

# Geophysical Fluid Dynamics Laboratory Review

June 30 - July 2, 2009



# Synthesis and Future Directions

Presented by

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# Synthesis and Future Directions

*“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.”*

# Future Directions

## **1. Use GFDL CM3, ESMs and new global high resolution models to pursue ...**

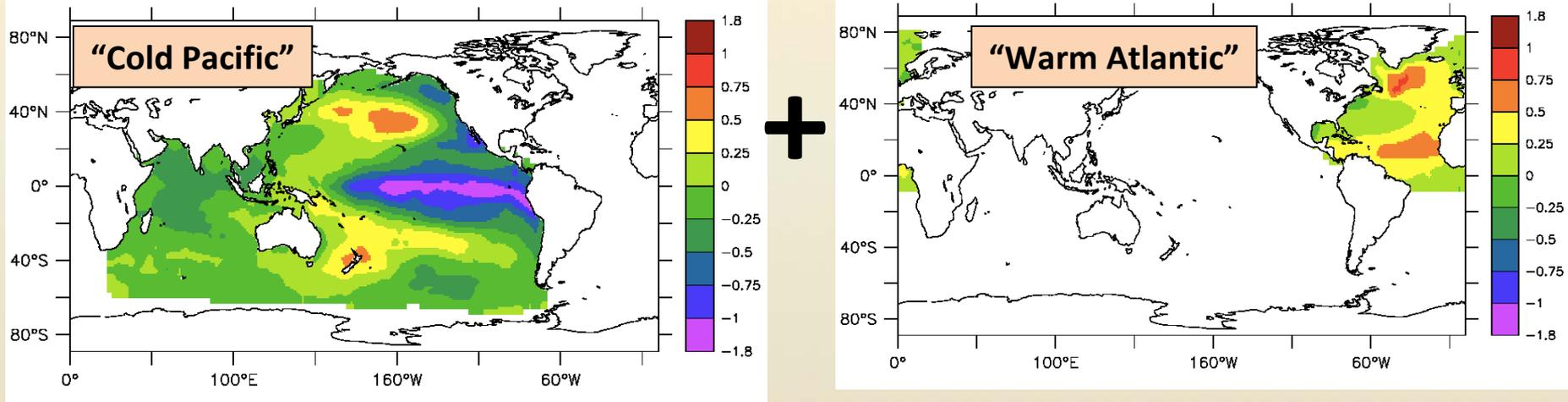
- large-scale tropical change, hurricanes, ENSO
- Sahel Drought – new perspectives with CM3 and beyond
- sea level rise, including land-based ice sheet changes
- cryospheric processes and feedbacks
- AMOC and climate
- North American drought, climate extremes

Experiments as part of AR5 protocol will be extremely useful, especially in combination with additional attribution and sensitivity experiments.

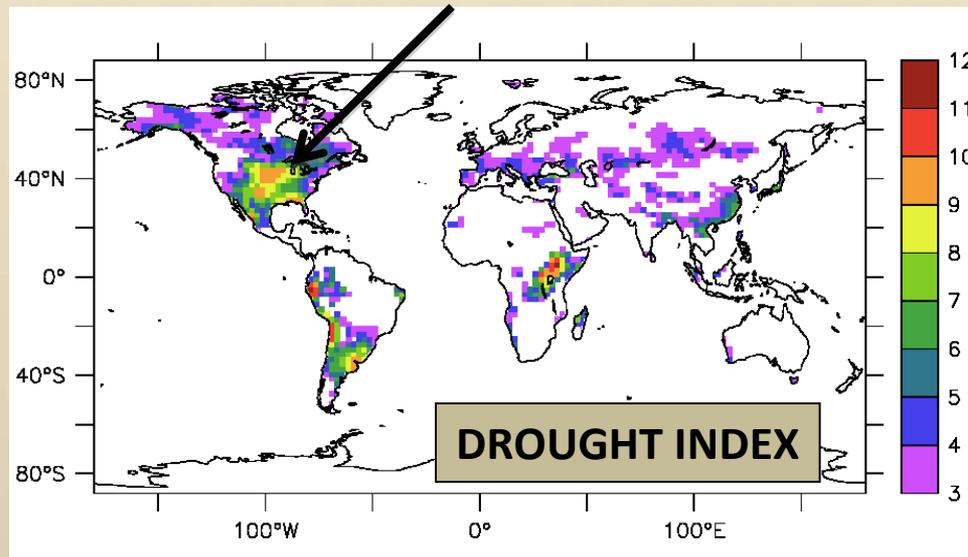
## **2. Seasonal to decadal predictability, predictions and attribution**

## **3. High-resolution coupled modeling**

# Oceanic Forcing of North American Drought



... leads to North American Drought



Number of months per year in drought

*K. Findell, T. Delworth in collaboration with US CLIVAR Working Group on Drought*

# Future Directions

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Experiments as part of AR5 protocol will be extremely useful, especially in combination with additional attribution and sensitivity experiments.

