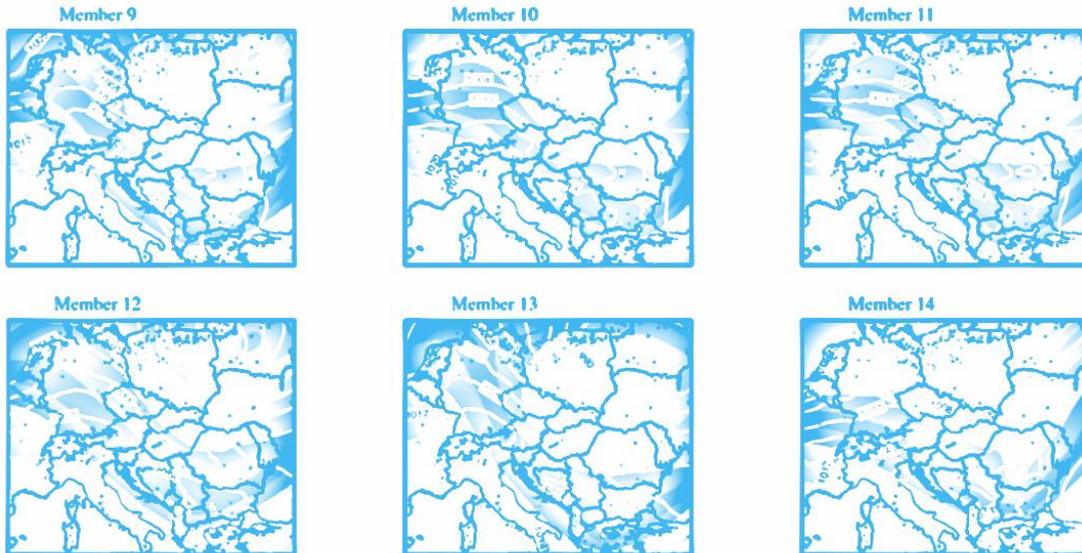
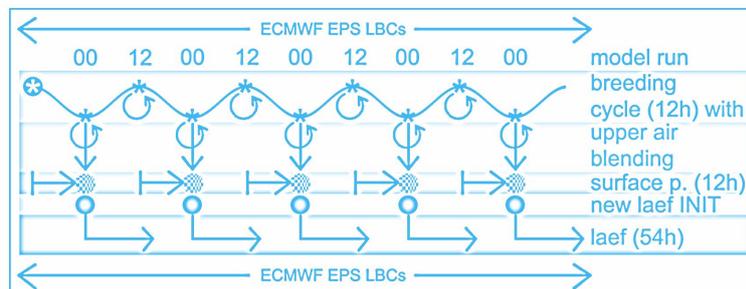


Report on stay at ZAMG

11/02 – 21/03/2008, Vienna, Austria



Combination of large scale initial conditions uncertainty with small scale initial perturbations obtained by breeding cycling using blending technique in LAEF experiments



::Supervised by
Yong Wang (ZAMG)
yong.wang@zamg.ac.at

::Author
Martin Belluš (SHMU)
martin.bellus@shmu.sk

::Content

Acknowledgement

Foreword

Motivation

I Spectral blending of initial conditions

II Limited Area Ensemble Forecasting

III Breeding cycle

IV Blending technique

V Blending tuning

VI Surface perturbations

VII Experiments (BRC, BRCBL, BRCBS, BRBCS)

VIII Verification of experiments

IX Some useful information

Conclusion

::Acknowledgement

As usually, I am very grateful to the whole local NWP team for their hospitality and friendly atmosphere, for really good meals in the canteen and for the opportunity to work on LAEF project. I was pleased to work with you. Thanks!

::Foreword

During this stay the applications *surfp* (surface perturbation procedure) and *laeff* (ensemble forecast integration with inline fullpos) were created and applications *breed* (breeding cycling) with *blend* (blending procedure) were upgraded from the previous versions written during the last stay (all together more than 3000 lines of code).

All these applications can be combined with each other in the final LAEF production line, where different settings can lead to different experiments (breeding cycling + blending, breeding cycling + blending + surface perturbations, breeding-blending cycling + surface perturbations, etc.). Further, the scripts for launching such individual long-time experiments (for optimal submission of the particular jobs to HPC) were prepared as well.

Since all experiments were coupled with ECMWF LBCs for 16 members' ensemble based on singular vectors method (and one control run), the blending setting was retuned accordingly. New climate files for necessary transformation into the lower spectral resolution while filtering the files, were created on tori machine in Toulouse.

70 days long archive containing ECMWF ensemble LBCs was reorganized (230 GB) in order to simplify the work with it and also partly repaired (some missing/wrong files were noticed and restored).

Quite big initial problems regarding the preempting functionality of queuing system (NQSII) on NEC SX-8R HPC were thanks to our expensive experiments (jobs) addressed at the beginning and later investigated by NEC support team from Germany and even from Japan. However, the collisions between our jobs in test queue and the operational ones in privileged queue were solved just at the end of the stay. Hence, for security reasons, all jobs except the operational ones were usually held for the whole nights and the weekends. The overall demands for CPU time for our experiments were so enormous, that unfortunately not all planned experiments could have been fully finished in such conditions.

::Motivation

We suppose that the combination of large scale perturbations obtained from driving model with the small scale perturbations generated by breeding cycling (produced by limited area model) will be more consistent with used lateral boundary conditions, while still keeping the small scale features produced by breeding cycle. Such combination can be done by spectral blending technique with the application of standard Dolph-Chebyshev digital filter.

::I Spectral blending of initial conditions

The general and well known idea of blending is the combination of large scale features resolved by global model analysis (or global model source of information – in our case ECMWF singular vectors) with the small scale features provided by limited area model (usually by short-range forecast). In our case, we are not using directly short-range forecast, but an initial file obtained by breeding method (which is based on 12h integration and will be explained in the next chapter). However, the theory laying behind is still the same. The short-wave part of the spectra of our ALADIN breeding files is more realistic than the short-wave

part of corresponding interpolated ECMWF files (where it can be considered as pure numerical noise). In our case, blending method is used to introduce the large scale perturbations produced by singular vectors into the ALADIN breeding files rather than the original idea of meso-scale data assimilation without direct input of the observations (standard usage of blending procedure in pseudoassimilation cycle).

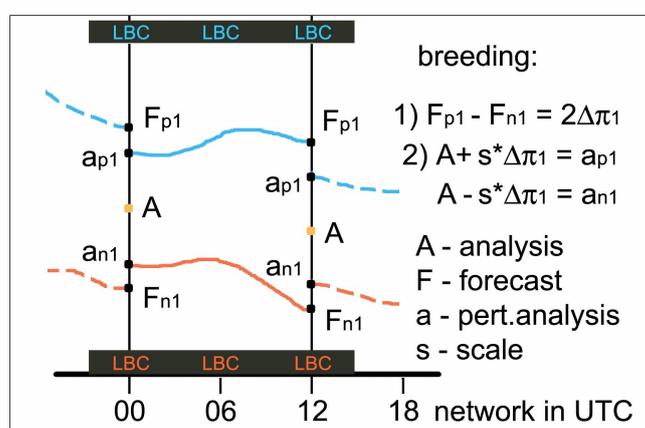
::II Limited Area Ensemble Forecasting

Limited Area Ensemble Forecasting (LAEF) is connected to the global ensemble forecast in the same manner as limited area model depends on global one (through the coupling files). In our case the global ECMWF EPS system was used. It is based on singular vector technique, where perturbed initial conditions are created by adding and subtracting singular vector perturbations to the unperturbed analysis. It consists of 16 members (8 pairs) and 1 control run.

The basic (and the easiest) option is a simple downscaling of global ensemble forecast, but there is mostly no added value to the final result. Therefore, the breeding method is used in our experiments as the source of LAM perturbations. It has to simulate the effect of uncertainty in observations by rescaling the nonlinear perturbations. Breeding cycle is used to generate the perturbed initial conditions for limited area ensemble forecasting (it will be explained in the next chapter). Since these initial conditions have to be still coupled with the global ensemble members which are actually physically incompatible with the breeding files – an idea to blend the two corresponding initial states was more than logical.

::III Breeding cycle

The general scheme of breeding cycle is shown on the picture (Fig.1). The difference between two integrations (one labelled as *positive* and the other as *negative*) for 12 hours coupled with ECMWF EPS is rescaled and centred around the analysis of ECMWF control run. The difference is actually computed only for some meteorological variables as temperature, specific humidity, wind components in 3D and for surface pressure. By this means, two new initial states (perturbed) for the subsequent limited area ensemble forecasting are created. These perturbed initial conditions provided by breeding cycle will be further blended with the corresponding ECMWF EPS initial conditions in order to ensure said compatibility.

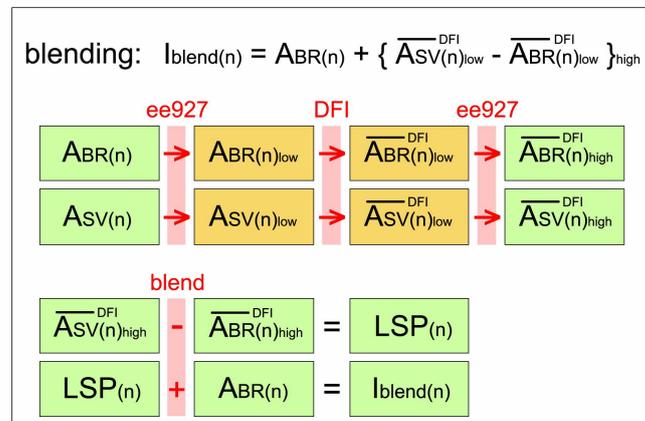


::Fig.1 Scheme of 12h breeding cycle.

::IV Blending technique

The whole blending process consists of several consequent steps. But the main principle is to apply a digital filter on both ECMWF and ALADIN files on the original ALADIN grid but at a lower spectral resolution. The difference between those filtered files, already at the ALADIN full spectral resolution, represents a large scale increment which should be added to the original ALADIN file. The computation leading to a reasonable low spectral resolution will be shown in the next chapter together with some basic tuning of digital filter.

Detailed information about used blending procedure can be obtained from the following diagram (**Fig.2**). The equation at the top just summarizes what was already said (“SV” stands for singular vector and “BR” means breeding). Further, all individual steps to reach the final result are displayed, while the processes itself are red coloured and the different spectral resolutions are highlighted by the colours: orange (for low) and green (for high).



::**Fig.2** The blending procedure.

