Introduction

2019 RMMC Summer School
Inverse Problems in Imaging

Jodi Mead
Department of Mathematics

BOISE STATE UNIVERSITY

My background

- Professor of Mathematics, co-Director Computing PhD, Associate Dean in Residence Graduate College, Boise State U.
- PhD in Computational Math, Arizona State University, 1998
- Postdoc in Oceanography, Oregon State University
- Visiting faculty: Computer Science, Portland State U. and National Centre for Groundwater Research and Training, Adelaide Australia

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Boise, Idaho
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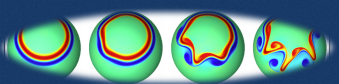

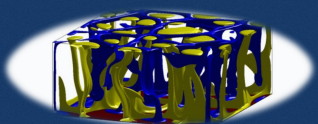

Computational and Applied math

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Geoscience at Boise State

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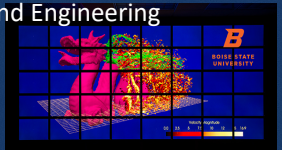
Computing PhD at Boise State

Computational Science and Engineering

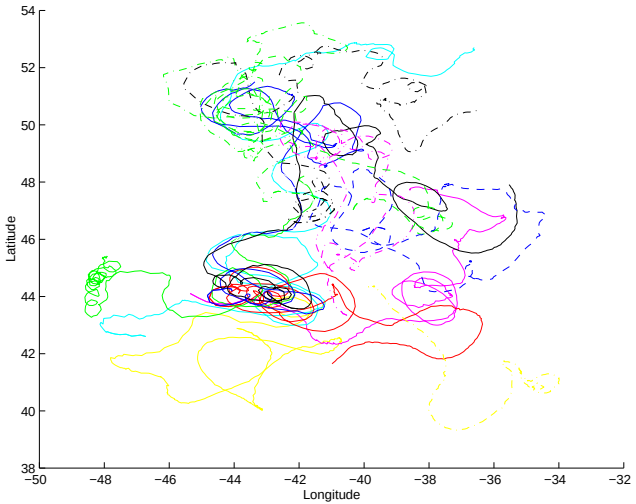


Computer Science

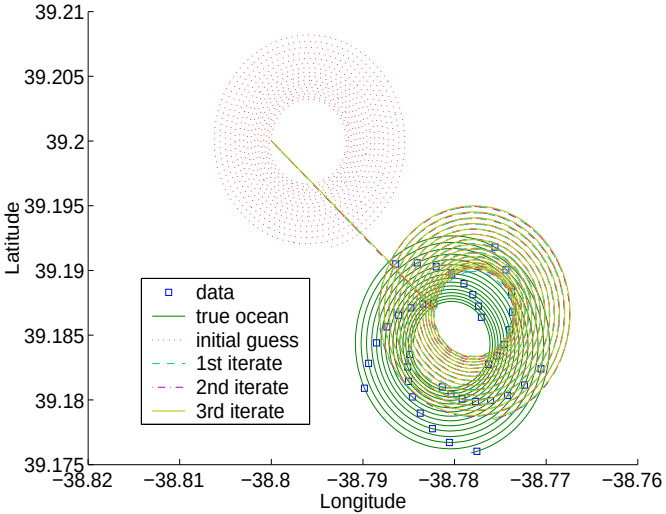
Data Science

Cybersecurity

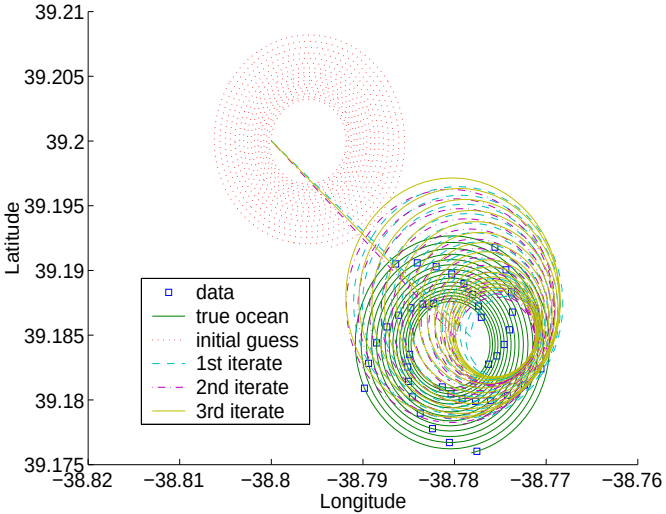
Oceanographic float data in the North Atlantic