## **2. Seasonal to decadal predictability, predictions and attribution**

## **3. High-resolution coupled modeling**

## 2. Seasonal to decadal predictability, predictions and attribution

1. Participation in national multi-model ensemble for seasonal prediction
2. Further development and application of Ensemble Coupled Data Assimilation system
3. Publicly available updated ocean reanalyses
4. Initial suites of decadal prediction experiments using GFDL CM2.1 model for IPCC AR5
  - role of Atlantic, Pacific, Indian Oceans in decadal variability and predictability
  - output publicly available
  - research on initialization
  - statistical decadal prediction (see poster by Salil Mahajan)
5. Collaboration with NCAR, MIT on AMOC variability and predictability
6. If scientifically warranted and resources permit, additional suites of decadal prediction experiments in 2010 and beyond:
  - a. GFDL CM3
  - b. high resolution coupled model using DOE and NOAA computer resources

### 3. “Push the envelope” with high resolution coupled modeling

One goal is to assess how simulated climate variability and change depend on explicit inclusion of small-scale processes.

#### Examples:

- dependence of simulated decadal variability and predictability on resolution
- dependence of ocean heat uptake and transient climate sensitivity on resolution

Over the next several years: Develop and use models “CM2.4”, “CM2.5”, possibly “CM2.6”

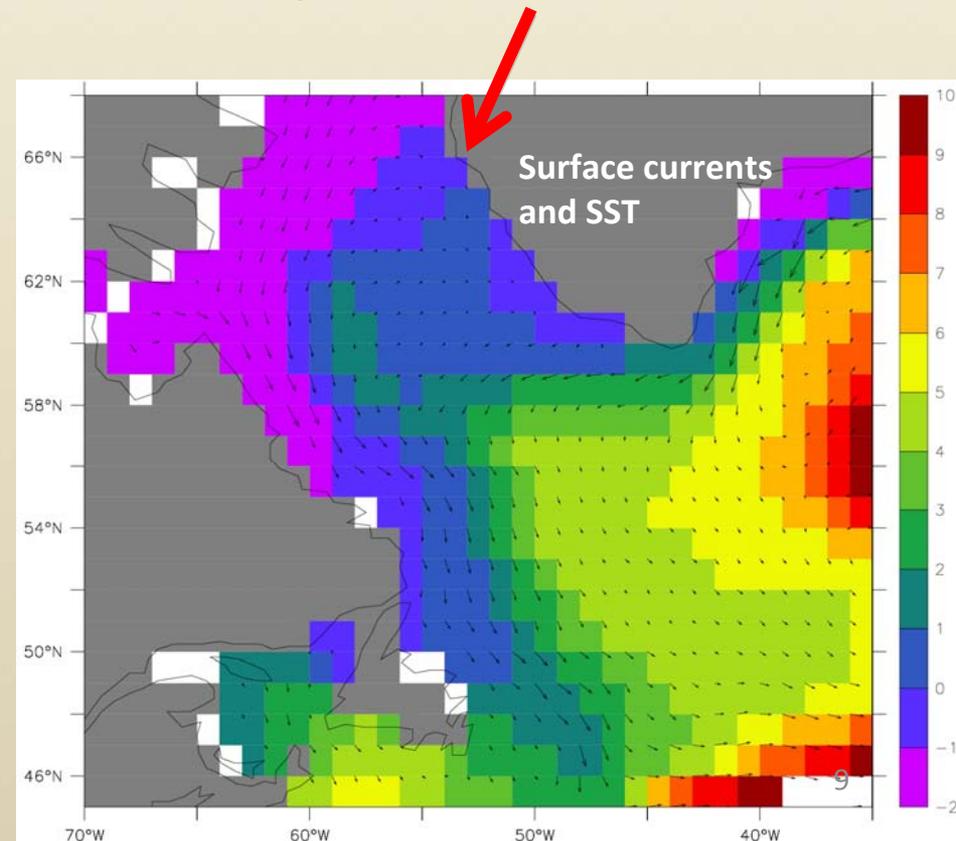
(atmospheric components based on GFDL high resolution atmosphere modeling efforts)

