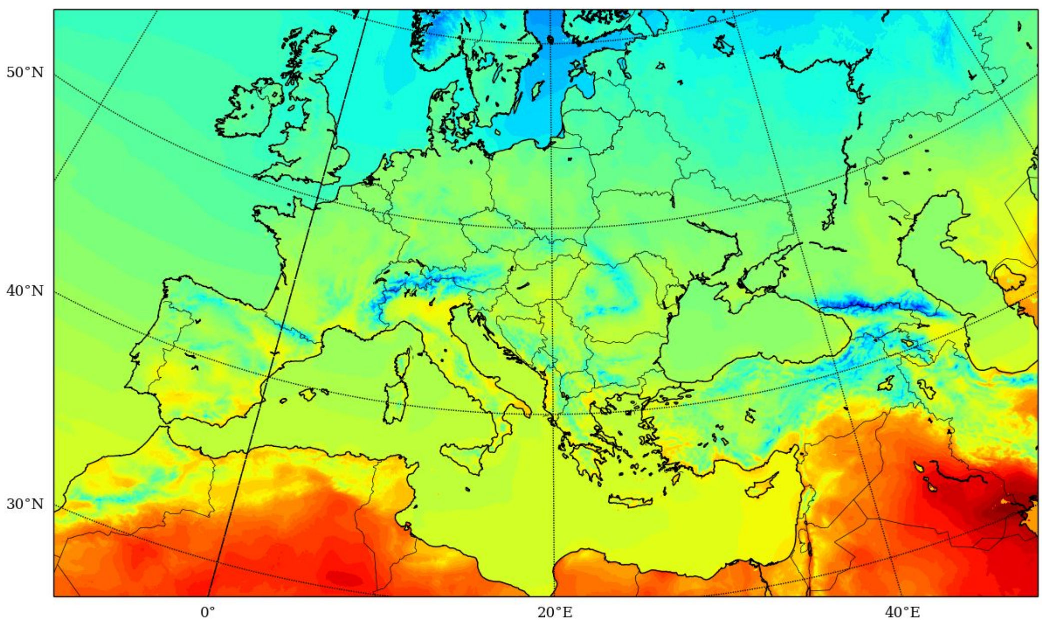
Report on stay at ZAMG

25/04~13/05 + 06/06~10/06, 2016, Vienna, Austria

New high resolution ALADIN-LAEF on CY40T1 with ALARO-1 physics



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::Acknowledgement

I would like to express my gratitude to Alena Trojáková, whose expertise on the data assimilation techniques (but also her attitude to the systematic work) brought a fresh air into rather small ALADIN-LAEF group. Many thanks to Florian Weidle, Christoph Wittmann and the other austrian colleagues for their valuable help. Last but not least many thanks to Mária Derková for having always an interesting brainstorming with her and also for her useful hints on the data assimilation issues.

::Foreword

The plan for this stay was quite ambitious despite the fact the time was really short. We got an expert help from Alena Trojakova, the RC LACE Data Manager. She has deep knowledge about the 3DVar and B-matrix computation, which was about our main interest. The general idea was to set up a new high-resolution domain for ALADIN-LAEF (~5 km) and implement new perturbation method for the upper-air initial conditions (IC). The new method Ensemble BlendVar, if successful, should replace the functional but obsolete Breeding-Blending method, that is still used in the operational configuration of ALADIN-LAEF. BlendVar is the combination of the upper-air spectral blending technique (the same as in case of Breeding-Blending method) and 3DVar assimilation procedure. The real benefit should come from the assimilation of local 3D observations. In case of regional ensemble system like ALADIN-LAEF - with the perturbed observations involved - it will become a new method referenced as the Ensemble BlendVar.

::I. ALADIN-LAEF 5 km

The technical upgrade of ALADIN-LAEF system towards the higher resolution (5 km, 60 vertical levels) was our main goal for 2016. However, it was not an easy task to meet all the geographical, political and technical requirements concerning the new high resolution LAEF domain, but that was expected. What was definitely unexpected was the problem with boundary condition preparation. Due to lack of current global input data and in order to make possible a later comparison of our experiments on new 5 km ALADIN-LAEF domain (including the implementation of Ensemble BlendVar) with the historical data from summer 2011 on 11 km domain (we have several interesting experiments archived for that period), we've decided to create new 5 km domain as the subdomain of the current operational one. This way we could couple new experiments with the interpolated boundary conditions from 2011 archive, which is still available. Unfortunately, using CY40T1 (bf05) we came straight into already known issue within ee927 configuration:

```
SUEFPG3 : THERE ARE POINTS OUT OF THE DOMAIN
          OR TOO NEAR OF THE DOMAIN BORDER
 ABOR1 CALLED
 SUEFPG3 : ABOR1 CALLED
```

That was despite the fact, that we were sure our target domain fits perfectly inside the coupling one (see Fig.1, left). Not even the proposed increase of RCO_EZO parameter from NEMFPEZO namelist helped to solve this situation. Although, ee927 on CY38T1 with the same input and output domains and the same CLIM files worked well. Eventually, to make some conclusion, we did the code “hacking” in CY40T1 and commented the relevant abort in *suefpg3.F90* (aware of the fact, that this is just related to a dummy E-zone which has to be set for the interpolations and then it will be anyway overwritten by a true bi-periodization later). With the configuration ee927 on CY40T1 and this modified code we were technically able to produce the LBCs. Nevertheless, for our experiment we have used ee927 from CY38T1, which worked properly even without changes in the code.

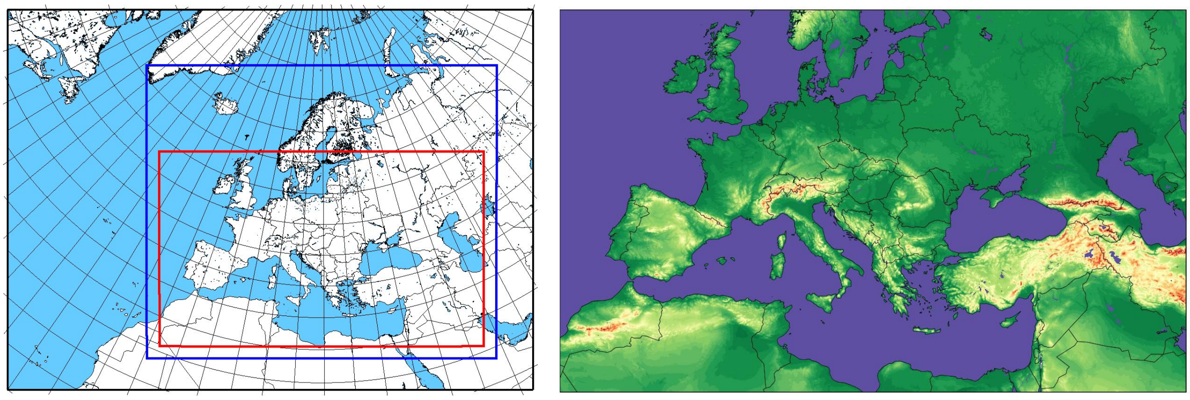


Fig.1: *Current operational 11 km ALADIN-LAEF domain borders (blue) with the nested new 5 km domain (red) - left, and the model orography of the new 5 km domain - right.*

To validate new domain we have performed the dynamical adaptation of both 11 km and 5 km ALADIN-LAEF. The experiments were compared to each other for one month trial (15-05-2011 ~ 15-06-2011, 12 UTC run), while the identical version of the code has been used (CY40T1 bf05 with the ALARO-1 physics). In general, the dynamical adaptation on 5 km resolution (and 60 vertical levels) performed significantly better than it’s 11 km counterpart (with 45 vertical levels), but the most obvious improvement was observed for temperature (see the following figures with the statistical scores) and for moisture (not shown).

There is a positive impact for the surface fields as well as for the pressure levels. At the surface it is clearly the effect of improved orography (5 km model has very much reduced bias directly from the beginning of the integration, see Fig.2). But for the upper air both experiments start from the equal values. There, the error growth in 5 km version is significantly reduced along the forecast lead time in comparison with the 11 km version (see Fig.3-4).

