



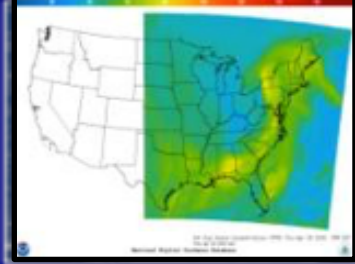
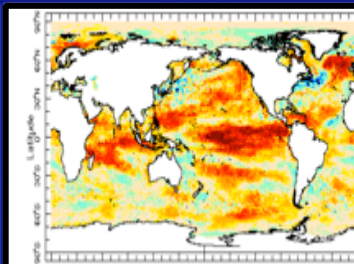
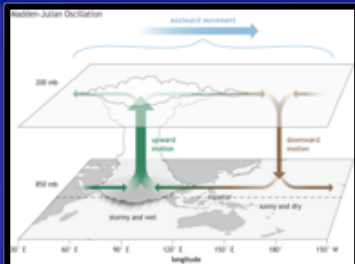
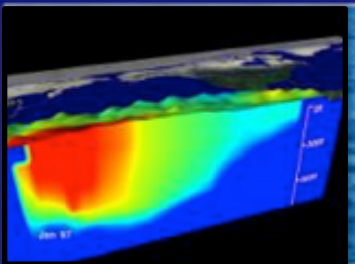
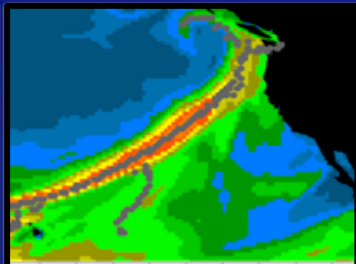
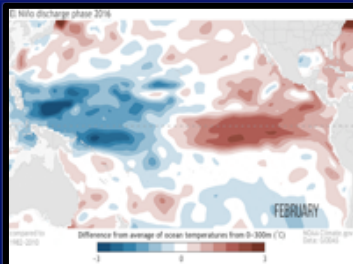
**NOAA
RESEARCH**

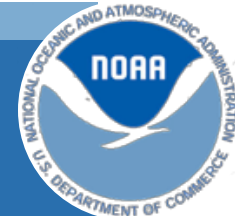
Update on NOAA / OAR Climate Activities

Dr. Wayne Higgins, Director
OAR Climate Program Office*

February 26, 2019

* Special Thanks to Jin Huang (CPO)





Outline

- What is the role of NOAA? OAR? CPO?
- Key Climate Activities*
 - Observations
 - Research
 - Modeling & Prediction
 - Applications and information systems
- Looming Gaps
- Interagency Coordination
- Discussion topics and questions for GEWEX

* Climate activities span WCRP Scientific Objectives (understanding, predictions, projections, applications)

What is the Role of NOAA?

NOAA provides essential environmental information



Observations Monitoring Assessment Modeling Forecasts and Products

TOP PRIORITIES FOR 2017-2022

<p>1</p> <p><i>Minimize Impacts from Severe Weather (implement Public Law 115-25)</i></p>	<p>2</p> <p><i>Increase the Sustainable Contributions of Our Fisheries and Oceans</i></p>
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Putting environmental information into the hands of those who need it

What is the Role of OAR?

Vision: To deliver NOAA's Future



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 is mandated by Congress to deliver climate information to society

