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 to work relates on the Incremental analysis update (IAU) approach of Houtman et al. (1999), to the 3D-Var assimilation framework. The analysis increment is carried back a constant model timescale. This forces the assimilation model over the 6-hour assimilation window. In 3D-Var, GEOS implementation the IAU is based on incremental update of background starting from the control vector, including model bias in the 6-hour OBCs.

![IAU Based Variational Data Assimilation Diagram](image)

#### Goddard Earth Observing System Data Assimilation System (GEOS DAS)

The Goddard Earth Observing System is an integration of models using the Earth System Modeling Framework (ESMF). The use of deep reservoirs of data and the use of ensemble techniques allow for the assimilation of data and the assimilation of oceanic data.

![Goddard Earth Observing System Data Assimilation System](image)

### 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


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