PEARP initialization with Ensemble Data Assimilation and Singular Vectors

C.Labadie - L. Descamps -
P. Cebron - Y. Michel

Acknowlegements to :
L. Raynaud - M. Boisserie
L. Berre - G. Desroziers
E. Bazile - P. Arbogast

Météo-France/CNRM/GMAP/RECYF

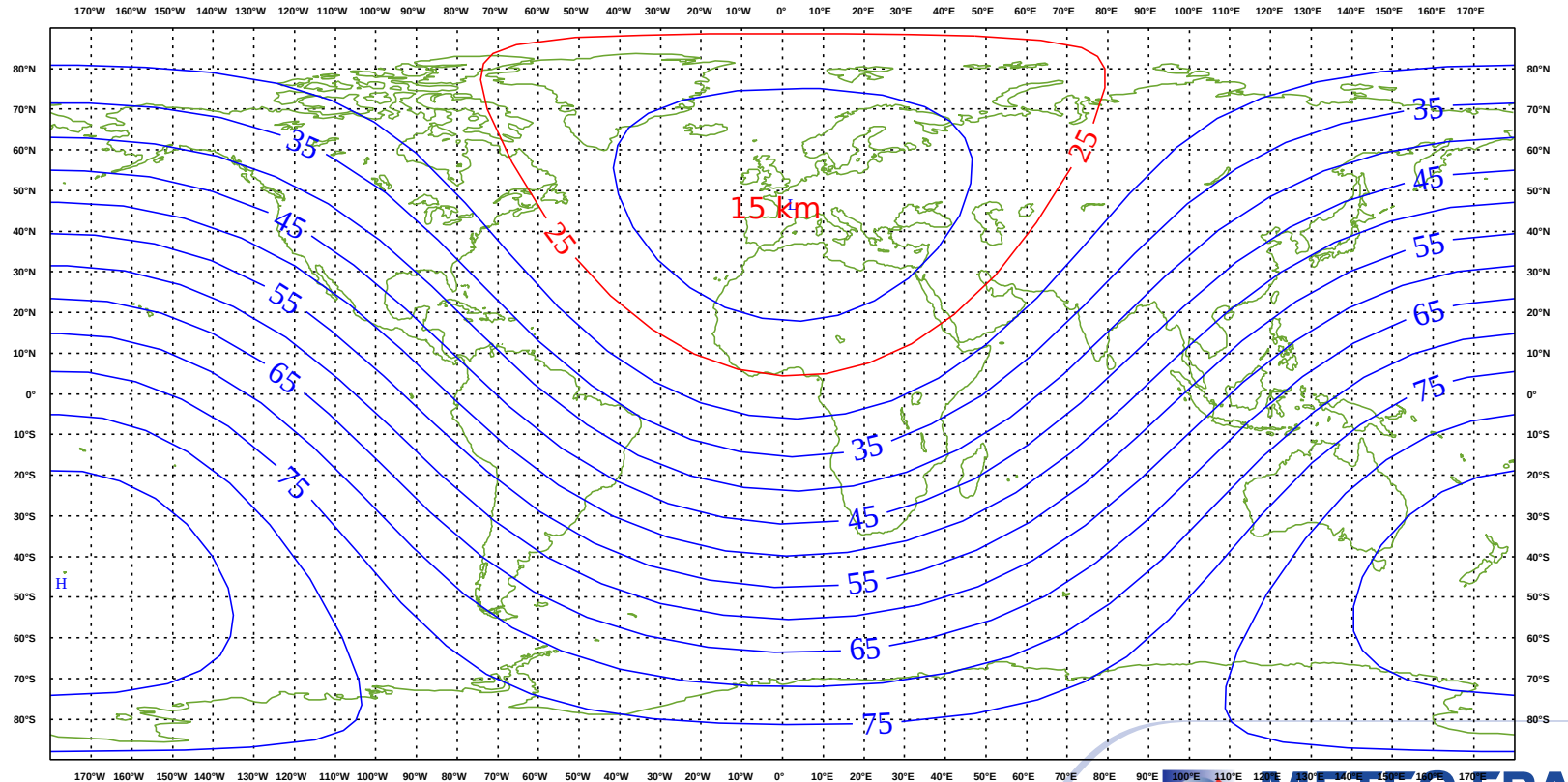
2012/11/15

METEO FRANCE
Toujours un temps d'avance

PEARP - Prévision d'Ensemble ARPEGE

General characteristics

- 35 members including the control member
- Running at : 06UTC (72h range) and 18UTC (108h range)
- Forecasts resolution : T538C2.4L65 (≈15km over France, 90km on the opposite side of the globe)



METEO FRANCE
Toujours un temps d'avance

PEARP - Prévision d'Ensemble ARPEGE

General characteristics

- 35 members including the control member
- Running at : 06UTC (72h range) and 18UTC (108h range)
- Forecasts resolution : T538C2.4L65 (≈15km over France, 90km on the opposite side of the globe)

Initialization procedure

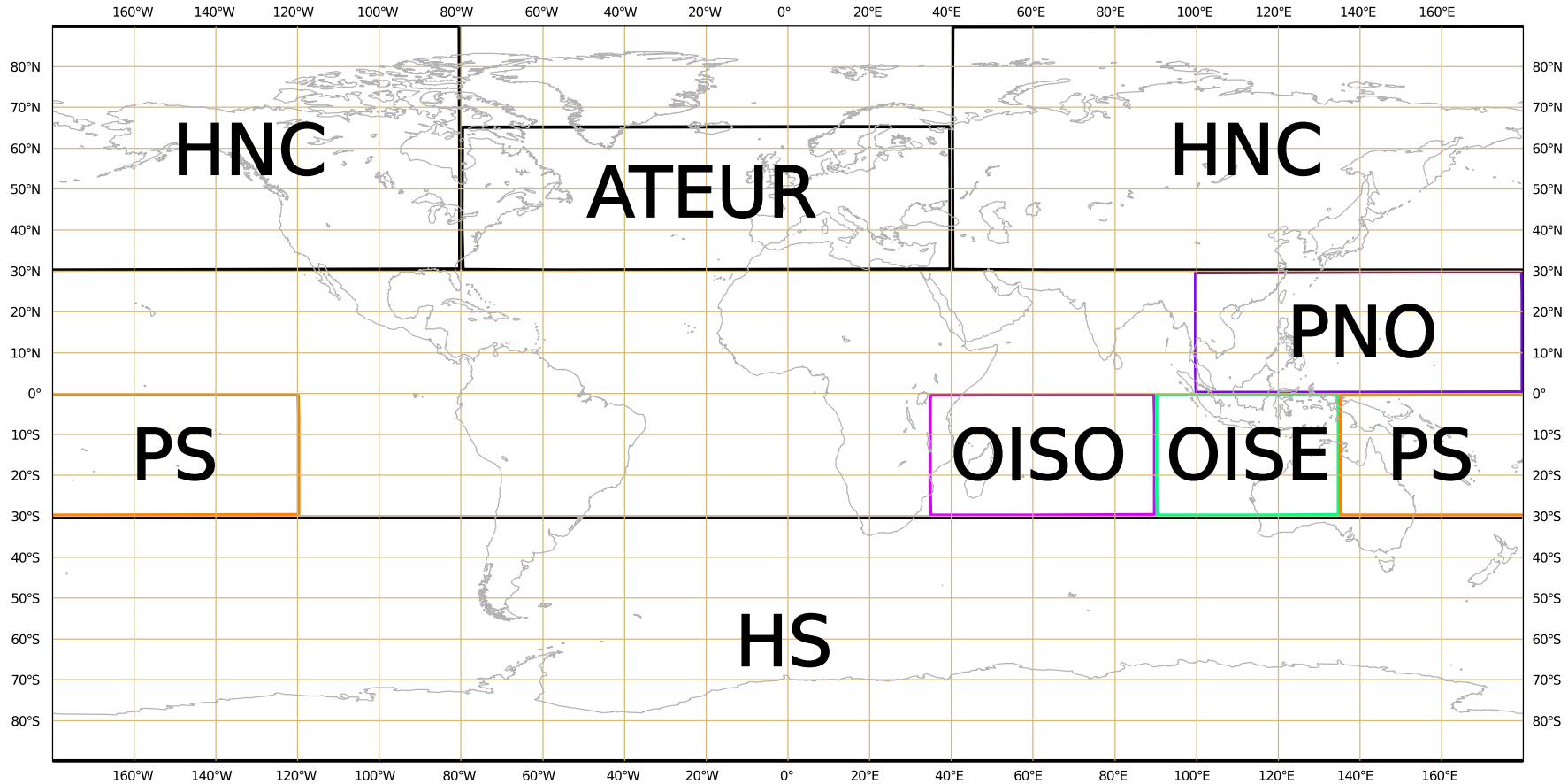
- using the 6 background states and the mean from the EDA of Météo-France (AEARP, since december 2009 *(L. Berre, G. Desroziers)*)
- singular vectors computed over 7 areas* (rescaled by σ_b)

