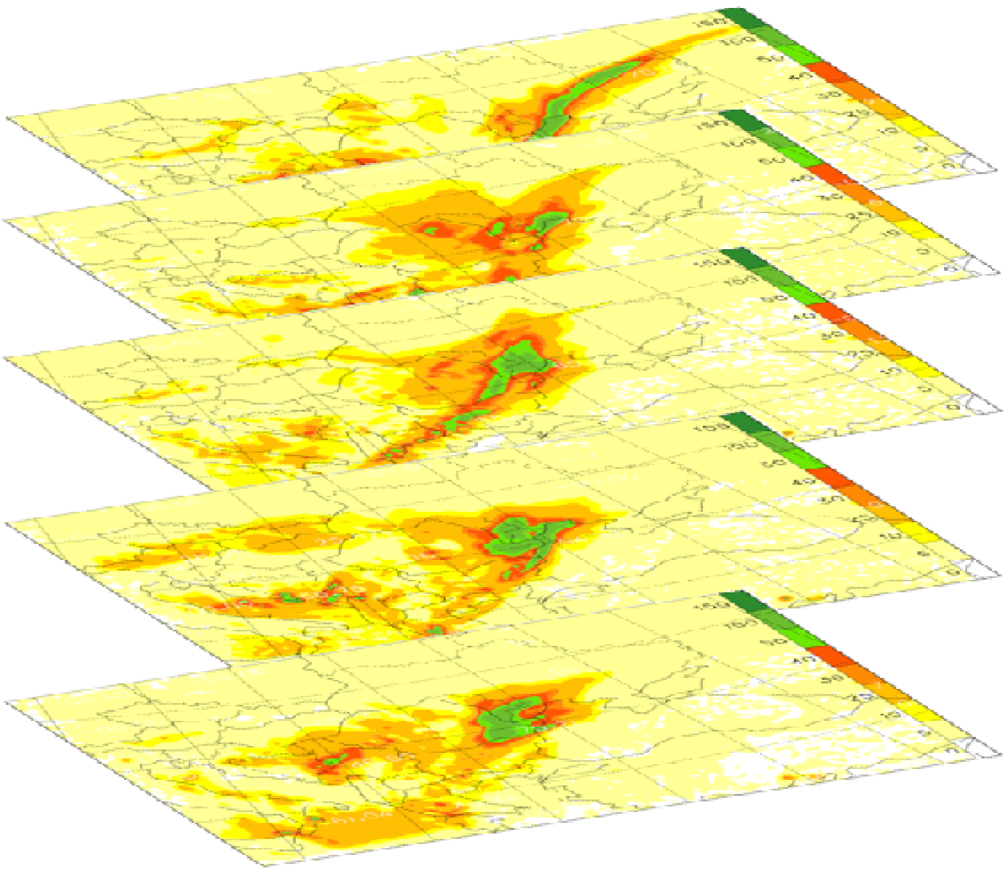
Report on stay at ZAMG

Vienna, Austria

01.10.2013 - 15.10. 2013

I. LAEF verification tool

II. Time-lagged ALARO ensemble versus LAEF ensemble



Supervised by:

Yong Wang (ZAMG)
Theresa Gorgas (ZAMG)

Author:

Simona Taşcu (NMA)

A forecast verification tool is very important in order to establish the quality of weather forecast systems (deterministic or probabilistic) over time, the final goal being to improve the forecasts in the future. The huge amount of data, from one or more ensemble systems, requires an appropiate, optimized and flexible verification tool which is essential to assess and manipulate these data.

This stay had two important parts: a technical one regarding the computation, in fortran, from daily ASCII files in order to average the scores over a specific period and an experimental one for the evaluation of the LAEF system performance from different points of view.

I. Technical part

The actual structure of the new verification package is presented in figure 1, where with red is the master script in shell, with blue are perl scripts, with black additional modules in perl and with magenta are fortran programs. Thanks to Martin Bellus, all shell scripts were adapted to perl programming language, except MasterVerification.job. This master script was kept and adapted for the new version, because shell language is more used in our community and can be accessed easily by other users.

In MasterVerification.job, the following steps, in order to run the verification package, are:

1. Verification type:
   - LEVEL=SURFA - for surface
     or
   - LEVEL=UPPER - for upper levels
2. Exported paths
   - export MainDir=$HOME/LAEF_VERIFICATION_EXPORT_2013_v1 - main verification directory
   - export BINDIR=${MainDir}/BIN - exe files
   - export SCRIPTS=${MainDir}/SCRIPTS - scripts
   - export PERLLIB=$PERLLIB:${SCRIPTS} - perl modules
   - export INCLDIR=${MainDir}/SRC - source files
   - export WorkDir=${MainDir}/TMP - working directory
   - export LogDir=${MainDir}/LOG - log directory
   - export ScoreDir=${MainDir}/DATA_OUT/Verif_Scores - output scores values
   - export PlotDir=${MainDir}/DATA_OUT/Verif_Plots - output plots
   - export DATA_IN=${MainDir}/DATA_IN - root path for input data
   - export ForecastDir=${DATA_IN}/GRIBS - eps forecasts
   - export DIRORO=${DATA_IN}/ORO_DIR - orography (if needed)
   - export RefForecastDir=${DATA_IN}/AUST - reference forecast (if needed)
   - export ClimAvgDir=${DATA_IN}/ERA40_NEW_RES - climate (00, 06, 12, 18 UTC)
   - export GNUPLOT=/home/util/gnuplot-4.6.0/bin/gnuplot - gnuplot path
   - export GNUPLOT=/usr/bin/convert - convert path

- export AnalDir=${DATA_IN}/OBS_LAEF - observations for surface
  or
- export ANA_TYPE=ECMWF - analyse type (for upper levels)
- export AnalDir=${DATA_IN}/ECMWF_ANA/ecmwf_ana_mod
  - analysis for upper levels

3. Debug Option
   - export DEBUG=1 (0 in order to delete temporary directory)
4. Set Verification Period and Ranges
   - export StartDate=20130423
   - export StartHour=12
   - export EndDate=20130623
   - export StartHour=12
   - export DataIntervals=24
   - export tsteps="000 006 012 018 024 030 036 042 048"
5. Parameters Abbrevations, Levels and Domain

   Surface:
   - export
     PARAMETER_ABBREV=" 'T2M' 'MSLP' 'U10M' 'V10M' 'RH2M' "
     or
   - export PARAMETER_ABBREV=" 'RR12' ", ($RR06$, $RR24$)
   - export levels="0001"
   - export xdim=1215 - number of stations
   - export ydim=1 - always for surface

   Upper levels:
   - export PARAMETER_ABBREV=" 'G' 'T' 'RH' 'U' 'V' "
   - export levels="0500 0850"
   - export xdim=206 - x-dimension
   - export ydim=164 - y-dimension
6. Experiments Settings
   - export exps="LAEF11km ALARO_LAGG" - experiment names
   - export neps="17 5" - number of EPS members for each experiment
   - export neps_ECONOMIC="16" - number of EPS for economic value >= 3
   - export blackmems=" 04 13 16 " - to remove specific members
     or
   - export blackmems=" " - if all members are used

7. Computation and plotting

   - export LPROC4GRIBS=".TRUE." - use gribs to compute the scores

     or

   - export LPROC4ASCII=".FALSE." - use ascii files to compute the scores

   - export LPLOTS=".TRUE." - make generic set of verification plots

All the necessary variables which are needed in fortran are in red. Blue color is chosen for directories which are created automatically by perl scripts, black for the existent directories in exported version and dark-cyan is chosen for all directories and variables where the user should create or change them. At the end of the master script, the perl script DoConfSettings.pl is called and it will call other perl scripts for computation and plotting. More details about perl scripts can be found in Martin Bellus's report from October - November 2013.

The input files, in order to run the verification package, are in grib data format (latitude-longitude projection). For each day and each forecast range, the scores are saved in specific ASCII files and kept in allocatable variables in order to compute the averaged scores over a specific period. The existence of these files and the new structure of the verification package, which is very flexible and easy to use, made possible to implement the computation of the averaged scores from daily ASCII files. The computation from ascii daily files is controlled by LPROC4ASCII variable.

When this variable is set to true, LPROC4GRIBS should be set to false. When LPROC4GRIBS is set to true, the Rd_GribsAllData.f90 subroutine is called and when LPROC4ASCII is set to true, the Calc_4DailyAscii.f90 (as shown in figure 1) is called. The other subroutines, which are not depending of Rd_GribsAllData.f90, are called in both cases.

More details about Rd_Gribs_API.f90 subroutine are presented in this report. If the corrections at surface stations are required (from Settings.pm perl module), the orography parameter is read only after the first member. In this way, the consistency between orography and eps gribs it is checked in order to avoid any misunderstanding.

In principle, the ALADIN grib files are written from South to North:

latlon: lat 38.625000 to 54.925000 by 0.100000 nxny 33784
long 2.825000 to 31.525000 by 0.140000, (206 x 164)

and ECMWF grib files are written from North to South:

latlon: lat 54.925000 to 38.625000 by 0.100000 nxny 33784
long 2.825000 to 31.525000 by 0.140000, (206 x 164)

Therefore, Rd_Gribs_API.f90 subroutine is able to read any kind of this type of grib files and it is not necessary anymore to invert the latitude.

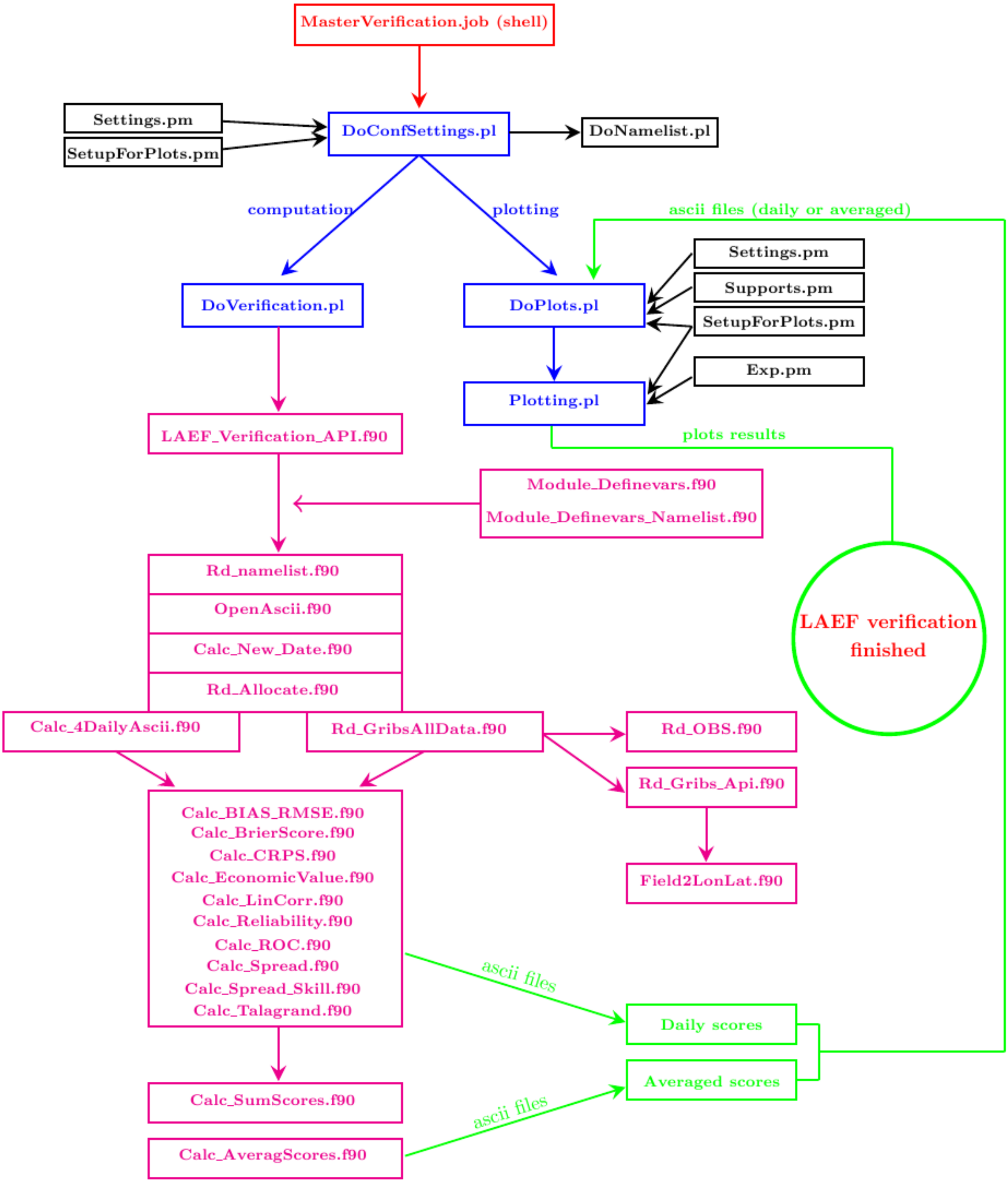


Figure 1: LAEF verification scheme

I. Experimental part

The experimental part of this stay is a continuation work of the previous one. Again, two approaches have been studied in order to assess the forecasts performance provided by the ensemble and deterministic weather systems. For the both experiments, the domain verification used for these experiments covers almost whole Europe: from 38.625 to 54.925 North latitude and from 2.285 to 31.525 East longitude.

A) Time-lagged ensemble versus ensemble with black listed members

In the previous experiments (previous stay at ZAMG), a time-lagged ensemble system using the ALARO - AUSTRIA forecasts (as shown in table 1) from different runs, but valid at the same forecast ranges, was generated and compared with the new LAEF system (aprox 11 km horizontal resolution).

