

Water Cycle Science Coordination Among U.S. Federal Agencies to Advance Predictive Understanding of Water Cycle Extremes and Their Impacts

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Climate, Water Energy Exchanges Subgroup: Jared Entin (NASA, Vice Chair), Jin Huang (NOAA), Renu Joseph (DOE, Vice Chair), Sally McFarlane (DOE)

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8TH GEWEX OPEN SCIENCE CONFERENCE: EXTREMES AND WATER ON THE EDGE

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U.S. Global Change
Research Program

Outline

- Who: About the Program and our Interagency working groups
- Why: Motivation from our Science and Assessment
- How, What & When: Some Recent Interagency Activities and Looking Ahead



U.S. Global Change Research Program

USGCRP comprises **13 Federal agencies** that conduct or use research on global change and its impacts on society



*"... assist the Nation and the world to **understand, assess, predict** and **respond** to human-induced and natural process of global change."*

Global Change Research Act, 1990

Through USGCRP, agencies:

- Coordinate global change research and **advance science** across the U.S. government
- Use research results and products to **inform decisions and responses** to a changing climate
- **Deliver mandated products**, including the quadrennial National Climate Assessment (NCA)
- **Promote international cooperation** on global change research and coordinate U.S. activities with the programs of other nations and international organizations



Current Interagency Groups

(<https://www.globalchange.gov/about/iwgs>)

- Interagency Group on Integrative Modeling (IGIM)
- Integrated Observations

- Adaptation Science
- Carbon Cycle
- Climate Change and Human Health
- Global Change Information
- Indicators
- **Integrated Water Cycle (April 2018)**
- International Activities
- Social Science Coordination
- Sustained Assessment

Task Teams and other efforts

Process Research – Clouds, Chemistry & Aerosol Processes

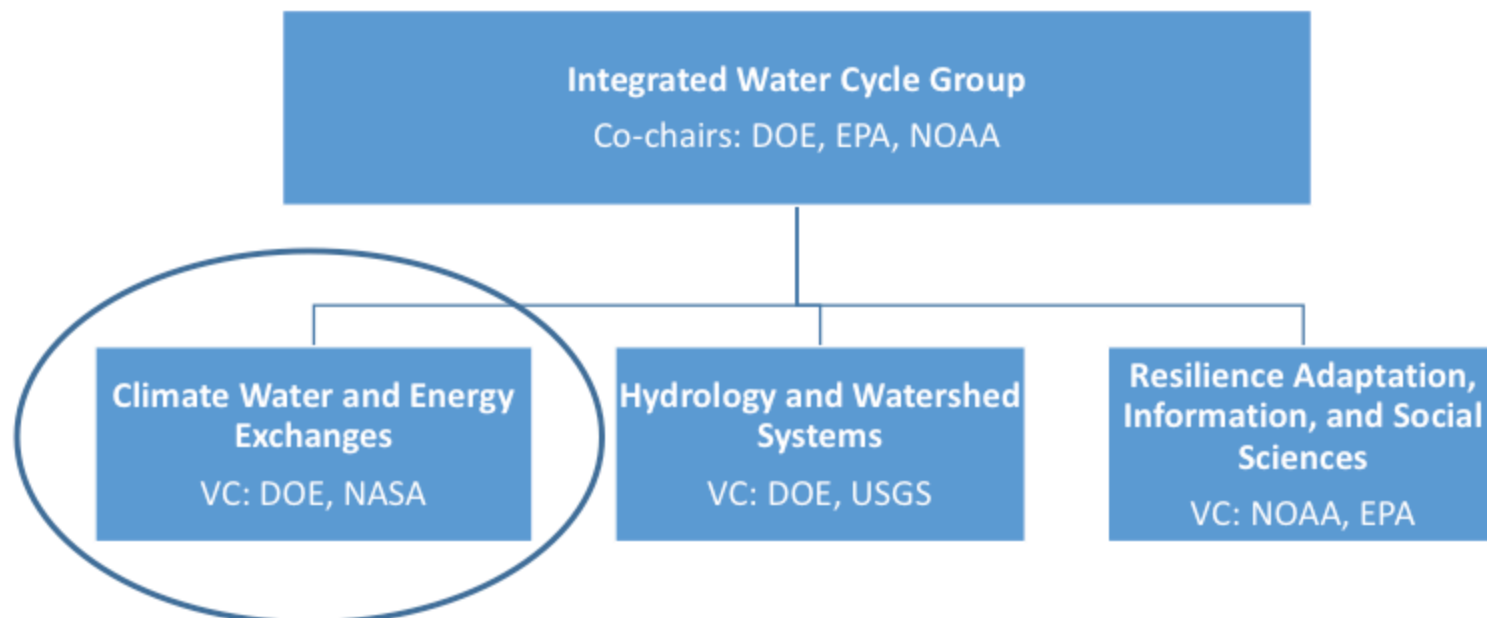
Process Research – Biodiversity & Ecosystems

