Application of Normal Mode Strong Constraint for Initialization of WAM

Miodrag Rancic[a], Houjun Wang[b], David F. Parrish[c], Daryl T. Kleist[c], and Jun Wang[a]

[a]*EMC,IMSG,USA, miodrag.rancic@noaa.gov,* [b]*CIRES, University of Colorado,USA,* [c]*EMC,NOAA,USA.*

Whole Atmosphere Model (WAM), developed by extensions of the vertical domain and functionality of NCEP's Global Spectral Model (e.g. [1]), in preliminary free runs showed a remarkable ability for research and study of the middle and upper atmosphere. The model was combined with corresponding extensions of NCEP's data assimilation system and successfully applied for simulation of phenomena such as sudden stratospheric warming [2]. One of the problems noted in this, as well as in other similar studies (e.g. [4]), is that techniques of non-incremental filtering applied for balance of the initial field result in an excessive damping of the atmospheric tides, which represent an important feature of the upper atmosphere. At the time, this problem was addressed by application of technique of incremental analysis update [2,3,4].

In the present study an alternative approach is considered, based on modifications of the balance imposed on the analysis increment of NCEP's 3DVAR data assimilation system, through a tangent-linear normal mode strong constraint [5]. A straightforward application of this constraint in WAM, where the upper part of the domain does not have enough observations, results in an erroneous adjustment of the analysis. This situation is attributed to the large amplitudes of the vertical modes in the upper portion of the domain, which are presumable consequence of a physically unjustifiable reflection from the upper lid boundary and a very low density of the upper atmosphere. The problem is solved by damping of the vertical modes in the formulation of strong constraint and by a selective application of digital filtering at the beginning of integration. The effect of these interventions on initialization of the lower atmosphere and on preservation of tides in the upper is analyzed.

Since NCEP, as many other centers, is planning to increase height of the vertical boundary of its operational global model in the near future, a study of various approaches to initialization in situation when the upper atmospheric perturbations are present has a general significance.

References

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