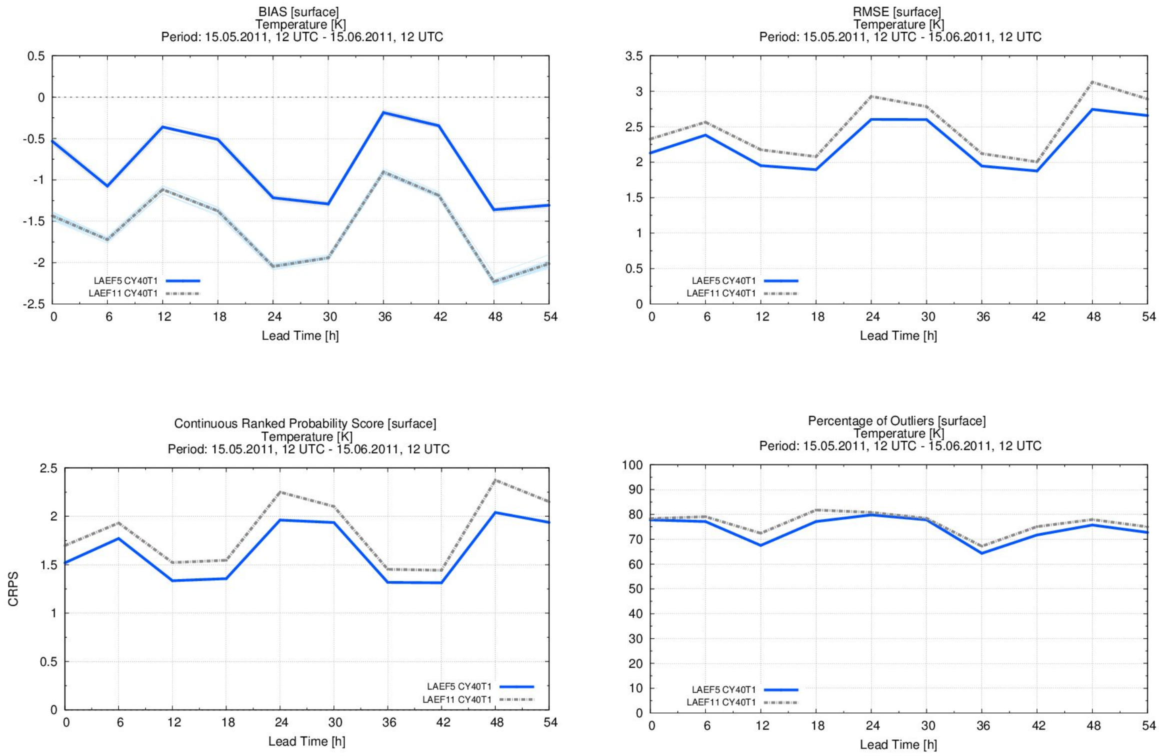


***Fig.2:** BIAS, RMSE, CRPS and outliers for Temperature at 2m for ALADIN-LAEF 5 km (blue) versus 11 km (grey dashed) dynamical adaptations.*

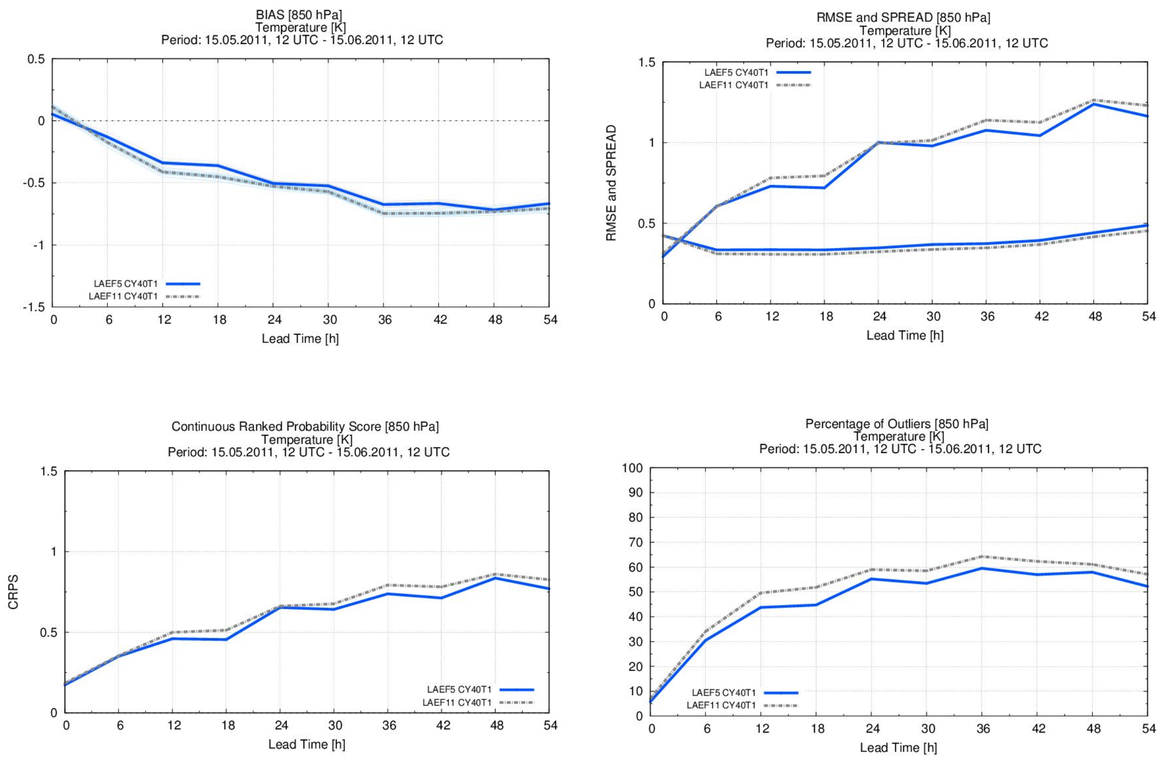


***Fig.3:** BIAS, RMSE/spread, CRPS and outliers for Temperature at 850 hPa for ALADIN-LAEF 5 km (blue) versus 11 km (grey dashed) dynamical adaptations.*

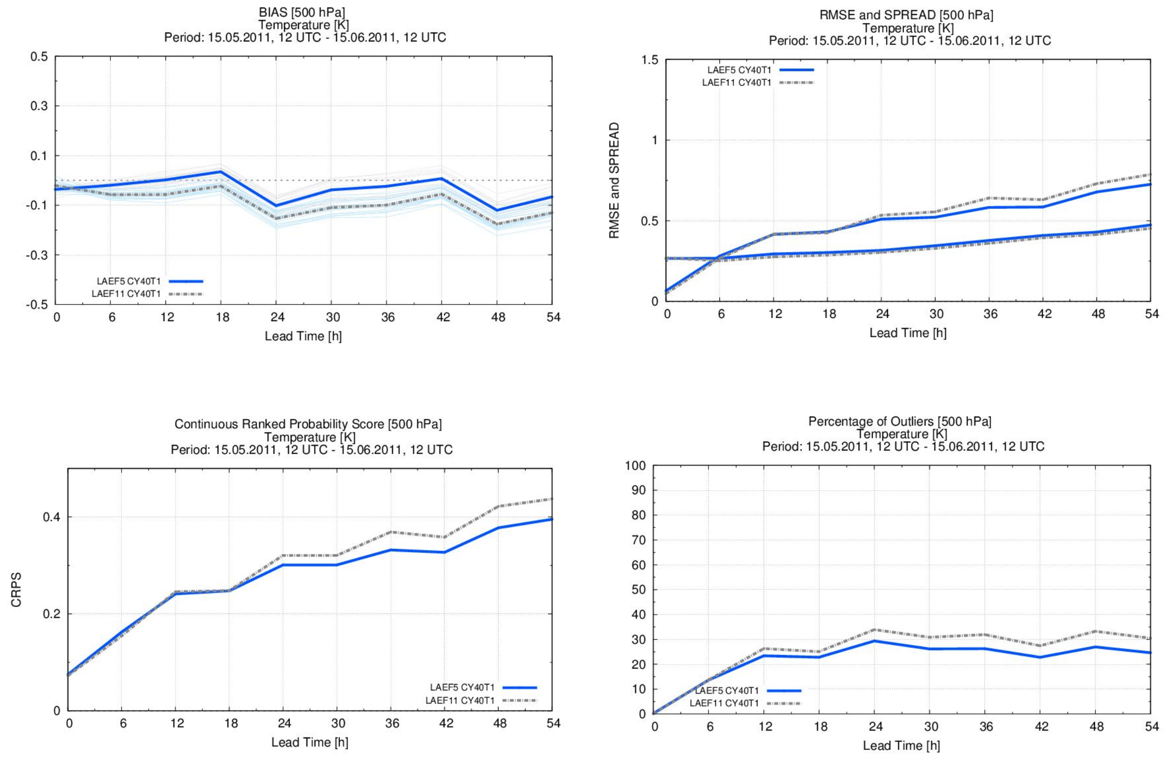


Fig.4: *BIAS, RMSE/spread, CRPS and outliers for Temperature at 500 hPa for ALADIN-LAEF 5 km (blue) versus 11 km (grey dashed) dynamical adaptations.*

