Introduction

The Global Modeling and Assimilation Office (GMAO) is currently using an IAU-based 3D-Var data assimilation system. GMAO has been experimenting with a 3D-Var-hybrid version of its data assimilation system (DAS) for over a year now, which will soon become operational and it will rapidly progress toward a 4D-EnVar. Concurrently, the machine to exercise traditional 4D-Var is in place and it is desirable to have a comparison of the traditional 4D approach with the other available options, and evaluate their performance in the Goddard Earth Observing System (GEOS) DAS. This work will also explore the possibility for constructing a reduced order model (ROM) to make traditional 4D-Var computationally attractive for increasing model resolutions. Part of the research on ROM will be to search for a suitably acceptable space to carry on the corresponding reduction. This poster illustrates how the IAU-based 4D-Var assimilation compares with our currently used IAU-based 3D-Var:

4D-Var Development at GMAO

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IAU Based Variational Data Assimilation

The assimilation procedure used in this work relies on the incremental analysis update (IAU) approach of Rienecker et al. (1998), in a 3D-Var DAS utilizing the analysis increment from data assimilation in a conventional 3D-Var system. One may think of assimilation with the IAU approach as a basis for the incremental analysis update (IAU) in a hybrid 4D-EnVar. The 4D-EnVar is then derived from these increments by using two methods: the 4D-EnVar and 3D-Var. The 4D-EnVar is then compared with the 3D-Var results.

Goddard Earth Observing System Data Assimilation System (GEOS DAS)

The NASA Goddard Earth Observing System is an integration of models using the Earth system modeling Framework (ESMF). The data assimilation of GMAO is an implementation of the Goddard Earth Observing System (GEOS) and the Goddard Earth Observing System (GEOS). The GEOS DAS presently implements a number of data assimilation approaches: 4D-Var, 4D-EnVar, and hybrid 3D-Var and hybrid 4D-Var.

Results

Experiments use a slightly simplified configuration of GEOS DAS. Comparisons are for 3D-Var versus 4D-Var. The experiments were conducted when inner and outer loops are both at low resolution (2 degrees), and when inner loop is at 2 degrees and outer loop is at 1/2 degree. Experiments cover March 2014.

Conclusions

The purpose of this work is to evaluate IAU-based 4D-Var performance in GEOS DAS in comparison with currently used IAU-based 3D-Var system. Results showed that 4D-Var is able to perform at least as well as 3D-Var, often showing slightly better results than 3D-Var. This work establishes that GEOS 4D-Var results are reliable and serve as the basis for extension to 4D-hybrid and development of reduced-order model approaches.

References