Séminaire vendredi le 31 mai 2019 11:00 / Seminar Friday May 31st 2019 11:00h

Sujet/Subject: Latest developments of the GEM dynamical core with height-based vertical coordinate

Langue/language : Anglais/English

Conférenciers/Lecturers: **Syed Husain (RPN-A)**

Résumé/Abstract:

A new dynamical core of the GEM model, referred to as GEM-H, has recently been developed that introduces the option of a height-based terrain-following coordinate (TFC) in the vertical in addition to the log-hydrostratic-pressure-type TFC employed in the operational GEM-P core. In the absence of physics forcings, predictions by the new height-based dynamical core is found to be statistically equivalent in terms of objective scores. Later, efforts were made to couple the RPN Physics Package with the new dynamical core without any additional calibration. During the process, a number of dynamics-physics coupling approaches — available for GEM-P — were considered. The operational GEM-P model utilizes the 'split method' for dynamics-physics coupling where the dynamical equations are resolved in the absence of any physical forcing and at the end of the dynamics sub-step the contributions from subgrid-scale physics parameterizations are incorporated as adjustments to some of the prognostic variables in the so called 'split mode'. Another approach for dynamics-physics coupling works by directly incorporating the impact of physics forcings as tendencies into the discretized dynamical equations, and hence is referred to as the 'tendency method'.

Researchers in the past have raised concerns regarding the erroneous behavior of the split method, particularly for large time steps that are permissible by the semi-Lagrangian semi-implicit (or iterative implicit) approach. Efforts to couple the RPN Physics Package with the GEM-H dynamical core reaffirmed some of the concerns around the split method. Overall, the tendency method for dynamics-physics coupling is found to be more acceptable, and it also leads to a very good agreement between the two dynamical cores. A split-tendency hybrid approach for GEM-H has also been developed that results in forecast scores that are equivalent to GEM-P with the split method. In addition to providing further details pertaining to the issue of dynamics-physics coupling in GEM, results comparing the two dynamical cores with respect to the different dynamics-physics coupling using a series of 25-km GDPS simulations will be presented at the seminar.

Strong numerical instability over steep orography (slopes > 45°) poses a major challenge for the operational GEM-P dynamical core. The utility of the height-type vertical coordinate in incorporating improvements to the horizontal pressure gradient discretization for addressing the stability problem has been one of the principal motivations behind the GEM-H development. Without implementing any special approach dedicated to improving model stability, the GEM-H dynamical core at its

current form is not expected to lead to considerable stability improvement. Nevertheless, the initial results obtained for a two-dimensional test case — involving a steep isolated mountain under an isothermal atmosphere at rest — point to stability improvements with the GEM-H dynamical core. This theoretical test case is internally referred to as the ‘no flow’ case. The initial test results in this regard will also be presented at the seminar.