BlendVAR – an assimilation system at ALADIN/CE

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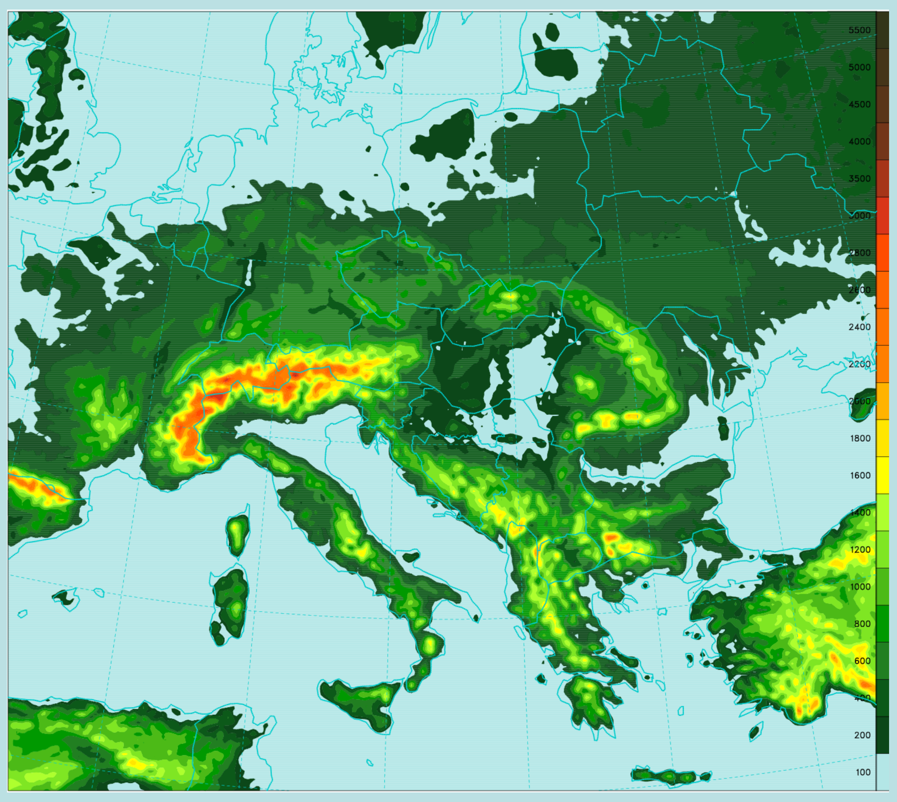
Introduction:

Current operational implementation of the ALADIN data assimilation system in Czech Republic (ALADIN/CE) comprises digital filter blending and a local surface analysis based on optimum interpolation using SYNOP observation. Blending is a technique allowing to obtaining a more exact initial state by a combination of large scale information coming from the driving model ARPEGE 4D-VAR analysis with small scale features resolved by the high resolution ALADIN/CE model guess (Brožková et al., 2001, Derková and Belluš, 2007).

The new scheme so called BlendVAR consists of adding a 3D-VAR analysis on the top of digital filter blending. ALADIN 3D-VAR relies on IFS/ARPEGE incremental formulation introduced in global assimilation (Courtier et al., 1991). Detailed description of BlendVAR implementation and it's a posteriori tuning (following Desroziers et al.2005), together with the first evaluation of the system's performance will be presented.

Model set-up

Reference experiment was based on the ALADIN/CE operational settings from 20080318 (former parallel test AHO "ALAROminus 3MT")



