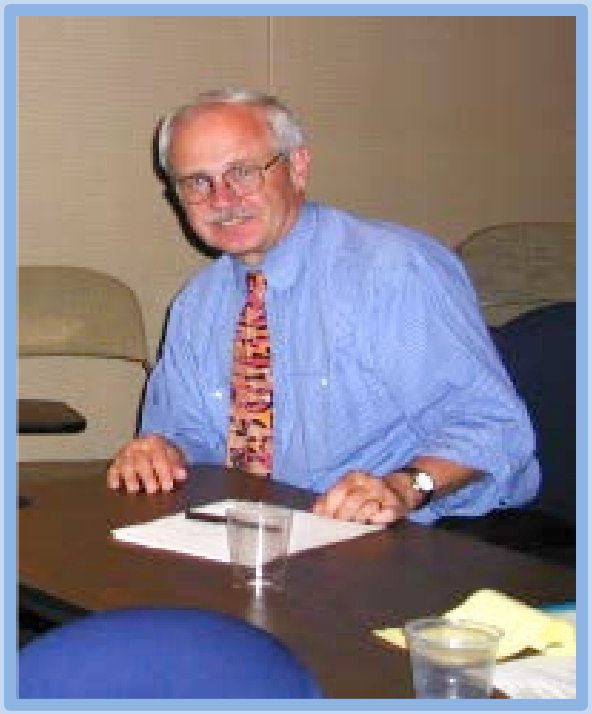
Welcome to NOAA/ OAR/ GFDL Symposium

V. “Ram” Ramaswamy

Geophysical Fluid Dynamics Laboratory Fall Science Symposium

November 2, 2017



SYMPOSIUM is dedicated to the Memory of

ANTS LEETMAA

(1942 – 2017)

Logistics

- Please silence your cellphone during the Symposium
- Breaks will be upstairs (note: Taylor Auditorium is on B Level)
- No food or beverages allowed in the Taylor auditorium
- Restrooms are located on the A Floor – right side
- The GFDL “bell” will be used to call you all back from the breaks.
- See Dale Walton or Morina Royer for any logistics questions.

DOC Strategic Objective
NOAA - Alignment of Strategy

Research

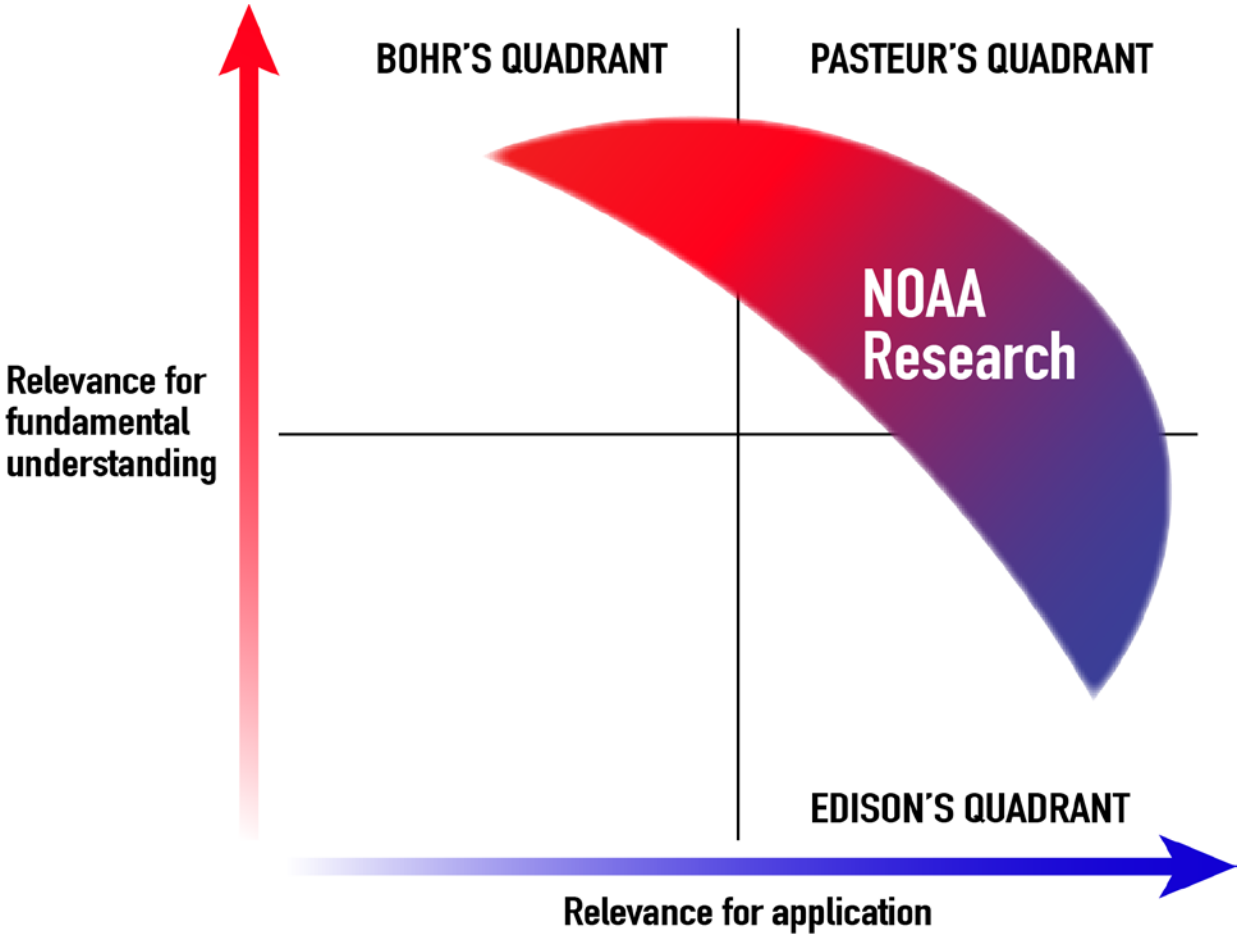
Development

Transition

OAR MISSION

Conduct research to understand and predict the Earth's oceans, weather and climate, to advance NOAA science, service and stewardship and transition the results so they are useful to society.

