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# The 2010 Upgrade of the Canadian Global Ensemble Kalman Filter and Ensemble Prediction System

The 5th NAEFS workshop

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# Overview

The global EnKF and EPS as well as their coupling will be improved near the end of 2010.

1) 192 members with a 400x200xL58 grid and a model top at 2 hPa for the EnKF.
2) The initial ensembles used for the EPS are coherent with the initial ensembles used in the EnKF.
3) 20 members and a 600x300xL40 grid for the medium-range EPS.
4) Conclusions and future plans.

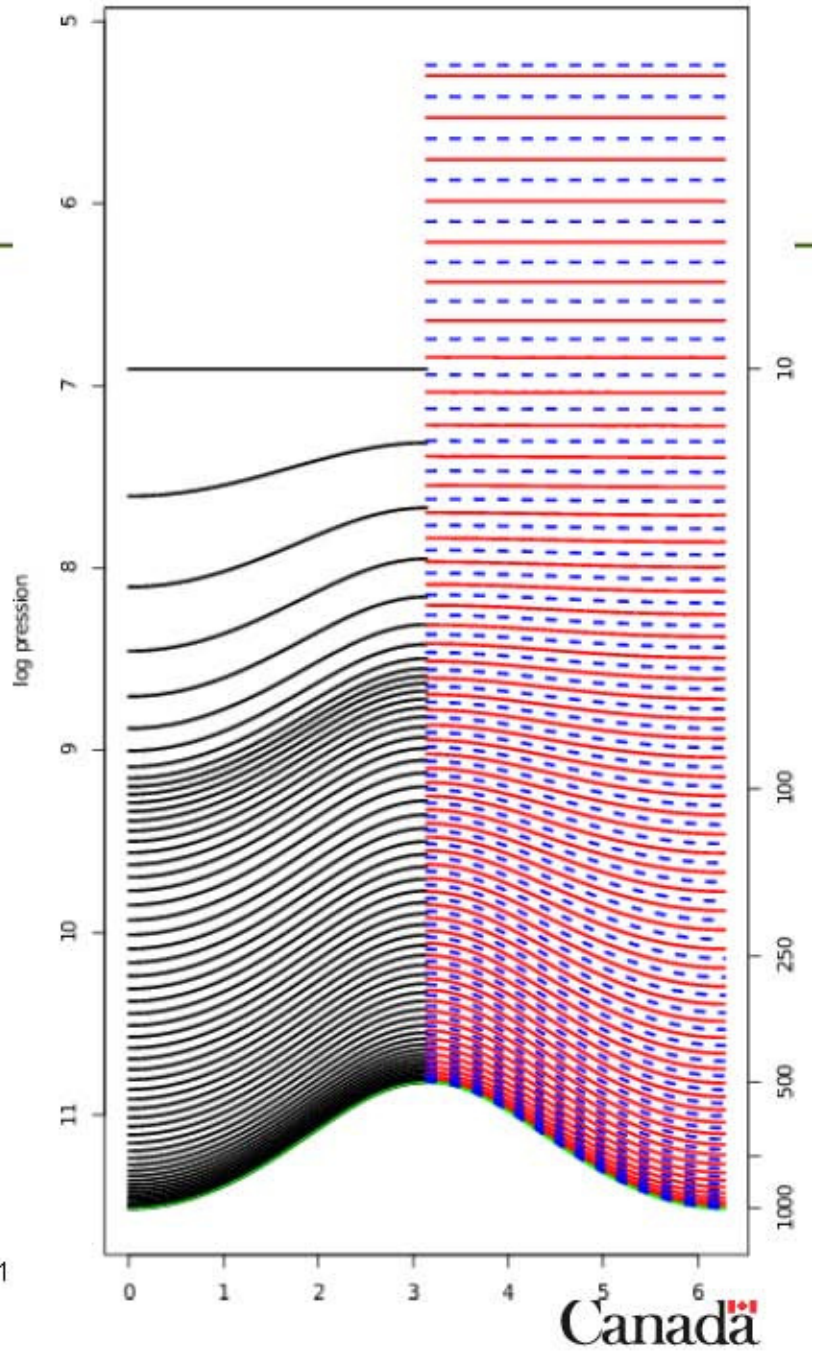
# Vertical grid (EnKF)

In the new dynamical model, we have Charney-Phillips staggering for the vertical coordinate.

black lines: 58 levels of the operational EnKF (top at 10 hPa).

dashed blue: levels with temperature and humidity (top near 2 hPa).

solid red: levels with winds (still 58).



