

# How things can go well/wrong with DA

M.Derkova, M.Mile

# Outline

- Impact of bad observations (AMDAR example)
- Impact of bugged source code (LQCPL)
- Impact of incorrect parameter initialization (SST, snow)
- Impact of imbalances and bad initialization (IDFI, SCC vs TCC)
- Impact of bad DA construction (1hRUC vs 3hRUC)
- Impact of more good observations (Freezing rain in Slovenia)
- Impact of more accurate B representation (AROME EDA)

# Impact of bad observations

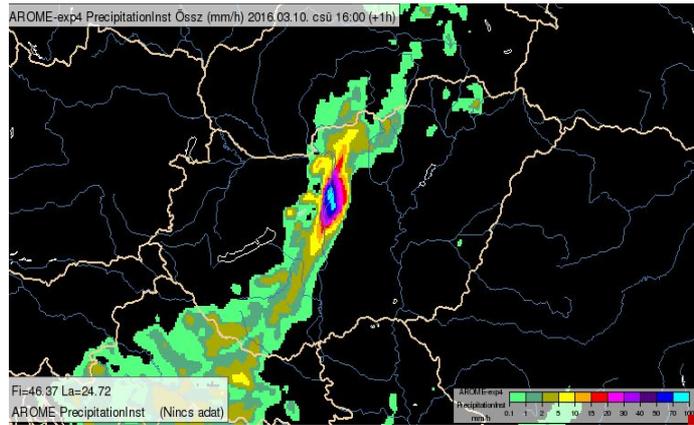
## Bad observations!

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- ▶ At 10th of March, 2016, AROME model predicted unrealistic high precipitation on very short-range started from 15UTC 3DVAR analysis. It turned out that AMDAR report of aircraft EU0827 deviates in temperature from other aircrafts (see profiles in the next slide) and contains incorrect lat-lon values (incorrect means coordinates didn't change during the full ascent) which made the initial conditions of the AROME wrong.
- ▶ The blacklisting of EU0827 for this case study fixed the overestimation of precipitation (figures on the left side of the next slide).

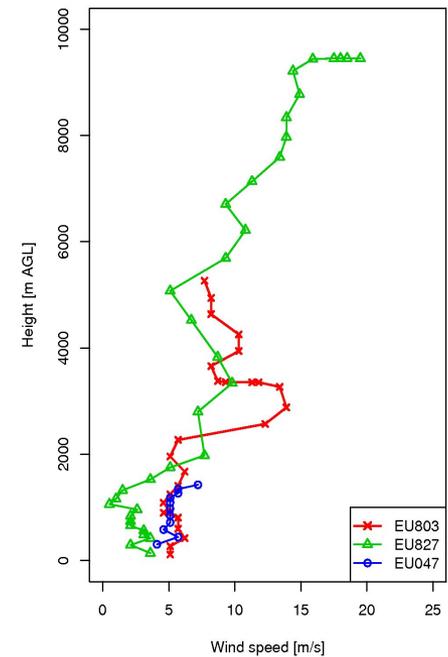
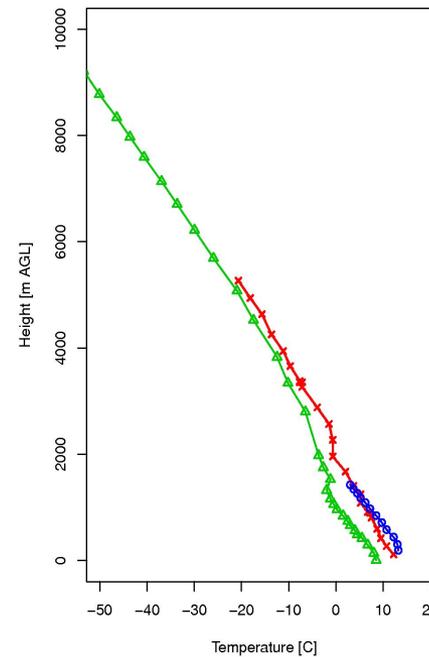
# Bad observations!

AROME assim with EU0827



AROME assim without EU0827

Vertical profiles for 20160310\_15 UTC, Station: Budapest



# Impact of bugged source code

# Cycling and a bug in quadratic coupling @SHMU (1)

Installation of CY40t1 @SHMU: two problems investigated

- Oscillating MSLP on meteograms

ALADIN/SHMU 9.0 km



ALADIN/SHMU 4.5 km



ALADIN/SHMU 1.0 km (dynamic adaptation)



# Cycling and a bug in quadratic coupling @SHMU (1)

Installation of CY40t1 @SHMU: two problems investigated

- Oscillating MSLP on meteograms
- Spin-up on MSLP scores **ALARO\_3MT CY36T1 (9km.37l)**,  
**ALARO-1vA CY40T1 (4.5km/63l)**, **ALARO-0 CY38T3 (4.5km/63l) P012**

ALADIN/SHMU 9.0 km



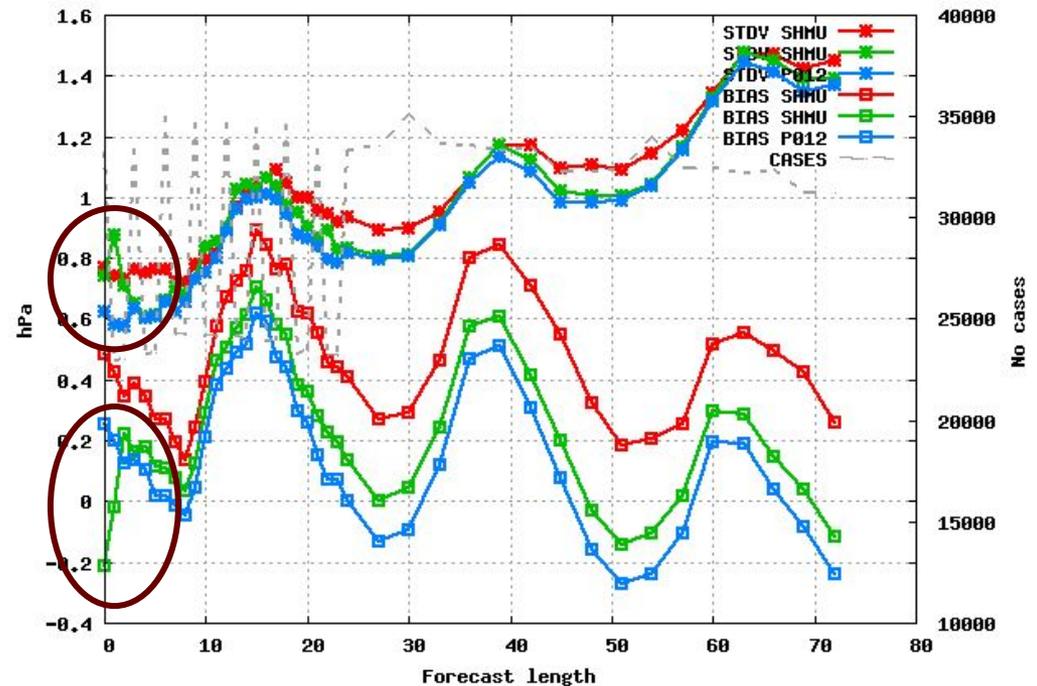
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ALADIN/SHMU 1.0 km (dynamic adaptation)



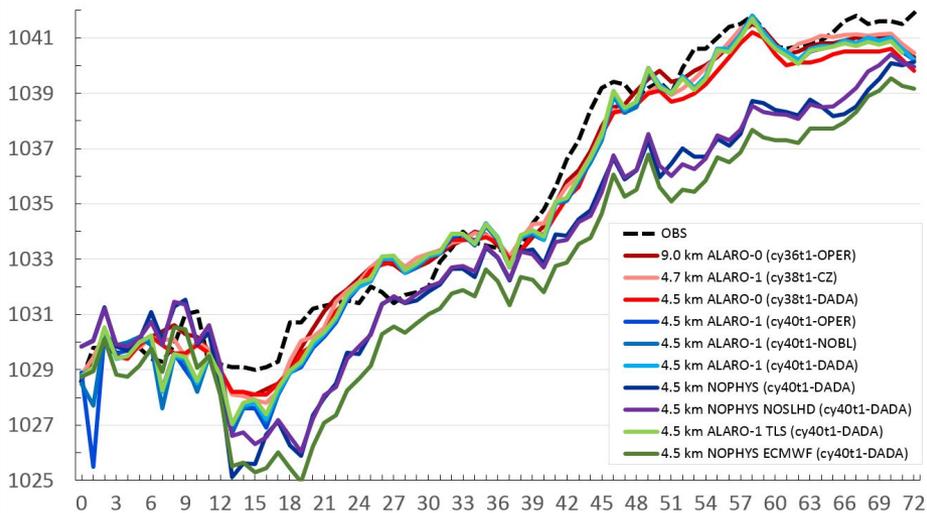
Selection: ALL using 1252 stations  
Mslp Period: 201609  
Hours: {00}



# Cycling and a bug in quadratic coupling @SHMU (2)

Many many many experiments indeed to figure out ...

MSLP/SURFP: Bratislava 27-12-2016 00 UTC

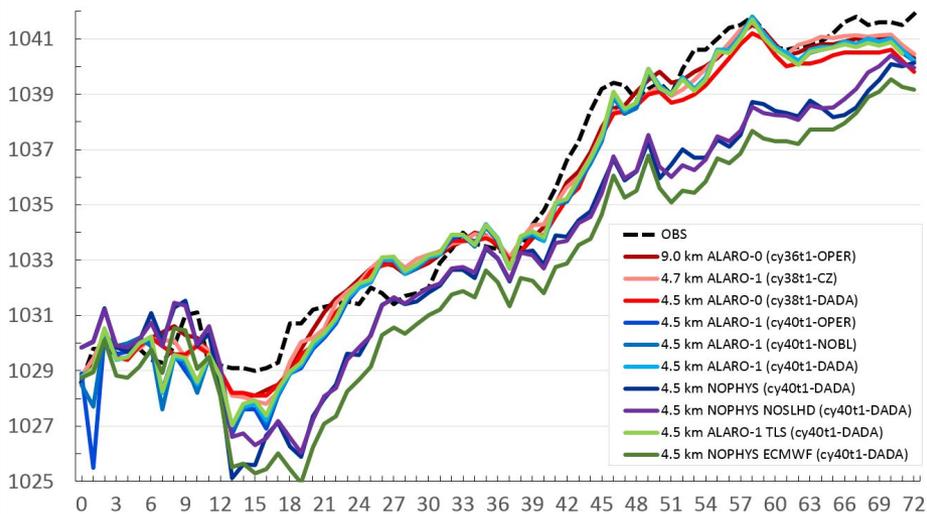


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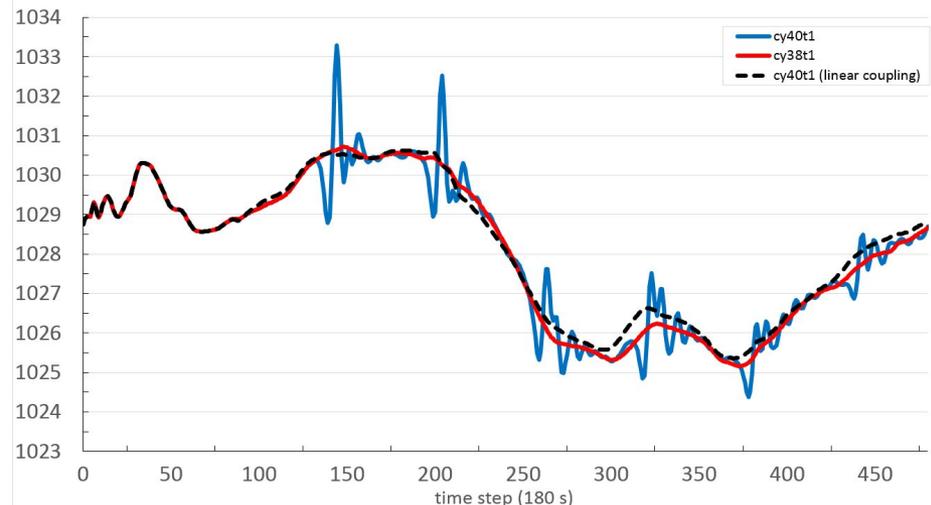
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... a bug in CY40t1 was discovered: wrong LBC file was read at particular NSTEP (TEFRCL/TSTEP) in quadratic/cubic coupling. See the every TSTEP MSLP plot of adiabatic run with LQCPL: **CY40t1**, **CY38t3** and with linear coupling.

