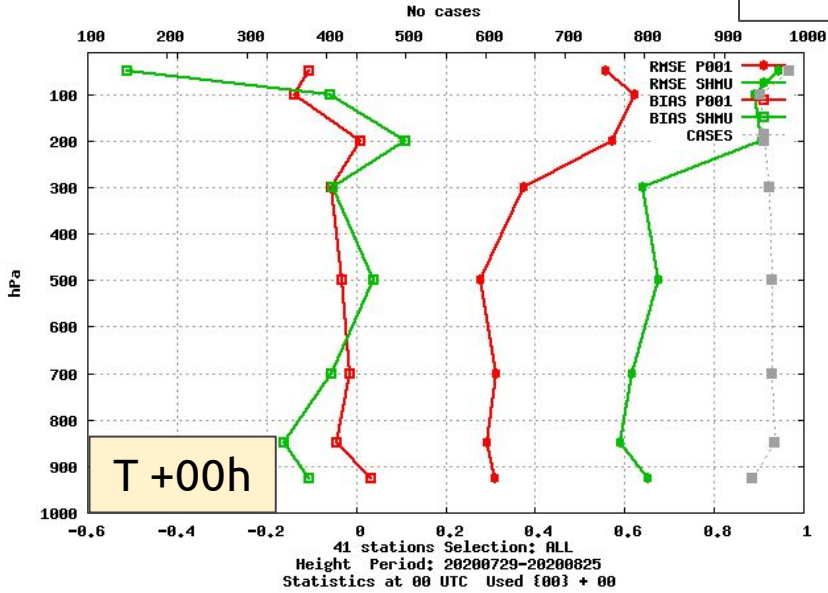


# CY43T2bf10 BLENDVAR e-suite

**P001 - SHMU**

41 stations Selection: ALL  
 Temperature Period: 20200729-20200825  
 Statistics at 00 UTC Used {00} + 00

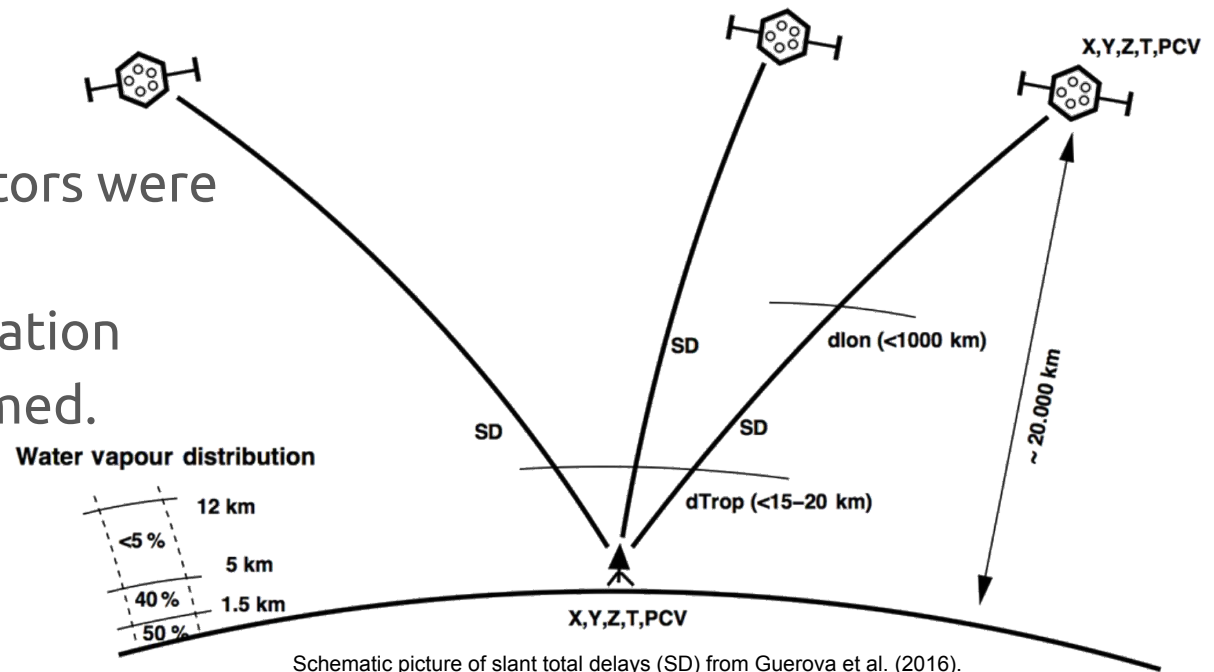
40 stations Selection: ALL  
 Temperature Period: 20200729-20200825  
 Statistics at 00 UTC Used {18} + 06