*SV charact.	OTI(h)	res.	norm
ATEUR	18	Tl95	TE
HNC et HS	24	Tl95	TE
TROP	18	Tl95	KE

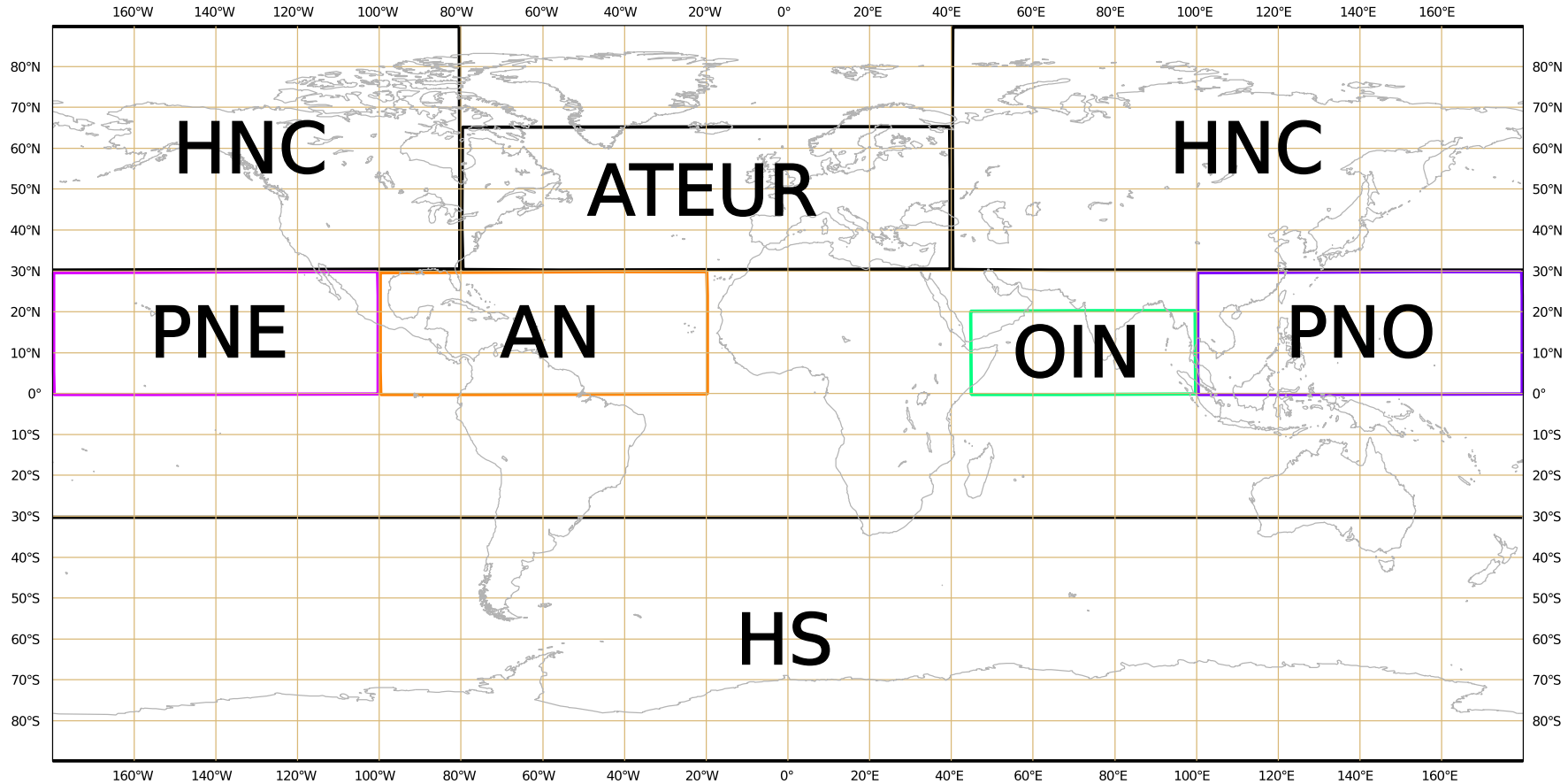
Model error (since december 2009)

- using 10 physical packages including that of operational ARPEGE model

PEARP - SV : target areas (SH cyclonic season)



PEARP - SV : target areas (NH cyclonic season)



Objectives

The future increase of computational resources will allow one to increase the size of EDAs.

- Do an increase of the EDA size leads to an increase of the EPS skill ?
- Is it then possible to deal without singular vectors ?

Experiments on initial perturbations :

- with different sizes of EDA ;
- with or without singular vectors.

Experiments on initial perturbations

Ensemble Data Assimilation (EDA) used (*Y. Michel*)

- It is a 90 members EDA based on 4D-VAR ;
- The model error component is taken into account by inflating perturbed background states ;
- The background states $P_{+6h}EDA$ and the mean $\overline{P_{+6h}EDA}$ of this ensemble are used.

6 Ensemble Prediction Systems (EPS)

Exp	N_{EDA}	SV ($N_{SV} = 64$)	pert nb	symmetry	N_{EPS}
35_EDA6	6	no	17	yes	35
35_EDA17	17	no	17	yes	35
35_EDA34	34	no	34	no	35
35_EDA6SV ($\sim$ oper)	6	yes	17	yes	35
91_EDA45	45	no	45	yes	91
91_EDA90	90	no	90	no	91

Model error in the EPS

Use of 10 physical packages (randomly chosen) of the Météo-France EPS (PEARP) for all the experiments.

Scores

Period - 9 days - 1 run/day

- Probabilistic scores from 31/10/2011 to 08/11/2011.

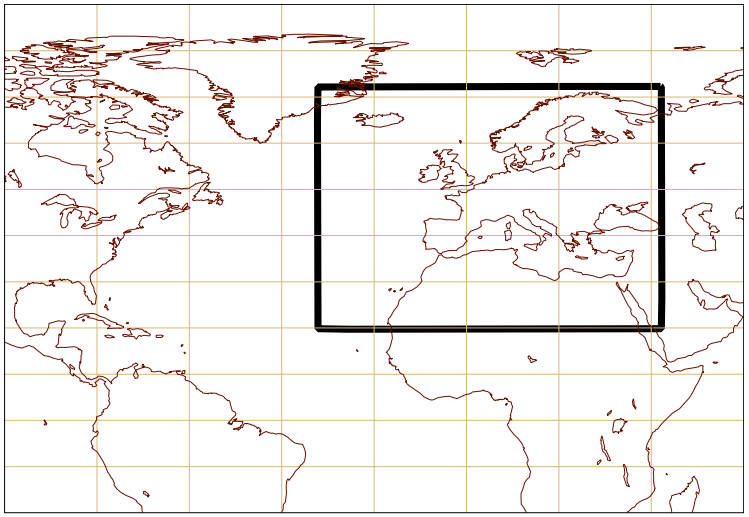
Variables

- T850
- 10m wind speed

not shown :

