AOSC 615 Project. Framework

- Building of a data assimilation system
  - Flexible for implementing several data assimilation methods
  - Validation & verification are crucial

\[ \text{Step 1. Model Forecast} \]
Forecast (=background): \( x^b_k \)
\[
\begin{align*}
  x^b_k &= m_{k,k-1}(x^{a}_{k-1}) : x \in \mathbb{R}^N
\end{align*}
\]

\[ \text{Observation} \]
Measurement: \( y^o_k \)
\[
\begin{align*}
  y_k &= h_k(x_k) : y_k \in \mathbb{R}^L
\end{align*}
\]

\[ \text{Nature} \]
Truth: \( x^t_k \)
\[
\begin{align*}
  x^t_k &= m_{k,k-1}(x^{t}_{k-1}) : x \in \mathbb{R}^N
\end{align*}
\]

\[ \text{Step 2. Analysis} \]
(Integration of \( x^b_k \) and \( y^o_k \))
Analysis: \( x^a_k = \text{func of } x^b_k \) and \( y^o_k \)

\[ \text{Diagnostic Module: Validation of codes} \]
Analysis of the results
AOSC 615 Project. Model

❖ Recommended models
  ▪ Lorenz 40-Variable Model
  ▪ Lorenz 960-Variable Model
    • Lorenz, E. N., 2005: Designing Chaotic Models, J. Atmos. Sci. 62, 1574-1587
  ▪ Point Vortex Model with tracers
  ❖ Other models:
    ▪ Lorenz 3-Variable Model
      • Kalnay, K. and co-authors, 2007: 4-D-Var or Ensemble Kalman filter? Tellus, 59A, 758-773.
    ▪ SPEEDY Model
AOSC 615 Project. Framework

- Setup: Identical (or Semi-Identical) Twin Experiments
  - Idea: Use the same dynamic/computational model for nature & data assimilation system
- Main elements
  A. “nature run” (control/truth) by running the computational model.
     - Quite often under a “perfect model scenario”.
  B. “Observations” of the “nature run”.
     - Quite often adding Gaussian noise to nature run
  C. Data Assimilation System
     - Iterative process
     - Flexible so that one can change the methods
  D. Validation of the codes & analysis of the results, including visualization
- Evaluation
  - Presentation, except Project I
  - Report
  - Codes


AOSC 615 Project. Report Outline

- Typical report may consist of (but change as necessary)
  - Title: “AOSC 615. Project No. <...>”
  - Name
  - Abstract
  - Main text: sample
    1. Introduction / Background / Objectives
    2. System
      a. Model choice & nature run (how IC was generated, spin-up?, duration of nature run, output frequency of the nature run)
      b. Observations (what are/how often observed, noise characteristics)
    3. Data assimilation system
      a. Assimilation method (how forecast IC was generated, spin-up?, assimilation window size)
      b. Validation approach (how to verify your codes do what they are supposed to do)
    4. Experimental set-up
    5. Results (including visualization)
      a. Validation discussion
      b. Results
    6. Concluding discussion
  - References