A Brief and Superficial Introduction to Data Assimilation

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[1]ATM S 559 Climate Modeling

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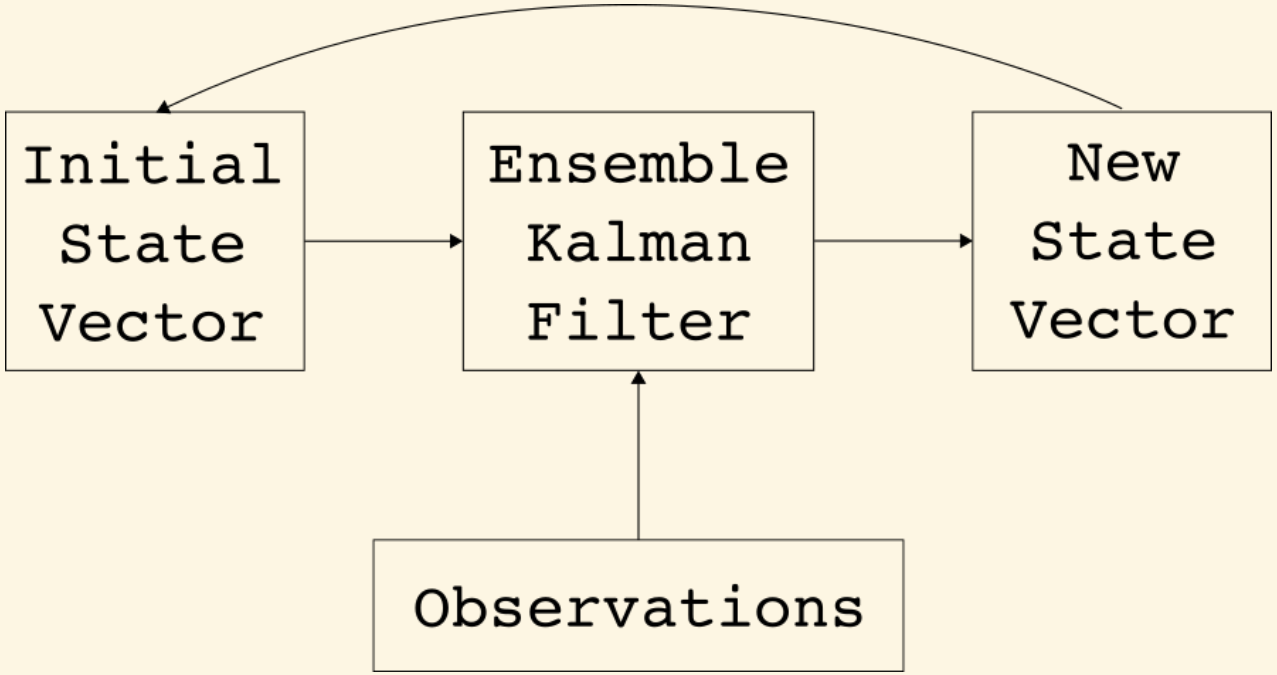
Data Assimilation

Data assimilation (DA) is a set of methods for adjusting a model to account for observations.

- Improves prediction accuracy.
- Helps to reduce model bias[3].

The Process


Initial
State
Vector
Ensemble
Kalman
Filter
New
State
Vector
Observations

The Process

The Process

Bayes theorem [1]:

$$P(T|T_O, C) = \frac{P(T_O|T, C)P(T|C)}{P(T_O|C)} \tag{1}$$

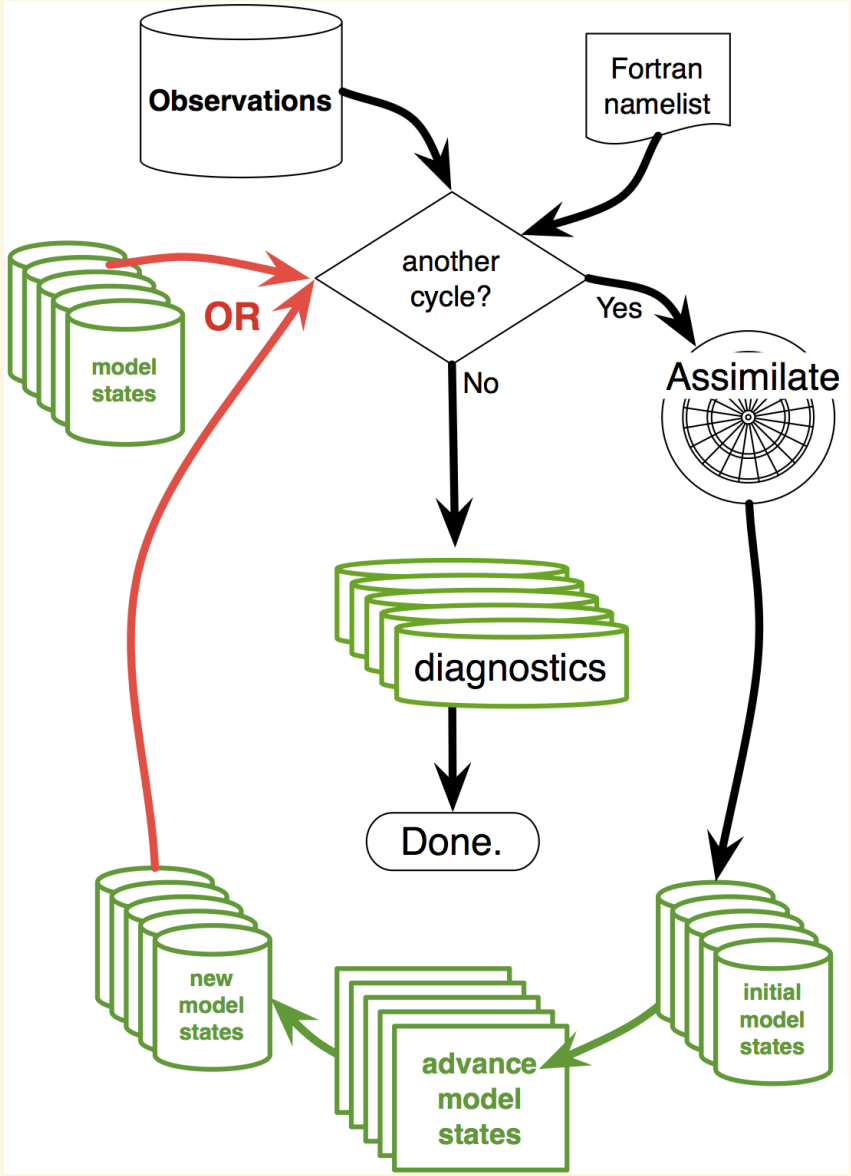
- Posterior or update
- Likelihood
- Prior
- Normalization

Data Assimilation Research Testbed (DART)

A community facility for ensemble DA developed and maintained by the Data Assimilation Research Section (DAReS) at the National Center for Atmospheric Research (NCAR).

- DART code includes tutorials for models ranging in complexity.
- The lorenz_63 is an easy place to start.

Data Assimilation Research Testbed (DART)