Actually, to perform all 8 displayed processes (**Fig.2**) we need just 3 different functions. In the blending script this was reached by programming the following 3 subroutines designed to fulfil our needs:

&chspecreso(\$fileA, \$fileB, \$kA, \$kB)

It changes the spectral resolution of fileA characterised by the elliptic spectral truncations kA and saves it into fileB with the new truncations kB. To go from one spectral resolution to the other, ee927 model configuration is used without any geometry changes but with different climatological files for input and target domain. They were created (e923) in the same way but with the different NSMAX a NMSMAX values. The existence, date validity and spectral resolution of the input file are verified. The spectral resolution of climatological files for input and target domain is also verified. Necessary ENV setup is done and namelist is dynamically created from the template (lancelot.template) according to the local configuration in subroutine. When the output file is created, its new spectral resolution is finally controlled as well.

&filteratls(\$fileA, \$fileB)

It does the digital filtration of fileA and the result is saved into fileB. To perform the filtration a model configuration e001 with only DFI and constant coupling is used. The existence and date validity of the input file is verified. Necessary ENV setup is done and namelist is

dynamically created from the template (morganeDFI.template) according to the local configuration in subroutine.

&blendathis(\$fileA, \$fileB, \$fileC, \$nsign)

It does the combination of fileA and fileB which is then saved into fileC. Whether the first two files will be added together or the second file will be subtracted from the first one, depends on the value of nsign. In this case it makes sense to have either nsign equal 1.0 (add) or -1.0 (subtract). Necessary ENV setup is done and namelist is dynamically created from the template (blend.template). The existence of input files is checked and special copy procedure at the beginning of the process required by the external aladin/blending executable is performed, user do not need to take care about.

Warning: Only upper air spectral blending is done here. However, whether the unchanged surface fields from the original ALADIN or ECMWF file is going to be used in the result, depends on the order of input files while blending function (&blendathis) is applied for the second time. It is because at the beginning of each process the first input file is the origin of every untouched data (e.g. surface). This can be decided while calling the function in the main production line (the order of input files can be changed only in the second step, since the files are adding to each other here!). We recommend to use the surface fields from ECMWF file, because if taken from ALADIN one (which comes from the breeding cycle) – one may risk a possible drift of surface fields from the climatology after long enough period of cycling. (Anyhow, in one of our essential experiments, we changed that surface completely by the new perturbed one, which is going to be explained later in this report.)

The script is well self documented and everything what can be changed, shall be obvious. The blending script has to be released with the following arguments (to see some help, just run it without any):

dd [*day*] **mm** [*month*] **yyyy** [*year*] **HH** [*network*] **mem** [*member*]

The date consistency is verified in the beginning of the process using some support date subroutines written for this purpose. This date will be also checked in the headers of input files (they must have of course the same validity, if not – an error message will be displayed).

The following file names can be found during the process in working directory with the corresponding meanings:

ARLYyyyymmdd-HH – driving model file in low spectral resolution
ALLyyyymmdd-HH – ALADIN file in low spectral resolution
ARFyyyymmdd-HH – driving model file after DFI in low spectral resolution
ALFyyyymmdd-HH – ALADIN file after DFI in low spectral resolution
ARHyyyymmdd-HH – driving model file transformed back to the high spectral resolution
ALHyyyymmdd-HH – ALADIN file transformed back to the high spectral resolution
BLAYyyyymmdd-HH – large scale increment (LSP in diagram – **Fig.2**)
BLByyyyymmdd-HH – final blended file (will be saved differently)

(All the files are valid at dd.mm.yyyy HH UTC.)

Each of the three aforementioned subroutines (called eight times all together) creates its own working subdirectory (under the main working directory) named by the subroutine name and appended with the resultant file name (e.g. chspecreso.ARL20070611-00). At the end of the

process (in normal circumstances) the whole main working directory is removed and only the final blended file is saved into the specified output directory. If the environmental variable CNF_DEBUG is defined, nothing will be removed and this is also true if some fatal error occurs during the process, so one can check the error output listings and all the files.

::V Blending tuning

Consider this chapter to be a kind of very basic manual to set the reasonable low spectral resolution parameters for blending purpose with some useful hints and sample computations.

Chosen low spectral truncation depends on the limit resolution of driving model analysis (in our case ECMWF EPS singular vectors) and on the location, size and resolution of target ALADIN domain. Firstly an average resolution (truncation) of ECMWF EPS forecast over the target domain has to be computed (1). Originally it can be acquired from the actual driving model truncation multiplied by the average map factor over the domain (map factor m can vary from $1/c$ to c , where c is the actual stretching). Since ECMWF model is not stretched unlike ARPEGE, m is simply equal to 1. Further we can compute the mean resolution of ECMWF analysis (i.e. singular vectors) over the target domain (2), which is the geometric mean between the truncation obtained in the previous computation and resolution of ECMWF singular vectors. Then we can perform the computation of equivalent-ECMWF truncation for ALADIN (3). This is actually the truncation which would have global model with ALADIN original resolution and corresponding grid (for linear grid there should be “2” in denominator, but we are using quadratic one). The last computation is the ECMWF-equivalent low spectral truncation (4).

$$1 \quad T^{fa}_{ECM} = T^f_{ECM} * m = 399 * 1 = 399$$

$$2 \quad T^a_{ECM} = \sqrt{T^{fa}_{ECM} * T^m_{ECM}} = \sqrt{399 * 42} \cong 129$$

$$3 \quad T^f_{ALD} = L / 3 * dx = 40000 / 3 * 18 \cong 741$$

$$4 \quad T^c_{ALD} = \sqrt[3]{T^{a^2}_{ECM} * T^f_{ALD}} = \sqrt[3]{129^2 * 741} \cong 231$$

Now we have everything to get the final blending ratio (5), which should be larger than the coupling ratio (6) – in our case perfectly satisfied.

$$5 \quad r_b = T^f_{ALD} / T^c_{ALD} \cong 3.2$$

$$6 \quad r_c = T^f_{ALD} / T^{fa}_{ECM} \cong 1.9$$

As a final step, this blending ratio must be used to compute the elliptic truncations (NSMAX and NMSMAX) for low spectral resolution (7). (N stands for NSMAX and M for NMSMAX, while L and H represent the low and high spectral resolution respectively.)

$$7 \quad \sqrt{N_L^2 + M_L^2} * r_b \cong \sqrt{N_H^2 + M_H^2} \quad \text{and} \quad \frac{N_L}{M_L} \cong \frac{N_H}{M_H} \cong \frac{NDGL}{NDLON}$$

If our original ALADIN truncations are NSMAX=74 and NMSMAX=107, than low spectral resolution truncations will be NSMAX=23 and NMSMAX=33.

Since we cannot just simply combine the ECMWF large scale information up to some specific truncation with the ALADIN small scales (this would lead at least to an initial inconsistency

in physical processes), we need to use a digital filter for smooth transition between the two spectra centred around that truncation.

We have used standard Dopplh-Chebyshev filter and according to the theory we chose the stop-band edge period of 5 hours (TAUS=18000.). Digital filter is applied twice, adiabatic integration backward and diabatic forward (NEDFI=7). Further, we have to recompute the number of filter steps in such way, that the real time-span of the filter (Ts) will be at least the minimum time-span associated to the given stop-band edge and at the same time it will be an even number of time steps (see following computation). (Since we are working now in lower spectral resolution, we can prolong the time step by the blending factor, i.e. we will have now TSTEP=RTDFI=1800s. what means that 12 steps will be done within 6h coupling frequency)

$$T_s \geq f(r) * TAUS \geq 0.69 * TAUS \geq 12420 = 3.45h$$

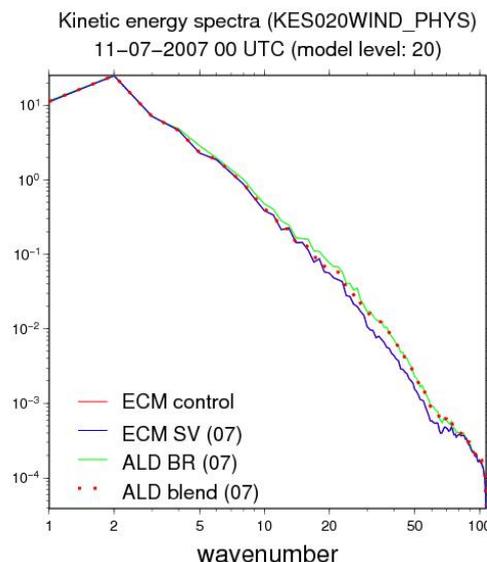
$$T_s = 2 * NSTDFI * RTDFI$$

$$NSTDFI \geq 12420 / 2 / 1800 \geq 3.45$$

$$\Rightarrow NSTDFI = 4 \quad \text{and} \quad T_s = 14400 = 4h$$

This means, that we will integrate 8 steps (4 hours) each direction (with constant coupling). One has to keep in mind, that also horizontal diffusion must be rescaled by the blending factor (i.e. RRDXTAU = 123/ r_b = 38 in NAMDYN, while 123 is its default value).

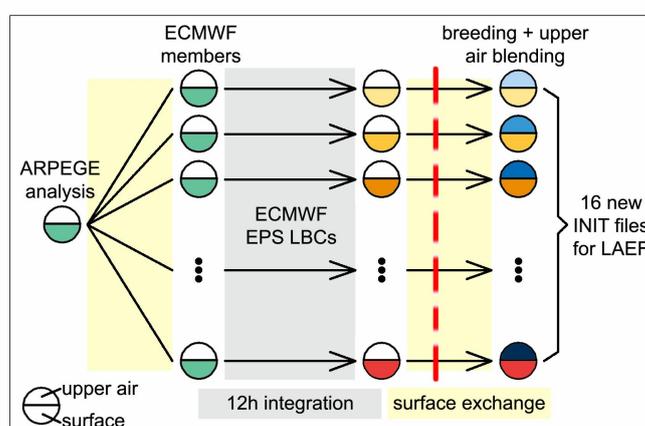
In order to prove the correctness of our settings, we drew the charts of kinetic energy spectra for all input files and the result. As it is shown on **Fig.3**, the spectrum of file modified by blending (red dotted line) well corresponds to the theory. For the small wave numbers (i.e. large scale information) it is converging to the spectrum of ECMWF EPS member (blue line) and for the big wave numbers (i.e. small scale features) it clearly follows the ALADIN one from breeding (green line) while the transition in-between is smooth enough thanks to digital filter. A spectrum of ECMWF control run (red line) is not clearly visible, since it is mostly hidden under the spectrum of ECMWF EPS member. These two spectra are usually very close to each other. But in principle it doesn't mean, that in ECMWF EPS members there is no additional information over the control run (keep in mind that the general idea of singular vectors is to produce some spatially distributed perturbations centred around the original analysis, and this is just an average over the whole domain).



