Towards a High Resolution Global Model for Data Assimilation and Medium-Range Weather Forecasting in Canada

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1. Introduction

Operational forecasting and data assimilation both at regional and global scales have been performed at the Canadian Meteorological Centre in the context of a unified model strategy, the Global Environmental Multi-scale (GEM) model (Côté et al. 1998a and Côté et al. 1998b). The global model configuration of the system has remained stable in the past few years while the data assimilation was being significantly upgraded, going from optimal interpolation to three dimensional variational data assimilation (3DVAR) (Gauthier et al. 1999) and now to four dimensional variational data assimilation (Stephane Laroche, personal communication). The next step is now to improve the modeling aspect of the system.

2. An improved global model

The objective of this work is to improve upon the model's behaviour by a significant increase in horizontal and vertical resolution and by replacing many of the physical parameterizations used in the model by schemes more adapted to high resolution. From the assimilation point of view, the shorter time step together with the sharpness of this new meso-scale version of the model should take full advantage of the capacity of the 4DVAR to assimilate data at the correct time of observation while imposing a temporal constraint on the model's trajectory. From the forecasting point of view, the physical realism of the simulated weather is greatly improved. The changes to the dynamical configuration with respect to the operational one are shown in table 1. The comparison of the new and old physics package is shown in table 2.

3. Discussion

There is an increase in resolution by a factor of three of the global model together with a significant improvement to the physical parameterizations. This leads, among other things to a much better representation of the global characteristics of the precipitation patterns while at the same time improving the behaviour of the weather systems down to the meso-scale. To illustrate this point an analysis of the global distribution of precipitation is used and objective scores are performed at the regional scale.

Figure 1 shows the zonally averaged precipitation for the winter season for the new and operational model as compared to the analysis from the Global Precipitation Climatology Project (GPCP). The latitudinal distribution of the precipitation maxima and minima is better represented in the new version of the model.

Objective precipitation scores against the SHEF observation network over the United States for the winter season are shown in figure 2. Again, the new version of the model shows a significant improvement over the operational model.

	New version	Operational version
No. of points	800 x 600 x L58	400 x 200 x L28
Grid	Non-rotated Lat/Lon grid	Rotated Lat/Lon grid
Resolution	33 km at 49 deg.	100 km at the computational equator
Time step	900 sec.	2700 sec.
Orography	USGS	US NAVY

Table 1. Comparison of the dynamics characteristics of the new and operational versions of the GEM model.

	New version	Operational version
Thermodynamic Roughness over water	Constant in the Tropics	Charnock formulation everywhere
Mixing length for the vertical diffusion	Bougeault-Lacarrere	Blackadar 1962
Overshooting cumulus clouds	Yes	No
Deep convection	Kain-Fritsch	Kuo
Grid-scale condensation	Modified Sundqvist scheme	Sundqvist scheme

Table 2. Comparison of the physics characteristics of the new and operational versions of the GEM model.

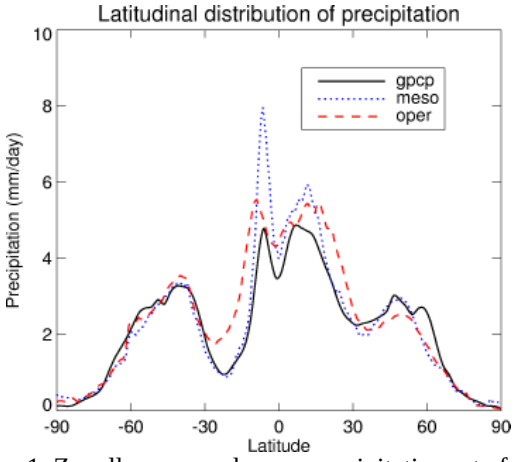

Fig. 1. Zonally averaged mean precipitation rate for December/January/February for the GPCP analysis (full), operational model (dashed) and new meso-global model (dotted)

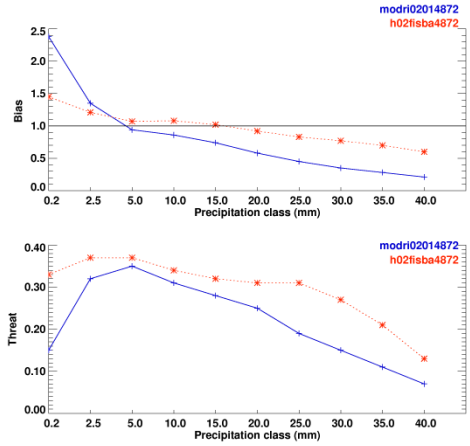

Fig. 2. Bias (top) and threat (bottom) scores for the 48 to 72 hour accumulation of precipitation over the United States for the SHEF network for January and February 2002 for the operational (full) and new meso-global (dotted) models

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