



# Data assimilation activities@SHMU

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RC LACE DA videoconference working days, 22-24/09/2021

# Outline

- Operational and experimental setups of ALADIN systems
- BLENDVAR e-suite
- Scientific work
  - utilization of Mode-S data (Katka)
  - utilization of GNSS data (Martin I.)
  - case studies and students thesis (Mariska)
  - CANARI in ALA2 (Martin D.)
- Future plans

# ALADIN/SHMU systems

<i>CMC</i>	<b>ALARO/SHMU</b>
<i>status</i>	operational
<i>code version</i>	CY43T2bf11
<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>	upper air spectral blending by DFI & CANARI surface assimilation
	e-suite BLENDVAR+CANARI
<i>initialization</i>	no initialization
<i>HPC</i>	IBM Flex System p460, linux

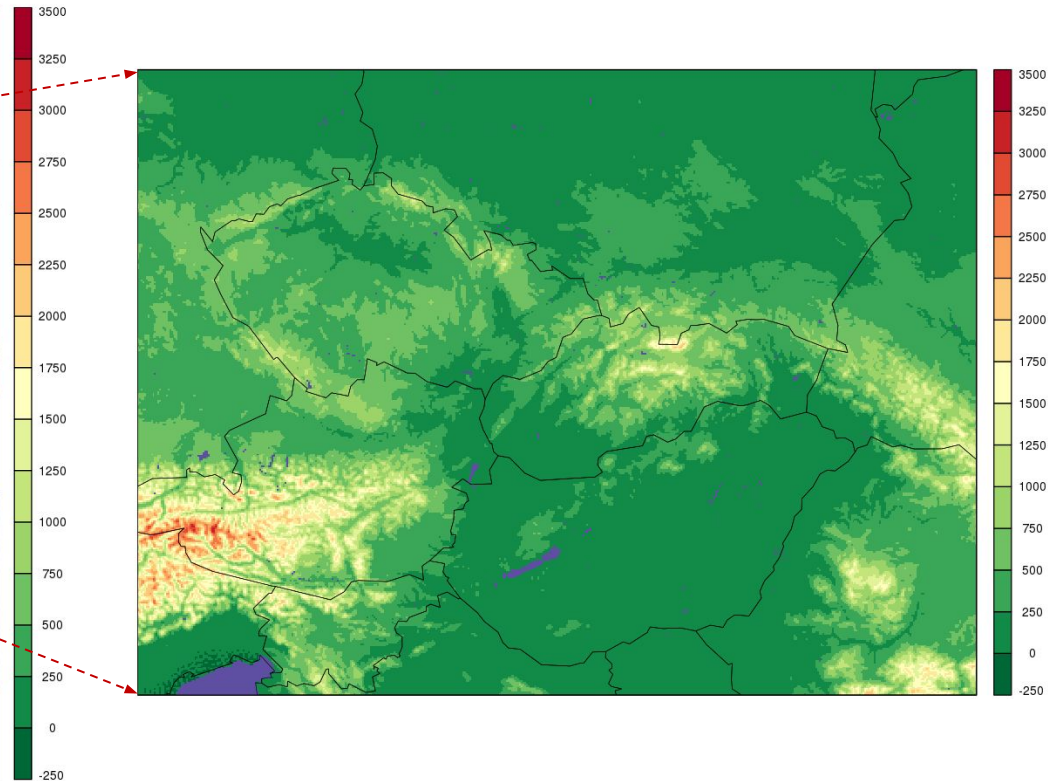
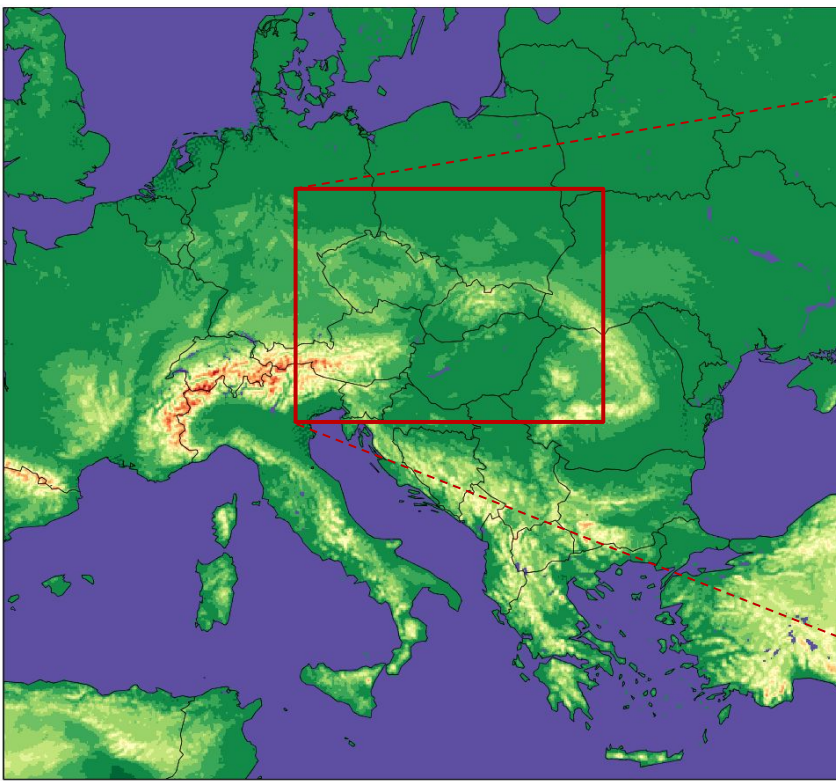
# ALADIN/SHMU systems

<i>CMC</i>	<b>ALARO/SHMU</b>	<b>ALARO/2km</b>	<b>AROME/2km</b>
<i>status</i>	operational	experimental	
<i>code version</i>	CY43T2bf11	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	
	e-suite BLENDVAR+CANARI		
<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	

# ALADIN/SHMU systems

<i>CMC</i>	<b>ALARO/SHMU</b>	<b>ALARO/2km</b>	
<i>status</i>	operational	experimental	
<i>code version</i>	CY43T2bf11	CY43T2_bf11	
<i>physics</i>	ALARO-1vB	ALARO-1vB	
<i>dx</i>	4.5 km	2.0 km	
<i>pts</i>	625 x 576	512 x 384	
<i>vertical levels</i>	63	87	
<i>tstep</i>	180 s	120 s	
<i>forecast ranges</i>	78/72/72/60 (a' 1h)	78/72/72/60 (a' 1h)	81/-/81/- (a' 1h)
<i>coupling model</i>	ARPEGE (long- & short cut off), 3h	ARPEGE, 1h	ECMWF, 3h
<i>assimilation</i>	upper air spectral blending by DFI & CANARI surface assimilation	downscaling -> "CANARI"	downscaling of A-LAEF CNTRL
	e-suite BLENDVAR+CANARI		
<i>initialization</i>	no initialization	DFI	
<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

# From DA WD 2020: 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) ..... *ongoing*
- Start observation monitoring 
- Resolution increase ..... *pending new HPC*

# 3D-Var/BLENDVAR for ALARO 4.5 km

- 2020: 3D-Var validated on CY43t2bf11, scripts were adapted for operational environment (run\_app in perl) => milestone for SHMU 3D-Var
- **BLENDVAR in e-suite** (only assim) since March 2021 + further studies
- BLENDVAR setup:
  - B-matrix - downscaled ARPEGE EDA LBC
  - SYNOP, TEMP, AMDAR, HRWIND
  - Sept. 2021 Mode-S data (EHS whitelisted)
  - *scores*



# CY43T2bf11 BLENDVAR e-suite

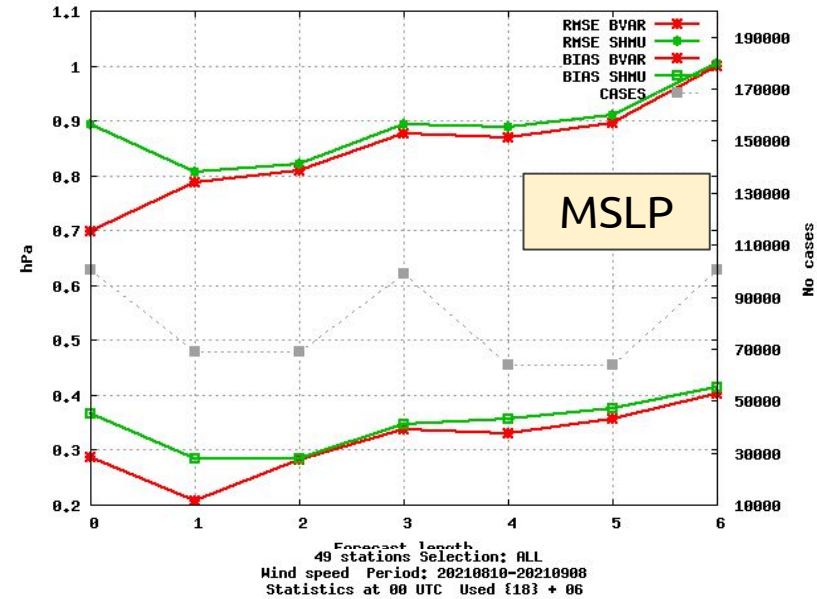
**SHMU** operational BLENDING CY43t2

**BVAR** BLENDVAR CY43t2

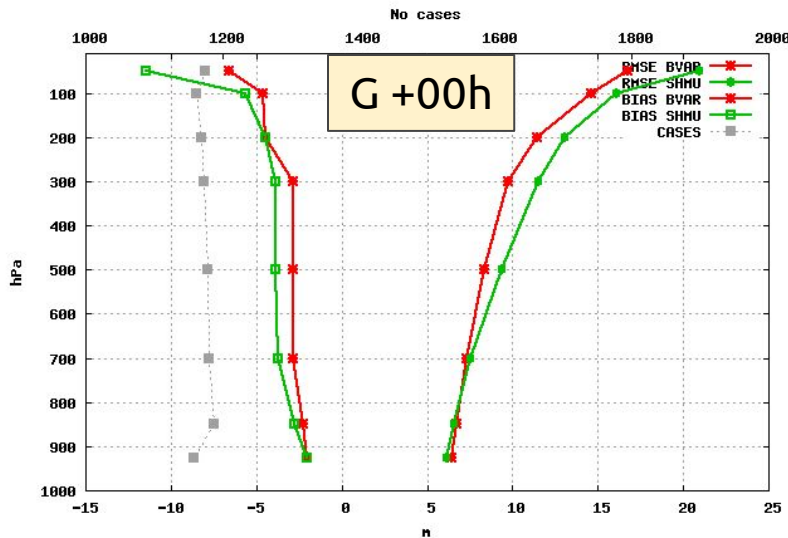
e-suite 10/08-08/09 2021

- LS parameters improved
- 2m thermodynamic params. "neutral"
- Impact lost after 6h

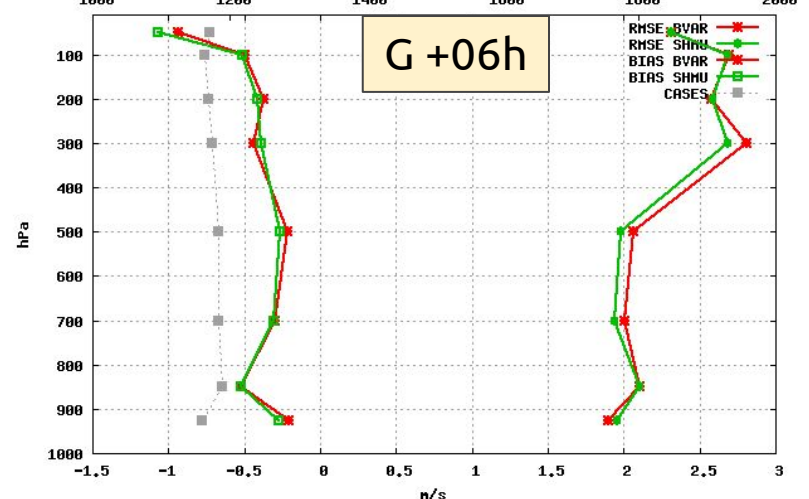
Selection: ALL using 921 stations  
 Mslp Period: 20210810-20210908  
 Hours: {00,06,12,18}



