Review of the joint EPS-DA Workshop in Bologna

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Outline

Introduction

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Purpose of the workshop

On the one hand, data assimilation techniques require accurate estimates of forecast uncertainty in order to blend optimally the prior forecast with the new observations. On the other hand, ensemble forecasts are designed to estimate the flow-dependent uncertainty of the forecast, therefore a good representation of the analysis uncertainty is crucial, especially for short-range EPS.

$\rightarrow$ Bring together both communities.

- A snapshot of (mainly European) state of the art and trends.
- A lot of stimulating informal discussions not only during the coffee breaks, but at the sessions as well.

Workshop agenda

- Preliminary LAM-EPS meeting (22-23 March)
- Presentations (6 sessions). Not necessarily stratified by EPS vs DA.
- Discussions: a list of questions was proposed. These were then discussed first in 2 groups (DA and EPS), in the last session the outcome of both groups was presented and further discussed together.

Preliminary LAM-EPS meeting

- Overview of LAM-EPS systems
  - Most notable: several high resolution ensembles.
  - DWD: 2.8 km Nested inside 7 km LAM-EPS
  - MetOffice: plan to nest 1.5 km MOGREPS directly into 16km global
  - Perturbations from different global models
- Ensemble LBC discussion
  - LBC'sfor LAM-EPS at 06 and 18 UTC
  - A: 50+1 members at T639 (=EPS)
  - B: 24+1 at T799
  - Both based on same EDA perturbations from 6h earlier.
  - M.Leutbecher did some first tests and found very similar skill (higher resolution vs more members)
  - Option C: T1279 in first 2 days, then continued at T639 up to +144h.
  - M.Leutbecher will explore feasability & prepare test data. Consortia should experiment and come to common conclusion by spring 2012.
  - Cost...

Ensemble Prediction – quick overview

- High resolution ensembles are appearing in several places. Nested inside existing LAM ensembles.
- Large impact of EDA on ensemble skill.
- Importance of consistency of LBC's and IC's shown in some presentations and posters.
- Representation of model error.

Ensemble Data Assimilation: Introduction

- Harnessing the ensemble approach is the key problem to date in DA, both theoretically and practically.
- Technologies are far from being mature.
- The most challenging and exciting area of DA research.

The essence of EDA

Try to predict background-error statistics using a Monte-Carlo (ensemble) sample.

Two big problems:

1. Representation of model errors
2. Ensemble size

EDA requires prediction of spatial correlations – a fundamental difference with EPS.

EDA - Major topics

1. Design of the EnKF

   7 talks

2. Design of the hybrid variational/ensemble filter

   9 talks

3. Model errors

   3 talks exclusively dedicated to model errors + 6 talks actively dealing with model errors

Other topics

1. Lateral Boundary Conditions in EDA

   Normally: take fields from a *global* EDA.

   However, imposing *random* LBC perturbations can be effective.

   Need to avoid inconsistent initial and boundary perturbations.

2. Lower Boundary Conditions

   None

3. Localization issues

   5 talks

4. Non-linearity

   3 talks

5. Non-Gaussianity

   3 talks, among them 2 talks on Particle Filtering

6. Ensemble size

   6 (Meteo-France), 4 (Hungary), 10 (ECMWF), 50-100 (WRF), 32 (COSMO), 20 (Japan), 40 (Italy), 12 (HIRLAM), 24 (UKMO 1.5 km)

Design of the EnKF

1. Ensemble-space techniques: ETKF/LETKF

   6 talks
2. Observation-space techniques

   2 talks
3. Exotic filters (sigma-point, morphing, ...)