::II. Blending implementation

For the new LAEF domain the blending truncation needed to be recalculated because its geometry has been modified. This time we have changed also the grid type from quadratic to linear, which affects the computation as well. Moreover, ECMWF has increased recently the resolution of their EPS forecast but that is only for the grid-point, where they went from the linear to the cubic octahedral grid. But the spectral resolution of EPS forecast was not changed (T_L639 => $T_{CO}639$) and nor the truncation of singular vectors (T_L42). Hence the prerequisites for the new blending truncation computation are as follows:

- spectral truncation of ECMWF forecast: $\mathbf{T_{CO}639}$
- spectral truncation of ECMWF singular vectors $\mathbf{T_L42}$
- spectral truncation of ALADIN-LAEF forecast **NSMAX=374**, **NMSMAX=624**
- linear grid

Computation according the blending theory:

$$(1) \quad T^{f}_{ECM}=639$$

$$(2) \quad T^{a}_{ECM}=\sqrt[2]{T^{f}_{ECM}*T^{sv}_{ECM}}=\sqrt[2]{639*42}=163.82$$

$$(3) \quad T^{f}_{ALD}=\frac{L}{2\Delta x}=\frac{40000}{2*4.8}=4166.66$$

$$(4) \quad T^{c}_{ALD}=\sqrt[3]{(T^{a}_{ECM})^{2}*T^{f}_{ALD}}=481.77$$

$$(5) \quad r_{b}=\frac{T^{f}_{ALD}}{T^{c}_{ALD}}=8.64$$

$$(6) \quad r_{c}=\frac{T^{f}_{ALD}}{T^{f}_{ECM}}=6.52$$

Our new blending ratio is 8.6 (after equation 5). Therefore, the resulting blending truncation for the new domain was set to **$NSMAX_b$=43** and **$NMSMAX_b$=72**. Analogically, the time step for DFI has been enlarged by blending ratio to $TSTEP_b$=1200s, which corresponds to 18 steps within the coupling frequency (TEFRCL). The number of steps in DFI filtration is according to the theory NSTDFI=5 (for TAUS=18000s).

Having the above settings we did proceed with the experiments, i.e. with the implementation of blending cycle, as this would be the entry point for the new Ensemble BlendVar method. Upper-air spectral blending is quite complicated procedure consisting of several “calls” to ee927 and DFI (both special configurations of e001). In the following bullets the issues and their solutions for particular “steps” are briefly summarized.

- **EE927** - problem with aerosols, ozone, etc. (the fields were included in the INIT and Clim files, but model was anyway aborting).

```
ABORT!   35 RDFA2GP: FIELD IS MISSING :SURFAEROS.DESERT
ABORT!   31 RDFA2GP: FIELD IS MISSING :SURFALBEDO.VEG
ABORT!   30 RDFA2GP: FIELD IS MISSING :SURFALBEDO.SOLNU
ABORT!   32 RDFA2GP: FIELD IS MISSING :SURFAEROS.SEA
ABORT!   34 RDFA2GP: FIELD IS MISSING :SURFAEROS.SOOT
ABORT!   33 RDFA2GP: FIELD IS MISSING :SURFAEROS.LAND
ABORT!    6 RDFA2GP: FIELD IS MISSING :SURFDENSIT.NEIGE
ABORT!    5 RDFA2GP: FIELD IS MISSING :SURFALBEDO NEIGE
```

This was solved by using NFPOS=2 (fullpos-2) in the namelist instead of NFPOS=927 (“old” fullpos).

- **DFI** (in low spectral truncation) - was constantly crashing during the forward diabatic integration (step +3/+4 out of 10) with a segmentation fault error.

Several tests were performed, even with the shortened time step and increased diffusion. Eventually we have identified the problem with the regular ETA levels spacing in VFE operators. The main switch for VFE (LVERTFE) was “true” by namelist, while LVFE_REGETA was “false” (default value) which caused the model crashes. In fact the combination of LVFE_REGETA “false” with LREGETA “false” was responsible. This combination is allowed in the model but can be dangerous. The reason for LVFE_REGETA implementation was that normally we want to have LREGETA equal “false” (more precise interpolations) but that was causing some problems for specific selection of vertical levels with VFE turned on. Therefore, it has been splitted in the code. For the VFE computations we have LVFE_REGETA while otherwise LREGETA is used (e.g. in Semi-Lagrangian interpolations).

So, finally, all the other tested settings were rolled back, while LVFE_REGETA was changed to “true” by namelist. Furthermore, the tested diffusion settings for DFI in low spectral truncation (see Tab.1 below) can be probably used later on as an additional tuning for blending, if necessary.

Tab.1: *Diffusion tuning for DFI at low spectral resolution for blending (default values in brackets). These settings were taken from CZE namelist.*

```
RDAMPDIVS=1. (10.)
RDAMPVORS=1. (10.)
SLEVDH=0.4   (0.1)
REXPDH=4.0   (2.0)
SLEVDH3=9.8692327E-05
SLEVDHS2=0.01
```

- **Blending** - the computation of large-scale increment coming from ECMWF perturbed analyses and its combination with the small-scale ALADIN-LAEF guess (final “arithmetics” with the FA files).

Due to the fact that the operational ALADIN-LAEF system has no separate assimilation cycle (guess is taken from the production line), it is not technically possible to include prognostic hydrometeors, 3MT fields and TKE in the output historical files, which would be an enormous amount of data. Therefore, for the time being only the standard upper-air hydrostatic prognostic spectral fields such as T, U, V, q and p_s are blended (L_HYDRO=.T., L_Q=.T.). Once there will be an individual assimilation cycle in ALADIN-LAEF, the other prognostic fields such as liquid water, solid water, rain, snow, TKE, and 3MT fields could be cycled in blending as well (transfered via the high-resolution guess file).

For now, also the final 8^{th} step of the whole blending procedure, where the long waves are combined with the short waves from the guess, has to be treated carefully. Here we have two possibilities (see Tab.2) - to keep the surface fields either from driving model input file (ECMWF) or from the ALADIN-LAEF high-resolution guess. As far as no surface assimilation is involved in the procedure, we have to keep the analysed surface fields from the driving model, otherwise there is a potential risk of diverging far away from the model climatology after several assimilation loops (depending on the variable this might be either days or weeks).

Tab.2: *Calling &blendathis function in the last step of the blending procedure with the two possible configurations.*

```
# keep the surface from ecmwf member
&blendathis($blend_a, $ald_org, $blend_b, 1.0);

# keep the surface from laef member
##&blendathis($ald_org, $blend_a, $blend_b, 1.0);
```

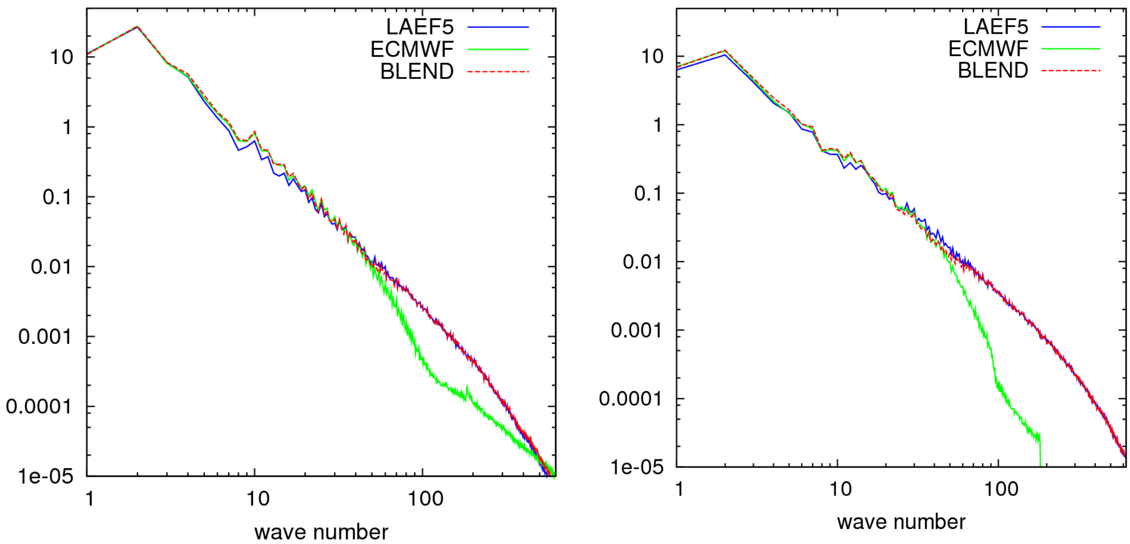


Fig.5: *Kinetic energy spectra (KES) for two input files - high-resolution ALADIN-LAEF guess (blue line), perturbed global analysis of ECMWF (green line) and the result - blended initial state (red dashed line). KES is computed for 30th model level (left) and 40th model level (right), for ensemble member 7 and after the 2 weeks of assimilation loop.*