NOAA Strategic Research



Adapted from
Donald Stokes (Woodrow Wilson School, Princeton University):
"Pasteur's Quadrant: Basic Science and Technological Innovation" (1997)

NOAA: Science, Service, Stewardship

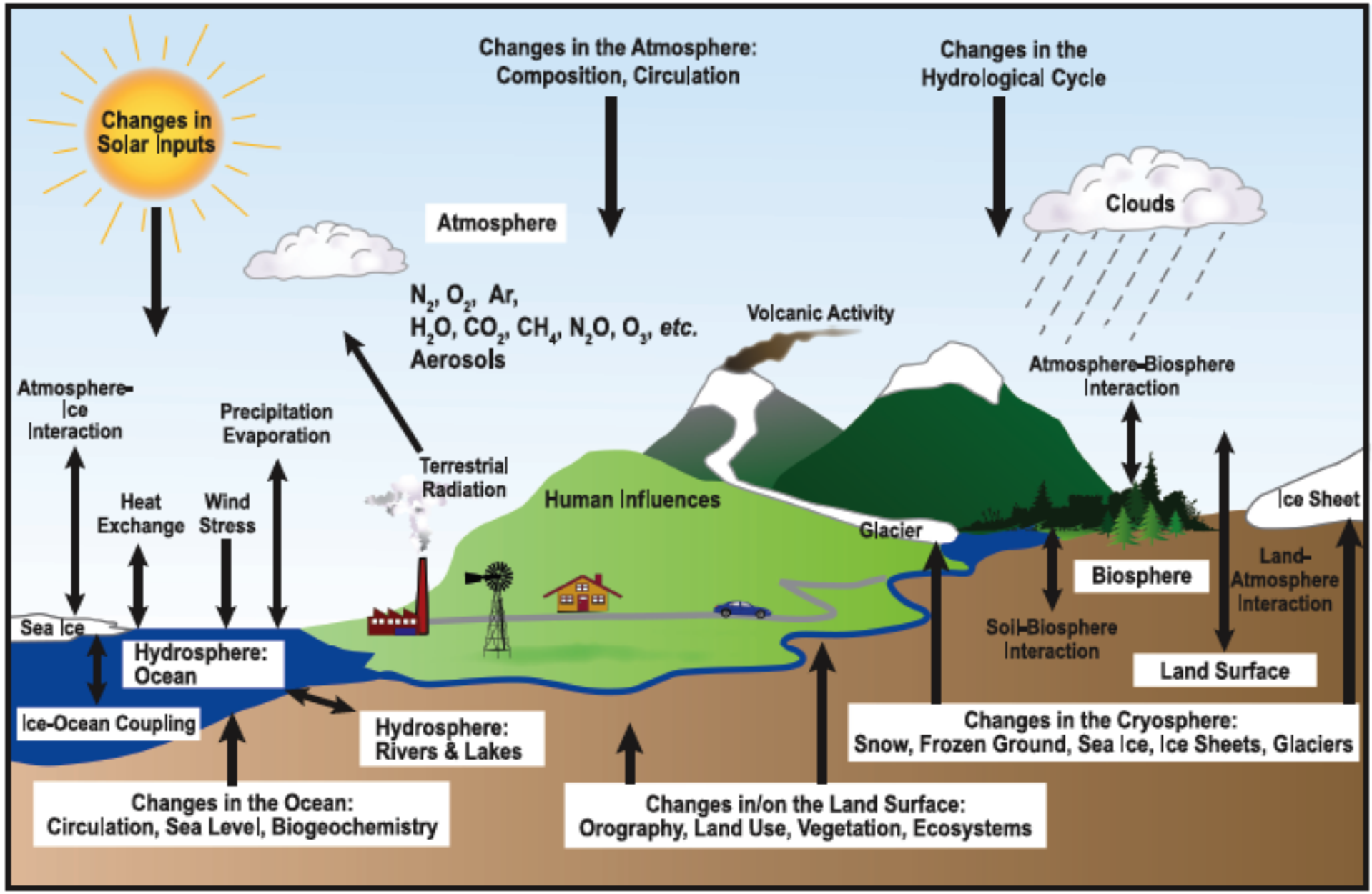
GFDL
(Founded 1955)

GFDL Research ➔ supporting the DOC, NOAA and OAR Objectives

"To advance scientific understanding of climate and its natural and anthropogenic variations and impacts, and improve NOAA's predictive capabilities, through the development and use of world-leading computer models of the Earth System."