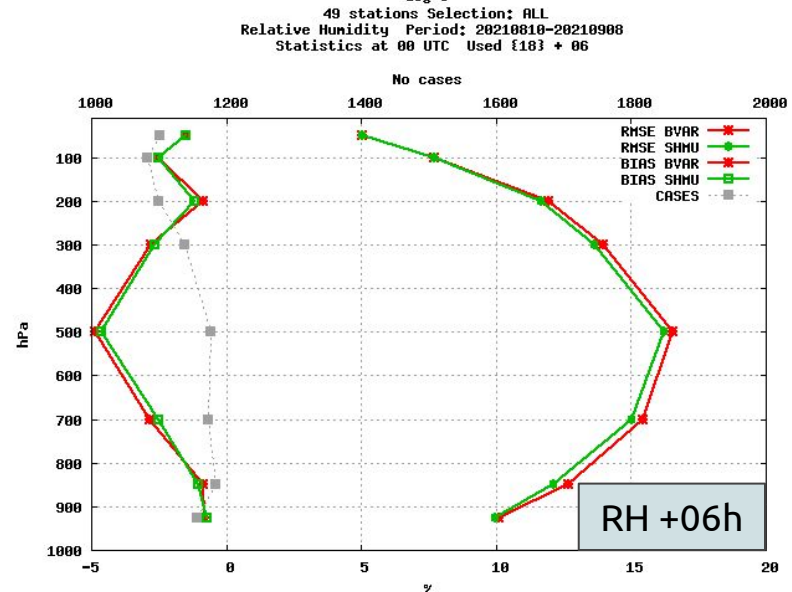
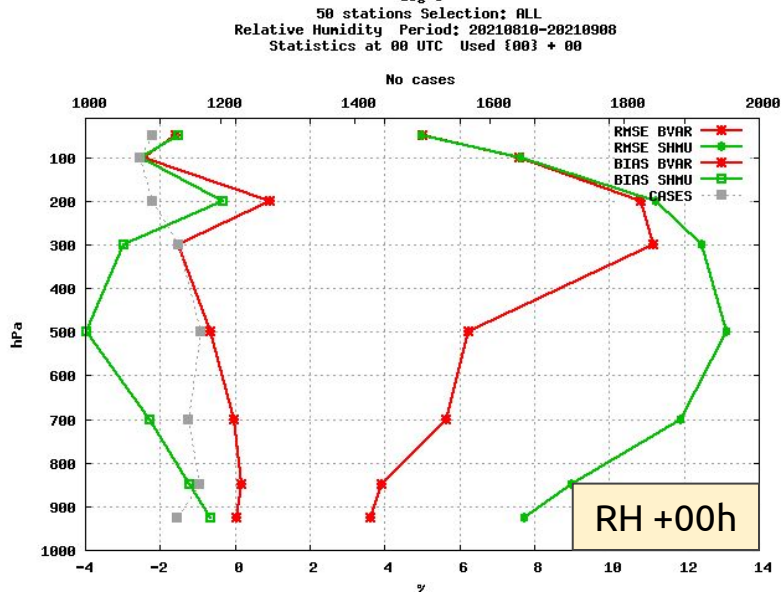
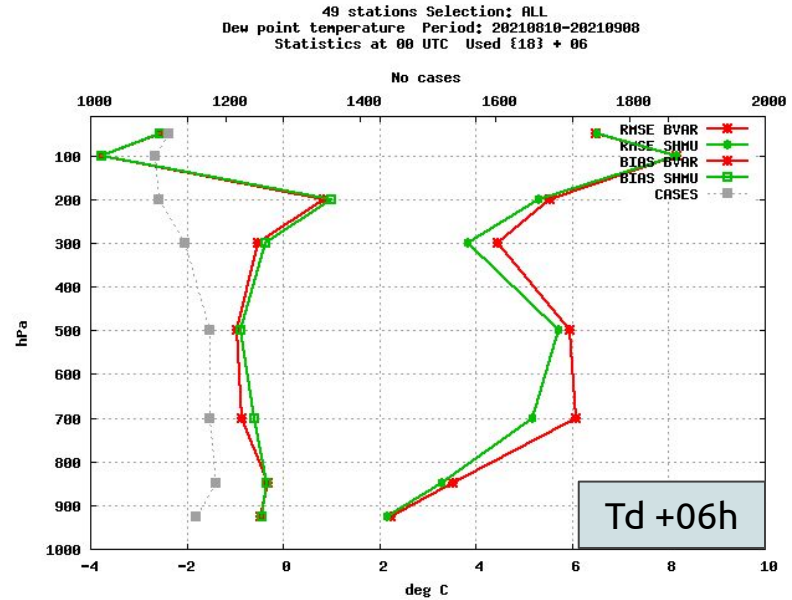
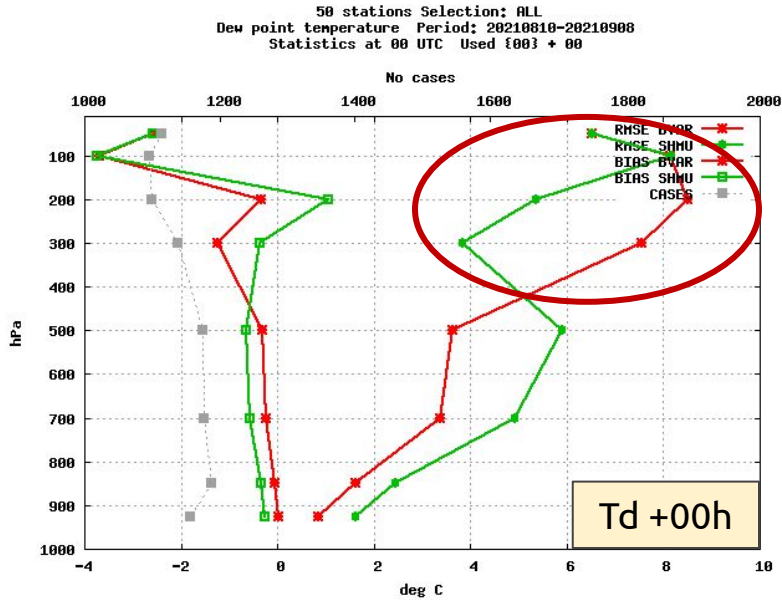
50 stations Selection: ALL  
 Height Period: 20210810-20210908  
 Statistics at 00 UTC Used {00} + 00



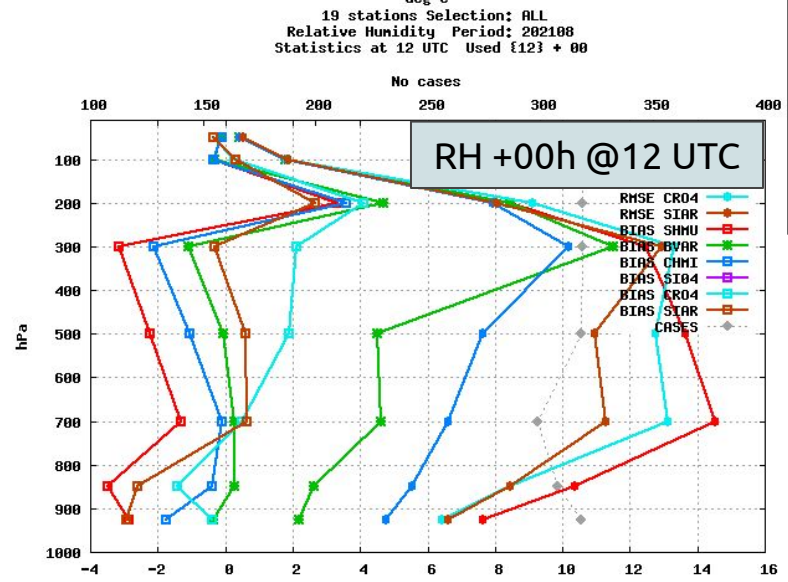
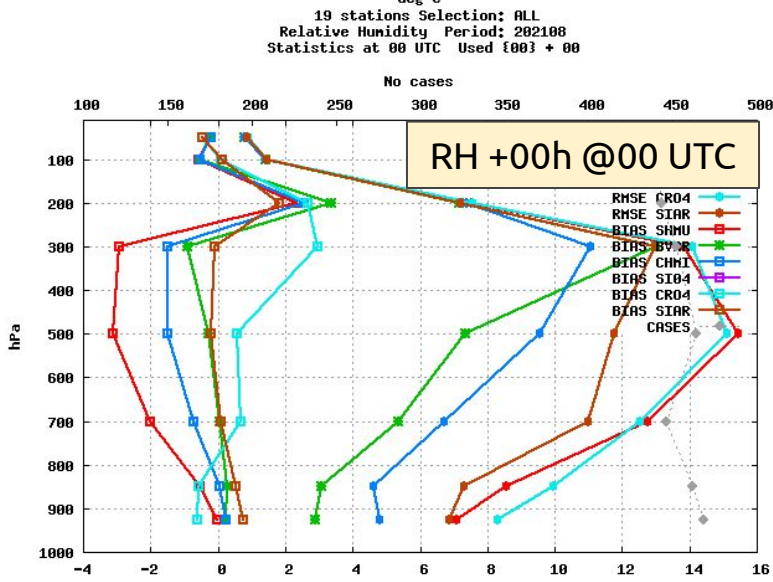
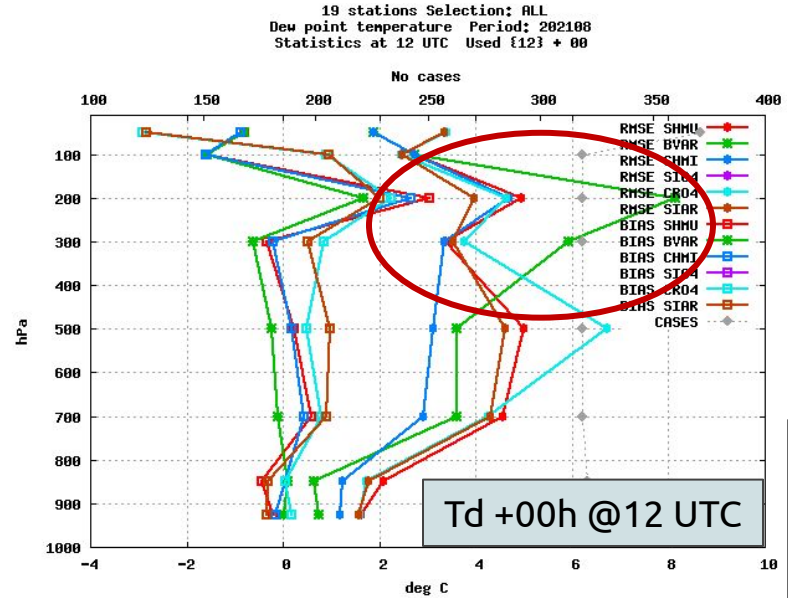
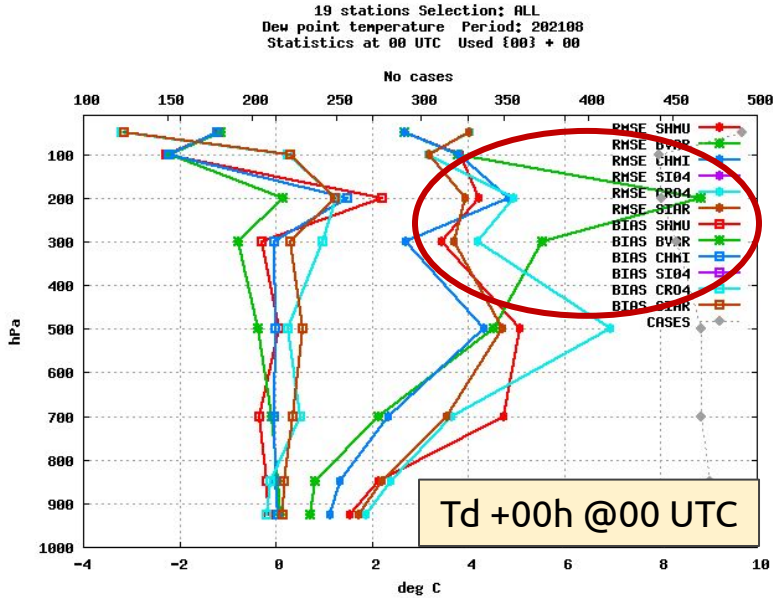
No cases



