

Work on the Common Verification Package for the evaluation of ensemble forecasts

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1. Preface

The work on the common verification package (CVP) for evaluation of ensemble

forecasts has been started by Edit Hagel in summer 2006 during the LACE stay in Vienna. The originaly Hungarian scripts and programs were adopted and modified to match the requirements (see Edit Hagel's report). The verification package is based on fortran 90, shell scripts and gnuplot graphic software.

The work described here is a direct continuation of the CVP development. The final aim is to have simple to use and portable on unix/linux platforms verification system for ensemble forecasts.

The report is organised as follows:

1. Preface
2. List of the new modifications in CVP
 - 2.1 Modifications in fortran code
 - 2.2 Modifications in shell scripts
3. Proposal for next development
4. Final notes
5. Examples of the new outputs of CVP

Only the most important new features are mentioned in the report. See please updated manual for full description of CVP.

2. List of the new modifications in CVP

2.1 Modifications in fortran code

● wind speed computation

If the wind speed calculation is asked for and u, v components are to disposal the wind speed is computed. The new variable is added as (NVAR+1)th item in the arrays used for verification computations, where nvar is a number of all asked parameters. The number 250 is used as an internal identification code for wind speed.

new variables:

```
&RECORD_02  
  WINDSPEED_CODE = 250
```

● anomaly scores computation

Very often is better to compute the threshold based scores not for the same threshold value over the whole 3-D space but to use different threshold values related to for example climatic averages in given point. E.g. for the temperature we are not computing the scores for the events where $T(x,y,z,t) > 30$ Celsius but $T > (30 + T_{avg}(x,y,z,t))$ Celsius). As the climatic values has been used the monthly averages extracted from ERA 40 database. To be able to compute such climatic anomaly scores for any parameter some parts of the code had to be refined and done in more general way.

updated variables:

```
&RECORD_05
  NUMTHRESHOLD(NVAR, 2)
  THRESHOLD(MAX_THR, NVAR, 2)
```

=> NUMTHRESHOLD(NVAR, 1) .. Number of thresholds for each parameter
=> NUMTHRESHOLD(NVAR, 2) .. 1/0 Use climatic mean for given variable? (It means logical switch for computation of climatic anomaly based score or not.)

=> THRESHOLD(1:NUMTHRESHOLD(NVAR, 1), NVAR, 1)
.. list of thresholds for NVARth parameter
=> THRESHOLD(1:NUMTHRESHOLD(NVAR, 1), NVAR, 2)
.. 1/-1 Bigger/lower then the asked threshold for NVARth parameter? (E.g. for T and threshold 0 Celsius we can compute the scores for both cases: when T in given point and time is lower or higher than 0 Celsius)

● Brier skill score computation

The skill scores are useful to find out if the model performs better than the chosen reference. In our case we are using the type of persistence (analysed state at the starting time of forecast) as a reference. If daily climatology is available it is simple to add it as an another reference possibility. At the moment it is not possible to extract the daily climatic values from ERA 40 database so only monthly values could be used instead of them.

new variable:

```
&RECORD_04
  LCALCBSANA = .T./F.
```

=> LCALCBSANA = .T. ... Brier score for analysis at +00hh is computed. Then Brier skill score can be easily computed with analysis at +00hh as a reference ($BSS = 1 - (BS / BS_{ana})$)

● input fields control

To be sure that all asked fields are available new logical array is created and checked after every reading of asked input field

new variable:

LINP (NLEV, NVAR) .. .TRUE./.FALSE. if the field for NVARth parameter, given vertical level and time range is available or not

● others

new variable:

```
&RECORD_01
  LCLIM
```

LECMWF

=> LCLIM .. Read climatological input data? Must be .TRUE. if anomaly coefficients will be computed

=> LECMWF .. Analyses from ECMWF (rescaling of relative humidity is necessary)?