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MSLP: Bratislava 27-12-2016 00 UTC +24h  
adiabatic run (no physics), spectral diffusion (no SLHD)



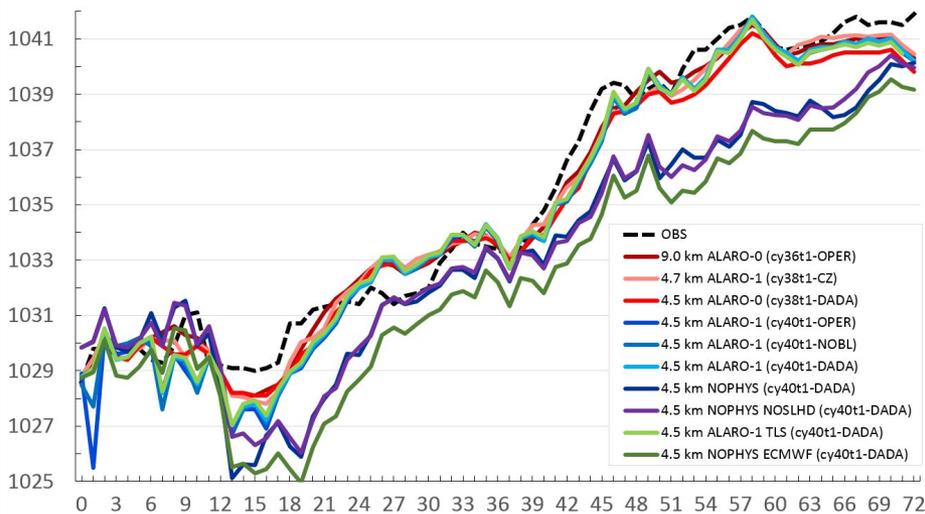
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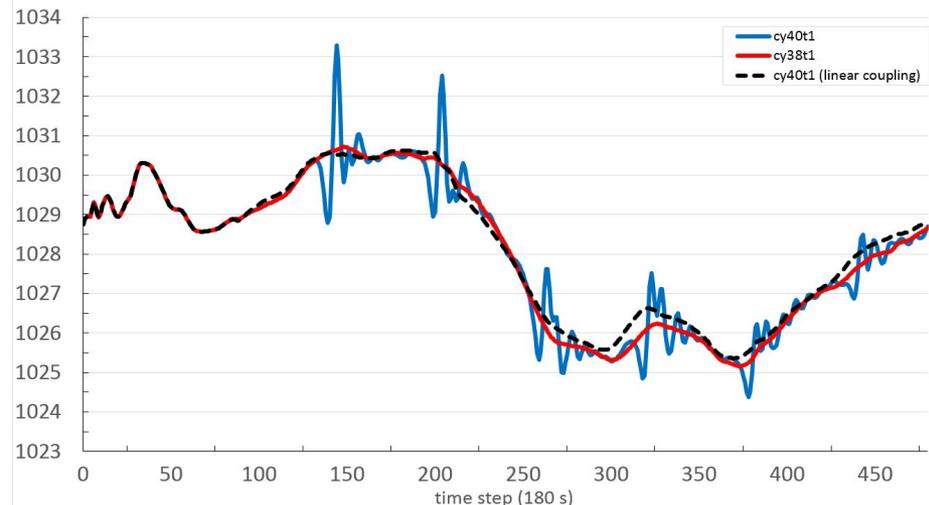
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Consequences with 3h coupling frequency were detrimental for the initial state after blending.

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adiabatic run (no physics), spectral diffusion (no SLHD)



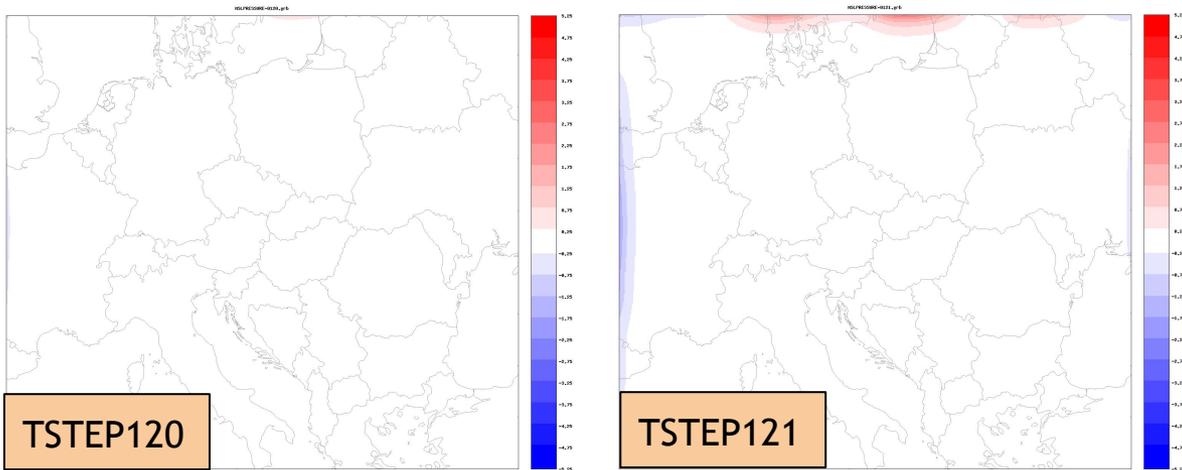
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Adiabatic runs with CY38t3 and CY40t1: MSLP difference plots every TSTEP



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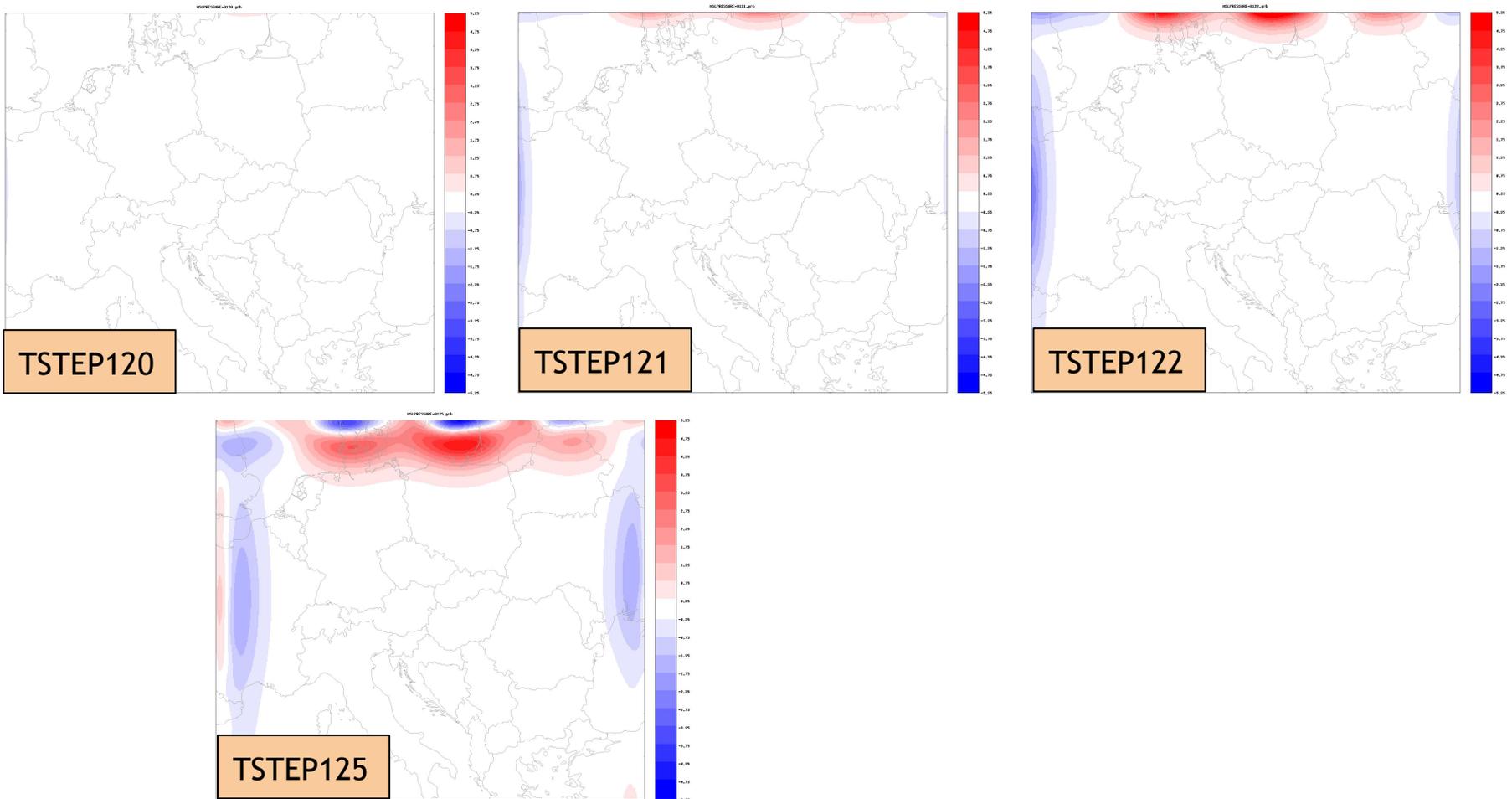
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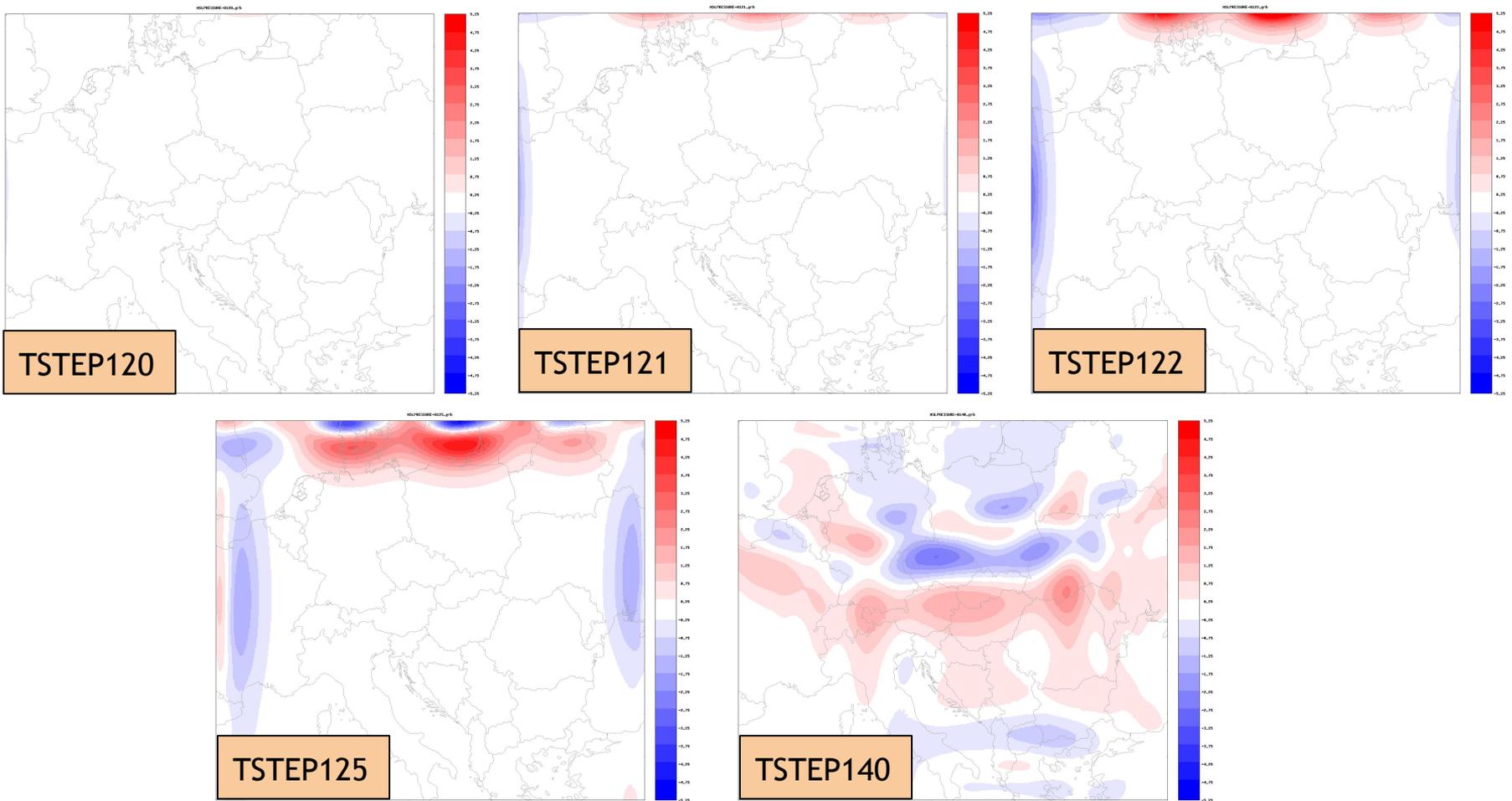
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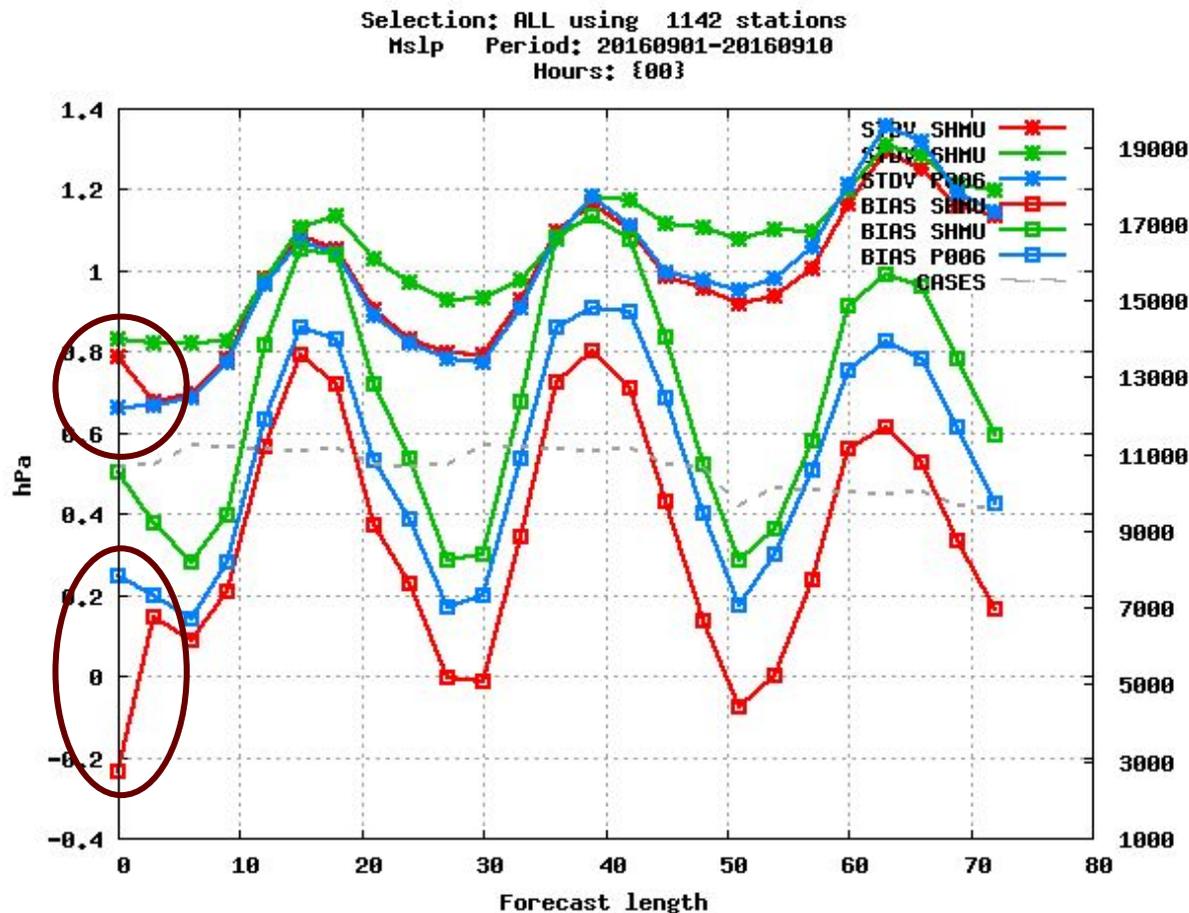
# Cycling and a bug in quadratic coupling @SHMU (3)

