# Geophysical Fluid Dynamics Laboratory Review

June 30 - July 2, 2009

# Physical Climate Change: Understanding and Prediction

Presented by

**Thomas Delworth**

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# NOAA's Climate Mission:

*"NOAA is charged with helping society understand, plan for, and respond to climate variability and change.*

*This is achieved through … focused research and modeling to understand key climate processes.*

*The NOAA climate mission is an end-to-end endeavor focused on providing a predictive understanding of the global climate system so the public can incorporate the information and products into their decisions."*

# Goals and Methods

## Goals:

• Increase understanding of observed and projected climate variability and change

• Assess predictability of the climate system and conduct predictions on seasonal to decadal time scales

## Methods:

Use well designed numerical experiments and novel assimilation techniques in concert with observational analyses

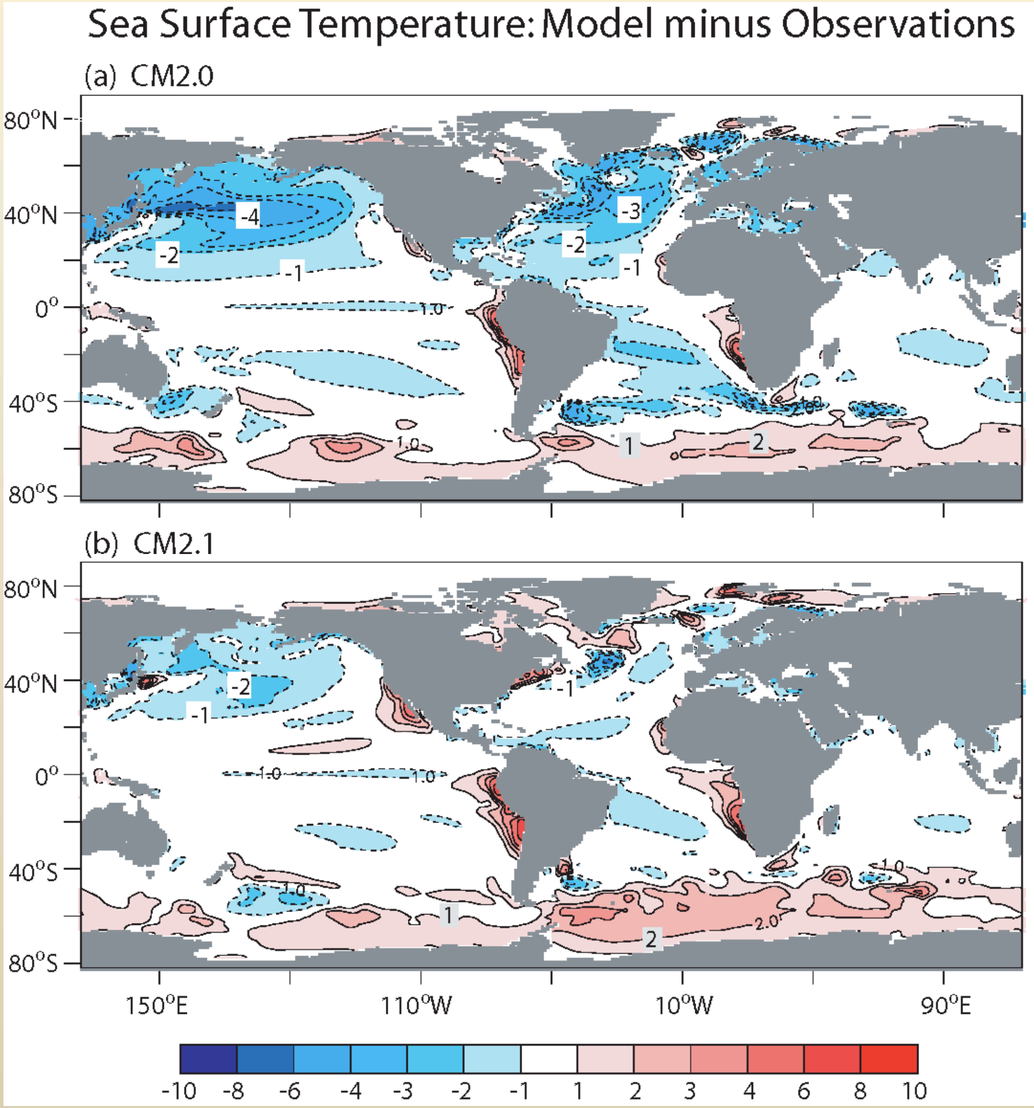
## Modeling Tools:

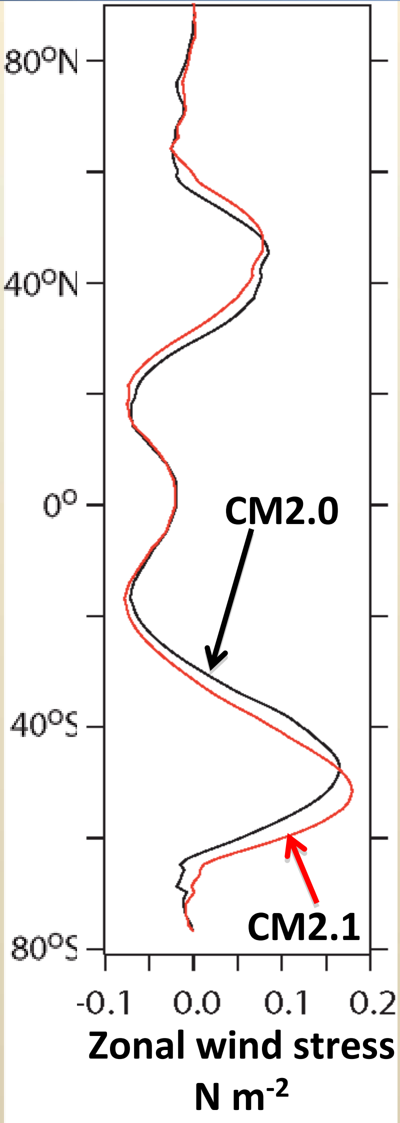
1. CM2 – global coupled climate model used in IPCC AR4
2. High resolution atmospheric models
3. Ensemble Coupled Data Assimilation (ECDA)
4. CM3 and newly emerging high resolution coupled models

# Differences between CM2.0 and CM2.1 largely due to improved winds in CM2.1

**B-Grid Dynamical Core**

**FV Dynamical Core**



# Independent assessments of GFDL CM2 conclude that it is one of top models used in IPCC AR4

## ENSO

Of the 19 models examined, GFDL CM2.0 and CM2.1 were among the 4 models identified as having an ENSO "based on the same physical processes as in the observations." *(Oldenborgh et al., 2005)*

## Tropical African Climate

One of top three models "… selected for their reasonable simulations of the twentieth-century climate …" *(Cook and Vizy, 2006)*

## Arctic and Northern Hemisphere Temperature, Precipitation, SLP

GFDL CM2.1 one of top 2 models out of 15 models for AR4 *(Walsh et al 2008)*

## Southern Ocean

GFDL CM2.1 was an AR4 "best" – important for heat and carbon uptake *(Russell et al, 2006)*