12 UTC(one day before):														
	member 5 -	**00**	**06**	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**	**66**	**72**
18 UTC(current day):														
	member 4 -		**00**	**06**	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**	**66**
00 UTC(current day):														
	member 3 -			**00**	**06**	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**
06 UTC(current day):														
	member 2 -				**00**	**06**	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**54**
12 UTC(current day):														
	member 1 -					**00**	**06**	**12**	**18**	**24**	**30**	**36**	**42**	**48**

Table 1: time-lagged ALARO-AUSTRIA ensemble

For the actual experiments, taking in account the results obtained by Martin Bellus in his stay at ZAMG (between 13 May - 21 June 2013), some members (4, 13, 16) which showed less performance were eliminated from the computation. This approach is addressed by comparing time-lagged ensemble (labelled with *ALARO_LAGG*), new LAEF system (labelled with *LAEF11km*) and blacklisted new ensemble LAEF (labelled with *LAEF11km-04-13-16*). *ALARO_LAGG* is the time-lagged ensemble constructed using the 5 most recent forecast, *LAEF11km* is the ensemble constructed using 16 LAEF ensemble members and the control forecast and *LAEF11km-04-13-16* by removing members 04, 13, 16 from *LAEF11km*.The performance of the previous ensembles has been assessed for surface and upper altitude parameters. For surface, 1219 synop stations are used for validation and for upper altitude ECMWF analysis is used. For all, the input grib data are defined on a 0.1 x 0.14 latitude - longitude grid, summarizing (206 x 164 grid points). The ALADIN-AUSTRIA model was used as a reference for skill scores.

The performance of the three ensembles has been assessed by different deterministic and probabilistic scores for surface and upper altitude over a period of two months, from 23 April to 23 June 2013. For surface, figures 2, 3, 4, 5 and 6 show the performance of *LAEF11km* with small differences for temperature and relative humidity at 2 m (worse scores for *LAEF11km-04-13-16*). For 500 hPa level (figures 7-11), the results indicate better performance, in general, for *ALARO_LAGGED*. The comparasion between *LAEF11km* and *LAEF11km-04-13-16* shows, in this case too, a small difference for temperature and relative humidity at 500 hPa, with a better performance for *LAEF11km-04-13-16* The results for 850 hPa level (figures 12 - 16) show the same performance as for surface parameters.

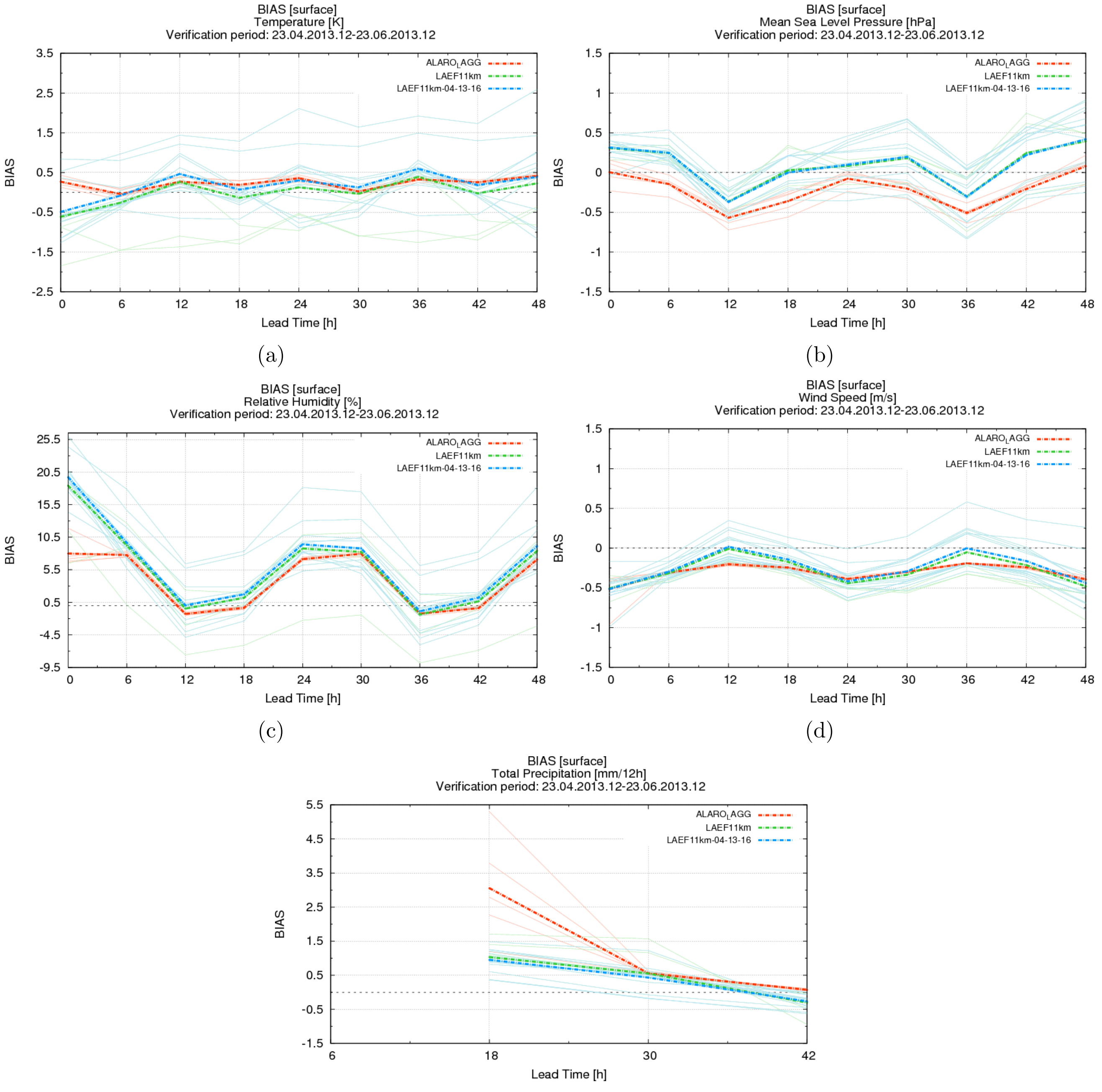
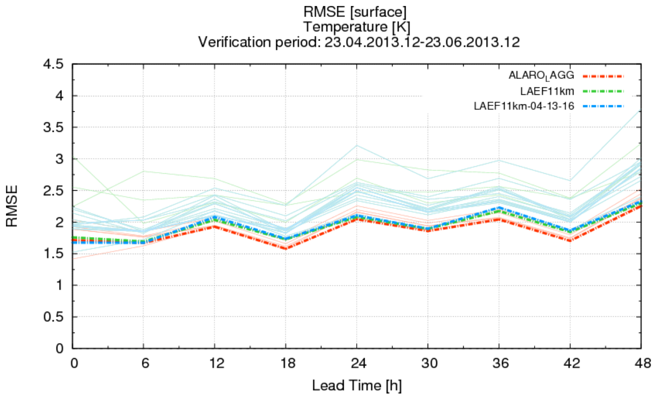
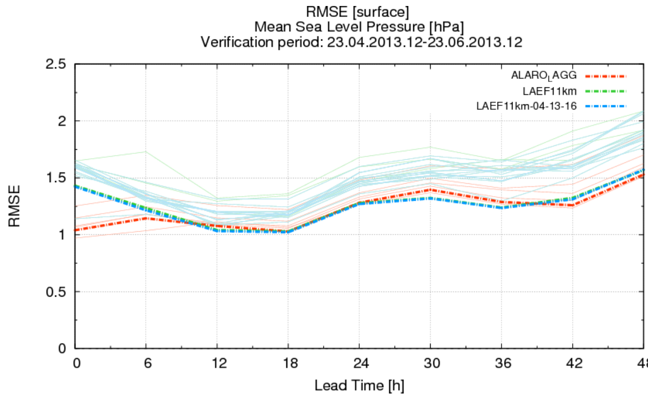


Figure 2: BIAS of ensemble mean: T2M (a), MSLP (b), RH2M (c), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).



(a)



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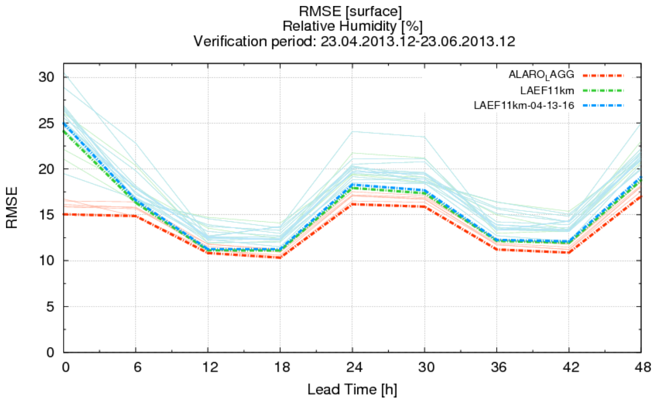

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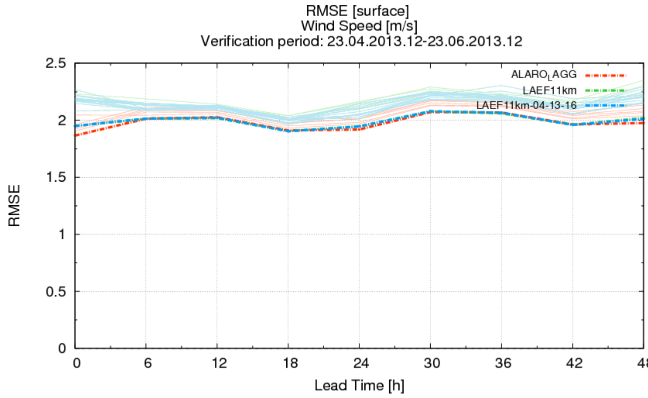

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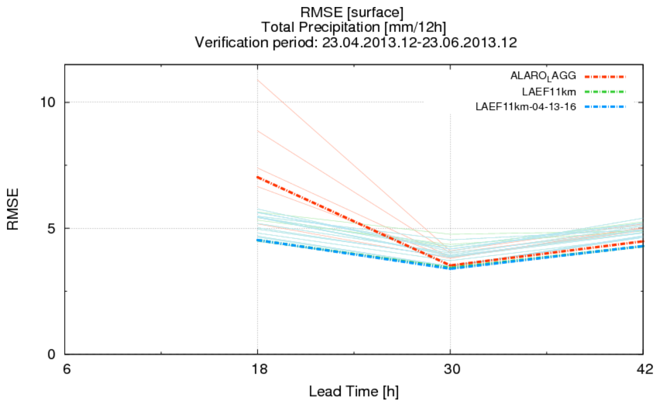
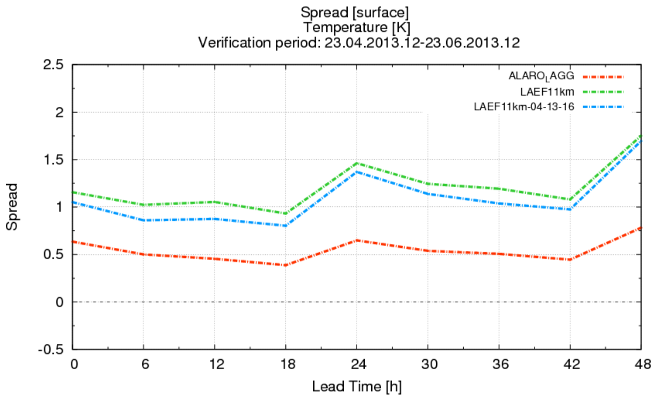
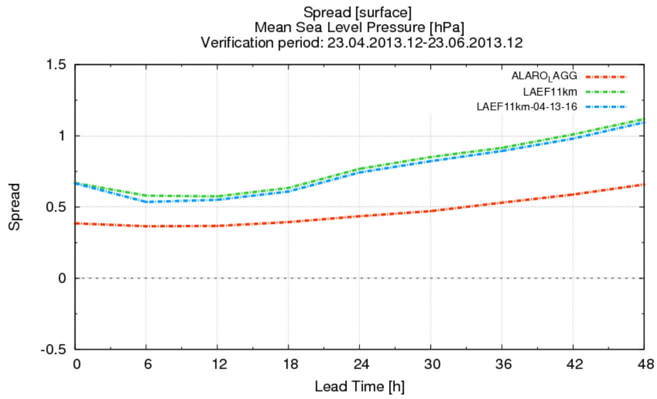


(e)

Figure 3: RMSE of ensemble mean: T2M (a), MSLP (b), RH2M (c), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).



(a)



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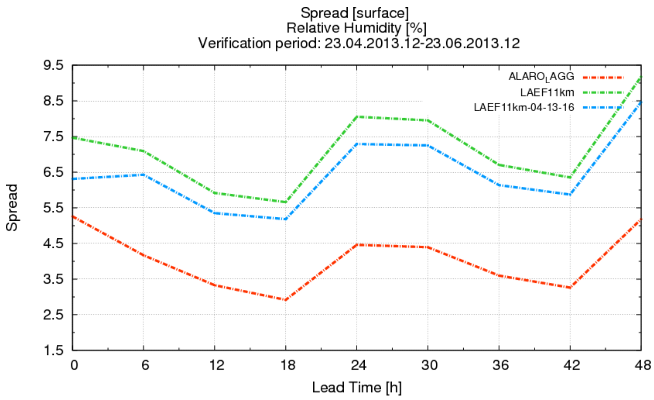

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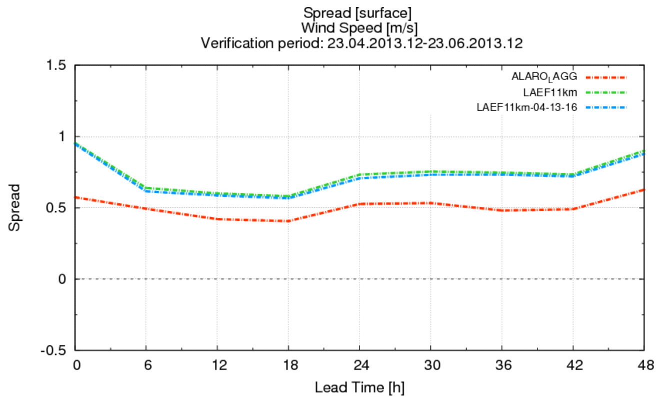

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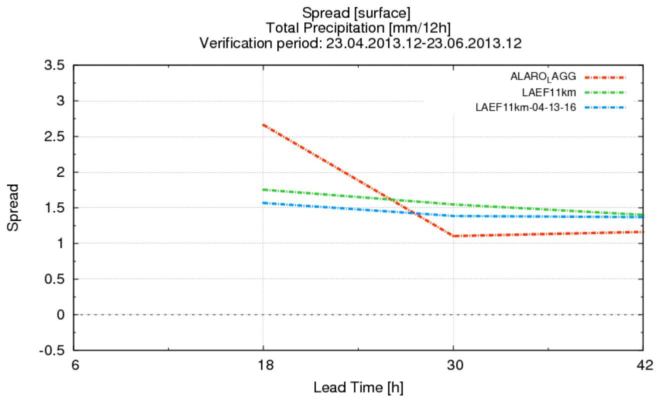