::Fig.3 Kinetic energy spectra for one selected member and model level

::VI Surface perturbations

The former experiments have shown, that LAEF in combination with ECMWF surface fields suffers from bigger BIAS and RMSE than the one with ARPEGE surface fields. Therefore we decided to use completely new approach to create perturbed surface ARPEGE analysis driven by ECMWF EPS couplings for our experiments. The basic idea is simple. We have replaced the surface fields in each ECMWF EPS member by the surface taken from the corresponding ARPEGE analysis. Thus, we had 16 perturbed ECMWF members with one uniform set of surface fields. After 12h integration coupled with the particular ECMWF EPS LBCs, we have obtained already 16 “perturbed” sets of surface fields (based on ARPEGE analysis and now even compatible with ECMWF couplings). These were afterwards exchanged again, this time within the LAM ensemble (files after breeding cycle and upper air blending with ECMWF). As a final result, we have got 16 new initial conditions for LAEF with LAM-generated perturbations for upper air as well as for surface fields (and consistent with ECMWF EPS couplings). But one picture can tell more than a thousand words – see **Fig.4**.



::Fig.4 Surface perturbation scheme

Different colours mean different perturbations, while the uncoloured file parts are not necessarily the same (sure, they are not) – but are thrown away afterwards, so they are not really used. It is also possible to use various physical parameterizations (or even different models) for the 12h integration in order to make the spread larger (but this wasn't tested yet in our experiments).

Moreover, in our experiments we have used for surface perturbation the ECMWF EPS couplings from the previous model run (12 hours ago), while for subsequent LAEF integration itself - new couplings were applied. Since, it is planned for operational usage to do so called lagged coupling (mostly to save time), ECMWF EPS LBCs from the same model run will be used for both surface perturbation and LAEF integration. Hence, even more compatibility is expected.

::VII Experiments (BRC, BRCBL, BRCBS, BRBCS)

The main goal of this stay (except the preparation of all necessary applications and production lines) was to run several experiments together with the verification in order to see the effect of chosen method and its benefit on the ensemble quality.

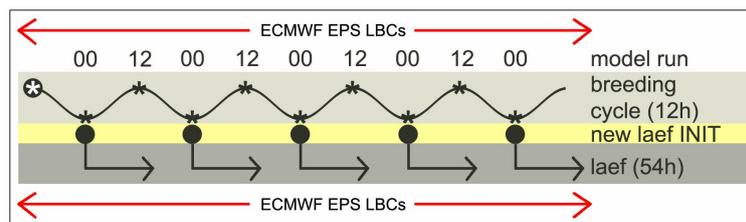
For this purpose the following experiments have been executed:

BRC: Breeding cycling every 12h (and then LAEF integration only for 00 UTC +54h) –

Fig.5. Production line consists of the following application bricks:

1. breed (00, 12) - the breeding outputs from BRCBL experiment were used, because it was running in advance (and there was no need to recompute the same data again)
2. laeff (00) – with env variable CNF_INIT=BR

Script for this experiment: `~laef/bellus/BRC/run.pl` (it can wait for input breeding files 10 hours if necessary)

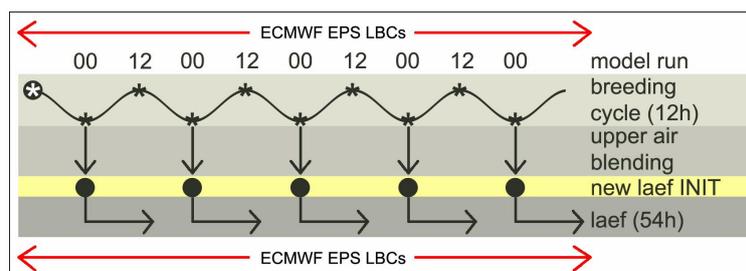


::Fig.5 Experiment BRC

BRCBL: Breeding cycling every 12h + blending with the ECMWF members only for 00 UTC (and then LAEF integration only for 00 UTC +54h) – **Fig.6**. Production line consists of the following application bricks:

1. breed (00, 12) – with env variable CNF_FILE=BR
2. blend (00) – with env variable CNF_FILE=BR
3. laeff (00) – with env variable CNF_INIT=BL

Script for this experiment: `~laef/bellus/BRCBL/run.pl`

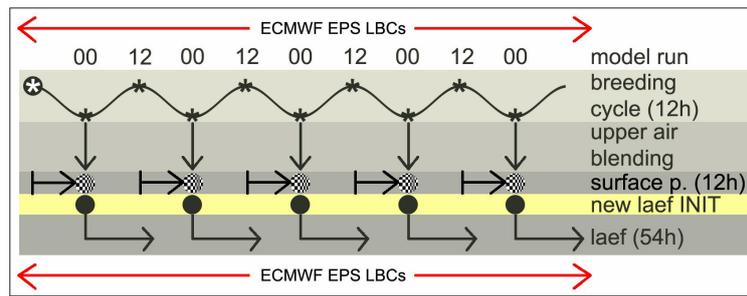


::Fig.6 Experiment BRCBL

BRCBS: Breeding cycling every 12h + blending with ECMWF members and surface perturbations only for 00 UTC (and then LAEF integration only for 00 UTC +54h) – **Fig.7**. Production line consists of the following application bricks:

1. breed (00, 12) - the breeding outputs from BRCBL experiment were used, because it was running in advance (and there was no need to recompute the same data again)
2. blend (00) - the blending outputs from BRCBL experiment were used, because it was running in advance (and there was no need to recompute the same data again)
3. surfp (00) – with env variable CNF_FILE=BL
4. laeff (00) – with env variable CNF_INIT=BS

Script for this experiment: `~laef/bellus/BRCBS/run.pl` (it can wait for input blending files 10 hours if necessary)

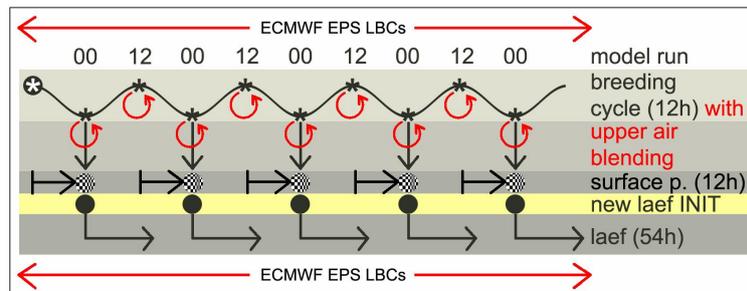


::Fig.7 Experiment BRCBS

BRBCS: Breeding-blending cycling every 12h + surface perturbations only for 00 UTC (and then LAEF integration only for 00 UTC +54h) – **Fig.8**. This most complicated experiment was only tested for several days (6 J) due to the lack of time (related to said NQSII problems). However, we believe, that this should be (probably along with the combination of different physical parameterizations used for individual processes) the most promising method for future operational LAEF production line. It consists of the following application bricks:

1. breed (00, 12) – with env variable CNF_FILE=BB
2. blend (00, 12) – with env variable CNF_FILE=BB
3. surfp (00) – with env variable CNF_FILE=BB
4. laeff (00) – with env variable CNF_INIT=BX

Script for this experiment: `~laef/bellus/BRBCS/run.pl`



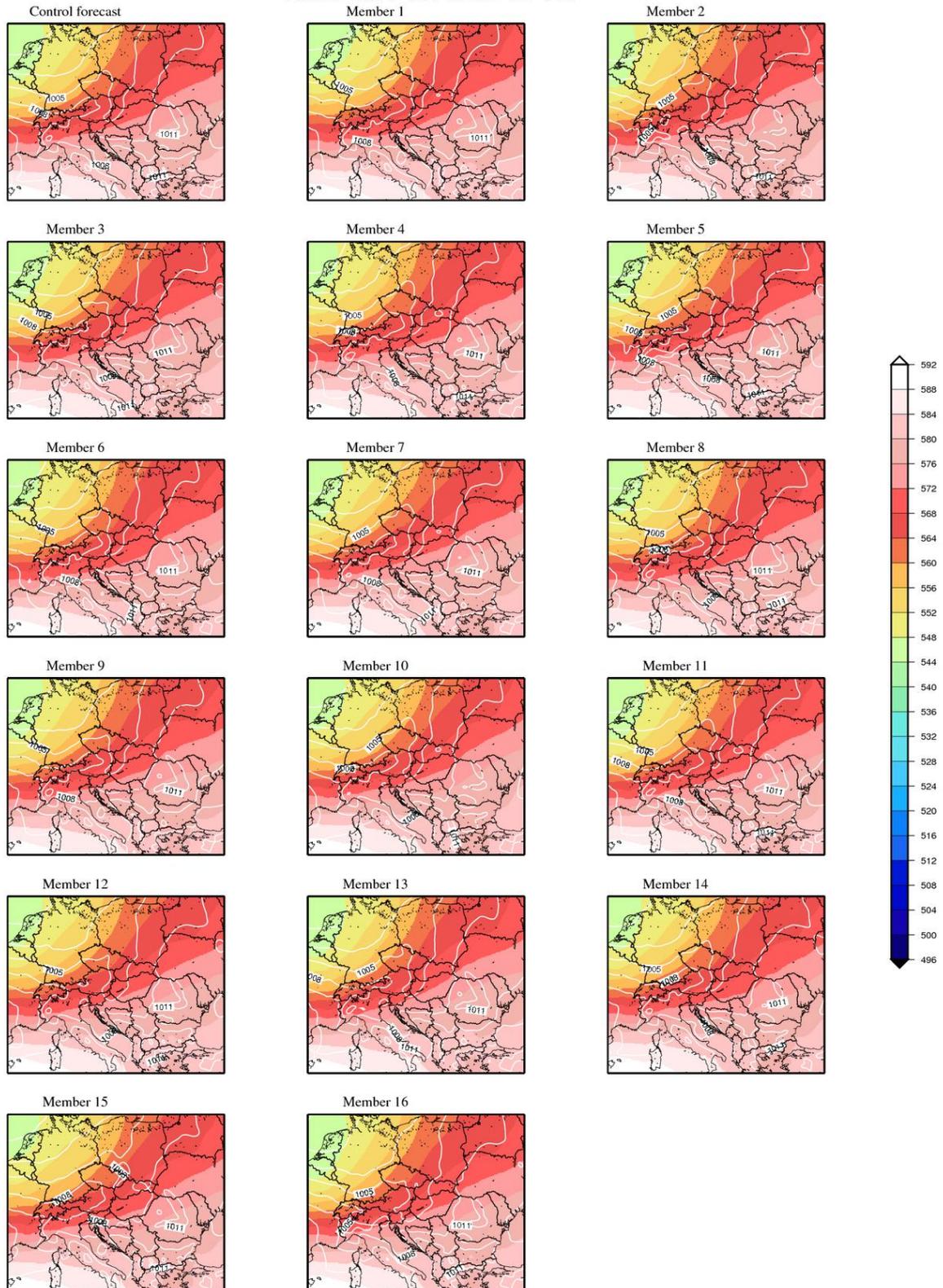
::Fig.8 Experiment BRBCS

Poststamp maps are convenient format to see the evolution of individual ensemble members. 500hPa Geopotential and MSLP analysis of LAEF integration from 04-07-2007 00 UTC (experiment BRCBL) are shown on **Fig.9**, and even though no significant differences can be observed among individual members here (by the human eye) – it is already changed after 54 hours of integration (**Fig.10**).