Adiabatic runs with CY38t3 and CY40t1: MSLP difference plots every TSTEP



# Cycling and a bug in quadratic coupling @SHMU (4)

Bug corrected (arpifs/module/elbc0b\_mod.F90) => MSLP spin-up disappeared.



**ALARO-1vA**  
(4.5km/63l)  
**CY40t1\_\_BUGGED**

**ALARO\_3MT**  
(9km.37l) **CY36t1**

**ALARO-1vB**  
(4.5km/63l)  
**CY40t1\_bf07**

# Impact of incorrect parameter initialization

# Wrong SST treatment in LAM/CANARI @SHMU (1)

CANARI surface analysis was introduced at SHMU in 2011 with generally positive impact on the forecasts.

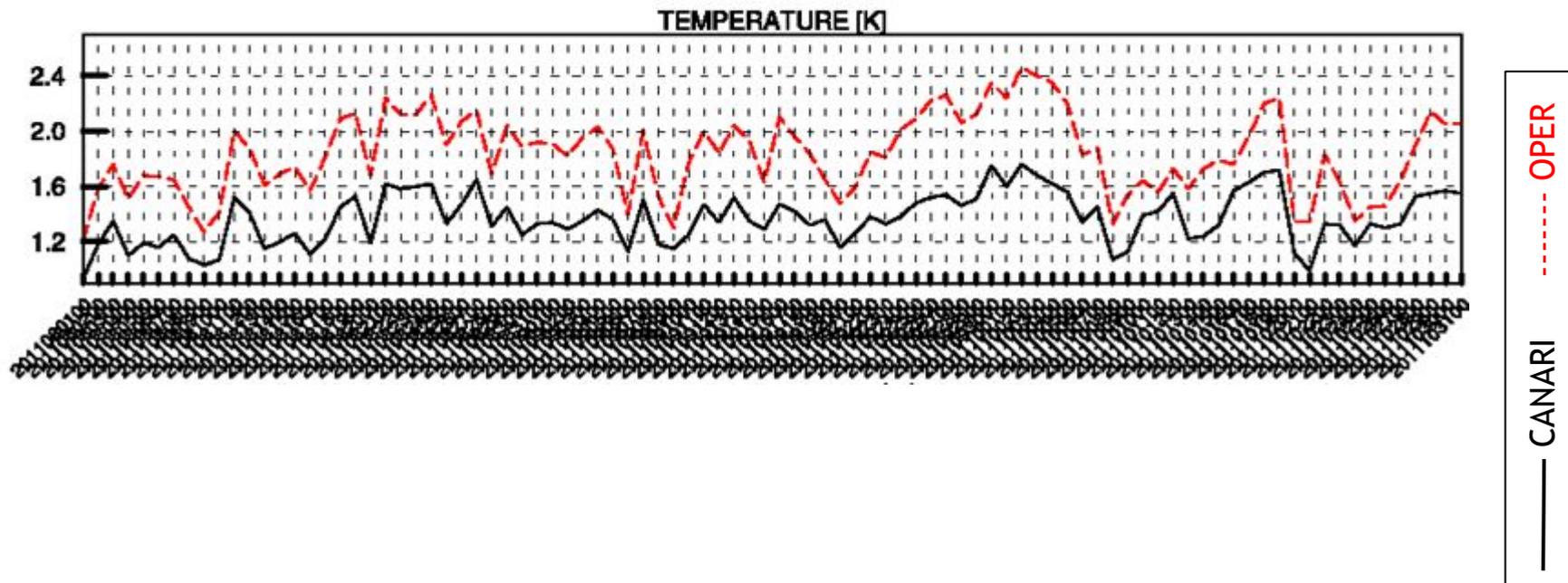
A problem discovered when checking the 2mT analysis RMSE scores of individual runs (01/08-31/10/2011): for *Slovakia* OK, but not over the *whole domain*!

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SLOVAKIA



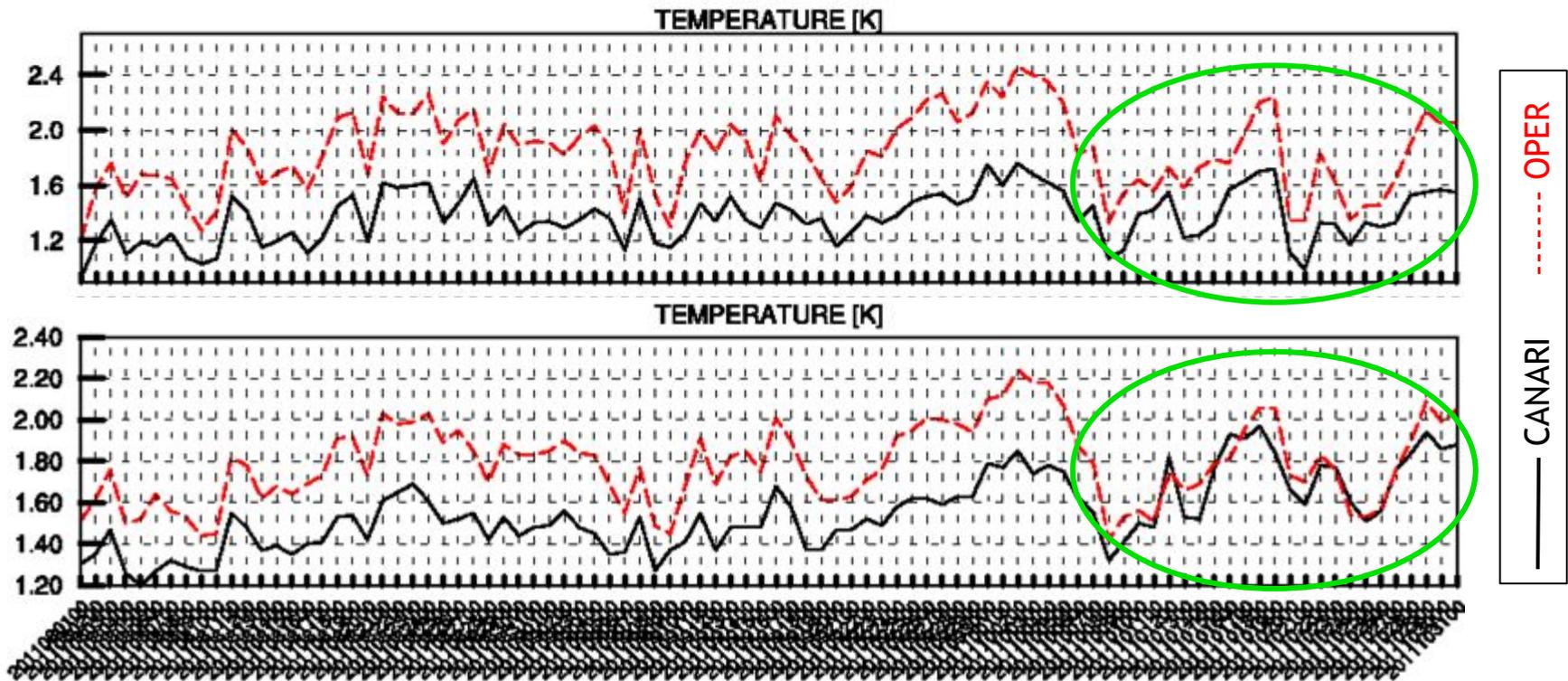
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SLOVAKIA

WHOLE DOMAIN



# Wrong SST treatment in LAM/CANARI @SHMU (2)

In SHMU CANARI original setup the sea surface temperature (SST) field was cycled in the same way as other surface prognostic fields. But! No SST data available @SHMU for SST analysis.

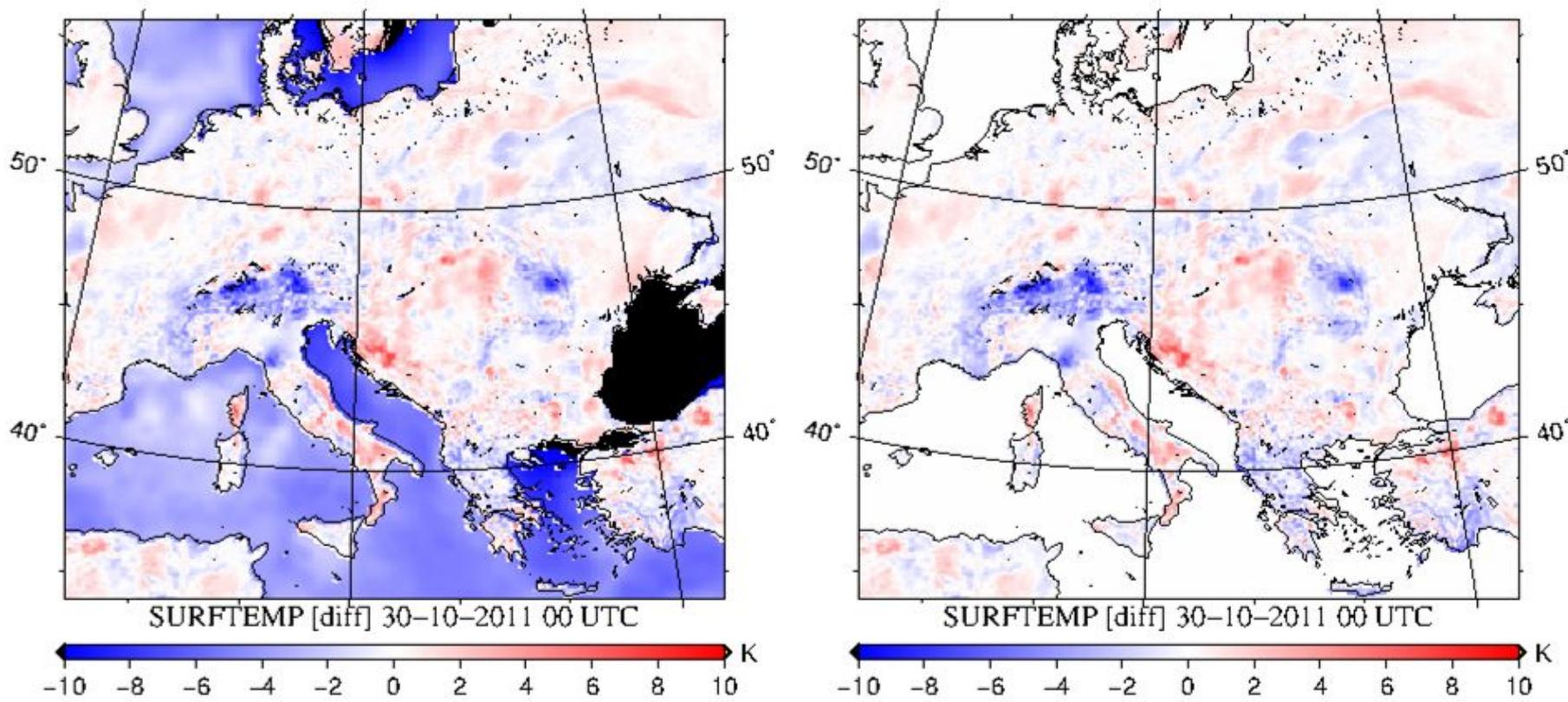
**Correction: the SST from the ARPEGE analysis is copied from LBC0 (analyzed by Arpege).**

