Ensemble assimilation methods for limited area data assimilation

Y. Michel

CNRM, Météo-France & CNRS, Toulouse, France

April 27th, 2016

Joint ALADIN/HIRLAM strategy meeting.

Strategy

Next generation AROME DA system

Goals

- we are convinced about the use of ensembles to build **B** statistics;
- we need to think about coupled ocean-atmosphere assimilation;
- we want assimilation of radars and satellites (MTG/IRS) with high spatio-temporal density.

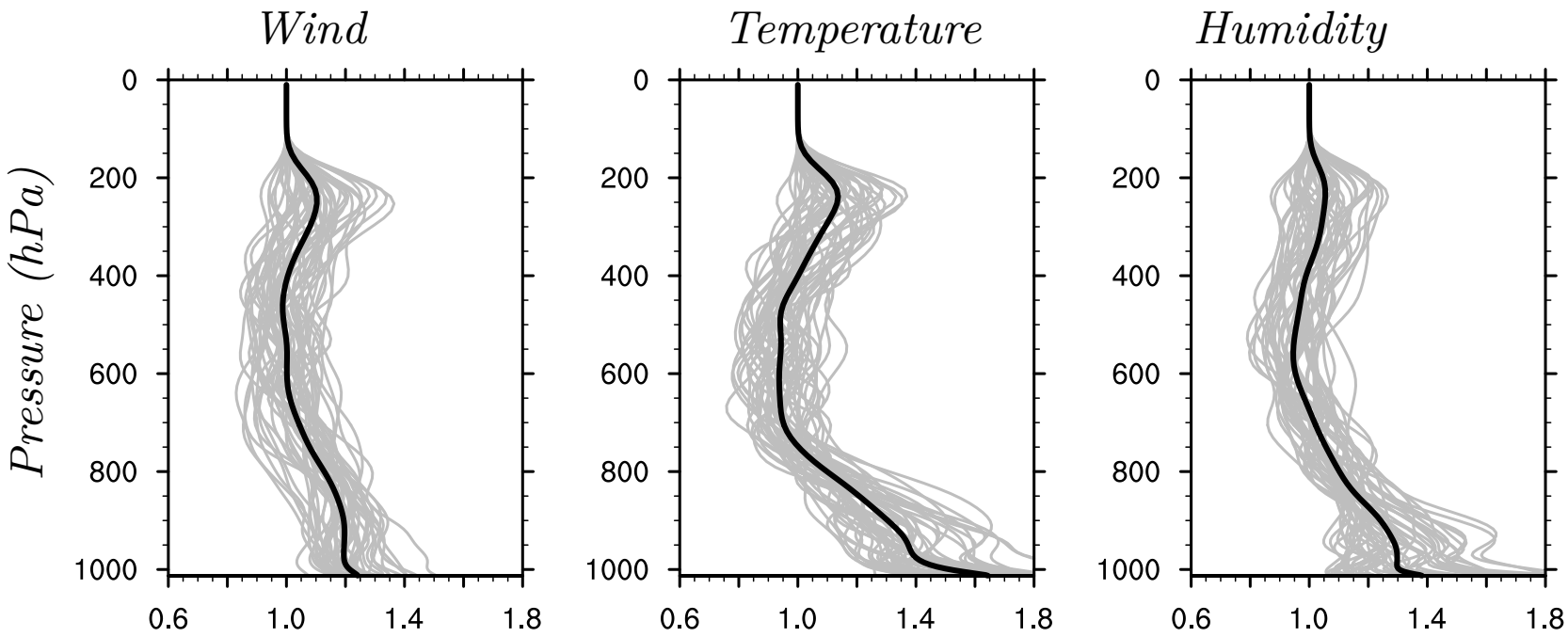
Design of a 4D-EnVar assimilation for AROME

- being close enough to the operational 3D-Var: same **H**;
- with objective localization in model space;
- with a variational solver that is preconditioned with a square-root free approach – *OOPS*;
- using an ensemble that is consistent with the (higher resolution) deterministic assimilation;
- that can be extended to 4D, like 4D-Var.

Situation of the topic: AROME EDA (2016)

