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Review of the perturbation methods in the Meteorological Service of Canada (MSC) Global Ensemble Prediction System (GEPS)

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1) Introduction:

•MSC is running a 20 member GEPS (0.45x0.45L40) up to Day 16 operationally (32 days on Thursdays at 00Z). This system is using an Ensemble Kalman Filter as a data assimilation scheme (Houtekamer et al. 2014) to generate the initial conditions for the medium-range ensemble forecasts. The forecast perturbations are coming from set a multi-physical parameterizations as well as two stochastic approaches (physical tendencies perturbations and the stochastic energy back-scattering scheme).

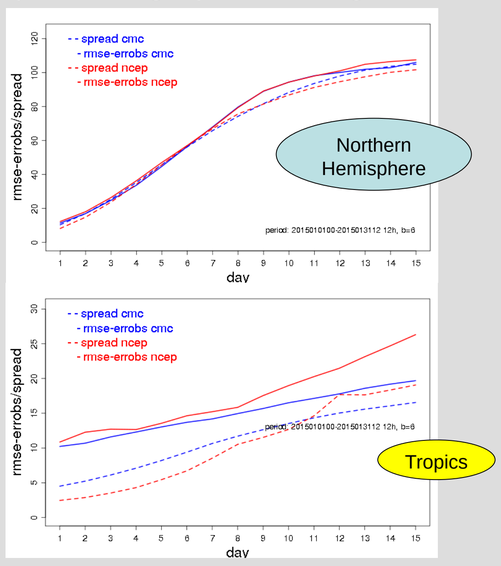
•**Context:** In preparation of the arrival a new supercomputer and the associated opportunity to increase model resolution, an evaluation of the different perturbations methods of the MSC Global Ensemble Prediction System is performed.

•**Goal of the study: review the source of spread in the system.**

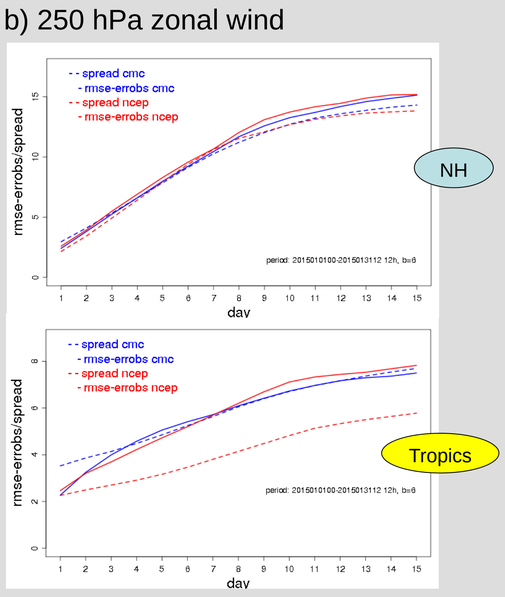
•**Method: several experiments with individual source removed incrementally**

2) Forecast error and spread in the operational GEPS (January 2015):

