Environment Canada’s Regional Ensemble Kalman Filter: Some preliminary results

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Global EnKF at the Environment Canada

- Operational since 2005
- Maintain reasonable meteorological quality.
- Weak components of the algorithm need to be improved. (e.g., localization, bias correction, ......)
Monte Carlo methods in the global ensemble

192 sets of perturbed observation

- 192 9h forecasts with different model configurations
- Add random system error

Ensemble Kalman filter

- Use all 192 analyses for data assimilation cycle
- Select 20 members for medium-range forecasts

Generation of products for users

- Perform 20 16-day forecasts using different model configurations and stochastic parameterizations
- Add random system error
Assimilation window

digital filter
analysis
background
observation

6 H

0 3 6 9

0 3 4 5 6 7 8 9
Sequential ensemble Kalman filter

192 first-guess fields

first-guess covariance from the ensemble

EnKF

first set of observations

192 second-guess fields

second-guess covariance from the ensemble

EnKF

second set of observations

192 third-guess fields

Kalman filter: observations can be grouped into independent batches with the same final result.

192 analyses

Stochastic EnKF with localization: the final result depends on the order of the observations.
Main purpose of EnKF is to generate the 20 initial conditions for the global ensemble forecast for every 12 hours.

REPS has the same initial conditions as the GEPS.
- Initial states: 100 km, 2 hPa top
- GEPS: 66km, 2hPa top
- REPS: 33km, 10hPa top
Regional Deterministic Prediction System (RDPS)

G: Global Model (33 km)
D: Driver Model (33 km)
R: Regional Model (15 km)

Driving
Trial field
Global analysis used

Trial field
3D-VAR FGAT Analysis
4D-VAR Analysis
NL-High 15-km grid (649x672)
NL-High 10-km grid (996x1028)

NL-Low/TL/AD 100-km grid (141x141)
Following the regional 4D-Var, no cycling is performed.
Data assimilation for every 36 hours.
No model parameter perturbation.
Comparison of 48 hour forecasts

- Perform the regional deterministic forecasts (GEM-15km) from two initial conditions for every 36 hours.
  1. Mean analysis from the regional ensemble Kalman filter.
  2. Mean analysis from the global ensemble Kalman filter.
- Verify against radiosonde observations every 12 hours.
Global EnKF vs. Regional EnKF (0H, 12H)
Global EnKF vs. Regional EnKF (24H, 48H)
Experiment summary

- The global EnKF is ported to the regional EnKF with little efforts.
- Regional ensemble mean produces 48 hour deterministic forecast as comparable as the global mean.
- Computational cost of the regional EnKF is acceptable for the operational use.
Synchronous coupled EnKF: Global and Regional

- Bias correction from global 4D-Var.
- Background check from global and regional 4D-Var.
Future work

• Localization distance adjustment.
  • Flow dependent covariance localization.
• Observation density: reduced data thinning.
• Higher vertical resolution.
• Perturbations from the regional covariance.
• Model parameter perturbation.
• Background check and bias correction.
• It can be beneficial to share the main algorithm between the global and regional EnKF.