Ensemble scheme

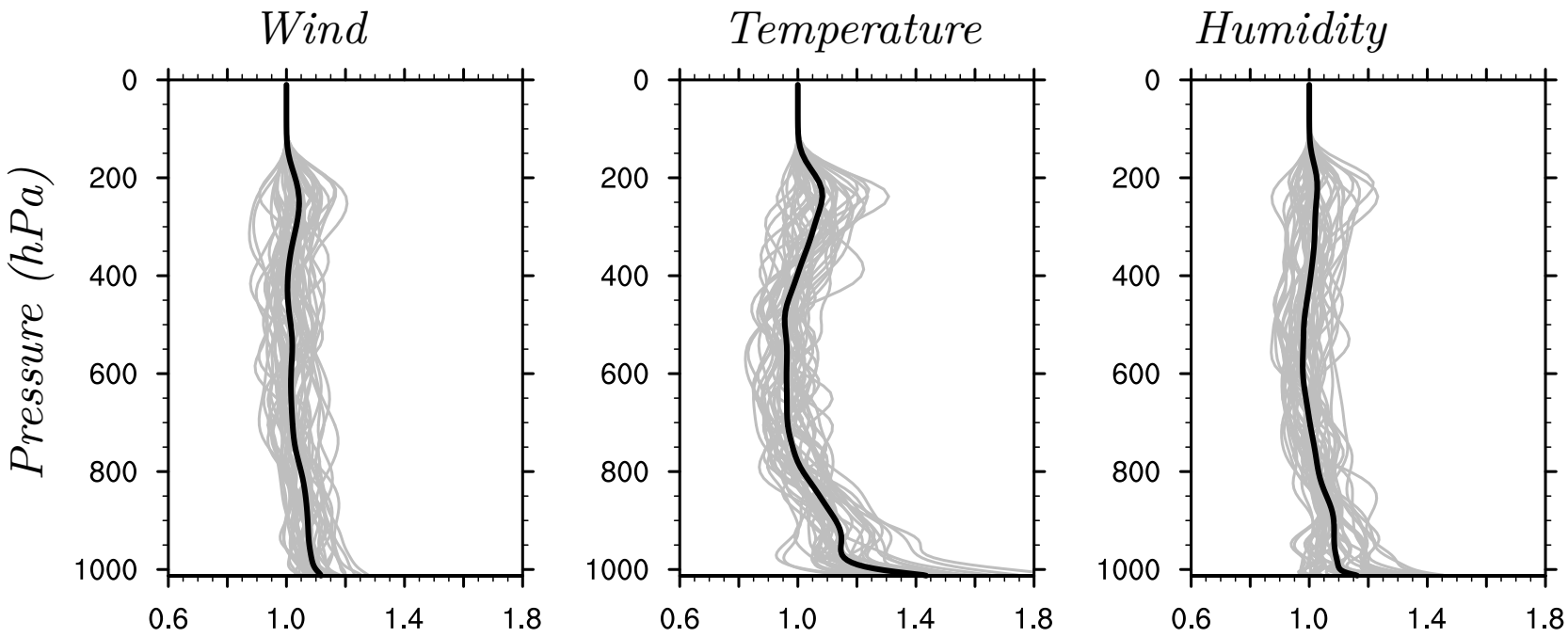
- Ensemble of AROME 3D-Vars (EnVars) at reduced resolution;
- Perturbed observations (incl. surface), SPPT, SST perturbations.
- Multiplicative inflation ("spread-skill" scheme) – Offline



Situation of the topic: AROME EDA (2016)

Ensemble scheme

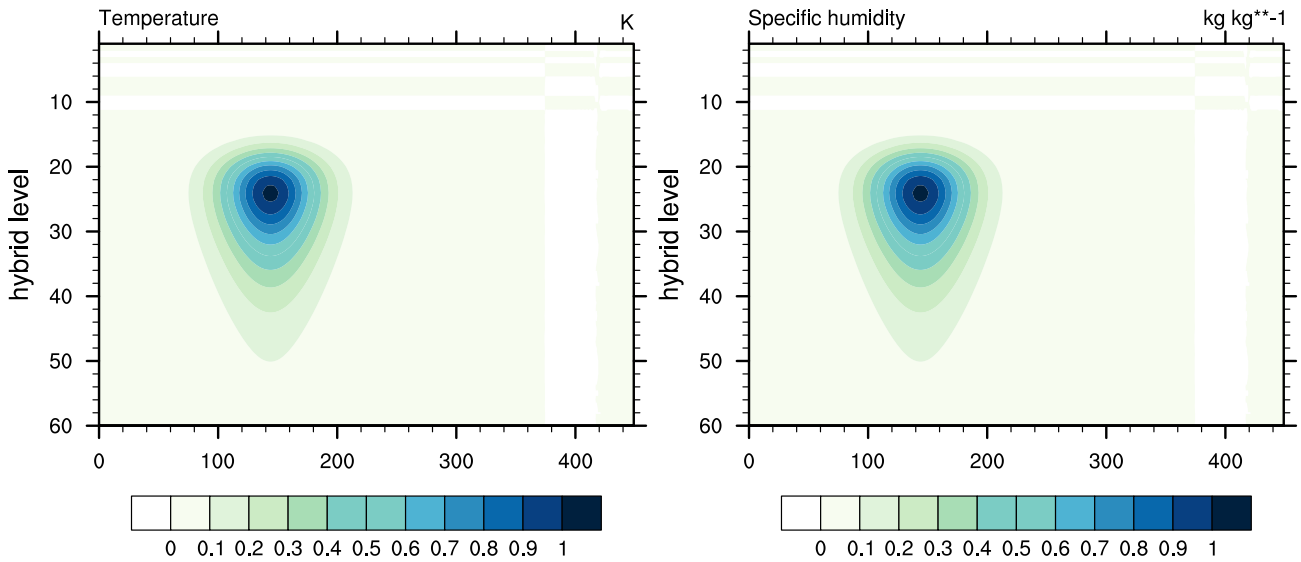
- Ensemble of AROME 3D-Vars (EnVars) at reduced resolution;
- Perturbed observations (incl. surface), SPPT, SST perturbations.
- Multiplicative inflation ("spread-skill" scheme) – Online