(e)

Figure 4: SPREAD of ensemble mean: T2M (a), MSLP (b), RH2M (c), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

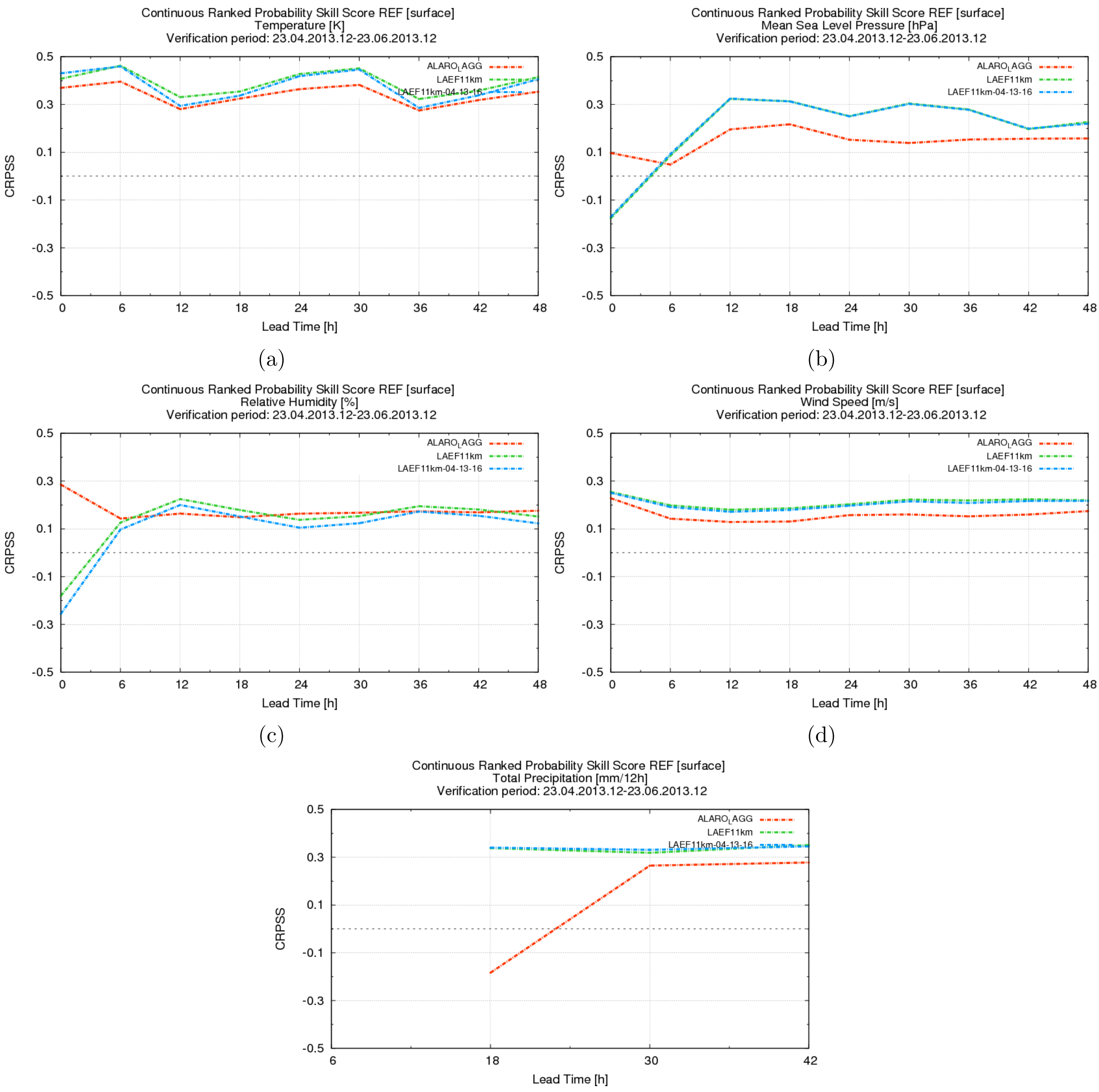
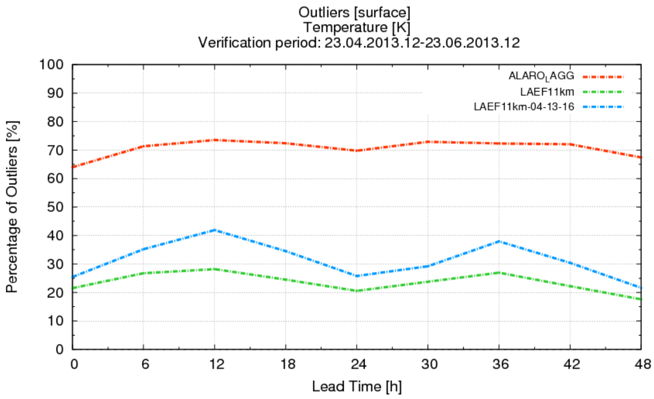
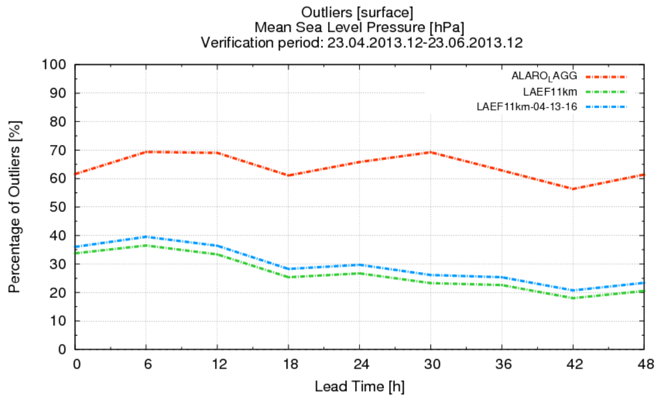


Figure 5: CRPSS: T2M (a), MSLP (b), RH2M (c), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).



(a)



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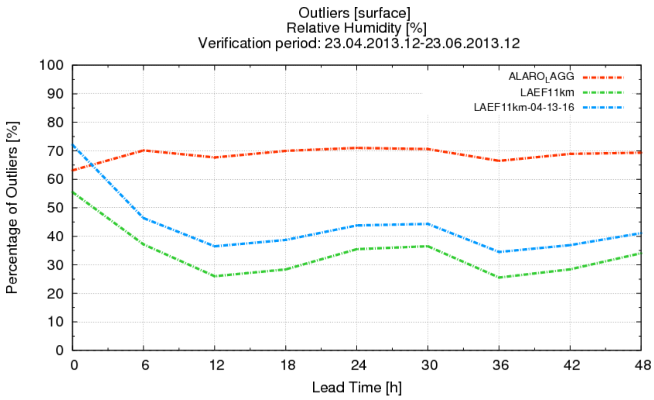
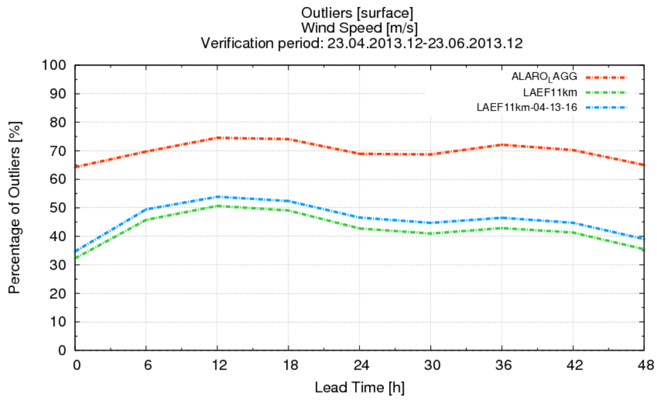


(c)



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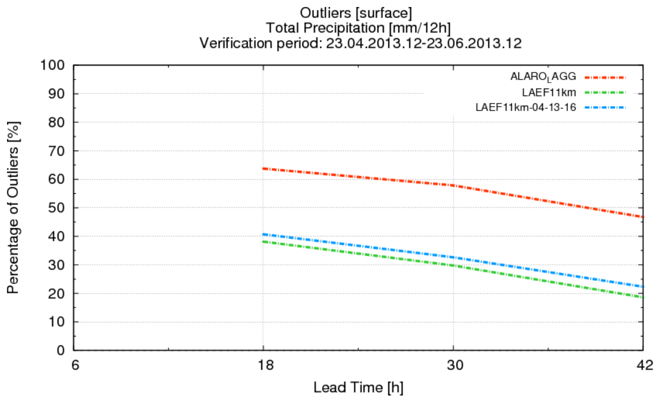


(e)

Figure 6: Percentage of Outliers: T2M (a), MSLP (b), RH2M (c), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

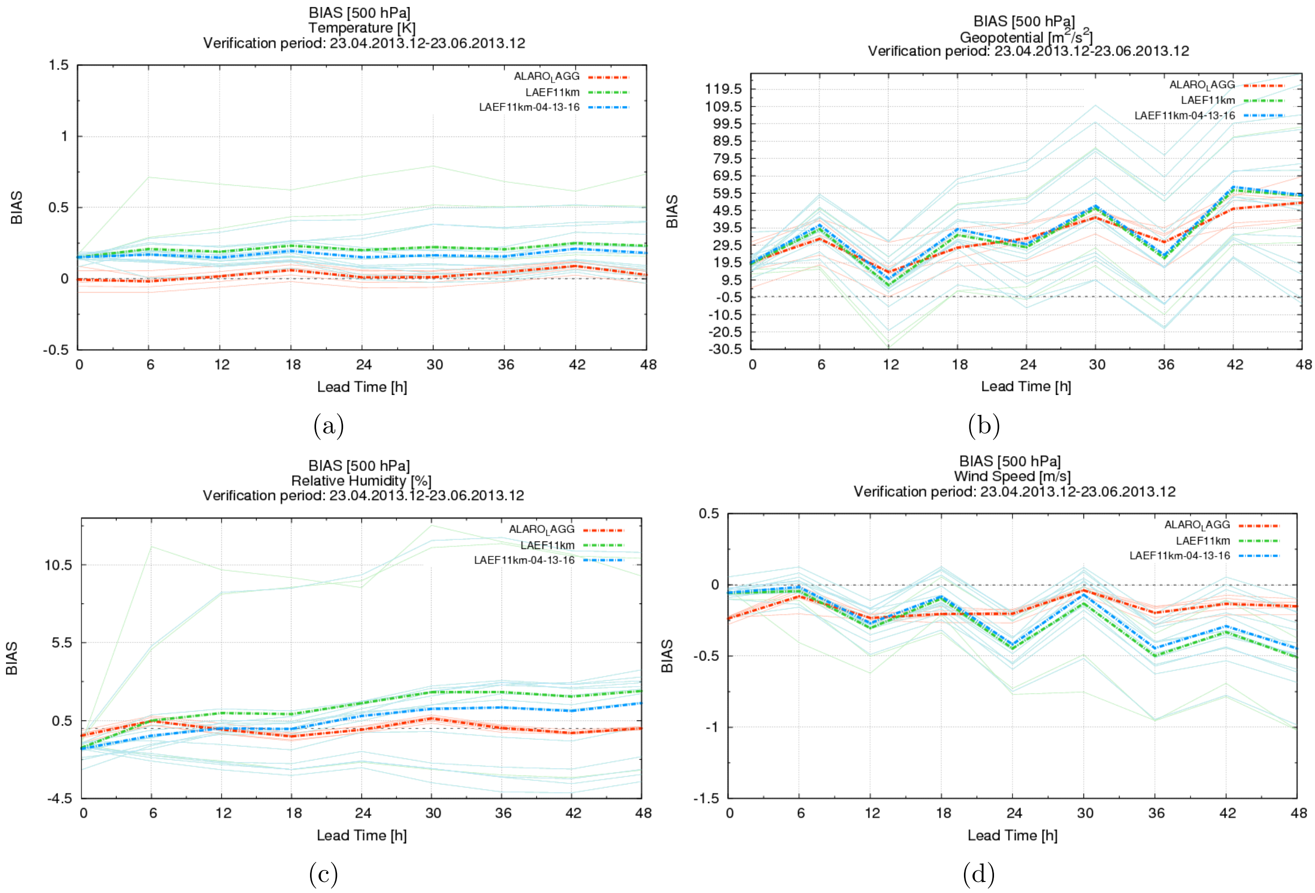


Figure 7: BIAS of ensemble mean: T (a), G (b), RH (c), WS (d) at 500 hPa for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