Partnership with Princeton University since 1968

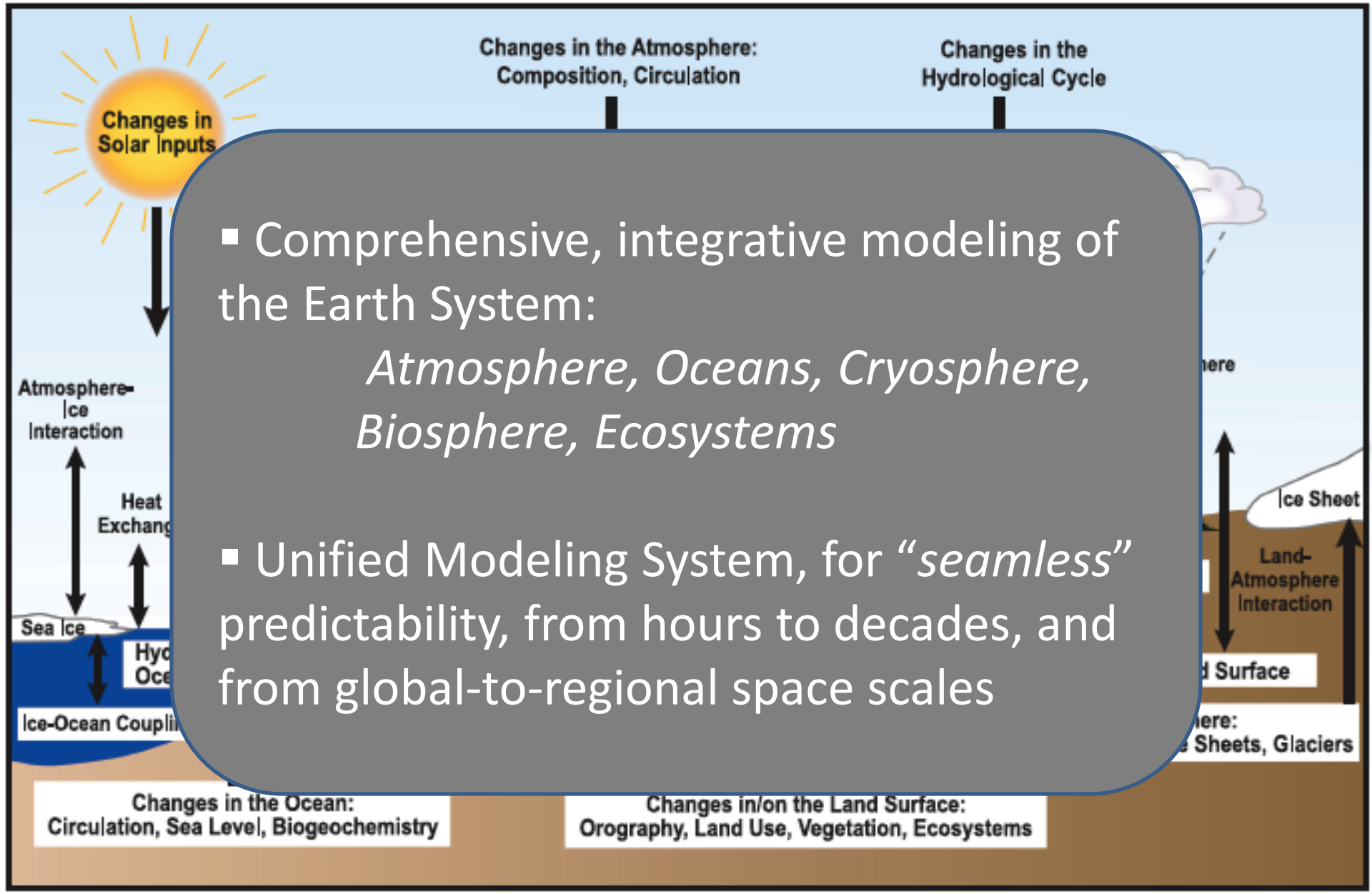
The Earth System
(Atmosphere, Oceans, Biosphere, Cryosphere, Ecosystems)



Chronology of recent **GFDL** Symposia and Review

- 2008: *Climate Research and Modeling Review*
- 2009: *OAR External Review*
- 2011: Symposium: *"Advancing Scientific Understanding"*
- 2013: Symposium: *"Frontiers in Climate and earth System Modeling"*
- 2014: *OAR External Review*
- 2015: *GFDL 60th Anniversary (Diamond Jubilee): "Past, Present, and Future GFDL Success"*
- 2017: Symposium: *"Current Research and Modeling of the Earth System"*

The Earth System
(Atmosphere, Oceans, Biosphere, Cryosphere, Ecosystems)



- Comprehensive, integrative modeling of the Earth System:

  Atmosphere, Oceans, Cryosphere, Biosphere, Ecosystems

- Unified Modeling System, for "*seamless*" predictability, from hours to decades, and from global-to-regional space scales

Major advancements in weather and climate science have come about with

- **Improvements in theory & observations;**
- **Improved understanding of processes; and**
- **Advances in computational modeling**