&RECORD_02

PARAMETER_DESCR

CODE_PARAMETER_CLIM

=> PARAMETER_DESCR .. array: possible values 'G', 'T', 'U', 'V', 'RR' (what parameters are in input files CODE_PARAMETER_ANA, CODE_PARAMETER_FOR)

=> CODE_PARAMETER_CLIM = array, list of ID identification codes for the parameters in climatic files (must be in the same order as ID in CODE_PARAMETER_ANA, CODE_PARAMETER_FOR)

2.2 Modifications in shell scripts

Both main shell scripts RunVerification.job and RunPlotScores.job were rearranged and updated.

RunVerification.job

The script was divided into the two parts which are activated by the logical switches lsc0 and lproc. In the first part the basic computations are done for every day, score and experiment. Starting from those daily files (for every score/experiment) the final scores averaged over the asked time period can be computed in the second part of the script. Unix tools awk, grep and sort are used to process the daily files. At the end one final file with all scores for all variables and experiments is produced as the input for graphics or database storage.

RunPlotScores.job

The script calls individual plotting scripts and is divided into the more parts for different kinds of plots which are activated by the logical switches (see below). GNUPLOT freeware is used for the graphics. The script is prepared for automatised plotting of the results and is easily manageable. Setup is similar to the setup used in the script RunVerification.job

lind switch

The plots can be produced for every combination of input parameters (experiments, variables, levels, timesteps, thresholds). The list of available plotting scripts:

Plot_BIAS_RMSE_SPREAD.scr

Plot_Outliers.scr

Plot_Talagrand.scr

Plot_BrierScore.scr

Plot_BrierSkillScore.scr

Plot_Reliability.scr

Plot_ROC.scr

lmultithr switch

Here the plotting scripts for multicurves plots (scores for all thresholds in one plot) are called:

Plot_BrierScore.multiThr.scr

Plot_BrierSkillScore.multiThr.scr

Plot_Reliability.multiThr.scr

Plot_ROC.multiThr.scr

Similarly additional switches can be added for another multicurves plots in future (scores for all experiments or time ranges in one plot).

3. Proposals for next development

verification at the surface

There are still missing the verification for surface against synop observations. It means that reading of the input files with synop values, finding the closest corresponding model point should be implemented. Then an utilization of ready fortran routines for the score computation is straightforward.

number of ensemble members

Until now the code is written for the ensembles with ten members only. To be able to use CVP for arbitrary number of the members generalisation of the code must be done.

The final data processing for longer period and more experiments which is now done in second part of the script RunVerification.job can be quite time demanding depending on the available computer power. It can be worth to consider rewriting of this part of job to fortran. This could speed up the work distinctively.

There is a need to find the source of daily climatological data for skill scores computation. They can be computed from ERA 40 database but not directly extract from it at the moment.

The verification package must be thoroughly tested on the real data with all possible combinations of input parameters.