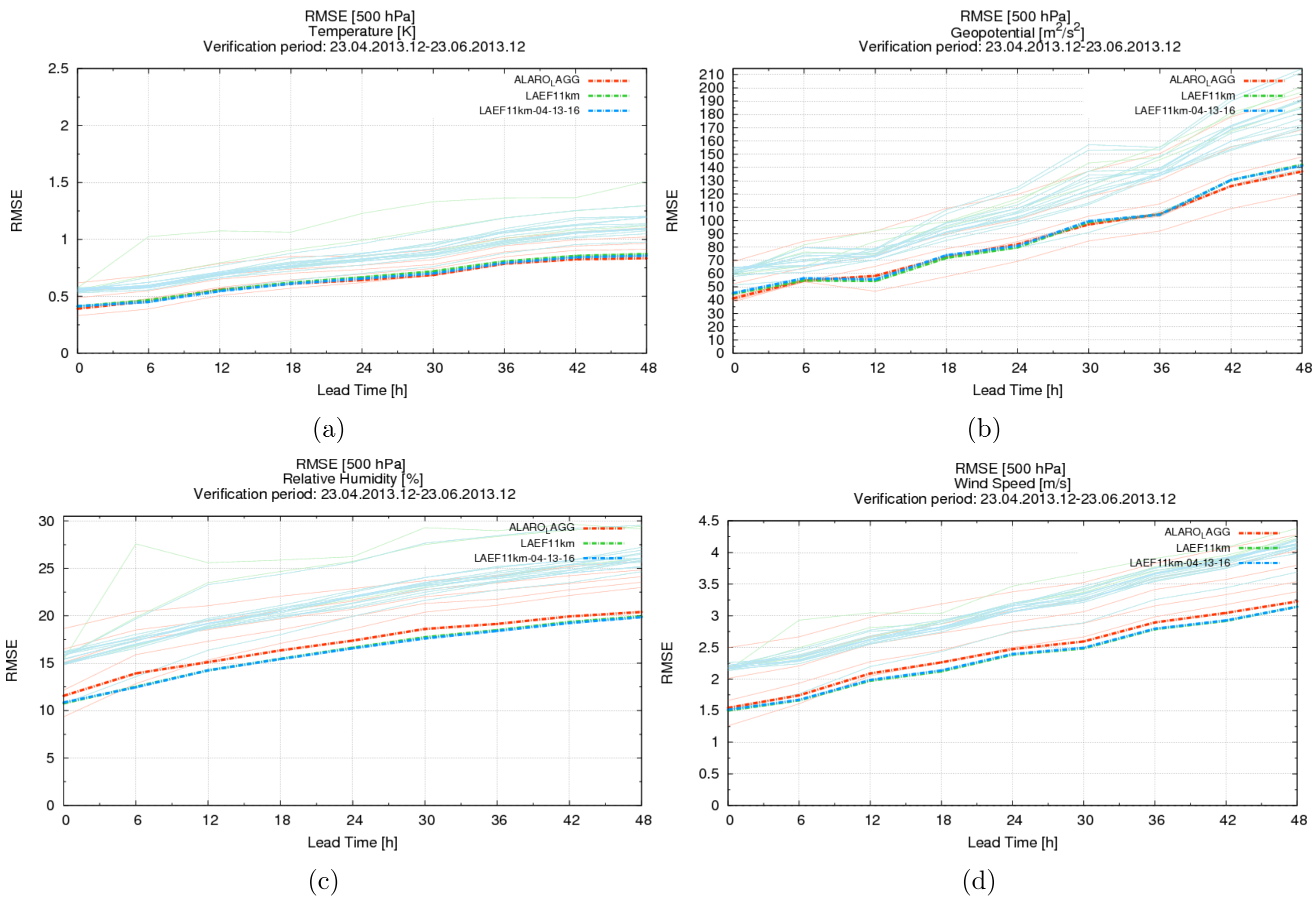


Figure 8: RMSE of ensemble mean: T (a), G (b), RH (c), WS (d) at 500 hPa for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

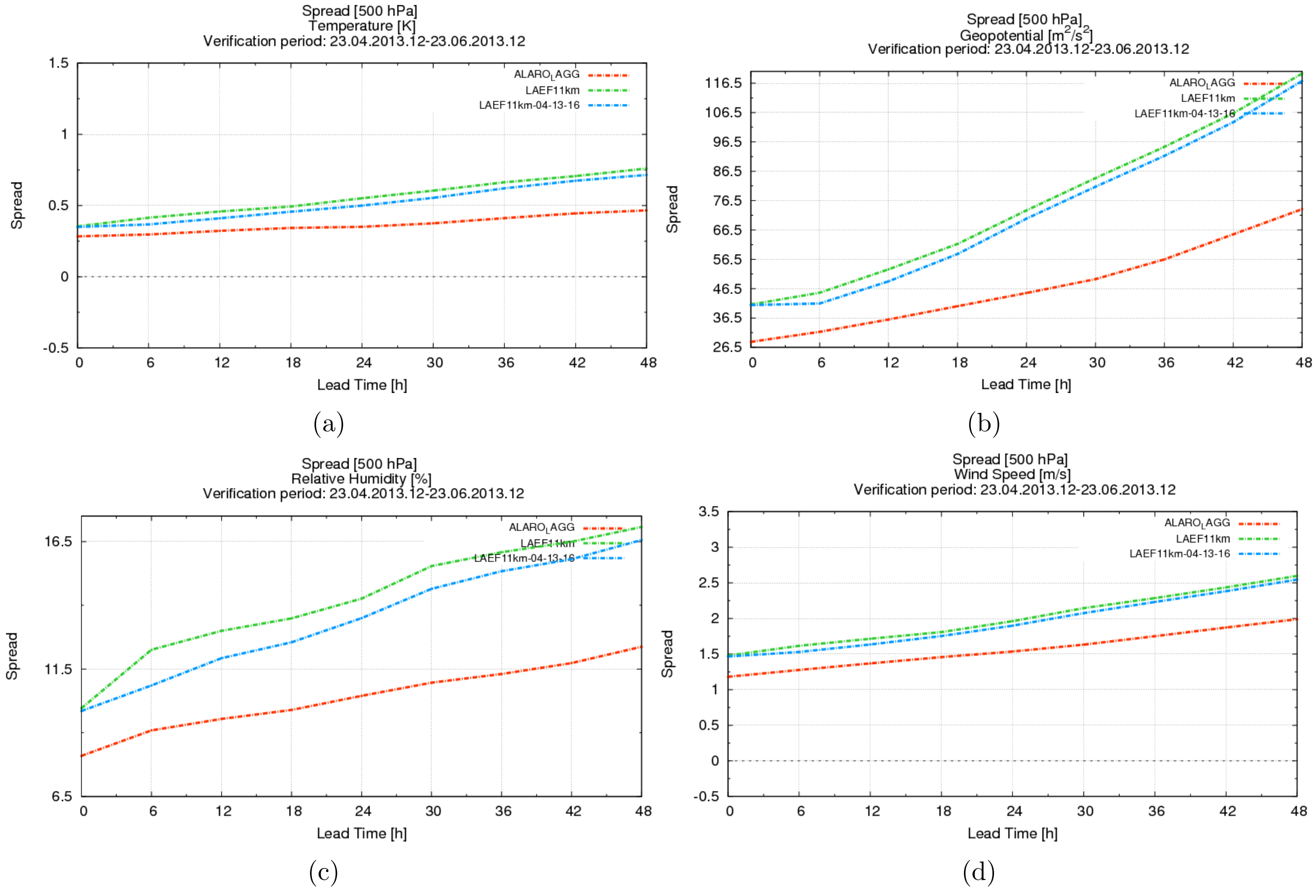


Figure 9: SPREAD of ensemble mean: T (a), G (b), RH (c), WS (d) for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

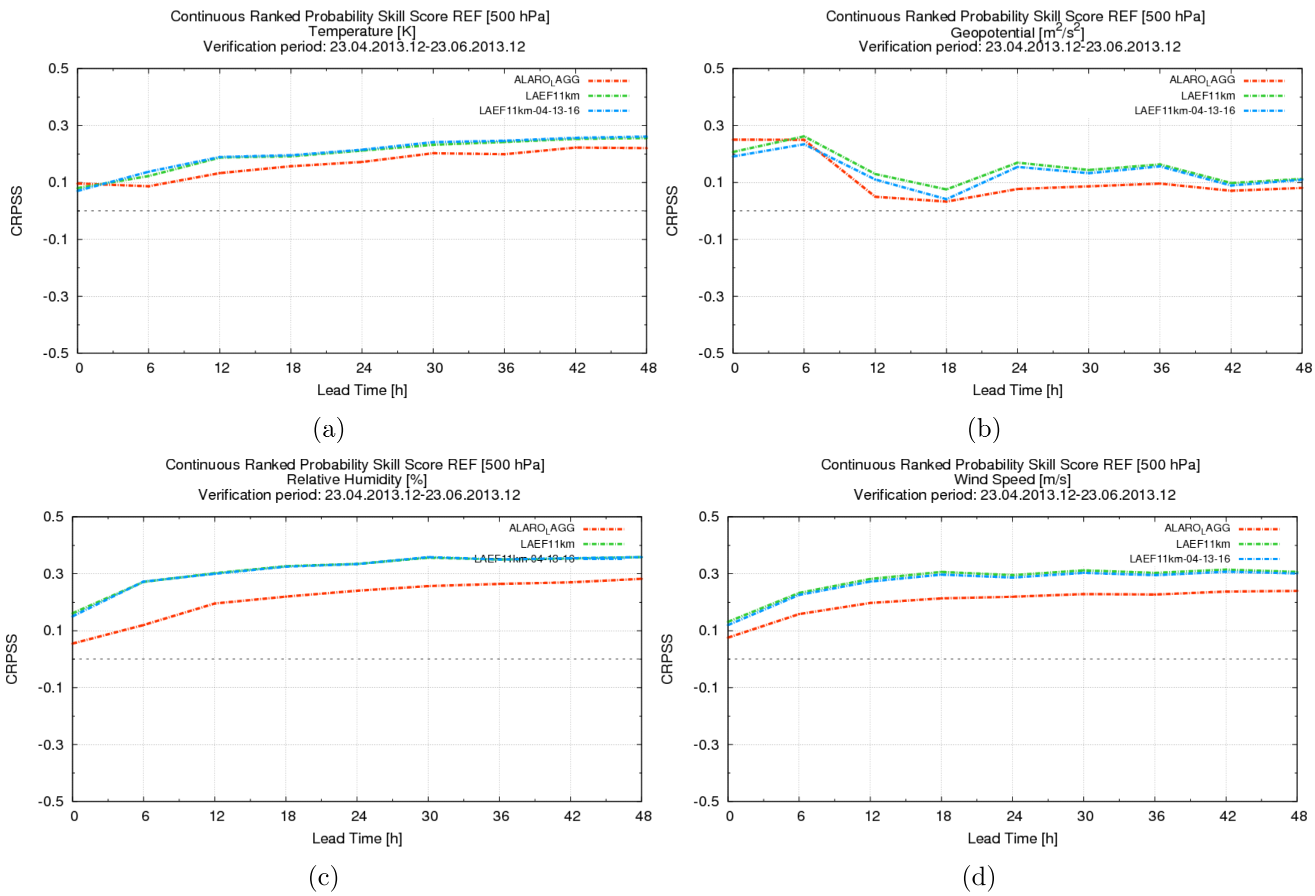


Figure 10: CRPSS: T (a), G (b), RH (c), WS (d) at 500 hPa for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

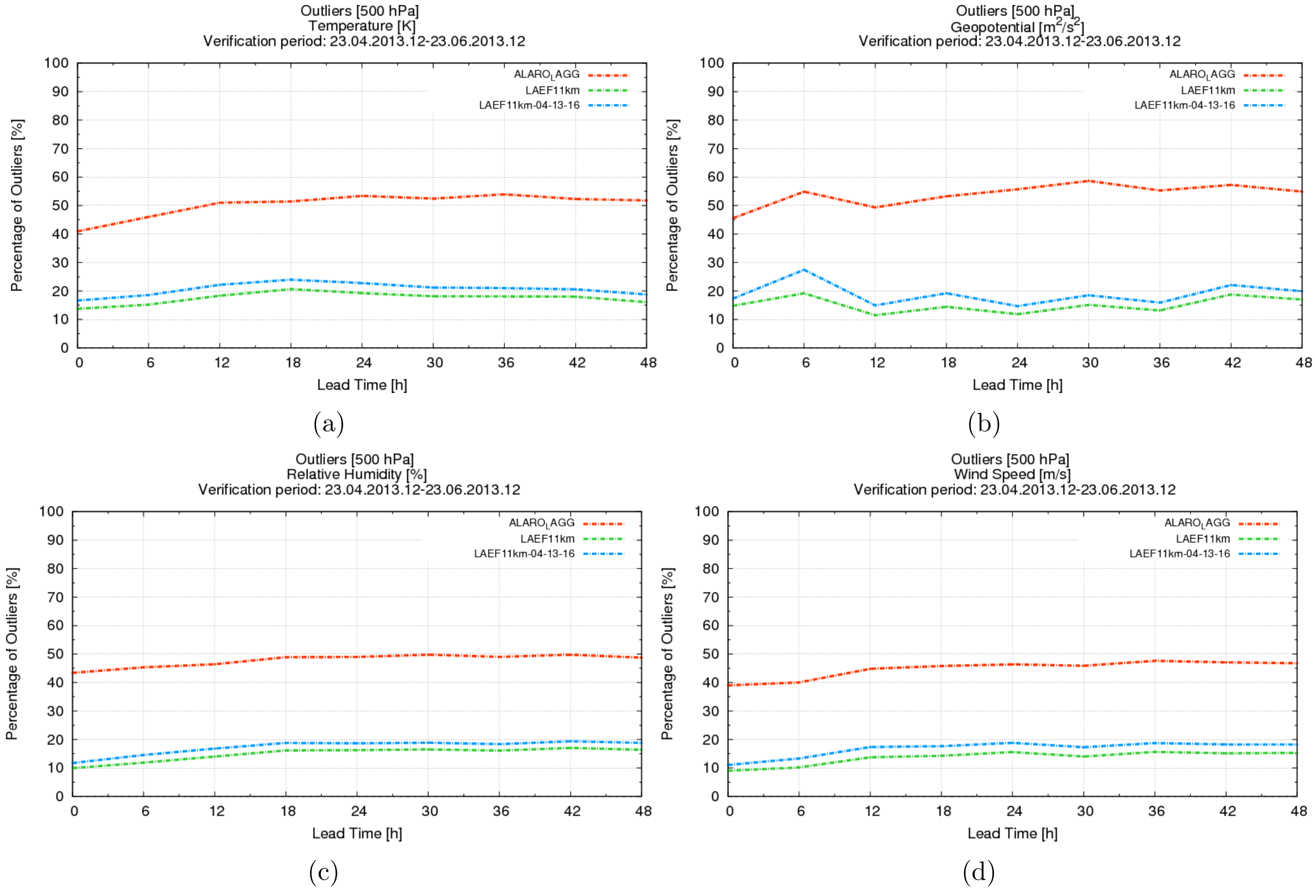


Figure 11: Percentage of Outliers: T (a), G (b), RH (c), WS (d) at 500 hPa for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