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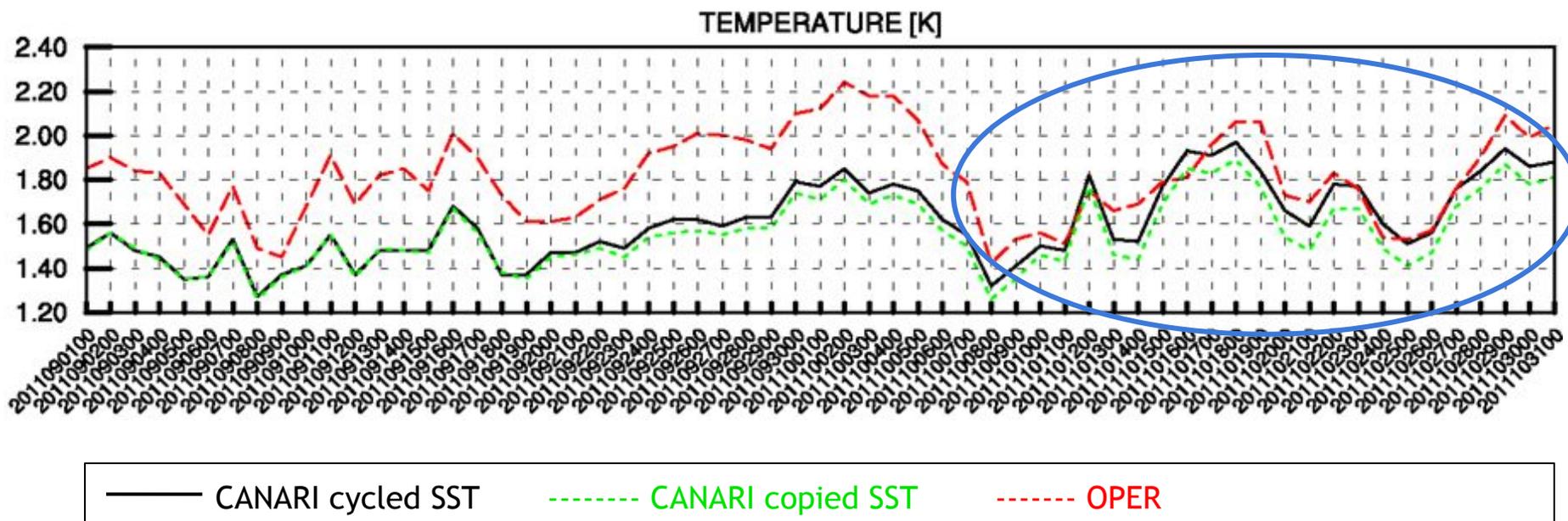
Plotted are the differences in Tsurf between the local CANARI analysis and the LBC0 file with wrongly SST cycled (left) and correctly treated (right).



# Wrong SST treatment in LAM/CANARI @SHMU (3)

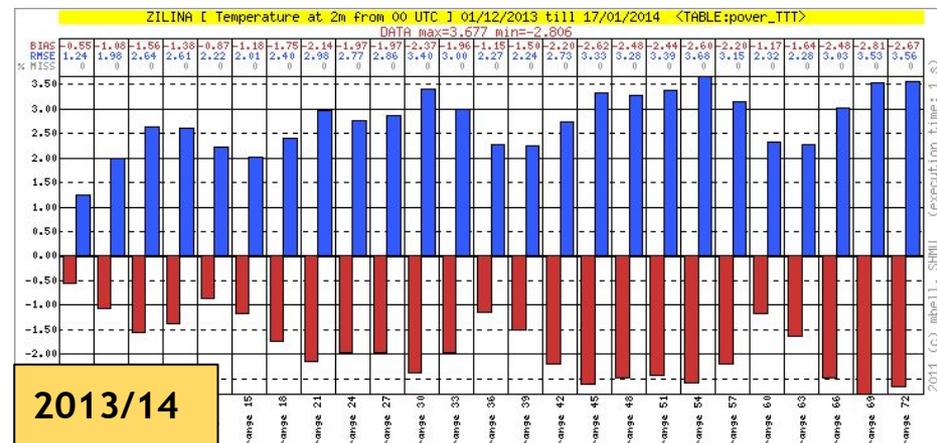
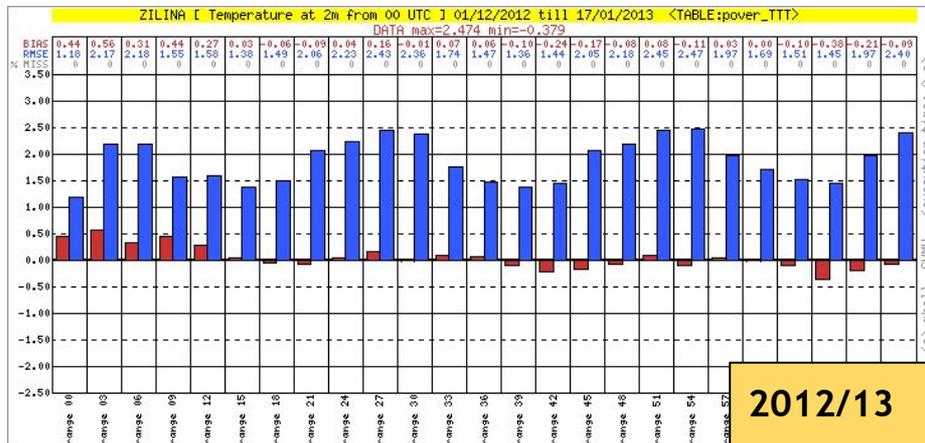
2mT analysis RMSE scores of individual runs over whole domain after SST treatment correction: everything OK!

## RMSE of individual runs



# Wrong T2m forecast due to snow cover @SHMU (1)

- Winter 2013/14: long-lasting negative temperature BIAS on almost all Slovak stations was observed, that was not present during winter 2012/13 despite no change in the operational setup.
- HYPOTHESIS: problem due to unrealistic snow cover in ALADIN -in reality there was NO SNOW in January 2014 over whole Slovak territory except highest mountains.
- Snow cover is not analyzed in CANARI, but it is cycled from the guess. Only new precipitation and melting are taken into account.



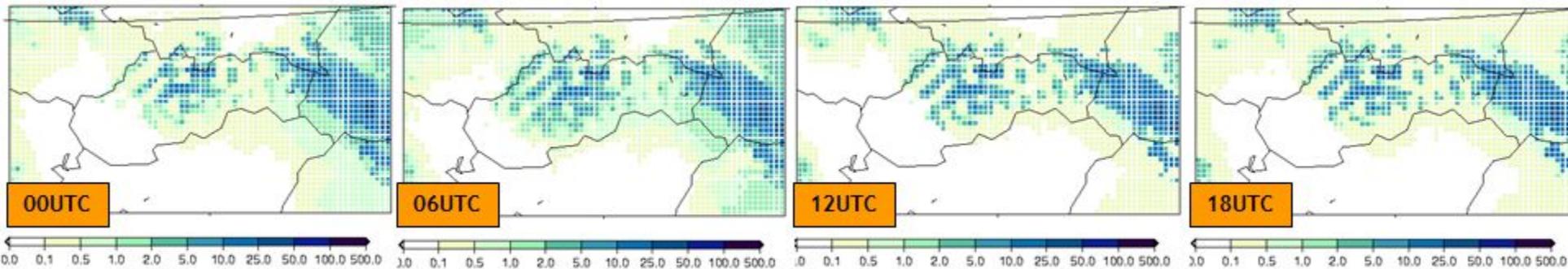
## Wrong T2m forecast due to snow cover @SHMU (2)

There was much less snow in Arpege (in LBC), but its amount was changing forecast to forecast! Check an example of the snow reservoir on 15/01/2014 in assimilation files (+0000) - no snow fall that day

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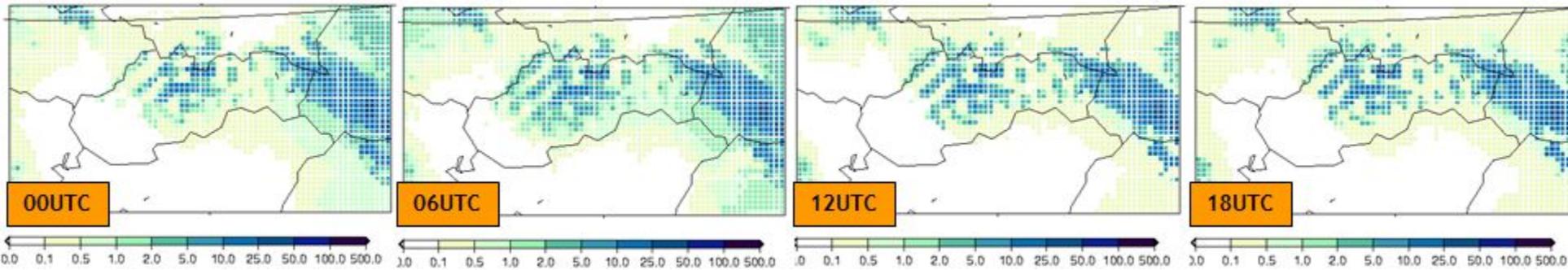
ALADIN: completely unrealistic (there was no snow at all), but amount consistent from NT to NT



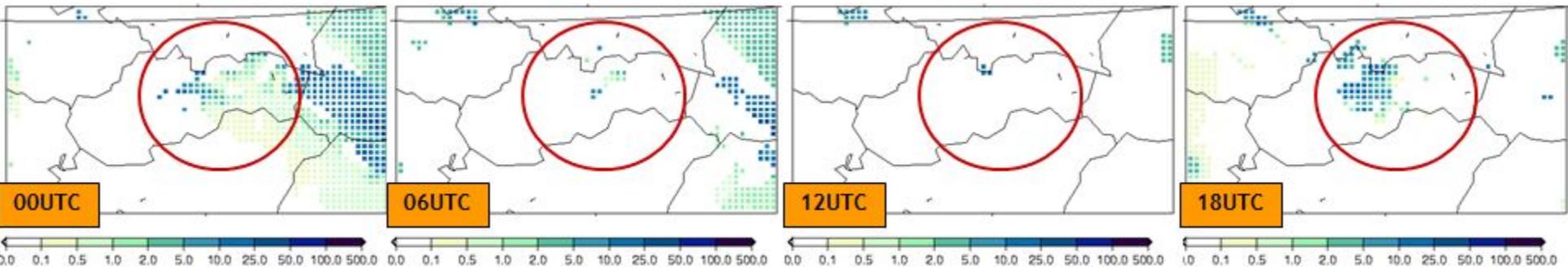
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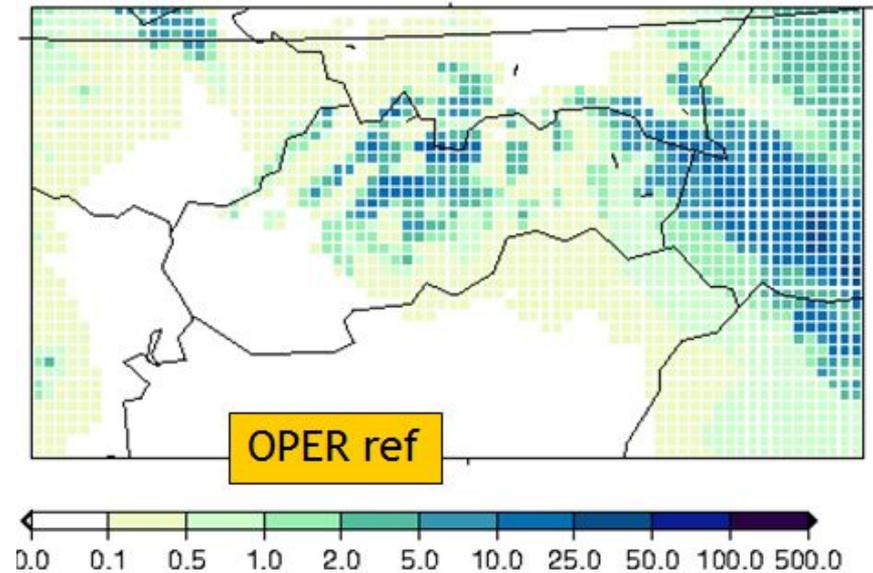
ARPEGE: more reasonable, but changing with network times (this is generally observed feature)