Lorenz's 3-variable Chaotic Model

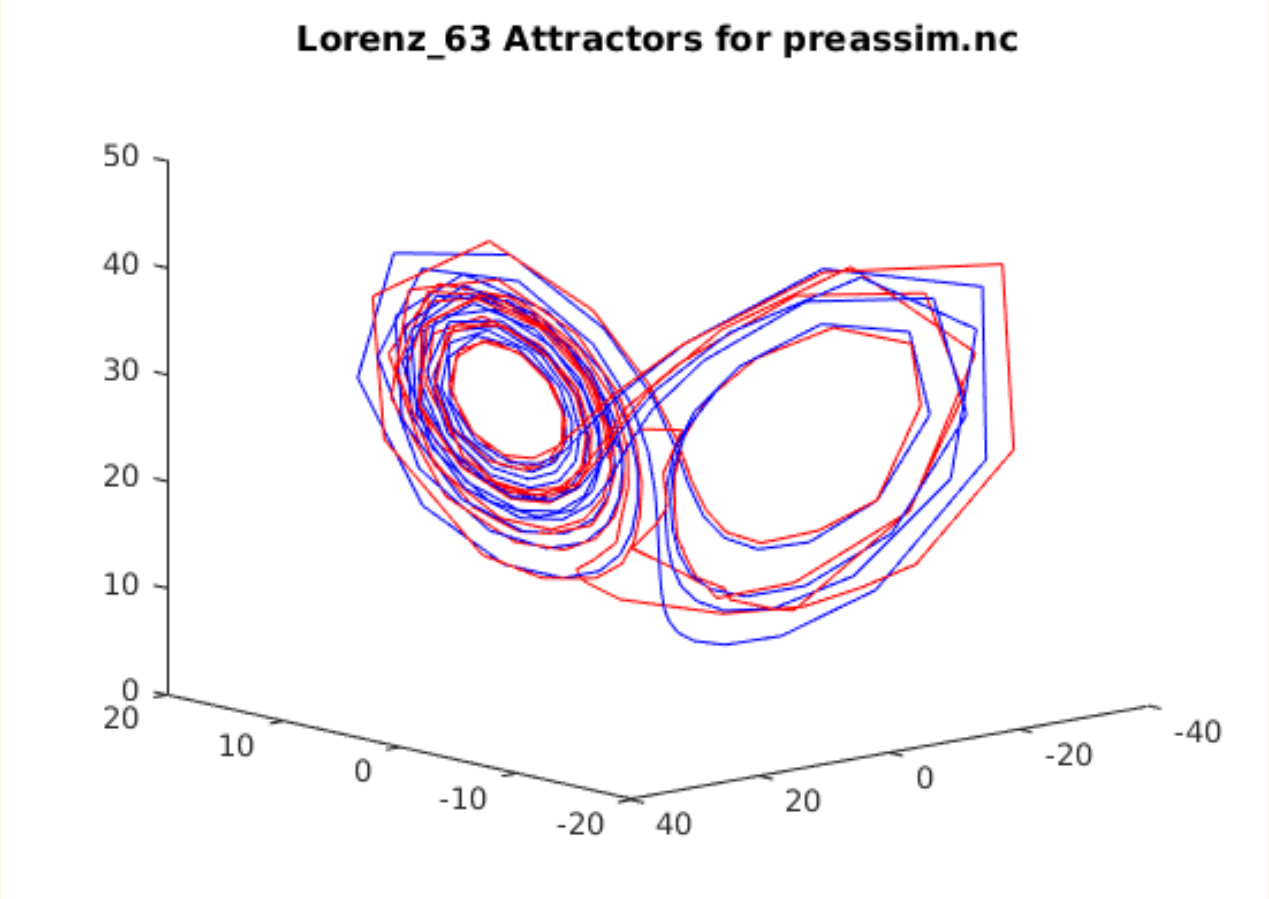
$$x_1' = -\sigma x_1 + \sigma x_2 \tag{2}$$