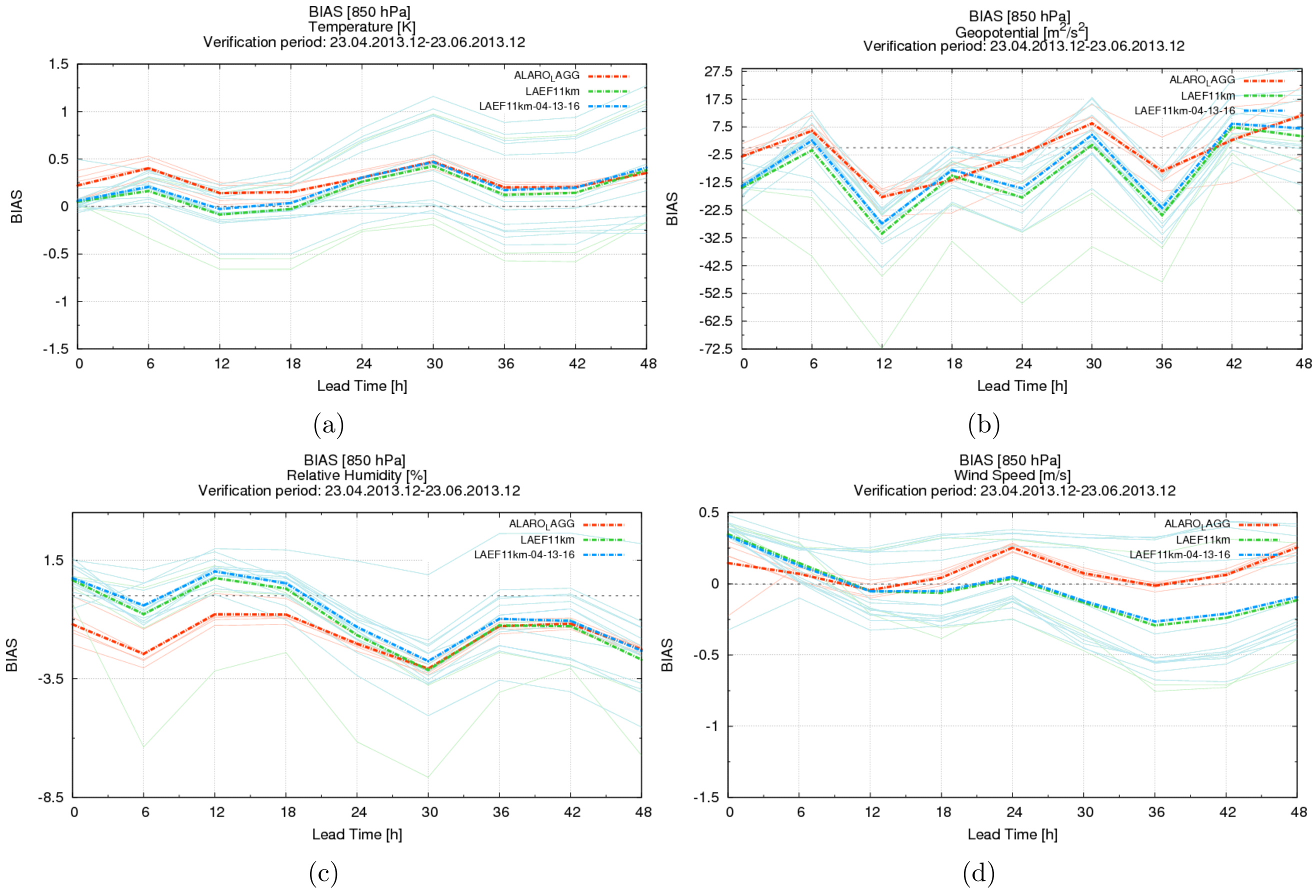


Figure 12: BIAS of ensemble mean: T (a), G (b), RH (c), WS (d) at 850 hPa for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

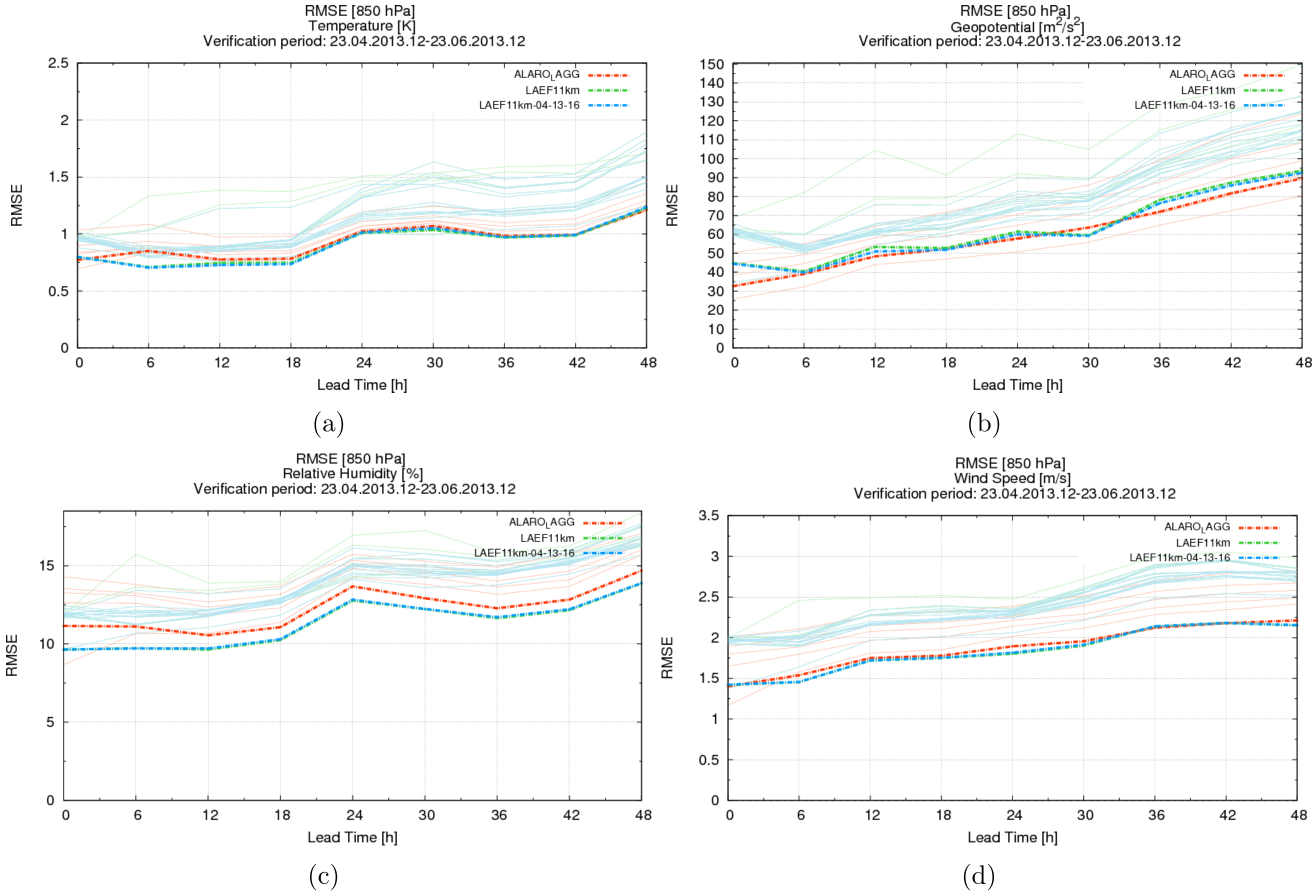


Figure 13: RMSE of ensemble mean: T (a), G (b), RH (c), WS (d) at 850 hPa for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

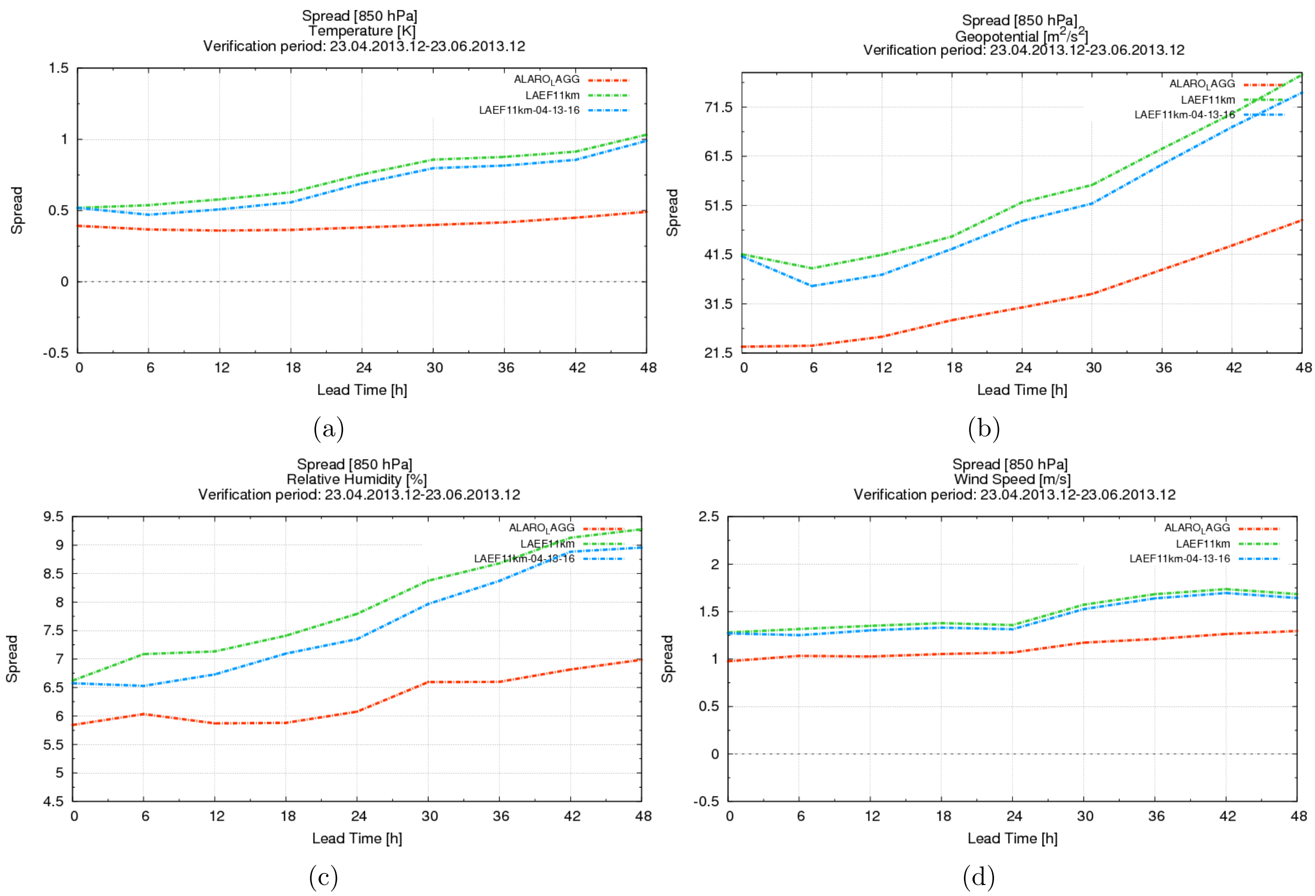


Figure 14: SPREAD of ensemble mean: T (a), G (b), RH (c), WS (d) at 850 hPa for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

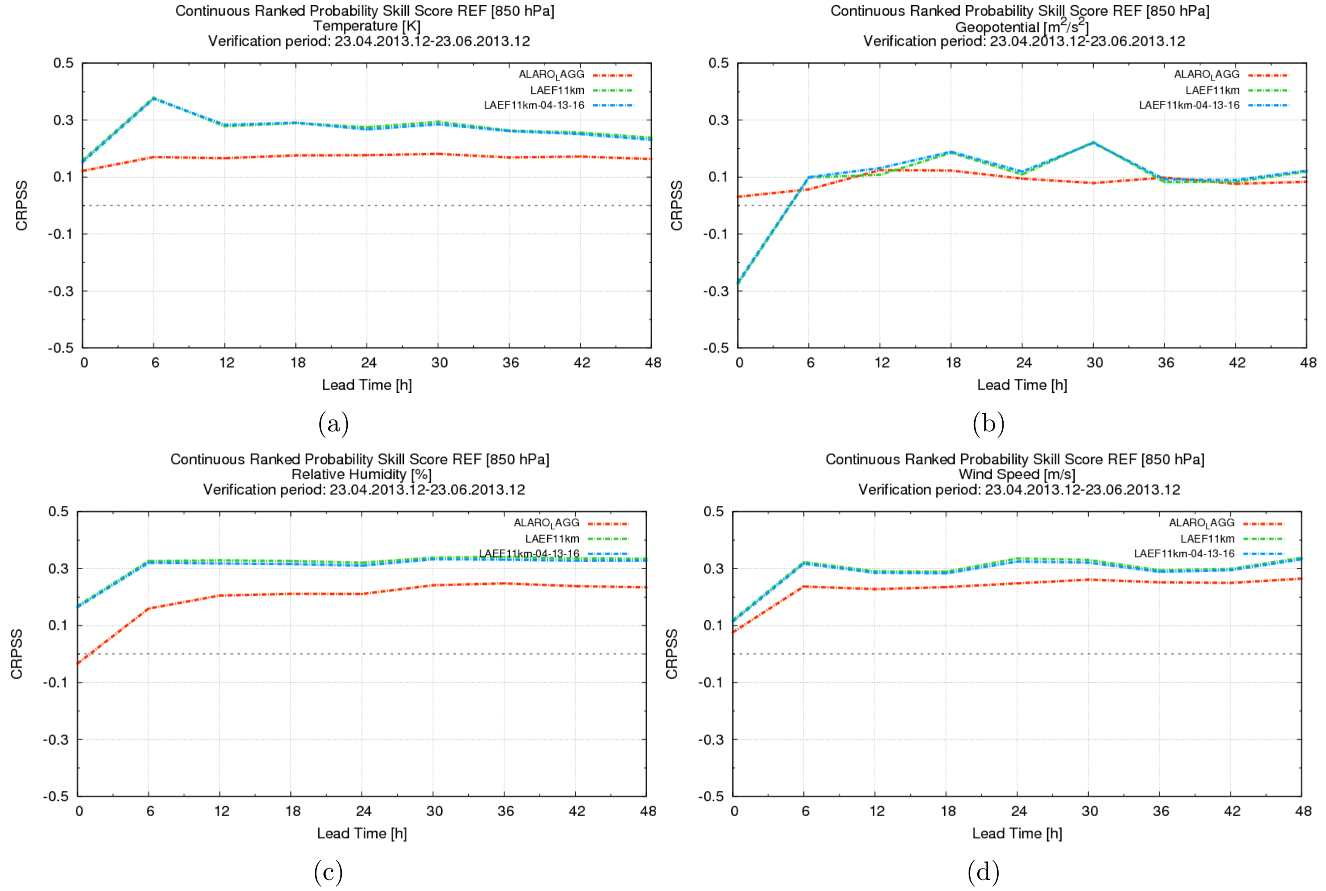


Figure 15: CRPSS: T (a), G (b), RH (c), WS (d) at 850 hPa for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