It was also necessary to modify the subroutine which does the conversion of spectral resolution of the FA files - &chspecreso. A new argument $shift [hours] was added to tell the function what is the difference between the experiment run date and the input FA file ($fileA) base date. According to this time shift, the appropriate CLIM files are chosen for input ($kA) and target ($kB) domains:

```
&chspecreso($fileA, $fileB, $kA, $kB, $shift) --> $fileB with
resolution of $kB
```

One has to be aware that the first call to &chspecreso on ALADIN-LAEF guess input file must involve 12h shift (cycling frequency), while the second call is already on filtered file (after DFI) and its base date is changed to experiment run date. Thus the second call to &chspecreso (conversion from low spectral truncation to the high resolution) is already with the $shift=0.

::III. Blending cycle test

The upper-air spectral blending for the new 5 km ALADIN-LAEF domain was tested on the historical data set (15 May ~ 15 June, 2011) and compared against the reference (11 km LAEF) and against pure downscaling (see Fig.6-7 and Fig.8-10). Unfortunately, according to the first verification results it was clear, that the upper-air spectral blending cycle on 5 km domain has definitely some issues. Moreover, the scores were even worse in comparison with the pure downscaling, especially for the beginning of the integration while for the longer lead times such effect already disappeared. This can be seen in the following figures where +0h and +18h scores are compared side by side (most obvious for MSLP and RH2m and for the upper-air fields).

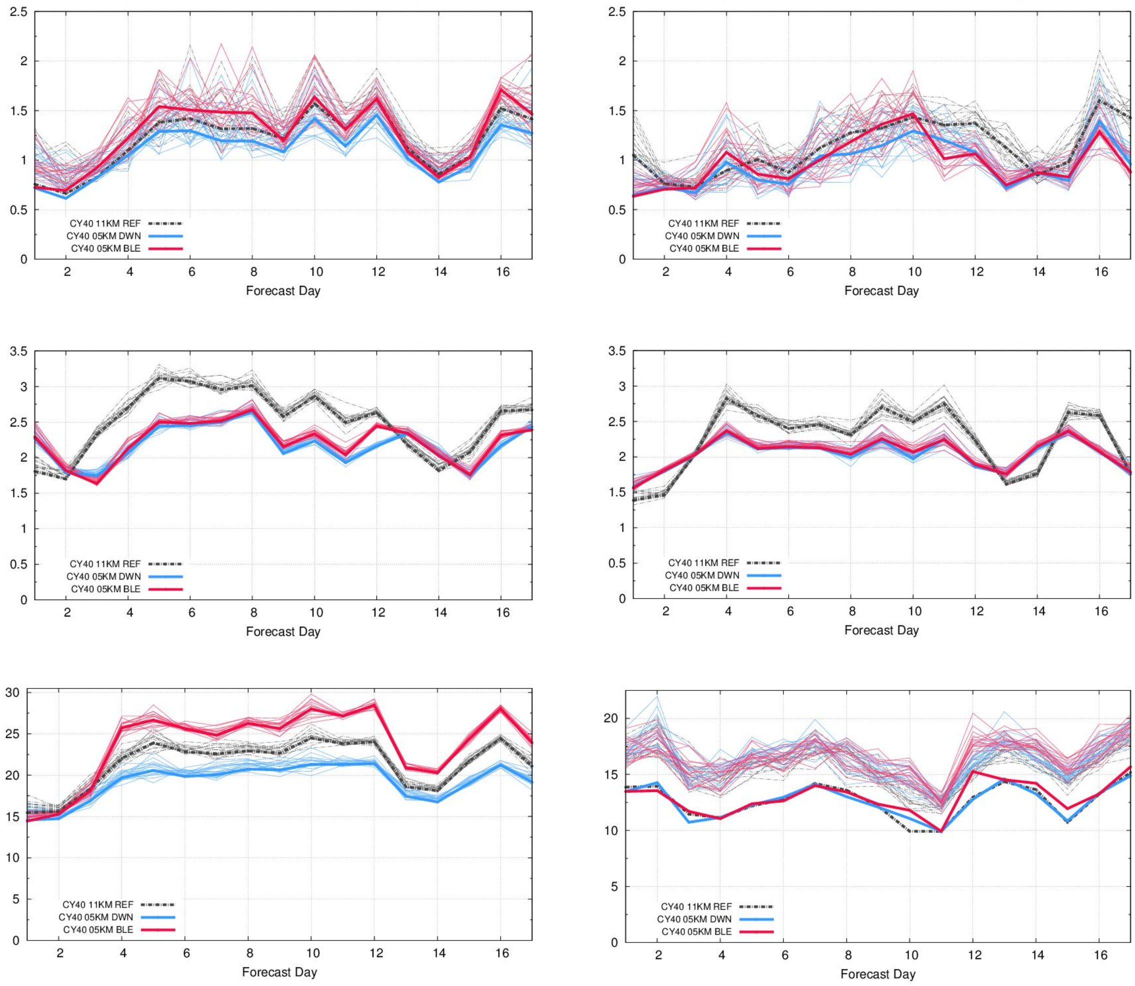


Fig.6: *Daily RMSE scores at screen-level for the first 17 days of the experiment (11 km LAEF - gray dashed, 5 km LAEF downscaling - blue, 5 km LAEF blending cycle - red) for MSLP (first row), T2m (second row) and RH2m (third row). The first column is the initial-time output (+0h) while the second column is +18h forecast.*