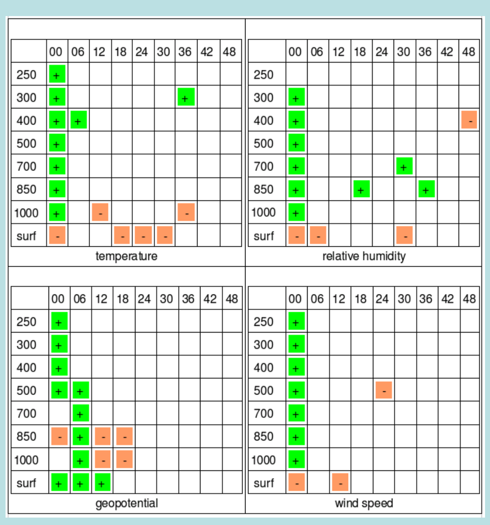
- cycle 32t1 (ALARO-0 minus 3MT)
- LACE domain (309x277 grid points, linear truncation E159x143, Δx=9km)
- 43 vertical levels, mean orography
- time step 360 s
- 3h coupling interval
- surface analysis (performed before an upper-air one) is provided by
  - OI surface analysis based on SYNOP
  - SST is taken from ARPEGE
  - any other land soil parameter which is not analyzed (like snow) is initialized from the ALADIN guess
- an upper-air analysis is provided by
  - digital filter spectral blending of the upper air fields, long cut-off cycle 6h cycle (filtering at truncation E61x55, no DFI in the next +6h guess integration)
  - digital filter blending + incremental DFI initialization of short cut-off production analysis of the upper air fields

The BlendVAR configuration consists of adding a 3D-VAR on the top of upper-air blending, with following characteristics:

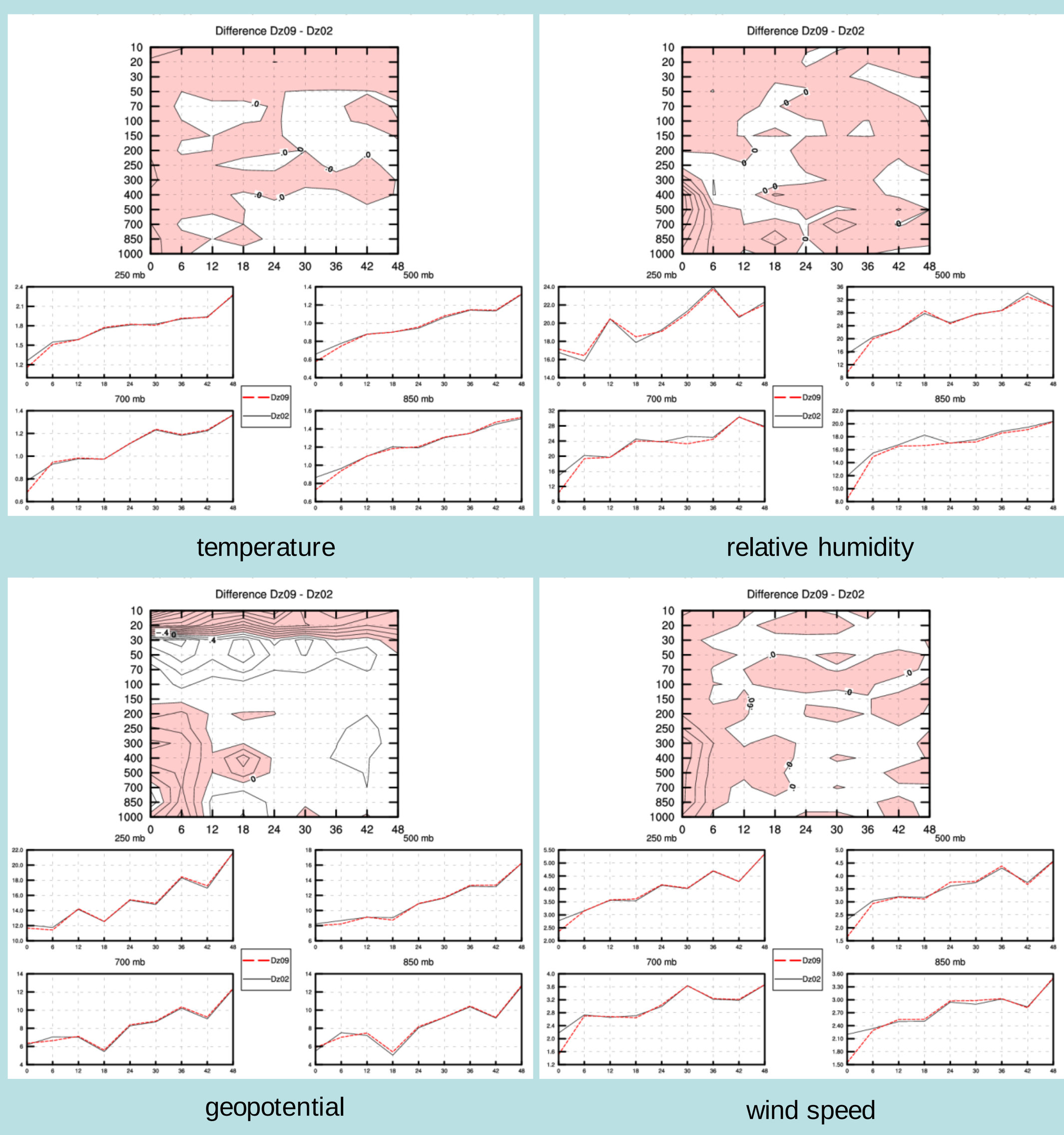
- B matrix was computed following the lagged NMC method (Široká et al., 2003) for period of October - December 2006
- REDNMC=1
- the atmospheric analysis includes the assimilation of SYNOP (surface reports of geopotential) and TEMP (upper-air reports of temperature, specific humidity and wind)

