Verification of an Hybrid Short-Range EPS

Callado, A., García-Moya, J.A., Santos, C., Santos-Muñoz, D., Simarro, J. (INM, SPAIN)

3rd International Verification Methods Workshop, ECMWF, January 2007

MINISTERIO DE MEDIO AMBIENTE

INTRODUCTION

Framework

- Two high resolution deterministic models are currently running at the Spanish Met Service (INM).
- A Short-Range Ensemble Prediction System (SREPS, García-Moya, J.A., *et al.*, 2007) is daily running at INM as well, but a lower resolution.
- A goal could be combine both systems in order to improve the quality of the probability forecast, especially the precipitation forecast.
- One method to unified both forecasting systems could be the Hybrid Ensemble.
- A few Hybrid Ensemble has been developed and verified.

Theoretical Foundation of Hybrid EPS (Du, J., 2006)

Combine the spread or uncertainty information from the coarse EPS with the more detailed and higher accuracy deterministic model in order to form a more robust ensemble: the Hybrid Ensemble

The Concept of Hybrid EPS (Du, J., 2006)

- Each EPS member could be decomposed into two parts:

  EPS member = base + perturbation

- The high-resolution model could be considered as better base:

  high resolution base = deterministic forecast

- A new Hybrid Ensemble could be obtained exchanging the bases:

  Hybrid EPS member = high resolution base ± perturbation (''two side approach'')

- The **base** is the control member from EPS which is more close in dynamics and physics to the high resolution deterministic forecast

METHOD

Data

Deterministic models

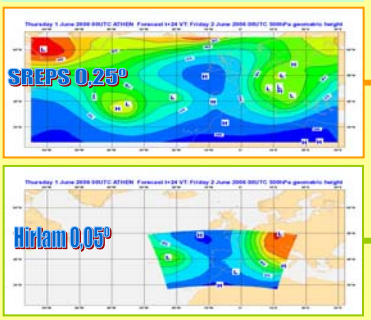
Deterministic HIRLAM Models	Forecast length (daily runs)	Horizontal resolution
ONR	72 (4)	0,16º
HNR	36 (4)	0,05º

Short-Range EPS (SREPS)

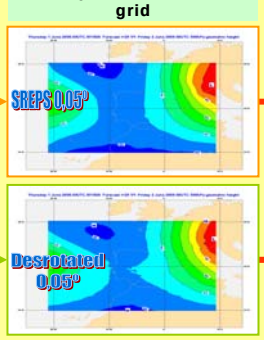
Multi-Model	Multi-boundaries	Num. EPS Members	Forecast length (daily runs)	Horizontal resolution
Hirlam HRM (DWD) MM5 UM (UKMO) Lokal Model	**ECMWF** GME GFS UKMO	5 models X 4 boundaries = 20	72 (twice)	0,25º

Method Example (Z500)

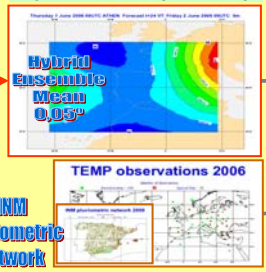
Integration areas of Deterministic and SREPS member



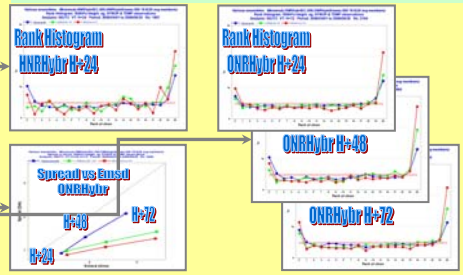
Interpolation common grid



Hybrid Method (HNRHybrIEC)



Verification results



Hybrid Ensembles

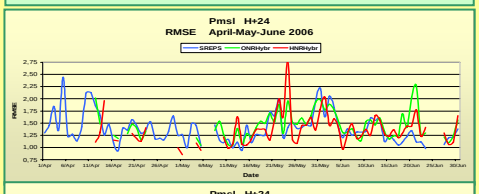
Description of Experiments

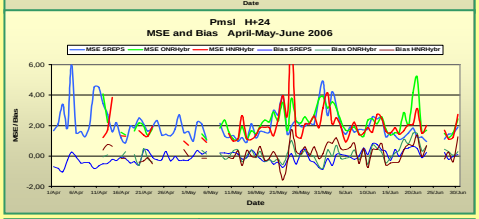
Hybrid Ensemble experiments	Method (Note: the negative precipitation values are set to zero)	Horizontal Resolution	Forecast length Precipitation	Forecast length Z500, T500, Pmsl and S10m
ONRHybrEmean	***high resolution base*** = **ONR** **base** = EPS Mean	0,16º	30 and 54	24, 48 and 72
ONRHybrIEC	***high resolution base*** = **ONR** **base** = EPS member **Hirlam + ECMWF**	0,16º	30 and 54	24, 48 and 72
HNRHybrEmean	***high resolution base*** = **HNR** **base** = EPS Mean	0'05º	30	24
HNRHybrIEC	***high resolution base*** = **HNR** **base** = EPS member **Hirlam + ECMWF**	0,05º	30	24