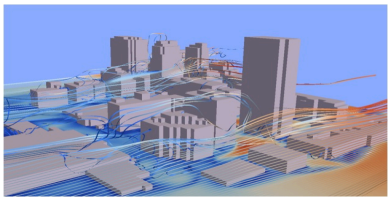
Assimilation Results from Experiment 1



Assimilation Results from Experiment 2

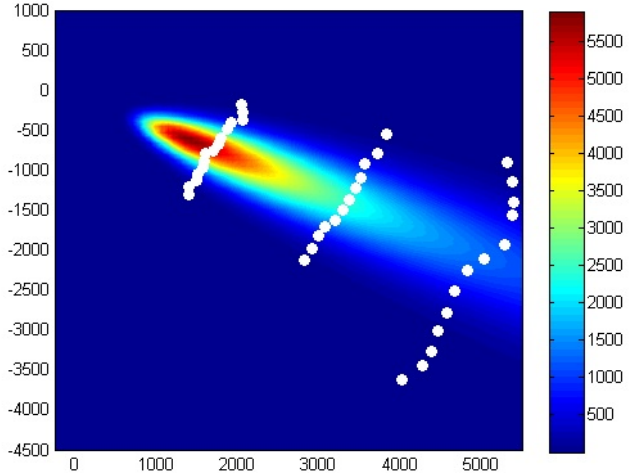


Atmospheric releases in an urban environment

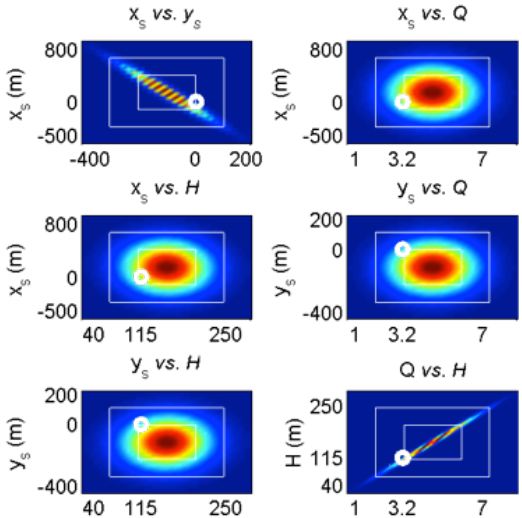


- Chemical or biological agent released into atmosphere
  - Homeland security (bioterriosm)
  - Environmental monitoring (nuclear, pollution)
- Determine source location and emission rate or strength
- Simulate spatial and temporal evolution of contaminant

Fixed network of concentration measurements



Parameter estimates and their uncertainty



Hydrological Processes

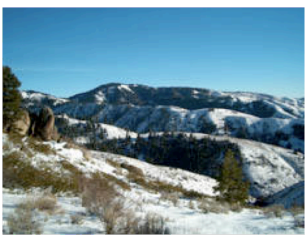
Soil Moisture

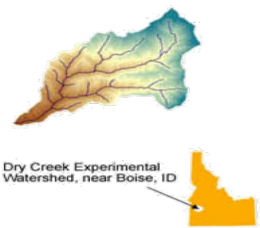
- Can significantly impact weather patterns and precipitation.
- Controls whether precipitation absorbs into, runs off, or evaporates.

Dry Creek Watershed near Boise, ID

Dry Creek Watershed

- Established in 1999 to investigate hydrologic processes
- Semi-arid climate, open, dry land vegetation
- Typical of small watersheds in the Idaho Batholith

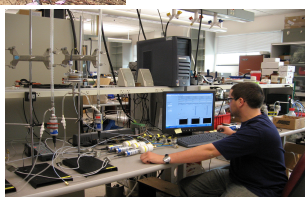




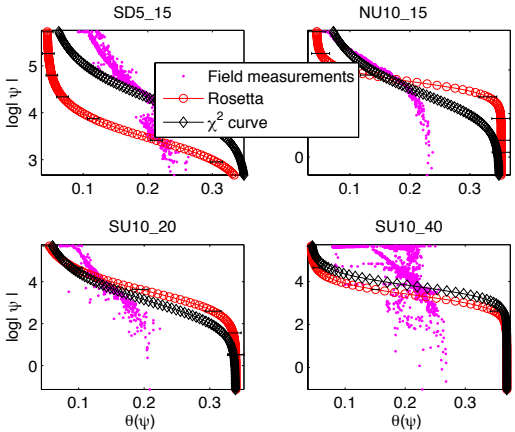
Measurements of Soil Moisture θ and Pressure Head ψ

Two approaches to measuring $\theta(\psi)$ at each soil pit:

$\Rightarrow$



Soil Moisture Estimates



Outline of lectures

- Recent work on near subsurface imaging
  - Full physics incorporated in inversion
  - Regularization informed by additional data
- Statistical aspects of inverse methods
  - Noise assumptions
  - Frequentist vs Bayesian
  - Uncertainty estimates
  - Regularization