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 machinery 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

IAU Based Variational Data Assimilation

The assimilation procedure used in this work relies on the incremental analysis update (IAU) approach of Houra et al. (1996). In a 3D-Var DAS implementation, the analysis increment is carried back to a control model tendency that forces the assimilative model over a 6-hour assimilation window. In a 4D-Var GEOS implementation, these tendencies are extended over a longer time-period. This approach is used to force the model during the 6-hour IAUs.

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 base for extension to 4D-hybrid and development of reduced-order model approaches.

References


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.

Figures display monthly mean difference of experiments with ECMWF analysis mean for March 2014. Monthly means for temperature (left panel: 300 mb, right panel: zonal means). Top panels correspond to 3D-Var, and bottom ones to results from 4D-Var. Above: low resolution experiments; below: low-high resolution experiments.

Figure above shows the difference between the number of observations admitted for assimilation in 4D-Var and 3D-Var. Values above zero indicate that more observations were accepted using the 4D-Var approach, and below zero that more observations were used in 3D-Var.

Goddard Earth Observing System Data Assimilation System (GEOS DAS)