# Ensemble size for the EnKF

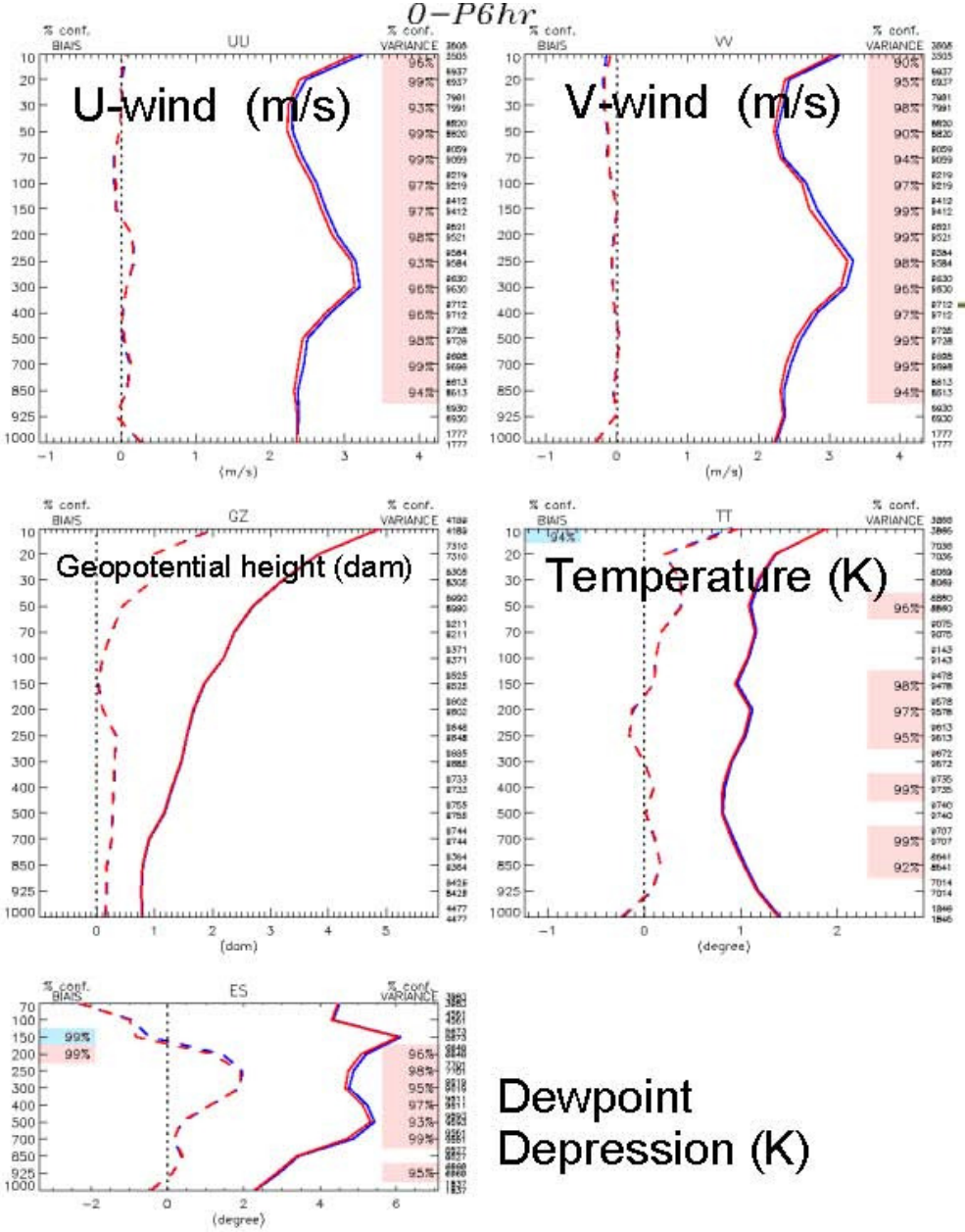
In Monte-Carlo methods, estimation errors decrease only with the root of the ensemble size. We also need many ensemble members to extract the information from a high-density observational network.

==> We have an interesting improvement in quality just from going to 192 members.