Scenarios

Water Cycle Extremes Priority Task Team
Arctic Priority Task Team
Methane Cycling Priority Task Team



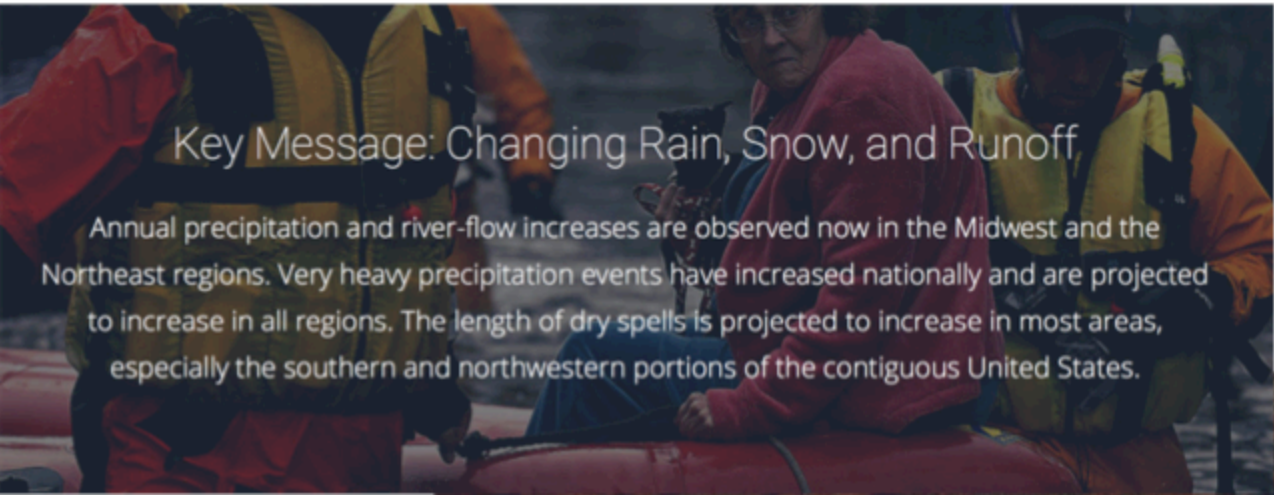
Integrated Water Cycle Group (IWCG)



Climate, Water, and Energy Exchanges (CWEX)

- Vice Chairs: Jared Entin (NASA), Renu Joseph (DOE)
- Provides a focal point for coordinating **interagency, collaborative research on the coupled roles of energy and water in a changing global climate system**
- Provides a space for agencies and programs to coordinate interactions with relevant efforts of the World Climate Research Program (WCRP), e.g. GEWEX






Key Message: Changing Rain, Snow, and Runoff


Annual precipitation and river-flow increases are observed now in the Midwest and the Northeast regions. Very heavy precipitation events have increased nationally and are projected to increase in all regions. The length of dry spells is projected to increase in most areas, especially the southern and northwestern portions of the contiguous United States.

WHY: Selected Key Messages from 2014 US National Climate Assessment



Key Message: Drought is Affecting Water Supplies

Changes in precipitation and runoff, combined with changes in consumption and withdrawal, have reduced surface and groundwater supplies in many areas. These trends are expected to continue, increasing the likelihood of water shortages for many uses.



Key Message: Increased Risk of Flooding in Many Parts of the U.S.

Flooding may intensify in many U.S. regions, even in areas where total precipitation is projected to decline.

(NCA4 Vol. II is scheduled for release in late 2018.)



Water Cycle Extremes and Impacts

Some Motivating Questions

- How do we advance our understanding of the relationships between **global climate change, continental and regional water cycles**, and the interdependent human and natural systems that rely on them?
- How do we better **predict and characterize extreme events and how they are changing**, particularly on decadal and longer timescales?
- How do we better **assess and anticipate the ecological and societal impacts** of water-cycle extremes on key sectors, such as energy, agriculture, infrastructure, and health?