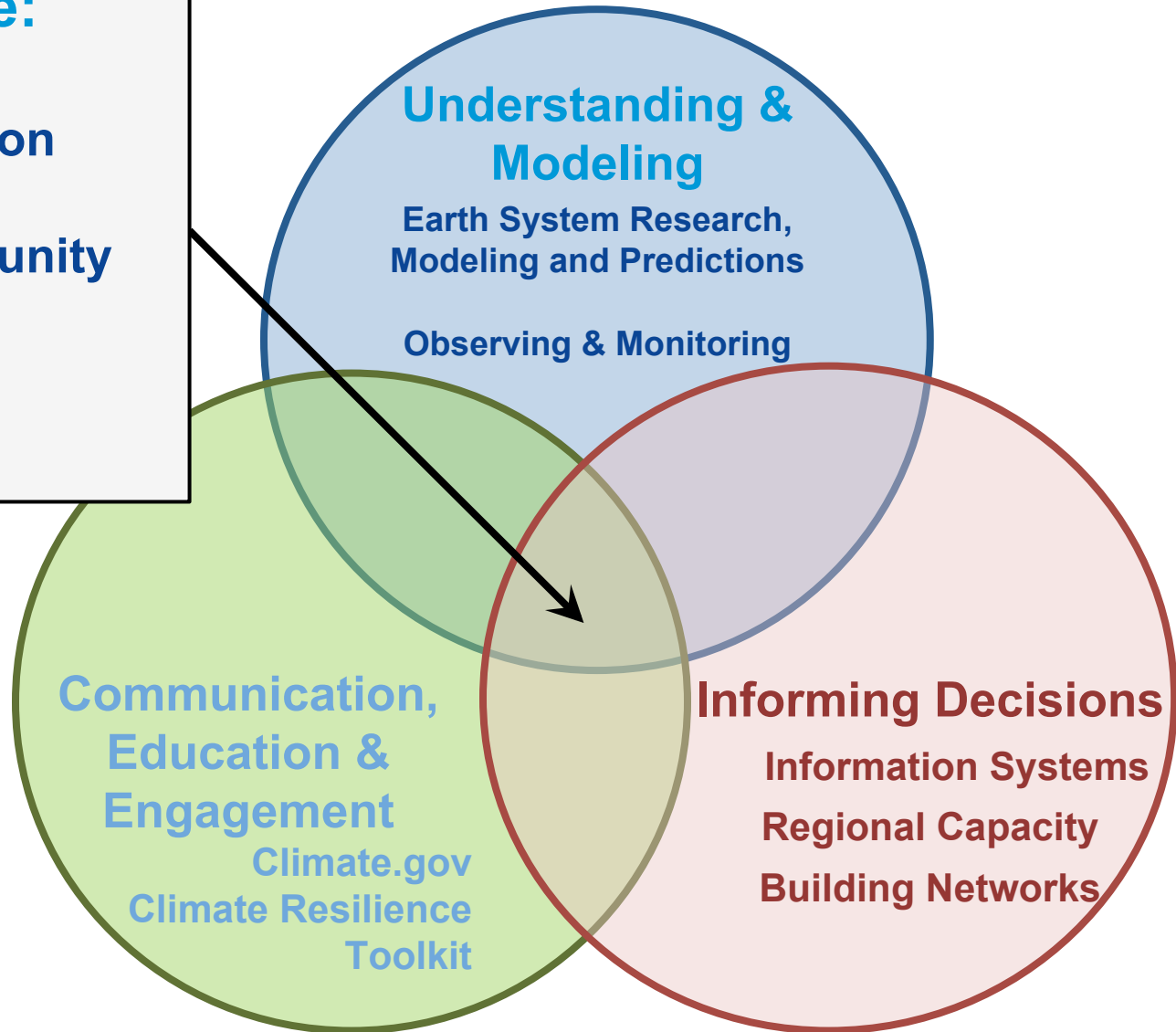


- National Climate Program Act of 1978
- Global Change Research Act of 1990
- International Cooperation in Global Change Research Act of 1990
- National Integrated Drought Information Services Act of 2018
- Arctic Research and Policy Act of 1984

What is the role of OAR's Climate Program Office?

CPO's Unique Value:

- Integrating Information
- Engaging the Community
- Collaboration





Climate Activities Span Research to Applications

• Observations & Research

- Global Ocean Observations
- Dataset Development & Analysis
- Process Studies & Field Campaigns
- Experimental Decadal Prediction

• Modeling & Prediction

- Climate Process Teams
- Model Development & Diagnostics
- Subseasonal-to-Seasonal Prediction
- North American Multi Model Ensemble
- Evaluation

• Applications & Information Systems

- Drought and Water
- National Integrated Drought Information System
- Assessments