# vertical profile of Td and RH scores

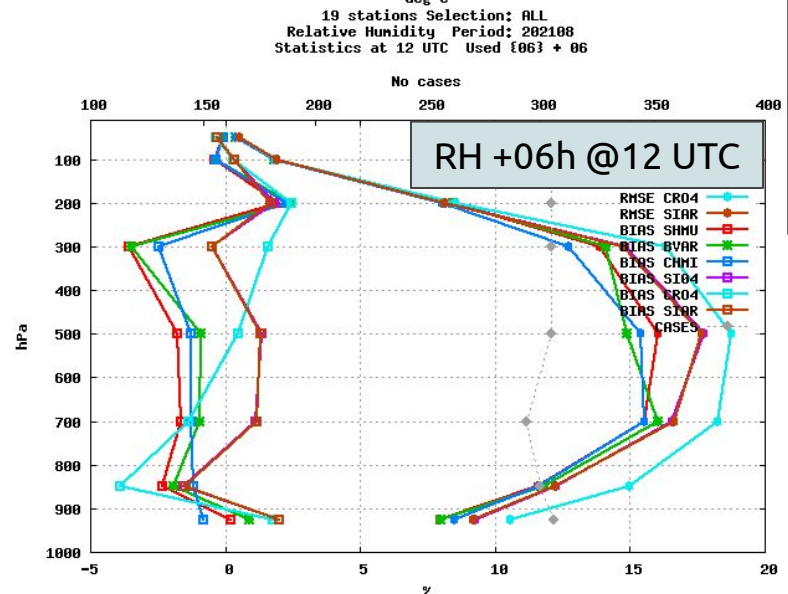
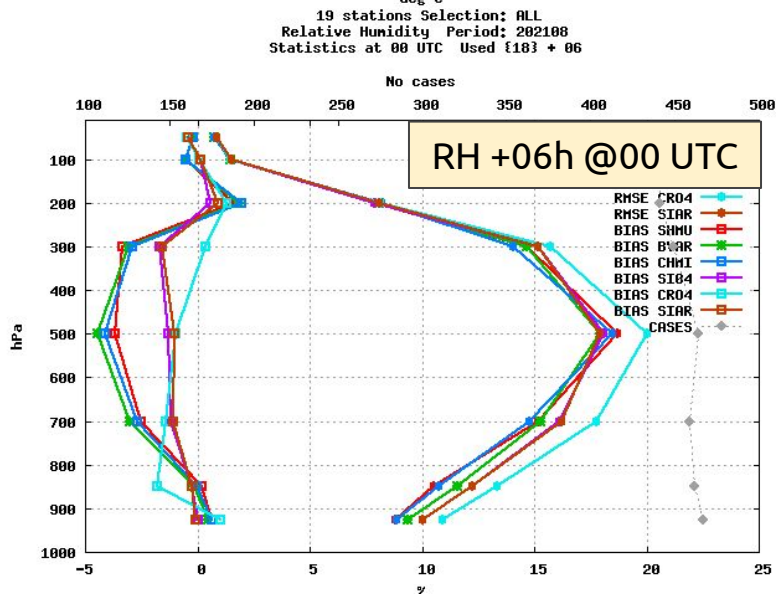
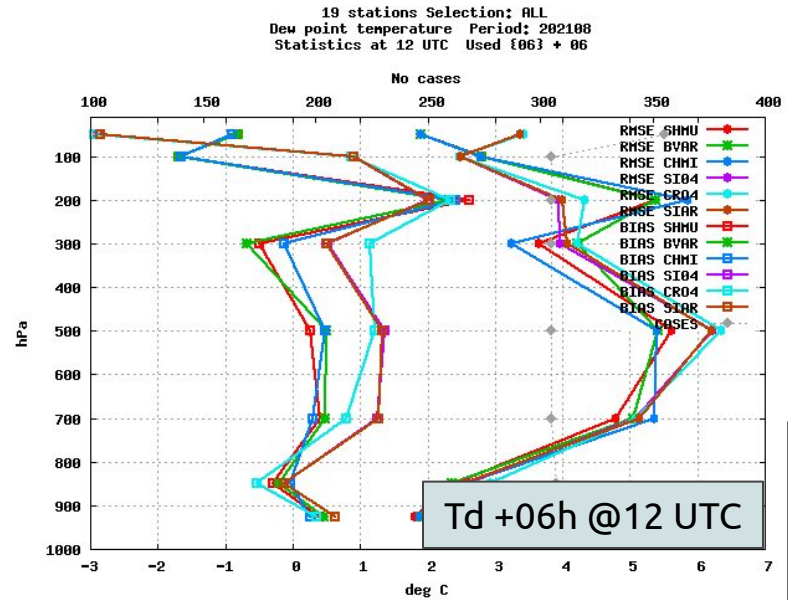
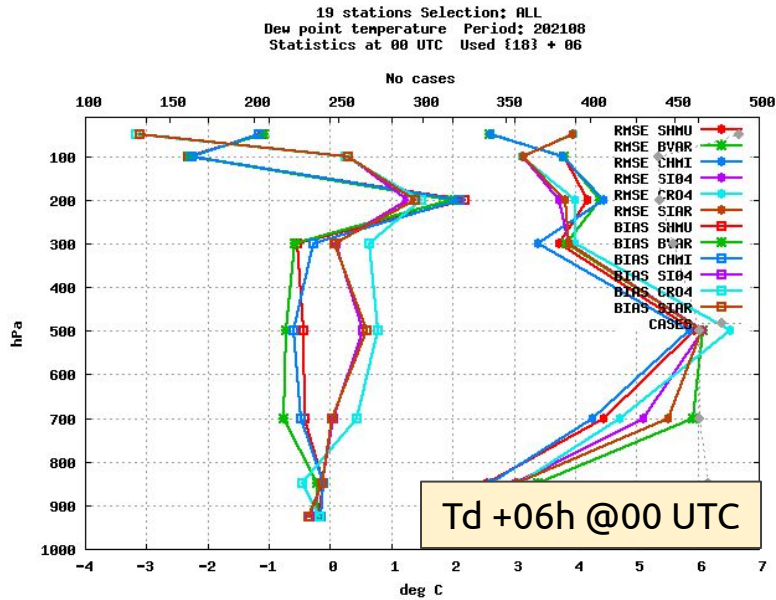


# vert. profile of Td and RH - LACE +00 h



SHMU  
BVAR  
CHMI  
SI04  
SIAR  
CRO4

# vert. profile of Td and RH - LACE + 06h

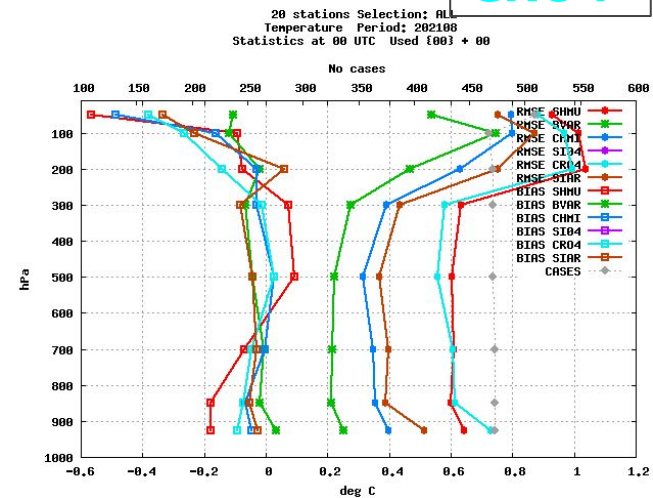
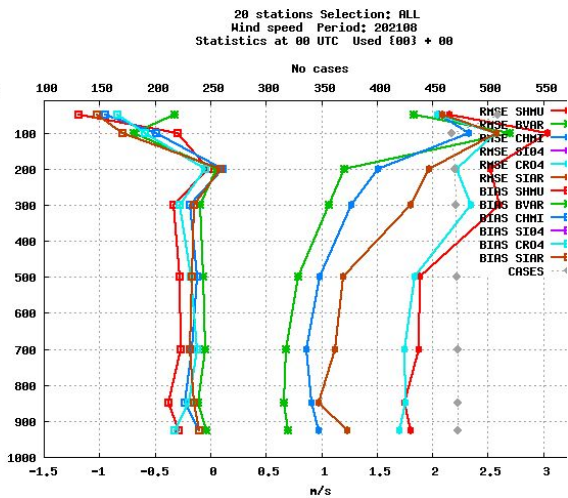
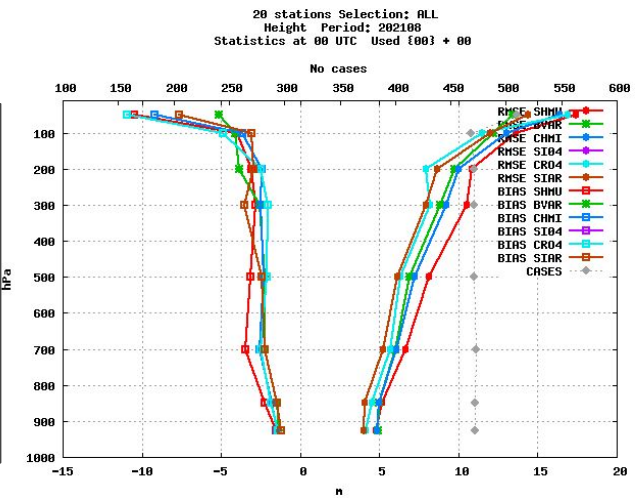


SHMU  
BVAR  
CHMI  
SI04  
SIAR  
CRO4

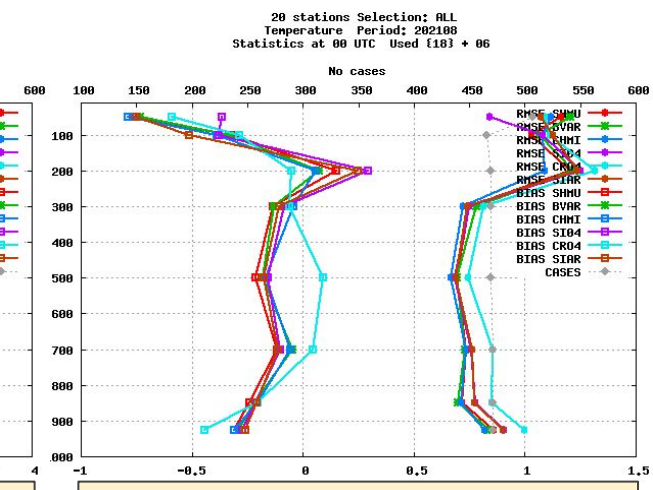
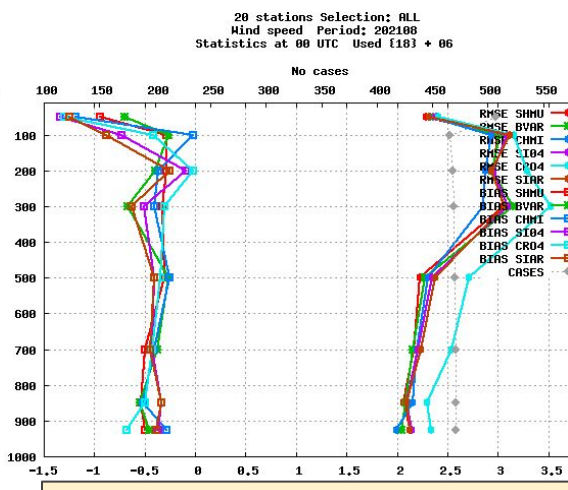
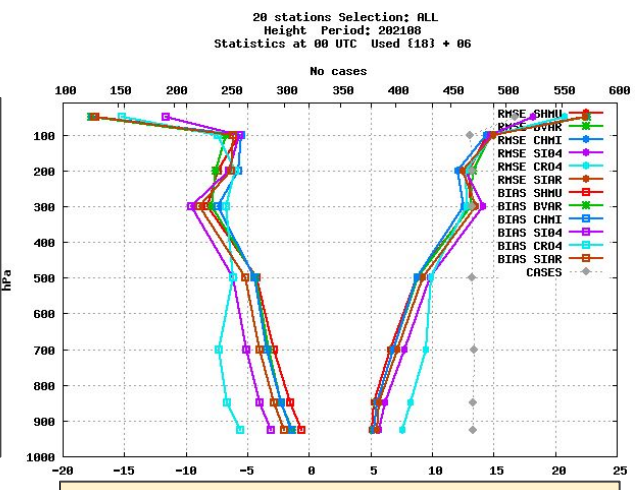
# vertical profiles of scores - LACE