Oceans, Atmosphere, Biosphere, Cryosphere, Ecosystems

Mathematical Modeling

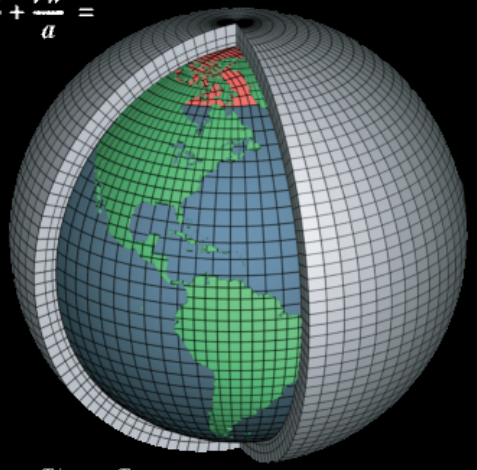
$$\frac{\partial v}{\partial t} + \frac{u}{a\cos\phi}\frac{\partial v}{\partial \lambda} + \frac{v}{a}\frac{\partial v}{\partial \phi} + w\frac{\partial v}{\partial z} + \frac{u^2\tan\phi}{a} + \frac{vw}{a} = -\frac{1}{\rho_0 a}\frac{\partial p}{\partial \phi} - fu + F^{\phi}$$

$$f = 2\Omega\sin\phi$$

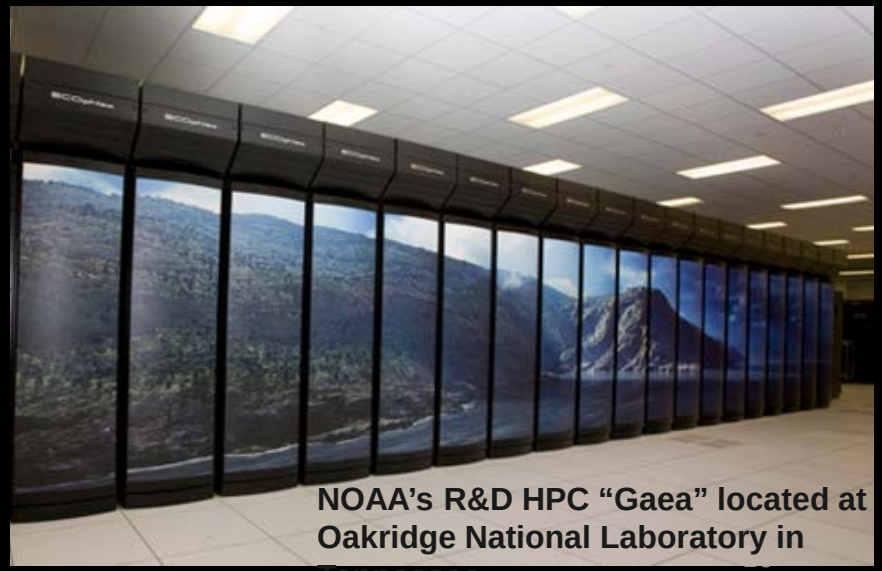
$$p(z) = \int_z^0 \rho g dz + p_s$$

$$\frac{1}{a\cos\phi}\frac{\partial u}{\partial \lambda} + \frac{1}{a}\frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0$$

$$\frac{dT}{dt} = \frac{u}{a\cos\phi}\frac{\partial T}{\partial \lambda} + \frac{v}{a}\frac{\partial T}{\partial \phi} + w\frac{\partial T}{\partial z} + D^{T\lambda} + D^{T\phi} + D^{Tz}$$



High-Performance Computing

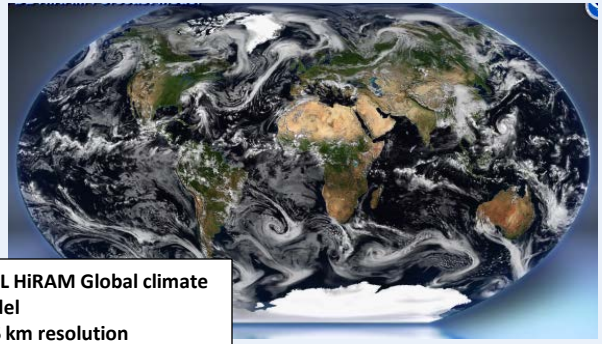


NOAA's R&D HPC "Gaea" located at Oakridge National Laboratory in Tennessee

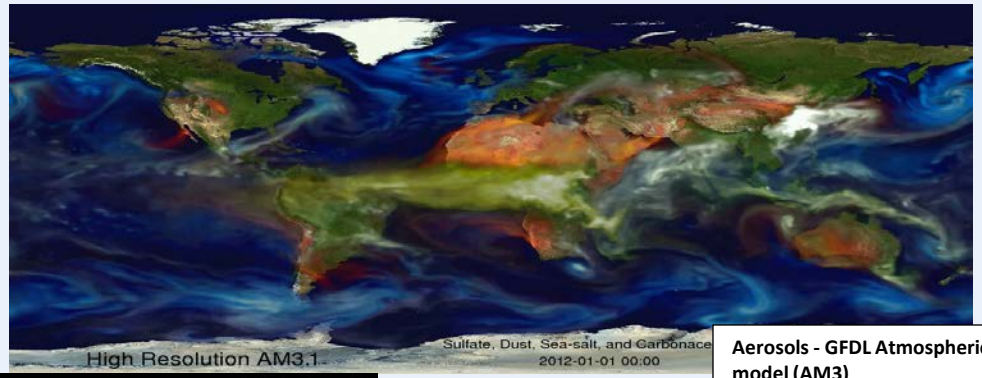
Use-inspired Research ➔

"Seamless" models across weather to climate timescales

[powered by the NOAA "FV3" atmospheric dynamical core, and MOM]

