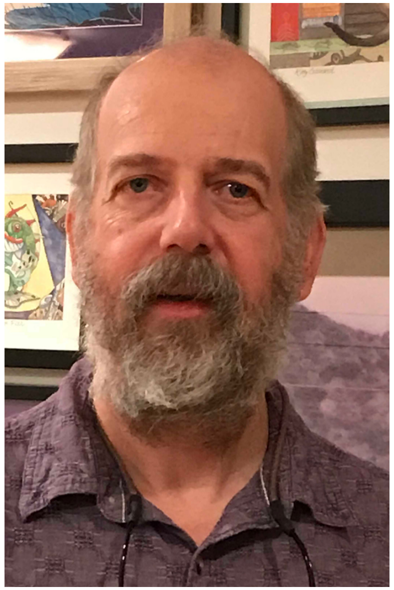
Charles E. Schmidt College of Science
Department of Mathematical Sciences
Florida Atlantic University

The FAU-SIAM student chapter invites you to a talk by

Erik S. Van Vleck, Ph.D.

Professor, University of Kansas



Dimension Reduction in Data Assimilation

Friday September 17th, 2021, 4:00pm EST

Open to all

Live on Zoom (Meeting ID: 726 327 6757, passcode: Fall2021)

Please contact us, see us on Twitter and Youtube, or visit our Webpage for more information about our student chapter.

Abstract

The understanding of nonlinear, high dimensional flows, e.g., atmospheric and ocean flows, is critical to address the impacts of global climate change. DA techniques combine physical models and observational data, often in a Bayesian framework, to predict the future state of the model and the uncertainty in this prediction. Inherent in these systems are noise, nonlinearity, and high dimensionality that pose challenges to making accurate predictions. In this talk we focus on some recent results for two dimension reduction techniques (adaptive spatial meshes and reduced order modeling techniques) and their impact on DA schemes. Adaptive moving spatial meshes are useful for solving physical models given by time-dependent partial differential equations by concentrating mesh points in portions of the spatial domain. We outline a framework to develop time-dependent reference meshes using the metric tensors that define the spatial meshes of the ensemble members. We propose a new, time-dependent spatial localization scheme based on adaptive moving mesh techniques. We also explore how adaptive moving mesh techniques can control and inform the placement of mesh points to concentrate near the location of observations, reducing the error of observation interpolation. In addition, we consider ROM techniques that include Proper Orthogonal Decomposition (POD), Dynamic Mode Decomposition (DMD), and Assimilation in the Unstable Subspace (AUS) for both model and data dimension reduction. Algorithms to take advantage of projected physical and data models may be combined with common DA techniques such as Ensemble Kalman Filter (EnKF) and Particle Filter (PF) variants with a focus on a projected optimal proposal particle filter. We illustrate the utility of our results using discontinuous Galerkin approximations of 1D and 2D inviscid Burgers equations, the Lorenz 96 equations, and a Shallow water model.

About the speaker

Erik S. Van Vleck is Professor of Mathematics at the University of Kansas. He received his PhD in Applied Mathematics from Georgia Institute of Technology in 1991, MSc at the University of Colorado- Boulder in 1987, and BS from the University of Kansas in 1985. His research areas are in numerical analysis, differential equations and dynamical systems, and applications of mathematics to problems in science and engineering. His primary research interests are in computation of time dependent stability spectra and applications of these techniques, and analysis and computation of lattice differential equations with applications in materials, physiology, and biology. In recent years, his interests have expanded to include applications in climate science including modeling and analysis of cloud dynamics, competition models for forests and grasslands, and data assimilation techniques and their application. He is an active member of the Mathematics and Climate Research Network (MCRN) and is active in developing distributed learning environments for undergraduate and graduate mathematics students in the mathematics of climate and sustainability. His pedagogical interests include active learning and project oriented techniques for the teaching of mathematics. He has held visiting positions at NIST, IMA, UC-Berkeley, Sussex, Auckland, and SAMSI.