Going to 192 members did also permit us to:

- use the *B_nmc matrix to simulate model error* (this matrix has smaller scales than used before),

- better *estimate low correlations between wind and temperature in the stratosphere* (for the assimilation of AMSU channels 11 and 12).




# Impact of going from 96 to 192 members

The verification of the ensemble mean trial field (6h) against the global radiosonde network is shown.

The only change evaluated here is the doubling of the ensemble size.

In particular for the wind components (upper two panels), we have a significant improvement.



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# EnKF changes

Impact of:

-going from 96 to 192 members,

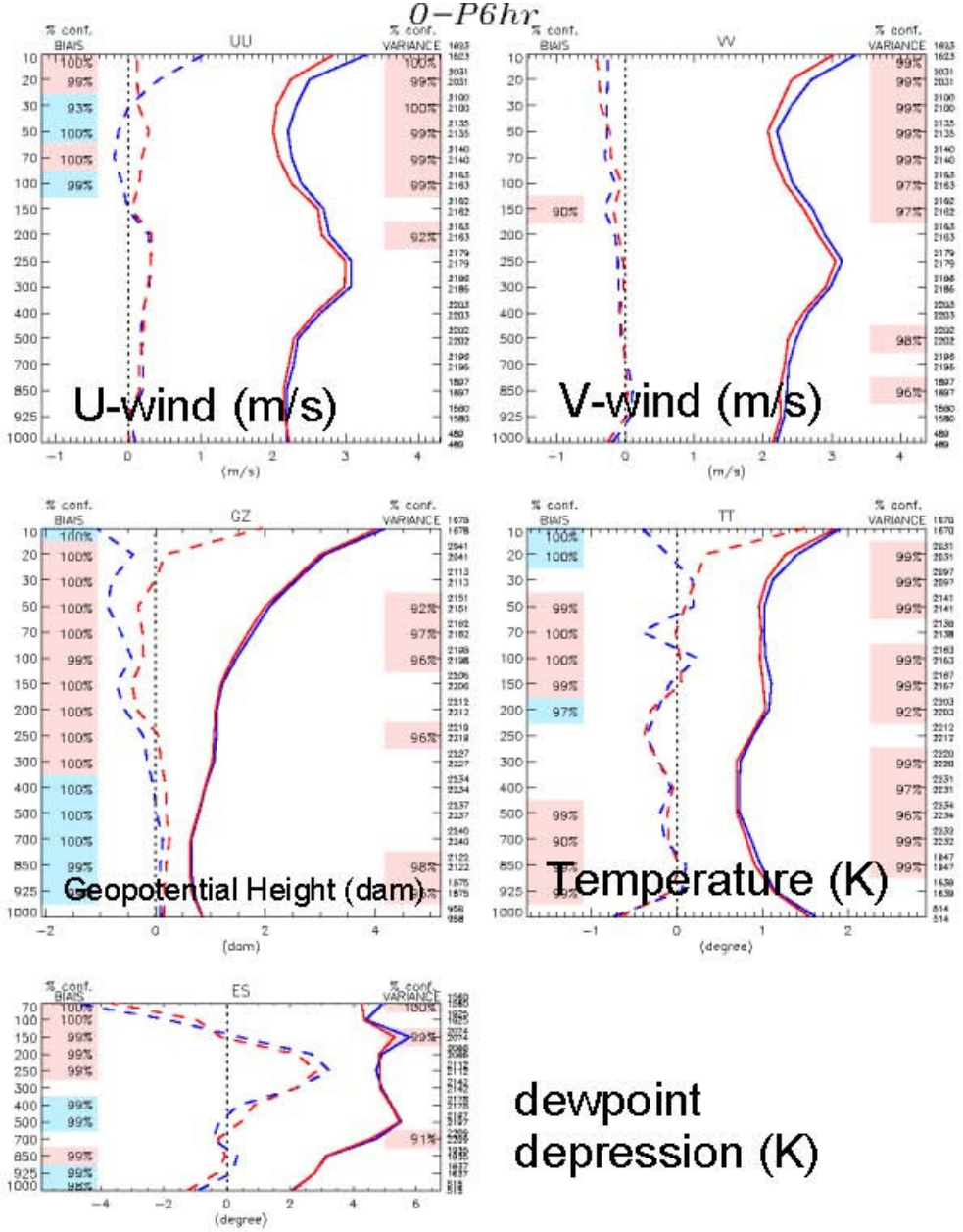
-the staggered coordinate,

-moving the top from 10 to 2 hPa,

-adding AMSU-A channels 11 and 12,

-adding more GPS-RO observations.