Impact of BlendVAR:

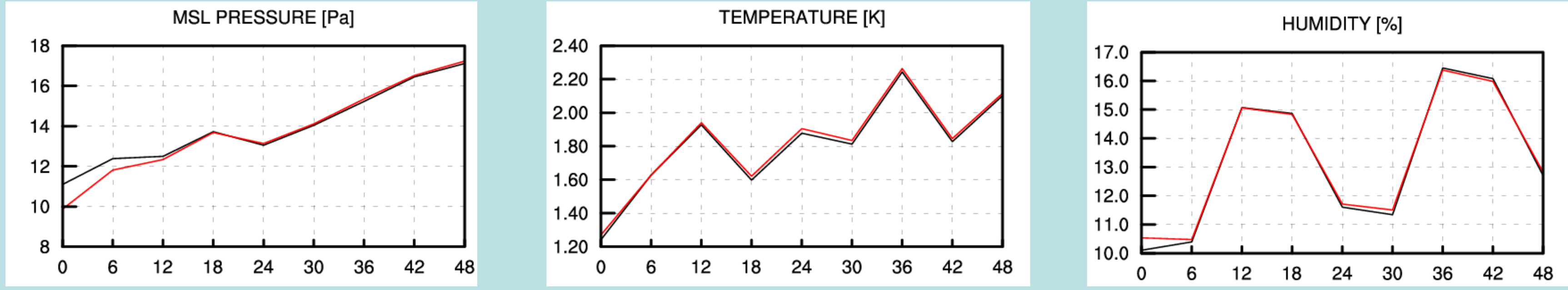
For the verification +48H forecasts from 00UTC short cut-off analysis were provided for period from March 30th till April 19th 2008. The objective scores against observation show small positive impact for the first +6H at least for most of the variables, except a degradation for some near surface parameters.



List of parameters and ranges where BlendVAR performs better (in green)/worse(in red) than blending in terms of RMSE scores with significance 90% two side confidence interval significance test.



RMSE differences against TEMP observation. Pink areas denote better performance of BlendVAR with respect to blending scheme. Isolines every 0.1K, 1%, 0.2 dynm and 0.2 m/s.



RMSE of *MSLP* (left), *T2m* (middle) and *RH2m* (right), BlendVAR experiment in red and blending in black.