RESEARCH

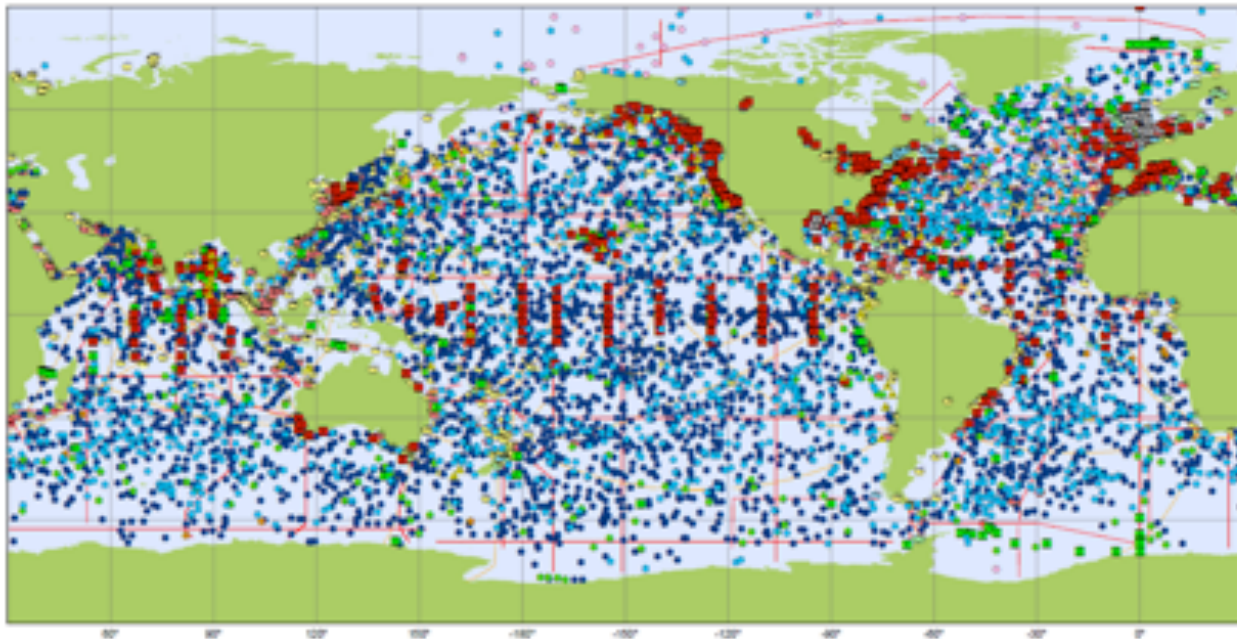


APPLICATIONS



Observations: Global Ocean Observations

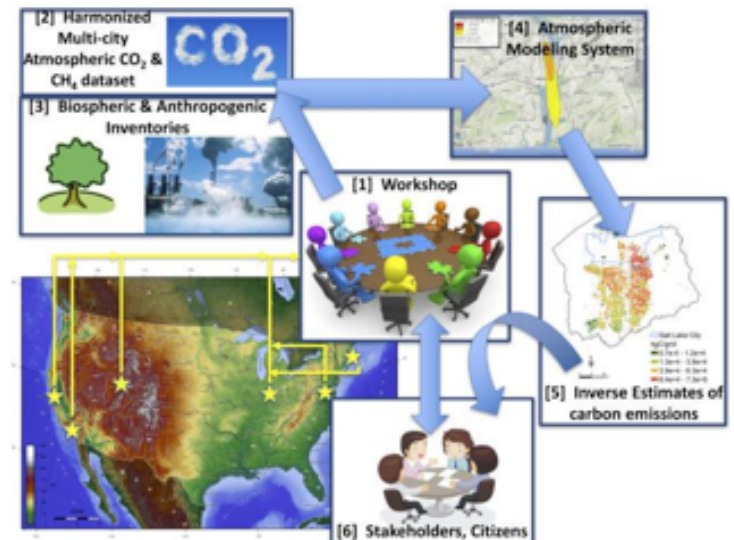
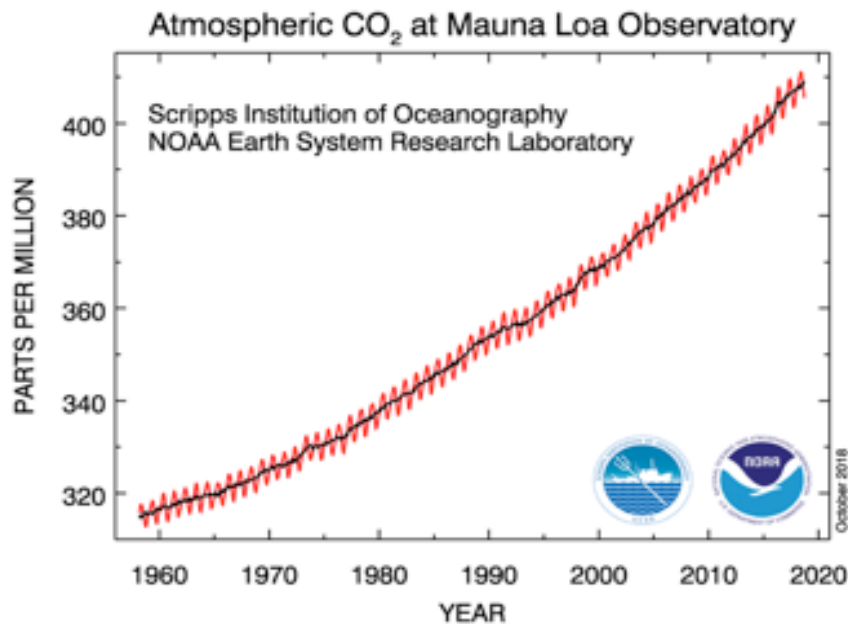
- Contributions to major global ocean observing systems (e.g. Argo, Global Drifters, RAMA, PIRATA, Oceansites, ocean gliders, etc.)
- Supports JCOMM infrastructure to deliver ocean data
- Collaborates with partners to advance the global in situ observing system (e.g. TPOS 2020 for ENSO monitoring and prediction).





Observations: Dataset Development and Analyses

Enhanced Climate Monitoring Program in FY19 to develop / improve climate-quality data sets that contribute to the assessment, monitoring, understanding, and projection of climate.





Process Studies & Field Campaigns

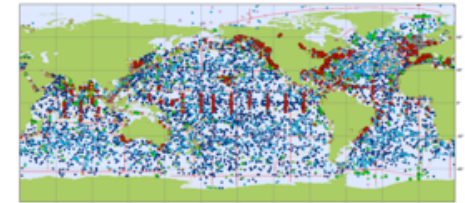
Madden Julian Oscillation

- DYNAMO field campaign (FY11-12) and research (FY13)
- Climate Process Team – Understanding MJO Initiation & Propagation (FY15)
- Year of the Maritime Continent field campaign (FY17)



Ocean Observing System (TPOS 2020)

- TPOS pre-field modeling studies (FY18)



Upper-ocean processes and shallow convection in Tropical Atlantic Ocean

- ATOMIC field campaign (FY19)



Wildfire smoke emissions and chemistry

- FIREX/FIREX-AQ field campaign 2016-2020

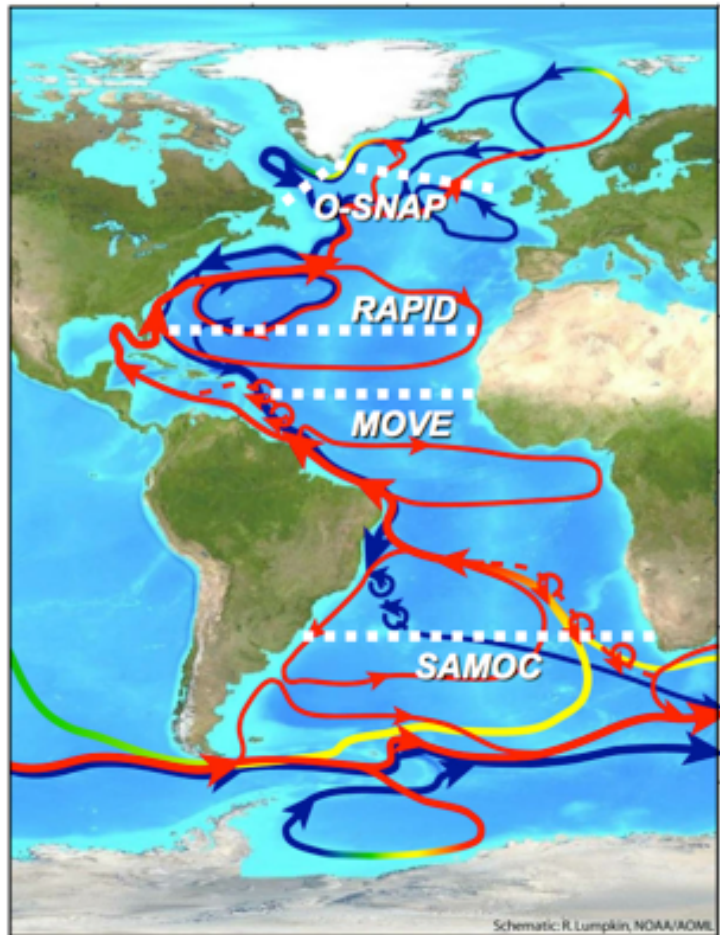
Methane leakages from oil & gas production

- TOP-DOWN field campaign (FY14)
- SONGNEX field campaign (FY15)
- National Academies of Science report (FY18)