The impact at 6 hours is shown for North-America (excluding Mexico) in summer 2008 (10 days).



# Coupling of the EnKF and the EPS

The EnKF provides more initial conditions than we need for the EPS. We use a fixed selection scheme but conserve the ensemble mean.

| EnKF member number | EPS member number |
|---|---|
| 1-5 (subensemble 1, 1-5) | 1-5 |
| 54-58 (subensemble 2, 6-10) | 6-10 |
| 107-111 (subensemble 3, 11-15) | 11-15 |
| 160-164 (subensemble 4, 16-20) | 16-20 |
| ensemble mean | control member |

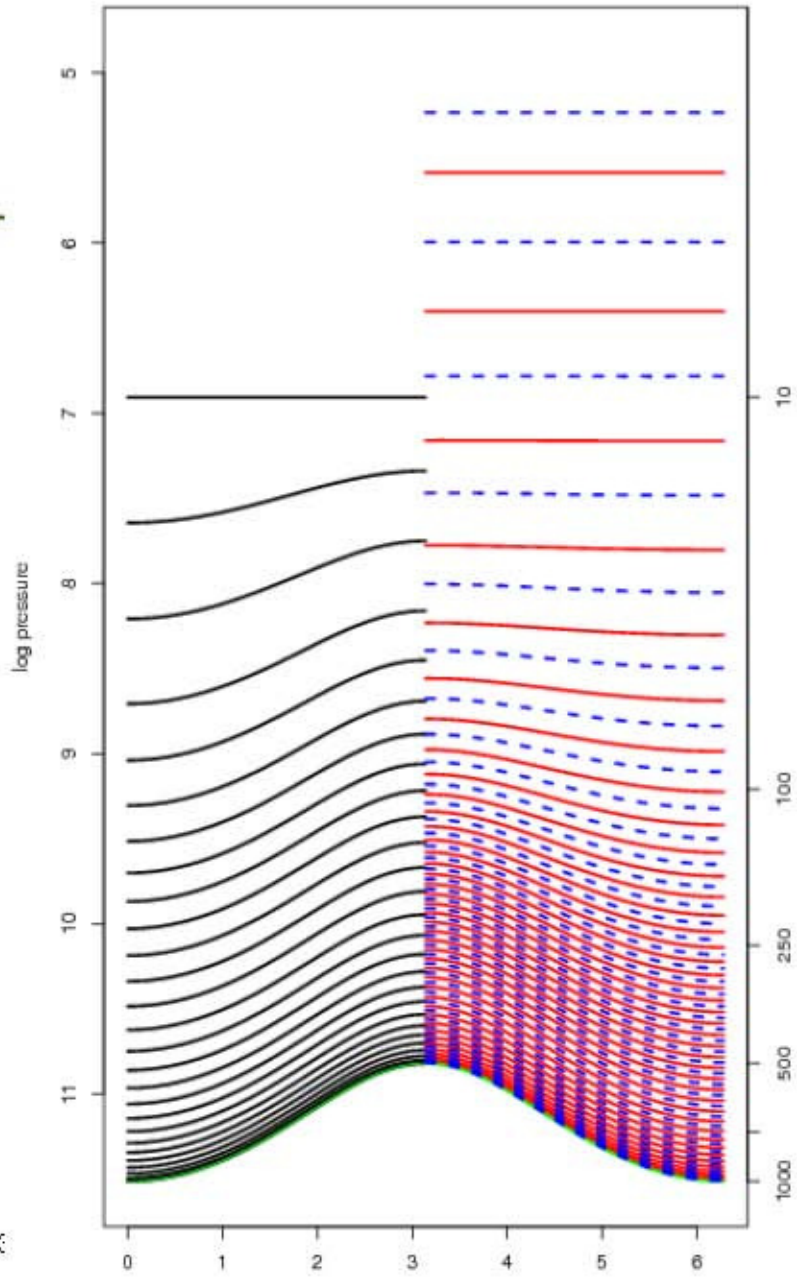
Exactly like in the EnKF, we add a small amount of model error to the 20 analyses before starting the 20 medium-range integrations. We no longer use any special procedures to obtain an unrealistically large initial spread.