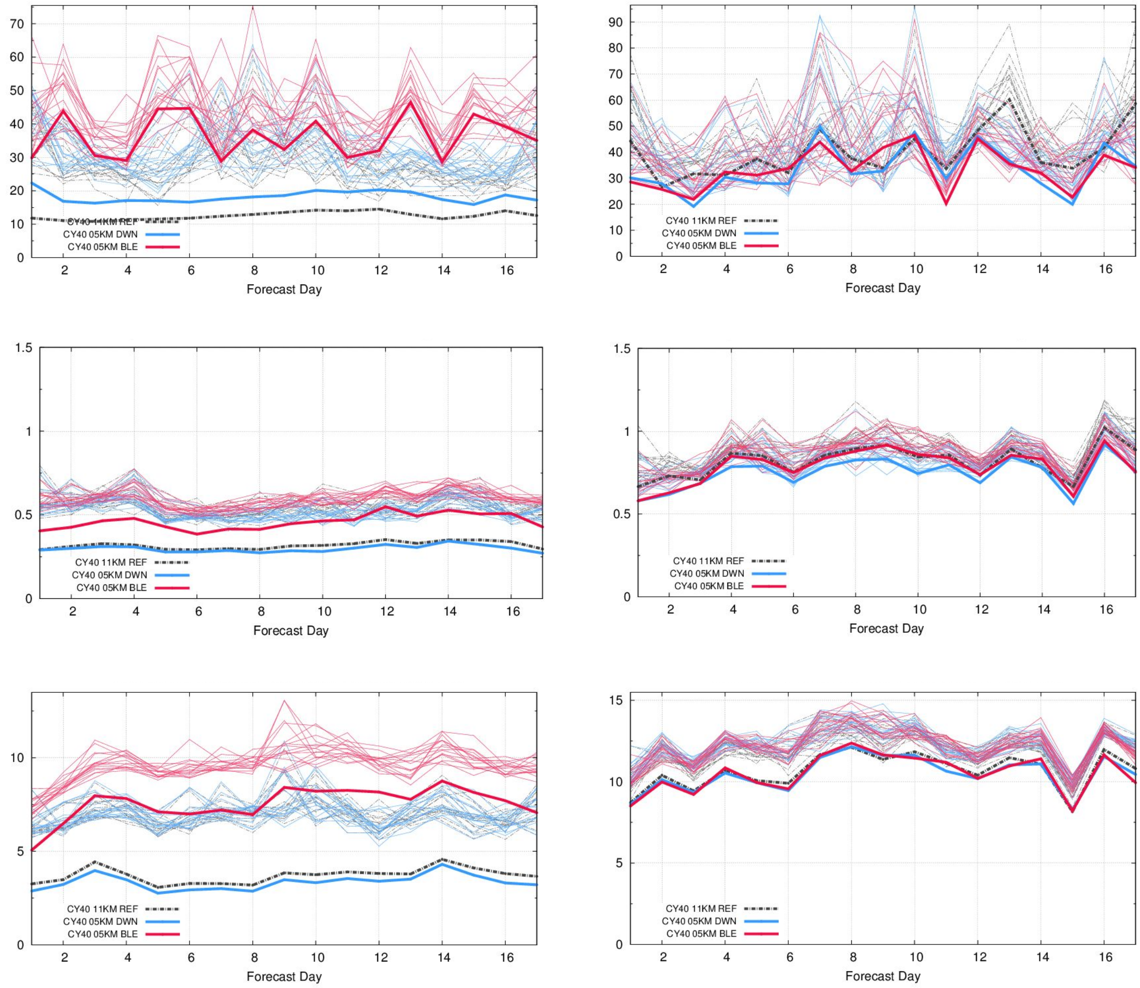


Fig.7: *Daily RMSE scores at 850 hPa level for the first 17 days of the experiment (11 km LAEF - gray dashed, 5 km LAEF downscaling - blue, 5 km LAEF blending cycle - red) for Geopotential (first row), Temperature (second row) and Relative Humidity (third row). The first column is the initial-time output (+0h) while the second column is +18h forecast.*

The problem at the initial time is obvious also when looking on standard verification scores by the forecast ranges (with the exception of T2m scores).

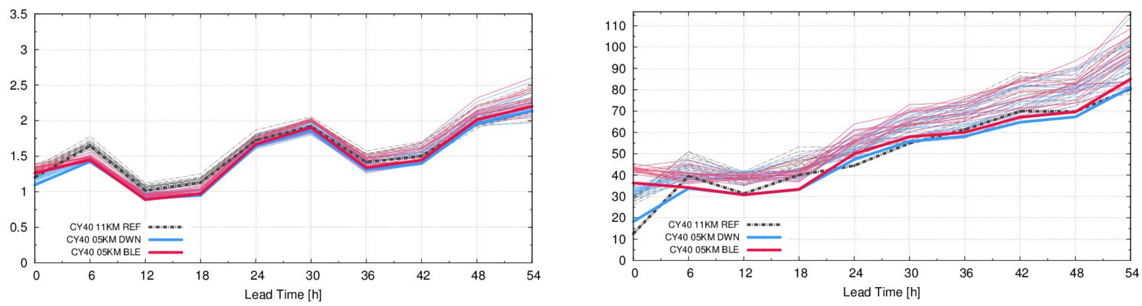


Fig.8: *RMSE scores for MSLP (left) and Geopotential at 850 hPa level (right) for the three experiments (11 km LAEF - gray dashed, 5 km LAEF downscaling - blue, 5 km LAEF blending cycle - red), for the verification period from 15 to 31 May, 2011.*

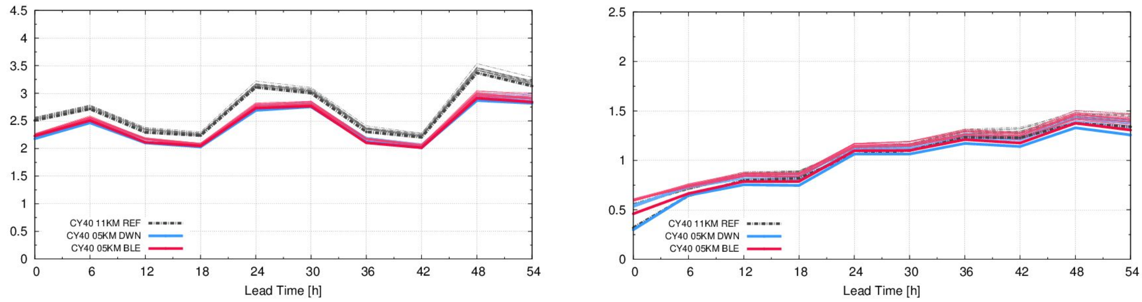


Fig.9: *RMSE scores for T2m (left) and Temperature at 850 hPa level (right) for the three experiments (11 km LAEF - gray dashed, 5 km LAEF downscaling - blue, 5 km LAEF blending cycle - red), for the verification period from 15 to 31 May, 2011.*

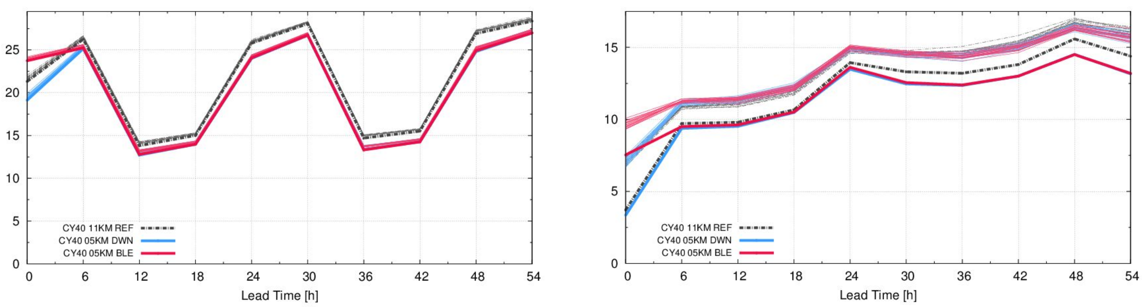


Fig.10: *RMSE scores for RH2m (left) and Relative Humidity at 850 hPa level (right) for the three experiments (11 km LAEF - gray dashed, 5 km LAEF downscaling - blue, 5 km LAEF blending cycle - red), for the verification period from 15 to 31 May, 2011.*

Intensively investigating this kind of mysterious problem we have found one by one several possible issues (incorrect CLIM files - see Fig.11-12, missing ALARO-1 tuning due to the vertical resolution changes - QXRTGH, other minor changes in the namelists), but none of them really helped to improve the situation! All those corrections had only minor impact on the statistical scores. The complete list of the carried experiments with the description can be seen in the appendix.

<u>CLIM files issue:</u>

There were some algorithmic changes (from CY38) regarding the computation of roughness length in e923 under the switch LZ0THER=.F. (default now), where the fluxes are calculated with the surface turbulent exchange coefficients not linked to the subgrid orography. This was validated for ARPEGE and ALADIN-MF physics, but not for ALARO physics! And since it drastically changes the values in SURFGZ0.THERM (see Fig.12) it was recommended to use the old computation while running ALARO physics under the switch LZ0THER=.T. in e923 namelist (plus FACZ0=0.53 and NLISSZ=3). That should give the backward compatibility.

Moreover, the first CLIM files used in our experiments were by mistake wrongly created as being for the quadratic grid (but with the spectral truncation computed for the linear grid), i.e. the orography in such CLIM files was not on quadratic grid with the expected truncation. Therefore, I have recreated the CLIM files in two steps, all fields on the linear truncation (NSMAX=374, NMSMAX=624) except the orography. Orography was prepared separately with the corresponding quadratic truncation (NSMAX=249, NMSMAX=416). New CLIM files were created using the Meteo-France scripts (see appendix for more details). At the same time I also used the “old way” of computing the thermal roughness length with the usage of subgrid orography (LZ0THER=.T., FACZ0=0.53, NLISSZ=3) recommended for ALARO-1 physics (see Tab.3).

Tab.3: Surface turbulent fluxes for heat & moisture are computed without the contribution of subgrid orography (a’la SURFEX).

NEW	OLD
E923: LZ0THER=.F. FACZ0=1. NLISSZ=1	E923: LZ0THER=.T. FACZ0=0.53 NLISSZ=3
E001: LZ0HSREL=.T.	E001: LZ0HSREL=.F.