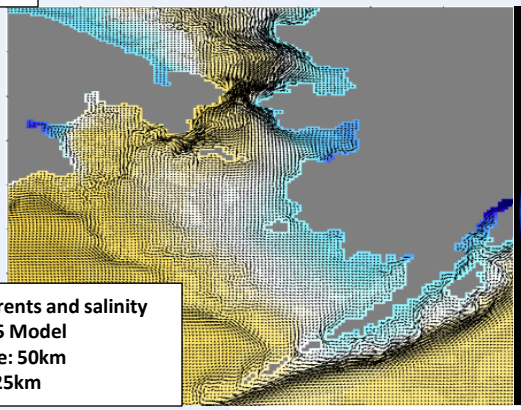


GFDL HiRAM Global climate model
12.5 km resolution

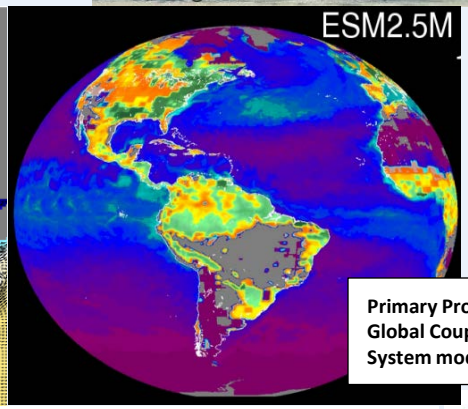


Aerosols - GFDL Atmospheric model (AM3)

Resolution

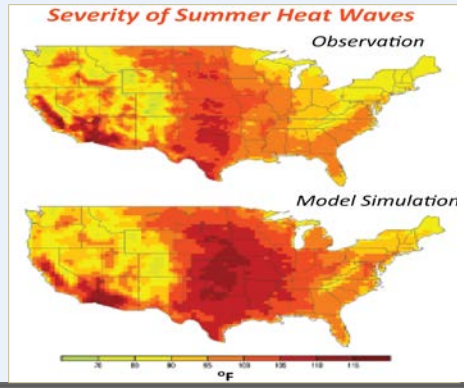


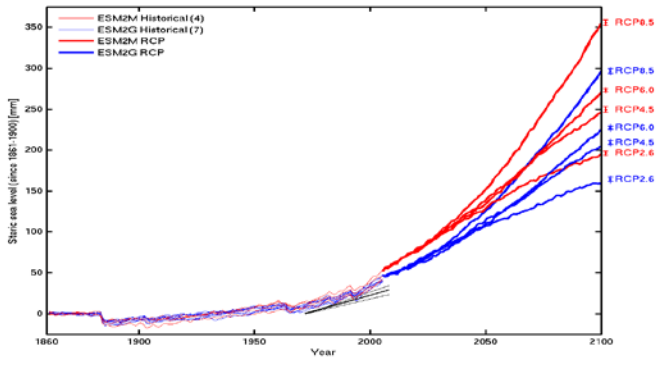
Surface currents and salinity
GFDL CM2.5 Model
Atmosphere: 50km
Ocean: 10-25km