	Ocean	Atmos	Computer	Status
GFDL CM2.4	10-25 Km	100 Km	GFDL	Running
GFDL CM2.5	10-25 Km	50 Km	DOE	In development
GFDL CM2.6	4-10 Km	50 Km	DOE	Ocean component in development

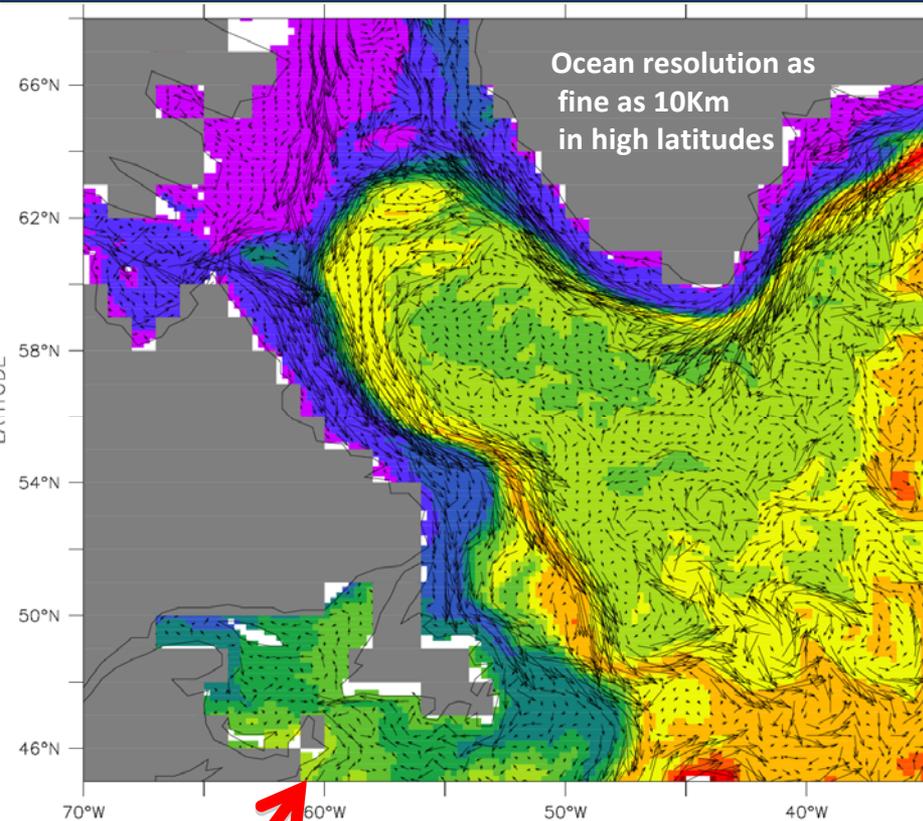
# How sensitive is simulated decadal variability, predictability and climate change to model resolution and physics?

**GFDL CM2.1 model was one of the best in the world for Atlantic simulations in AR4. Even so, important processes are not well resolved.**

