

An Introduction to Ensemble Data Assimilation Using the Data Assimilation Research Testbed

Sunday 12 January 2020

Time	Topic	Speaker (All speakers are from NCAR, Boulder, CO)
8:30 AM	Ensemble Data Assimilation Concepts in 1D*	Jeffrey Anderson
9:00 AM	Multivariate Ensemble Data Assimilation*	Jeffrey Anderson
10:00 AM	Coffee Break	
10:30 AM	Sampling Error and Localization*	Moha Gharamti
11:00 AM	Adaptive Inflation*	Moha Gharamti
11:45 AM	More on 1D Ensemble Data Assimilation*	Jeffrey Anderson
12:30 PM	Lunch	
1:30 PM	Introduction to the Data Assimilation Research Testbed (DART)	Nancy Collins
2:00 PM	Examples of Ensemble Data Assimilation for Large Geophysical Models	Tim Hoar
3:00 PM	Using New Models or Observations with DART	Nancy Collins & Tim Hoar
3:45 PM	Adjourn	

* This topic is a combination of lecture and interactive MATLAB graphical tutorials. Lecturers will present concepts and students will strengthen their understanding by applying the concepts in the interactive tutorials. All instructors will be available to assist students with the tutorial.

Ensemble Data Assimilation Concepts in 1D

The basic data assimilation problem is introduced. The Kalman filter and the deterministic ensemble Kalman filter will be developed for a one-dimensional system that includes a forecast model for a single variable and periodic observations of that variable.

Multivariate Ensemble Data Assimilation

The 1D ensemble filter will be extended to a case with two model variables, one of which is observed. It is shown that understanding the bivariate case is sufficient to understand an ensemble Kalman filter for forecast models of any size and any number of observations.

Sampling Error and Localization

Running ensemble forecasts is expensive, so using small ensembles is always desirable. However, small ensembles often work poorly and may fail completely when used with large geophysical models. This problem is addressed by localization in which observations are only allowed to change model variables that are nearby. Students will learn how localization can improve performance by exploring several low-order model examples.

Adaptive Inflation

Ensemble forecasts tend to be too confident (have too little spread) for a variety of reasons. If this problem is not addressed, even ensemble Kalman filters with good localization can still fail. The solution, inflation of ensembles, is introduced and students will explore how it can be combined with localization to produce state-of-the-art assimilation results.

More on 1D Ensemble Assimilation

The 1D problem is revisited and some additional ensemble Kalman filter methods are presented. These methods can extend the capabilities of the ensemble Kalman filter to problems that are less Gaussian, including many geophysical models.

Introduction to the Data Assimilation Research Testbed (DART)

The morning session will have introduced students to all algorithms that are commonly used in geophysical ensemble Kalman filter data assimilation. This session will discuss how students can use DART to apply these algorithms for large geophysical models, like those used for numerical weather prediction.

Examples of Ensemble Data Assimilation for Large Geophysical Models

A number of examples of ensemble Kalman filter assimilation for geophysical models and observations will be used to highlight the power of these methods. Examples will include atmospheric, oceanic, land surface and sea ice applications. Specific challenges and methods to overcome these challenges will be highlighted for each example.

Using New Models or Observations with DART

DART already supports many geophysical models and observations. An overview of what is required to develop a DART capability for a new model or observation is presented. Students should leave with an ability to assess whether ensemble data assimilation with DART could be helpful for their unique applications.