- *MSLP, Z500, UV850, UV300...*
- *24h rainfall*

Domain : EURAT

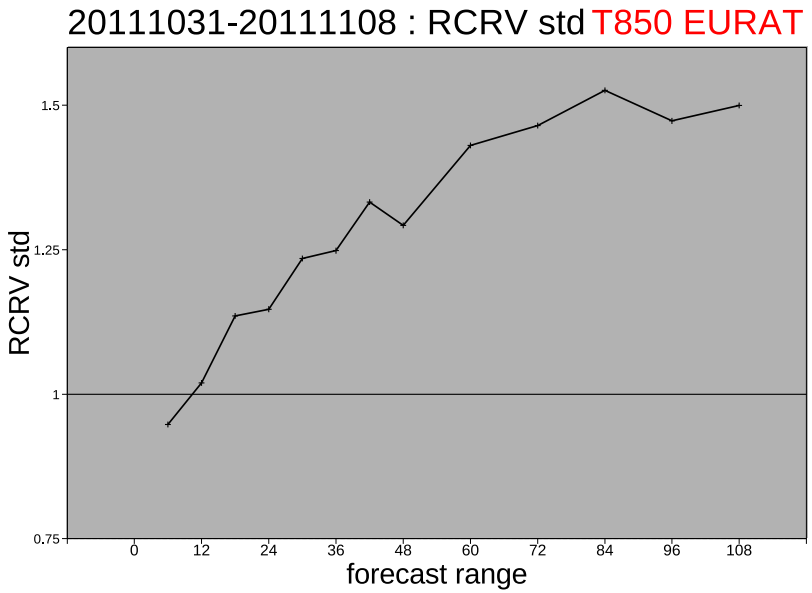


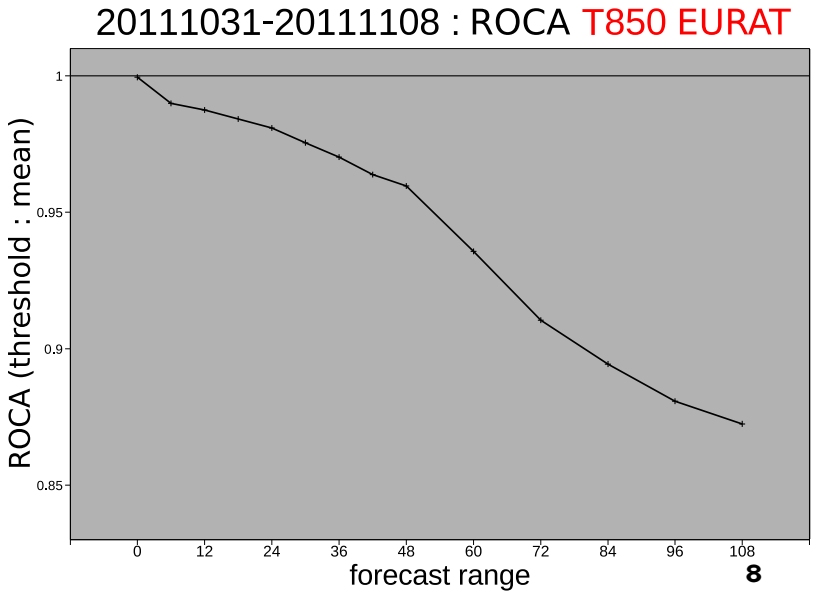
Scores

- RCRV std (reliability measure = statistical coherence between the forecasted probability and the observed occurence, 1 for a perfect score)
- ROC Area (resolution measure = ability of an ensemble to distinguish different forecasted probability categories, 1 for a perfect score)