Another example is the comparison between precipitation forecast (mm/24h) of BRCBL and BRBCS experiments (i.e. the effect of exchanged perturbed surface fields), which is shown on **Fig.11** (selected BRCBL members on the left and BRBCS on the right side).

500hPa Geopotential [gpm] + MSLPRESSURE [hPa], 20070704 00UTC + 00, EXP:BL

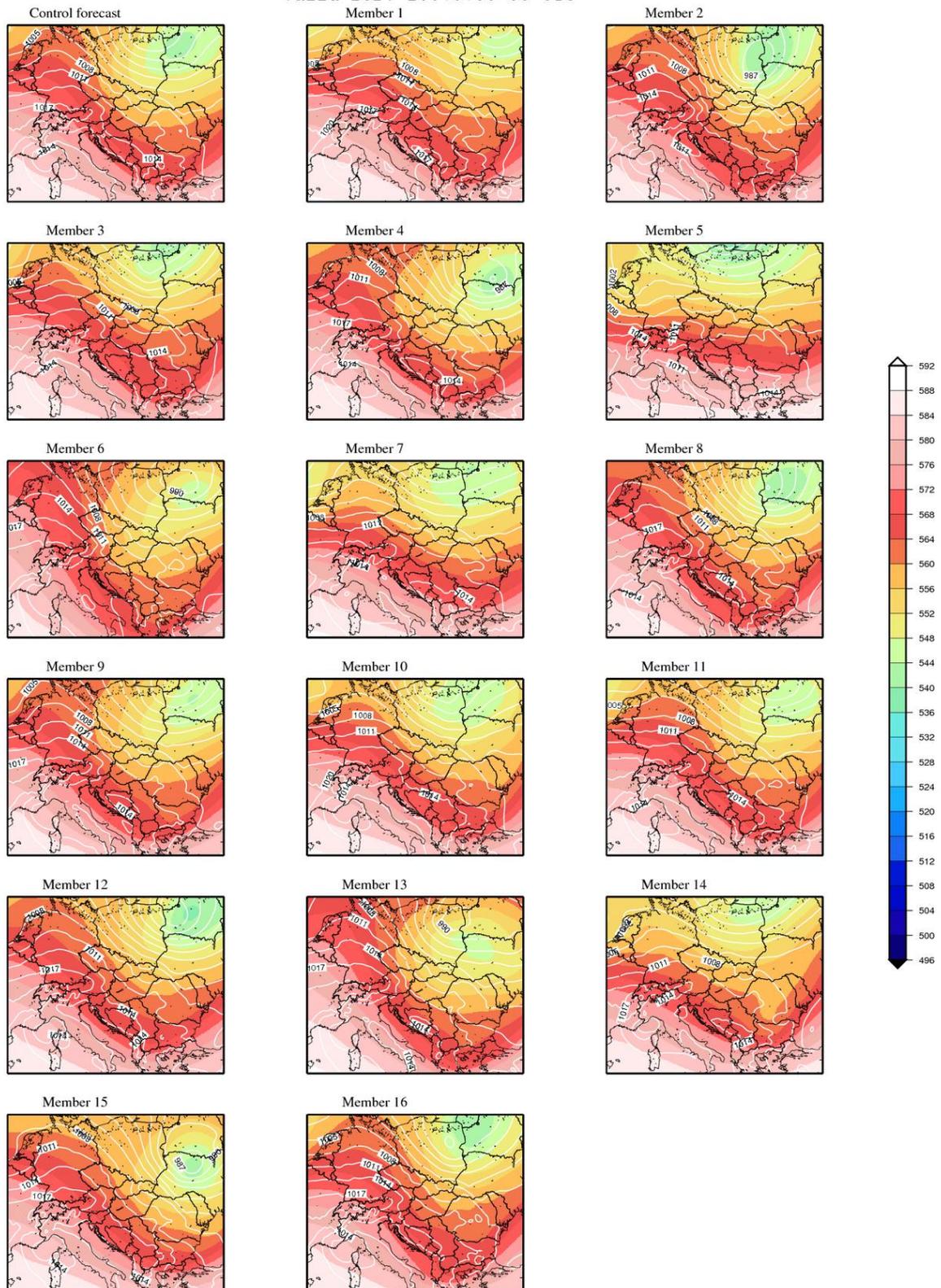
Valid for: 20070704 00 UTC



::Fig.9 Analysis of all ensemble members and control run (experiment BRCBL)

500hPa Geopotential [gpm] + MSLPRESSURE [hPa], 20070704 00UTC + 54, EXP:BL

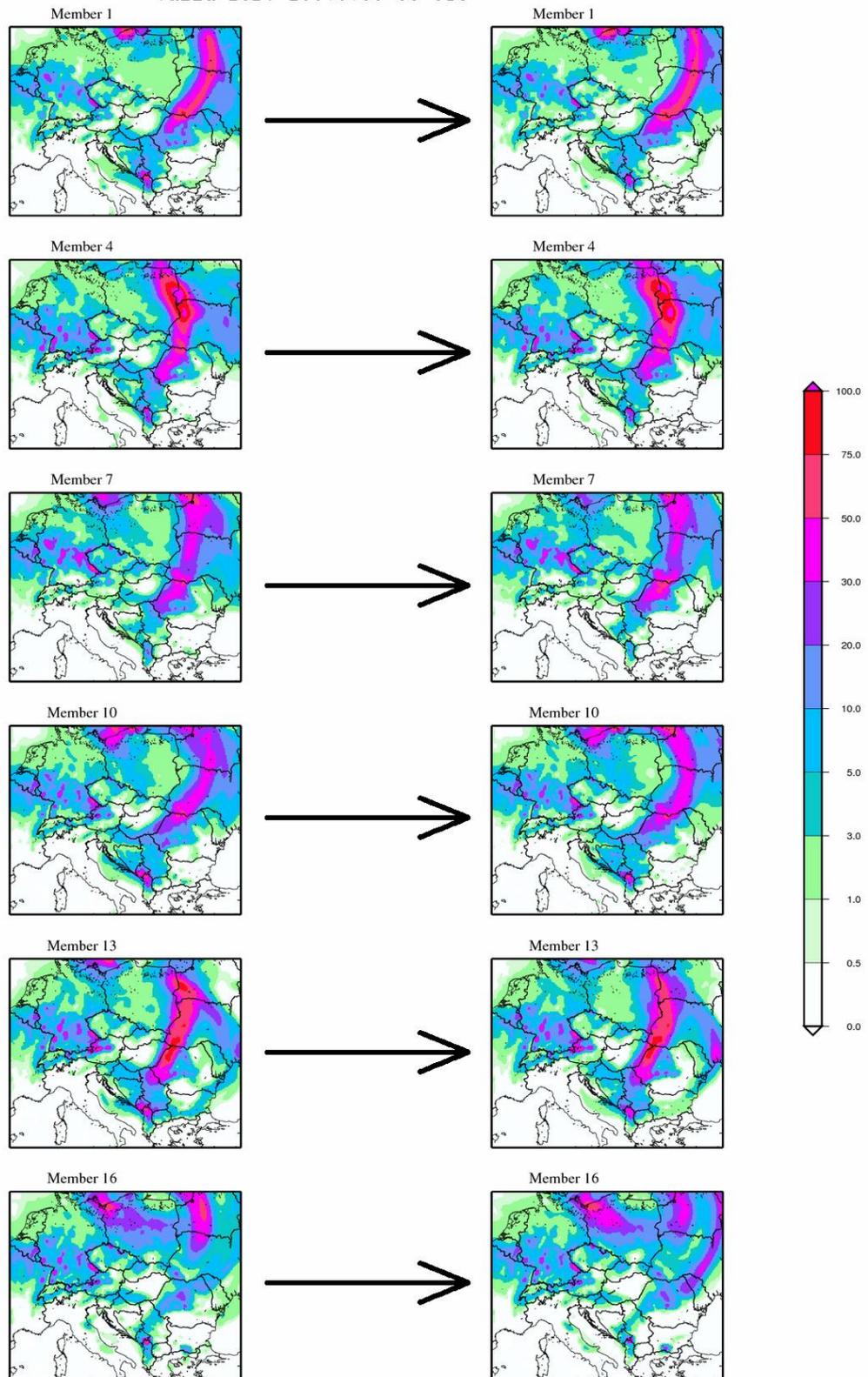
Valid for: 20070706 06 UTC



::Fig.10 Forecast of all ensemble members and control run (+54h, experiment BRCBL)

Precipitation [mm/24h], 20070704 00UTC + 48, EXP:BL vs. BS

Valid for: 20070706 00 UTC



::Fig.11 Precipitation forecast (experiment BRCBL left and BRCBS right)