# Grids of the EPS

In the medium-range EPS, we now have 28 vertical levels and a model top at 10 hPa. We intend to move to 40 levels with a top at 2 hPa.

In the horizontal, we move from a 400 x 200 uniform grid to a 600 x 300 uniform grid.

In particular in the NAEFS context, we see no reason to increase ensemble size beyond 20 for our center. With NCEP (and FNMOC) we have 40 (60) members. Most scores saturate at this ensemble size (around 50).



# Evolution of Sea Surface Temperature

Operationally, we keep the SST fixed during the two-week forecast. We intend to superimpose a fixed anomaly on the evolving climatology. In the future, we could use the EPS for intraseasonal forecasts (~40 days).

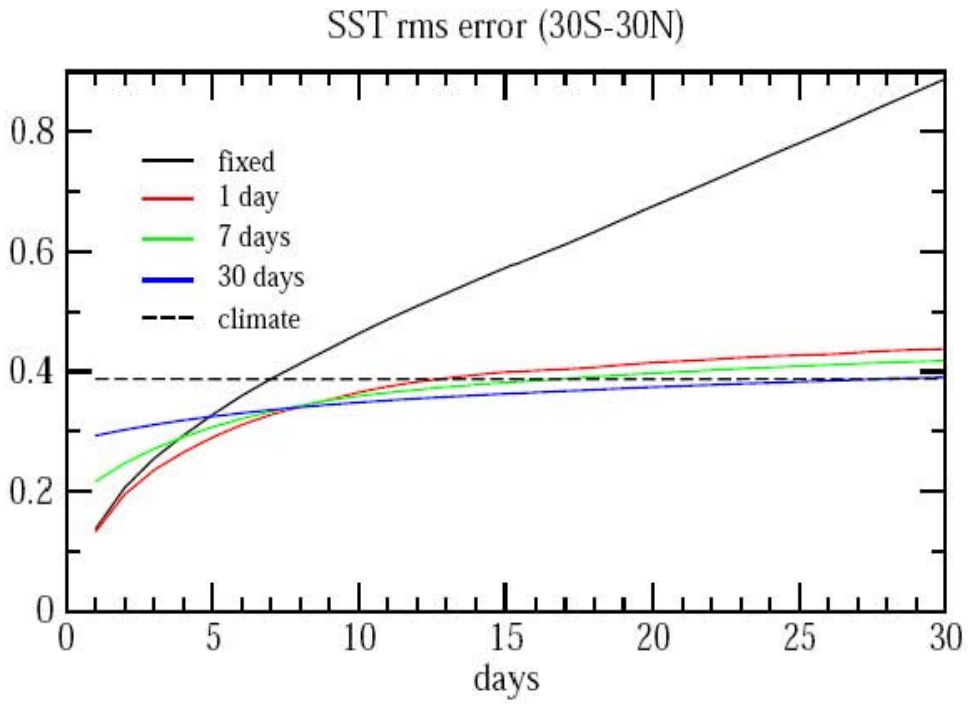
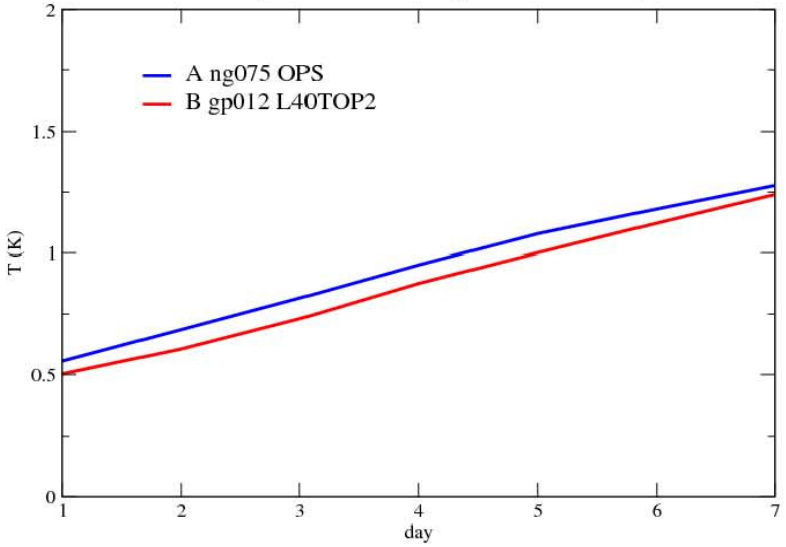



Figure from Hai Lin.

