

Geophysical Fluid Dynamics Laboratory Review

June 30 - July 2, 2009



Seasonal-Decadal Predictability, Prediction and Ensemble Coupled Data Assimilation

Presented by
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- **What seasonal-decadal predictability exists in the climate system, and what are the mechanisms responsible for that predictability?**
- **To what degree is the identified predictability (and associated climatic impacts) dependent on model formulation?**
- **Are current and planned initialization and observing systems adequate to initialize models for decadal prediction?**
- **Is the identified decadal predictability of societal relevance?**

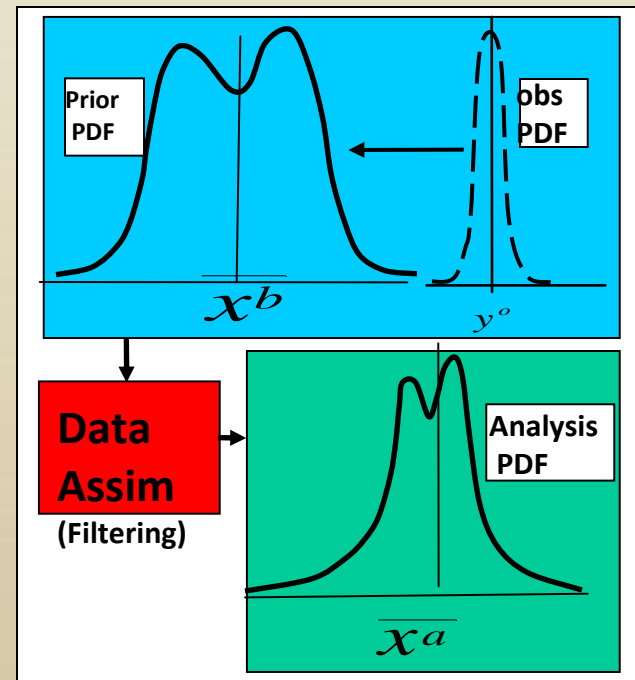
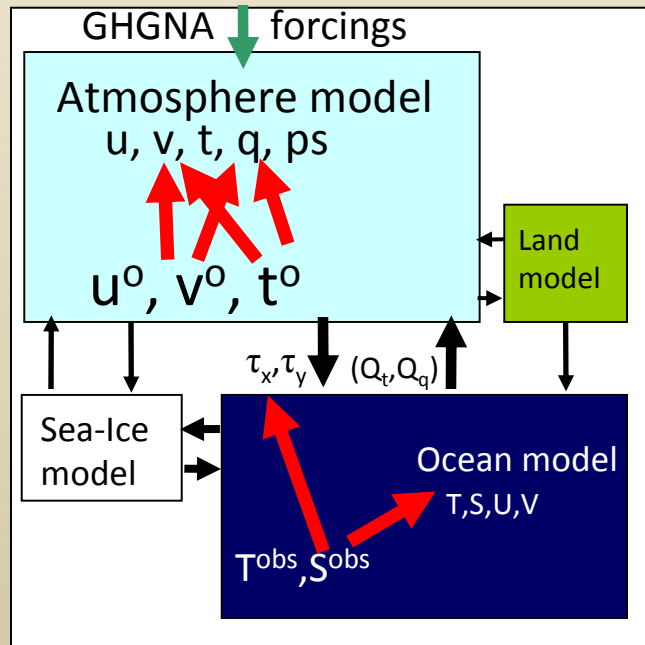
Ensemble Coupled Data Assimilation (ECDA) is at the heart of prediction efforts

- **Provides initial conditions for Seasonal-Decadal Prediction**
- **Provides validation for predictions and model development**
- **Ocean Analysis kept current and available on GFDL website**
- **Active participation in CLIVAR/GSOP intercomparisons**