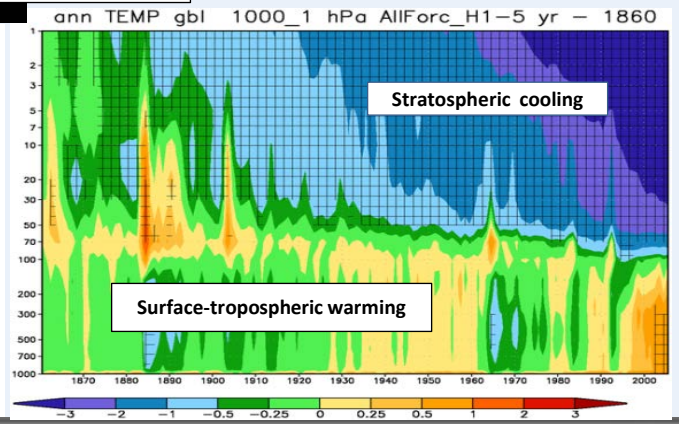


Primary Productivity GFDL Global Coupled Earth System model

Earth System Complexity

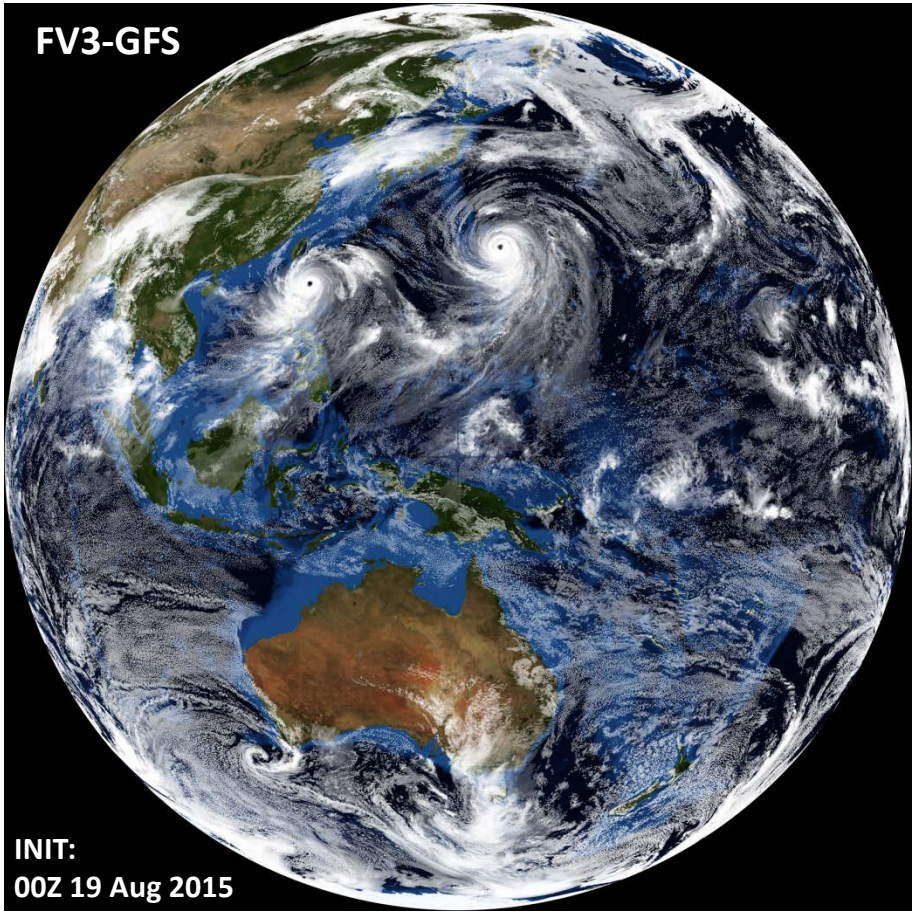


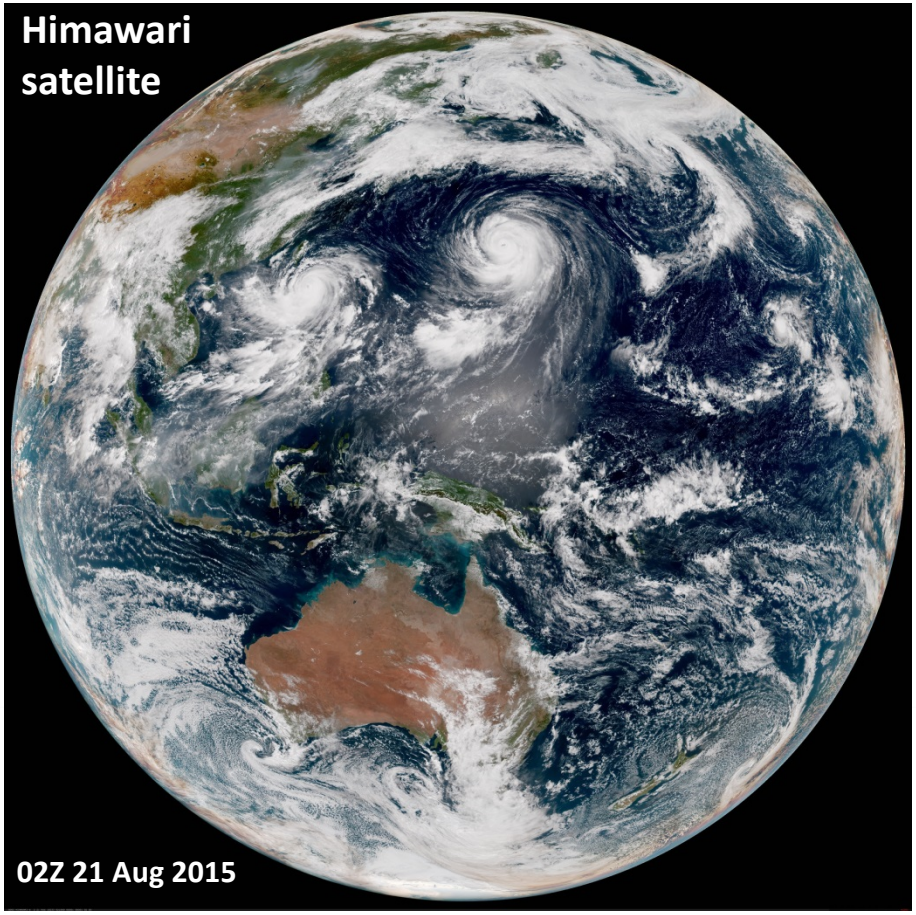




FV3 core and GFS-based physics