SHMU  
BVAR  
CHMI  
SI04  
SIAR  
CRO4

ANALYSES @ 00 UTC



+06 h FCST @ 00 UTC



GEOPOTENTIAL

WIND SPEED

TEMPERATURE

# obs monitoring@RC LACE: q wrt TEMP

CHMI

OMSZ

SHMU

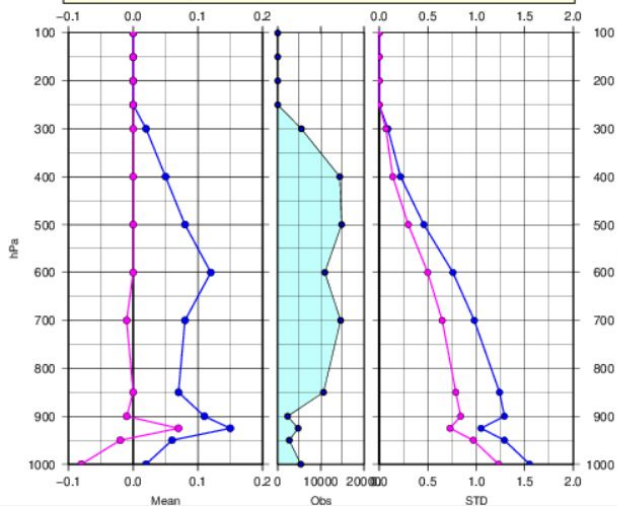
Var	Total	Active	Pass	Reject	Black	O-G Mean	O-A Mean	O-G STD	O-A STD
Report	3376	3375	0	1	0	-	-	-	-
Geo	45709	43257	0	84	2372	2.27	0.00	10.50	0.00
T	140935	140337	0	560	38	-0.03	-0.01	0.92	0.65
U	164124	162943	0	1172	346	-0.06	-0.00	2.40	1.75
V	164124	162943	0	1172	346	-0.04	-0.01	2.38	1.75
Q	143269	85880	0	2431	55988	0.08	-0.00	0.88	0.62
RH	139889	84993	0	610	54735	-1.38	0.00	16.50	0.00

Var	Total	Active	Pass	Reject	Black	O-G Mean	O-A Mean	O-G STD	O-A STD
Report	4064	3985	0	79	0	-	-	-	-
Geo	53659	49294	0	4365	3070	1.20	0.55	12.34	10.28
T	160345	159099	0	1246	457	-0.06	-0.03	1.13	0.74
U	186008	184260	0	1748	537	0.02	0.02	2.91	2.00
V	185643	184260	0	1383	203	-0.01	0.00	2.87	1.99
Q	162705	96786	0	65919	64355	-0.12	-0.08	1.17	0.83
RH	158673	95155	0	63518	62444	-3.78	0.00	18.89	0.00

Var	Total	Active	Pass	Reject	Black	O-G Mean	O-A Mean	O-G STD	O-A STD
Report	4241	4162	0	79	0	-	-	-	-
Geo	55942	52714	0	203	3035	2.64	0.00	14.52	0.00
T	166332	165437	0	697	198	-0.03	0.00	0.99	0.55
U	192798	191626	0	1034	473	-0.06	0.01	2.55	1.66
V	192798	191626	0	1034	473	-0.02	0.00	2.54	1.67
Q	168868	101795	0	2005	66272	0.08	-0.01	0.94	0.49
RH	164660	100139	0	402	64439	-1.17	0.00	16.55	0.00

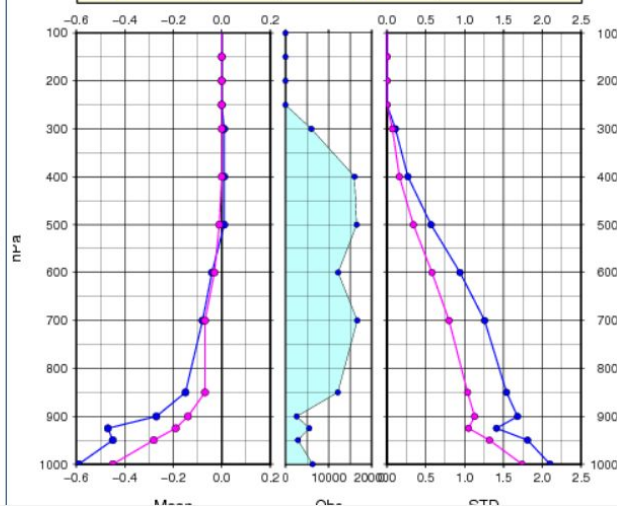
DA: ALD/3DVAR Exp: Oper Long Cut-off  
 Period: 2021.07.01-2021.07.31 HH: all UTC  
 Obs: TEMP Var: Q (g/kg)

● Obs-Guess (mean & std) ● Obs-An (mean & std)



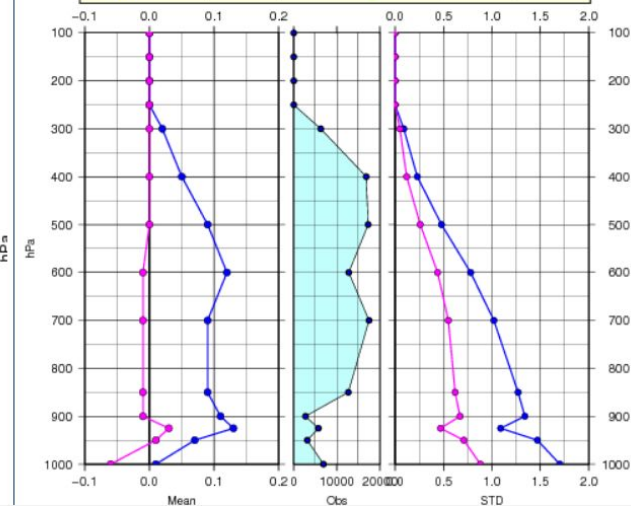
DA: ALD/3DVAR Exp: Oper Long Cut-off  
 Period: 2021.07.01-2021.07.31 HH: all UTC  
 Obs: TEMP Var: Q (g/kg)

● Obs-Guess (mean & std) ● Obs-An (mean & std)



DA: ALD/3DVAR Exp: BLENDVAR assim  
 Period: 2021.07.01-2021.07.31 HH: all UTC  
 Obs: TEMP Var: Q (g/kg)

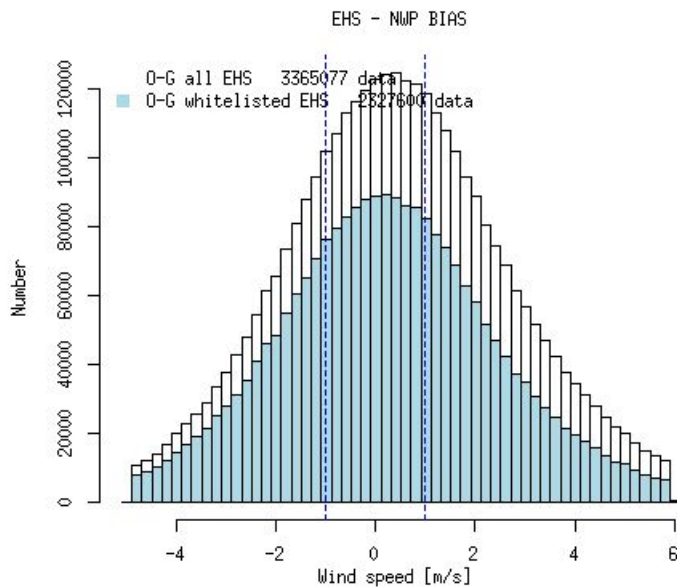
● Obs-Guess (mean & std) ● Obs-An (mean & std)



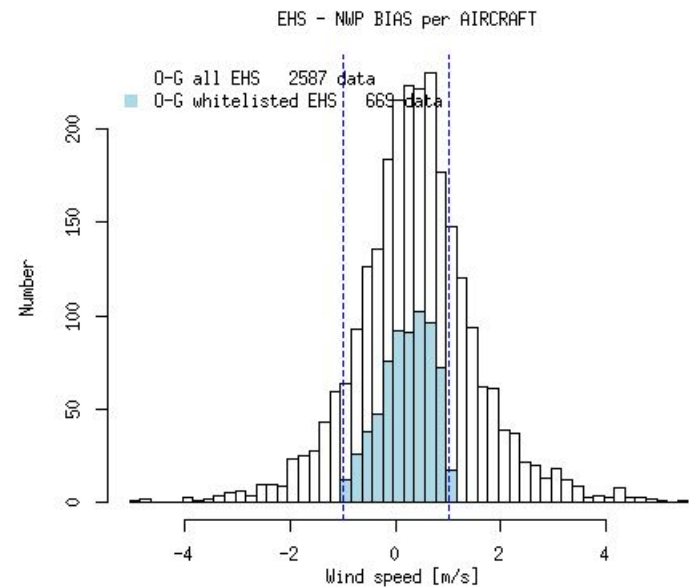
# Mode-S data

	N	Mean	Std
T	1 000	1 K	2 K
WS	1 000	1 m/s	5 m/s
WD	1 000	10 deg	100 deg

- new whitelist for EHS data recomputed for SHMU domain for 2 weeks of April 2021



all\_data\_plot: mean= 0.4265 m/s , sd= 2.1774 m/s , N = 3365077 data  
whitelisted\_data\_plot: mean= 0.2572 m/s ,sd= 2.1141 m/s , N= 2327600 data



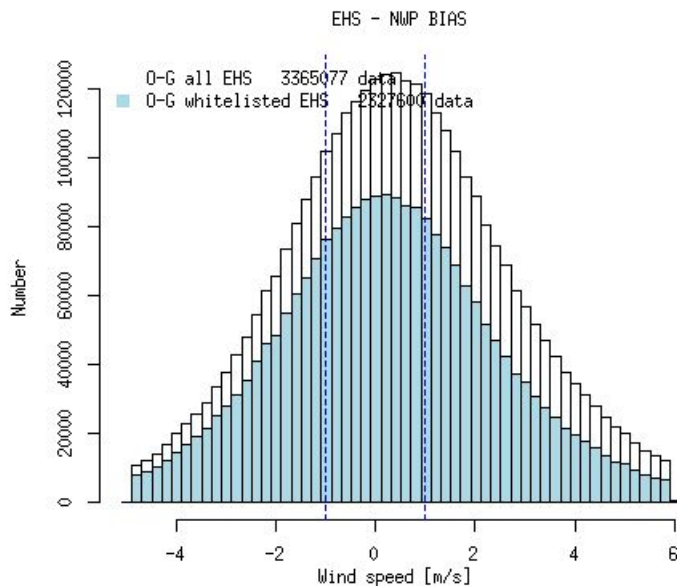
all\_data\_plot: mean= 0.3845 m/s , sd= 1.168 m/s , N = 2587 data  
whitelisted\_data\_plot: mean= 0.2065 m/s ,sd= 0.4754 m/s , N= 669 data

# Mode-S data

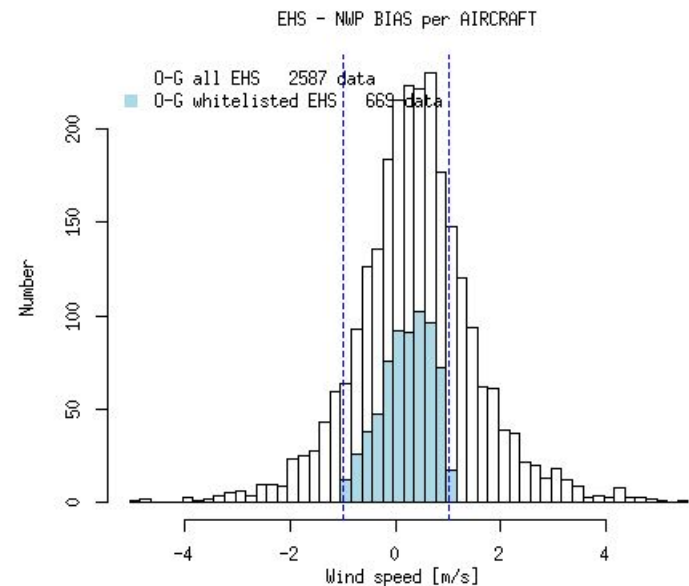
	N	Mean	Std
T	1 000	1 K	2 K
WS	1 000	1 m/s	5 m/s
WD	1 000	10 deg	100 deg