Scores 35_EDA6

against ARPEGE analysis

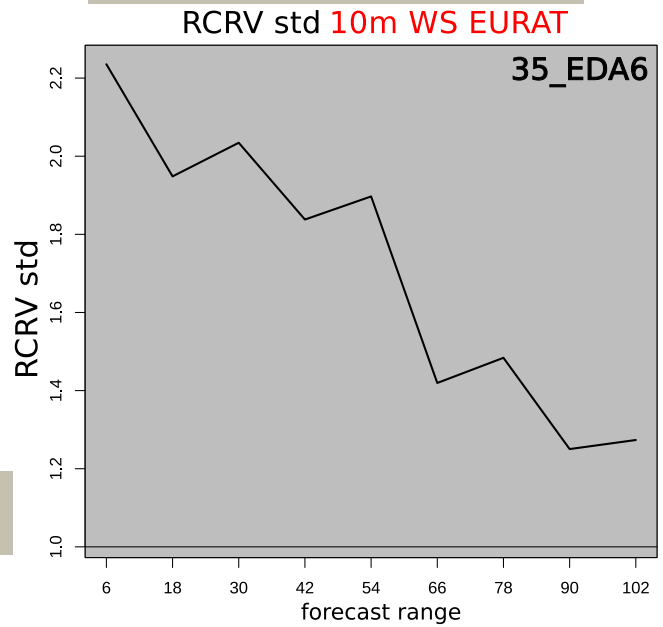


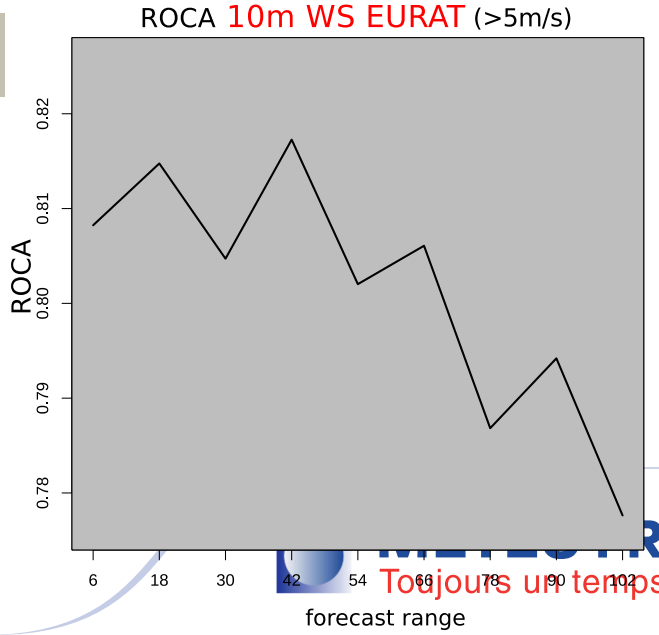


good=1

good=1

against observations



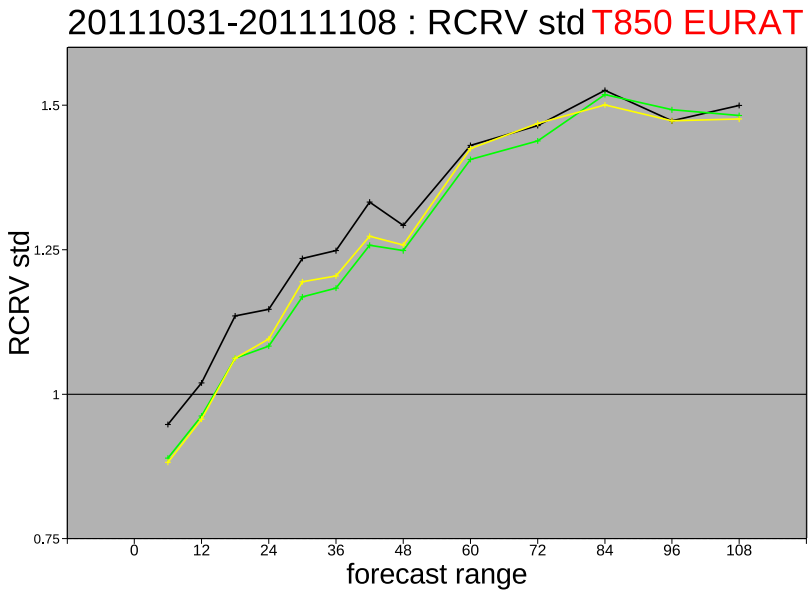


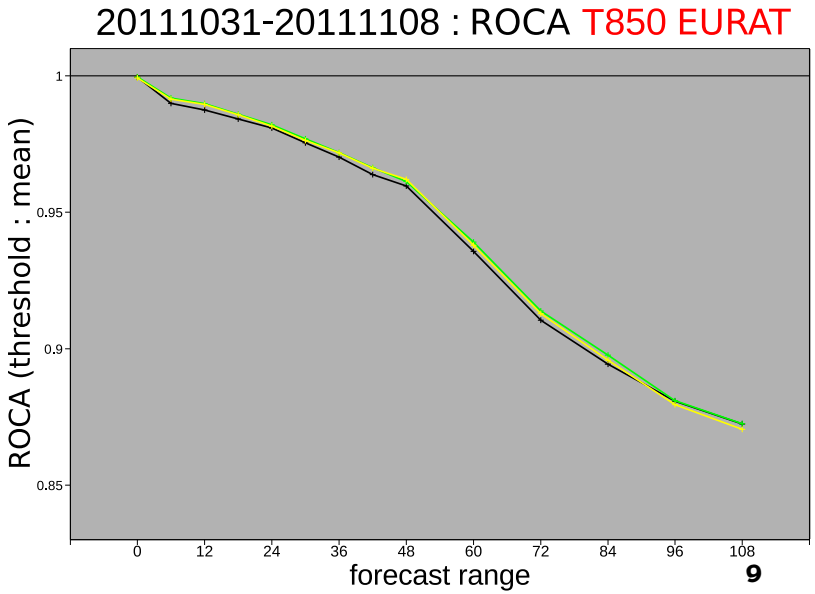
reliability

resolution

Scores 35_EDA6, 35_EDA17, 35_EDA34

against ARPEGE analysis

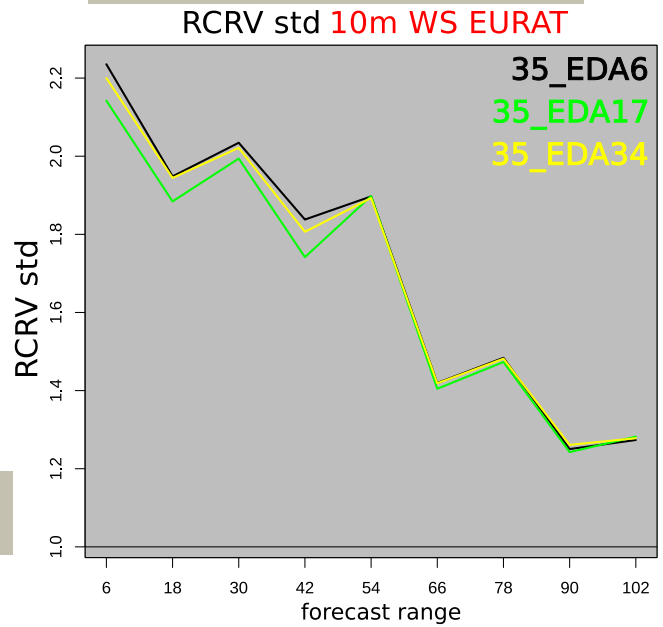


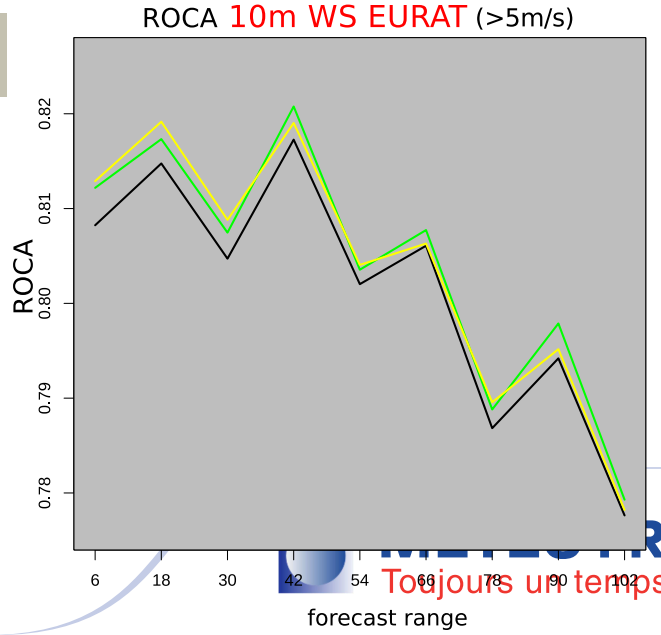


good=1

good=1

against observations



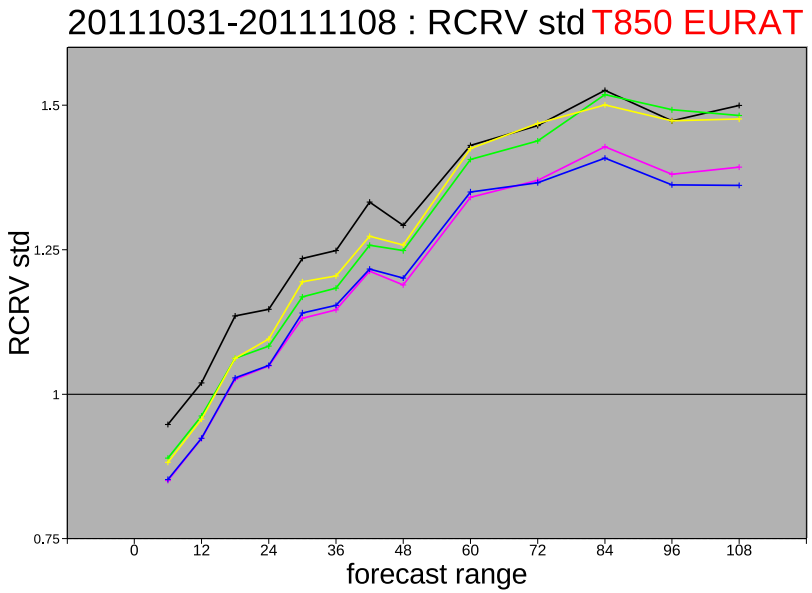


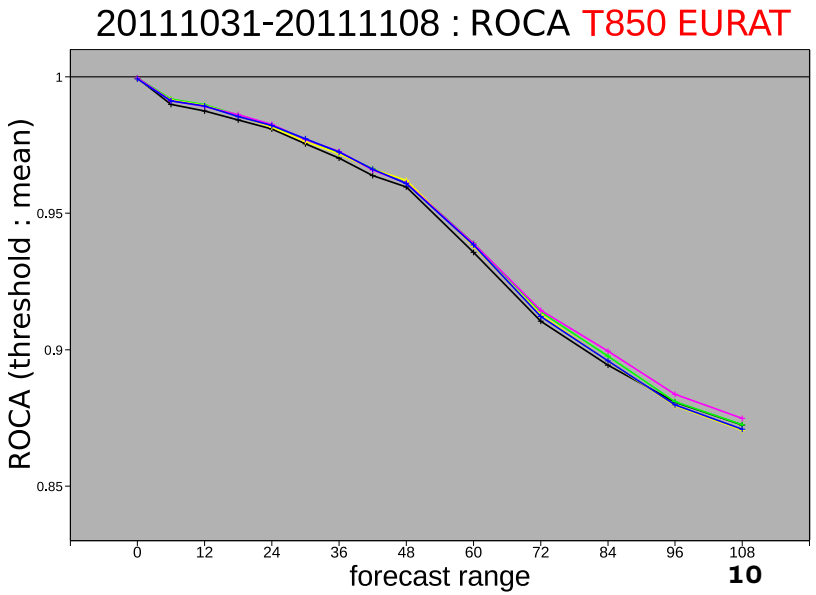
reliability

resolution

Scores 35_EDA6, 35_EDA17, 35_EDA34, 91_EDA45, 91_EDA90

against ARPEGE analysis

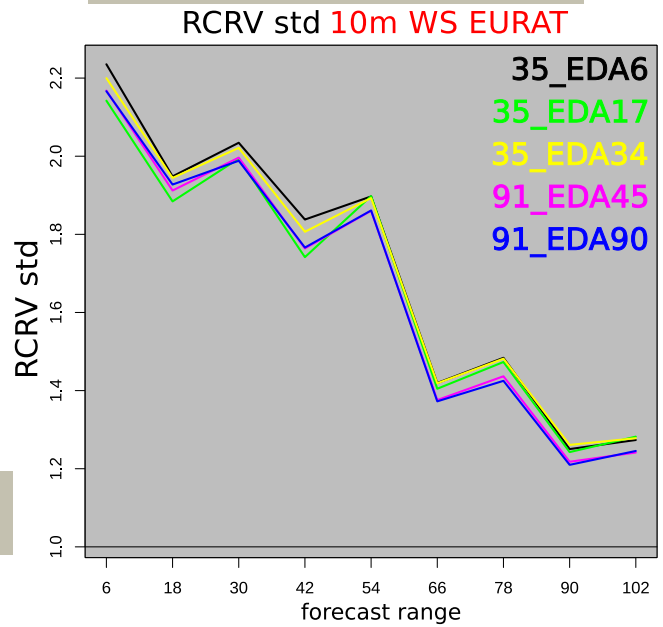




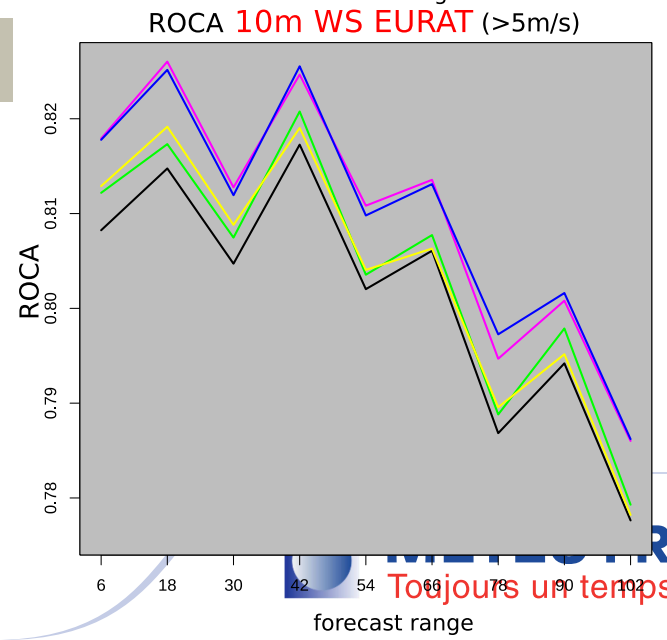
good=1

good=1

against observations



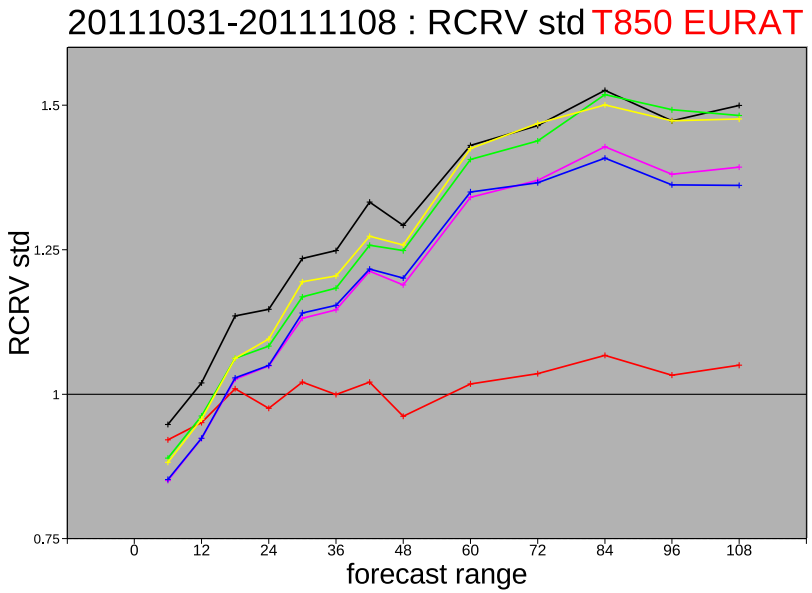
reliability

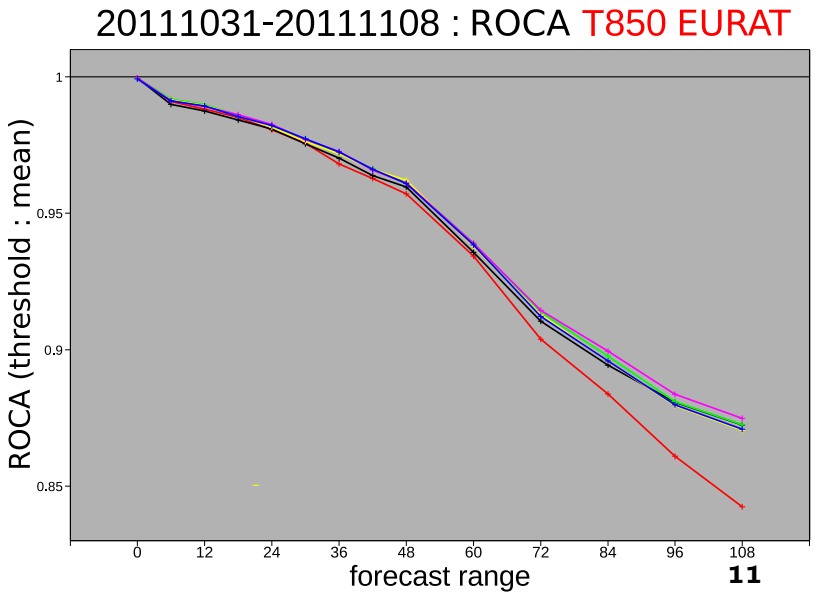


resolution

Scores 35_EDA6, 35_EDA17, 35_EDA34, 91_EDA45, 91_EDA90, 35_EDA6SV

against ARPEGE analysis

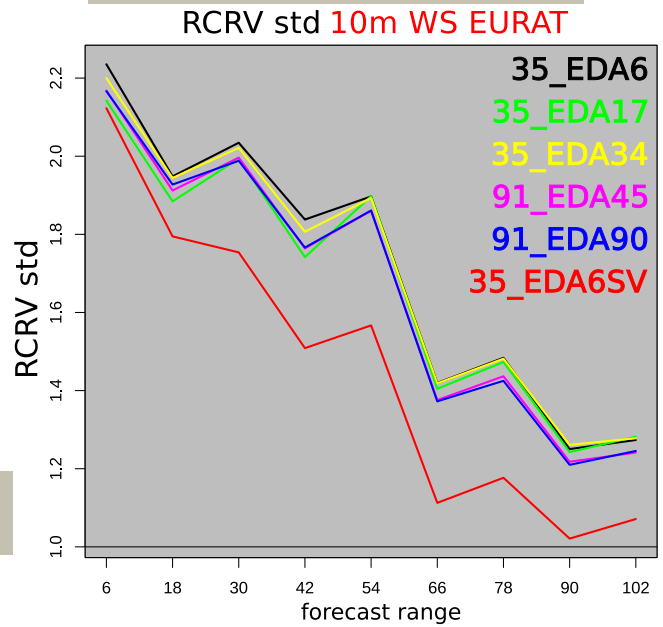


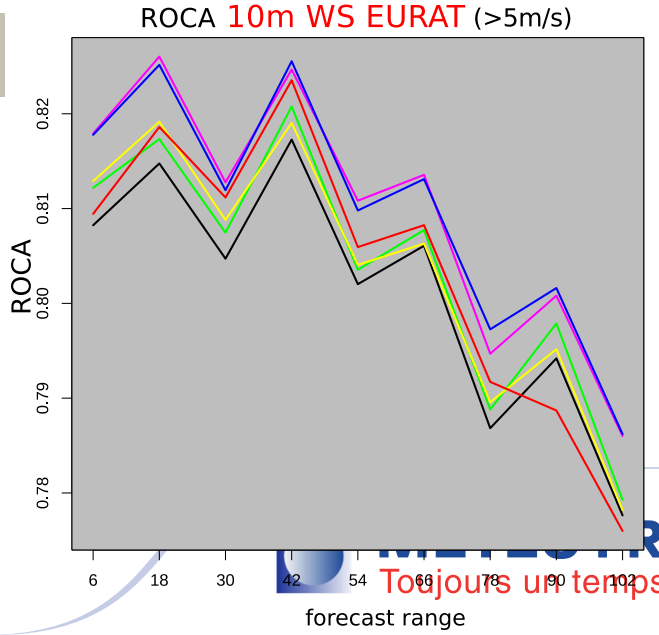


good=1

good=1

against observations





reliability

resolution

Conclusion - preliminary results

- extend the study to a longer period

sensitivity of EPS to initial perturbations

- using positive/negative pairs to increase the number of EDA perturbations does make sense ;
- increasing the number of EDA members does not improve much the EPS skill ;
- using singular vectors :
  - much better reliability ;
  - good resolution until 3 days of forecast range.

Conclusion - questions

what is the role of singular vectors in the EPS ?