FEMA's Urban Search and Rescue Teams go through neighborhoods with the National Guard to look for residents that may be stranded in a neighborhood that was flooded following Hurricane Matthew. (Source: Jocelyn Augustino, FEMA, as published in Our Changing Planet FY17)



Interagency, Integrated Approaches

Water cycle research at
selected USGCRP agencies
(courtesy Renu Joseph)

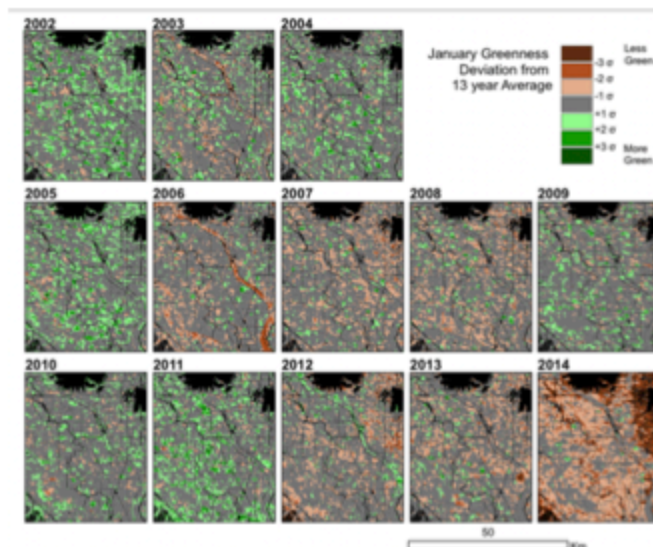


Recent Highlights of USGCRP Work on Water Cycle Extremes and Impacts

- Mapping Fallow Farmland During Drought (Our Changing Planet FY16¹)
- Building Capacity Among Water Resource Managers (OCPFY16)
- Explaining Extreme Events from a Climate Perspective (OCP FY16)
- Understanding Atmospheric Rivers and West Coast Precipitation (OCP FY17²)
- Focusing on the California Drought (OCP FY17)



Flooding from heavy rains damaged Boulder, Colorado, in September 2013—one of several extreme events examined in the collaborative report “Explaining Extreme Events of 2013 from a Climate Perspective” IBAMS, 2014) (Source: S. Zumwalt, FEMA)



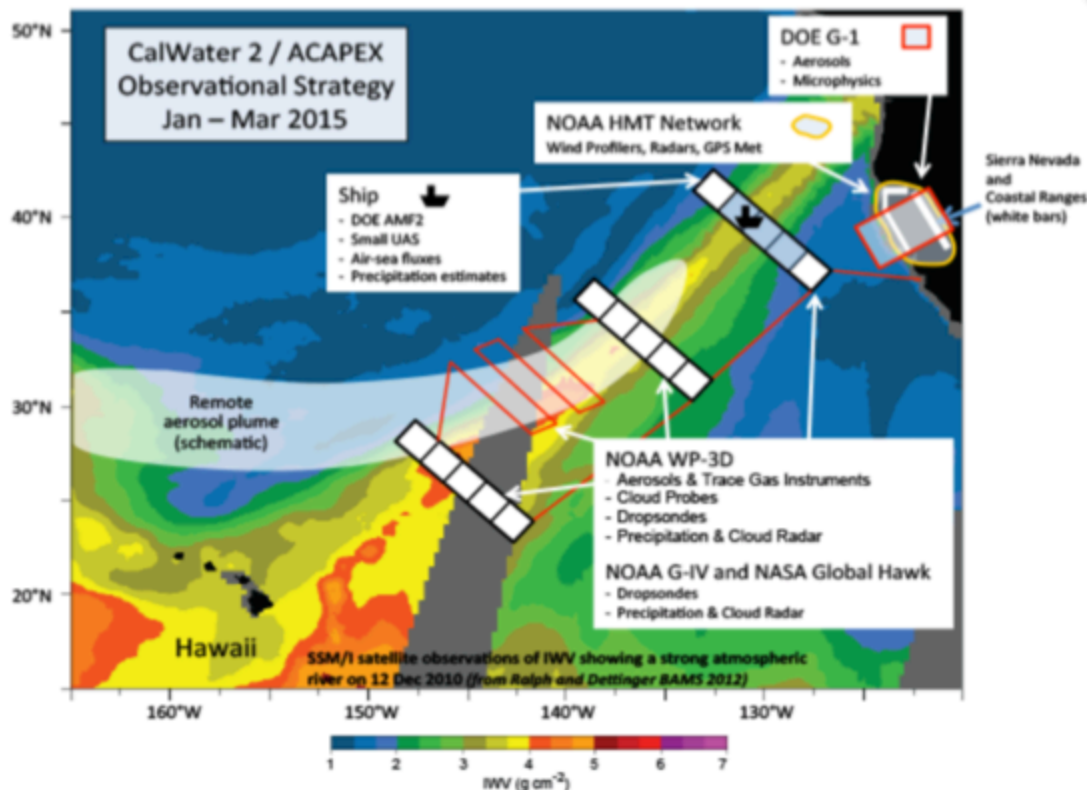
The greenness of croplands in January is shown relative to the 13-year average from NASA MODIS records. Satellite imagery can be a powerful tool for understanding the impacts of drought on agricultural lands. (Source: NIDIS Newsletter, April 2014)