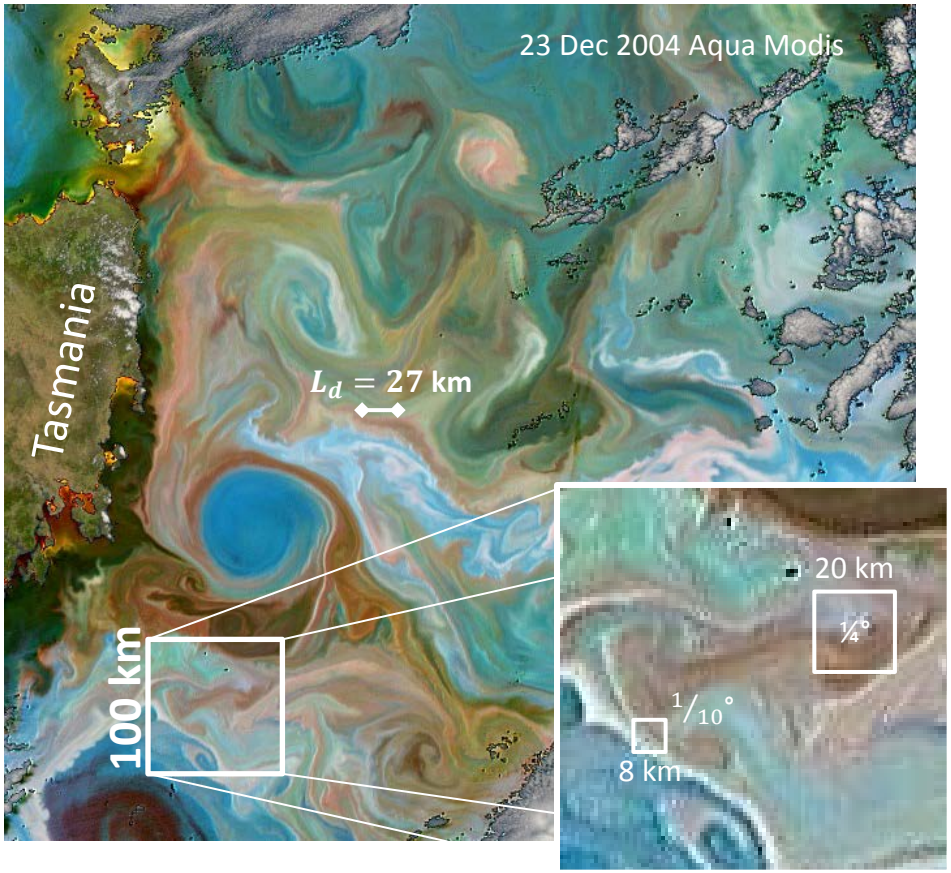
- **FV3-powered Global Forecast System to be a unified modeling system for regional to global predictions from 1-km to 100-km.**
- **Atmospheric dynamical core of NOAA's Next Generation Global Weather Model**