- is "EDA only" able to properly sample the initial error in the EPS ?
- are singular vectors filling a gap in the model error representation ?
- further work to improve the model error representation in EPS (see model error studies M. Boisserie's poster).

Thank you - any questions ?

Contacts :

PEARP carole.labadie@meteo.fr, pierrick.cebron@meteo.fr, marie.boisserie@meteo.fr

AEARP gerald.desroziers@meteo.fr, loik.berre@meteo.fr, yann.michel@meteo.fr

Experiments on initial perturbations

Initial perturbation j

$$Pert_{j=1,\ldots,nbpert} = \sum_{s=1}^{S} \sum_{k=1}^{N_{SV,s}} (\alpha_{j,k,s} SV_{k,s}) + (P_{+6h} EDA_{m(j)} - \overline{P_{+6h} EDA}), \qquad (1)$$

with

- $\alpha = 0$ if no SV
- $m(j) = j - (6 \times (int((j-1)/6)))$ if N_{EDA}=6
- $m(j) = j$ if N_{EDA}=17, 34, 45 or 90

finally

- $Ana_{i=1,\ldots,N_{EPS}} = Ana_{control} \pm Pert_j$ if N_{EDA}=6, 17 or 45
- $Ana_{i=1,\ldots,N_{EPS}} = Ana_{control} + Pert_j$ if N_{EDA}=34 or 90

Experiments on initial perturbations and model error

Ensemble Data Assimilation (EDA) used

- It is the operational 6 members EDA based on 4D-VAR (AEARP, *L. Berre, G. Desroziers*) ;
- The model error component is taking into account by inflating perturbed background states ;
- The background states $P_{+6h}EDA$ and the mean $\overline{P_{+6h}EDA}$ of this ensemble are used.

4 35-members Ensemble Prediction Systems (EPS)

Exp	Model Error (ME)	SV ($N_{SV} = 64$)
EDA	no	no
EDA_ME	yes	no
EDA_SV	no	yes
EDA_SV_ME	yes	yes

Model error in the EPS

Random use of the 10 physical packages of the Météo-France EPS (PEARP) for all the experiments.