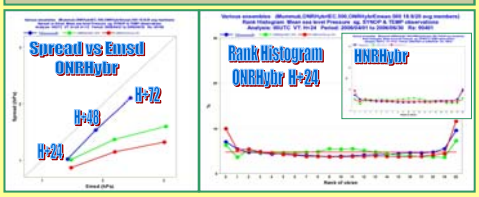
RESULTS

Verification Z500, T500 and Pmsl with SYNOPs and TEMPs

Pressure Mean Sea Level Verification





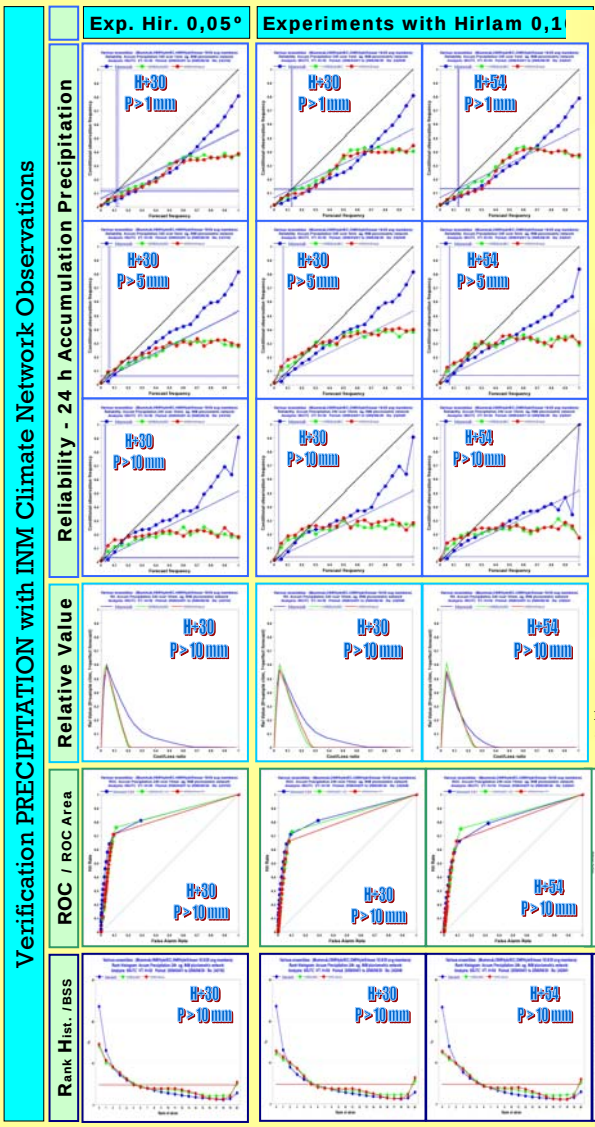


The verification of geopotential (shown in Method Example) and temperature (not shown) at 500 hPa and pressure at mean sea level (shown above) are achieved showing everyone field close results.

The Hybrid Ensembles errors and bias are slightly worst than the original counterpart SREPS. But, the excellent balance between the spread and ensemble mean standard deviation of the original ensemble SREPS is lost with the forecast length.

The hybrid ensembles using the Hirlam with ECMWF boundaries as **base** have better verification than the ones using the ensemble mean.

Verification PRECIPITATION with INM Climate Network Observations



The Verification Method

The verification method is the same used for Short-Range EPS presented in this workshop by Santos (Santos, C., *et al.*, 2007). The forecast values are bilinear interpolated to the observation network sites and then compared.

Legend

- **Mummub**: the original and reference Short-Range Ensemble Prediction System (SREPS).
- **HybrEmean**: Hybrid Ensembles which take the ensemble mean of original SREPS as **base**.
- **HybrIEC**: Hybrid Ensembles which take the member of original EPS with the Hirlam model and the ECMWF boundaries as **base**.

Reliability

The reliability of hybrid ensembles seems to be slightly better at low forecast frequencies, but quite worst at high ones than the original ensemble where they have poor resolution.

Furthermore, at lower forecast frequencies, as the precipitation threshold is increased, the hybrid ensembles tends to be overforecasting.

The **HybrIEC** appears to be a little bit more reliable than the hybrid ensemble using the ensemble mean as the **base** of the basic ensemble.

Relative Value

There is a little improvement in economic value at a very low cost/lost over original ensemble, but an important miss at high ones.

Relative Operating Characteristic and Roc Area

The **HybrIEC** ensembles seems to have a bit better resolution at lower frequencies and quite similar ROC area than the reference EPS, but the **HybrEmean** ensembles are definetively worst.

Rank Histogram

The Hybrid Ensemble spread represents slightly better the variability of the observations than basic ensemble, but it has still not enough spread. It shows a better performance to take into account the high outliers (turn up curve at right hand).

CONCLUSIONS

- A verification of an Hybrid Short-Range EPSs have been done in order to improve the probability forecasts of the original Short-Range EPS.
- In general the hybrid ensembles tested does not overcome the excellent performance of the original ensemble SREPS. But in particular, at low frequencies, they seem to be slightly more skilled.
- Using the 0'05° Hirlam with better horizontal resolution than 0'16° one as ***high resolution base***, does not seem to improve the performance significantly.
- The performance of the hybrid ensembles which take as **base** the **EPS member** of the original ensemble with the Hirlam model and ECMWF boundaries is quite better than the ones using the original ensemble mean. This seems to suggest that applying strictly the Hybrid Ensemble Method described by Du (Du, J., 2006), that is, using several ***high resolution base*** for each set of models in the original ensemble, not only the Hirlam one for all of them, could improve the performance overcoming the original ensemble just as Du showed.

References

[1] Du, J., 2006: Hybrid Ensemble Prediction System: a New Ensembling Approach. Workshop on Predictability, Observations, and uncertainties in Geosciences, 13-15 March 2006, Tallahassee, Florida.

[2] García-Moya, J.A. *et al.*, 2007: Multi-model Ensemble for Short-Range Predictability. 3rd International Verification Methods Workshop, ECMWF.

[3] Santos, C. *et al.*, 2007: Performance of the INM Short Range Multi-Model ensemble using High-resolution Precipitation Observations. 3rd International Verification Methods Workshop, ECMWF.

Alfons Callado, acallado@inm.es

Numerical Weather Prediction Department. INM.