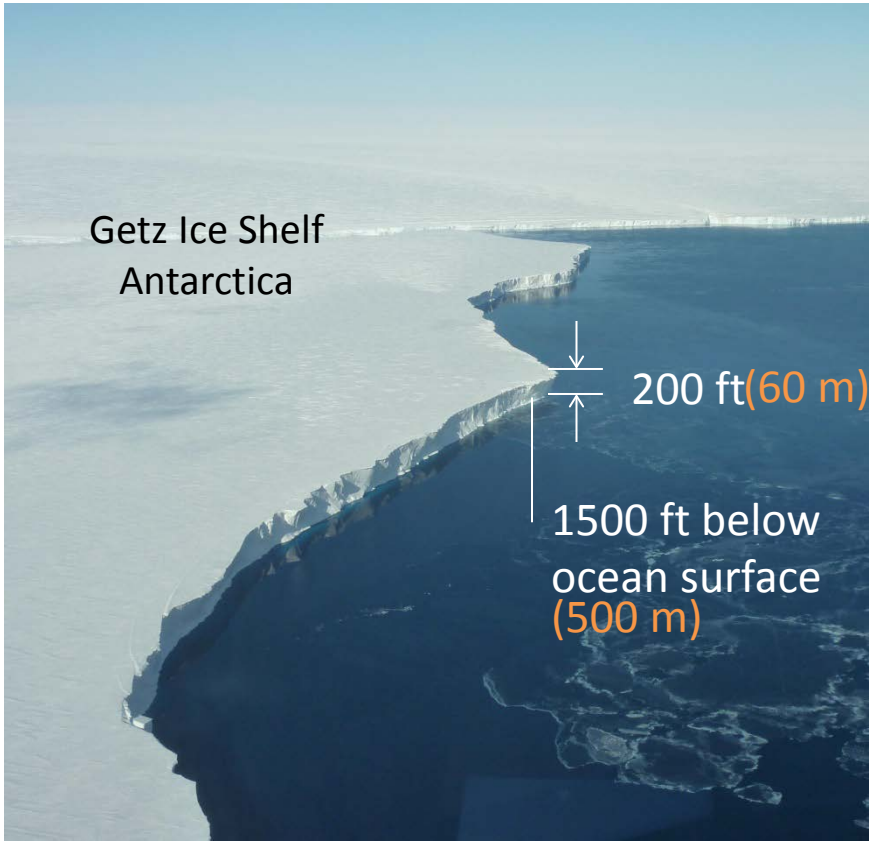


Frontiers in ocean/ice-sheet modeling: **MOM6**

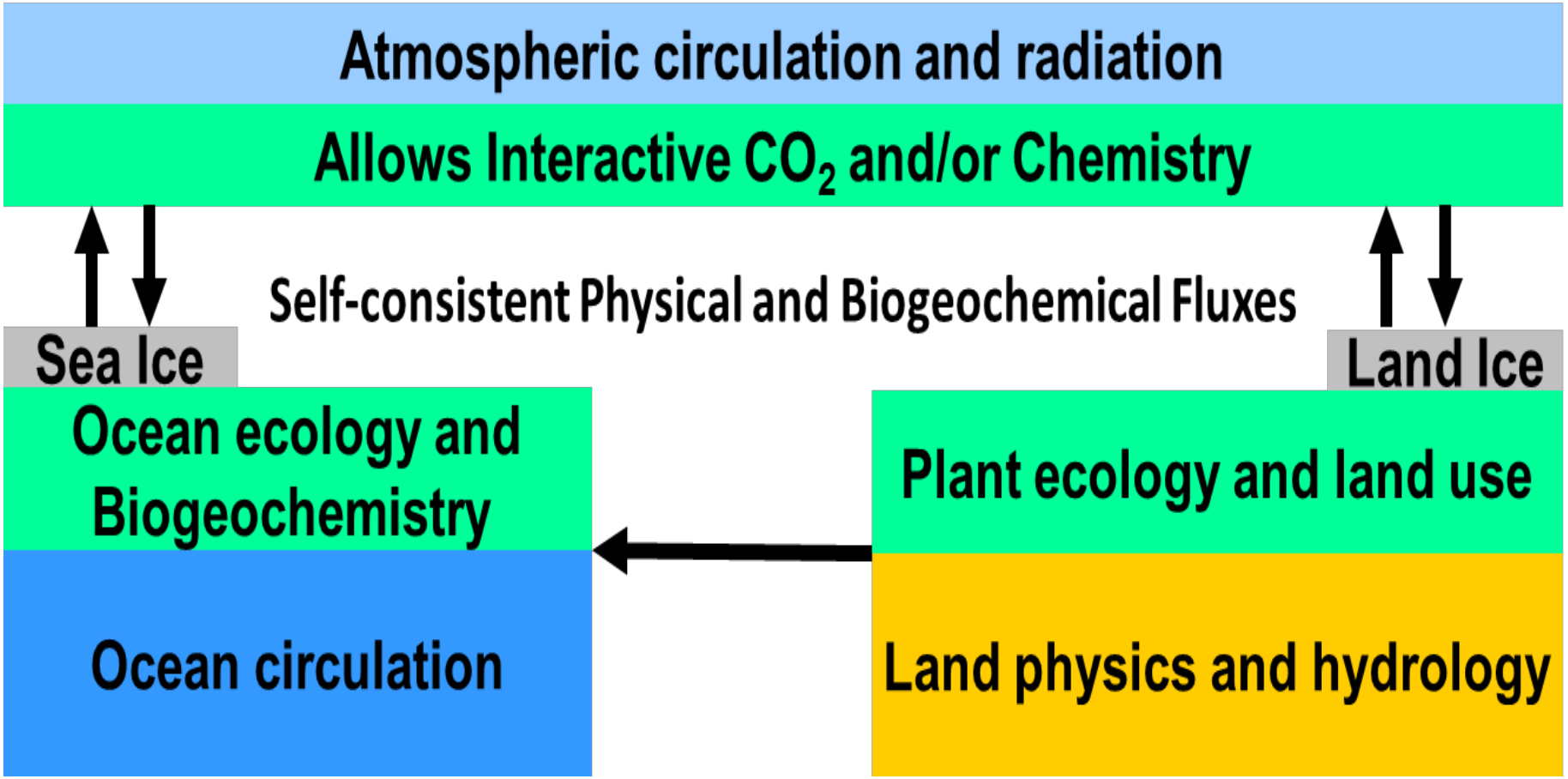
Role of ocean eddies in climate/earth system



Sea-level rise and ice-sheet/ocean interaction



GFDL ESMs for Coupled Biogeochemistry - Atmospheric Chemistry - Ecosystems - Climate



Multiple weather-climate phenomena to be addressed
Quantify variability, extremes, and change

National Research Council (2012) Recommendation:
"Unified" modeling approaches

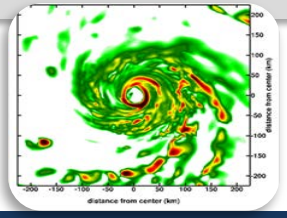
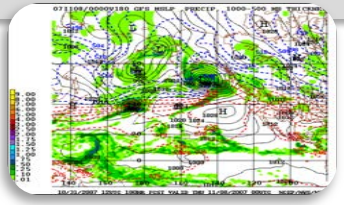
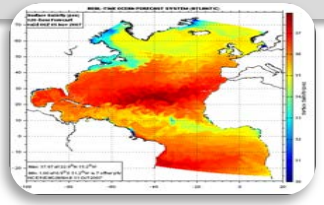
Internal Variability and External Forcings

Tornadoes	Heat Waves	El Niño-Southern Oscillation	Decadal to Multi-decadal Variability	Ocean: Circulation, SLR, Heat Content
Snowstorms	Storm Track Variations	Precipitation extreme	Cryospheric	Greenhouse Gases and Aerosols
Hurricanes	Madden-Julian Oscillation	Intra- & Inter-season Variation	Solar Variability	
Typhoons		Changes in the Arctic		

1 DAY | 30 DAYS | 1 SEASON | 3 YEARS | 10 YEARS | 30 YEARS | 100 YEARS

WEATHER | SHORT-TERM | INTERANNUAL | DECADE-TO-CENTURY

Sub-seasonal-to-Seasonal	Seasonal-to-Interannual	Interannual-to-Decadal	Decadal-to-Multidecadal

Weather to Climate is "Seamless"

Multiple weather-climate phenomena to be addressed
Quantify variability, extremes, and change

- **Seamless Modeling of Weather, Climate, and Earth System:**
  - **Components**
  - **Coupled Interactions**
- **Earth System Processes: Atmosphere-Land Focus**
- **Earth System Processes: Oceans-Cryosphere Focus**

Weather to Climate is “Seamless”

THANK YOU *to*

ALL for your presence here, and for tuning in to the Webinar

The Scientific Organizing Committee:

Rong Zhang (Chair), John Krasting,

Olga Sergienko, and Ming Zhao

The Communications and Logistics Committee:

Whit Anderson, Cathy Raphael, Laura Rossi, Morina Royer, Maria Setzer, Anna Valerio, and Dale Walton