Scores

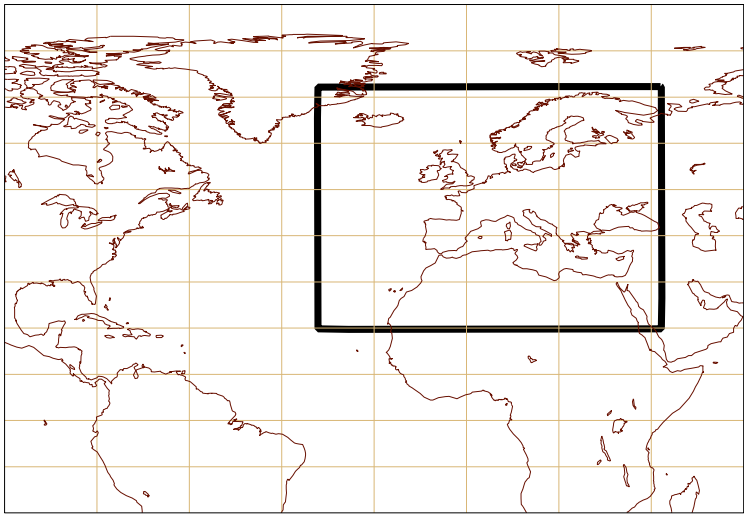
Variables

- T850
- 10m wind

Period - 19 days

- Probabilistic scores from 12/11/2011 to 30/11/2011.

Domain : EURAT

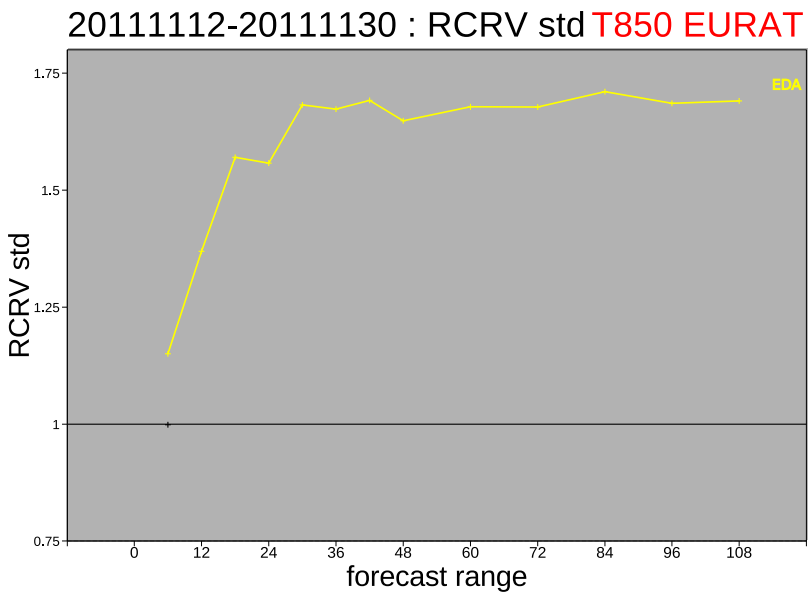


Scores

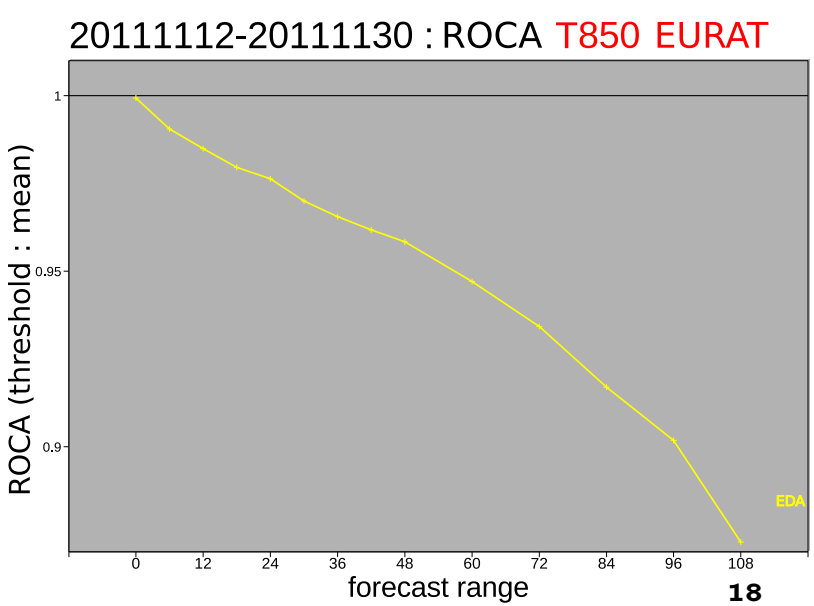
- RCRV std (reliability measure = statistical coherence between the forecasted probability an the observed occurence, 1 for a perfect score)
- Area Under the Curve (resolution measure = ability of an ensemble to distinguish different forecasted probability categories, 1 for a perfect score)