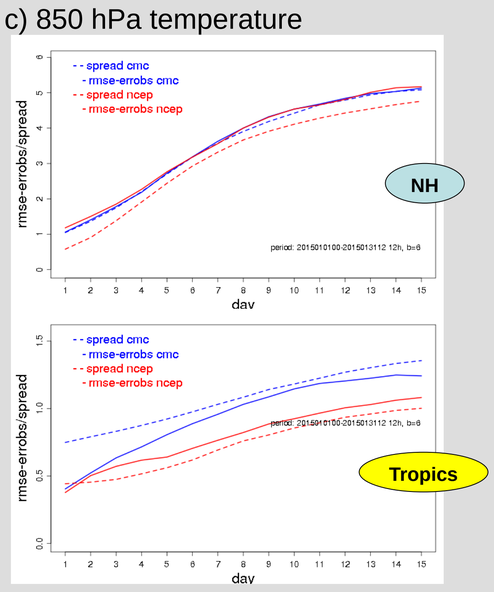
a) 500 hPa geopotential heights



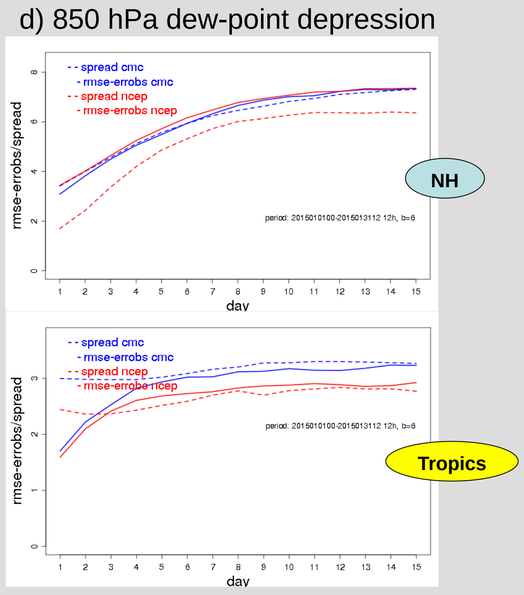
b) 250 hPa zonal wind



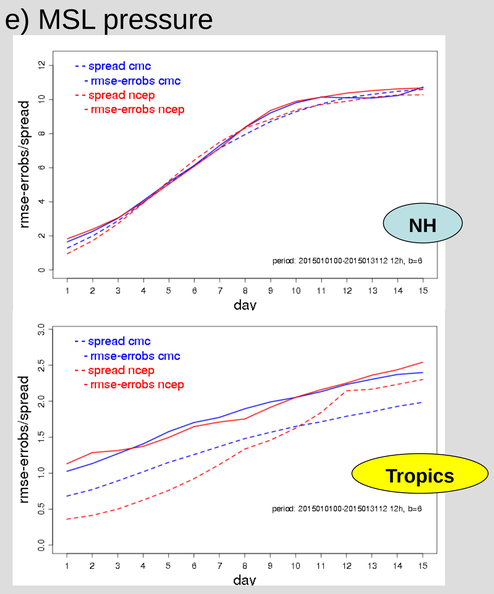
c) 850 hPa temperature



d) 850 hPa dew-point depression



e) MSL pressure



f) 2-m temperature

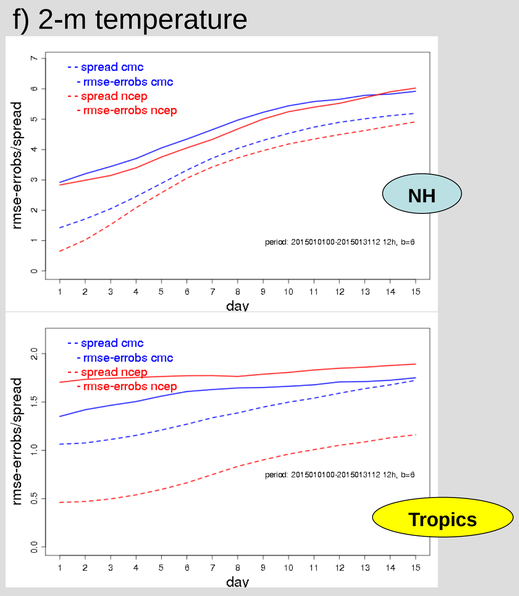


Figure 1: RMSE-obs error and spread of the GEPS and the NCEP GEFS in January 2015 for 500 hPa geopotential heights (a), 250 hPa zonal wind (b), 850 hPa temperature (c), 850 hPa dew-point depression (d), MSL pressure (e) and the 2-m temperature (f).

Remarks:

•Upper air:
- •in general the current GEPS is well balanced in NH.
- •Too much spread is noticed in the Tropics for temperature ,dew-point depression and winds.

•Near surface:
- •a clear lack of spread is noticed for T2m as well as the ES 2m and the 10-m wind speed (not shown) in Northern Hemisphere.as well as in the Tropics.

3) Where this spread is coming from ?