::VIII Verification of experiments

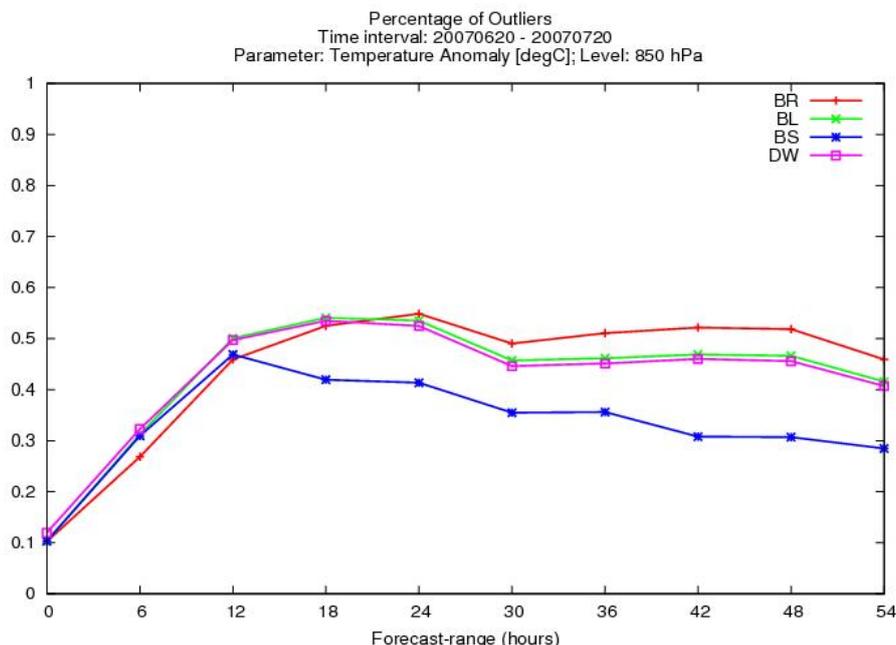
The breeding cycle started at 10-06-2007, but the verification of experiments was done for the period 20-06-2007 till 20-07-2007. The first 10 days were skipped in order to avoid the usage of data right after the cold start (since the breeding cycle was initialized with the arbitrary generated perturbations). Originally it was planned to do the verification for 2 months period, but this was not possible due to already mentioned problems with queuing system on NEC HPC. The whole period will be verified via remote access, when all experiments are finished.

We have done the verification for 3 experiments and downscaling (which is our benchmark). The nick names for the experiments used on charts are: BR=BRC (only breeding cycling) and will be referred as *breeding*, BL=BRCBL (breeding cycling + blending) and will be referred as *blending*, BS=BRCBS (breeding cycling + blending + surface perturbation) and will be referred as *surface perturbation* and finally DW (simple downscaling of ECMWF ensemble) referred as *downscaling*.

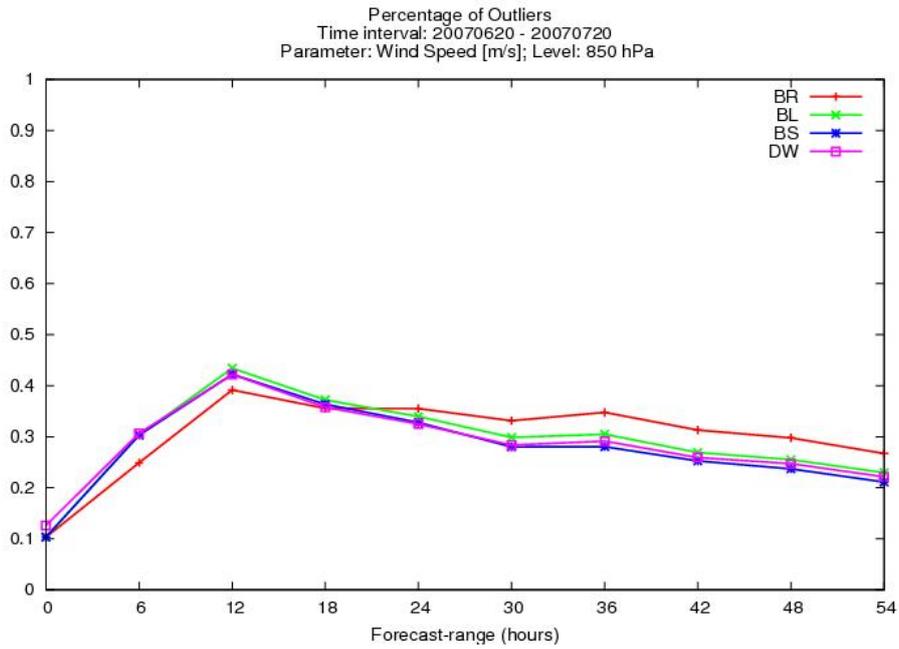
Generally, the best scores have been reached without a doubt with surface perturbation (BS beats the rest of the methods almost everywhere). Further, blending is better than breeding itself while there are not many differences between blending and downscaling. This can simply mean, that global ensemble is already of a high quality and blending applied on breeding cycle can improve the scores but hardly can beat the downscaling.

Maybe, it is also worth to mention, that the verification is done against the ERA-40 daily reanalysis (what is in principle the same model as generates the global ensemble). The another point which should be taken into account is, that the averaged long-term scores similar for blending and downscaling do not necessarily mean, that the LAM generated ensemble can not be better for some special weather conditions, than the global one. Therefore, it would be a good idea to do some case studies as well (especially for some extreme weather events).

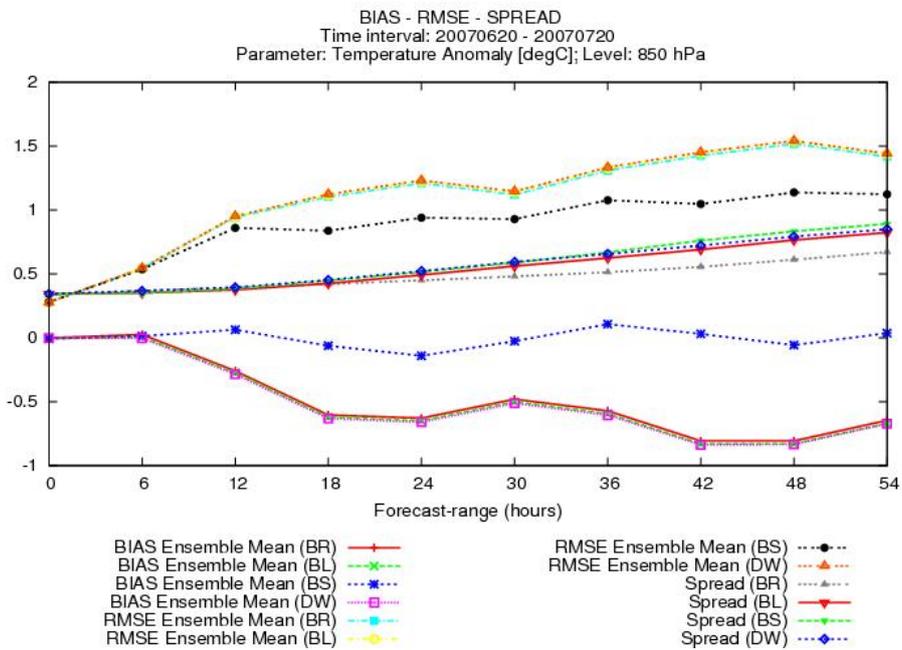
On the following figures (**Fig.12-28**) different verification scores for all our experiments (at 850 hPa and surface) are shown. The skill scores were computed with the ALADIN/Austria deterministic forecast as a reference.



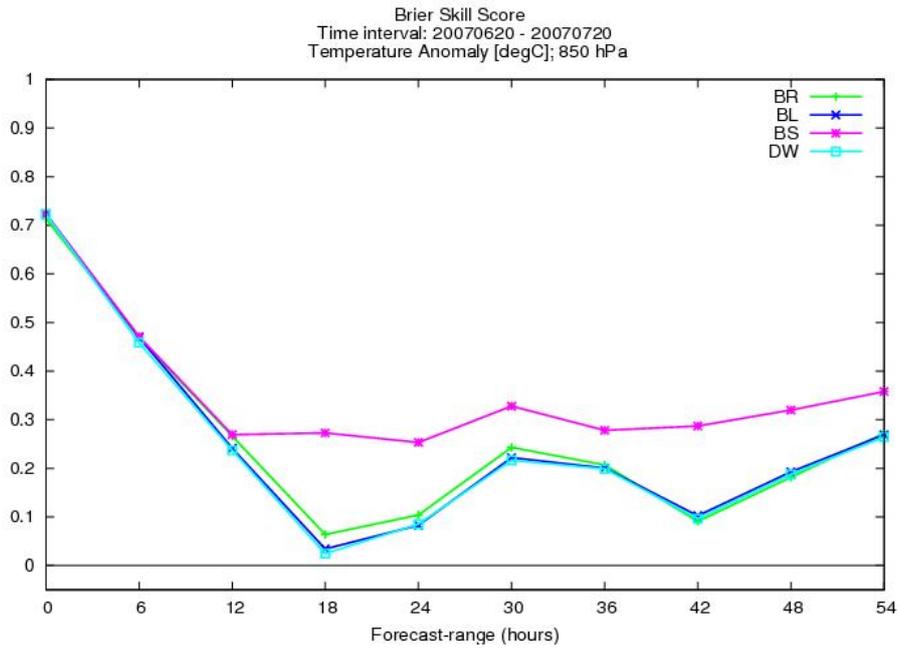
::Fig.12 Percentage of outliers for temperature anomaly at 850 hPa



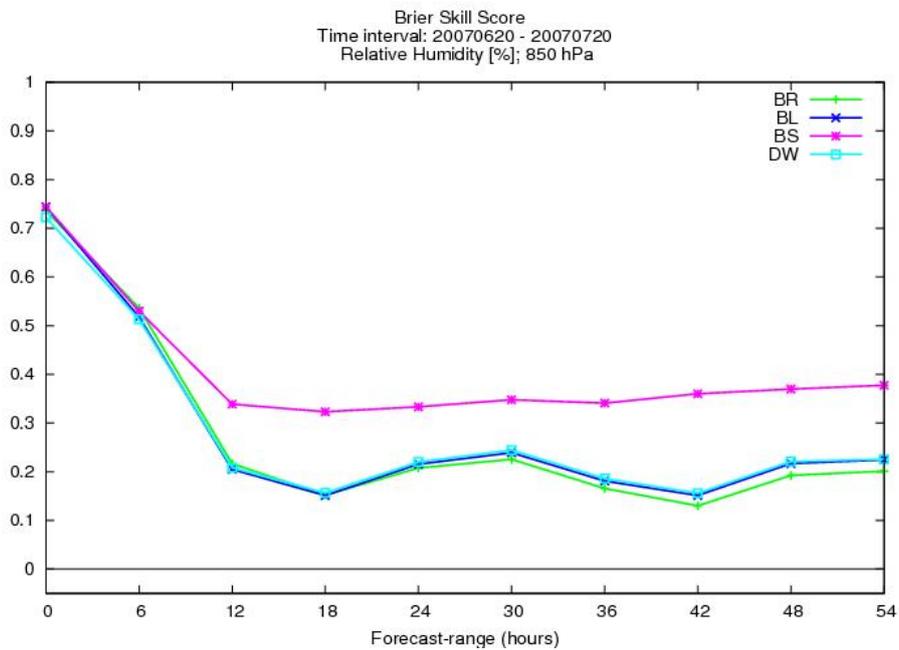
::Fig.13 Percentage of outliers for wind speed at 850 hPa