# Wrong T2m forecast due to snow cover @SHMU (3)

Assimilation experiments:

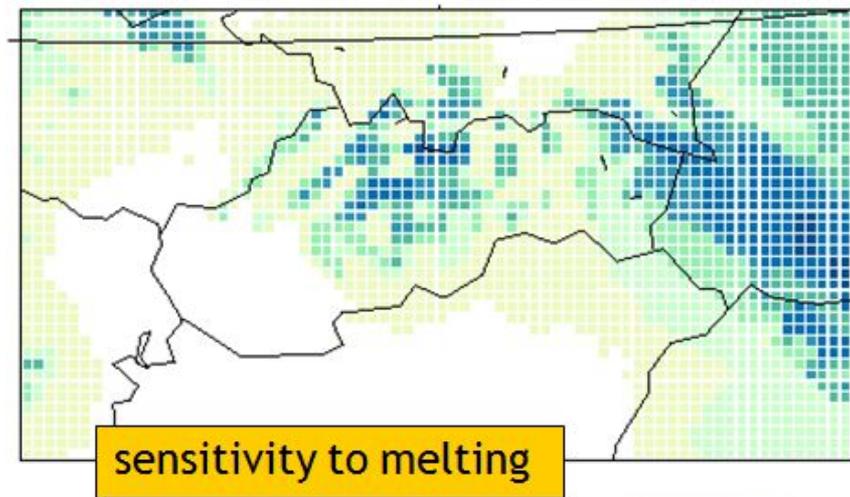
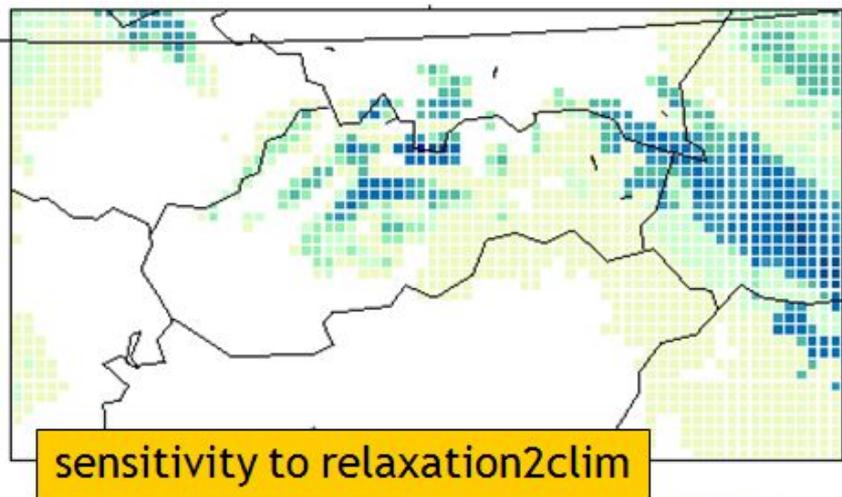
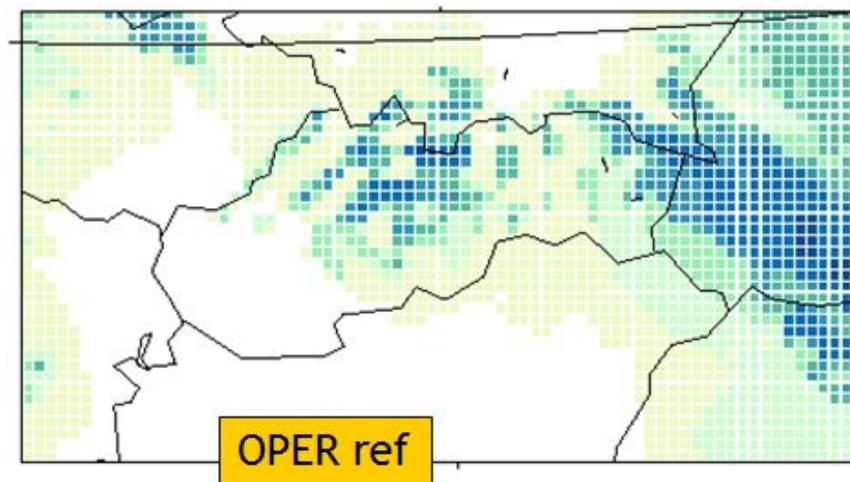
- sensitivity to relaxation to climatology (RCLIMCA=0.045) is weak
- sensitivity to melting (RSNSA=0.04; RSNSB=1.) is negligible



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# Wrong T2m forecast due to snow cover @SHMU (4)

Solution: it was snowing on 22/01/2014 in Slovakia => snow cover => T2m BIAS “under control”

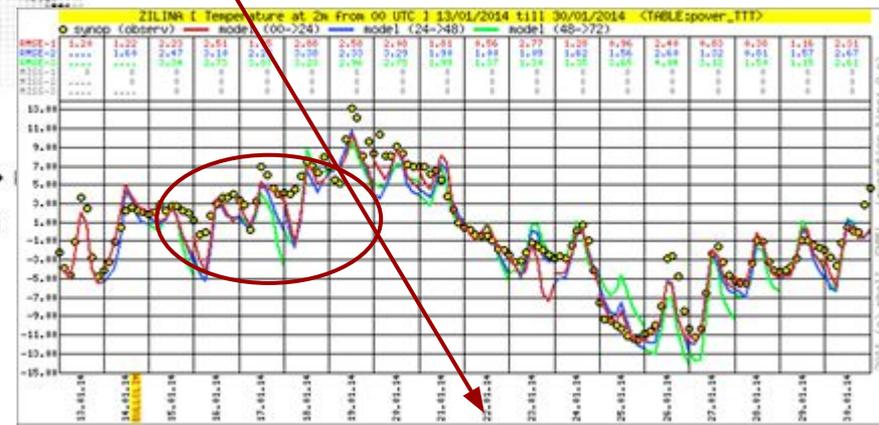
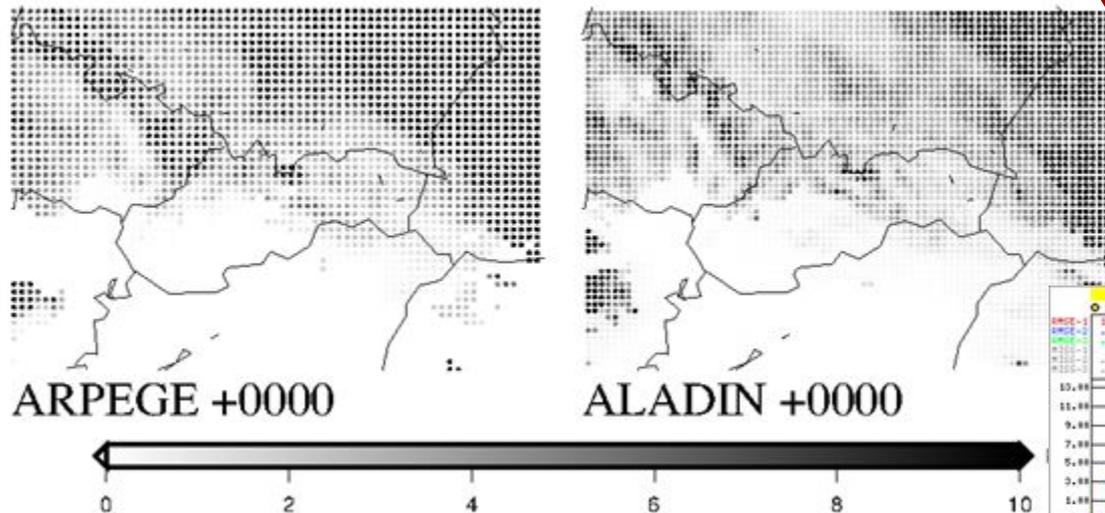
Stop joking: **there is a need to work on snow analysis**

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SURF SNOW :: 2014-01-22\_18

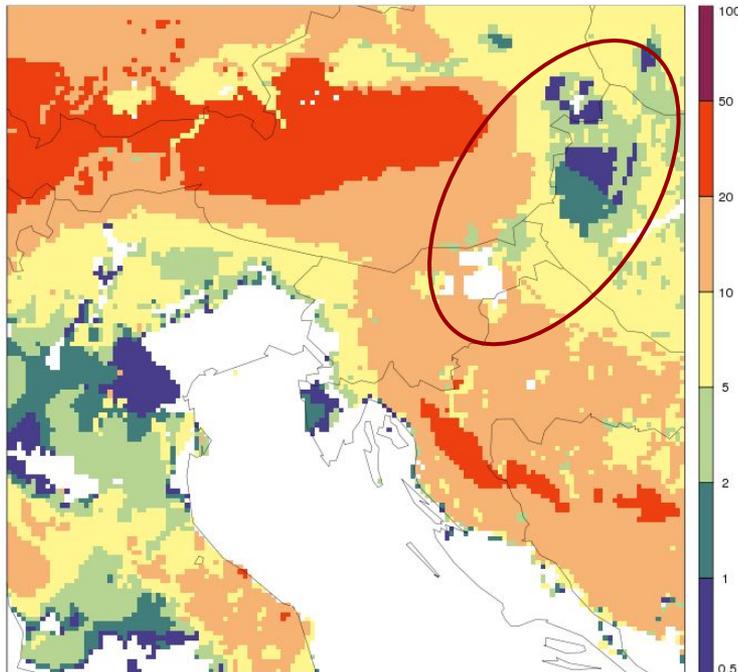


# LandSAF snow cover assimilation @ARSO (1)

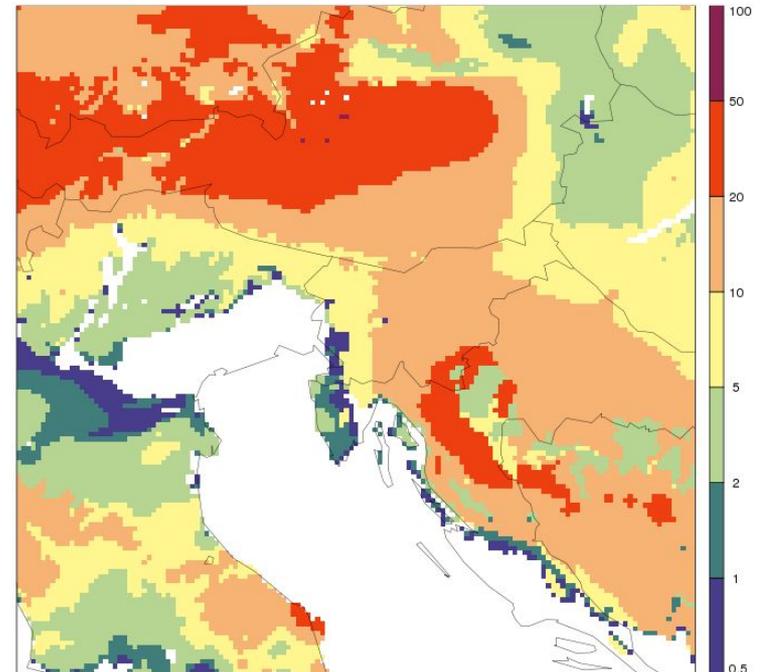
Courtesy of Jure Cedilnik, ARSO

Snow cover product (15 minute intermediate products) from LandSAF  
Snow either removed or added (10cm) in ALADIN analysis

Snow reservoir [kg/m<sup>2</sup>] on 17. dec. 2010 at 12 UTC (analysis)  
using LSAF 15 minute snow cover



Snow reservoir [kg/m<sup>2</sup>] on 17. dec. 2010 at 12 UTC (analysis)  
no snow analysis