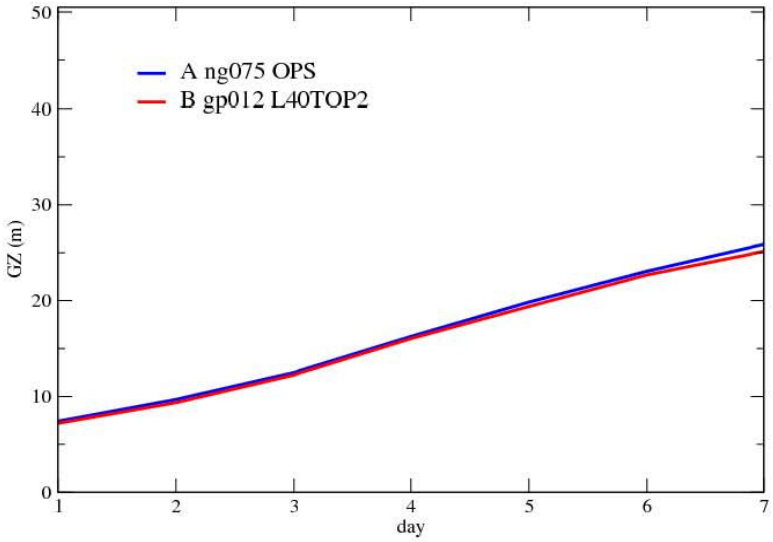
# Impact on forecasts (summer)

We have yet to run experiments with the final configuration of both the EnKF and the EPS. Here we show preliminary CRPS scores with respect to the global radiosonde network for a 10 day period in the summer of 2008.

Temperature (500 hPa)