Studies for Experimental Decadal Prediction



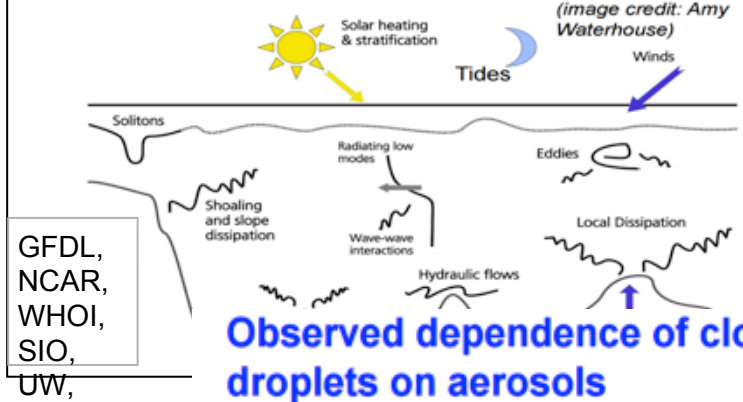
- The Atlantic Ocean drives long-term global ocean circulation by cold, salty water sinking at high latitudes
- The North-South movement of heat and currents is collectively called the AMOC (Atlantic Meridional Overturning Circulation)
- The AMOC cycle takes about 60 years.
- **Understanding AMOC and its variability is an important step towards an experimental multi-decadal prediction system**



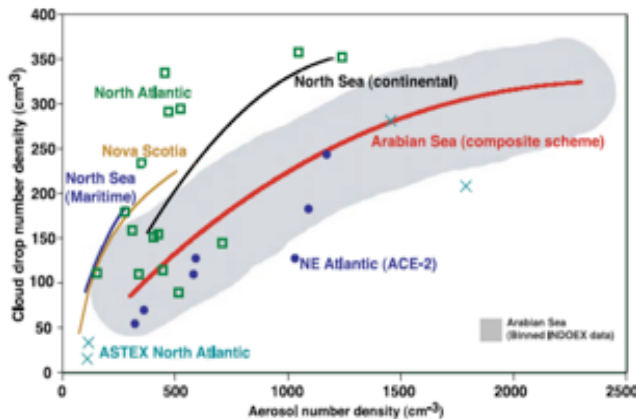
Model Development: Climate Process Teams

Climate Process Teams bring together process experts and climate model developers to improve the simulation of particular processes within the climate model

Internal-wave driven mixing CPT



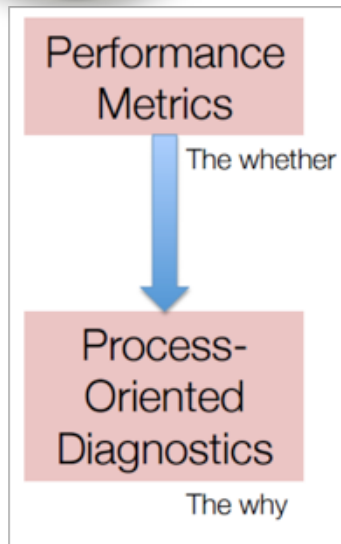
Observed dependence of cloud droplets on aerosols



- Internal-wave driven mixing in global ocean models (2010-2016, NOAA and NSF)
- Cloud parametrization and aerosol indirect effect (2010-16, NOAA and NSF)
- Cloud and boundary layer (2014-15)
- Land, atmosphere and ocean processes (2019, in review, partnering with NASA and DOE)



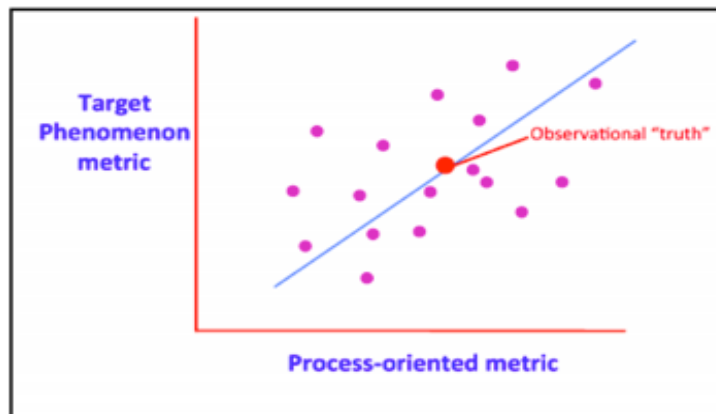
Model Development: Model Diagnostics Task Force



- Focused on process-oriented evaluation of climate and earth system models
 - ✓ Diagnostics to illuminate how processes lead to biases
 - ✓ Diagnostics that provide physical insight
 - ✓ Process-oriented metrics
 - ✓ Next-generation model development
 - ✓ CMIP