Situation of the topic: localization in AROME EnVar

Météo-France (2016)

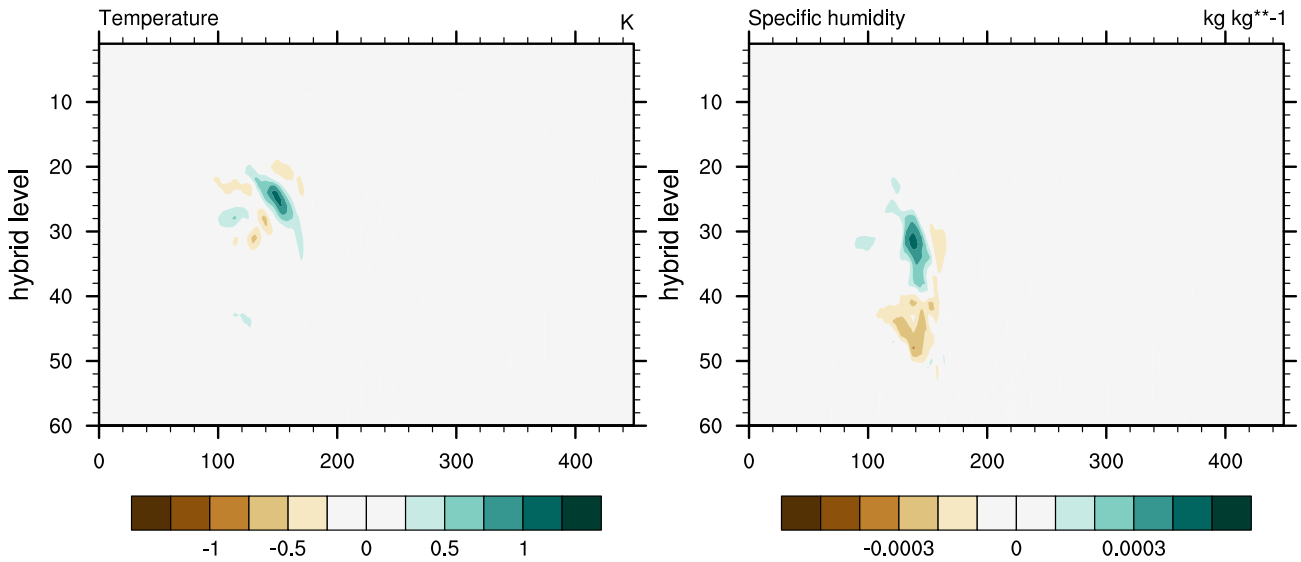
- Same localization for all 3D variables, lnPS treated as first level.
- Objective estimation of the localization from ensemble data only.
- Scheme 1: bi-Fourier and eigenmode decomposition + truncation on the vertical (similar to the correlation part of our $\mathbf{B}$ matrix)
- Scheme 2: gridpoint recursive filters with spatial deformations on the vertical (non-periodic, similar to GSI/WRF correlation model).



Situation of the topic: localization in AROME EnVar

Météo-France (2016)

- Same localization for all 3D variables, lnPS treated as first level.
- Objective estimation of the localization from ensemble data only.
- Scheme 1: bi-Fourier and eigenmode decomposition + truncation on the vertical (similar to the correlation part of our $\mathbf{B}$ matrix)
- Scheme 2: gridpoint recursive filters with spatial deformations on the vertical (non-periodic, similar to GSI/WRF correlation model).