- new whitelist for EHS data recomputed for SHMU domain for 2 weeks of April 2021
- *obsoul\_merge.pl* modified by M. Bellus to use whitelist:

```
$obsoul_merge -o OBSOUL.$base -f LISTFILE -t $obsWindow -w $nam/white_list.ModeS
```



all\_data\_plot: mean= 0.4265 m/s , sd= 2.1774 m/s , N = 3365077 data  
whitelisted\_data\_plot: mean= 0.2572 m/s ,sd= 2.1141 m/s , N= 2327600 data



all\_data\_plot: mean= 0.3845 m/s , sd= 1.168 m/s , N = 2587 data  
whitelisted\_data\_plot: mean= 0.2065 m/s ,sd= 0.4754 m/s , N= 669 data



# Mode-S data

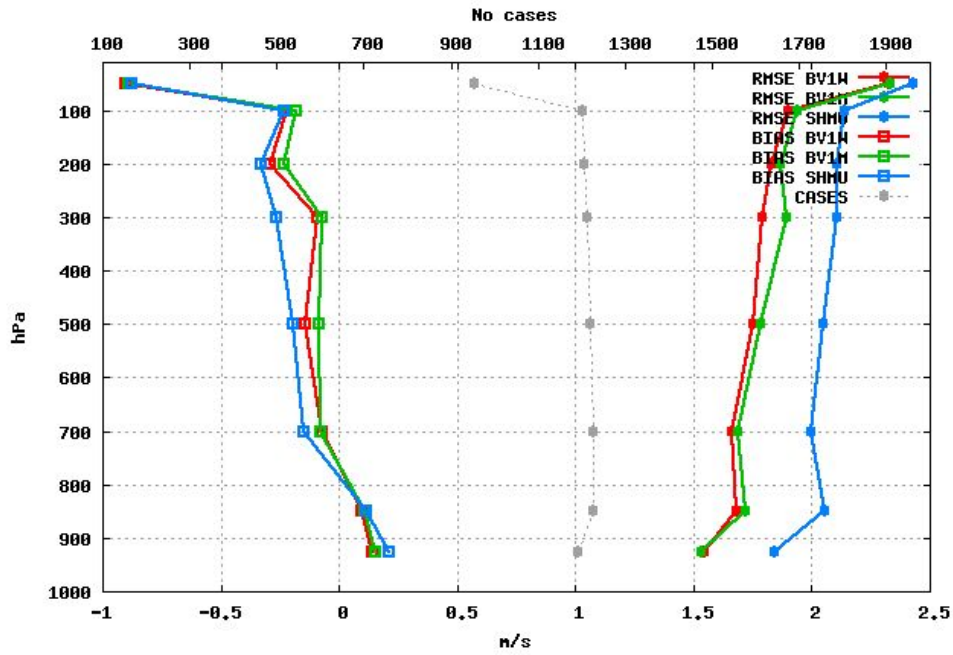
with whitelist scores of wind statistics were improved

**SHMU** - operational BLENDING

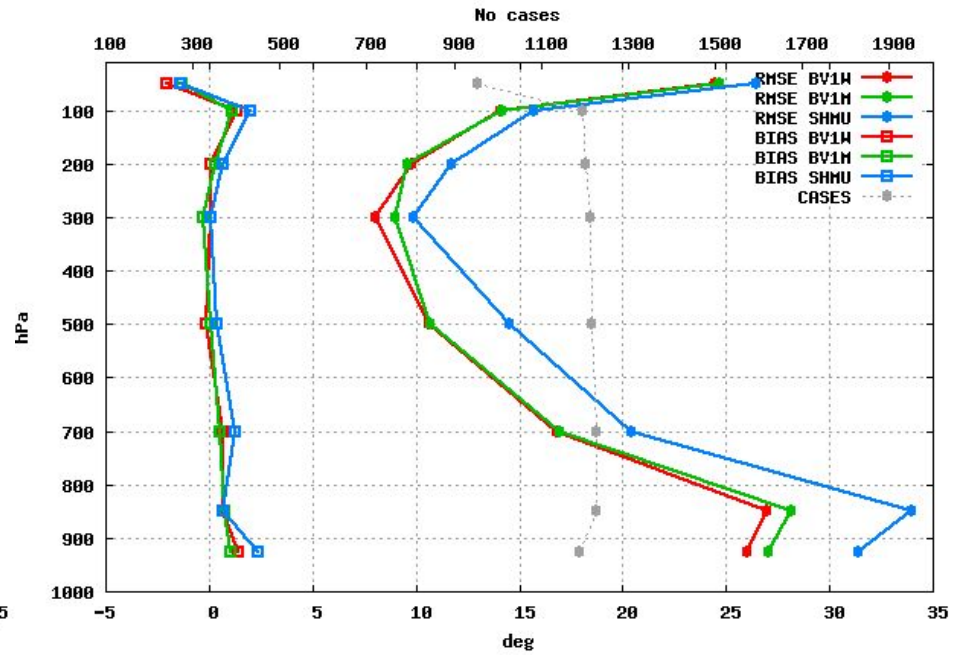
**BV1M** - BVAR with Mode-S data, no whitelist

**BV1W** - BVAR with Mode-S data, EHS whitelisted

45 stations Selection: ALL  
Wind speed Period: 20210410-20210430  
Statistics at 12 UTC Used {06,12} + 00 06

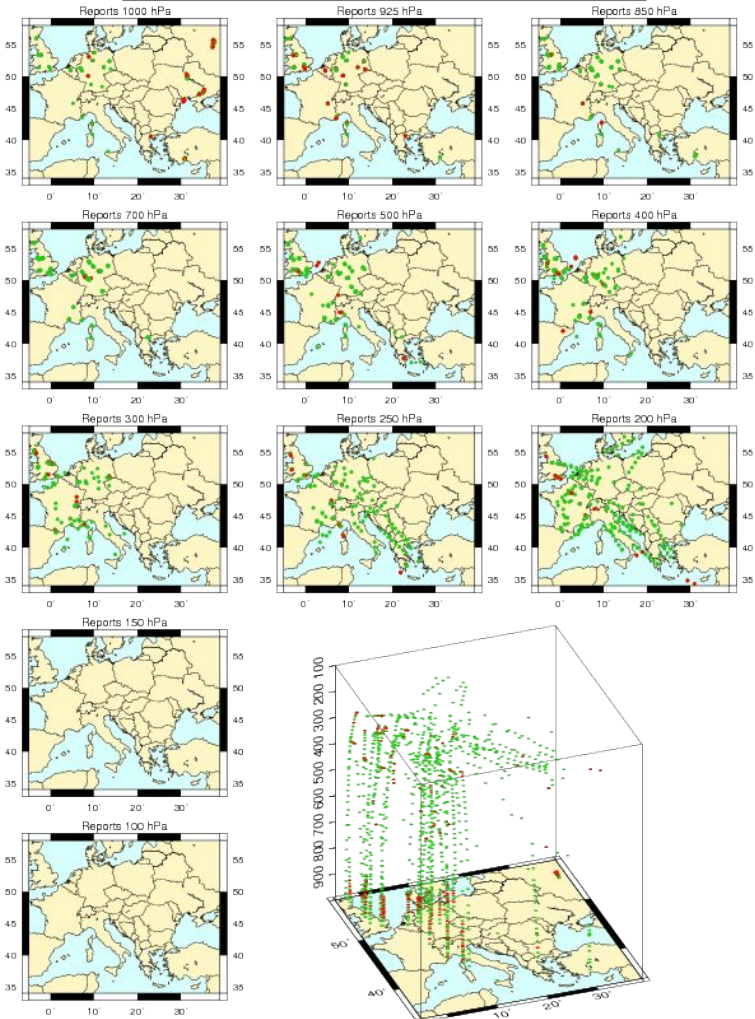


45 stations Selection: ALL  
Wind direction Period: 20210410-20210430  
Statistics at 12 UTC Used {06,12} + 00 06

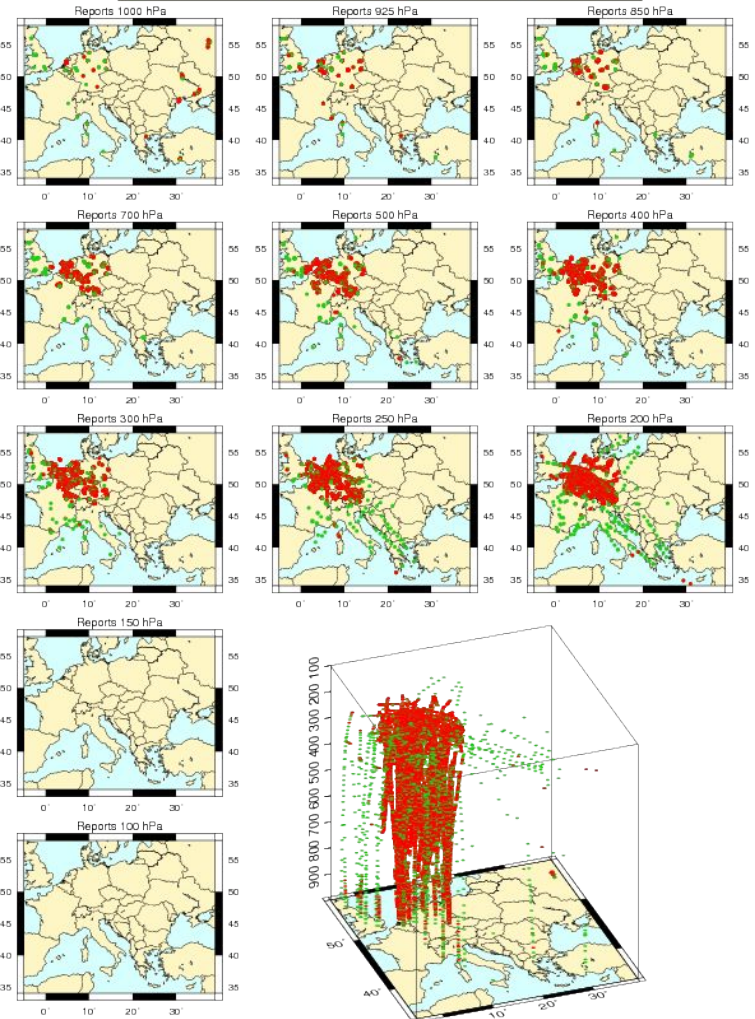


# Mode-S data

DA: ALD/3DVAR Exp: BLENDVAR assim  
Date: 2021.09.08. HH: 06 UTC  
Obs: AIREP Reports (1406)  
● Active (1120) ● Passive(0) ● Rejected (286) ● Blacklisted (0)



DA: ALD/3DVAR Exp: BLENDVAR assim  
Date: 2021.09.08. HH: 06 UTC  
Obs: AIREP Reports (34204)  
● Active (6525) ● Passive(0) ● Rejected (27679) ● Blacklisted (0)