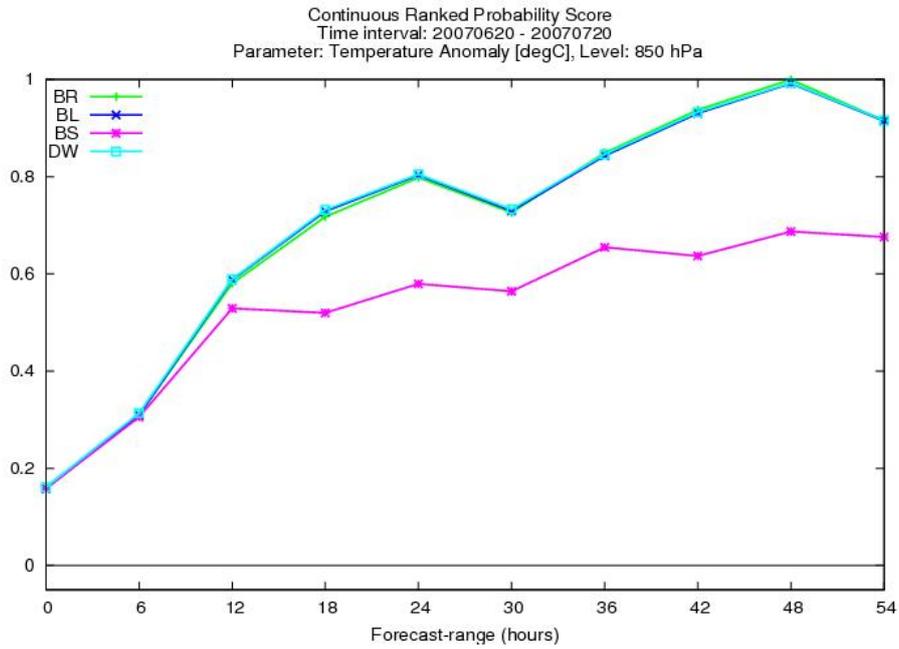
::Fig.14 BIAS, RMSE and SPREAD for temperature anomaly at 850 hPa



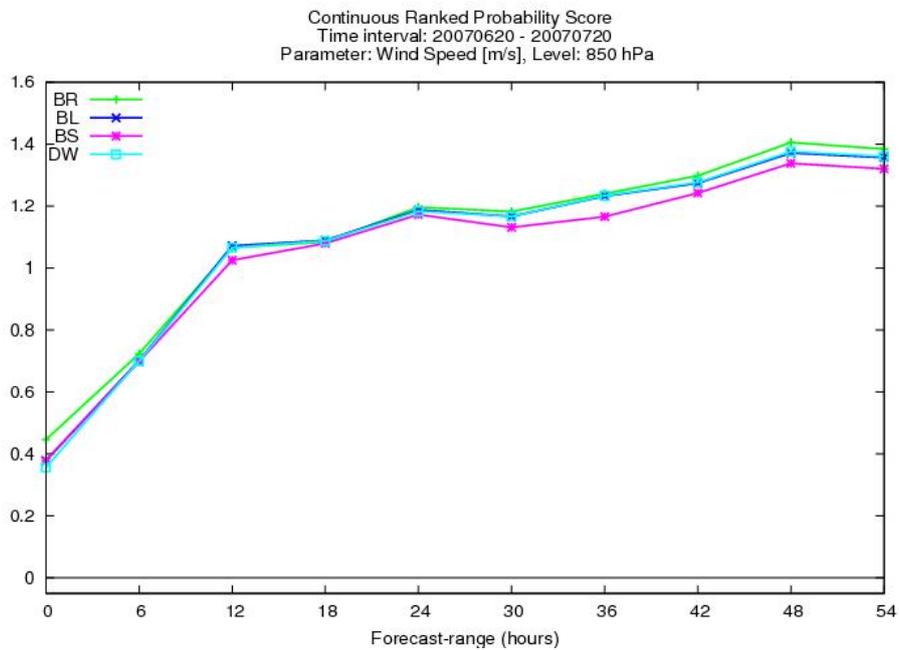
::Fig.15 Brier skill score for temperature anomaly at 850 hPa



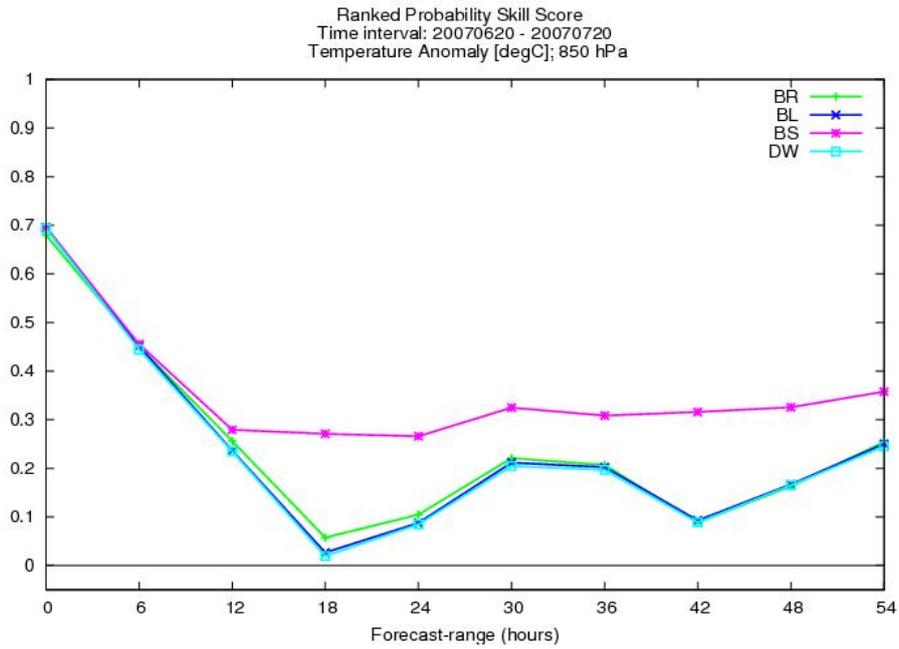
::Fig.16 Brier skill score for relative humidity at 850 hPa



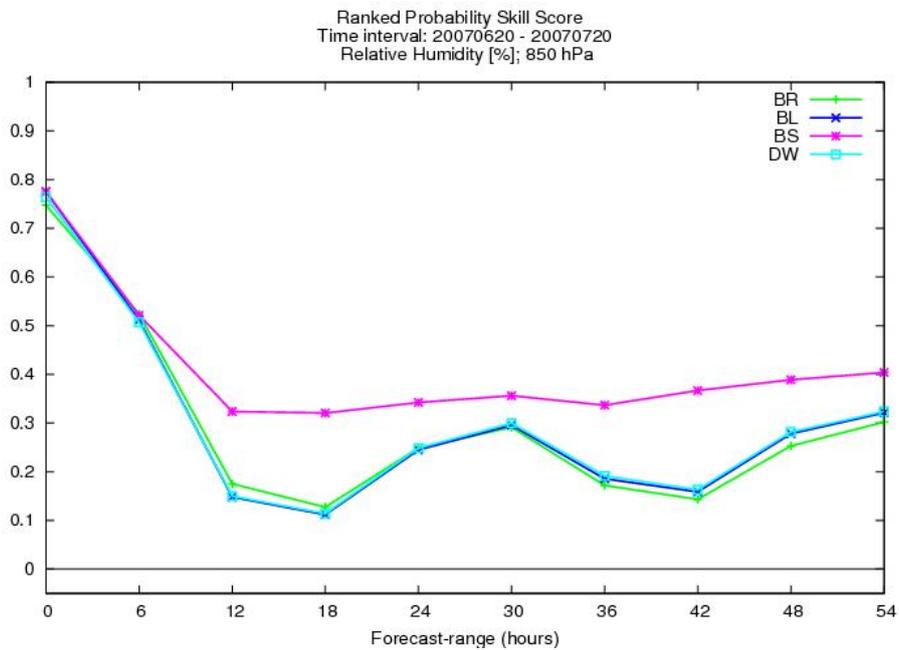
::Fig.17 CRP score for temperature anomaly at 850 hPa



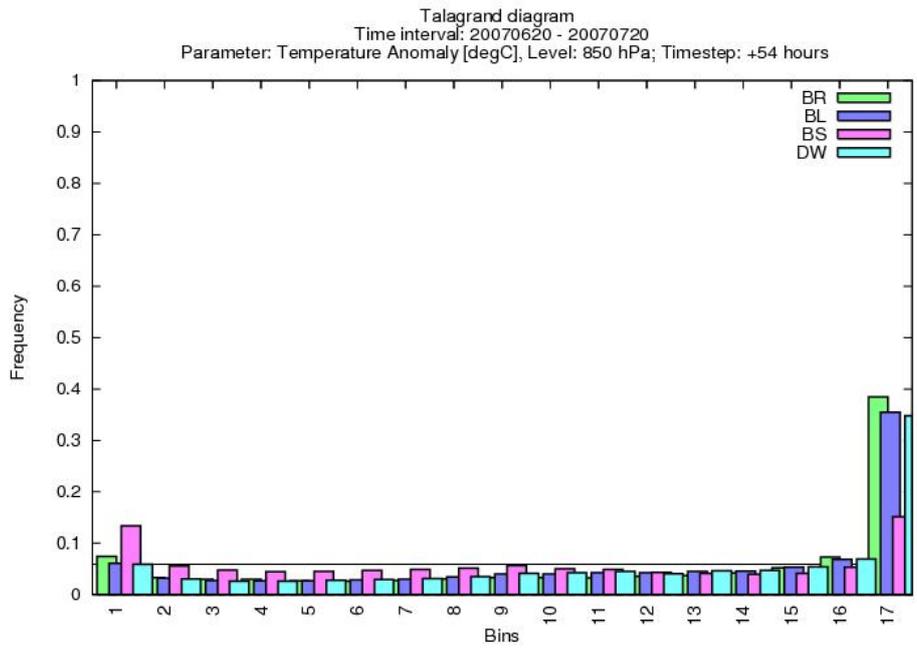
::Fig.18 CRP score for wind speed at 850 hPa