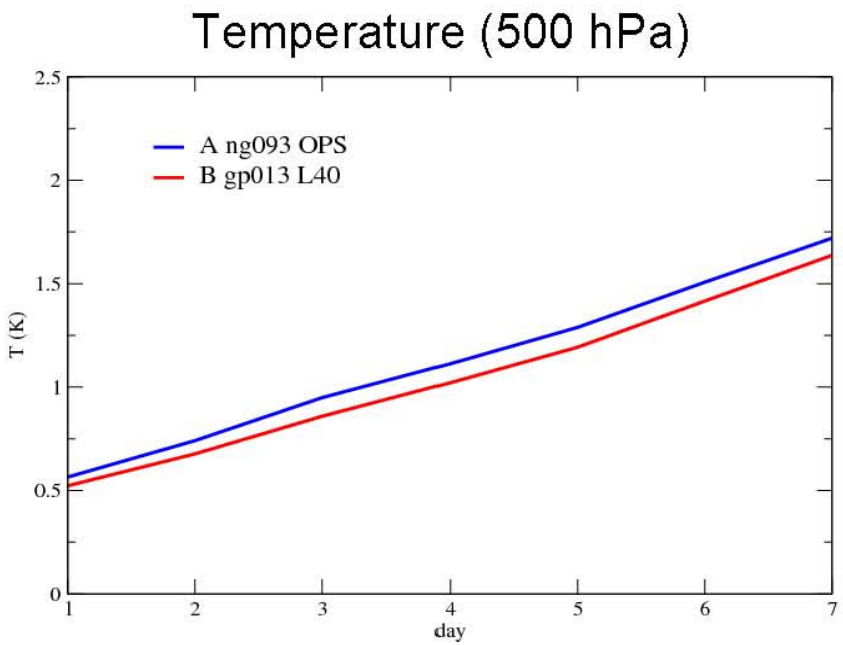


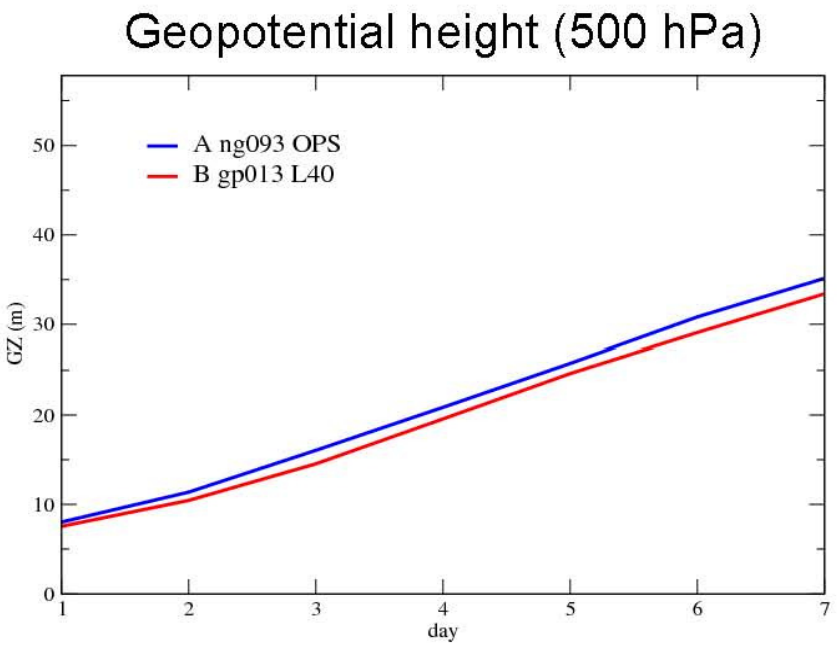

Geopotential height (500 hPa)



# Impact on forecasts (winter)

The anticipated improvement is a little bigger in winter than in summer. Generally, we expect a gain of several hours in forecast quality.

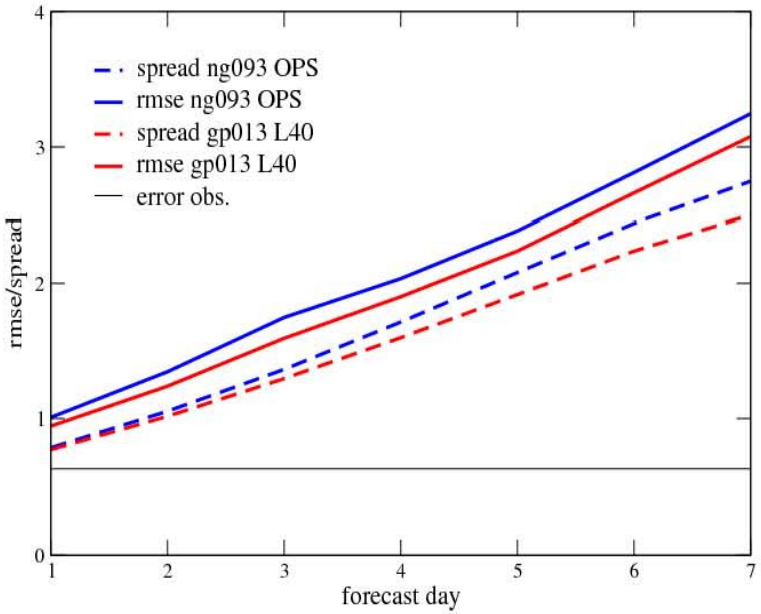


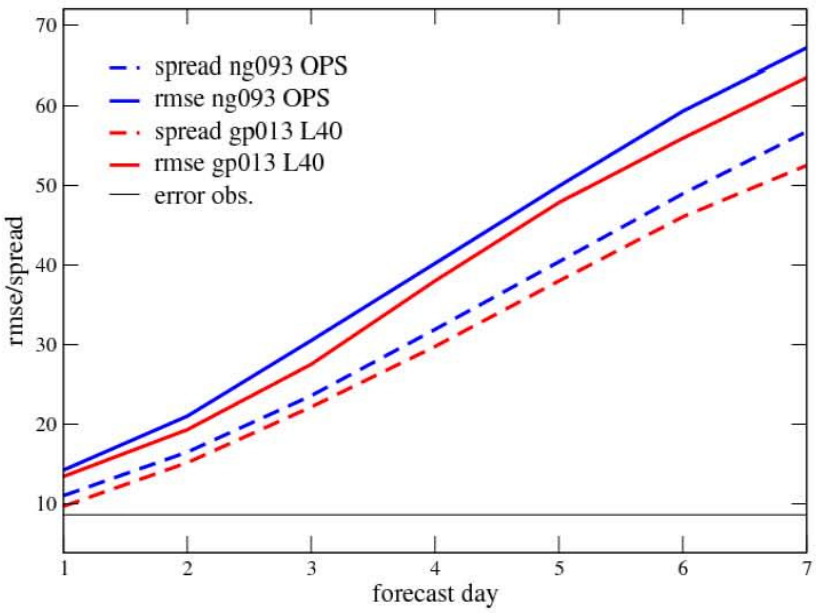
# Impact on ensemble dispersion (rms, winter)

With the more natural coupling between the EnKF and the EPS, we have a reduction of the ensemble spread (dashed lines). This reduction corresponds with a reduction of the rms error (solid lines).