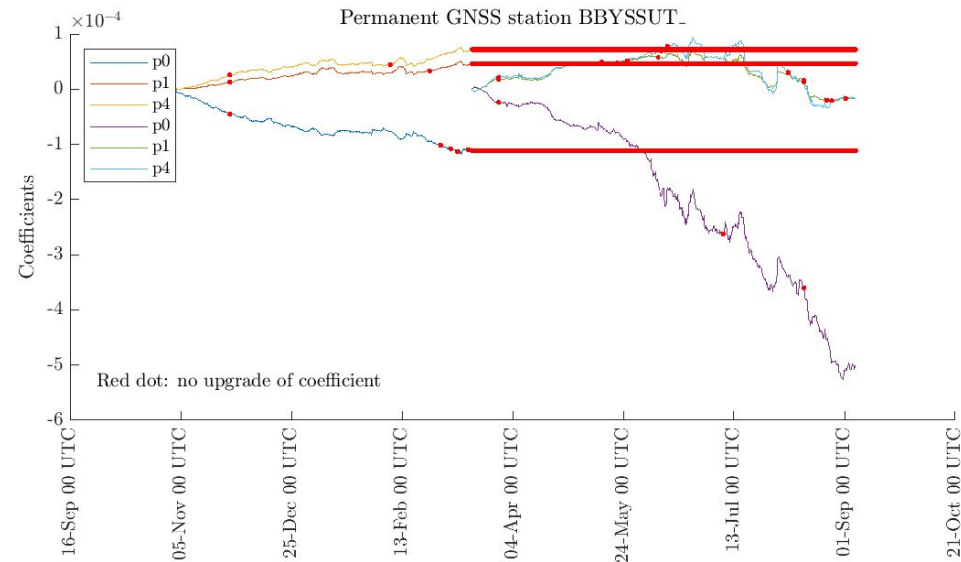
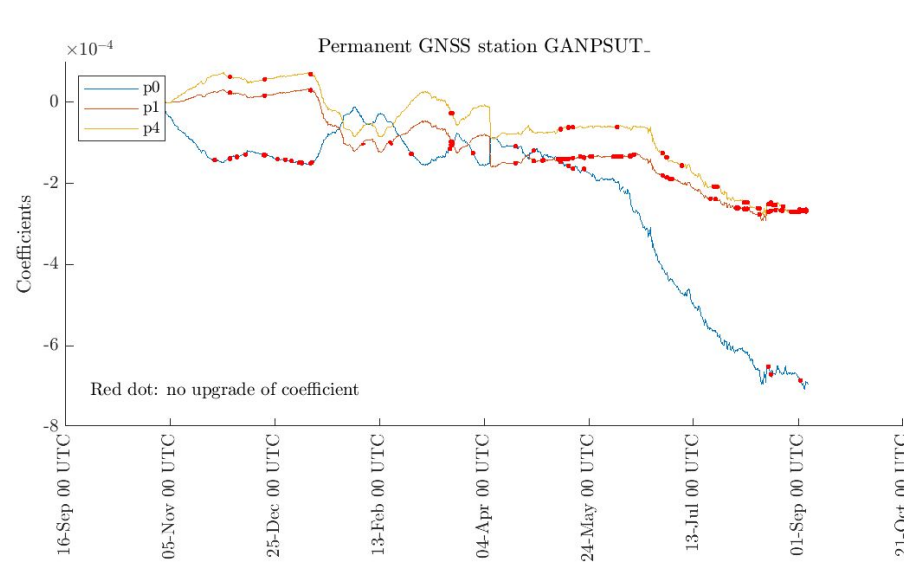
# Assimilation of GNSS data

Slant total delay:

- Developed code successfully phased to CY46T1
- Phasing to CY48T1 is ongoing

VARBC zenith total delay:

- estimation/warming of ZTD VARBC coefficients is ongoing

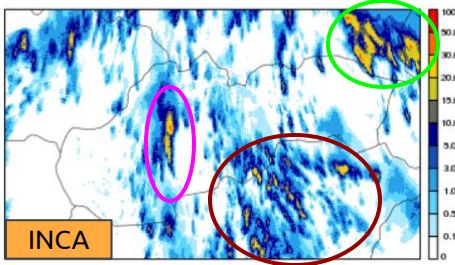


# convective case study 06-07-2020

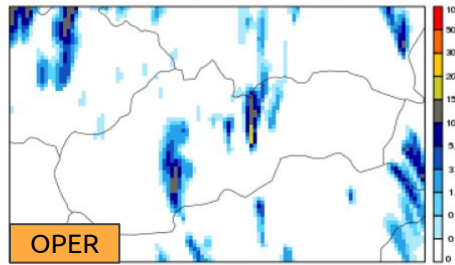
EXPN	obs	comment
<b>P432</b>	none for upper air, SYNOP for CANARI	reference, Blending+canari, current operational setting with CY43t2
<b>TSTI</b>	synop, temp, amdar	reference BLENDVAR setup
<b>HRWN</b>	as TSTI + hrwind	with code correction for HRWIND
<b>ZTDS</b>	as HRWN + GNSS ZTD	as HRWN + ZTD obsoul from SUT data, static whitelist
<b>AWS1</b>	as HRWN + AWS	as HRWN + all local AWS from OPLACE
<b>MODE</b>	as HRWN + Mode-S data	as HRWN + Mode-S data from OPLACE
<b>MODS</b>	as MODE	as MODE, but whitelist used for EHS
<b>BFTT</b>	as HRWN, TEMP BUFR - TT setup	BUFR TEMP, traj/time split off
<b>BFFF</b>	as HRWN, TEMP BUFR - FF setup	BUFR TEMP, traj/time split on => RS drift activated
<b>ALLD</b>	HRW+ZTDS+AWS+MODE+BFFF	all data
<b>ALLS</b>	HRW+ZTDS+AWS+MODS+BFFF	all data but EHS MODE-S whitelisted as in MODS
<b>ref</b>	CHMI setup	run with ALADIN/CHMI
<b>rad</b>	as CHMI + OPERA radial winds	outcome of Katka's stay at CHMI

# convective case study 06-07-2020

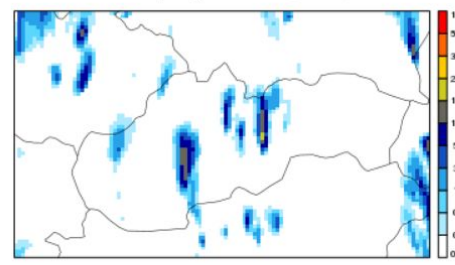
INCA 03h prec analysis at 2020-06-07\_15, max= NA



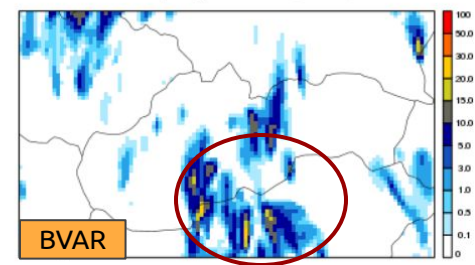
OPER ALADIN/SHMU 03h precip:2020-06-07\_00+15, max= 21.24



P432 suite 03h precip:2020-06-07\_00+15, max= 17.44



TSTI suite 03h precip:2020-06-07\_00+15, max= 22.18

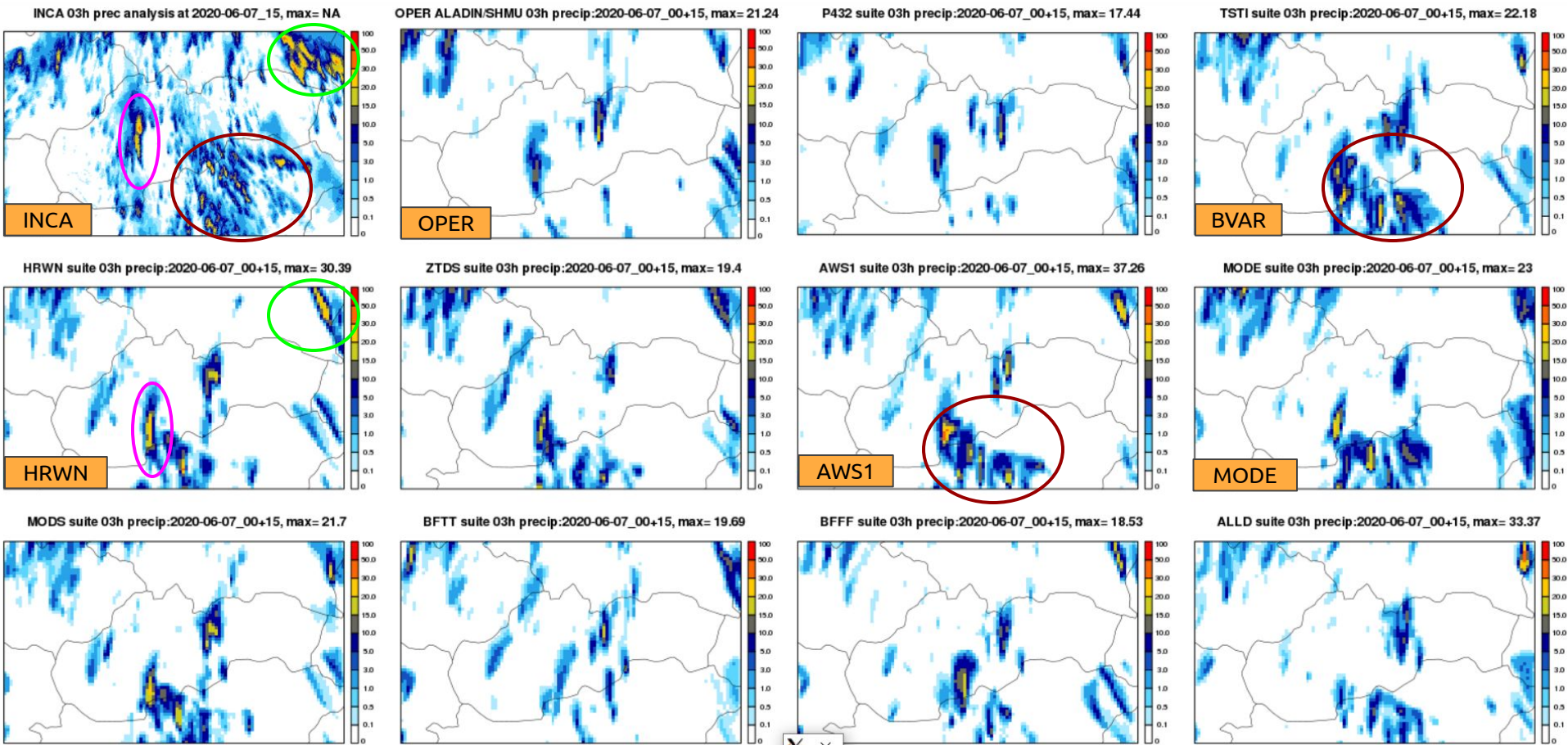


3-hourly accumulated precipitation  
at +15 h from 06-07-2020 00 UTC

...

3 days assimilation cycle from oper GUESS

# convective case study 06-07-2020

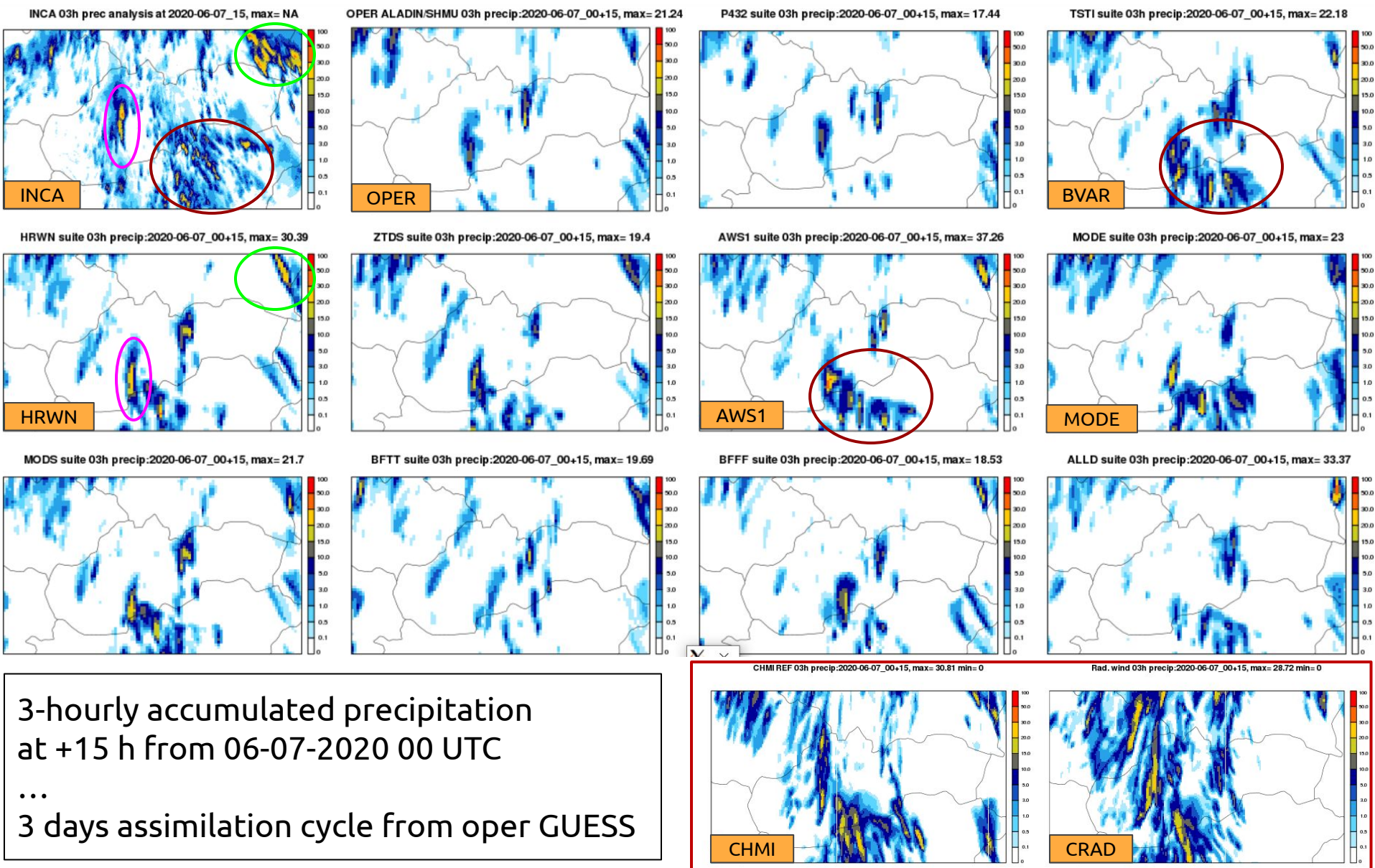


3-hourly accumulated precipitation  
at +15 h from 06-07-2020 00 UTC

...