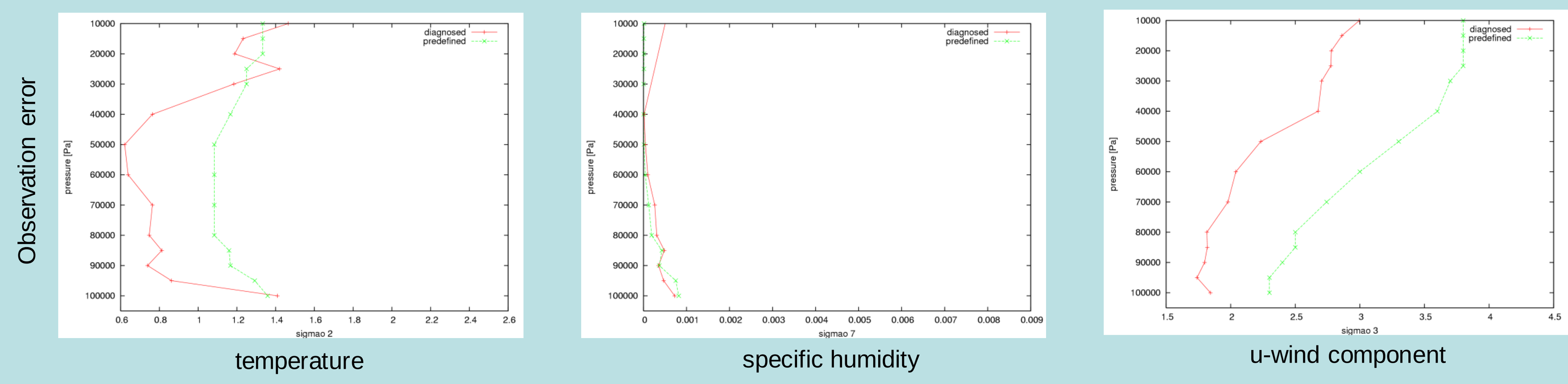
Tuning of error statistics:

On the basis of estimation theory Desroziers et al. (2005) proposed simple diagnostics which should be fulfilled in an optimal analysis. For any subset of observations *i* with p_i observations one can compute diagnosed value of observation and background error:

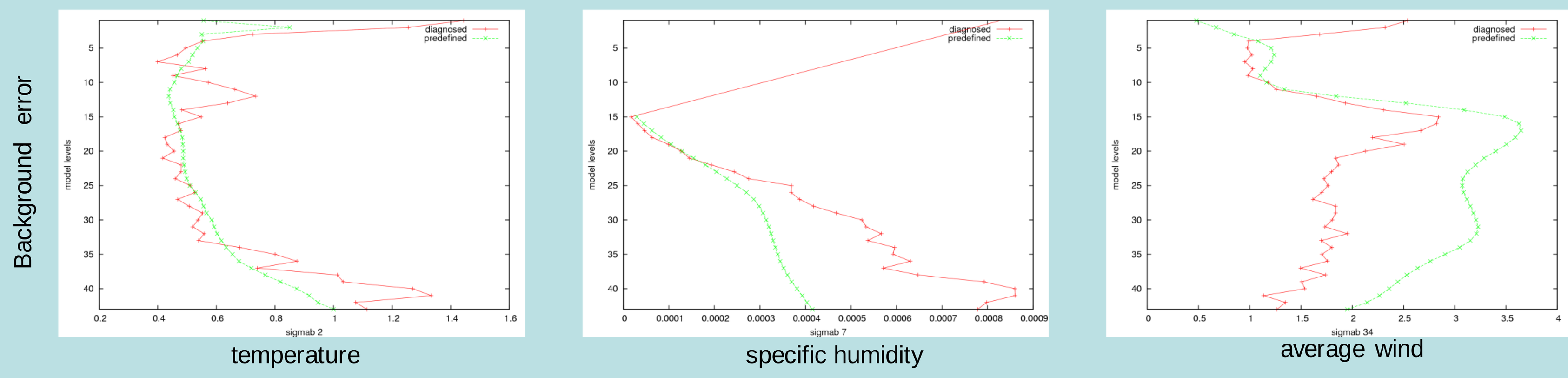
$$(\sigma_i^o)^2 = \sum_{j=1}^{p_i} \frac{(y_j^o - y_j^a)(y_j^o - y_j^b)}{p_i}$$

$$(\sigma_i^b)^2 = \sum_{j=1}^{p_i} \frac{(y_j^a - y_j^b)(y_j^o - y_j^b)}{p_i}$$

Diagnosed values of observation and background error were computed for analyzes of given experiment and compared with prescribed ones currently used in the model. The statistic were computed as an average for all the evaluation period of 21 days from 20080330 00 UTC till 20080419 18 UTC. We have noticed that some departures (obs-analysis) and (obs-guess) have different signs, which means that analysis is state not between guess and observation state and it can be considered as probably wrong analysis behavior. Those points were skipped from the statistic computations.