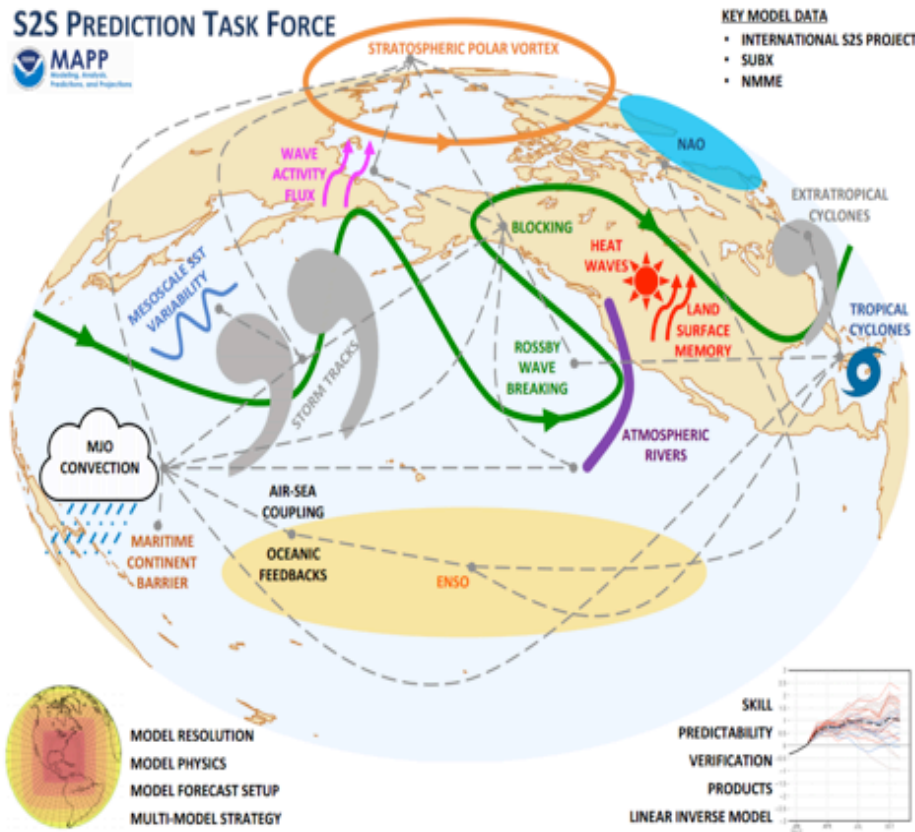
Focus areas

- Cloud microphysics
- Land-atmosphere coupling
- ENSO teleconnections
- T/ET cyclogenesis
- MJO variability/skill
- Water mass transport
- Diurnal cycle





Prediction: Subseasonal-to-Seasonal



These activities bolster NOAA support of the *Weather Act of 2017*

- S2S Task Force
- Operational S2S prediction systems (CFS, NMME)
- Operational S2S forecast products via Climate Test Bed
- Subseasonal Experiment (SubX)



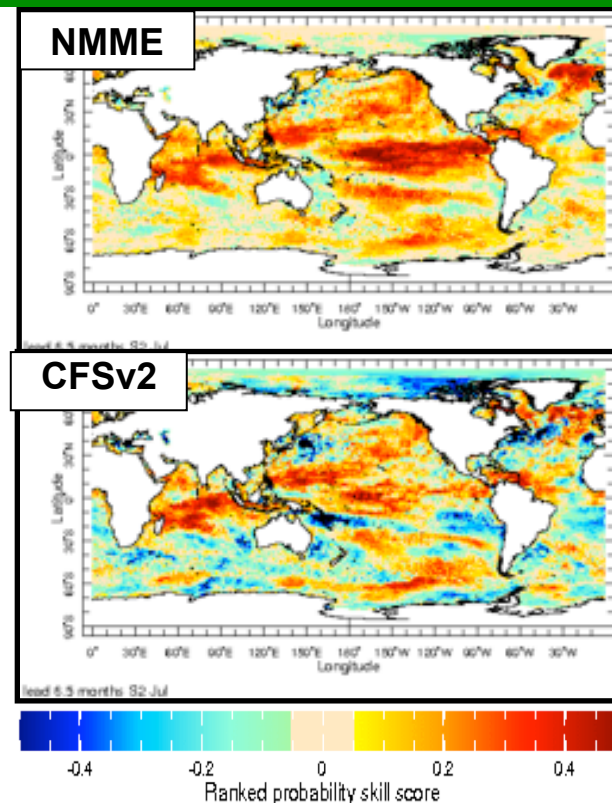
Prediction:

North American Multi Model Ensemble

Goal: Improve subseasonal to interannual predictions based on an ensemble of major US and Canada models

- 2011: Experimental system initiated (CTB)
- 2011-present: Supported by CPO with contributions from NSF, DOE and NASA.
- 2011-present: Evaluated real-time forecast reliability based on 30-year hindcasts
- 2015: NMME **Seasonal** Forecast System becomes operational at NCEP
- **Current: The most comprehensive seasonal prediction dataset for research and applications**
- **Future:** The discussion on sustaining NMME beyond 2018 is ongoing.

Comparison of Skill: NMME vs CFSv2





Evaluation: CMIP Models

FY11-14:

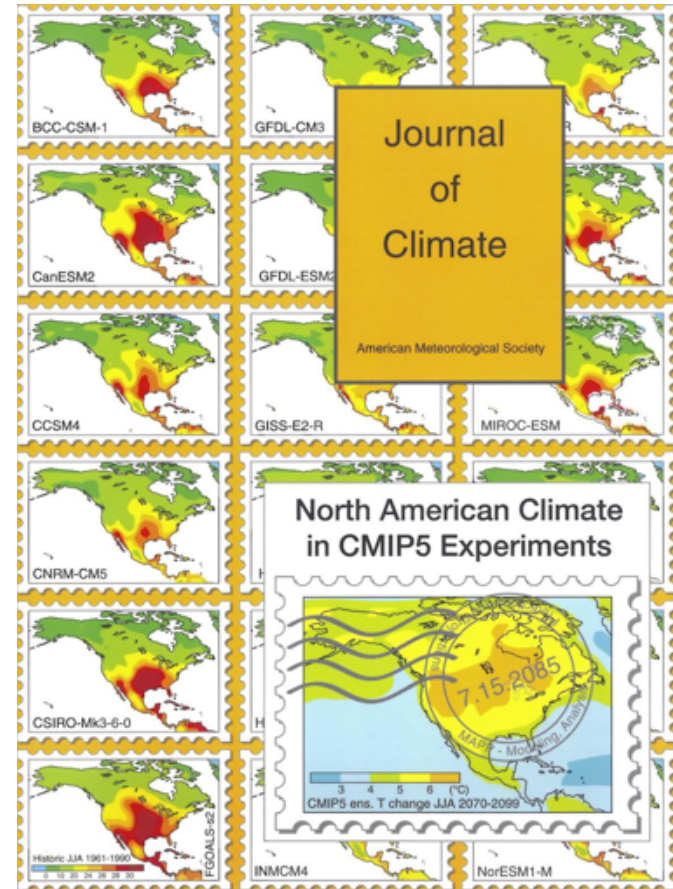
- Evaluated simulations of 20th century climate and uncertainties in long-term predictions and projection of 21st century climate over North America
- Developed process-oriented metrics for the evaluation of climate models.