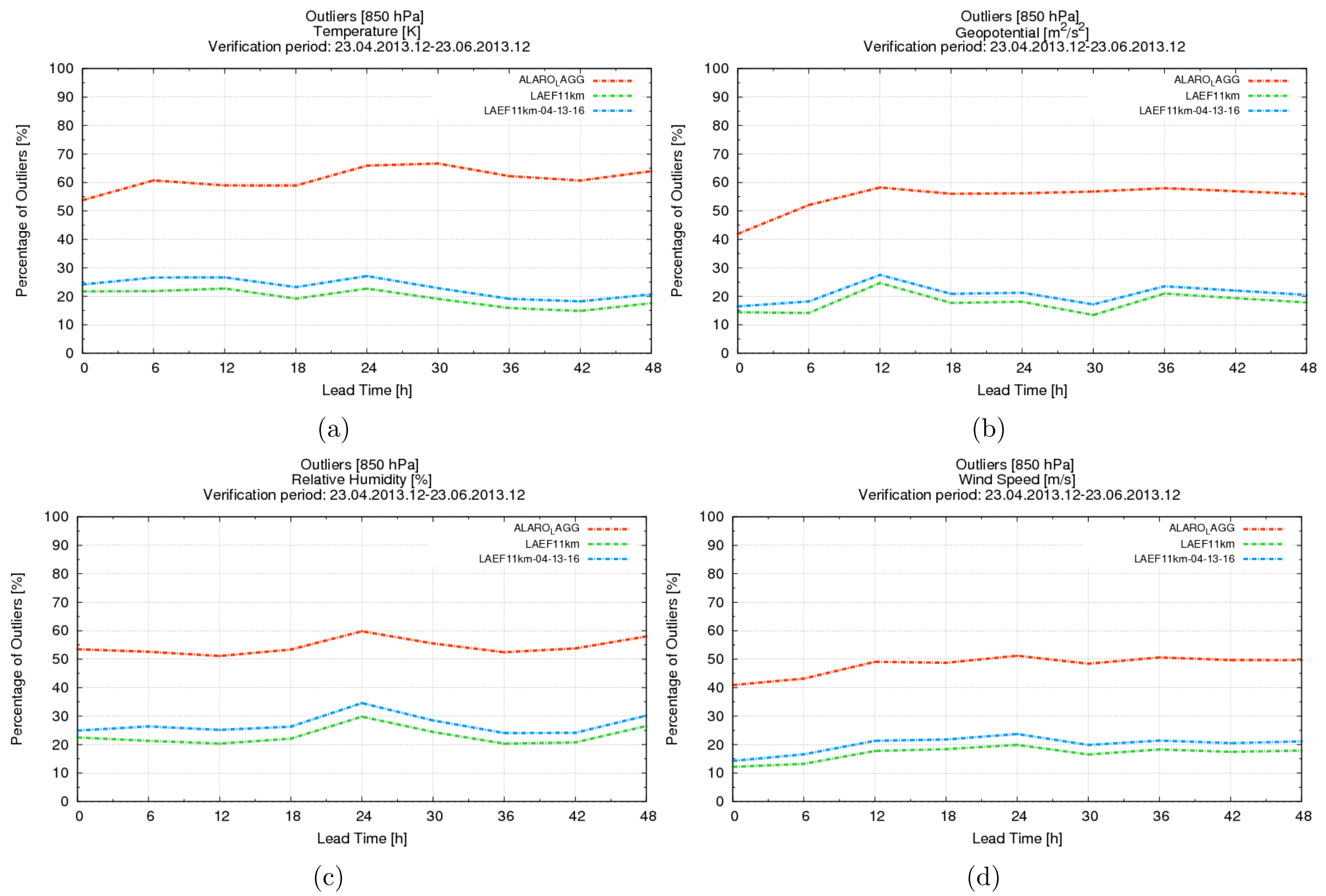


Figure 16: Percentage of Outliers: T (a), G (b), RH (c), WS (d) at 850 hPa for ALARO_LAGG (red), LAEF11km (green) and LAEF11km-04-13-15 (blue).

B) Deterministic model versus ensemble system deterministic solutions (mean, median)

The same deterministic verification was performed the same like in the previous stay at ZAMG. The mean and the median of the new LAEF system (16 members + 1 control forecast) are treated as solution of a deterministic model. The mean and the median were computed for two different emsembles: *LAEF11km-04-13-16* and *LAEF11km-13-15-16*. These ensembles are generated after the members contained in the name of the ensemble are removed from the *original* LAEF system at 11km horizontal resolution. The obtained scores (Hit Rate, False Rate Alarme, Equitable Threat Score, Accuracy score, Hanssen and Kuipers discriminant, Threat Score and Correlation Coeficient) were computed for T2M, W10M and 12 hours cumulated precipitation, for 23 April - 23 June 2013. In the next figures, from 16 - 26, the deterministic model ALARO-AUSTRIA is labelled with AUSTRIA, the mean of *LAEF11km-04-13-16* is labelled with *LAEFmean-04-13-16*, the median of *LAEF11km-04-13-16* is labelled with *LAEFmedian-04-13-16*, the mean of *LAEF11km-13-15-16* is labelled with *LAEFmean-13-15-16*, the median of *LAEF11km-13-15-16* is labelled with *LAEFmedian-04-13-16*. The results show only small differences.

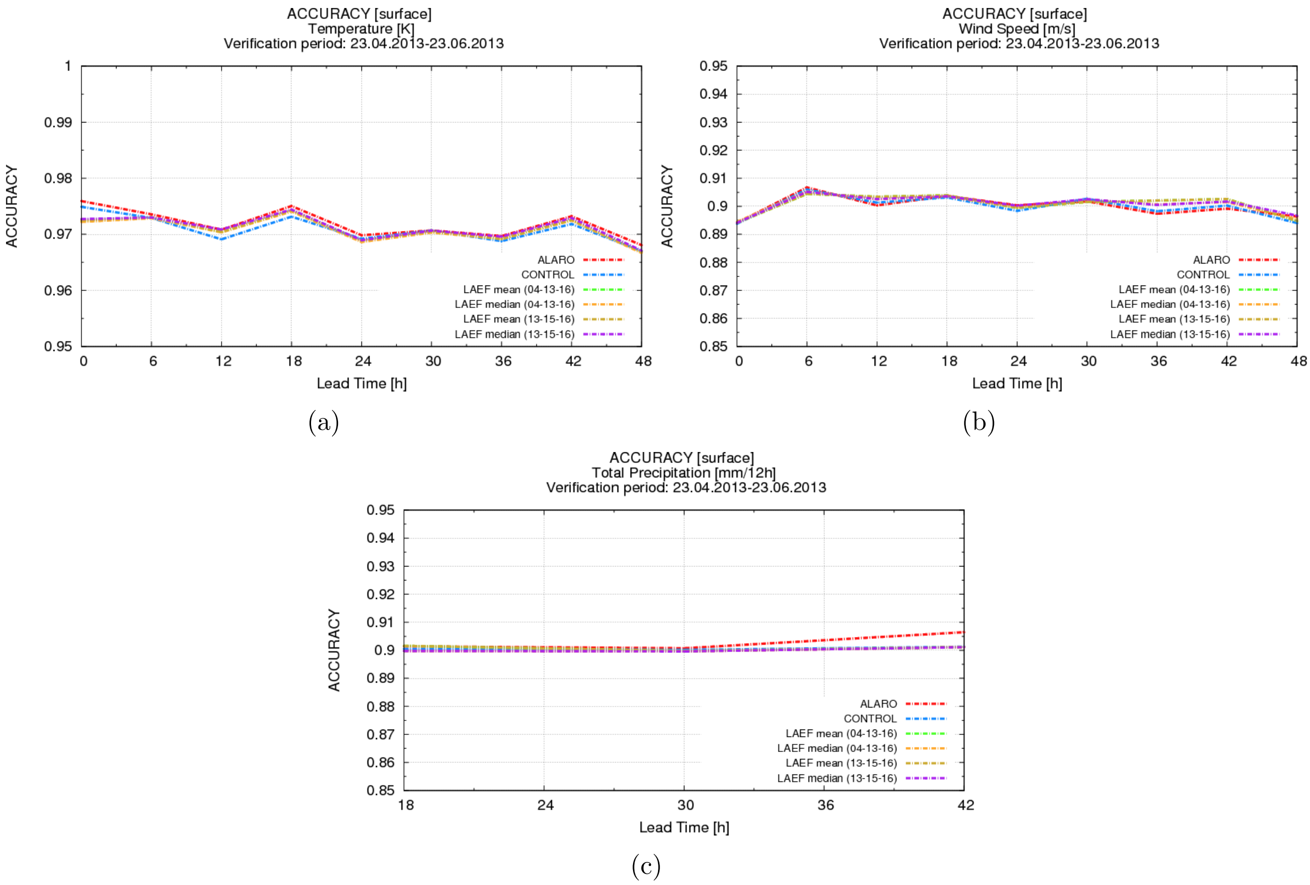


Figure 17: Accuracy: T2M (a), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), Control forecast (blue) LAEF mean-04-13-16 (green), LAEF median-04-13-16 (orange), LAEF mean-13-15-16 (brown) and LAEF median-13-15-16 (magenta).

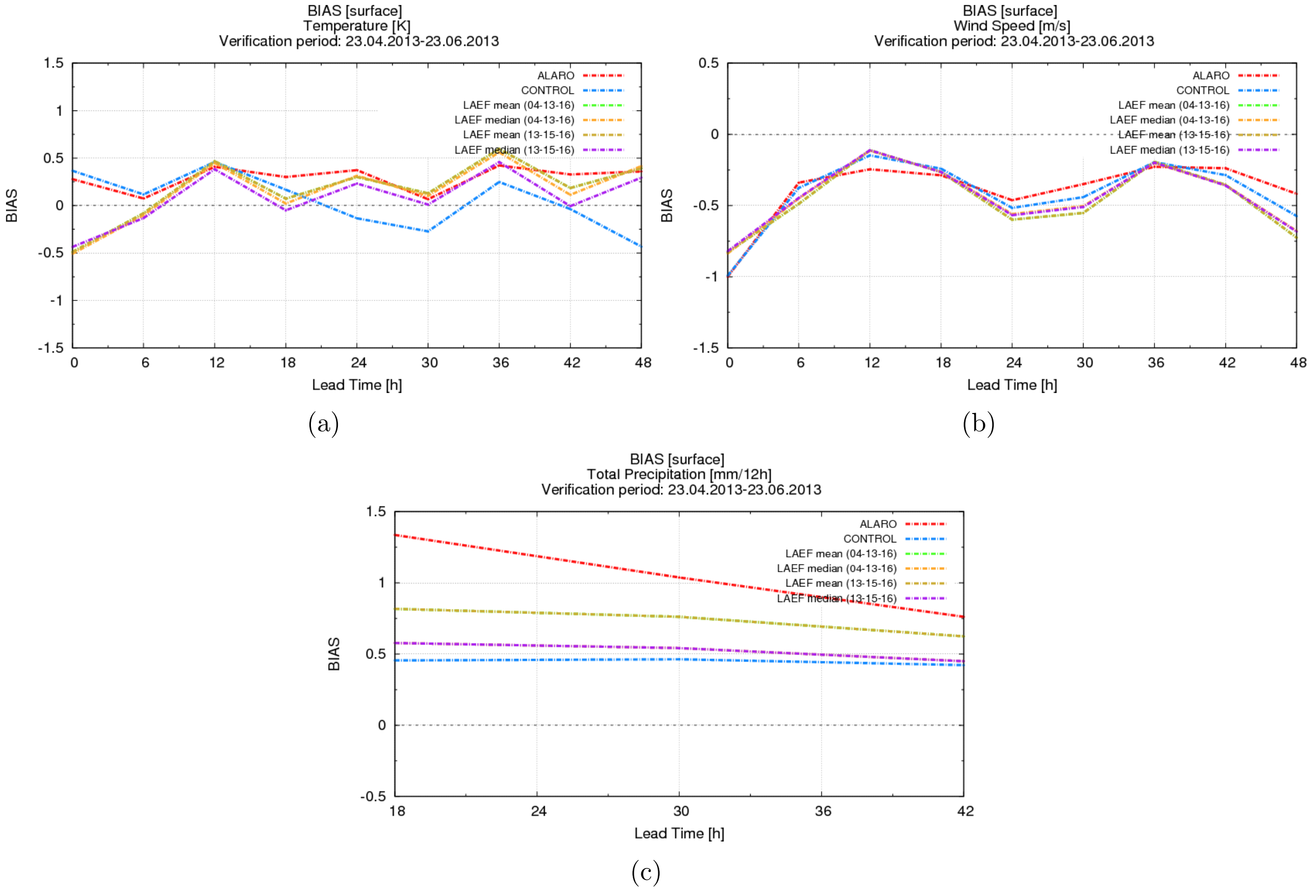


Figure 18: BIAS: T2M (a), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), Control forecast (blue) LAEF mean-04-13-16 (green), LAEF median-04-13-16 (orange), LAEF mean-13-15-16 (brown) and LAEF median-13-15-16 (magenta).