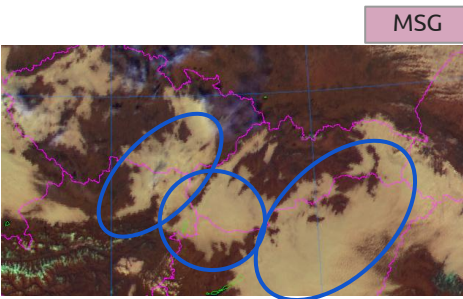
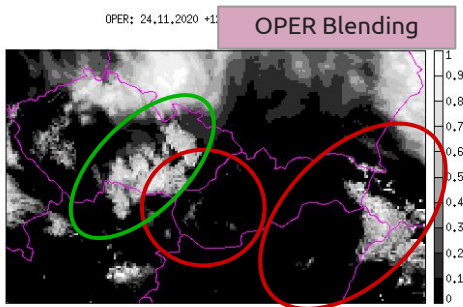
3 days assimilation cycle from oper GUESS

# convective case study 06-07-2020



# fog case study 24-11-2020

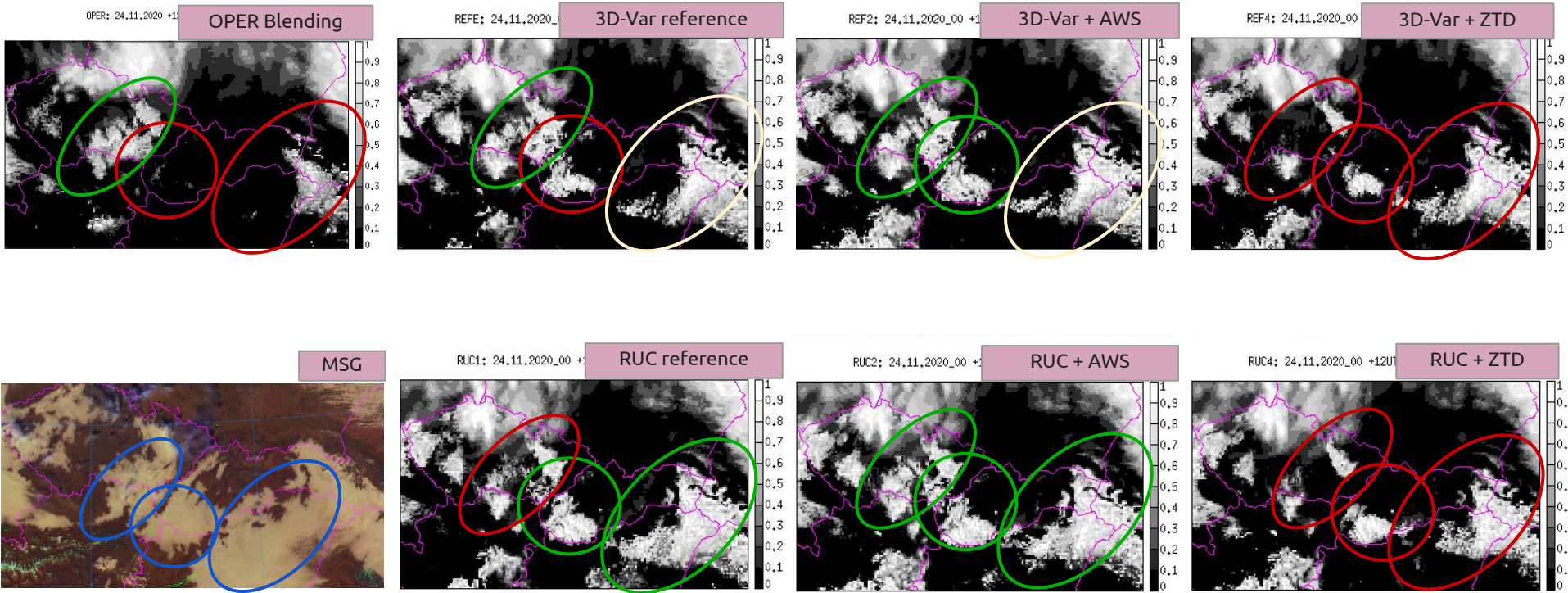
- bachelor thesis
- total cloudiness at 12 UTC, +12 h from 24-11-2020 00 UTC





# fog case study 24-11-2020

- bachelor thesis
- total cloudiness at 12 UTC, +12 h from 24-11-2020 00 UTC
- 3 days assimilation cycle from oper GUESS
- 3D-Var only, 3h assim cycling



# BUFR TEMP 3D-Var assimilation

- diploma thesis
- BUFR TEMP data from Meteo-France
- technical validation
- 3D-Var experiments (no BVAR)
- case studies (no spectacular results)
- 2 weeks verification



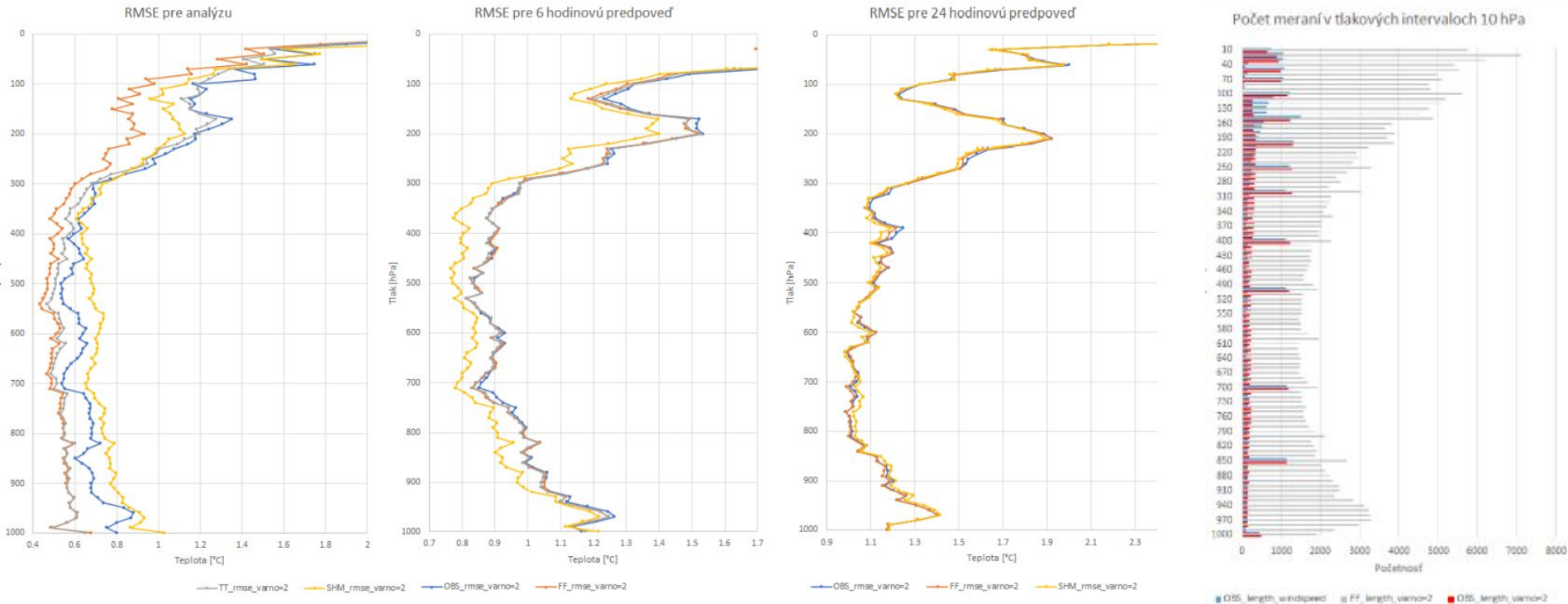
parameters	data format	explanation	abbreviation
TEMPSONSPLIT=T TemPSondOrTraj=T	BUFR	high-res profile with individual time intervals	TT
TEMPSONSPLIT=F TemPSondOrTraj=F	BUFR	RS drift: hig-hres profile with individual time intervals and position coordinates	FF
-	OBSOUL	3D-Var reference	OBS
		Blending by DF, no 3D-Var	SHM(U)

# BUFR TEMP 3D-Var assimilation

2 weeks verification of 3D-Var e-suite: 23.2. - 4.3.2020

Vertical profiles of RMSE for temperature for 00 UTC, grouped by 10 hPa.

Reference *OBS exp.* with *OBSOUL TEMP* blue, *TT exp.* grey, *FF exp.* orange, *SHM operational (only blending)* yellow



ANALYSIS

+06 h FCST

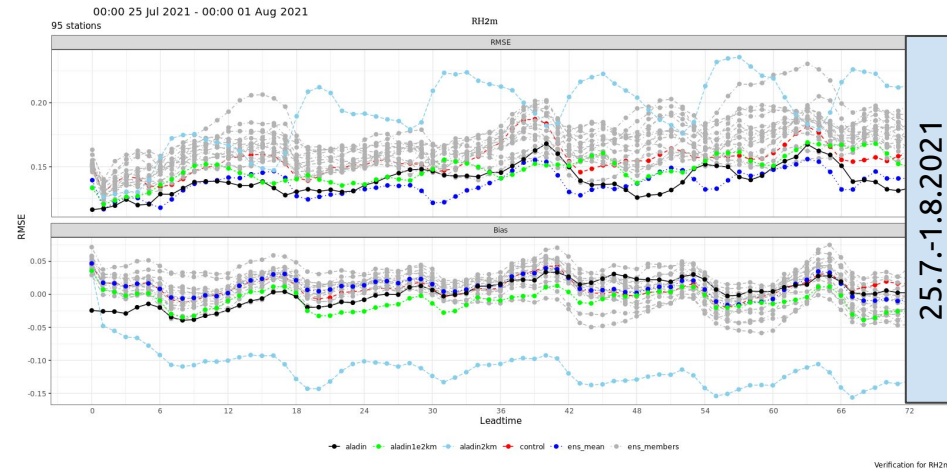
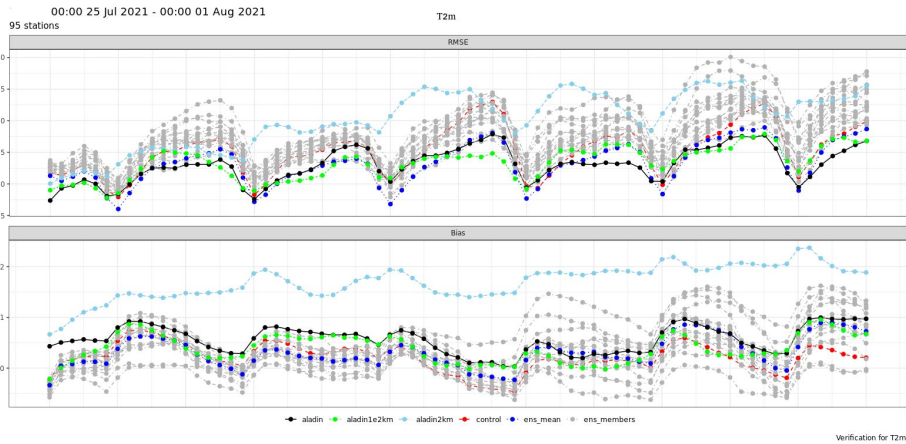
+24 h FCST

No. of data

# CANARI in ALA2

- Overestimation of 2mT in ALA2 runs reported during summer hot days
  - not observed in ALA2\_E and/or ALADIN/SHMU
- problem was traced down to unrealistic surface fields (temperature, moisture) in the initial state. INIT=ee927(ARPEGE), where surface fields are internally interpolated from SURFEX to ISBA variables ~ inconsistency?
- technical solution to get correct surface fields using CANARI analysis:
  - "technical" - there is no full data assimilation cycling applied.
  - 2 m temperature and relative humidity observations from the national AWS from OPLACE are utilized to correct the 6 h first guess surface and deep water soil and moisture.
  - 4 fields modified by CANARI are replaced in the INIT file, that is Arpege analysis represented as the LBC0 file.
  - This strategy enables to profit from the fresh upper-air fields provided by Arpege 4D-Var.