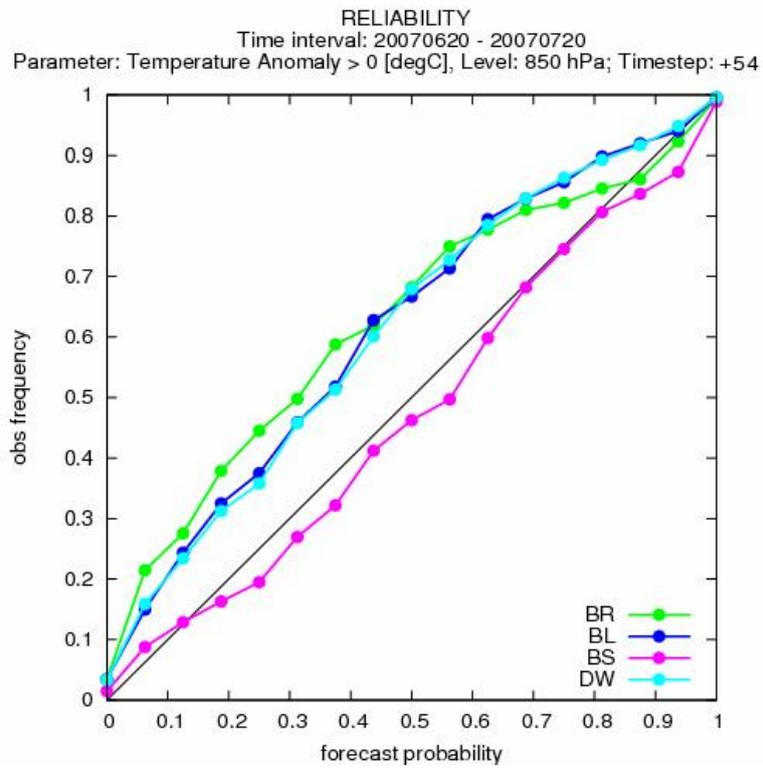
::Fig.19 RP skill score for temperature anomaly at 850 hPa



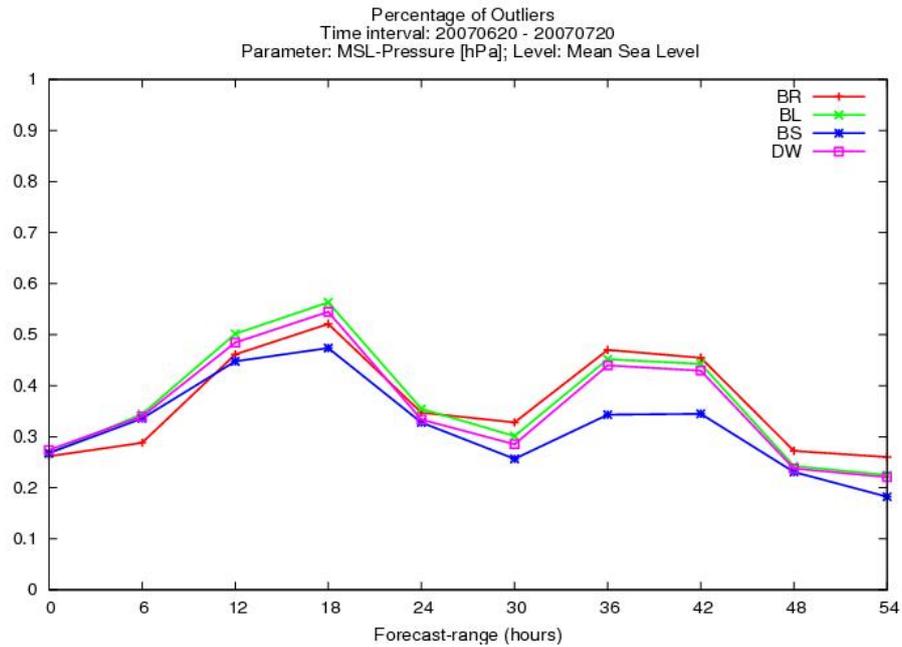
::Fig.20 RP skill score for relative humidity at 850 hPa



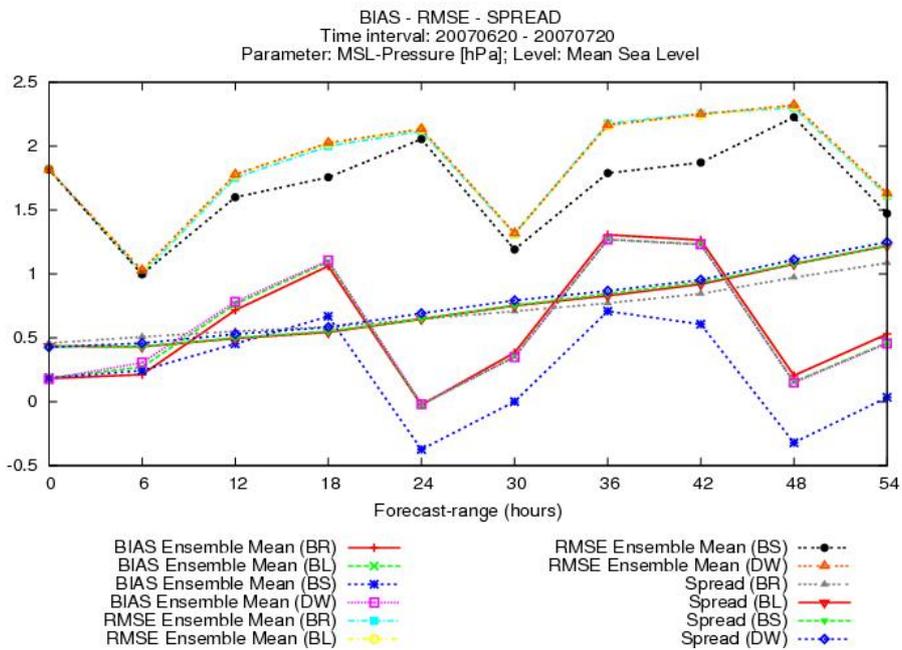
::Fig.21 Talagrand diagram for temperature anomaly at 850 hPa (+54h)



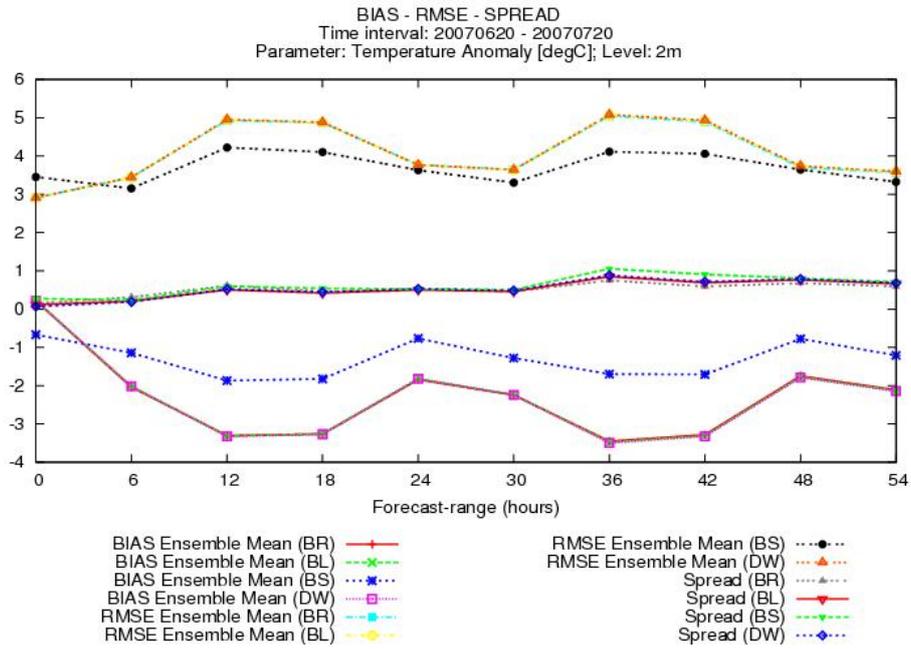
::Fig.22 Reliability for temperature anomaly >0 deg. at 850 hPa (+54h)



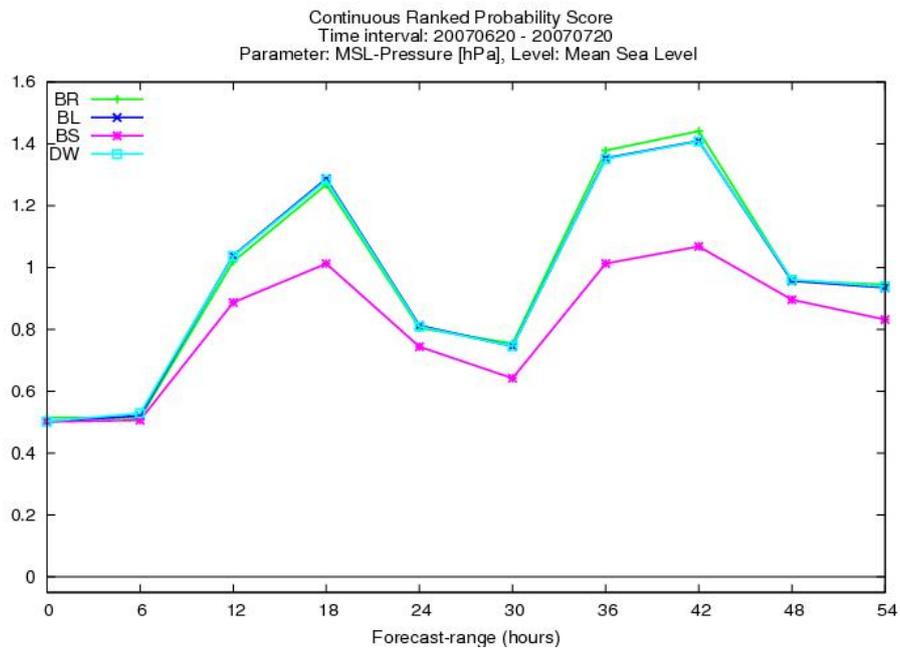
::Fig.23 Percentage of outliers for MSLP at mean sea level



