Data assimilation in atmospheric sciences

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Abstract

Data assimilation is a very important approach to initialize numerical weather prediction, seasonal prediction and even decadal climate prediction. It is a key bridge to link observations and predictions and is an efficient way to improve prediction skills.

In this course, the background and developing history of data assimilation in the field of atmospheric science will be reviewed, and the commonly used data assimilation approaches will be introduced in the views of interpolation and variational principle, including the methodology, meaning of dynamics, quality control of observational data, code-to-code generation technique of tangent linear model and adjoint model, and applications to predictions of typhoon and heavy rainfall. A well-known data assimilation system (such as WRF-VAR) will be provided for practice, and finally the future development direction of data assimilation will be prospected.

A Mathematical Introduction to Data Assimilation

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Abstract

These lectures will provide an introduction to the subject of data assimilation, formulated as a Bayesian inference problem, and from an applied mathematics perspective. Various standard methods are derived, analyzed and discussed, including variational methods (3DVar, 4DVar), the Kalman Filter/Smoother and its Ensemble variants, and fully nonlinear data-assimilation methods, with and emphasis on Particle Filters. Hybrids between these different methods will be discussed too, as this is the direction in which the field is moving. Explicit calculations, numerical examples, and exercises and matlab/python code will be provided in order to illustrate the theory. The lectures will also include an introduction to some state-of-the-art algorithms.

The lectures are based on two books,

Data Assimilation A Mathematical Introduction
Authors: Law, Kody, Stuart, Andrew, Zygalakis, Konstantinos
http://www.springer.com/us/book/9783319203249
specifically the chapters on discrete problems,

and

Nonlinear Data Assimilation
Authors: Van Leeuwen, Peter Jan, Cheng, Yuan, Reich, Sebastian
http://www.springer.com/us/book/9783319183466
specifically the chapter by the first author.

Truncated lecture notes are available here http://arxiv.org/abs/1506.07825 for the first book, and will be provided to the participants for the second book.