4. Final notes (similar verification packages)

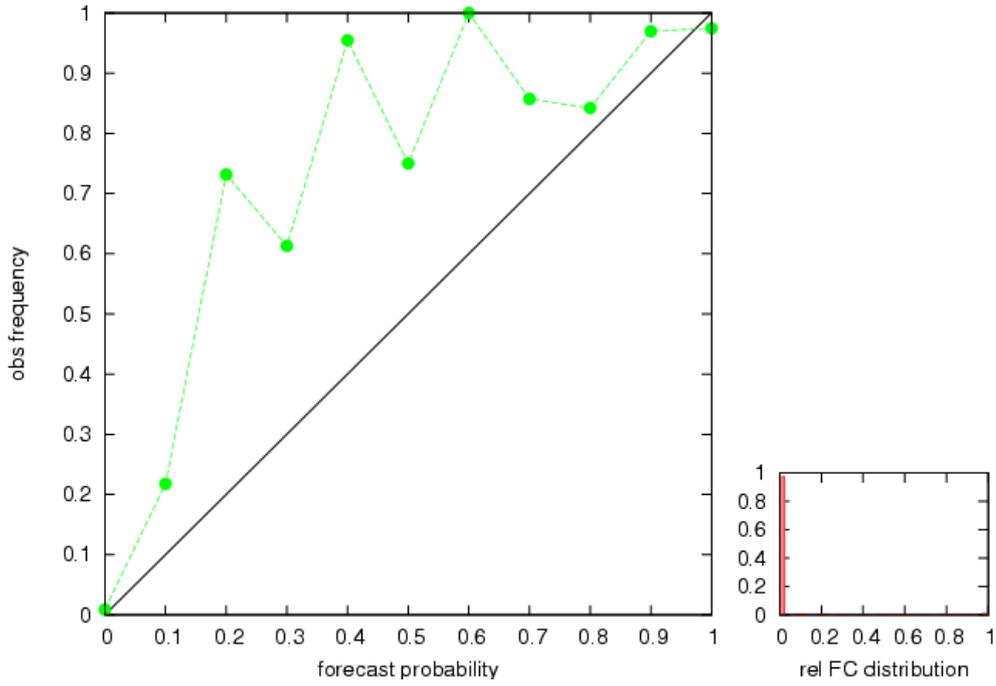
As came out during recent first eps workshop in Vienna there exist similar verification packages on european level in various stages of complexity, usability and interoperability. The most interesting mainly from the GLAMEPS point of view are the spanish operational eps verification scripts which can be easily implemented in ECMWF during "laboratory" GLAMEPS stage because they use metview for the plotting and are regularly used in INM. The problem can be in performance when huge past eps data would be verified because of known slowness of metview software. Also the metview is licensed product so it's not freely available to everybody.

New "platform independent" verification package has been reported by Michael Denhard from DWD. The score computations and visualizations should be done in Java with input files in NetCDF data format. This package will be prepared in the frame of PEPS project and should be freely available to its participants and enough general for using any ensemble system outputs. The main problem is that the work didn't start yet and Java application have also often performance problems on some platforms.

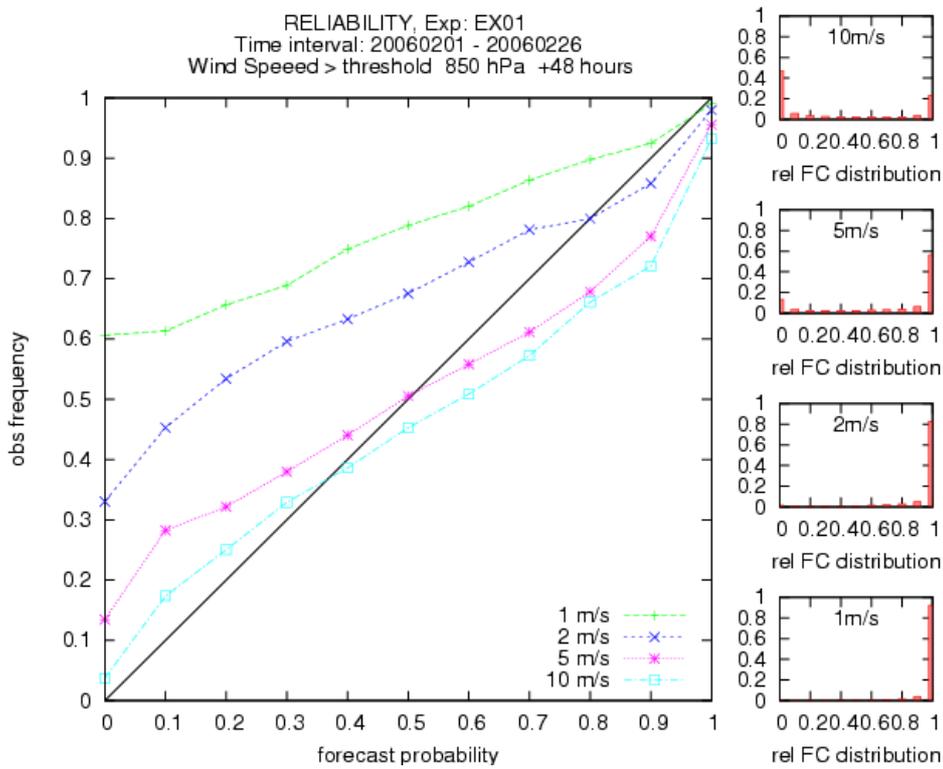
Another eps verification packages exist in ECMWF, COSMO and met.no. They are mostly very specific and not easily portable though. At least some ideas how to verify for example probabilistic precipitation forecast could be learnt and implemented in our CVP in future.