Scores

against ARPEGE analysis

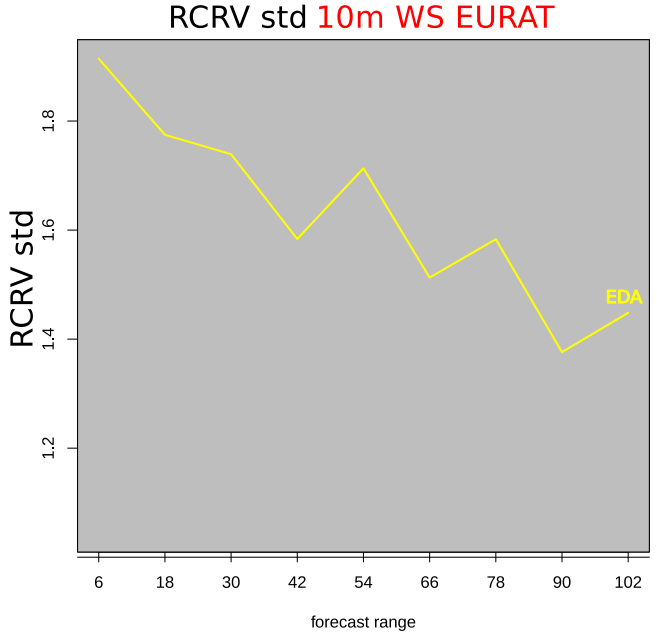


good

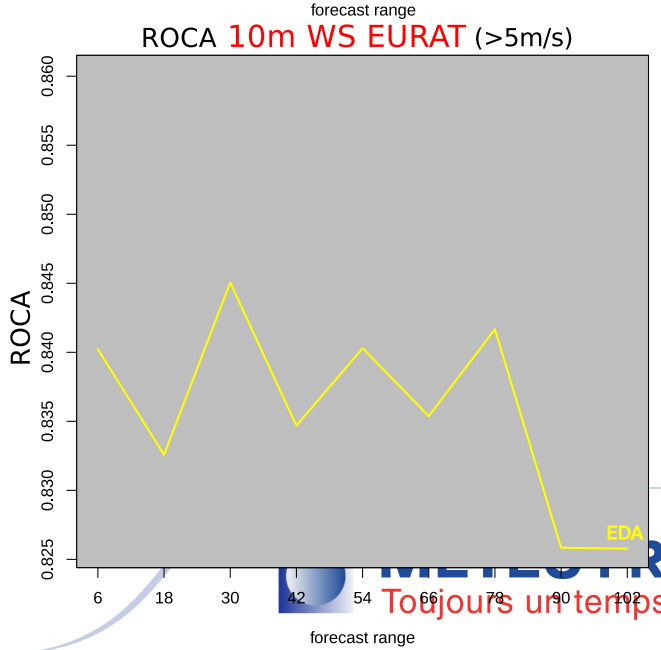


good

against observations



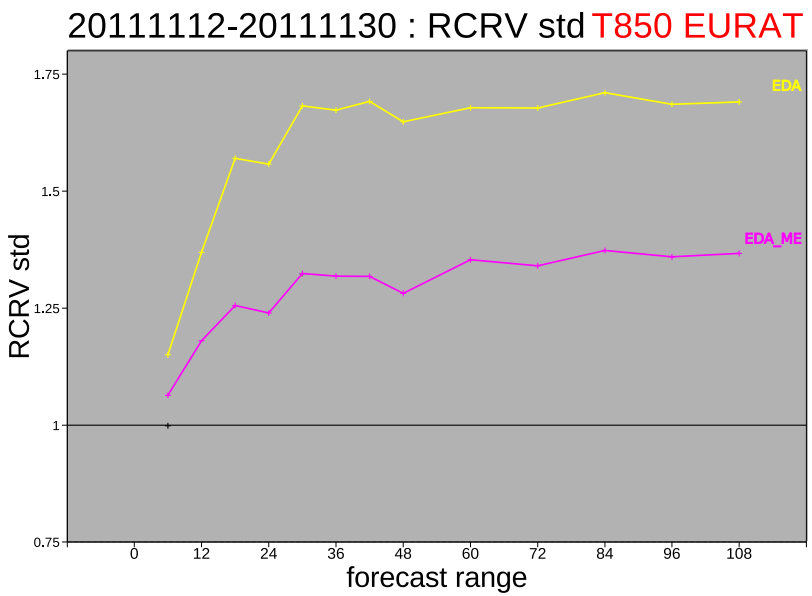
reliability



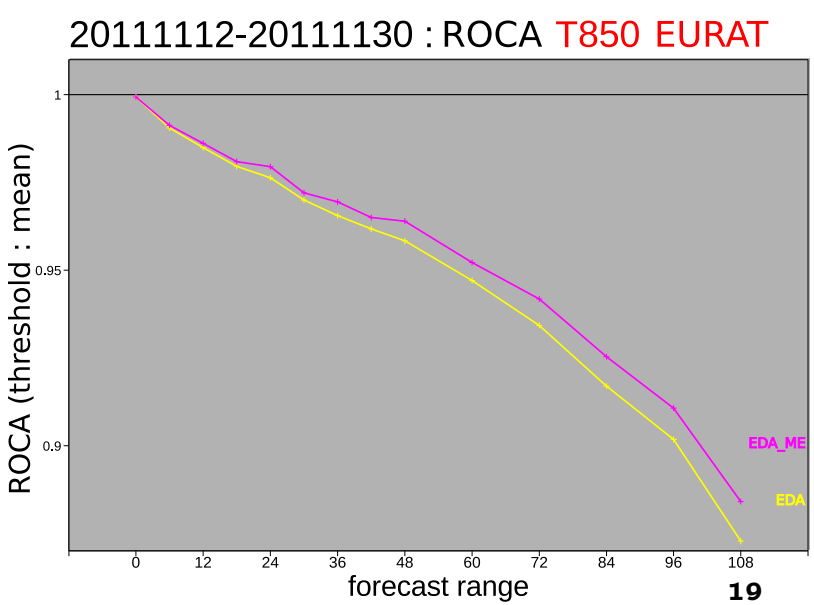
resolution

Scores

against ARPEGE analysis

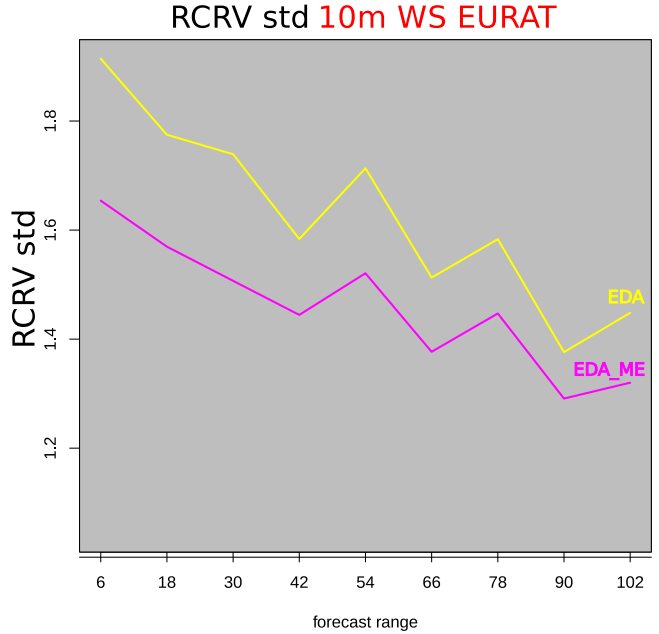


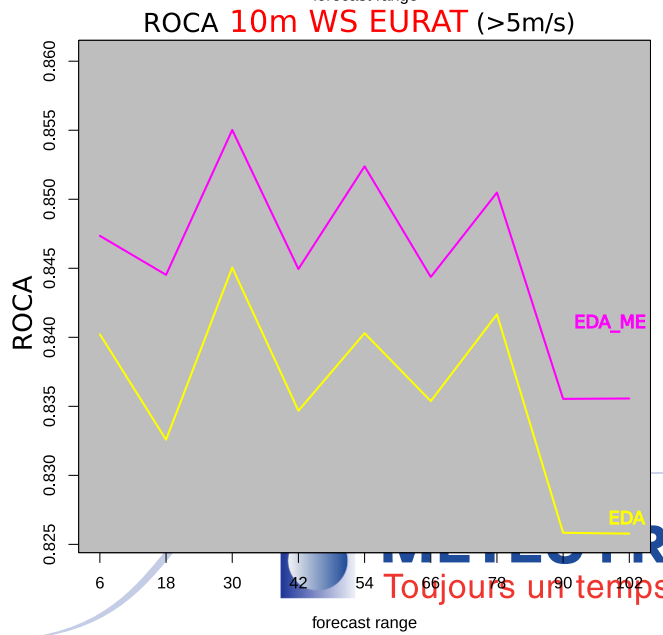
good



good

against observations



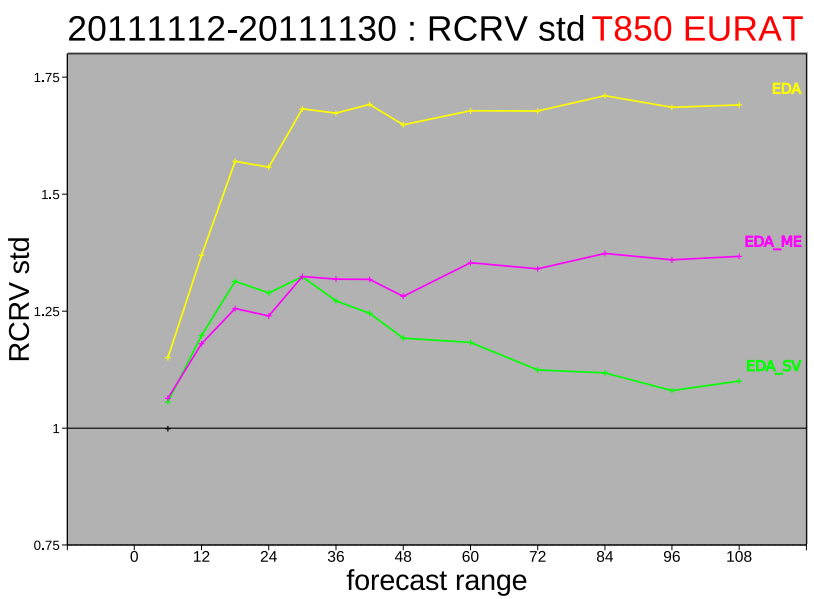


reliability