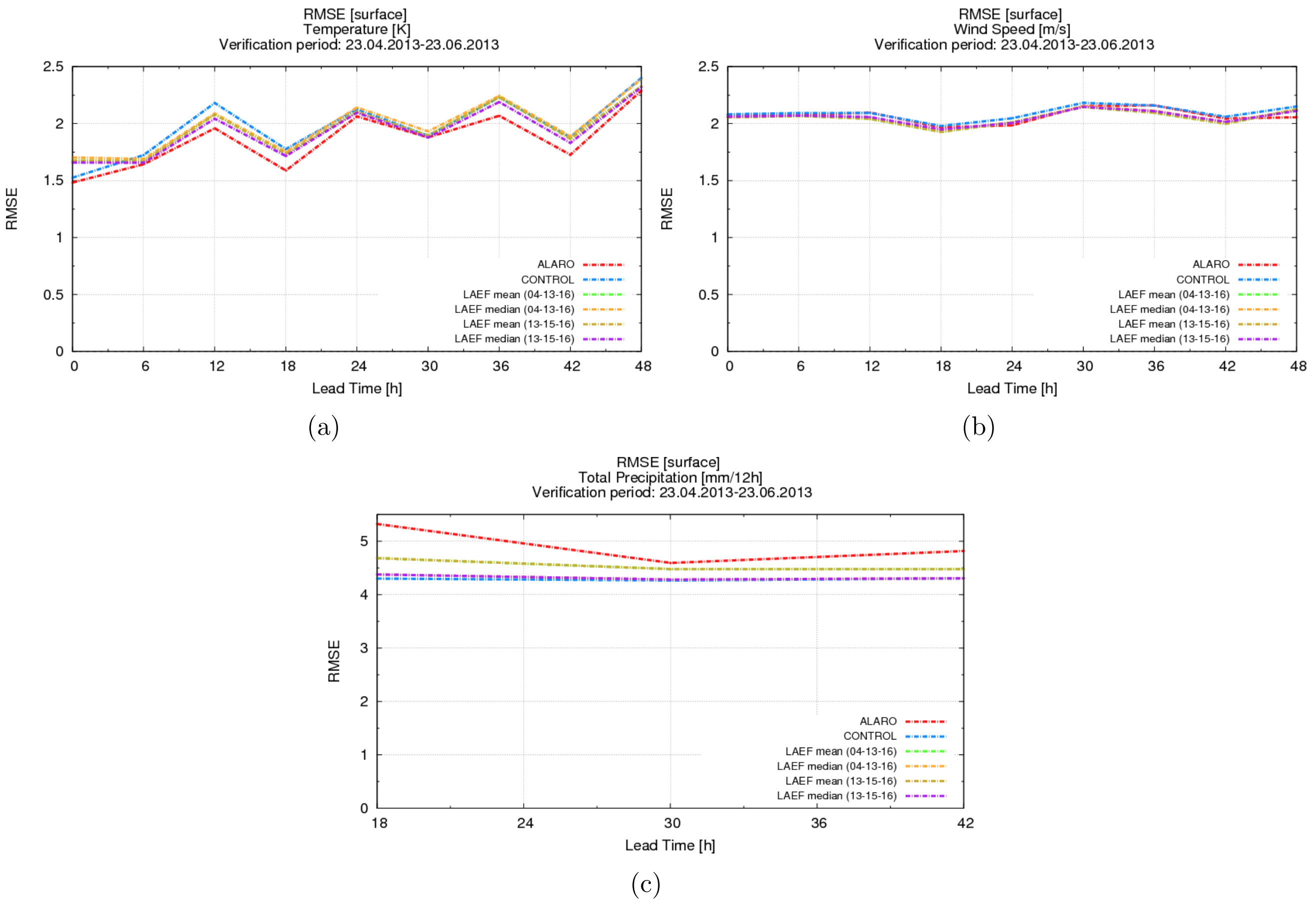


Figure 19: RMSE: T2M (a), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), Control forecast (blue) LAEF mean-04-13-16 (green), LAEF median-04-13-16 (orange), LAEF mean-13-15-16 (brown) and LAEF median-13-15-16 (magenta).

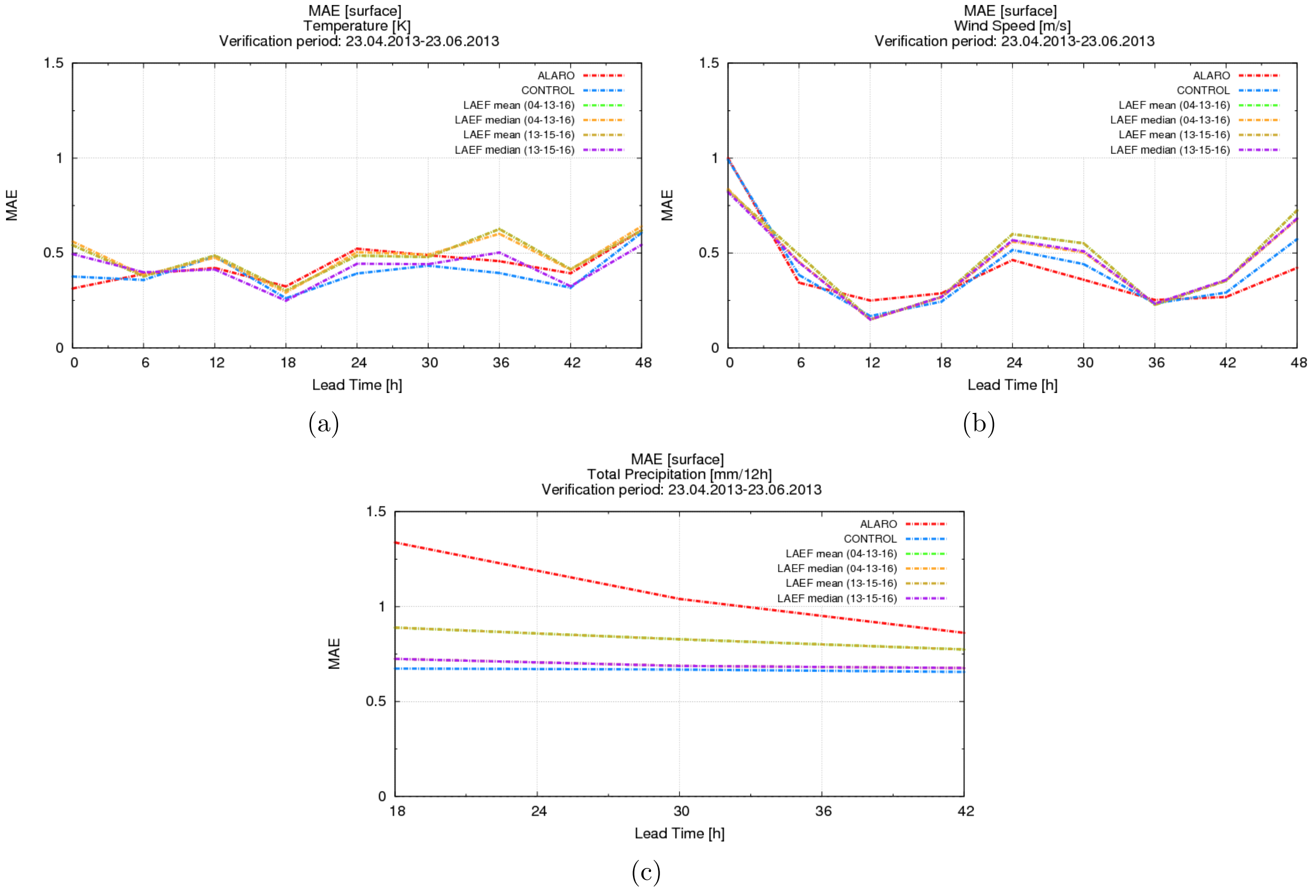


Figure 20: MAE: T2M (a), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), Control forecast (blue) LAEF mean-04-13-16 (green), LAEF median-04-13-16 (orange), LAEF mean-13-15-16 (brown) and LAEF median-13-15-16 (magenta).

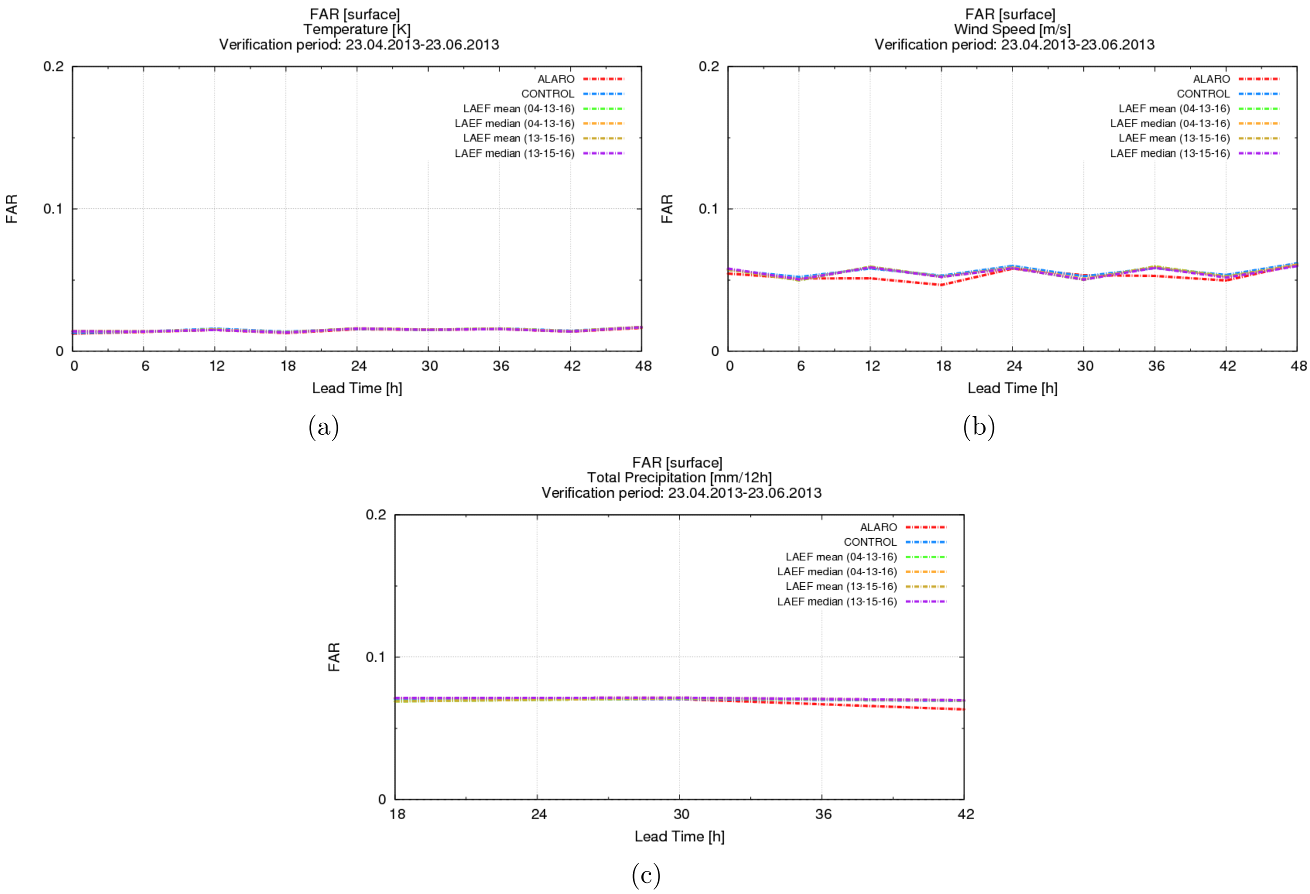
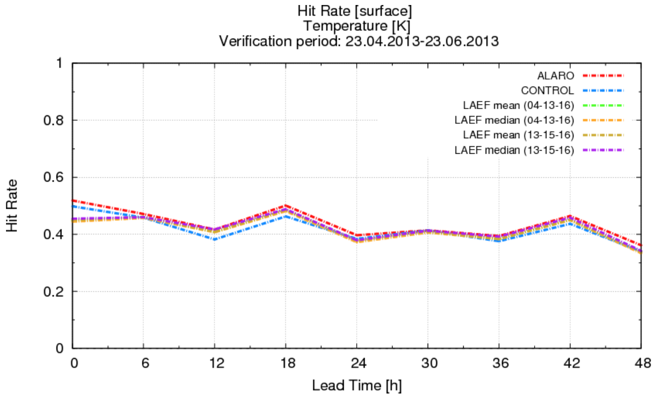
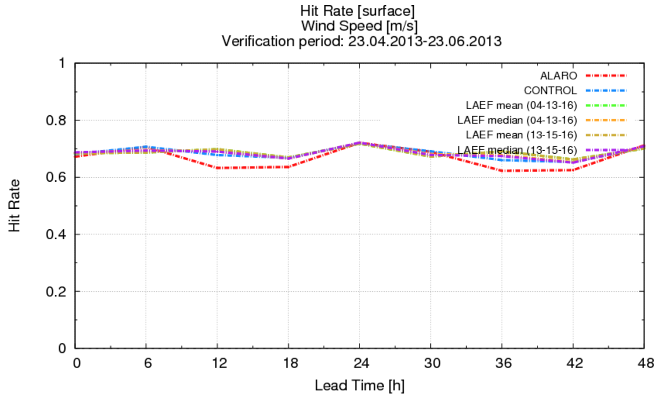


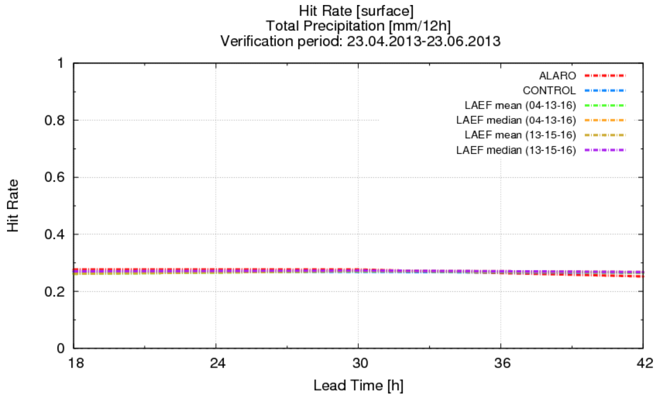
Figure 21: False Alarm Rate: T2M (a), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), Control forecast (blue) LAEF mean-04-13-16 (green), LAEF median-04-13-16 (orange), LAEF mean-13-15-16 (brown) and LAEF median-13-15-16 (magenta).