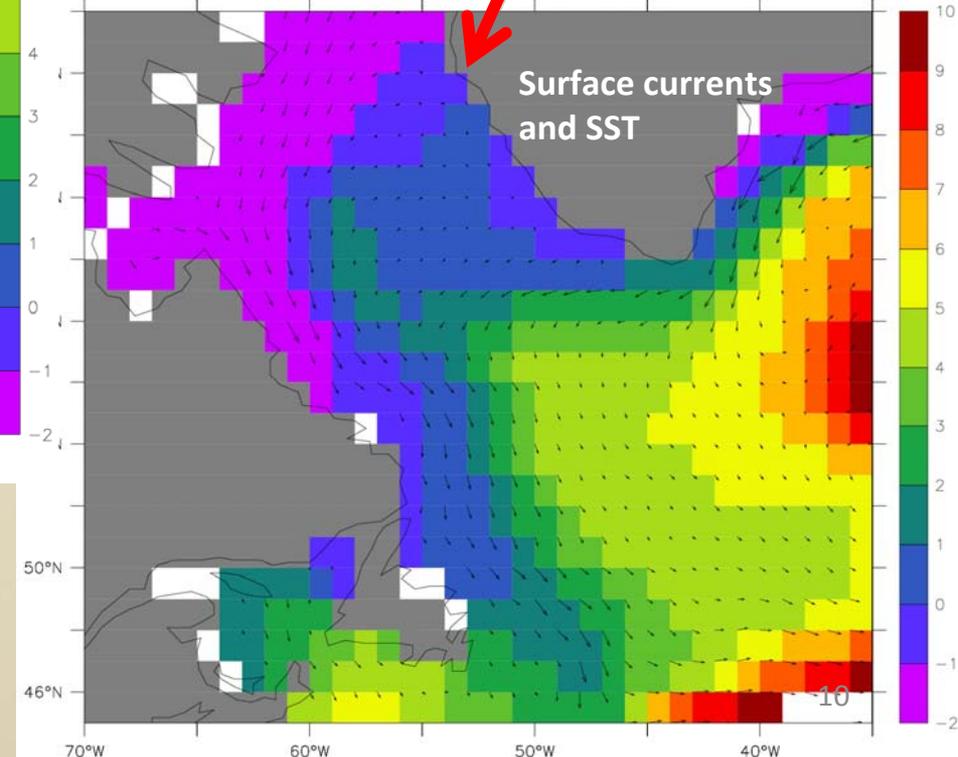
**GFDL CM2.1 Global Coupled Model  
SST, surface currents**