5. Examples of the new outputs of CVP

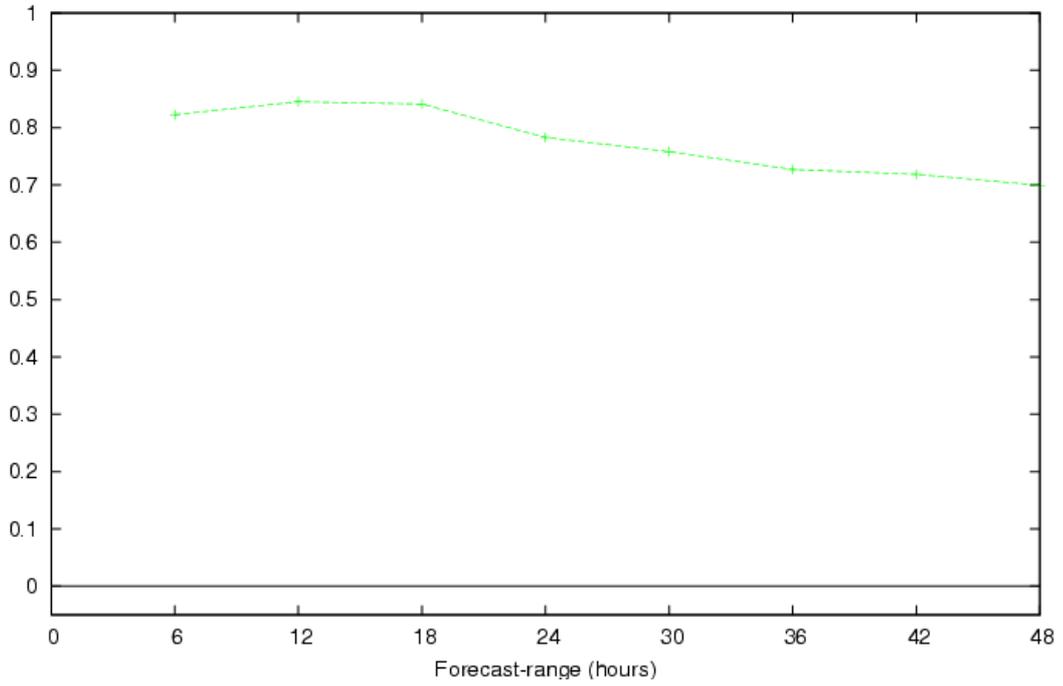
RELIABILITY, Exp: EX01
 Time interval: 20060201 - 20060201
 Parameter: Temperature anomaly < -4 Celsius, Level: 500 hPa, Timestep: +36 hours



RELIABILITY, Exp: EX01
 Time interval: 20060201 - 20060226
 Wind Speed > threshold 850 hPa +48 hours



Brier Skill Score, Exp: EX01
Time interval: 20060201 - 20060201
Parameter: Wind Speed m/s, Level: 850 hPa, Threshold: 10 m/s



ROC score, Exp: EX01
Time interval: 20060201 - 20060226
Wind Speed > threshold, 850 hPa, +42 hours