Temperature (500 hPa)




Geopotential height (500 hPa)



# Summary of the 2010 upgrade

An upgrade to the Canadian Global EnKF and EPS will be proposed to the CPOP committee which manages the Canadian parallel and operational systems.

We have an experimental Regional EPS, which is piloted by the Global EPS, and which will benefit directly from improvements.

Similarly, NAEFS verification scores can be expected to improve from improvements to the subensembles. With substantial improvements to both the NCEP and MSC ensembles, 2010 is bound to become a good year for NAEFS.

# Future plans

In the future, we expect to have:

1) an operational regional EPS piloted by the global EPS or possibly even using initial conditions from a regional EnKF piloted by the global EnKF,

2) an intraseasonal EPS which is obtained as an extension of the medium-range EPS.

We expect to improve the global EnKF/EPS by:

1) more consideration for the lower boundary (vertical resolution, surface fields, surface analysis, …);

2) a further extension of the model top (0.1 hPa);

3) the use of a Yin-Yang grid.

# The Yin-Yang horizontal grid

A new dynamical model, with a Yin-Yang grid is being developed. This model has no poles and therefore no pole-problem. It needs less grid points than a uniform grid.

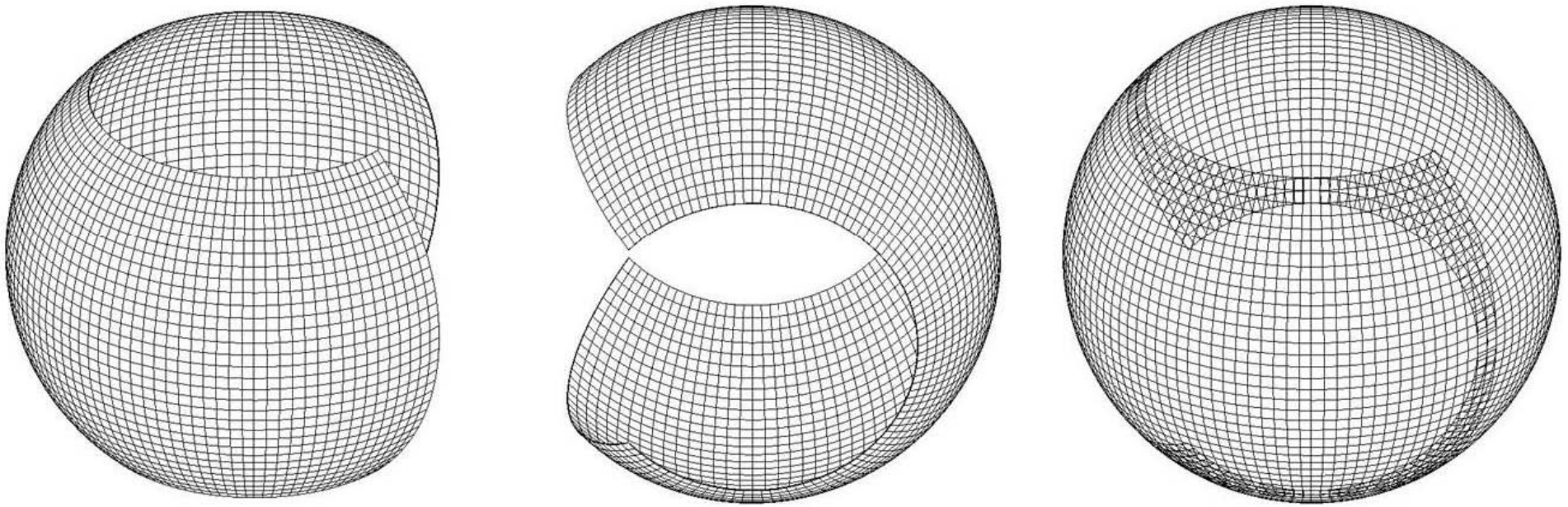


Figure from Abdessamad Qaddouri