$$x_2' = -x_1 x_3 + r x_1 - x_2 \tag{3}$$

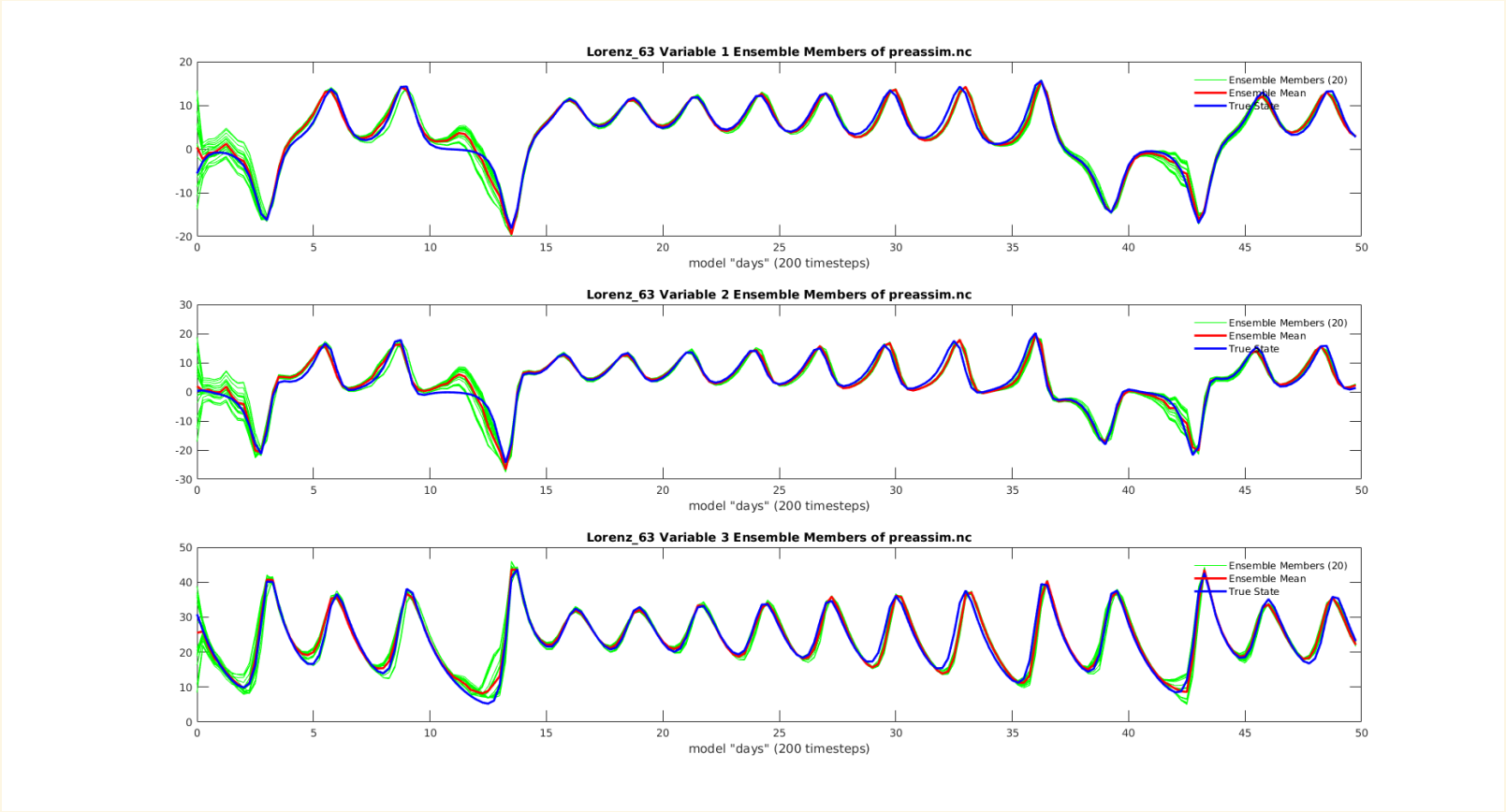
$$x_3' = x_1 x_2 - b x_3 \tag{4}$$

- A low-order atmospheric model, described in [2].
- Good sandbox for testing DA methods.
- Easy to combine with parts of GCMs. (Zhang et al. added a slab ocean model).