State of the art (from ISDA 2015)

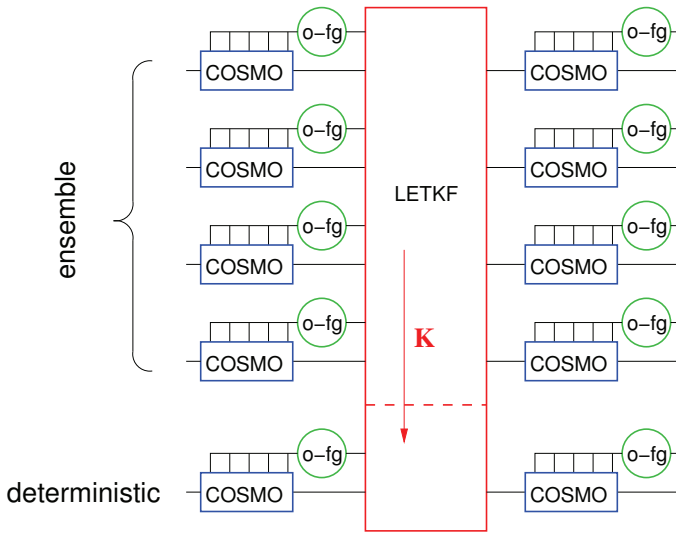
Kilometer Scale Ensemble Data Assimilation, DWD

"Replace (operational) nudging with deterministic LETKF analysis and use as COSMO-DE EPS initial conditions"

Observations

- Conv. data (radiosonde, aircraft, wind profilers, surface stations)
- Radar precipitation through latent heat nudging – plans for direct assimilation of radar reflectivities.

Model and assimilation scheme



- COSMO at 2.8 km;
- LETKF with 40 members at full resolution; hourly cycling.
- Inflation: relaxation to prior perturbations.
- Explicit soil moisture and SST perturbations.

State of the art (from ISDA 2015)

Hourly cycling 4D-Var and/or EnKF, UK Met Office

"Develop hourly 4DVAR / Explore the potential of ensemble data assimilation for high-resolution LAM DA."

Observations

- Visibility observations (humidity and aerosols);
- Observations of near-surface temperature and humidity from the UK's roadside sensor network;
- 3D cloud analysis from cloud top temperature (IR satellite) and surface cloud reports;
- Rainfall data through latent heat nudging;
- Doppler radial wind data.

Model and assimilation scheme

- 1.5km UK model, currently 3D-Var with a 3H assimilation cycle.
- Progress to develop hourly 4DVAR and **explore EnKF**.

State of the art (from ISDA 2015)

"Big Data" Assimilation for severe weather forecasting, RIKEN

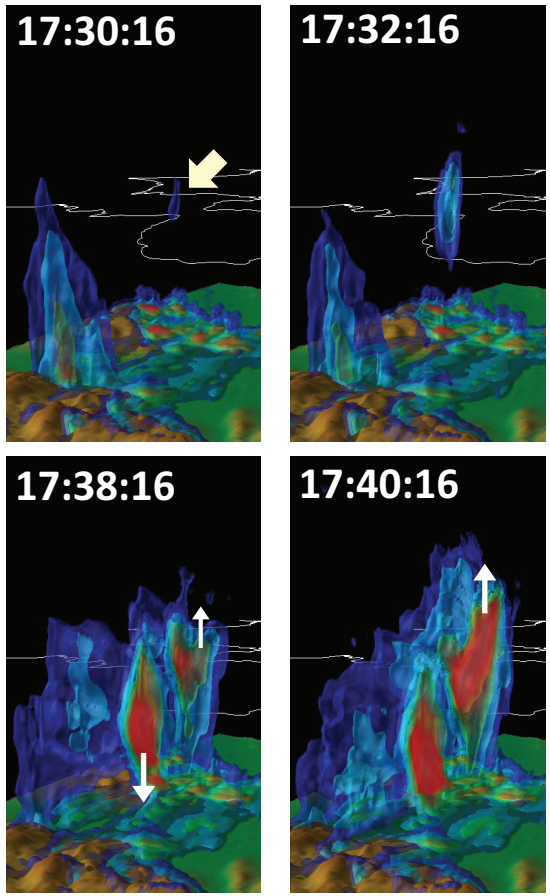
"Explore a 30-sec. super-rapid DA cycle to forecast sudden local torrential rainfalls (Tokyo 2020 to demonstrate?)."

Observations

- JMA geostationary satellite Himawari-8 (super-rapid scan every 30 seconds);
- Phased Array Weather Radar (volume scan in 10-30 seconds at a 100-m radial resolution with 100 elevation angles).

Model and assimilation scheme

- 30-minute forecasts at a 100-m resolution in LES.
- EnKF (40 members, 500-m resolution?)



Technical tasks (2016)

- Move AROME EnVar prototype to cy43 and to latest OOPS version – very first phasing!
- Allow the use of the same set of observations as oper. 3D-Var.
- Implement change of resolution between ensemble (4 km) and deterministic (1.3 km).
- Make AEARO operational (2018).

Scientific studies

- Extensive comparison of 3DEnVar versus oper. 3D-Var.
- Study 4DEnVar: 4D localization, initialization strategy, etc.
- Study (consistent) ensembles of EnVars.
- Later on, make profit of EnVar scheme to extend the control variable (coupling, hydrometeors...) - 2020?