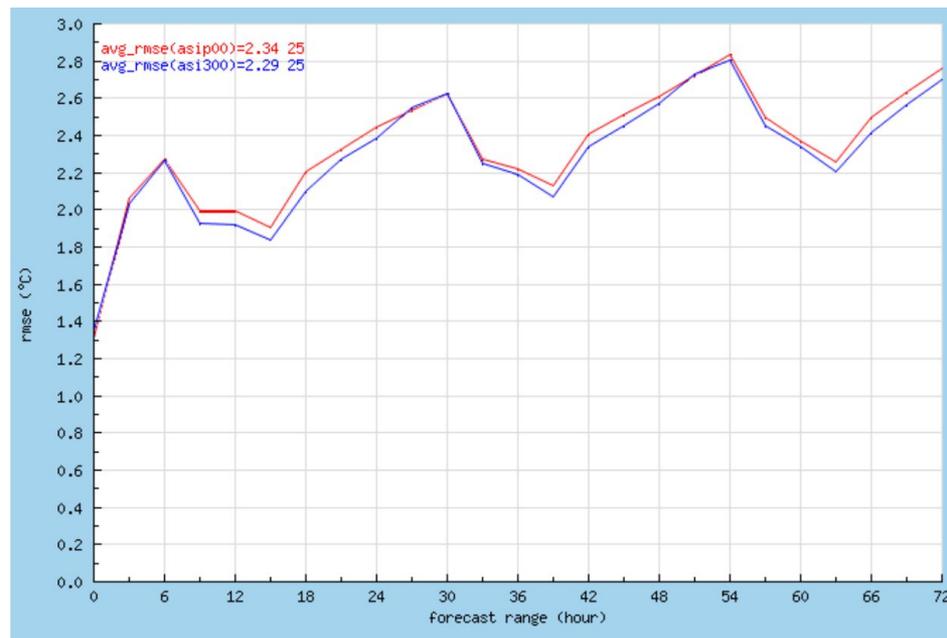
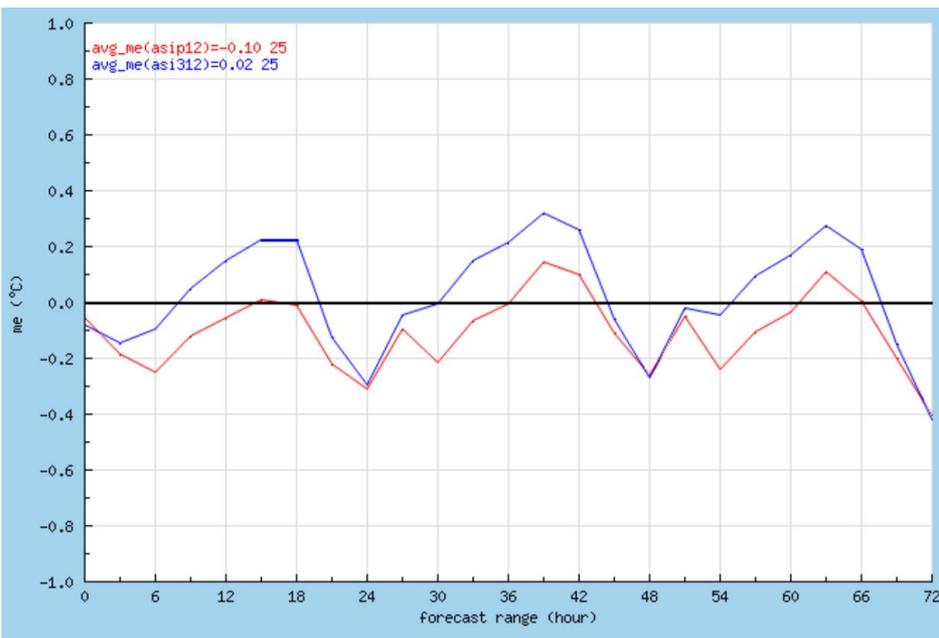
# LandSAF snow cover assimilation @ARSO (2)

Courtesy of Jure Cedilnik, ARSO

Evaluation period: 15 days in December 2010

Positive impact of LandSAF on forecast - see 2m temperature scores (ME, RMSE)

Not a standard products, but detects rapid changes in snow cover

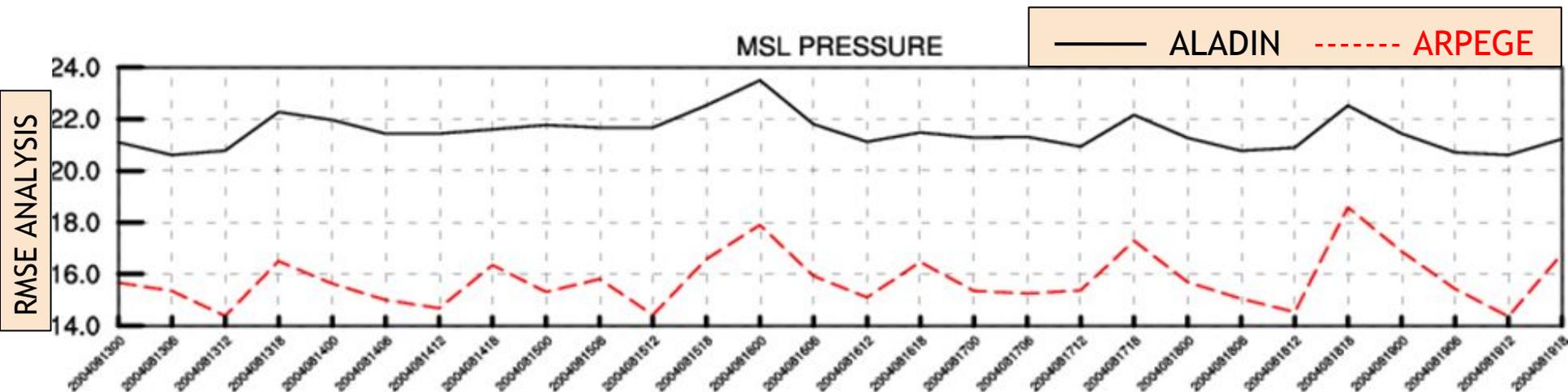


— REFERENCE — EXPERIMENT

# Impact of imbalances and bad initialization

# IDFI in assimilation for MFSTEP (1)

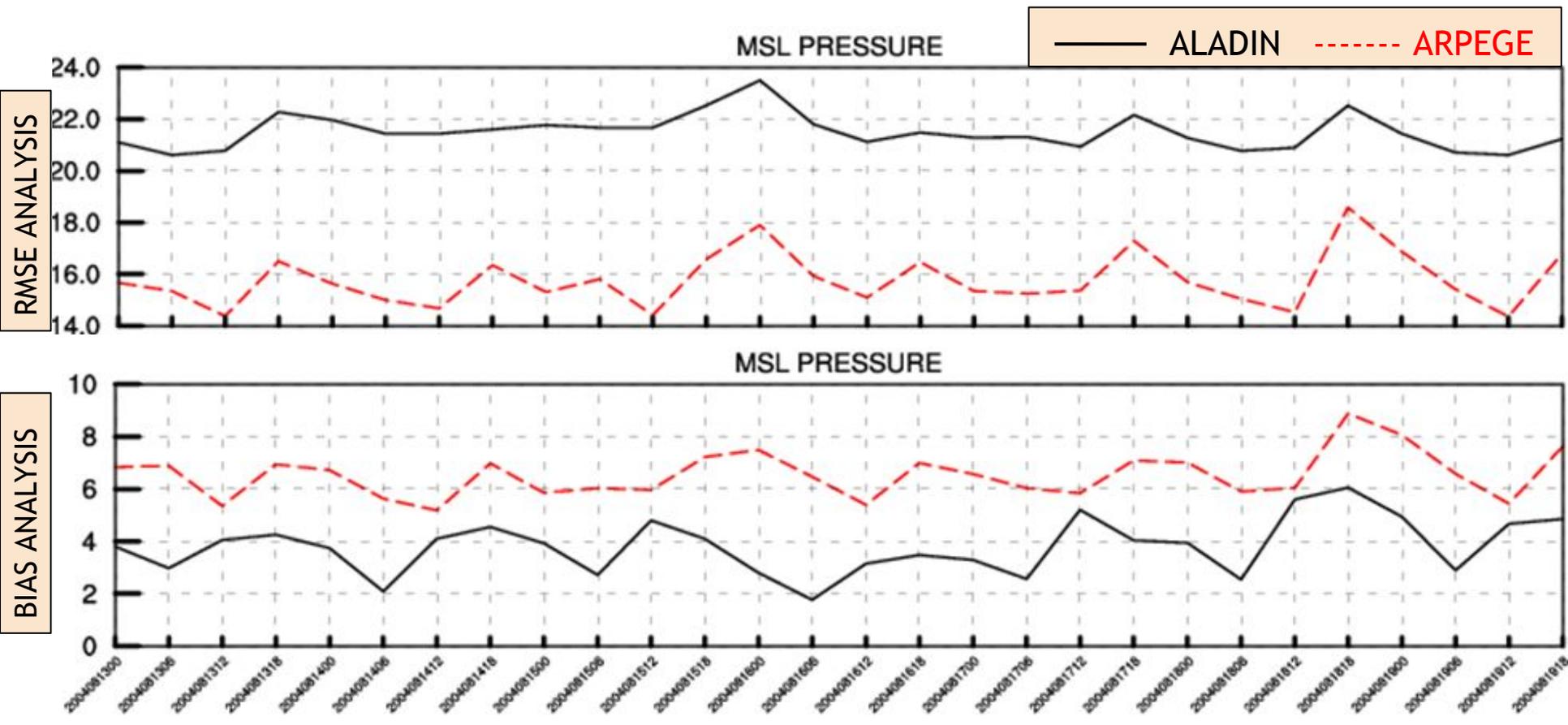
Problem: wrong RMSE scores of the MSLP analysis