FY18-20 :

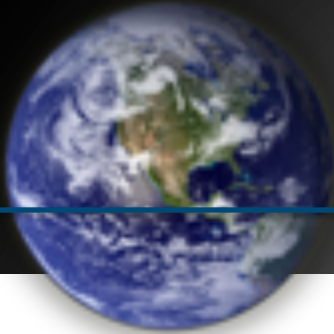
- Address key issues in the representation of Earth system processes in CMIP6-era models to improve model fidelity

FY19

- 21st Century integrated US climate predictions and projections.



MAPP CMIP5 Task Force



Applications: Drought and Water

MAPP Drought Task Force partnership with NIDIS

Drought monitoring

- Probabilistic monitoring tools;
- Objective methodologies to advance the US Drought Monitor)

Land data assimilation

- NLDAS development
- Assimilation of new data

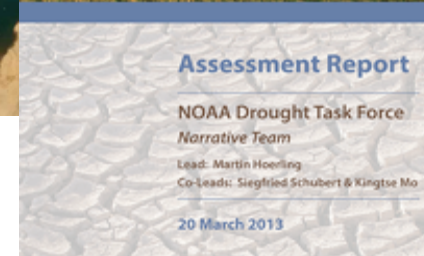
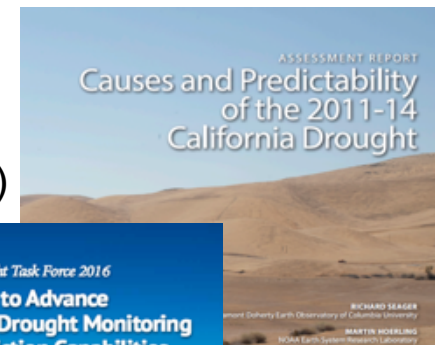
Drought predictability studies

Land and hydrologic modeling and prediction

- NOAA land model development
- Hydrologic modeling and uncertainty quantification

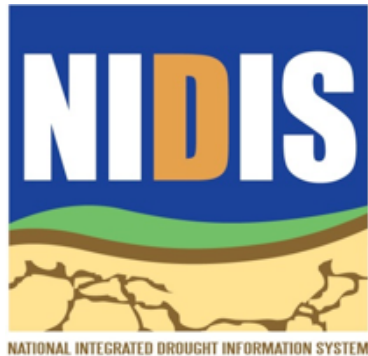
Drought prediction systems

- Probabilistic drought prediction supported by NMME
- Empirical methodologies



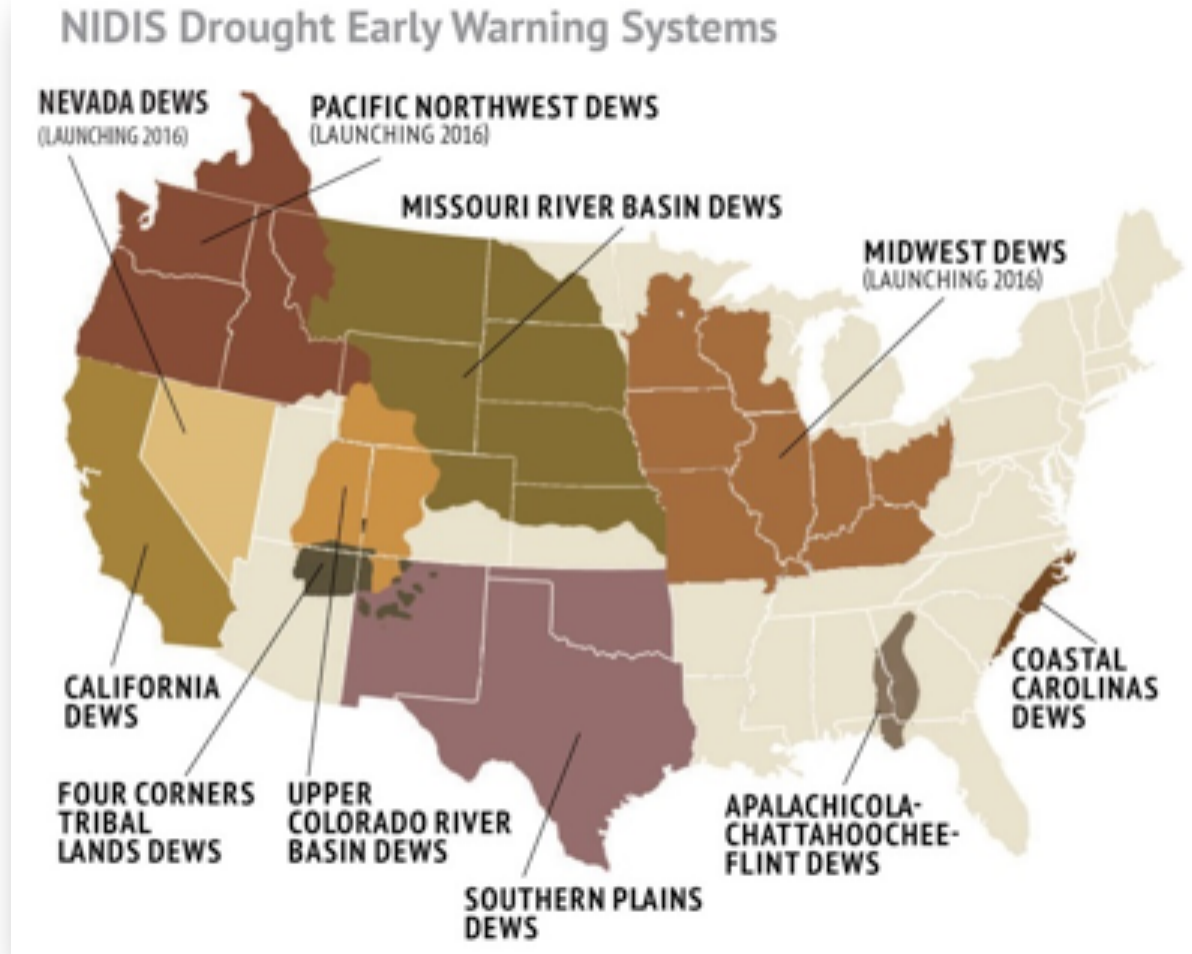


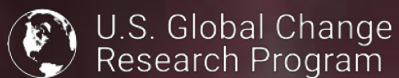
Information Systems: NIDIS Regional Drought Early Warning Systems



