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**MS125****Nonlocal Extensions of the Classical Phase Field Model**

The Classical Phase Field Model represents a coupling of an Allen-Cahn type nonlinear equation with a standard diffusion equation. This model has been proposed to describe non-isothermal phase separation in a pure substance. In this talk I will discuss an extension of that model which takes into account nonlocal effects by introducing a convolution term involving the phase field variable. Results of simulations will be compared with the classical model to understand the effects of the nonlocal contribution. Advisor: Dr. Thomas Wanner, George Mason University

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**MS126****Utilizing Computer Models for Assessing Risk from Geophysical Hazards**

Risk assessment of volcanic pyroclastic flows is addressed through a combination of computer modeling, statistical modeling, and extreme-event probability computation. A computer model of the pyroclastic flows is utilized to provide the needed extrapolation to unseen parts of the hazard space. Statistical modeling of the available data is needed to determine the initializing distribution for exercise of the computer model. Direct simulation of rare events is prohibitively expensive, so an adaptively designed emulator is utilized.

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**MS126****Bayesian Multiresolution Methods for Spatial Inverse Problems**

The Bayesian statistical approach is a natural method for dealing with both the estimation of the inputs as well as quantification of the uncertainty around the estimated values, or for finding a range of plausible values consistent with the observed data. A process prior, such as a Markov random field, Gaussian process, or treed Gaussian process, is used to represent structure in the inputs, and the posterior distribution is estimated via Markov chain Monte Carlo. Multiresolution methods will be illustrated with several examples.

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**MS126****Nonparametric Bayesian Density Estimation in Hierarchical Engineered Systems**

We formulate a hierarchical Bayesian method for estimating polynomial chaos representations of random quantities from limited and noisy data. We introduce a reversible-jump Markov chain Monte Carlo scheme that simultaneously traverses polynomial degree and the corresponding spaces of coefficients, thus allowing infinitely parametric representations of the underlying random variables. Likelihood evaluations rely on a robust polynomial system solver. Examples center on the reliability and ageing of complex engineered systems, with extensions to general multivariate density estimation.

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**MS126****Bayesian Inference Using an Adaptive Sparse Grid Collocation Method**

We introduce a surrogate model for the likelihood calculation using adaptive hierarchical sparse grid collocation. This constructs an interpolant to the solution of the forward stochastic model in the prior space. Hierarchical Bayesian formulation is used and the unknown spatial model is represented as a convolution of a smooth kernel and Markov random field. The methodology results in sig-

nificant computational gains. The technique is assessed with a number of non-linear inverse problems.

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### MS127

#### Feedback Flow Controllers to Suppress Vortex Shedding Past Bluff-bodies

In this talk, we present our progress to date for the design of feedback control laws to suppress vortex shedding behind a three-dimensional circular cylinder. We include a summary of our development of more accurate reduced-order modeling of the cylinder wake using the sensitivity of the proper orthogonal decomposition. In addition, we overview a number of strategies to incorporate Dirichlet boundary actuation and provide full-order closed-loop three-dimensional Navier-Stokes simulations at a range of Reynolds numbers.

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### MS127

#### Model Reduction in Cellular Neurophysiology

Each cortical pyramidal neuron has over 100 branches with tens of synapses per branch. Partitioning each branch into 10 compartments, with 5 currents each, yields 50 variables per branch and results in a nonlinear dynamical system of 50000 equations. The challenge is to reduce the dimension of this system without sacrificing the rich spatiotemporal pattern of synaptic input. We report on our successful application of Proper Orthogonal Decomposition and the Empirical Interpolation Method.

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### MS127

#### Reduced-Order Modeling of Turbulent Flow

Both accurate and computationally efficient simulations of turbulent flows are needed in important scientific and engineering applications, such as weather prediction and flow control. Reduced-order models represent natural choices in these applications. The fundamental challenge is to retain the physics of the underlying turbulent flow while keeping the computational cost at a minimum. In this talk, we present reduced-order modeling strategies synthesizing ideas originating from proper orthogonal decomposition and large eddy simulation of turbulent flows. In particular, we will present approaches based on the variational multiscale and dynamic subgrid-scale methods. Analysis and numerical illustrations of our methodology for both simplified settings and turbulent pipe flows will also be presented.

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### MS127

#### A Krylov $\mathcal{H}_\infty$ Optimal Reduced Order Modeling Technique Applied to the Two-dimensional Linearized Shallow Water Equations: A Case Study

Over the past few years the U.S. Navy's coastal ocean and riverine dynamical system modeling capabilities have taken large leaps forward. Direct numerical simulation using modeling tools is a standard approach and indeed one of the few available means to accurately predict environmental features that are influenced by riverine and near shore coastal processes. Reduced order modeling applied to these models is very promising and has enormous potential in the context of performing ensemble scenarios and data assimilation. The Krylov-based projection methods have emerged among the leading approaches for model reduction in large-scale settings, producing high quality models that satisfy (local) optimality conditions. In this talk, we present a case study in which we apply a Krylov  $\mathcal{H}_\infty$  optimal reduced order modeling technique to the two-dimensional linearized shallow water equations.

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### MS128

#### A Java Based Computational Framework for Simulation of Abnormal Thermo-Mechanical Environments

A Java based computational framework is presented for simulations of abnormal thermo-mechanical environments. The coarse grain object oriented decomposition of the problem is based on physical descriptions of the relevant physical continuum processes (rather than the mathematics) for execution on massively parallel computational platforms. The framework is largely based on Eulerian region objects which defines the material (and associated mesh),