# 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





# GNSS slant total delays: BATOR

```
1 20190824 00
2 17 19 111 48.751804 19.151007 'BBYSSUT_' 20190824 000000 448.183 1 11111 0
3 129 165.186112 64.179396 2.681502 1.003
4
5          NSTD                      NCINLV - number of slants/ROBODY-s  NCISTD
6  NGNSS  |          LAT          LON station id    date  time altitude |  Flag |
7  |      |          |          |          |      |      |      | |      | |
8  17 19 111 48.751804 19.151007 'BBYSSUT_' 20190824 000000 448.183 1 11111 0 -- header
9          satellite number
10 ASTD   azimuth elevation      STD | error
11  |      |          |          | | |
12 129 165.186112 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:

```
1 &NAMNPROF  
2 NOBSPROFS (19) =87,  
3 /
```

- $\varphi$  is the geocentric angle from GNSS station to satellite,
- $\Delta\varphi_k$  is 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.

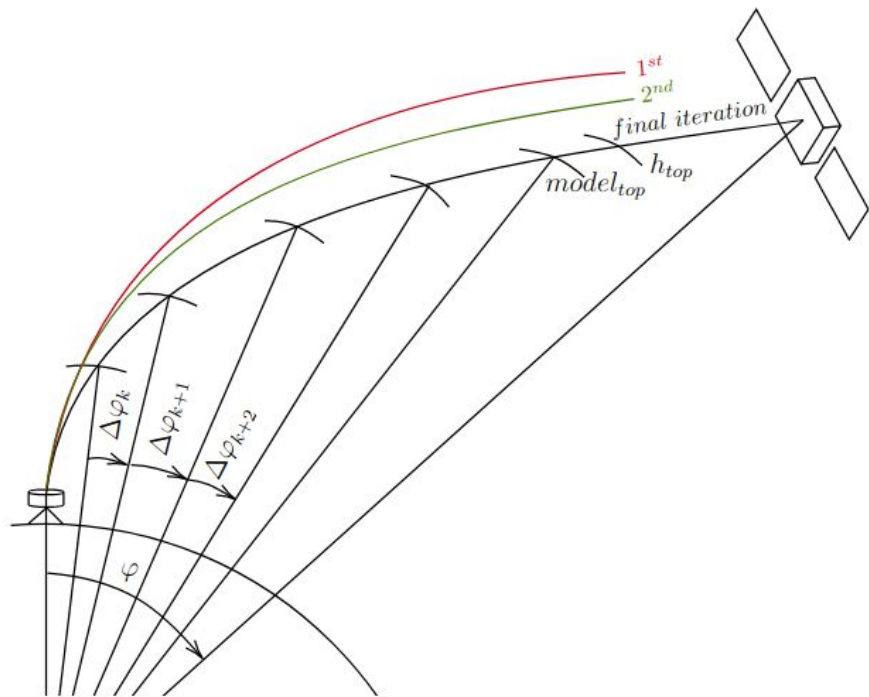


Figure 2: GNSS signal path.

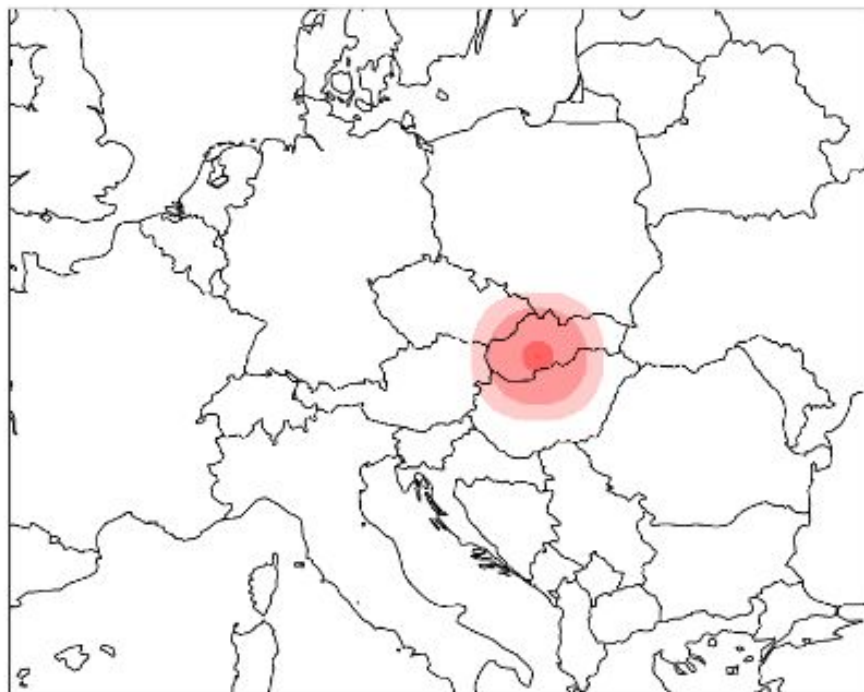
# GNSS slant total delays: MINIMISATION

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

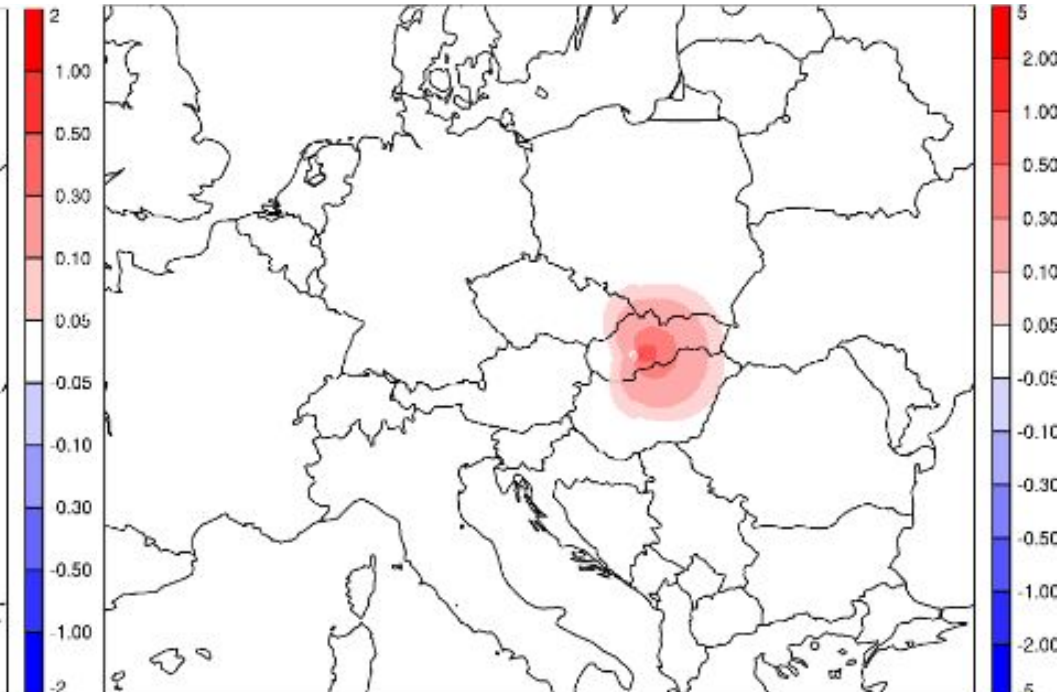
```
1 &NAMCOSJO  
2 NOTVAR(1,19)=-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,-1,  
3 /
```

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

