Simulated North Atlantic AMOC Index

- **All forcings**
- **Aerosol only forcing**
- **Greenhouse gas only forcing**
Climate & Earth System Model (ESM)

**Climate Model**
- Atmospheric circulation and radiation
- Ocean circulation
- Land physics and hydrology
- Sea Ice

**Earth System Model**
- Atmospheric circulation and radiation
- Chemistry – CO₂, NOₓ, SO₄, aerosols, etc
- Plant ecology and land use
- Land physics and hydrology
- Sea Ice
- Ocean ecology and Biogeochemistry
- Ocean circulation
- Land Ice
RECENT HIGHLIGHTS – III
New coupled assimilation system improves ENSO prediction skill

Correlation of observed and predicted NINO3 SST (measure of forecast skill)

3D-variational assimilation system

New coupled assimilation system

Geophysical Fluid Dynamics Laboratory
Atlantic Meridional Overturning Circulation (AMOC)

What will the next decade or two bring?

Two important aspects:

a. Decadal-multidecadal fluctuations
b. Long-term trend

- More intense hurricanes
- More rain over Sahel and western India
- Warm North Atlantic linked to ...
- Drought
Can we predict which trajectory the real climate system will follow?

Projected Atlantic SST Change
(relative to 1991-2004 mean)

Results from GFDL CM2.1 Global Climate Model
Decadal Predictability

- Decadal prediction/projection is a mixture of boundary forced and initial value problem
- Changing radiative forcing (esp. aerosols) will be a key ingredient
- Some basis for decadal predictability of internal variability, probably originating in ocean
- Some of predictability will arise from unrealized climate change already in the system
- Substantial challenge for models, observations, assimilation systems, and theoretical understanding
GFDL will contribute “time-slices” to AR5 at 25 km resolution
Initial emphases include tropical storms and regional climate change over US
GFDL Contribution to North American Regional Climate Change Assessment Program

Precipitation Response

Winter

Couple Model (CM2.1) with 2° resolution

Summer

Atmospheric GCM (AM2.1 M180) with 0.5° resolution

Wyman and Held
Frame science around impacts, adaptation, mitigation; a risk management framework

WCSP/GCOS/IGBP
Sydney Workshop (October 2007)
Lessons from AR4
[Doherty et al., BAMS, 2009]
Do-able Pieces

• Improved access to information and data, and sustaining it.

• Increased/better clarifications on uncertainties and quantification of levels of confidence.

• Scientists’ engagement in the “applications” of the fundamental advancements to produce information that is usable.

• Clear communication of the state-of-climate-science for Adaptation and Mitigation considerations, with accurate statements on the advances made in the predictive understanding of climate, and on the limitations in the information.

• Working alongside the other “experts” in providing collectively smart inputs into the Adaptation and Mitigation decision processes.
Schematic for Global Atmospheric Model

Horizontal Grid (Latitude-Longitude)

Vertical Grid (Height or Pressure)

Physical Processes in a Model

ATMOSPHERE
snow
momentum
heat
water
sea ice

solar radiation

terrestrial radiation

CONTINENT
mixed layer ocean

advection

OCEAN
FOUR GFDL Model Streams for AR5: Differences relative to CM2.1 indicated
[CM2.1 components ➔ AM2, LM2, MOM4, SIS]

1. CM3
   New atmosphere model (AM3). Interactive tropospheric and stratospheric chemistry, aerosols & aerosol-cloud interactions.
   New land model and hydrology (LM3).

2. ESM2
   Carbon biogeochemistry (land and ocean), 2 ocean configurations: MOM4.1 (ESM2M) and GOLD (ESM2G, isopycnal model).

3. CM2.x
   Decadal predictability research using GFDL’s ensemble coupled data assimilation.
   Begin with CM2.1, possibly advancing to higher resolution/complexity.

4. HiRAM
   High resolution (25 km) time slice integrations with AM2 (incl. alternative physics), forced by SSTs and sea-ice.