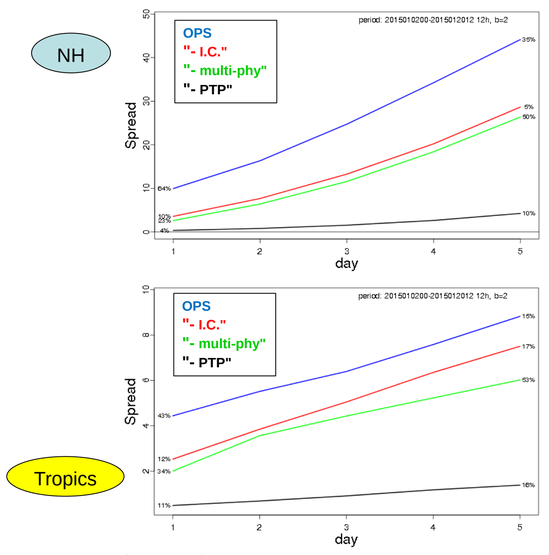
Let's look, experiments methodology: :

We have run 120 hour forecasts for 30 cases in January 2015 with:

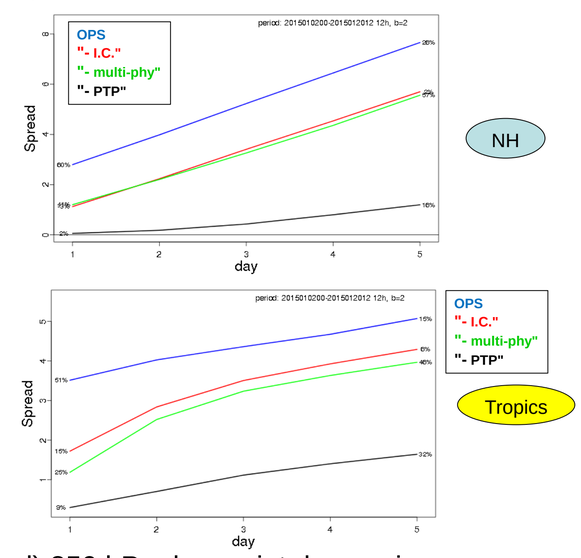
1) **Reference: quasi-Operational system with EnKF analyses(OPS)**
2) **minus Initial conditions perturbations: identical analysis for all members (-I.C.)**
3) **minus Multi-physics: identical physics for all members (-multi-phy)**
4) **minus PTP (-PTP)**

4) Individual impacts on the forecast spread:

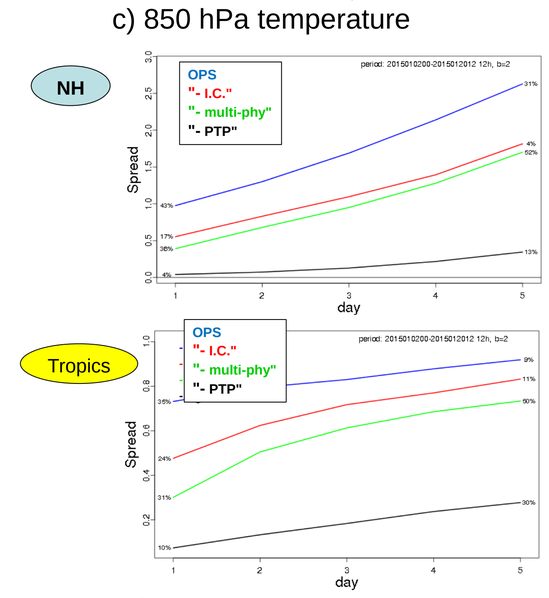
a) 500 hPa geopotential heights



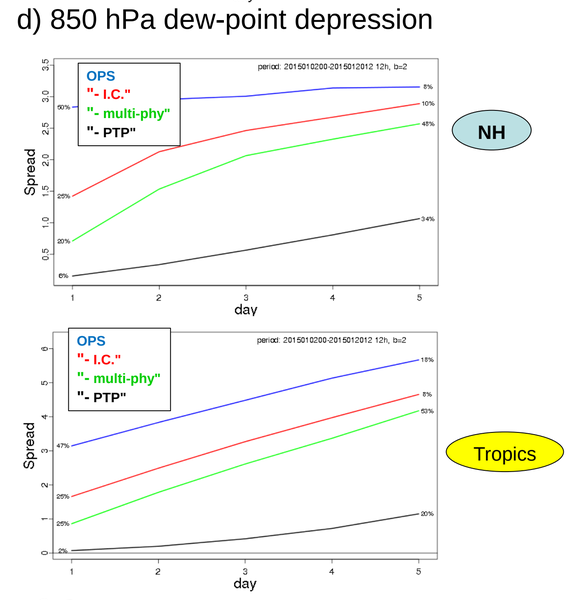
b) 250 hPa zonal wind



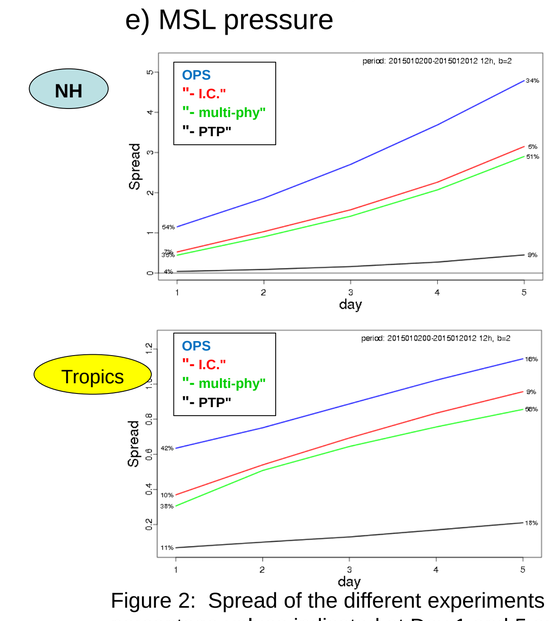
c) 850 hPa temperature



d) 850 hPa dew-point depression



e) MSL pressure



f) 2-m temperature

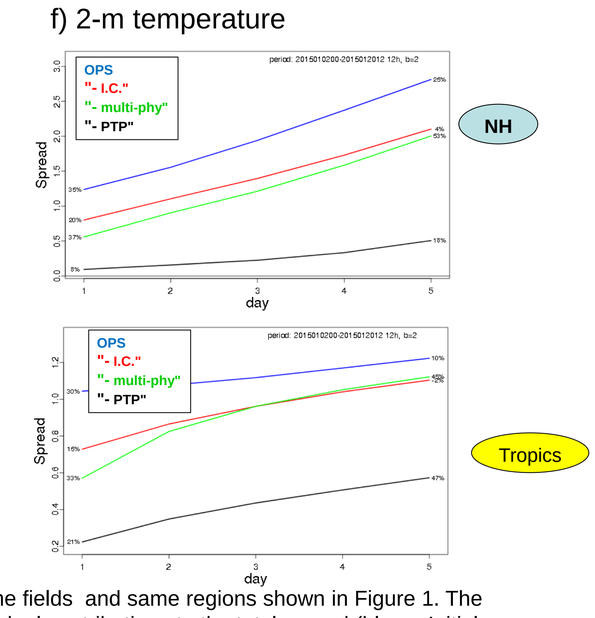


Figure 2: Spread of the different experiments for the same fields and same regions shown in Figure 1. The percentage values indicated at Day 1 and 5 are the individual contributions to the total spread (blue = Initial conditions, red = multi-physics, green = PTP and black = SKEB).

5) Conclusions:

- The most important contributor to the spread are the initial conditions at day 1 (obviously) and PTP scheme is second. That scheme is important at day 5.
- The multi-physics contribution is usually small specially at day 5 but can be significant at day 1.
- SKEB contribution is marginal at day 1 but more significant at day 5.
- Above 250 hPa, the initial conditions are the main contributor.