Pioneering development of coupled data assimilation system

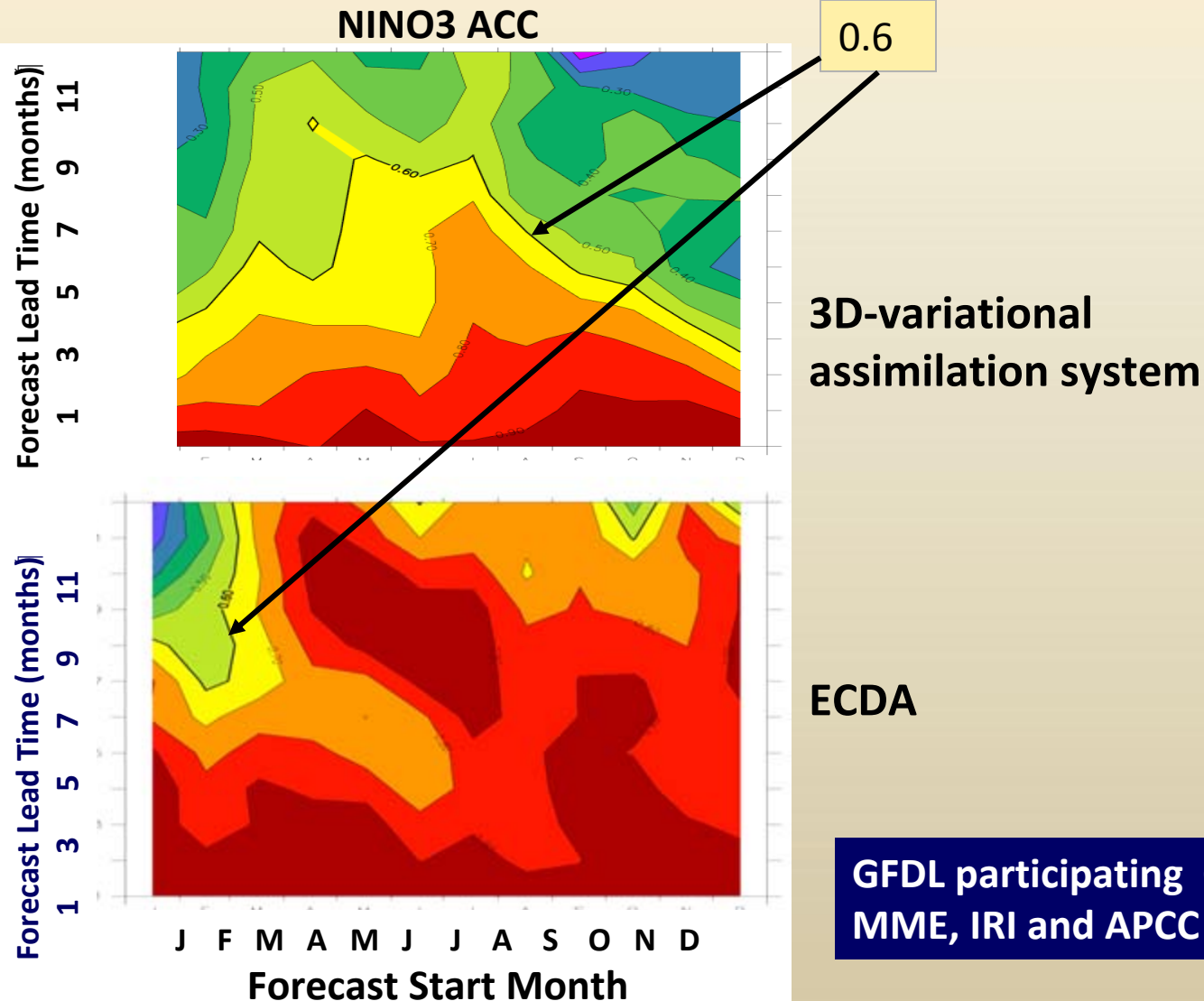
Ensemble Coupled Data Assimilation estimates the **temporally-evolving probability distribution** of climate states under observational data constraint:

- Multi-variate analysis maintains physical balances between state variables such as T-S relationship – primarily geostrophic balance
- Ensemble filter maintains the nonlinearity of climate evolution
- All coupled components adjusted by observed data through instantaneously-exchanged fluxes
- Optimal ensemble initialization of coupled model with minimum initialization shocks



OAR 2008 Outstanding Paper Award:
S. Zhang, M. J. Harrison,
A. Rosati, and A. Wittenberg

New coupled assimilation system dramatically improves ENSO prediction skill



GFDL participating CTB/NCEP/National
MME, IRI and APCC

ECDA research activities to improve initialization

- **Multi-model ECDA to help mitigate bias**
- **Fully coupled model parameter estimation within ECDA**
- **ECDA in high resolution CGCM**
- **Assess additional predictability from full depth ARGO profilers**

Decadal Potential Predictability with a focus on the Atlantic

- **How well does the ECDA system constrain the AMOC?**
- **Given that the ocean observing system is non-stationary, what impact does that have on the AMOC predictability?**
- **What are the sources of AMOC predictability and how dependent are they to the various observing networks ?**

We use a “perfect model” framework to address these questions

Results: The ARGO network outperforms the XBT network in both assimilation and forecast skill in idealized experiments

GFDL Decadal Prediction Research in support of IPCC AR5

Key goal: assess whether climate projections for the next several decades can be enhanced when the models are initialized from observed state of the climate system.

- **Use ECDA for initial conditions from “observed state”**
Produce ocean reanalysis 1970-2009
- **Use “workhorse” CM2.1 model from IPCC AR4 [2009]**
Decadal hindcasts from 1980 onwards (10 member ensembles)
Decadal predictions starting from 2001 onwards (10 member ensembles)
- **Use experimental high resolution model (if scientifically warranted) [2010]**
Decadal predictions starting from 2001 onwards (10 member ensembles)
- **Use CM3 model for IPCC AR5 [2010, tentative]**
Decadal predictions starting from 2001 onwards (10 member ensemble)

Summary

- **Development of new advanced assimilation techniques using coupled climate models**
- **Apply these techniques to detecting climate change while providing estimates of their uncertainty**
- **Improve our understanding of predictability at decadal time scales**
- **Provide a foundation for the development of a NOAA capability for decadal predictions**

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