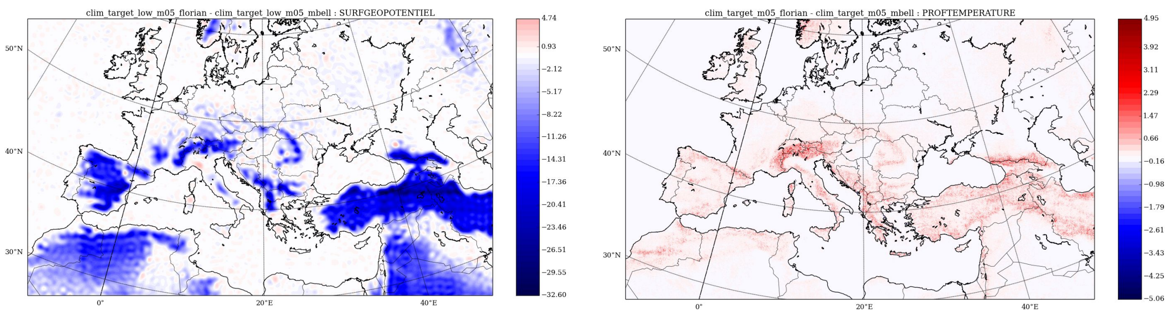
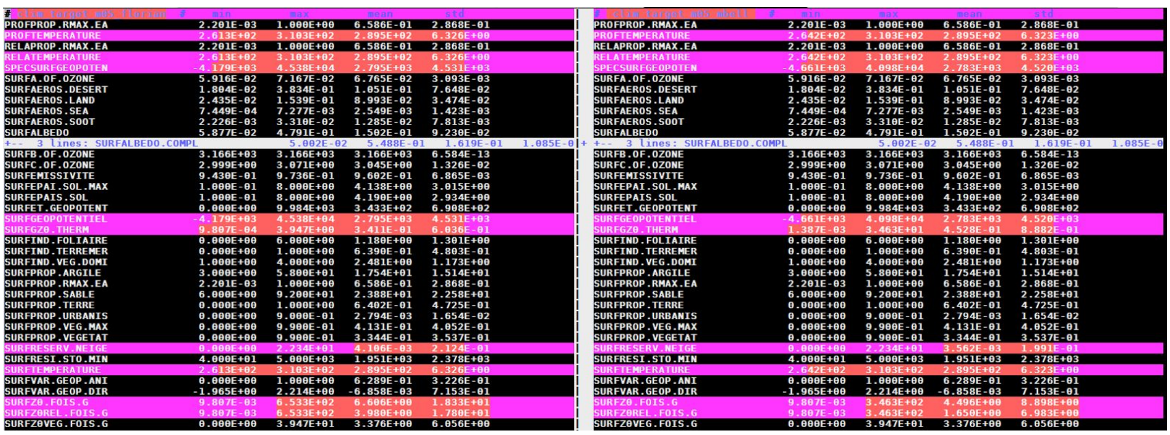


Fig.11: *The difference between the original (wrong) and recreated CLIM files for surface geopotential (left) and deep soil temperature (right). CLIM files are valid for May.*



# clim_target_m05_florian #	min	max	mean	std
PROFPROP.RMAX.EA	2.201E-03	1.000E+00	6.586E-01	2.868E-01
PROFTEMPERATURE	2.613E+02	3.103E+02	2.895E+02	6.326E+00
RELAPROP.RMAX.EA	2.201E-03	1.000E+00	6.586E-01	2.868E-01
RELATEMPERATURE	2.613E+02	3.103E+02	2.895E+02	6.326E+00
SPECSURFGEOPOTEN	-4.179E+03	4.538E+04	2.795E+03	4.531E+03
SURFA.OF.OZONE	5.916E-02	7.167E-02	6.765E-02	3.093E-03
SURFAEROS.DESERT	1.804E-02	3.834E-01	1.051E-01	7.648E-02
SURFAEROS.LAND	2.435E-02	1.539E-01	8.993E-02	3.474E-02
SURFAEROS.SEA	7.449E-04	7.277E-03	2.549E-03	1.423E-03
SURFAEROS.SOOT	2.226E-03	3.310E-02	1.285E-02	7.813E-03
SURFALBEDO	5.877E-02	4.791E-01	1.502E-01	9.230E-02
+-- 3 lines: SURFALBEDO.COMPL	5.002E-02	5.488E-01	1.619E-01	1.085E-0
SURFB.OF.OZONE	3.166E+03	3.166E+03	3.166E+03	6.584E-13
SURFC.OF.OZONE	2.999E+00	3.071E+00	3.045E+00	1.326E-02
SURFEMISSIVITE	9.430E-01	9.736E-01	9.602E-01	6.865E-03
SURFEPAI.SOL.MAX	1.000E-01	8.000E+00	4.138E+00	3.015E+00
SURFEPAIS.SOL	1.000E-01	8.000E+00	4.190E+00	2.934E+00
SURFET.GEOPOTENT	0.000E+00	9.984E+03	3.433E+02	6.908E+02
SURFGEOPOTENTIEL	-4.179E+03	4.538E+04	2.795E+03	4.531E+03
SURFGZ0.THERM	9.807E-04	3.947E+00	3.411E-01	6.036E-01
SURFIND.FOLIAIRE	0.000E+00	6.000E+00	1.180E+00	1.301E+00
SURFIND.TERREMER	0.000E+00	1.000E+00	6.390E-01	4.803E-01
SURFIND.VEG.DOMI	1.000E+00	4.000E+00	2.481E+00	1.173E+00
SURFPROP.ARGILE	3.000E+00	5.800E+01	1.754E+01	1.514E+01
SURFPROP.RMAX.EA	2.201E-03	1.000E+00	6.586E-01	2.868E-01
SURFPROP.SABLE	6.000E+00	9.200E+01	2.388E+01	2.258E+01
SURFPROP.TERRE	0.000E+00	1.000E+00	6.402E-01	4.725E-01
SURFPROP.URBANIS	0.000E+00	9.000E-01	2.794E-03	1.654E-02
SURFPROP.VEG.MAX	0.000E+00	9.900E-01	4.131E-01	4.052E-01
SURFPROP.VEGETAT	0.000E+00	9.900E-01	3.344E-01	3.537E-01
SURFRESERV.NEIGE	0.000E+00	2.234E+01	4.106E-03	2.124E-01
SURFRESI.STO.MIN	4.000E+01	5.000E+03	1.951E+03	2.378E+03
SURFTEMPERATURE	2.613E+02	3.103E+02	2.895E+02	6.326E+00
SURFVAR.GEOP.ANI	0.000E+00	1.000E+00	6.289E-01	3.226E-01
SURFVAR.GEOP.DIR	-1.965E+00	2.214E+00	-6.858E-03	7.153E-01
SURFZ0.FOIS.G	9.807E-03	6.533E+02	6.606E+00	1.833E+01
SURFZ0REL.FOIS.G	9.807E-03	6.533E+02	3.980E+00	1.780E+01
SURFZ0VEG.FOIS.G	0.000E+00	3.947E+01	3.376E+00	6.056E+00

