



Divecha Centre for Climate Change
Indian Institute of Science
Bangalore



Short Course on Forecast Error Correction using Data Assimilation July 4-15, 2016



Image Courtesy of RIKEN

Many aspects of human life are controlled by prediction/forecast of one kind or another: likelihood of a good monsoon for agricultural planning; revenue estimates for the next year to develop budget priorities by governments; maximum temperature for the next week so that a local Electric Company can plan its generation schedule, etc. Except in very few cases, such as prediction of solar and lunar eclipses, forecast is often riddled with errors. In this course we provide a classification of forecast errors and develop methods for correcting these errors using data assimilation, which is a process for systematic fusion/merging of data into models. Our aim is to provide a broad background on basic principles and mathematical tools needed to assimilate data into models of various kinds.

About the Instructor:



S. Lakshmivarahan
University of Oklahoma,
Norman, Oklahoma, USA

After completing his PhD from Indian Institute of Science, Bangalore, India in 1973, S. Lakshmivarahan served as an assistant professor at Indian Institute of Technology, Madras, India (1973-75), a visiting assistant professor at the Division of Applied Mathematics, Brown University (1975-76) and Electrical Engineering at Yale University (1976-78). He joined the School of Computer Science, University of Oklahoma in 1978 where he is the George Lynn Cross Research Professor since 1995. He is Fellow of the IEEE (1993), ACM (1995) and IEEE Life Fellow since 2013. His interests are in Applied Mathematics and Computation.

4-15 July 2016, 9.00 am to 5.00 pm

The course requires mathematical skills at the level of post graduation in science or engineering/ M.Tech. For more details on the course and to register, please visit our website:
<www.dccc.iisc.ernet.in>

Note: Due to limited seating capacity, preference will be given to those who register early.

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Indian Institute of Science, Bangalore, India**

**Short Course on
Forecast Error Correction using Data Assimilation
July 4-15, 2016**

Professor S. Lakshmivarahan
University of Oklahoma, Norman, Oklahoma, USA

Scope: Many aspects of human life are controlled by prediction/forecast of one kind or another: likelihood of a good monsoon for agricultural planning; revenue estimates for the next year to develop budget priorities by governments; maximum temperature for the next week so that a local Electric Company can plan its generation schedule, etc. Except in very few cases, such as prediction of solar and lunar eclipses, forecast is often riddled with errors. In this course we provide a classification of forecast errors and develop methods for correcting these errors using data assimilation, which is a process for systematic fusion/merging of data into models. Our aim is to provide a broad background on basic principles and mathematical tools needed to assimilate data into models of various kinds.

Topics:

- 1) Data Mining, Data Assimilation and Prediction - Parts of a continuum
- 2) An overview of mathematical tools - Linear Vector Spaces, Matrices, Multivariate Calculus, Principles of optimization
- 3) Assimilation of data in deterministic, static models - linear and nonlinear least squares formulation
- 4) Matrix methods - Cholesky, QR- decomposition, SVD, Iterative methods
- 5) Optimization methods - Gradient, Conjugate Gradient, Quasi-Newton methods
- 6) Assimilation of data in dynamic models - First-order Adjoint Method, Forward Sensitivity Methods
- 7) Principles of Bayesian estimation, statistical least squares
- 7) Assimilation of data in stochastic dynamic models - Kalman Filtering
- 8) Principles of ensemble/reduced rank filters
- 9) Introduction to Nonlinear Dynamics

Note: A good working knowledge of programming in MATLAB would greatly facilitate the practical sessions

Modus Operandi:

1) On each working day (Monday, July 4th through Friday, July 15th) we will have two sessions - first in the morning (9.00 am to 1.00pm) and the second (2.00 to 5.00pm) in the afternoon.

2) The morning session will include two lectures of about 75 minutes each, between 9.00 am and 1.00 pm with ample room for coffee break and discussions. The afternoon session between 2.00 to 5.00pm will consist of one lecture followed by a Practicum session focused on applications and problem solving, with ample time for coffee break and discussions.

References

[1] J.M. Lewis, S. Lakshmivarahan and S. K. Dhall (2006) *Dynamic Data Assimilation: a least squares approach*, Cambridge University Press

[2] S. Lakshmivarahan, J.M. Lewis and R. Jabrzemski (2106) *Forecast Error Correction using Dynamic Data Assimilation*, Springer

Note: The registered participants should produce their identity card.