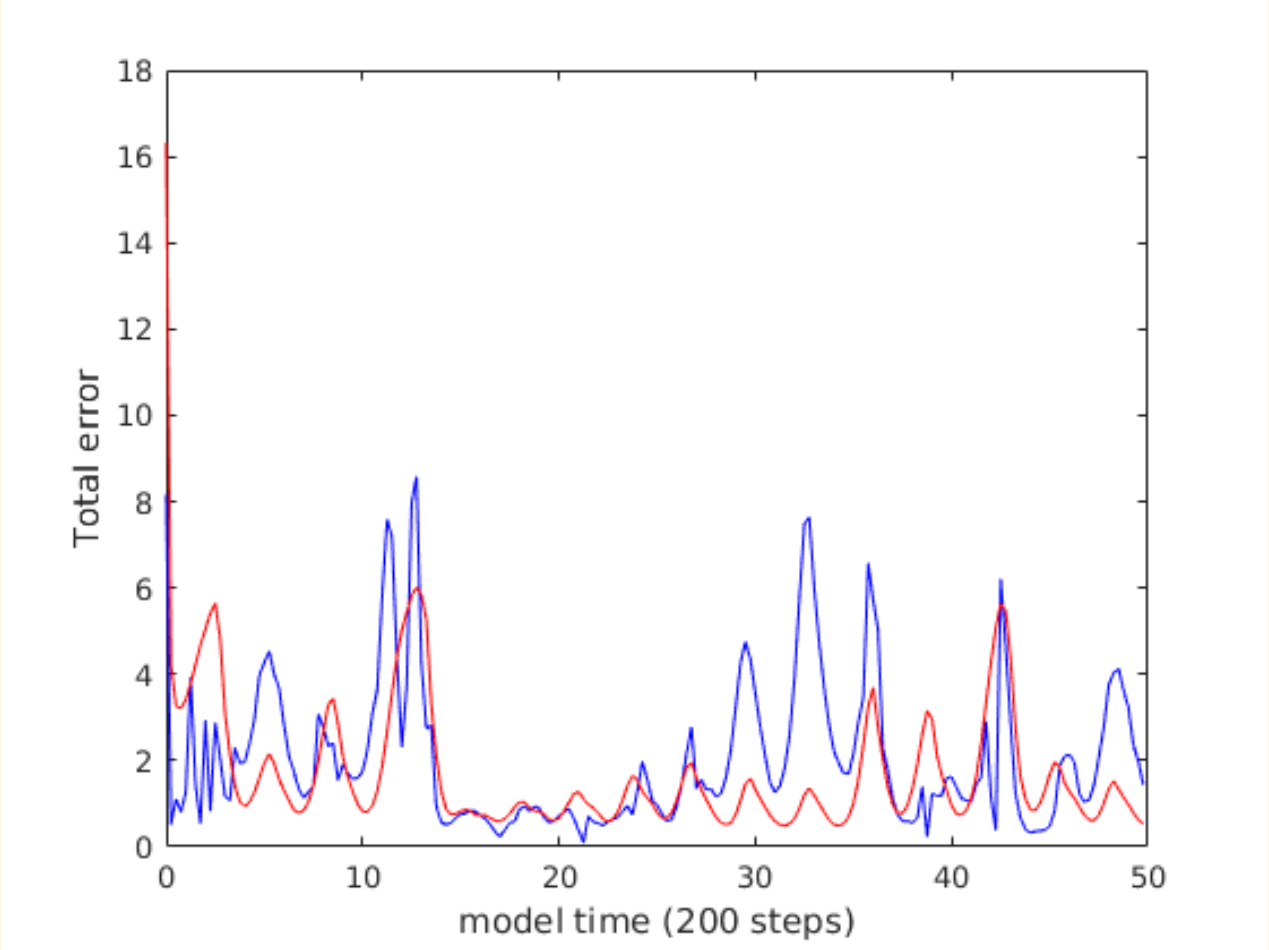
Results (so far)



Results (so far)



Results (so far)



Still to Do

- Understand why the ensemble is close to the truth in certain parts.
- See if error increases when parameters are changed.

Questions?

Thank you for your attention.

[1] DAReS, *Dart lab tutorial section 1: Ensemble data assimilation concepts in 1d*.
[Online; accessed 20-April-2017].

[2] E. N. Lorenz, *Deterministic nonperiodic flow*, Journal of the atmospheric sciences, 20 (1963), pp. 130–141.

[3] S. Zhang, Z. Liu, A. Rosati, and T. Delworth, *A study of enhancive parameter correction with coupled data assimilation for climate estimation and prediction using a simple coupled model*, Tellus A, 64 (2012).