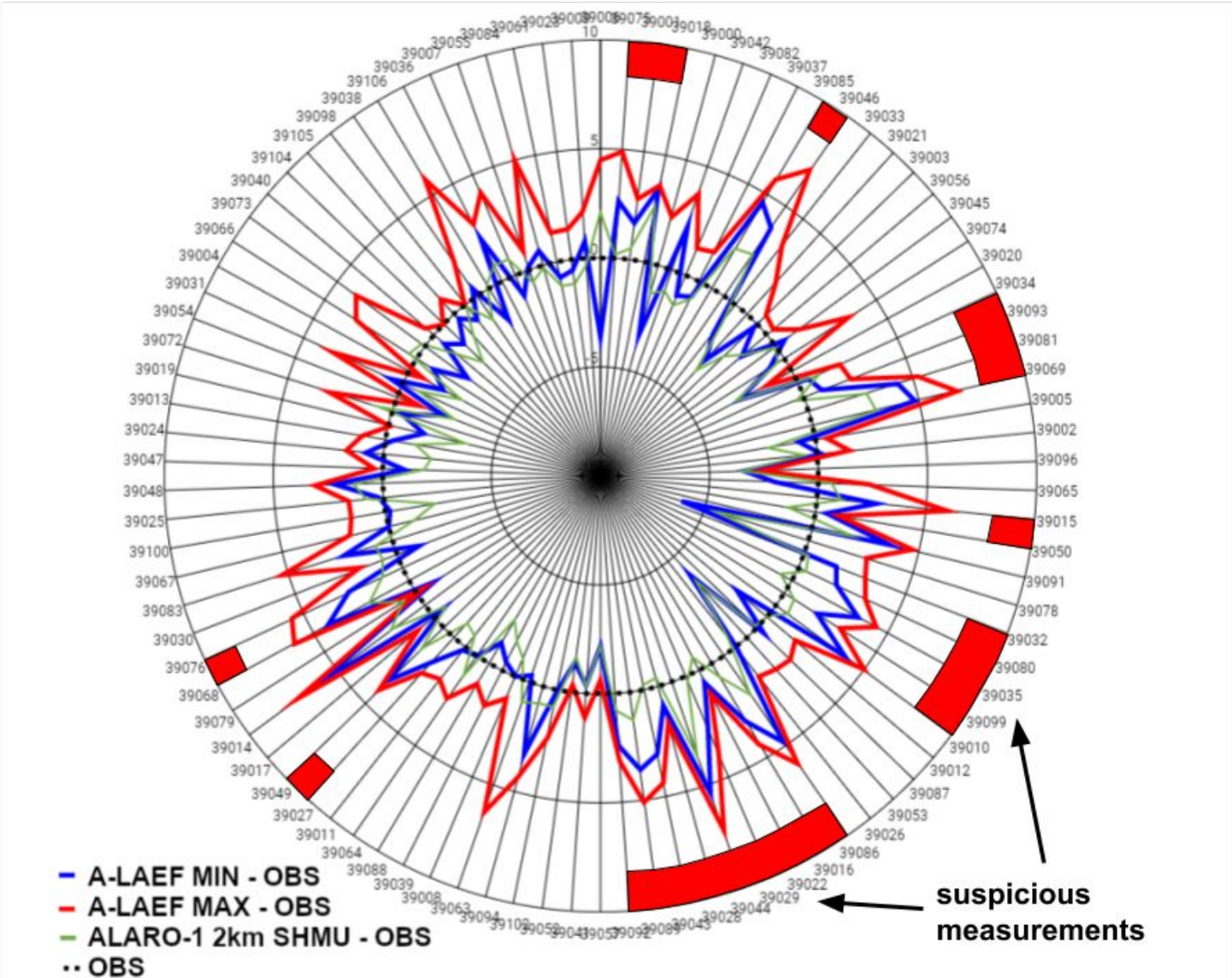
# Local QC based on A-LAEF

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





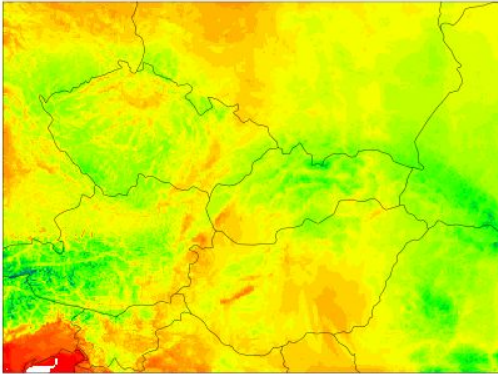
# HighRes surface DA

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).

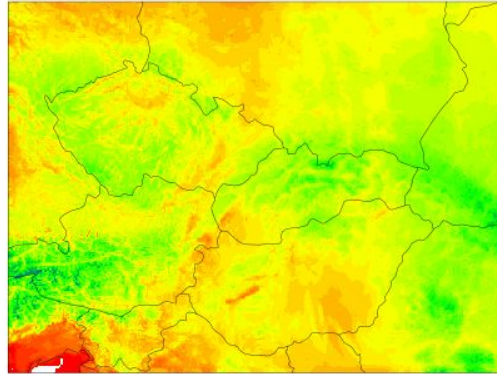
Also, the 10 min gradient in temperature is being checked for potential use in observations QC

# HighRes surface DA

CLSTEMPERATURE  
2020/06/02 04:00 +0



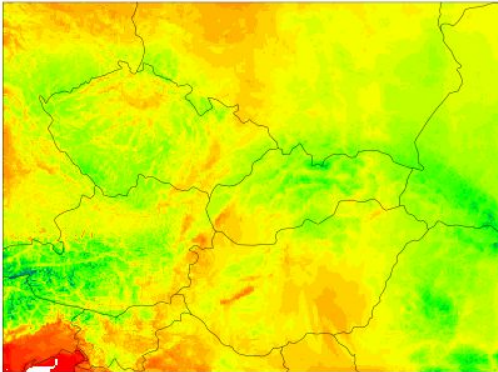
0350



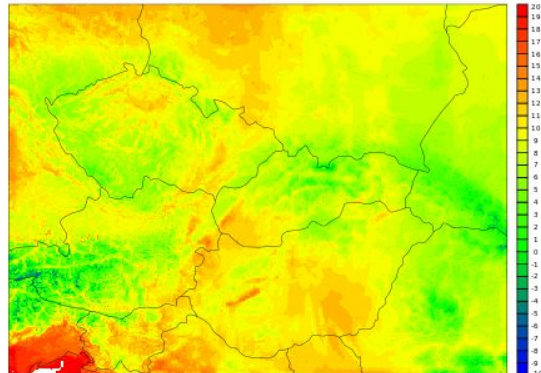
m0400-m0350



CLSTEMPERATURE  
2020/06/02 04:00 +0



0410



m0400-m0410



# 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