   None

Design of the hybrid variational/ensemble filter

1. Mixing of ensemble and 'climatological' covariances

   3 talks

2. The alpha-control technique (mixing the localized ensemble covariances with 'climatological' ones)

   2 talks

3. Fitting a parametric model to ensemble covariances

   4 talks

Model errors

- Multiplicative inflation

  3 talks
- Additive inflation

  3 talks
- Multi-physics

  2 talks
- Perturbed parameters

  1 talk
- Stochastic physics

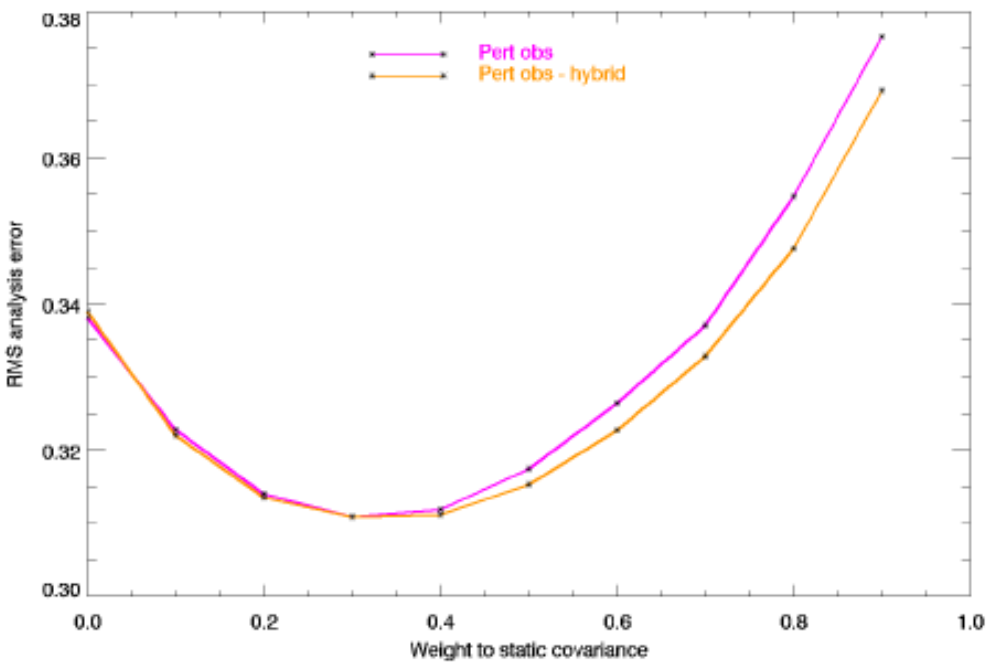
  4 talks
- Stochastic parametrizations

  None
- Stochastic backscatter

  4 talks

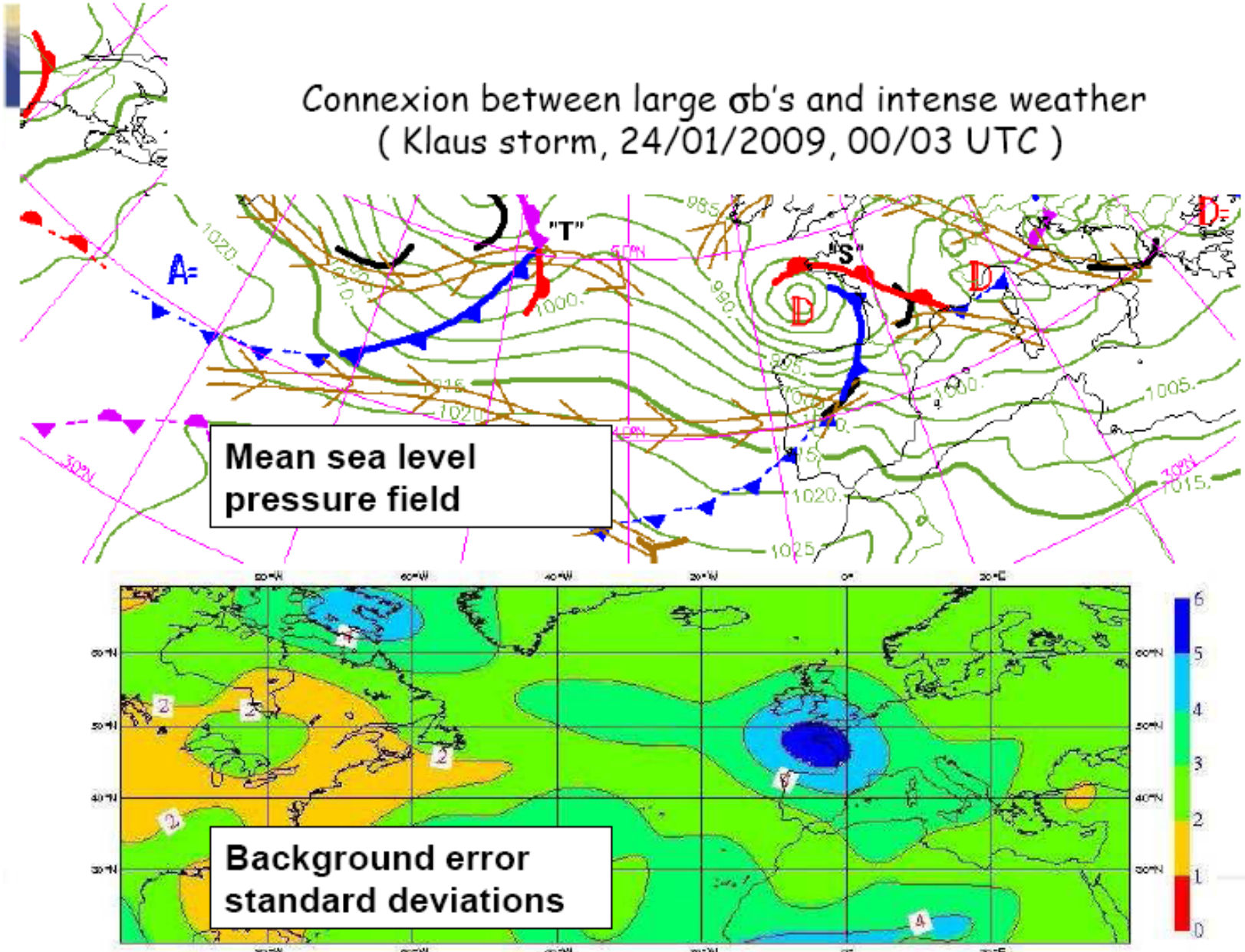
Optimality of a hybrid assimilation

Using hybrid covariances



- Obs error 1.0, observations every grid-point
- 5 ensemble members
- Hybrid covariance used in control analysis

Ensemble spread: a Meteo-France example



Discussion. Open questions: 1

- The same ensemble generation techniques for *assimilation* and *prediction*?
- *Model errors*: employ the same approaches in EPS and EDA?
  How to combine different model-error generation techniques?
  Which model errors really matter?
  Use field experiments to assess model errors?
- Is it worth using multi-model/multi-physics ensembles in DA/EPS? Is it just a temporary solution?
- What are suitable IC perturbations for a convective-scale model?
- EPS: How to select a small number of members?

Discussion. Open questions: 2

- Should LBC's come from a global model aimed at short time-scale?
- More members or higher resolution?
- Perturb everything uncertain? Orography etc.?
- How to optimize *localization* techniques?
- Ready to skip singular-vector based perturbations?
- DA: the ultimate solution: Var or EnKF or Hybrid?
- *Non-Gaussianity*: acceptable for EnKF?
- *Non-linearity*: how to design the *outer loop*?
  Is non-linearity worse for 4D-Var or EnKF?

Conclusions

1. EPS and DA share many common techniques and goals!
2. EDA should be part of EPS, whilst EPS is part of EDA.
3. EDA is a very active area.
4. Practical approaches dominate. Theoretical justifications are often lacking.
5. EnKF is simpler, Hybrid approaches seem to be more powerful.
6. Model error remains to be an issue.

7. Very many thanks to the organizers!: Tiziana, Chiara, Andrea ...

   Especially for the idea to collect questions and stimulate the discussion!

Ciao!