# IDFI in assimilation for MFSTEP (1)

Problem: wrong RMSE scores of the MSLP analysis

Cross-check (1): BIAS of MSLP analysis OK

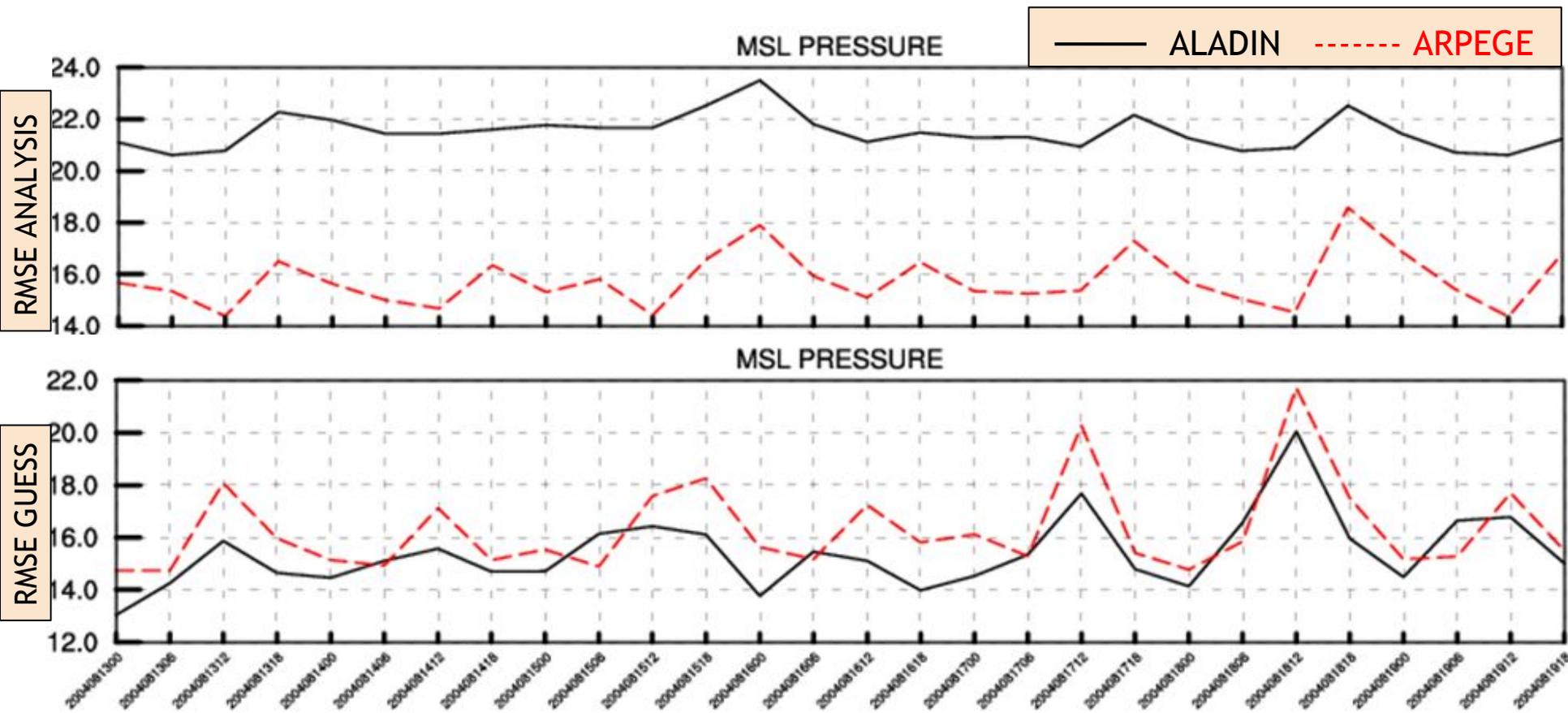


# IDFI in assimilation for MFSTEP (1)

Problem: wrong RMSE scores of the MSLP analysis

Cross-check (1): BIAS of MSLP analysis OK

Cross-check (2): RMSE of MSLP guess OK



# IDFI in assimilation for MFSTEP (2)

**Problem:** wrong RMSE scores of the MSLP analysis

**Cause:** too big jump between LBC, blending and target resolutions

**Cure:** implement incremental digital filter (IDFI) in the assimilation step

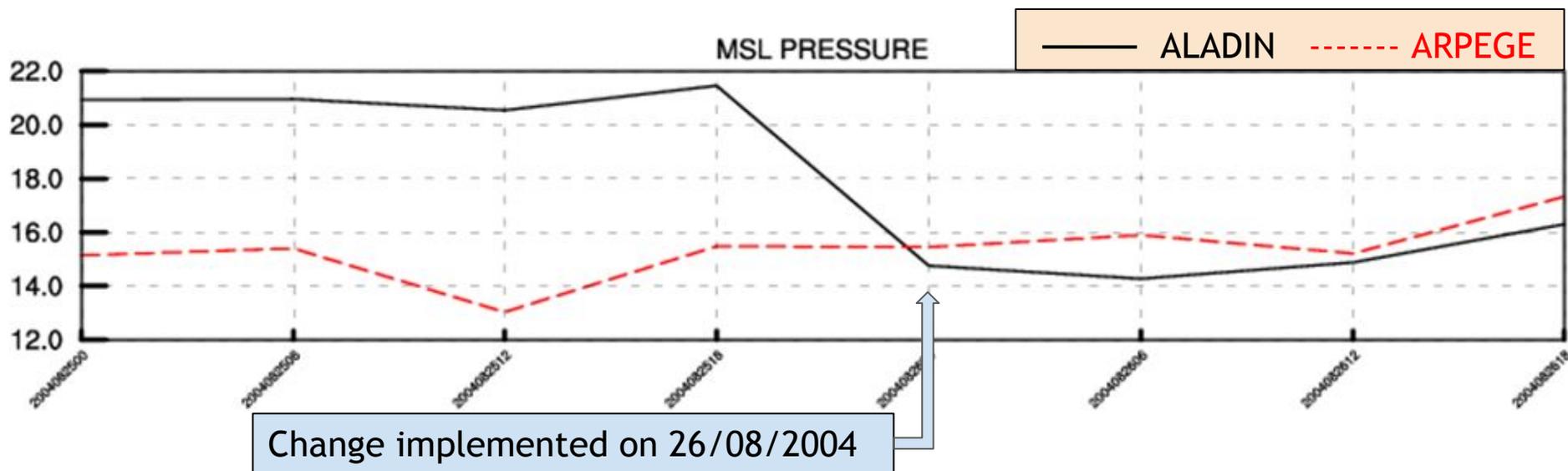
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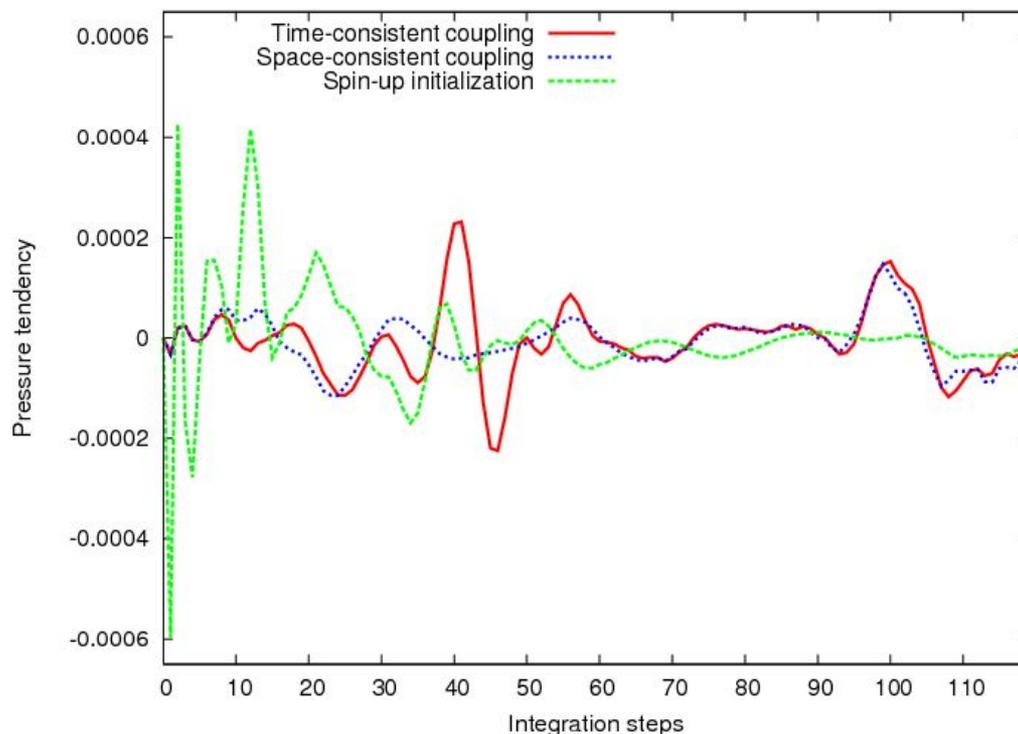
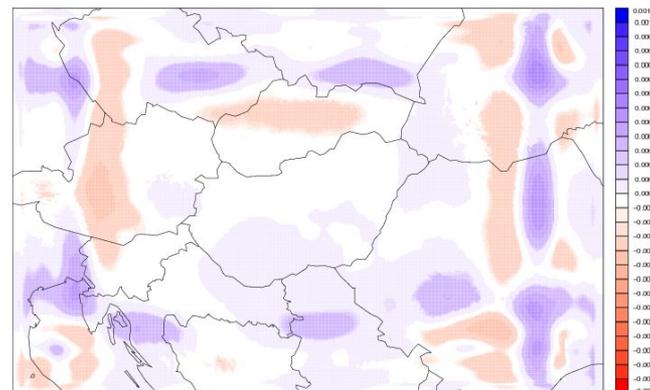
Note: no problem in the forecast, there is IDFI active



# Bad initialization!

- Initialization is disabled in AROME to not distort small scales
- Therefore in such DA system the accumulation of noises has to be controlled
- For 3h RUC space-consistent coupling (SCC) has been found sufficient to avoid noise accumulation (compared to TCC).

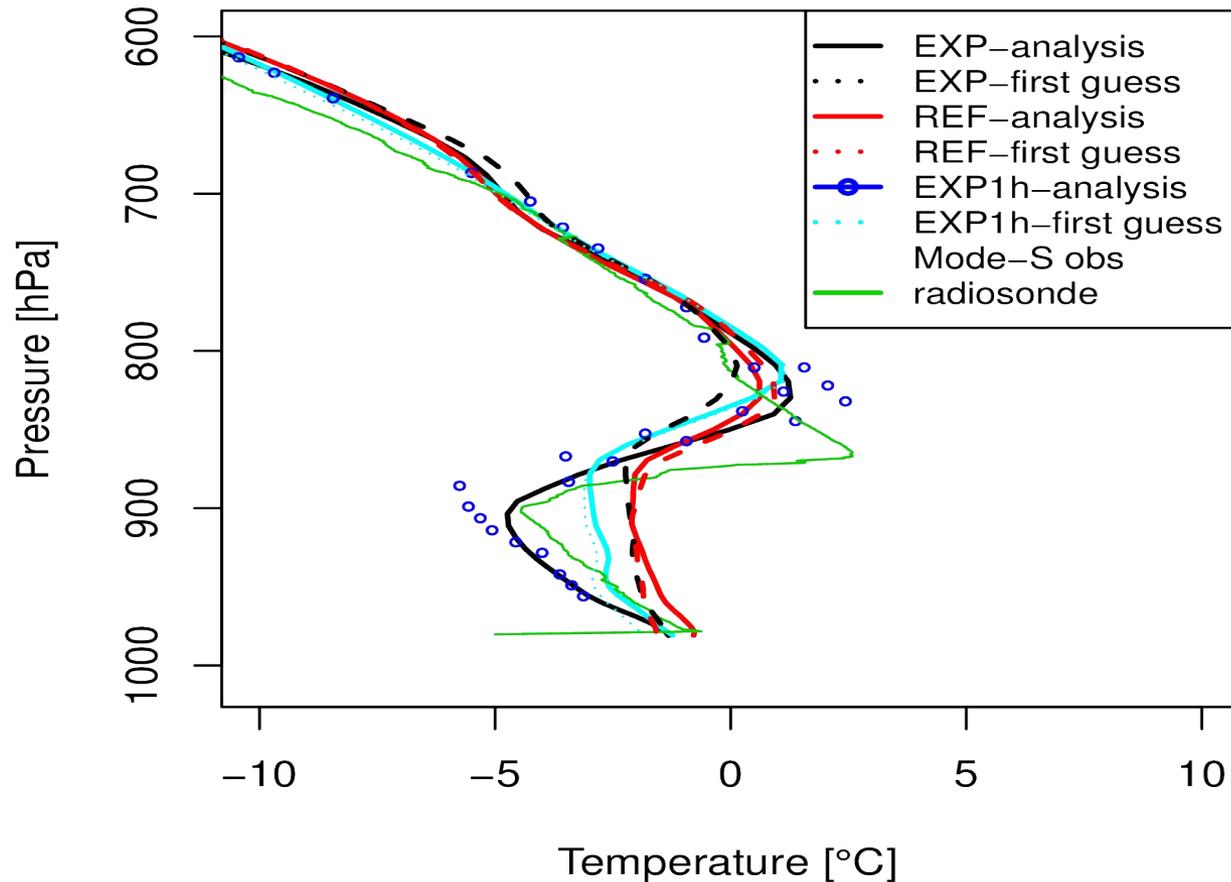
SURFPRESSION  
2012/8/1 20:0 Initialized



# Impact of bad DA construction

# Bad DA construction!

Need more observations to 1h RUC!



Courtesy of Benedikt Strajnar (ARSO)

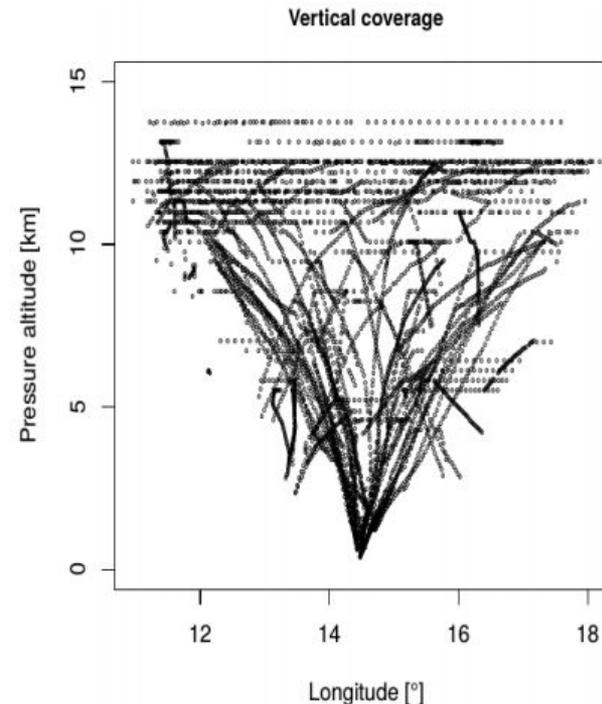
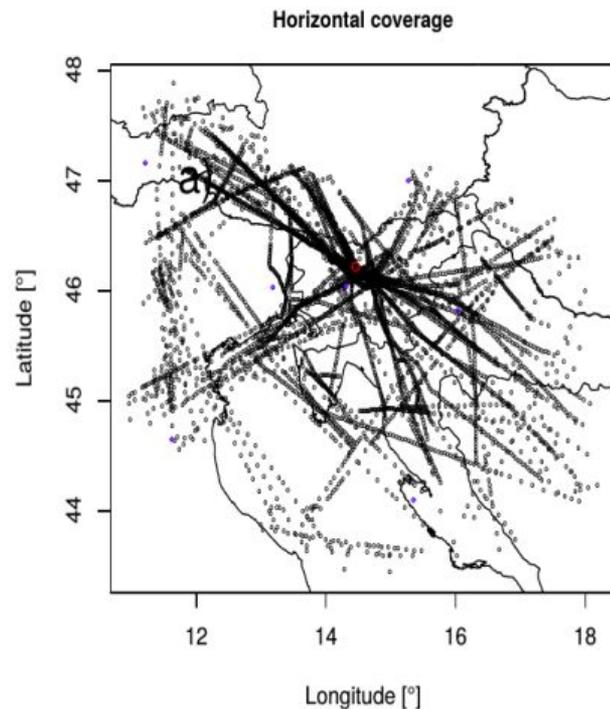
# Impact of more good observations

# Assimilation of the Mode-s MRAR @ARSO (1)

Courtesy of Beni Strajnar, ARSO

Meteorological routine air report (wind speed & direction, temperature, humidity, turbulence).