# clim_target_m05_mbell #	min	max	mean	std
PROFPROP.RMAX.EA	2.201E-03	1.000E+00	6.586E-01	2.868E-01
PROFTEMPERATURE	2.642E+02	3.103E+02	2.895E+02	6.323E+00
RELAPROP.RMAX.EA	2.201E-03	1.000E+00	6.586E-01	2.868E-01
RELATEMPERATURE	2.642E+02	3.103E+02	2.895E+02	6.323E+00
SPECSURFGEOPOTEN	-4.661E+03	4.098E+04	2.783E+03	4.520E+03
SURFA.OF.OZONE	5.916E-02	7.167E-02	6.765E-02	3.093E-03
SURFAEROS.DESERT	1.804E-02	3.834E-01	1.051E-01	7.648E-02
SURFAEROS.LAND	2.435E-02	1.539E-01	8.993E-02	3.474E-02
SURFAEROS.SEA	7.449E-04	7.277E-03	2.549E-03	1.423E-03
SURFAEROS.SOOT	2.226E-03	3.310E-02	1.285E-02	7.813E-03
SURFALBEDO	5.877E-02	4.791E-01	1.502E-01	9.230E-02
+-- 3 lines: SURFALBEDO.COMPL	5.002E-02	5.488E-01	1.619E-01	1.085E-0
SURFB.OF.OZONE	3.166E+03	3.166E+03	3.166E+03	6.584E-13
SURFC.OF.OZONE	2.999E+00	3.071E+00	3.045E+00	1.326E-02
SURFEMISSIVITE	9.430E-01	9.736E-01	9.602E-01	6.865E-03
SURFEPAI.SOL.MAX	1.000E-01	8.000E+00	4.138E+00	3.015E+00
SURFEPAIS.SOL	1.000E-01	8.000E+00	4.190E+00	2.934E+00
SURFET.GEOPOTENT	0.000E+00	9.984E+03	3.433E+02	6.908E+02
SURFGEOPOTENTIEL	-4.661E+03	4.098E+04	2.783E+03	4.520E+03
SURFGZ0.THERM	1.387E-03	3.463E+01	4.528E-01	8.882E-01
SURFIND.FOLIAIRE	0.000E+00	6.000E+00	1.180E+00	1.301E+00
SURFIND.TERREMER	0.000E+00	1.000E+00	6.390E-01	4.803E-01
SURFIND.VEG.DOMI	1.000E+00	4.000E+00	2.481E+00	1.173E+00
SURFPROP.ARGILE	3.000E+00	5.800E+01	1.754E+01	1.514E+01
SURFPROP.RMAX.EA	2.201E-03	1.000E+00	6.586E-01	2.868E-01
SURFPROP.SABLE	6.000E+00	9.200E+01	2.388E+01	2.258E+01
SURFPROP.TERRE	0.000E+00	1.000E+00	6.402E-01	4.725E-01
SURFPROP.URBANIS	0.000E+00	9.000E-01	2.794E-03	1.654E-02
SURFPROP.VEG.MAX	0.000E+00	9.900E-01	4.131E-01	4.052E-01
SURFPROP.VEGETAT	0.000E+00	9.900E-01	3.344E-01	3.537E-01
SURFRESERV.NEIGE	0.000E+00	2.234E+01	3.562E-03	1.991E-01
SURFRESI.STO.MIN	4.000E+01	5.000E+03	1.951E+03	2.378E+03
SURFTEMPERATURE	2.642E+02	3.103E+02	2.895E+02	6.323E+00
SURFVAR.GEOP.ANI	0.000E+00	1.000E+00	6.289E-01	3.226E-01
SURFVAR.GEOP.DIR	-1.965E+00	2.214E+00	-6.858E-03	7.153E-01
SURFZ0.FOIS.G	9.807E-03	3.463E+02	4.496E+00	8.898E+00
SURFZ0REL.FOIS.G	9.807E-03	3.463E+02	1.650E+00	6.983E+00
SURFZ0VEG.FOIS.G	0.000E+00	3.947E+01	3.376E+00	6.056E+00

Fig.12: *The differences in extreme and mean values for some fields in the wrong original (left) and recreated CLIM files (right). CLIM files are valid for May.*

It was necessary to rerun ee927 for the whole testing period to create new LBCs in order to continue with the blending and 3DVar experiments using corrected HR and lowres CLIM files. New CLIM files, however, didn't bring any dramatic improvements regarding the global statistical scores.

::IV. BlendVar in ALADIN-LAEF

Regardless of unsatisfied results from the blending cycle experiments, a new var3d (3DVar) script adapted from current canari script (which does the ensemble of surface data assimilations) was prepared together with Alena Trojakova. New functions like &screen, &minim were added to run screening (quality control) and minimization (upper-air data assimilation) respectively. Furthermore, the function &getobs was modified to handle the multiple observation types such as TEMP, SYNOP, AMDAR, etc., used in the upper-air data assimilation.

New var3d application consists of the following steps:

[1] Get and merge the observations (filter out duplicated and corrupted OBSOULS)
[2] Run BATOR (observation preprocessing, create ECMA ODB)
[3] Run SCREENING (quality control)
[4] Run ECMA perturbation (not yet implemented)
[5] Run MINIMIZATION (get new analysis with perturbed/analysed upper-air fields)

ARGUMENTS: dd mm yyyy HH mem (day, month, year, network time, member)
INPUT: OBSOULS, ALADIN guess (e.g. from blending cycle)
OUTPUT: new ALADIN IC (for the given ensemble member)

The tool used for merging the observations - obsoul_merge (v04) - was modified in the way, that time window can be now specified via an optional argument “-twindow” (or any unambiguous abbreviation of it). If such argument is not supplied, the default value for observation time window (60 min) is used. As before, all observations from the time interval <-½ * $twindow, +½ * $twindow> are accepted and processed by the filter.

```
USE:
obsoul_merge.pl -o <new_merged_file> -f <list_of_input_files>
[-t <time_window_in_sec>] [-v]
```

A technical experiment to perform 3DVar assimilation using conventional data (SYNOP, TEMP, AMDAR) on new 5 km ALADIN-LAEF domain and B-matrix computed from (spoiled) blending experiment was successfully done, but the other work must have been suspended till the above mentioned issue with the inputs (blending cycle) is solved.

::Conclusions

New high-resolution domain for ALADIN-LAEF was prepared together with CLIM files for target and low spectral resolutions (according to retuned upper-air blending and transition to linear grid). Furthermore, first prototype of BlendVar on new 5 km LAEF domain with CY40T1_bf06 and ALARO-1 physics was implemented. However, it was tested only technically due to the unsatisfied results of upper-air spectral blending experiments. While the source of the blending issue was still not very clear by the end of the stay, there are some indications what could theoretically cause such scores deterioration:

a) The boundary conditions were prepared for 2011 data set when the historical files contained only 45 vertical levels in contrast to the 60 levels used for new high-resolution LAEF domain. The vertical interpolation from 45 to 60 levels could have brought some numerical noise into the blending input files, which was further amplified by the pseudo-assimilation loop. The impact of such undersampled vertical resolution in the driving model must be tested using the current 2016 data from ECMWF. In this case 91 vertical levels will be used on input for our 60 levels ALADIN-LAEF domain.

b) The situation seems to be quite similar to what happened few years ago in project MFSTEP. At that time, alike behaviour of surface pressure error was observed within the blending cycle due to the big jump between the driving, blending and target model resolutions. While surface pressure BIAS was good, the obvious deterioration of RMSE scores at the initial time was present (while for the longer lead times like +6h the error just disappeared) - see Fig.13 (MFSTEP, courtesy of Maria Derkova). However, they did not verified the other fields, so it is not certain, whether those two problems are identical. The solution for MFSTEP case was an inclusion of IDFI (incremental digital filter) in the assimilation procedure.

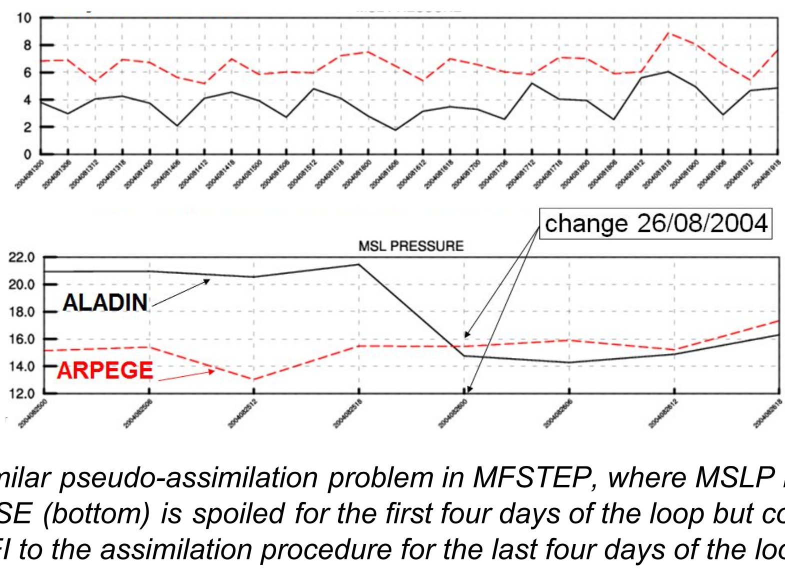


Fig.13: *The similar pseudo-assimilation problem in MFSTEP, where MSLP BIAS looks good (top) while RMSE (bottom) is spoiled for the first four days of the loop but corrected after the inclusion of IDFI to the assimilation procedure for the last four days of the loop.*

The investigation of the above possible solutions to our blending issue will be carried out during the next RC LACE stay.

