Fall, 2020: Geography 8901: Seminar Lecture Course

Data Assimilation: Combining Model with Data

Prof. Zhengyu Liu

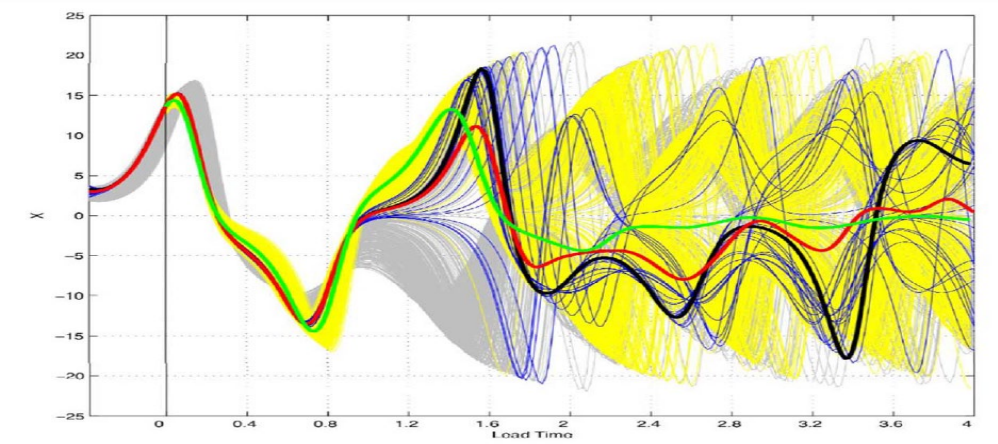
Department of Geography

Time: Tuesday, 10:00-12:48am
Location: Derby Hall, RM 1116

In any science and enginnering field, neither data nor model is perfect. An important question is therefore, how do we make use of the existing data and model to produce the optimal estimation? This is what data assimilation is about.

Data assimilation is the modern approach to combine data and model in the optimal way. It produces not only the optimal estimation but also its uncertainty. Data assimilation is now been used in many science fields, including weather, climate and engineering.

In this course, we will introduce the basic concept and theory of data assimilation, with the focus on the state-of-the-art ensemble Kalman filter (EnKF). We will discuss the practical implementation of data assimilation methods. The data assimilation will be studied first in one-dimensional models and will then be extended to multi-dimensional models.



G8901: Fall, 2020

Data Assimilation: Combining Model with Data

Prof. Zhengyu Liu
Dept. of Geography
The Ohio State University

Time: Thursday, 3:00-5:48pm
Location: Derby Hall, RM 1116

Ch0. Introduction and Overview

Part I: Data Assimilation: Scalar Analysis

Ch.1. Introduction to Data Assimilation
Ch.2. Intuitive Formulation: Least Square Estimate and Variational Approach
Ch.3. Probabilistic Formulation: Maximum Likelihood Estimate and Bayesian Theorem
Ch.4. Sequential Assimilation and Kalman Filtering
Ch.5. Ensemble Kalman Filter I: Scalar Case
Ch.6. Ensemble Square Root Filter I: Scalar Case

Part II: Data Assimilation: Multivariate Analysis

Ch.7. Multivariate Statistical Data Assimilation. I: OI
Ch.8. Variational Method. I: 3D-VAR
Ch.9. Ensemble Kalman Filter II: Multivariate Formulation
Ch.10. Ensemble Kalman Filter III: Parameter Estimation
Ch.11. Ensemble Kalman Filter IV: Advanced Issues in Practical Implementation
Ch.12. Variational Method. II: 4D-VAR

Part III: Predictability and Ensemble Forecasting

Ch.13. Introduction to Predictability
Ch.14. Transient Error Growth and Predictability:
Local Lyapunov Vectors and Singular Vectors
Ch.15. Ensemble Forecasts
Ch.16. Operational Ensemble Forecasts

Appendices: Basic Knowledge
A. Matrix operation
B. Probability and Statistics

Grading

Homework 50%
Final project (presentation and term paper) 50%

References

Zhengyu Liu, 2020: Data Assimilation (Handout for the course)

Kalnay Eugenia: 2003: Atmospheric modeling, data assimilation and predictability Cambridge Press, 3rd edition (2006)
(main reference!)
Evensen Geir, 2009, Data Assimilation, The Ensemble Kalman Filter, Springer Verlag, 2nd edition
(some reference on EnKF)
Morgan, M., 2011, Predictability and data assimilation, Class Notes, UW-Madison
(some reference on basic knowledge)