Data from the Ljubljana airport.

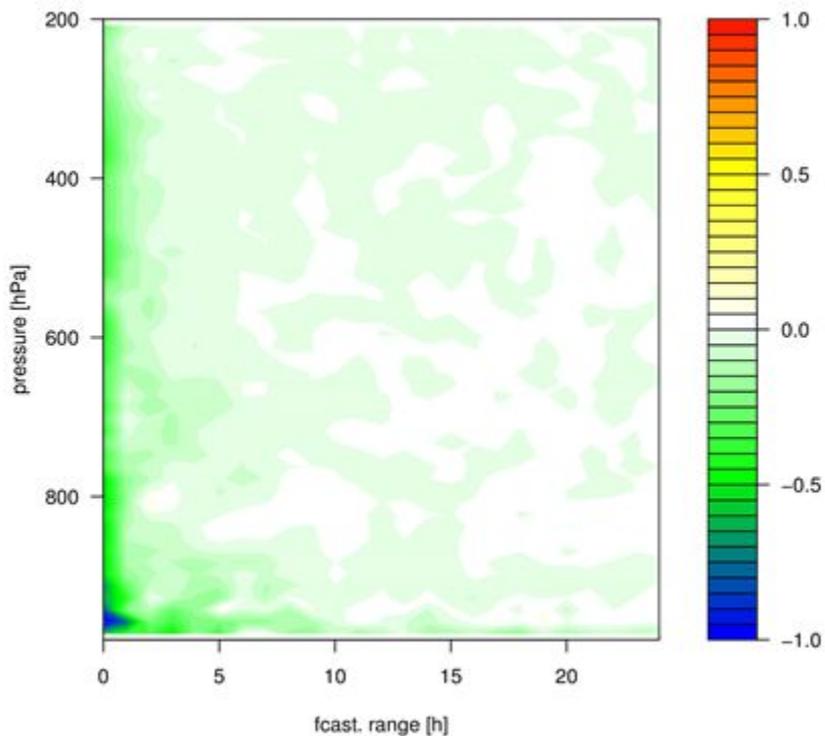


# Assimilation of the Mode-s MRAR @ARSO (2)

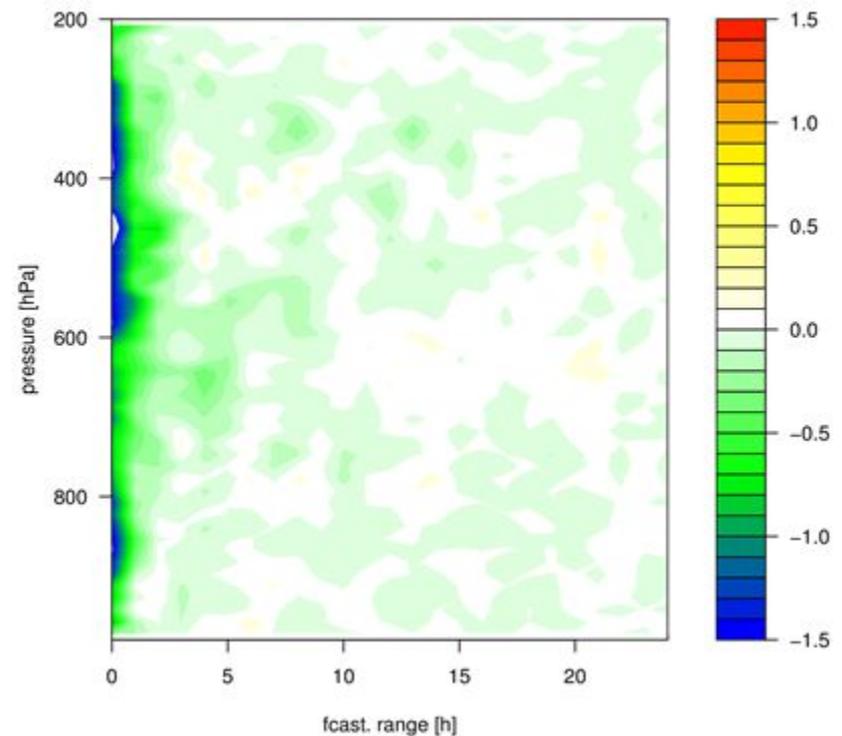
Courtesy of Beni Strajnar, ARSO

Impact on forecast (winter period):

Temperature RMSE reduction



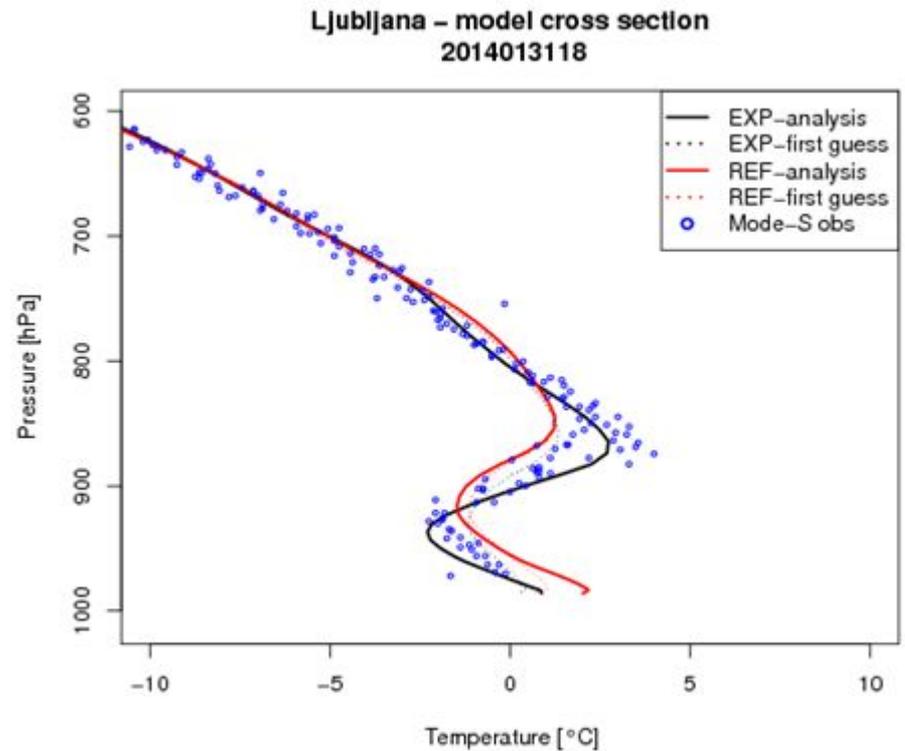
WS, WD RMSE reduction



# Assimilation of the Mode-s MRAR @ARSO (3)

Courtesy of Beni Strajnar, ARSO

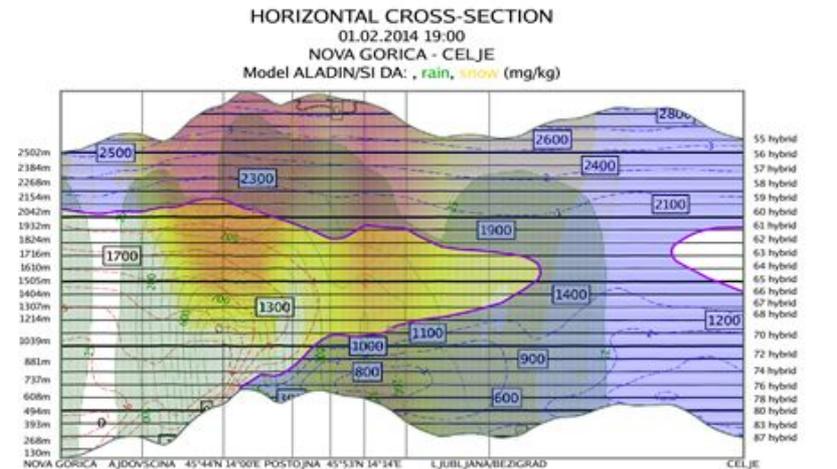
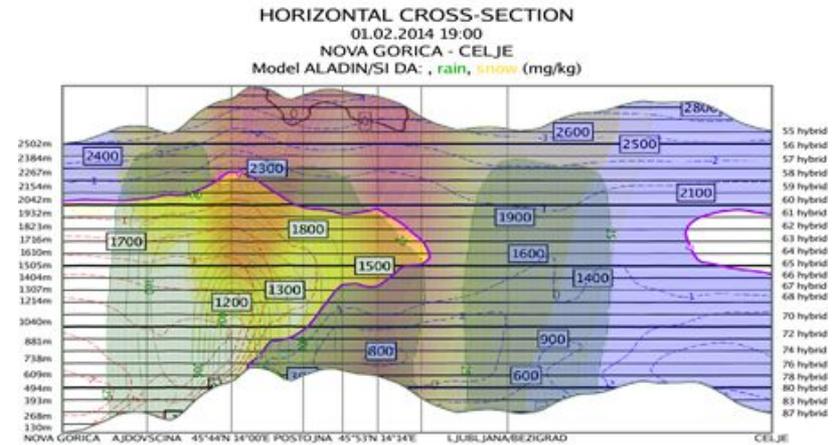
Severe freezing rain case, January 2014 - analysis



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Courtesy of Beni Strajnar, ARSO

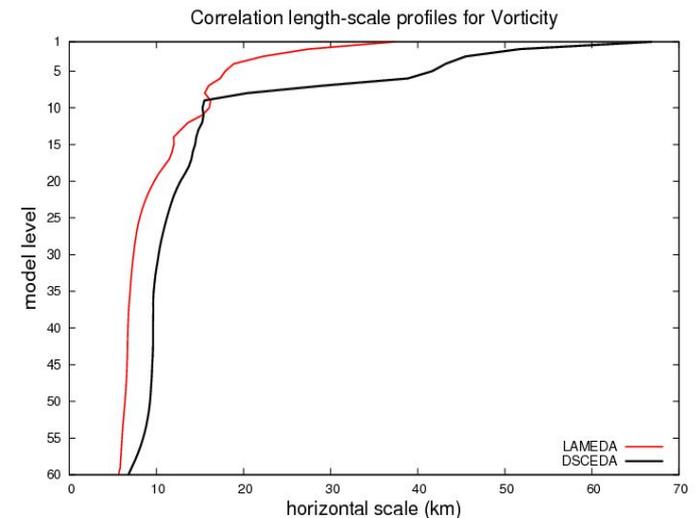
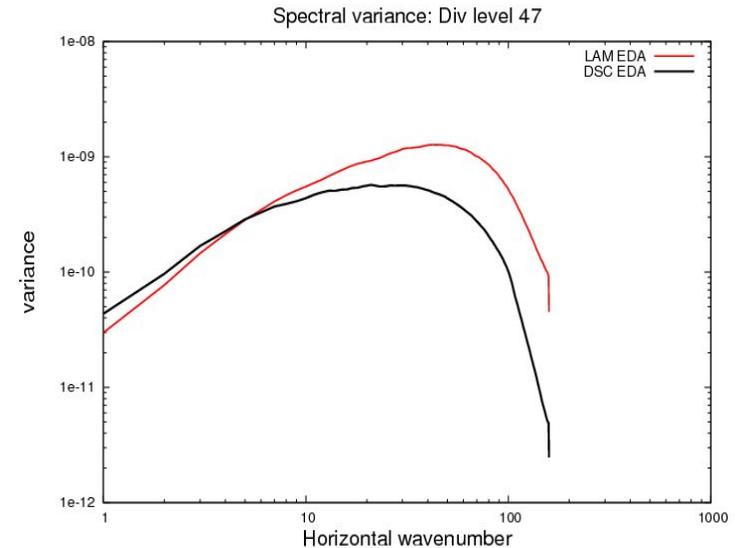
Severe freezing rain case, January 2014 - impact on the forecast



# Impact of more accurate B representation

# Good B!

- The best estimate of background error statistics is crucial
- AROME EDA 3h forecast differences were used to derive climatological B
- In Hungary AROME EDA based B matrix was calculated which corrects more the smaller scales and has more localized length-scales compared to downscaled EDA B matrix
- (Downscaled EDA Bmatrix vs. **AROME EDA Bmatrix**)



# Good B!

AROME short-range forecasts are significantly improved using better structure functions i.e. AROME EDA B  
 (Downscaled EDA Bmatrix vs. AROME EDA Bmatrix)

