Decadal prediction is both a boundary value and initial condition problem.
Ocean plays an important role.
Warm North Atlantic linked to ...

More rain

Less rain

Drought

Hurricanes

North Atlantic SST

Forced component

Internal variability

Ting et al. (2008)

Courtesy T. Delworth
ATLANTIC MERIDIONAL OVERTURNING CIRCULATION MAXIMUM (1850)
additional predictions
Initialized in
‘01, ‘02, ‘03 … ‘09

10-year hindcast &
prediction ensembles:
initialized 1960, 1965, …, 2005

30-year hindcast and
prediction ensembles:
initialized 1960, 1980 & 2005

100-yr “control”
& 1% CO2

AMIP

alternative initialization
strategies

prediction without
volcanoes

prediction with
2010 Pinatubo-
like eruption

atmos. chemistry
&/or aerosols &/or
regional air quality

• Our first prediction
experiments start
from 1 January
2000.

• Further strategy
related to the IPCC
experiment set will
be determined by
the CCSM SSC
(March 2010).

Informed guidance on near-term
evolution of the climate system
Initial Initialization Options for the Ocean Model

- Use 'hindcast' solutions from ocean-only or ocean-ice coupled simulations forced with CORE 2 interannual data sets for 1948-2007.
- Use modified ocean analyses from another center, i.e., GFDL and ECCO products.
- Embark on ocean data assimilation using Data Assimilation Research Testbed (DART).

Sea ice, atmosphere, and land initial conditions ?????
### Prediction experiments currently being examined

<table>
<thead>
<tr>
<th>Case</th>
<th>Configuration</th>
<th>Forcing</th>
<th>Salinity Restoring</th>
<th>Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Ocean only</td>
<td>CORE2 1948-2007</td>
<td>none</td>
<td>CCSM4</td>
</tr>
<tr>
<td>A2</td>
<td>Ocean only</td>
<td>CORE2 1948-2007</td>
<td>τ = 4 years</td>
<td>CCSM4</td>
</tr>
<tr>
<td>A3</td>
<td>Ocean only</td>
<td>CORE2 1948-2007</td>
<td>τ = 1 year</td>
<td>CCSM4</td>
</tr>
<tr>
<td>A4</td>
<td>Ocean only</td>
<td>CORE2 1948-2007</td>
<td>τ = 30 days</td>
<td>CCSM4</td>
</tr>
<tr>
<td>A5</td>
<td>Ocean only</td>
<td>CORE2 1949-2006</td>
<td>τ = 4 years</td>
<td>CCSM3.5</td>
</tr>
<tr>
<td>B1</td>
<td>Ocean-ice</td>
<td>CORE2 1948-2007</td>
<td>none</td>
<td>CCSM4</td>
</tr>
<tr>
<td>B2</td>
<td>Ocean-ice</td>
<td>CORE2 1948-2007</td>
<td>τ = 4 years</td>
<td>CCSM4</td>
</tr>
<tr>
<td>B3</td>
<td>Ocean-ice</td>
<td>CORE2 1948-2007</td>
<td>τ = 1 year</td>
<td>CCSM4</td>
</tr>
<tr>
<td>B4</td>
<td>Ocean-ice</td>
<td>CORE2 1948-2007</td>
<td>τ = 30 days</td>
<td>CCSM4</td>
</tr>
<tr>
<td>B5</td>
<td>Ocean-ice</td>
<td>CORE2 1949-2006</td>
<td>τ = 4 years</td>
<td>CCSM3.5</td>
</tr>
<tr>
<td>C1</td>
<td>Ocean only, data assim</td>
<td>CORE2 1998-1999</td>
<td>N/A</td>
<td>CCSM4/DART</td>
</tr>
</tbody>
</table>

### Initial Condition Experiments

<table>
<thead>
<tr>
<th>Case</th>
<th>Configuration</th>
<th>Initialization</th>
<th>Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>20C</td>
<td>20th Century, 1850-2005</td>
<td>1850 Control</td>
<td>CCSM4</td>
</tr>
<tr>
<td>P1</td>
<td>Prediction Test, 2000-2005</td>
<td>ocn/ice: B2 atm/Ind: AMIP</td>
<td>CCSM4</td>
</tr>
<tr>
<td>P3</td>
<td>Prediction Test, 2000-2005</td>
<td>ocn/ice: C1/B4 atm/Ind: AMIP</td>
<td>CCSM4</td>
</tr>
<tr>
<td>P4</td>
<td>Prediction Test, 2000-2005</td>
<td>ocn/ice: C1/B4 atm/Ind: 20C</td>
<td>CCSM4</td>
</tr>
</tbody>
</table>
ATLANTIC MERIDIONAL OVERTURNING CIRCULATION (AMOC) TIME SERIES

AMOC Strength (max below 500m at 26.5°N)

Year

Sverdups

B1
B2
B3
B4
C1
RAPID


AMOC Strength (max below 500m at 26.5°N)

Year

Sverdups

2004.0 2005.0 2006.0 2007.0 2008.0

RAPID
B2
Benefits of Assimilation

Barotropic Streamfunction (Sv)

Temperature Anomaly at 95m (°C)

AMOC (Sv)
AMOC Predictability and Climate Drift

AMOC Strength (max below 500m, north of 28N)

Model Year

2000.0 2002.0 2004.0 2006.0 2008.0
Upper ocean (0-300 m) heat content anomaly in the North Atlantic
Open Questions and Challenges

• What are the mechanisms for decadal variability?
• To what extent is decadal variability predictable?
• What is the optimal initialization for the components?
• Does oceanic variability have atmospheric relevance?

➢ Adequate climate observing system?
➢ Reliable assimilation systems to initialize models?
➢ Are models “good enough” to make skillful predictions?
Reduced SST Bias persists
SST information in the North Atlantic persists for 4-5 years