Dual Filtering Data Assimilation of Dynamic Systems

Student: Louis Nass  Mentor: Dr. Elaine Spiller
Department of Math, Statistics, and Computer Science at Marquette University

Introduction

Data Assimilation
- Using field data and modeled data to create a basis for prediction
- To create these 'means' we use algorithms: filters
  - Ensemble Kalman/Particle
- Ability to take dynamic, multi-variable systems and assimilate
- Commonly found in weather forecasting

![Figure 1: General graphic of data assimilation](image)

Methods

- Assimilate the Lorenz '96 model:
  \[
  \begin{align*}
  \frac{dx_i}{dt} &= x_{i-1}(x_{i+1} - x_{i-2}) - x_i + F - \frac{hc}{b} \sum_{j=1}^{J} y_j \\
  \frac{dy_j}{dt} &= -cby_{j+1}(y_{j+2} - y_{j-1}) - cy_j + \frac{hc}{b}x_{\text{floor}(j-1)/J+1}
  \end{align*}
  \]
  \[F = f_0 + \theta_k \sin\left(\frac{2\pi}{\theta_k + 1}\right)\]

![Figure 2: The Cyclical Lorenz '96 System](image)

- Create 'field data' \( y \) through simulation
- Create an ensemble of \( x^b \)'s from the Lorenz '96

![Figure 3: \( R = 10 \)](image) ![Figure 4: \( P^b = 1 \)](image)

- Assimilate \( y \) to the \( x^b \)'s to create an ensemble of \( x^a \)'s

![Assimilated Ensembles](image)

Conclusion/Continued Research

- \( P^b < R \) then \( x^a \approx x^b \)
- \( R < P^b \) then \( x^a \approx y \)
- Next Step: Developing a Particle Filter to assess the parameter of Lorenz '96:

References


Acknowledgements

I would like to thank those involved with the Marquette Summer REU, Dr. Dennis Brylow, Dr. Petra Brylow, Dr. Kim Factor and my fellow students. I would additionally like to thank the Wehr Foundation for my funding and personally thank Dr. Elaine Spiller for guiding and continuing to guide me through this project.