# How sensitive is simulated decadal variability, predictability and climate change to model resolution and physics?

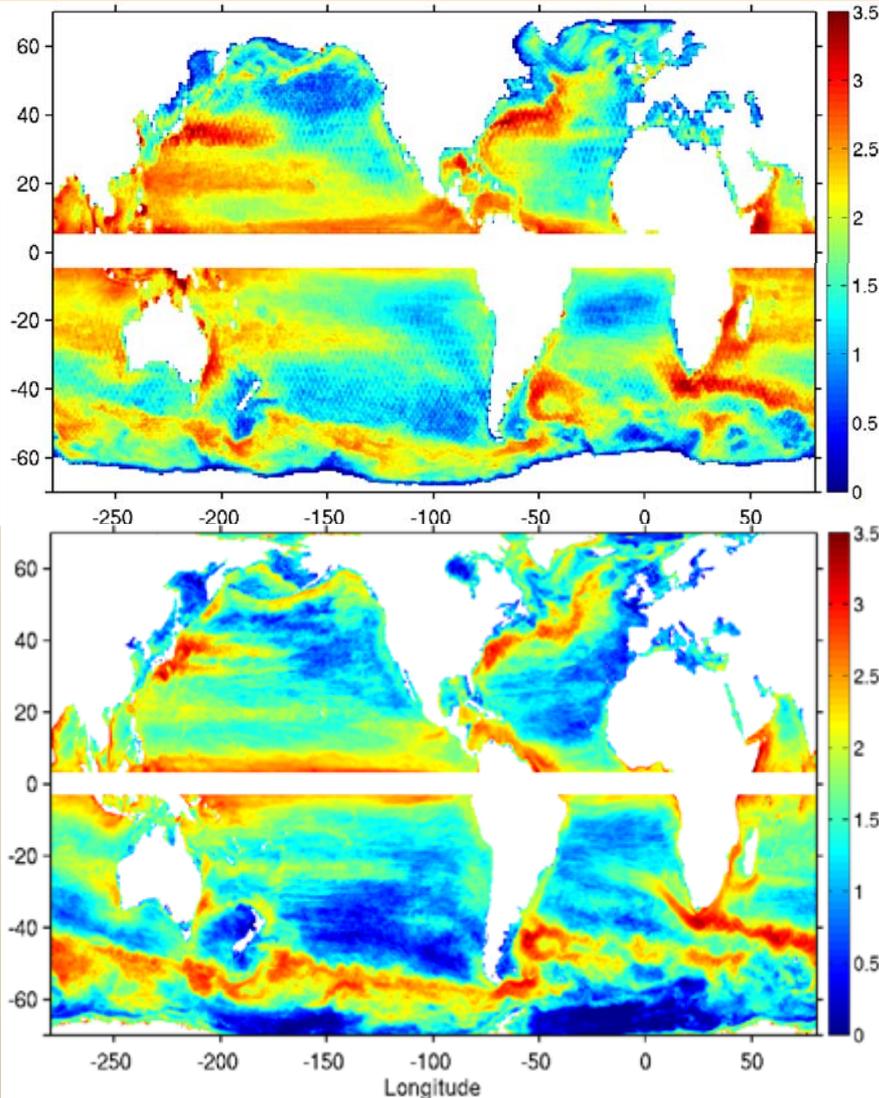


**GFDL CM2.1 Global Coupled Model  
SST, surface currents**



**GFDL CM2.4 Global Coupled Model  
SST, surface currents**

# High resolution coupled model shows realistic simulation of eddy kinetic energy



**Observational  
estimate (satellite)**

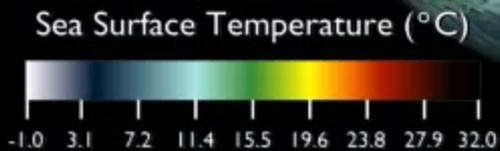
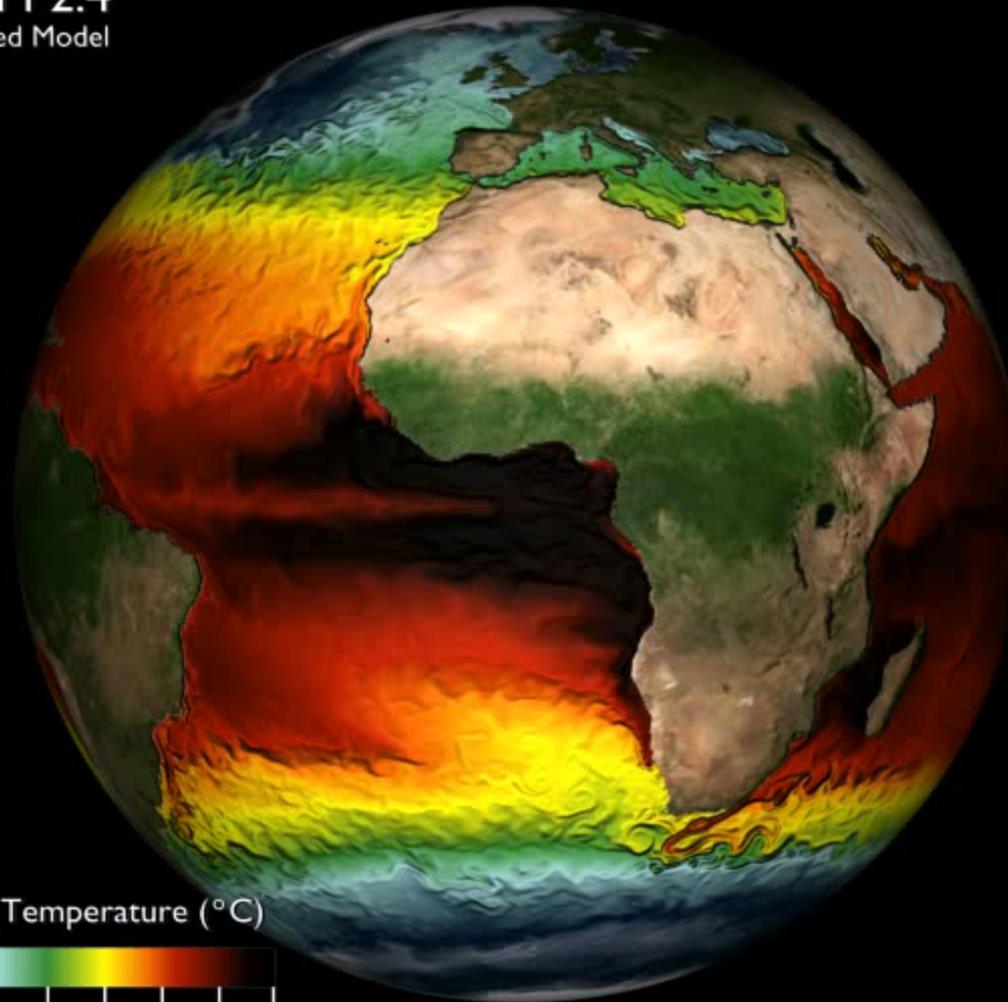
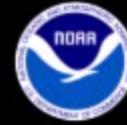
Eddy Kinetic Energy  
[Log scale,  $\text{cm}^2 \text{s}^{-2}$ ]

**GFDL CM2.4 Model**

*Courtesy Riccardo Farneti  
(see related poster)*

# GFDL CM 2.4 Hi-Res Coupled Model

GFDL CM 2.4  
Hi-Res Coupled Model



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