::Appendix

1) List of performed experiments

REF	the reference on 11 km LAEF domain (45 levels) with CY40T1_bf05 and ALARO-1 physics
LAEF5	the downscaling on 5 km LAEF domain (60 levels) with CY40T1_bf05 and ALARO-1 physics; in this experiment also ee927 script was used to create LBCs for all 5 km experiments for the period 15 May to 15 June 2011
LAEF5B	upper-air spectral blending cycle on 5 km LAEF domain (60 levels) with ALARO-1 physics and CY40T1_pre-bf06 (QXRTGH=2.6 tuned to 60 vertical levels, otherwise the ALARO-1 namelists are the same as for REF and LAEF5)
LAEF5BQ	the same as LAEF5B but with QXRTGH=1.6 (to have identical settings as for the downscaling experiment) in blending morgane_DFI and e001_morgane namelists
LAEF5BQX	the same as LAEF5BQ but with switched off instantaneous and cumulative fluxes during blending DFI integration (to be comparable to CZ operational settings)
LAEF5BC	the same as LAEF5B but with the recreated CLIM files for low spectral blending truncation (changes in e923 scripts/namelists - LZ0THER=.T., FACZ0=0.53, NLISSZ=3, “quadratic” orography)
LAEF5BCC	the same as LAEF5BC but also with the recreated HR CLIM files (to be able to run this experiment, I had to recreate 5 km LBCs - LAEF5C, because otherwise ee927 in blending was crashing on inconsistent model orographies!)
LAEF5BCS	the same as LAEF5BC but with the cycled ALADIN surface fields instead of getting always ECMWF’s analysed surface from LBC00
LAEF5BVAR	technical test of BlendVar cycle on 5 km LAEF domain (60 levels) with SYNOP, TEMP and AMDAR obsouls assimilated by 3DVar and B-matrix calculated from LAEF5 12h forecasts

LAEF5C	the downscaling on 5 km LAEF domain (60 levels) with CY40T1 and ALARO-1 physics, here the recreated high resolution CLIM files (with correctly calculated orography on quadratic grid) were used in ee927 script to prepare new LBCs for next 5 km experiments (2011-05-15 00 UTC ~ 2011-06-15 12 UTC)

2) Some useful technical notes

(**ECMWF**)
Source code:

```
drwxr-x--- 7 kah at 4096 May  4 07:38 40t1_bf05
drwxr-x--- 7 kah at 4096 May 11 15:26 40t1_bf05_assim
drwxr-x--- 7 kah at 4096 May 11 14:45 40t1_bf05_debug_festat
drwxr-x--- 7 kah at 4096 Apr 28 15:44 40t1_bf05_hack
drwxr-x--- 7 kah at 4096 Oct 29  2015 40t1_bf05_sppt
drwxr-x--- 7 kah at 4096 Oct 28  2015 40t1_bf05_test
drwxr-x--- 7 kah at 4096 May  6 09:33 40t1_pre-bf06
```

CLIM files for 5 km LAEF (**FAULTY***):

cca: /scratch/ms/at/kmw/LAEF_5km/newclim_v2/
clim_telecom_laef_5km_v2_m<mm> - HR clim files for 5 km domain
clim_telecom_laef_5km_v2_LowSpectral_m<mm> - lowres clim files for blending

** The orography in these CLIM files has a linear truncation instead of quadratic and the thermal roughness length is not validated with the ALARO physics.*

NEW corrected CLIM files for 5 km LAEF:

cca: /perm/ms/at/kah/mbell/clim_5km_mbell/
clim_target_m<mm> - HR clim files for 5 km domain
cca: /perm/ms/at/kah/mbell/clim_5km_low_mbell/
clim_target_low_m<mm> - lowres clim files for blending

Coupling files for 5 km LAEF (**FAULTY***):

ec:/kah/mbell/CY40_LAEF5/TCC/lbc/2011051500..2011061512/
12UTC: BC_LAEF_<mb>_5km.tar.gz (00, 06, 12, 18, ..54)
00UTC: [only for cycling] BC_LAEF_<mb>_5km.tar.gz (00, 06, 12)

** These LBCs were computed using the faulty CLIM files (see above).*

New corrected coupling files for 5 km LAEF:

ec:/kah/mbell/CY40_LAEF5C/TCC/lbc/2011051500..2011061512/
12UTC: BC_LAEF_<mb>_5km.tar.gz (00, 06, 12, 18, ..54)
00UTC: [only for cycling] BC_LAEF_<mb>_5km.tar.gz (00, 06, 12)

Dynamical adaptation LAEF on 5 km (**FAULTY***):

ec:/kah/mbell/**CY40_LAEF5**/TCC/lae/2011051512..2011061512/
ICMSHDW<mb>+00<RR> (32d x 16 mem, historical files up to +54)
PFDW<mb>DW<mb>+00<RR> (32d x 16 mem, fullpos.ver files up to +54)

** This experiment was computed using faulty LBCs (however the effect seems to be rather negligible).*

Blending cycle (12h) LAEF on 5 km (**FAULTY***):
ec:/kah/mbell/**CY40_LAEF5B**/TCC/lae/2011051500..2011060900/
12UTC:
ICMSHBL<mb>+00<RR> (26d x 16 mem, historical files up to +54)
PFBL<mb>BL<mb>+00<RR> (26d x 16 mem, fullpos.ver files up to +54)

00UTC: [only for cycling]
ICMSHBL<mb>+00<RR> (26d x 16 mem, historical files up to +12)

ec:/kah/mbell/**CY40_LAEF5B**/TCC/ble/2011051500..2011060912/
00UTC and 12UTC:
ICMSHBL<mb>+0000.blend (12h pseudo-assimilation cycle)

** This experiment was computed using faulty LBCs and CLIM files (however the effect seems to be rather negligible).*

New corrected blending cycle (12h) LAEF on 5 km:
ec:/kah/mbell/**CY40_LAEF5BQCC**/TCC/lae/2011051500..2011052112/
12UTC:
ICMSHBL<mb>+00<RR> (7d x 16m, historical files up to +54)
PFBL<mb>BL<mb>+00<RR> (7d x 16m, fullpos.ver files up to +54)
00UTC: [only for cycling]
ICMSHBL<mb>+00<RR> (7d x 16m, historical files up to +12)

ec:/kah/mbell/**CY40_LAEF5BQCC**/TCC/ble/2011051500..2011052112/
00UTC and 12UTC:
ICMSHBL<mb>+0000.blend (12h pseudo-assimilation cycle)

Grib files:
```
cca: /scratch/ms/at/kah/mbell/GRIB/
drwxr-x--- 34 kah at 4096 May  6 11:21 CY40_LAEF5
drwxr-x--- 19 kah at 4096 May 23 12:35 CY40_LAEF5B
drwxr-x--- 19 kah at 4096 Jun  6 11:55 CY40_LAEF5BQ
drwxr-x---  9 kah at 4096 Jun  8 12:11 CY40_LAEF5BQC
drwxr-x---  3 kah at 4096 Jun 10 09:54 CY40_LAEF5BQCC
drwxr-x---  8 kah at 4096 Jun  7 07:54 CY40_LAEF5BQX
```

ec:/kah/mbell/CY40_LAEF5_gribs.tar.gz(dynamical downscaling)

B-matrix sampling for LAEF on 11 km - dynamical adaptation:
ec:/kah/mbell/CY40_BMATRIX/TCC/**DW11km**/2011051500..2011061512/

`gribdiff_<mb1>-<mb2>+06  (32d x 8 diff, 6h forecast)`

<u>B-matrix sampling for LAEF on 5 km - dynamical adaptation:</u>
`ec:/kah/mbell/CY40_BMATRIX/TCC/`**`DW5km`**`/2011051500..2011061512/`
`gribdiff_<mb1>-<mb2>+12  (32d x 8 diff, 12h forecast)`

(**METEO-FRANCE**)
<u>CLIM files computation on beaufix (the correct procedure):</u>
`/home/gmap/mrpe/bellusm/e923_cy40/`

- `make_pgd_923_model_5km` - the orography and land/sea mask are forced to SURFEX values (SURFGEOPOTENTIEL, SURFIND.TERREMER) while the other parameters are computed as before (this creates the input for the following scripts)

- `job_923_model_5km` - creation of HR CLIM files with the linear truncation for all fields except the orography (which is still on quadratic grid - NSMAX, NMSMAX must be specified twice in both namelists!)

- `job_923_blend_5km` - creation of lowres CLIM files used for DFI blending (there is no special treatment for the orography, since everything is set as for the quadratic grid but with the NSMAX, NMSMAX computed for the given blending ratio)