## Atlantic Ocean temperature and salinity

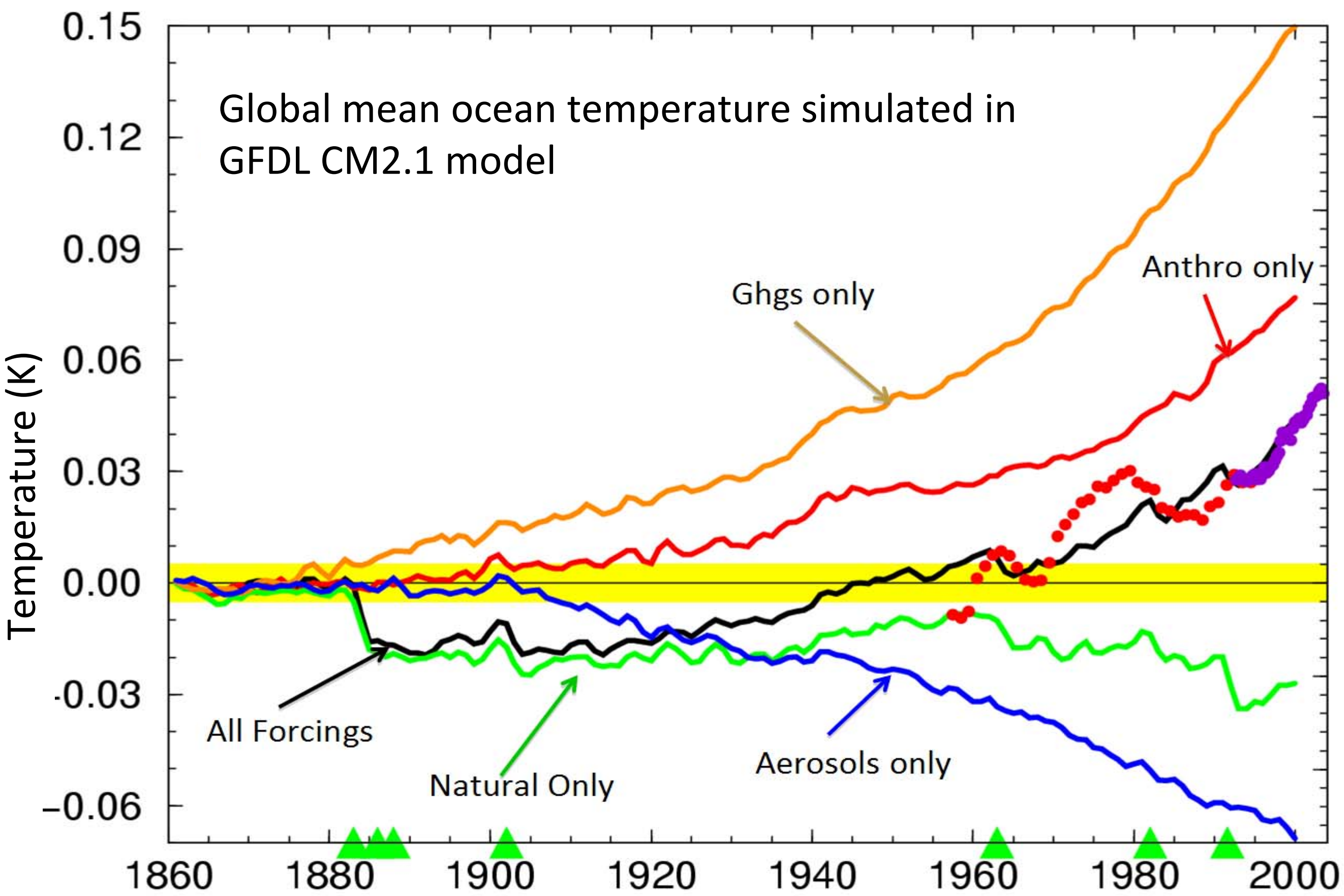
"… the GFDL CM2.1 model clearly shows the best performance …" *(Schneider et al. 2007)*

**➔ Expectation that GFDL CM3 will build on this very high standard**

# Extensive suites of GFDL CM2 experiments have led to important scientific results

- IPCC AR4
  - more than 7000 simulated years
  - includes major effort to make model output publicly available
  - important contributions to CCSP reports
- Additional attribution simulations and sensitivity studies
- Ensemble Coupled Data Assimilation (ECDA) – Output publicly available
- Seasonal prediction hindcasts and forecasts – contribute to NCEP, IRI, and other national and international efforts
- Decadal predictability

# Attribution experiments quantify impact of various forcings on ocean warming




*(Delworth et al., 2005)*

# Topics Presented

**1. <u>Observational analyses</u>**

Assessing and resolving differences between observed and simulated change
*(John Lanzante)*

**2. <u>Understanding key climate processes</u>**

– Tropical climate change *(Gabe Vecchi)*
– ENSO and climate change *(Andrew Wittenberg)*
– Hurricanes and climate change *(Tom Knutson)*
– Sahel Drought *(Isaac Held)*
– Atlantic Meridional Overturning Circulation (AMOC) and climate *(Rong Zhang)*
– Sea level rise and the ocean's response to radiative forcing changes *(Keith Dixon)*

# Topics Presented

**3. <u>Predictive understanding</u>**

– Coupled assimilation and seasonal predictions *(Tony Rosati)*
– Decadal predictability and predictions *(Tony Rosati)*

**4. <u>Pathway to the future</u>**

– CM2 to CM3 development *(Mike Winton)*
– Synthesis and future directions *(Tom Delworth)*

**<u>Additional Key Contributors:</u>**
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