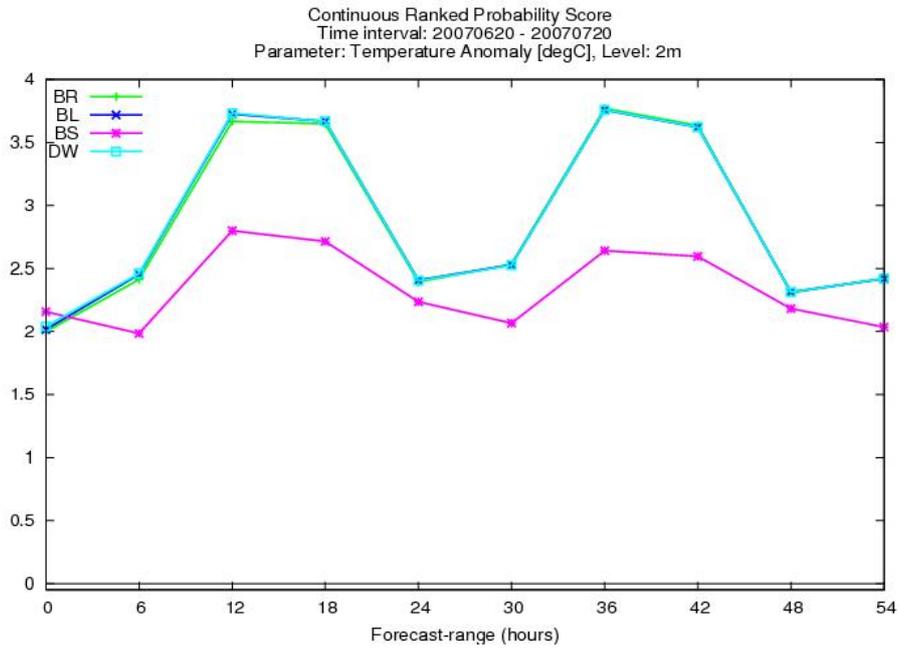
::Fig.24 BIAS, RMSE and SPREAD for MSLP at mean sea level



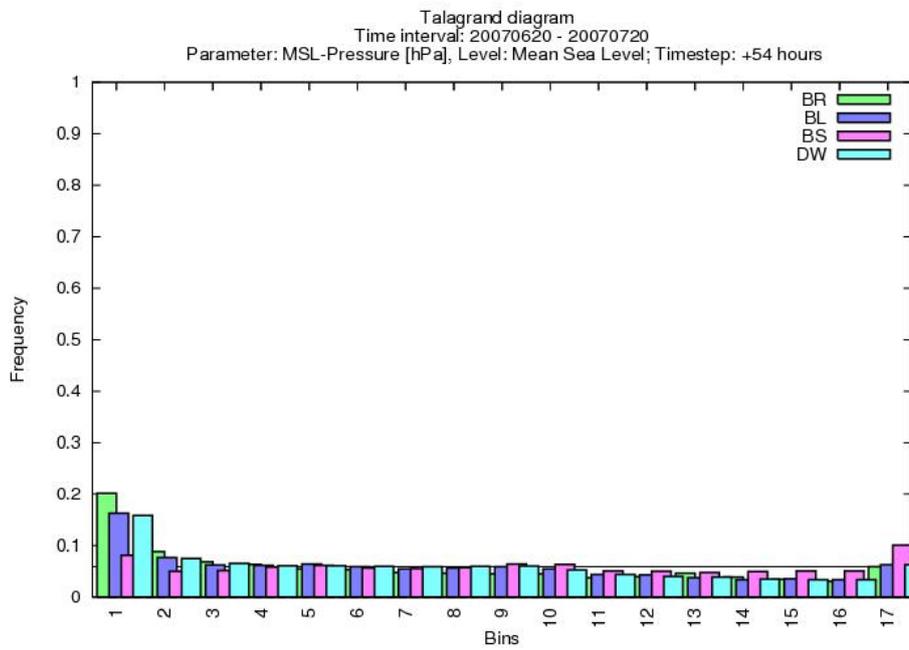
::Fig.25 BIAS, RMSE and SPREAD for temperature anomaly at 2m



::Fig.26 CRP score for MSLP at mean sea level



::Fig.27 CRP score for temperature anomaly at 2m



::Fig.28 Talagrand diagram for MSLP at mean sea level (+54h)

::IX Some useful information

Requirements of individual processes which are the basic bricks for all our experiments (full LAEF production line can be constructed from them) are summarized in the following table (**Tab.1**).

APP	NPROC	MEM	USER time	REAL time	SIZE/run
breed	8 CPUs	16 GB	13.5 x 8 => 2h	20m	370 MB
blend	4 CPUs	8 GB	5 x 16 => 1h30m	25m	280 MB
laeff	8 CPUs	25 GB	23.5 x 16 => 6h30m	1h10m	184x3 = 552 MB
surfp	1 CPU	10 GB	3.15 x 16 => 1h	55m	480 MB

::Tab.1 Individual application settings for NEC SX-8R

All created applications (bricks) and their location on frontend (under user *laef*):

BREED: <i>/home/laef/bellus/breed/bin</i>	<i>breed.pl</i> (Perl application)
	<i>nqs.scr</i> (*+) (NQS header for batch processing)
<i>/nam</i>	<i>morganePP.template</i> (morgane namelists)
BLEND: <i>/home/laef/bellus/blend/bin</i>	<i>blend.pl</i> (Perl application)
	<i>nqs.scr</i> (*+) (NQS header for batch processing)
<i>/nam</i>	<i>blend.template</i> (blending namelist)
	<i>lancelot.template</i> (change of spectral res.)
	<i>morganeDFI.template</i> (namelist for DFI)
SURFP: <i>/home/laef/bellus/surfp/bin</i>	<i>surfp.pl</i> (Perl application)
	<i>nqs.scr</i> (*+) (NQS header for batch processing)
<i>/nam</i>	<i>morganeMM.template</i> (morgane namelists)
	<i>blendsur_full.nml</i> (surface exchange nam)
	<i>e927_nam.template</i> (lancelot namelist)
LAEFF: <i>/home/laef/bellus/laeff/bin</i>	<i>laeff.pl</i> (Perl application)
	<i>nqs.scr</i> (*+) (NQS header for batch processing)
<i>/nam</i>	<i>morganeMM.template</i> (integration namelists)

(*) batch processing for one run of all members, where date is transferred via ENV variables dd (day), mm (month), yyyy (year) and HH (network 00, 12, ...) from the scripts for individual experiments
 (+) ENV variables CNF_INIT or CNF_FILE defines which initial conditions for the integration or which input files for given procedure will be used (can be either the breeding file or blending file or file with already exchanged surface fields or file from breeding-blending cycle or something else if specified in the application)

Prepared batch scripts (#) for running the individual experiments can be found here:

BRC: */home/laef/bellus/BRC/run.pl_template*
BRCBL: */home/laef/bellus/BRCBL/run.pl_template*
BRCBS: */home/laef/bellus/BRCBS/run.pl_template*
BRBCS: */home/laef/bellus/BRBCS/run.pl_template*

(#) Job ID is used to wait via `qwait` for the finish of previous application (return code is controlled). Subsequent job is submitted only if the former process finished successfully. The scripts to run the experiments should be launched from frontend via `nohup` (eventually the output can be redirected to some log file, e.g. `nohup ./run.pl > brbcs.log`).

All applications and scripts are deeply self documented.

The results (more than 130 GB) are stored in:

```

/data/laef/RESULT/mbell/  ble  (blending ICMSH files)
                          bre  (breeding ICMSH files)
                          bbc  (breeding-blending cycle ICMSH files)
                          bsr  (ICMSH files with perturbed surface)
                          bbs  (bbc ICMSH files with perturbed surface)
                          lae  (PF files for all LAEF experiments)

```

The convention for file names is as follows (ee): BR – cycled breeding, BL – blending applied on breeding file, BS – blending applied on breeding file with exchanged (perturbed) surface fields, BB – cycled breeding-blending, BX – cycled breeding-blending with exchanged (perturbed) surface fields. Thus, the fullpos files have the names like this: PFLAEFeemb+00rr (where mb=member, rr=range and ee=experiment).

Grib files for verification from all the experiments are stored on mounted storage (~40 GB):

```

/laef/inca/laef/laef_exp/yyyyymmddHH/      PFLAEFeemb+00rr.grb

```

File names' convention is the same as for fullpos files. And also DW grib files can be found there (which are from downscaling experiment), because this was used in the verification for a comparison.

The actual (20-03-2008 19:37) status of computations (for all the experiments):

BRCBL:	10-06-2007 00 UTC ~ 13-08-2007 00 UTC	(65/70 days)
BRCBS:	11-06-2007 00 UTC ~ 08-08-2008 00 UTC	(59/70 days)
BRC:	20-06-2007 00 UTC ~ 05-08-2007 00 UTC	(47/60 days)
BRBCS:	10-06-2007 12 UTC ~ 16-06-2007 00 UTC	(7/70 days)

::Conclusion

The blending results can be considered as satisfactory, since the blended initial states obviously inherited the large scale perturbations from ECMWF EPS members (which were not present in ALADIN breeding files), while the small scale perturbations generated by breeding cycle were still kept. It was shown, that the blending of global ensemble members with breeding initial conditions helped to improve the overall scores, even though they were only as good as for downscaling. Anyhow, the true benefit of blending procedure is, that such initial conditions suppose to be more compatible with the corresponding ECMWF EPS coupling files.

The results from our experiment BRCBS are quite improvement over the downscaling. But it is sure mainly due to the special surface perturbations based on ARPEGE analysis, rather than due to breeding and blending itself. However, this method of generating the surface

perturbations is very promising and should be included in the final operational implementation.

It is also possible, that used breeding scaling factor is not big enough (especially for temperature), so the spread from the beginning is not much larger then the global one. Hence, some experiments with changed scaling factor (for all or selected parameters) are proposed.

The experiment with breeding-blending cycling every 12h was fully prepared and already submitted (but up to now we have too few data to be used in verification). Its execution will be continued via remote access from home and afterwards confronted in the verification with the other experiments.

Finally, we propose to make new experiments with the breeding-blending cycle and surface perturbation along with the combination of different physical parameterizations used for individual processes (in the applications breed, surfp, laeff – various e001 namelists can be used for each pair/member). We hope, this could lead to a better ensemble spread.

*When we all give the power
We all give the best
Every minute of an hour
Don't think about the rest...
...LAEF is LAEF. J*

<Opus, 1984 >