# CANARI in ALA2



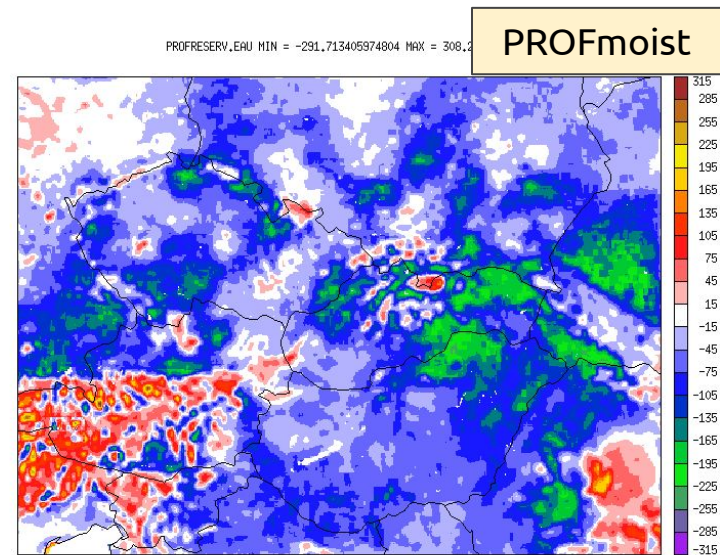
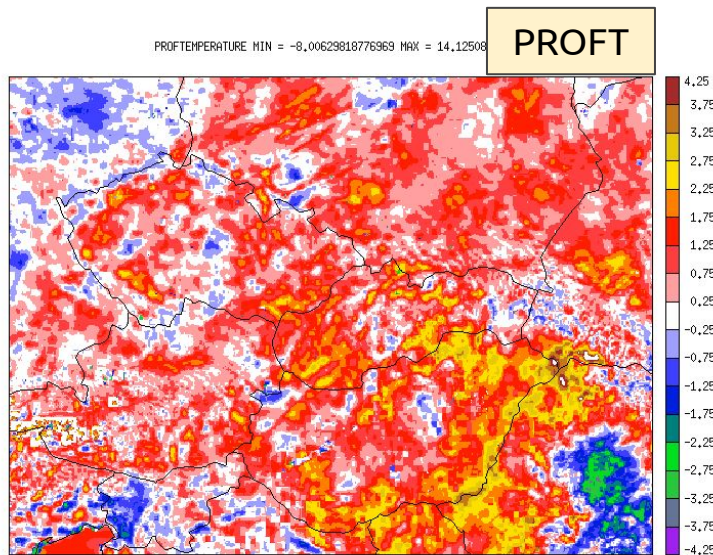
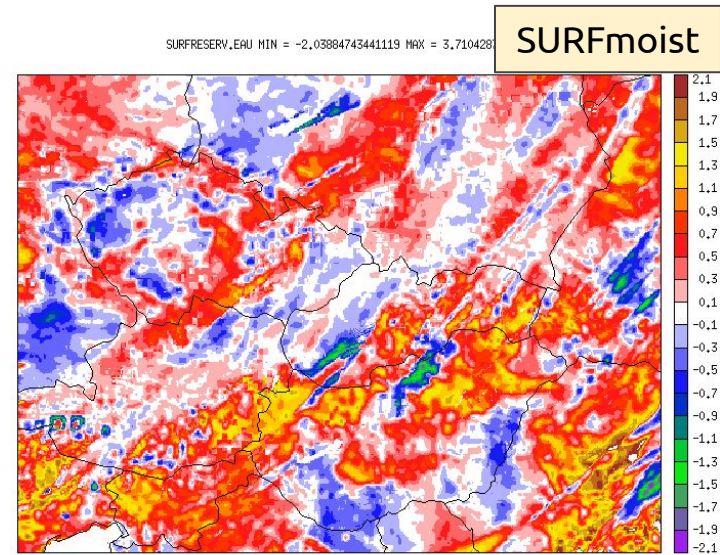
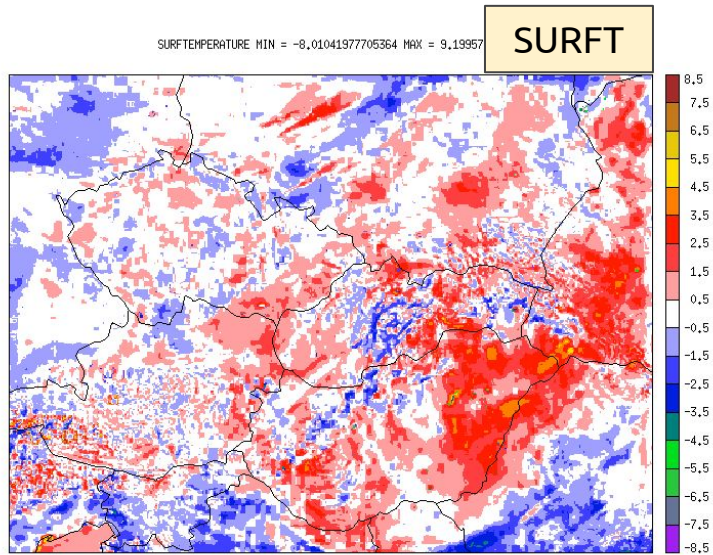
25.7.-1.8.2021

## ALADIN/SHMU

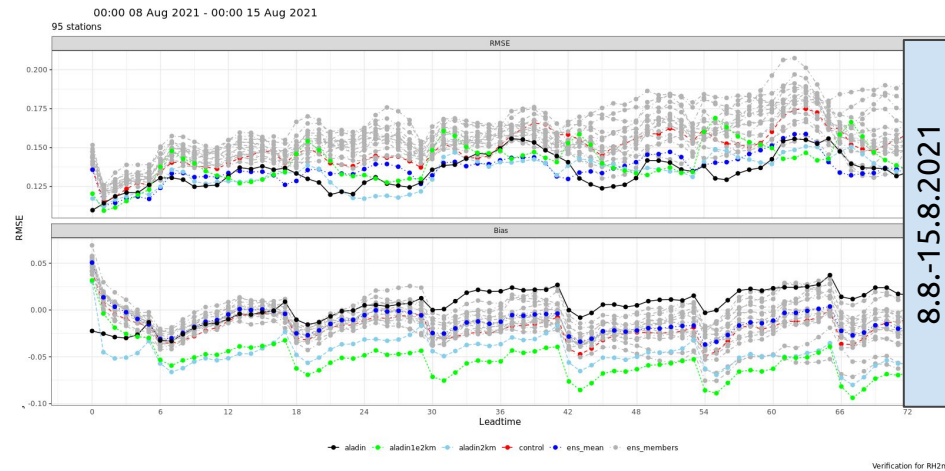
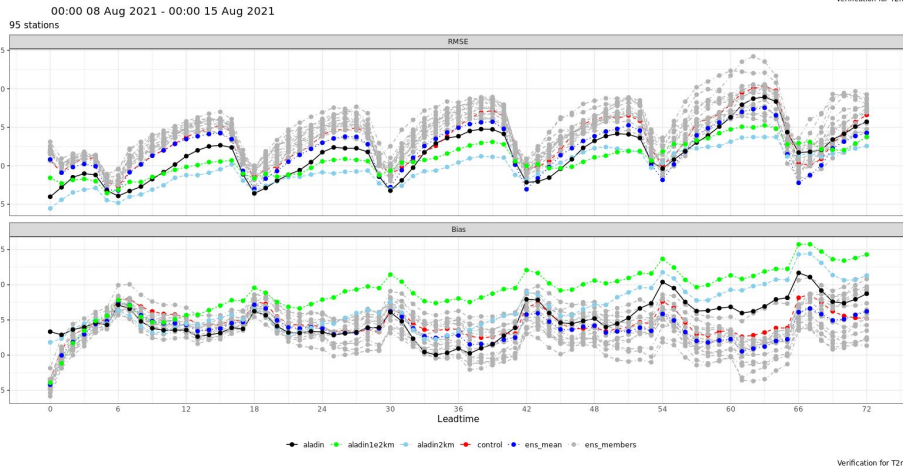
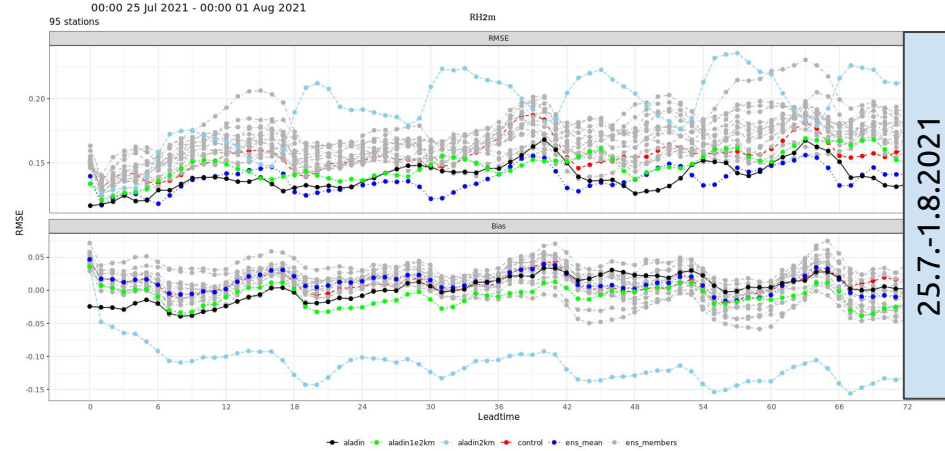
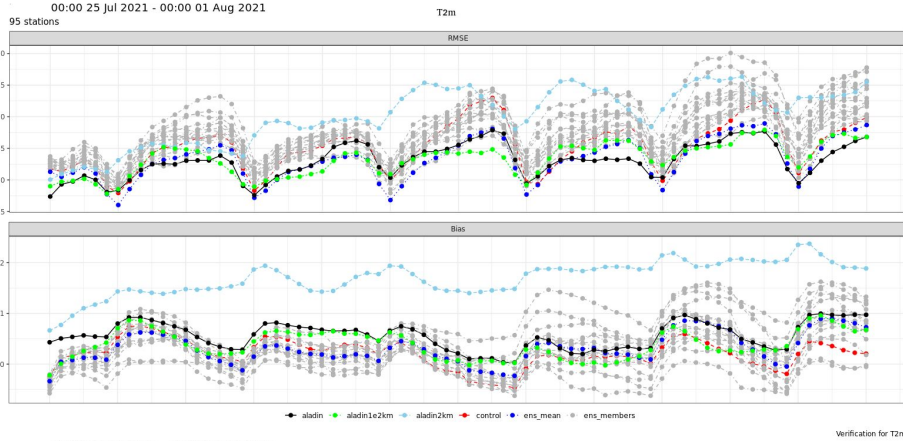
**ALA2\_E** - ALA2 coupled to ECMWF, INIT from A-LAEF

**ALA2\_A** - ALA2 coupled to Arpege, dynadapt

# CANARI in ALA2: diff (DynAdapt-CANARI)



# CANARI in ALA2



## ALADIN/SHMU

**ALA2\_E** - ALA2 coupled to ECMWF, INIT from A-LAEF

**ALA2\_A** - ALA2 coupled to Arpege + CANARI

# Future plans

- TuneBR package
- finish validation (BLENDVAR vs. VARBLEND vs. Jk)
- go operational (new HPC?)