Comparison of obtained diagnostics (in red) and prescribed ones (in green) for TEMPs.

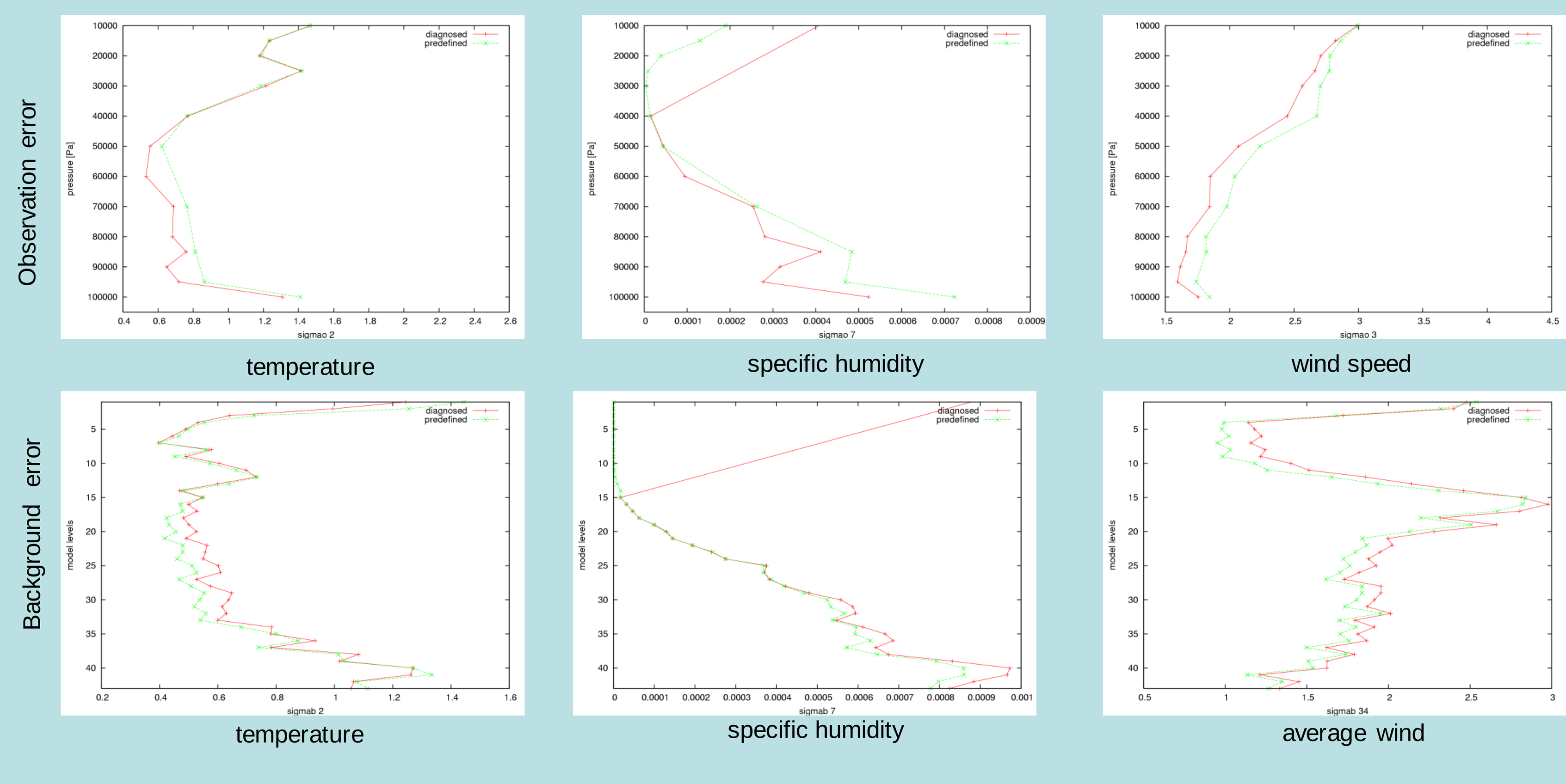


Comparison of predefined background errors obtained from minimization listing. Diagnostics are based on departures of analyzed parameters, so for the moment temperature, specific humidity and wind components are considered only. Following Boloni (2006) diagnosed standard deviation of wind components were recomputed to average wind using following formula