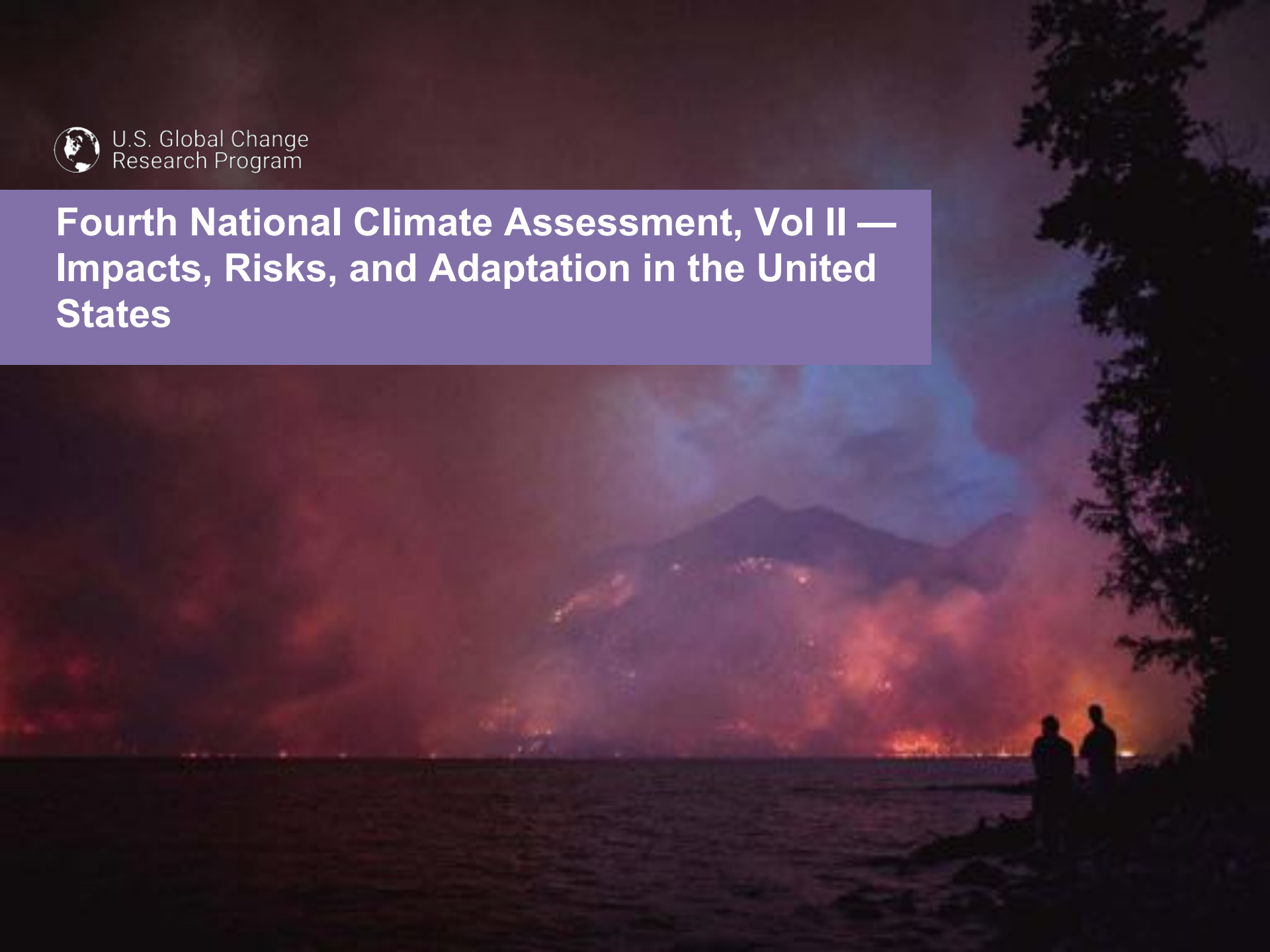
National
Integrated
Drought
Information
System

- Drought early warning and preparedness
- State drought planning
- RISA Networks
- Engagement (e.g. Tribal)





Fourth National Climate Assessment, Vol II — Impacts, Risks, and Adaptation in the United States



A Looming Gap

There have been several recent meetings and white papers at NOAA and in the U.S. focused on how a decadal prediction system involving hi-resolution coupled models could be built using state-of-the-art dynamical-core and physics.

- The real sticking point is lack of dedicated HPC
- U.S. should focus on dedicated HPC for doing the seasonal-to-decadal (S2D) predictions in support of a "seamless" modeling system from weather to decadal scales.