(a)

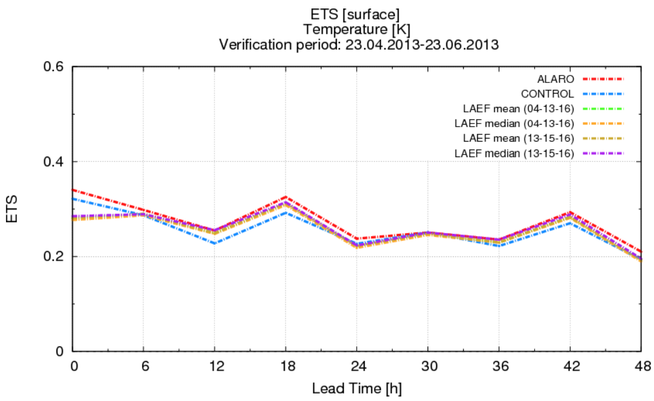


(b)

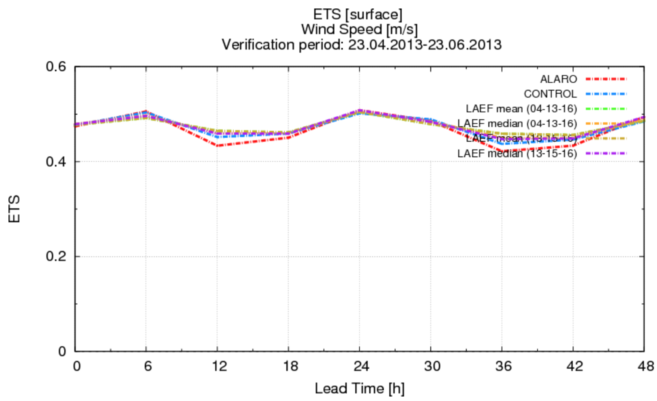


(c)

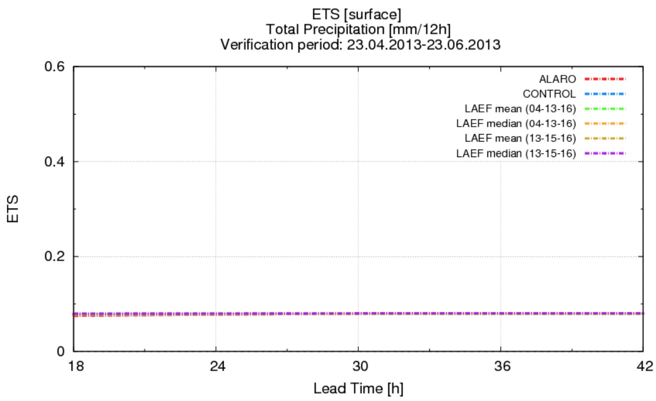
Figure 22: Hit Rate: T2M (a), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), Control forecast (blue) LAEF mean-04-13-16 (green), LAEF median-04-13-16 (orange), LAEF mean-13-15-16 (brown) and LAEF median-13-15-16 (magenta).



(a)



(b)



(c)

Figure 23: ETS: T2M (a), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), Control forecast (blue) LAEF mean-04-13-16 (green), LAEF median-04-13-16 (orange), LAEF mean-13-15-16 (brown) and LAEF median-13-15-16 (magenta).

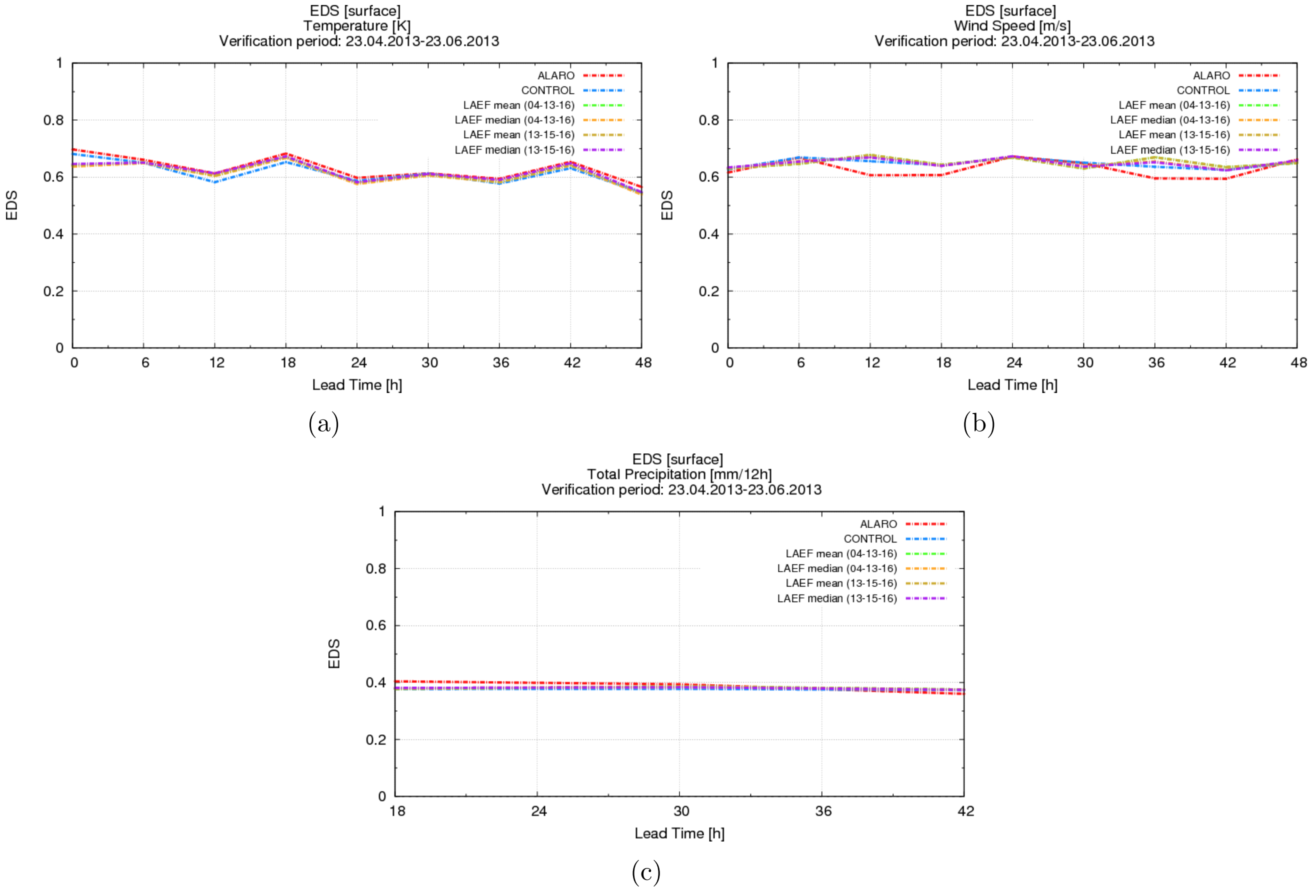


Figure 24: EDS: T2M (a), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), Control forecast (blue) LAEF mean-04-13-16 (green), LAEF median-04-13-16 (orange), LAEF mean-13-15-16 (brown) and LAEF median-13-15-16 (magenta).

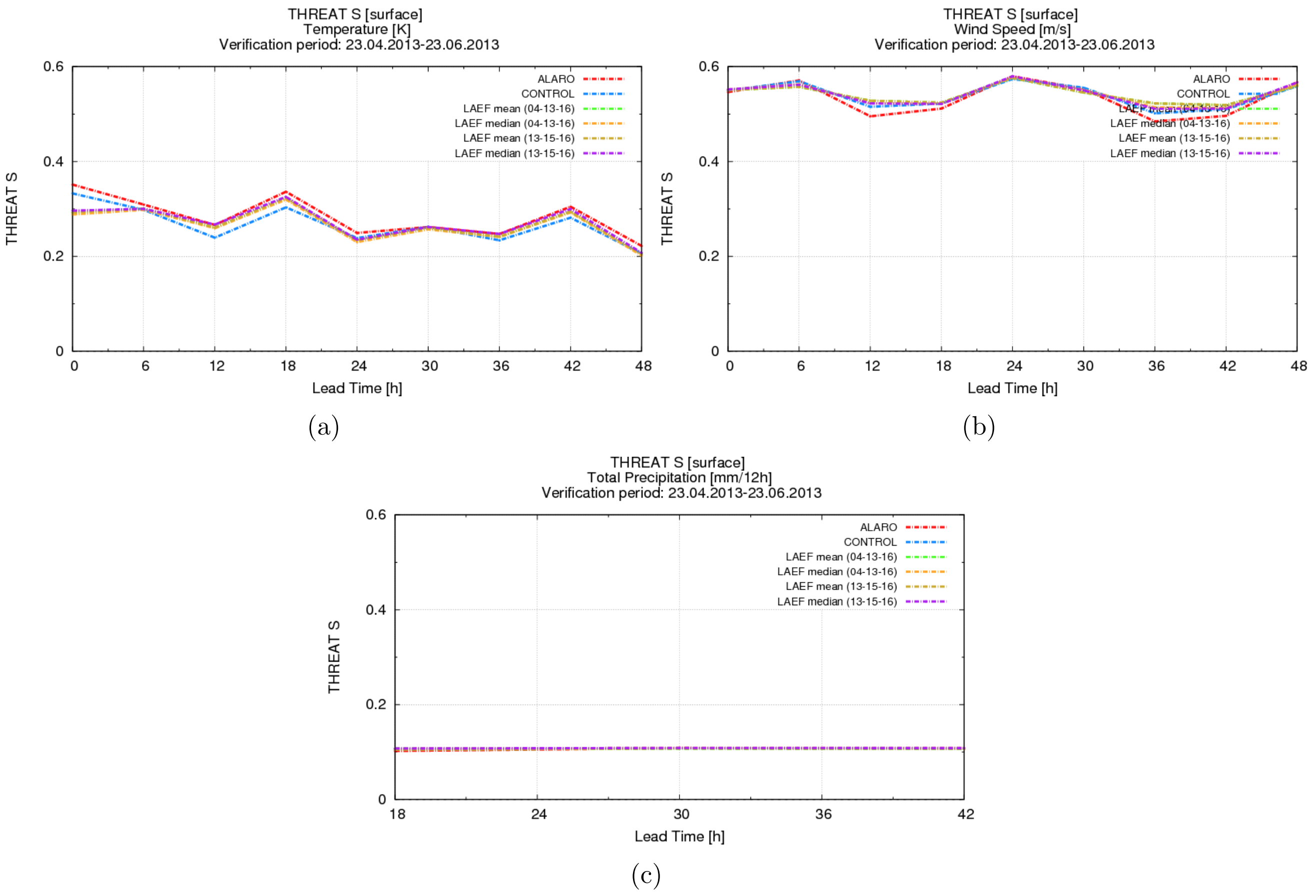
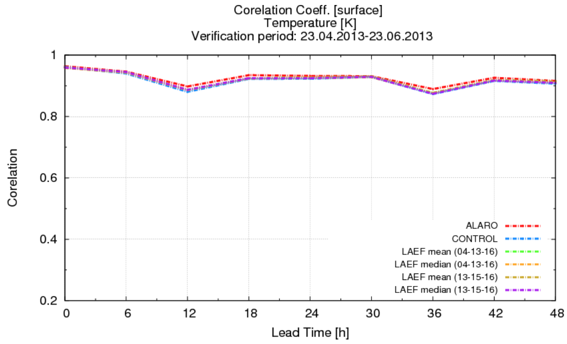
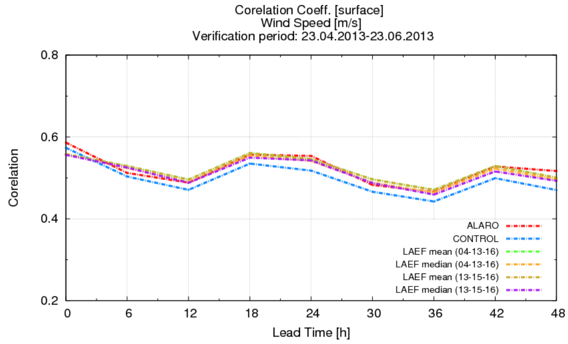


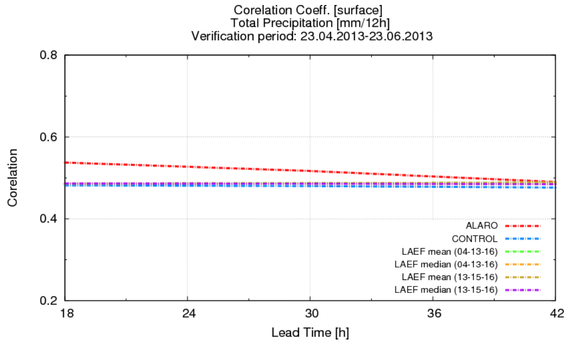
Figure 25: Threat Score: T2M (a), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), Control forecast (blue) LAEF mean-04-13-16 (green), LAEF median-04-13-16 (orange), LAEF mean-13-15-16 (brown) and LAEF median-13-15-16 (magenta).



(a)



(b)



(c)

Figure 26: Correlation Coefficient: T2M (a), WS10M (d), PREC_12h (e) for ALARO_LAGG (red), Control forecast (blue) LAEF mean-04-13-16 (green), LAEF median-04-13-16 (orange), LAEF mean-13-15-16 (brown) and LAEF median-13-15-16 (magenta).

Conclusions

- The new verification package is more flexible and easy to use package. More details about perl programs can be found in Martin Bellus's report.
- The new structure of the new package made possible the implementation of computing the averaged scores from daily ASCII files. In this way, the existence of the files will lead to time saving for a shorter verification period.
- The new LAEF system showed, in general, a better performance for surface and 850 hPa level parameters comparing with time-lagged ensemble ALARO system, which is not the same for the parameters at 500 hPa level.
- Removing some unperformand members (04, 13, 16), the results showed small diferrences for temperature and relative humidity (for surface and upper altitude). The scores are better for the LAEF system which contains all the members.

Acknowledgements

Many thanks to ZAMG team for their hospitality, especially to Yong Wang and Theresa Gorgas for their guidance and constructive suggestions during my stay and to Florian Weidle for his constant help and advice regarding the ensemble verification. I would like to express my very great appreciation to Martin Bellus (SMHU) for his valuable help and support regarding perl programming language, for his useful and constructive recommendations in order to manipulate ensemble data in a more efficient way.