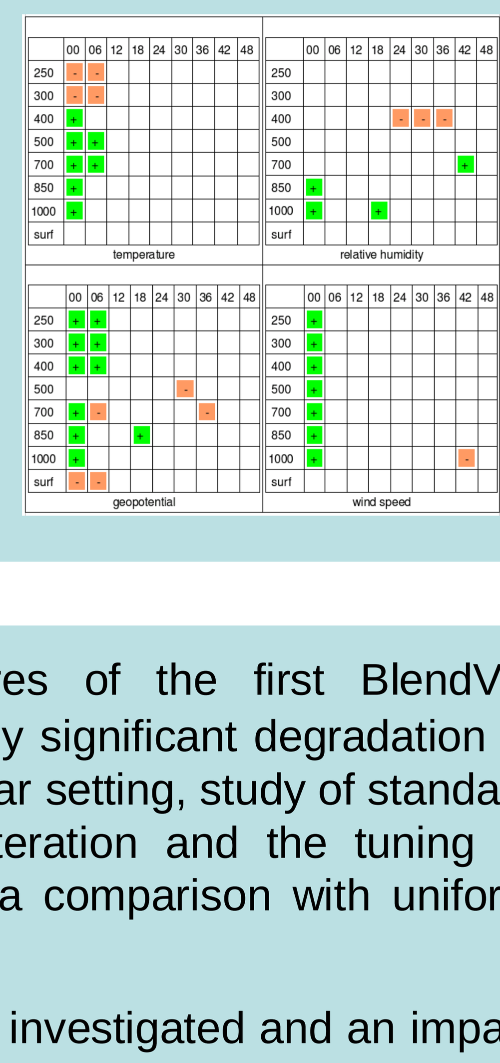
$$\sigma_b(uv) = \sqrt{\frac{\sigma_b^2(u) + \sigma_b^2(v)}{2}}$$

The diagnostics of error statistics can be used for estimation of misfit ratio ***r*** of predefined and diagnosed error statistics. To perform vertical dependent tuning (multiplication of misfit ratios in ald/var/suejbstd.F90) of temperature, specific humidity and wind standard deviations. The open question is if tuning can be performed on some parameters only, while remaining parameters are untouched or is better to try some kind of uniform tuning, e.g. by REDNMC factor. For the first trial we have tried vertically dependent tuning of temperature, specific humidity and wind for TEMP observation only.

In order to evaluate impact of error statistics tuning a new next experiment was performed with diagnosed standard deviations. The same diagnostics as above show better agreement of standard deviations.



RMSE differences in verification scores were very small (up to 0.1K for *T*,1% for *RH* and 0.2 dynm for geopotential and 0.2 m/s for wind speed). The scores didn't show clearly positive impact, for an illustration list of parameters and forecast ranges where BlendVAR with diagnosed observation and background error statistics performs better (in green)/worse (in red) than blending in terms of RMSE scores with significance 90% two side confidence interval significance test .



Conclusion and future plans:

Overall scores of the first BlendVar experiments are very encouraging, except small but statistically significant degradation of some near the surface parameters. Concerning optimal BlendVAR setting, study of standard deviation tuning should be more elaborated (the second iteration and the tuning of standard deviation of surface geopotential can be tested or a comparison with uniform tuning via REDNMC factor could be considered).

Regarding the future plans an effect of IDFI initialization will be investigated and an impact study of 2m SYNOP observation and variational bias correction of satellite data will be studied. Within verification issues, the evaluation with respect to ECMWF analysis, the case studies and more detailed verification of precipitation is planned.