Interagency Coordination

- U.S. Global Change Research Program (e.g. National Climate Assessment; Climate Modeling Summits; Integrated Water Cycle Group)
- Process Studies (e.g. DYNAMO, FIREX, ATOMIC)
- Prediction (e.g. North American Multi-Model Ensemble)

Looking Ahead: 2020-2030

1) **Interannual-to-decadal predictability and prediction** studies to address key priorities (e.g. make better forecasts; explore marine environment; drive innovative science)

2) **Coordinated observation and modeling approaches** to improve understanding and model representations of Earth system processes and interactions (e.g. raise the visibility of the science; integrate across capabilities; develop strategic partnerships)

Questions for GEWEX

There continues to be good alignment between GEWEX priorities and NOAA's climate mission. NOAA would benefit from additional clarity on the following:

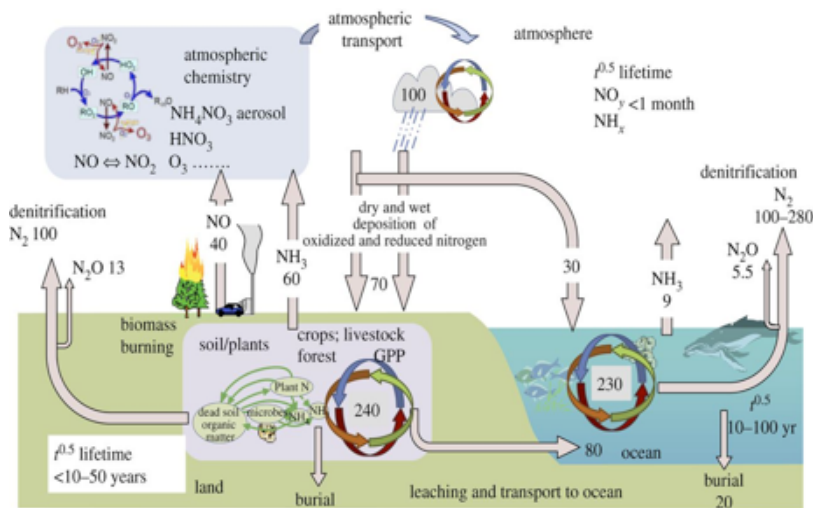
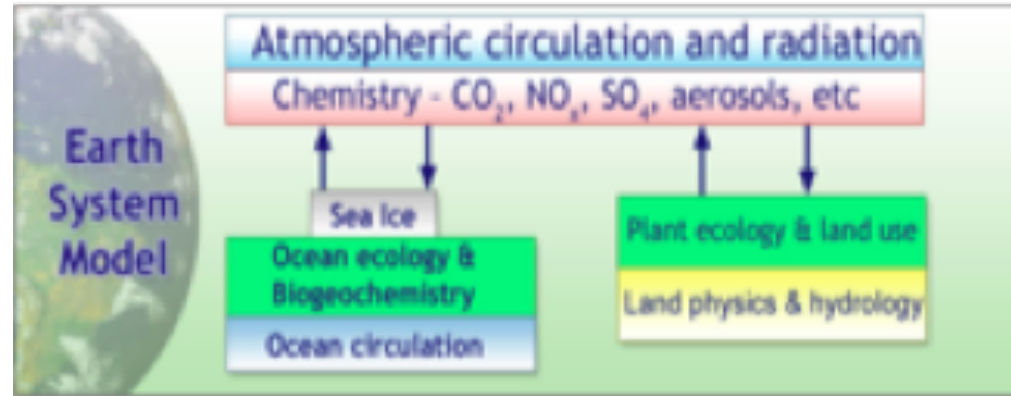
- What are the future GEWEX strategic priorities? Are they unique to GEWEX?
- How can NOAA (and other US agencies) benefit from GEWEX activities and vice versa?
- How can we better establish joint long-term objectives?
- What's already working well? What can be improved?

Extras



Process Studies: Atmospheric Composition

Processes that transform both natural and manmade Nitrogen compounds



Earth Science Climate Process Team: focuses on reactive nitrogen biogeochemical cycling (atmosphere-land interactions) in the GFDL Earth System Model.

FIREX field campaign projects focused on nitrogen containing aerosols.

Collaboration with ESRL Chemical Sciences Division, NASA, EPA, FS, BLM

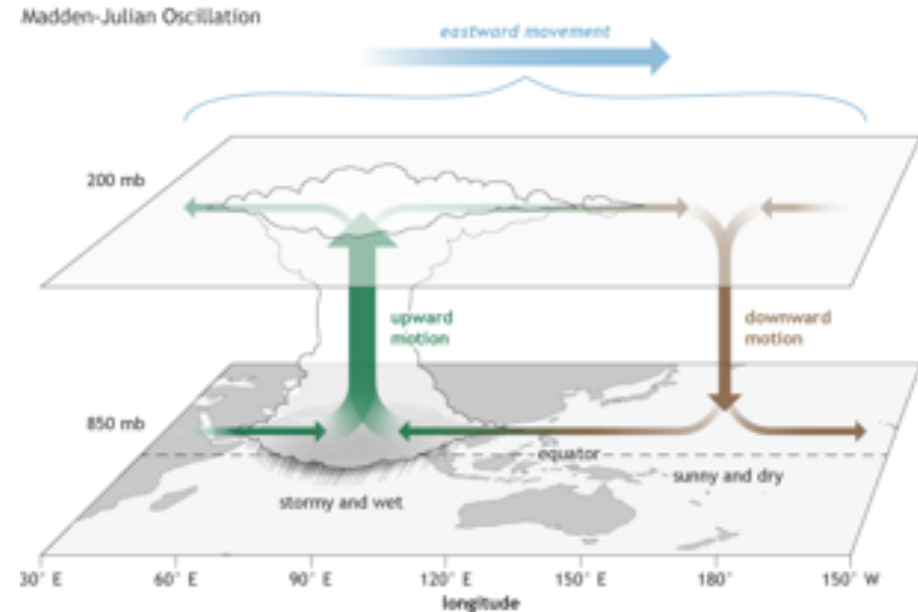




Process Studies: Field Campaign To Understand MJO

DYNAMO (Dynamics of the Madden-Julian Oscillation) field campaign research competitions.

- FY11 – Obs & process understanding
- FY13 – Analysis & modeling
- FY15 – Climate Process Teams to improve representation of MJO and S2S prediction skill in NCEP and GFDL models.
- FY17 – Joint ONR and NASA campaign to understand the role of the maritime continent in MJO propagation.



<http://cpo.noaa.gov/dynamo-webinars>