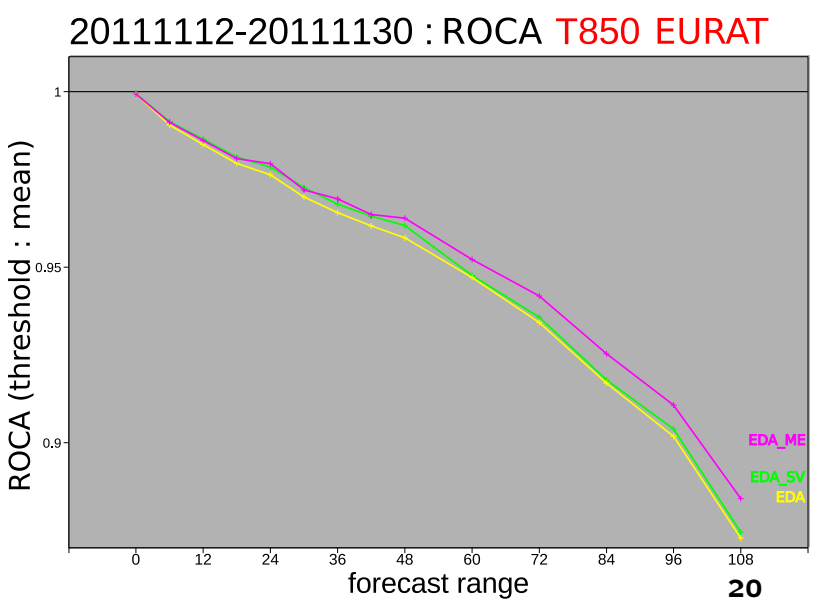
resolution

Scores

against ARPEGE analysis

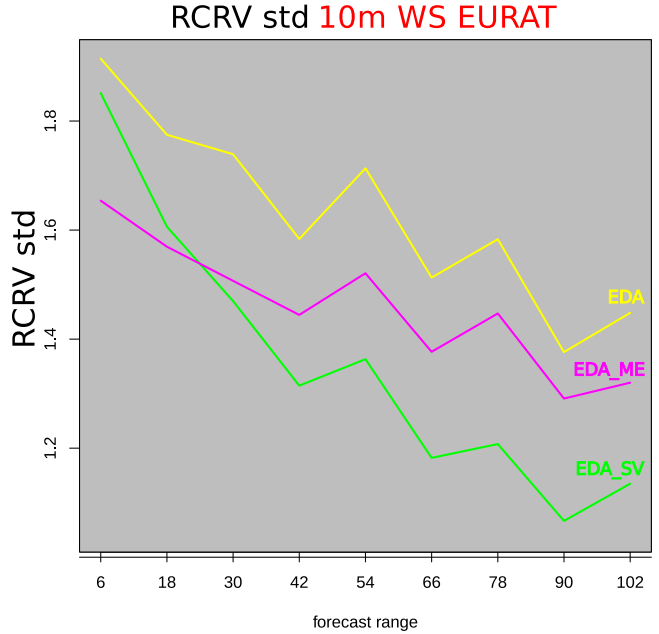


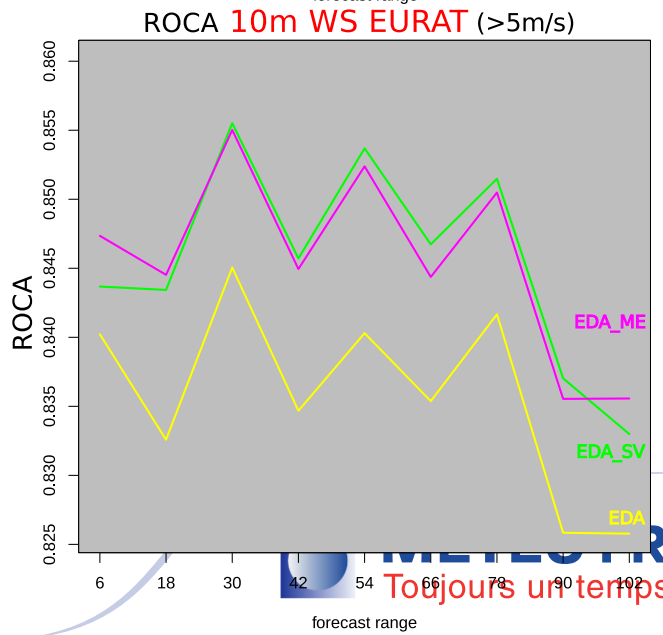
good



good

against observations



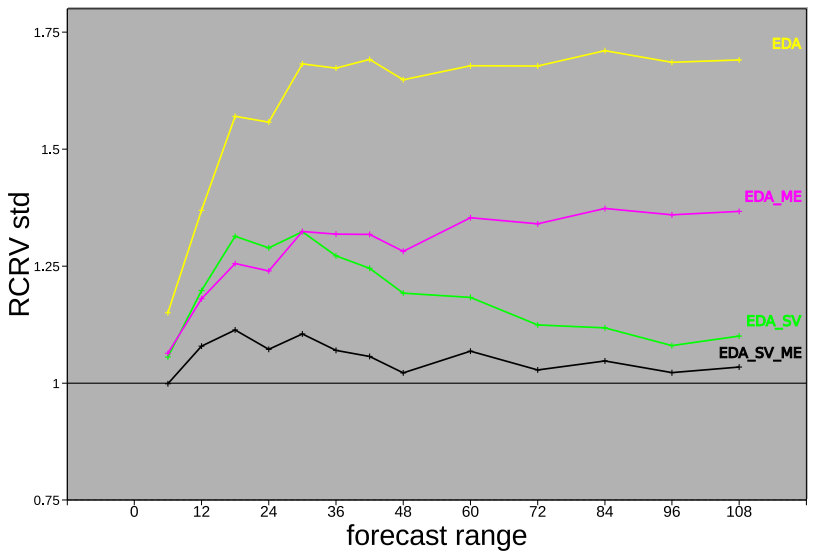


reliability

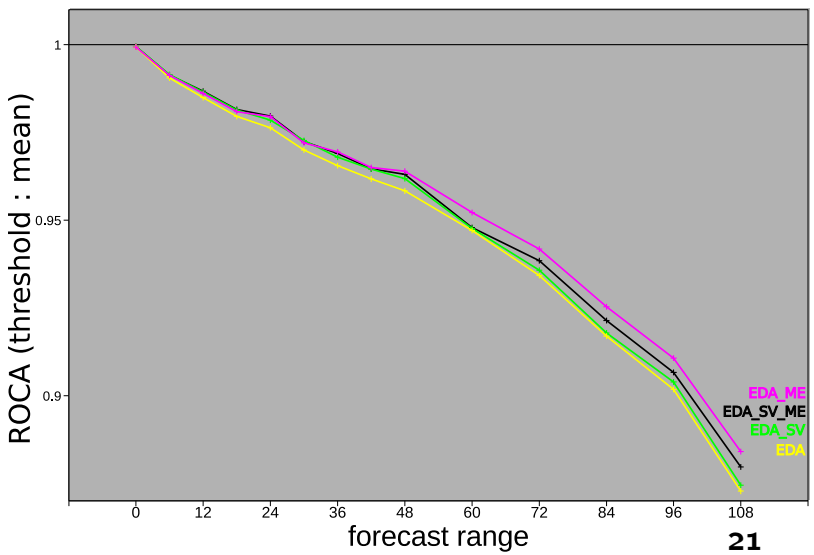
resolution

Scores

against ARPEGE analysis

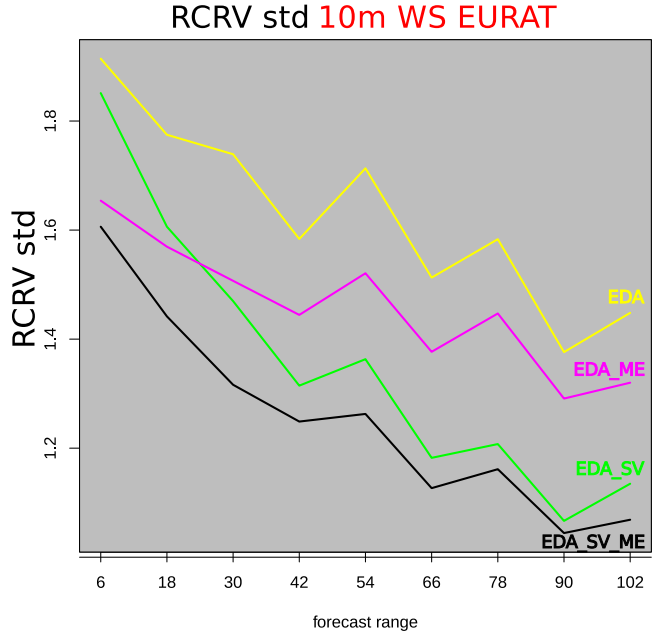


good

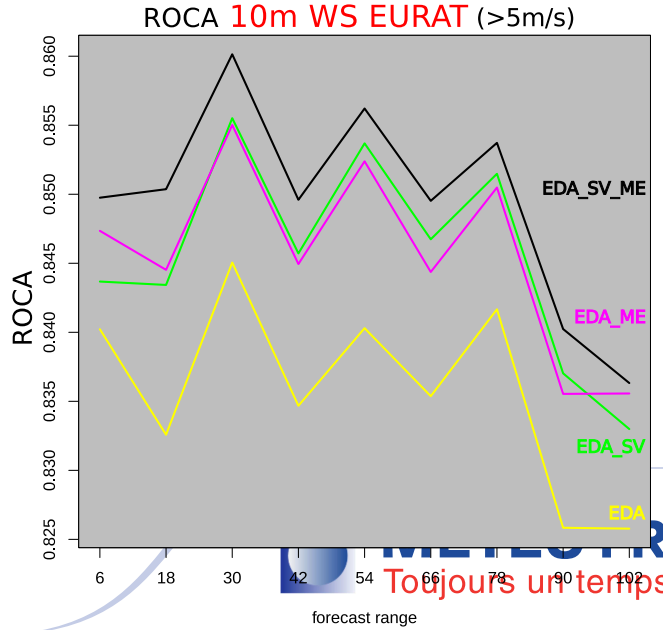


good

against observations



reliability



resolution