IMAGe Seminar

Institute for Mathematics Applied to Geosciences at NCAR

The Data Assimilation Research Testbed: Powerful, Adaptive and Fast Assimilation for Geophysical Applications

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Abstract:

The Data Assimilation Research Section in IMAGe is continuing the development of the Data Assimilation Research Testbed (DART). DART is a community facility designed to give geophysical modelers and observationalists easy access to state-of-the-art assimilation capabilities. DART also provides a variety of tutorial documents and low-order models that are used for ensemble assimilation education and basic research.

Ensemble assimilation combines observations with models to provide enhanced information about both inputs and the physical system. Traditionally, geophysical assimilation provided initial conditions for numerical weather prediction. DART includes this capability but also provides many other powerful applications. Model deficiencies can be detected and analyzed by examining inconsistencies with observations and using tools for adjoint and linear tangent analysis. Appropriate values for unknown model parameters can be directly estimated using observations. The information content of (new) observations can be evaluated and efficient observing systems can be designed. A smoothing capability, using observations both in the past and the future, can provide high-quality estimates of the state of the system. Examples of some of these capabilities using NCAR models will be discussed.

For a community assimilation facility to be fully successful, modelers and observationalists must be able to begin doing meaningful experiments with minimal effort. DART combines careful software engineering and adaptive assimilation algorithms so that a novice user can incorporate a new model or observation type in just a few weeks of effort. An overview of the sequential algorithm in DART leads to a discussion of error sources in ensemble filters. Adaptive algorithms including a hierarchical filter and adaptive inflation are used to reduce the impact of these errors. A detailed discussion of inflation will illustrate how adaptive ensemble algorithms work.

It is crucial that a community facility can be applied efficiently to large models on a variety of parallel computing platforms. The DART filter is a parallel implementation of a sequential filter algorithm. This apparent oxymoron leads to excellent scaling on a variety of parallel platforms. The algorithm is independent of the details of the model or the observation set.

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