Atmospheric Rivers

The joint NOAA, NASA, and DOE
CalWater-2 2015 campaign collected a
comprehensive dataset for AR
development and landfall (OCPFY17)

Coordinated Field Campaigns bring together multi-agency capabilities around compelling science and societal needs



Leading to better process understanding, forecasting and tools

- Structure and evolution of long lived events (Nieman et al. 2017)
- “AR portal” and tools (Cordeira, 2017)
- Evaluation of forecasts from WRF (Martin et al. 2018)

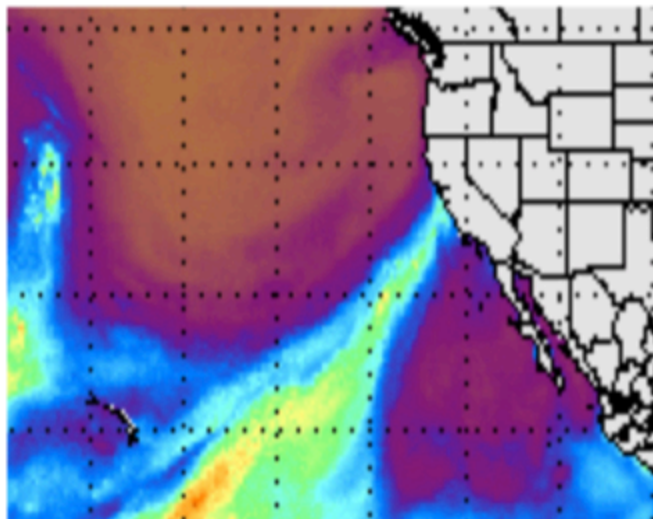


Atmospheric Rivers

ARTMIP | Atmospheric River Tracking
Method Intercomparison Project

<http://www.cgd.ucar.edu/projects/artmip/>

Collaborative Research Project Led by scientists from several US agencies, several research groups and international participants



Atmospheric River event February 10 00 GMT. The Oroville Dam Crisis, in northern California, occurred during this event in 2017.

A collaborative approach to these important Climatic and Societal Events

- The climatological characteristics of ARs, such as AR frequency, duration, intensity, and seasonality, are all strongly dependent on the method used to identify ARs.
- ***Tools, projects, and scientists coming together*** to create a framework to compare different algorithms to ultimately understand what's best for specific science questions.

Christine Shields (NCAR), Jonathan Rutz (NOAA) co-chairs
Michael Wehner (LBL) , Ruby Leung (PNNL), Marty Ralph (UCSD) committee members



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Land Atmosphere Interactions and Extremes

- Since 2015, the Interagency Group on Integrated Modeling has held Annual US Climate Modeling Summit for US CMIP-class climate model development centers and from operational climate prediction programs
- In 2018, this included a **Land-Atmosphere Interactions and Extremes Workshop** (April 4, 2018).



2015 Summit
(Courtesy Tia
Biggs, USGCRP)



Land Atmosphere Interactions and Extremes

- ***Trajectory of increasing complexity and comprehensiveness*** in land surface model (LSMs) components of global climate models
- ***New and high resolution data sets are key to many improvements***
 - Recognition of the impact/opportunities of SMAP (NASA's "Soil Moisture Active Passive" satellite), and criticality of other data sets (GRACE, GFED) to improvements (globally available datasets)
 - New avenues of research into LAI are enabled by data constraints provided by co-located field and remotely sensed measurements
 - High resolution vegetation and soil datasets coupled with dynamic models drive improvements in land surface representation
- ***Recognition of the need to better represent the role of humans and build the data and knowledge bases for (better) representation of***
 - Land use, fire suppression & ignition, agricultural processes and phenology, water management



Summary: Why Water Cycle Extremes Research under USGCRP

- **Interagency and interdisciplinary approaches are required** to understand the integrated water cycle – the movement of water among ocean, atmosphere, land, biosphere, and cryosphere, as well as the interaction of these with human activities
- These approaches can include **coordinated field campaigns, collaborative research, workshops, and training, tools, and services.**
- Science drivers require bringing together **satellite and surface-based observations, global and regional process resolving models,** and the resulting **diagnostics and data**
- To provide societally relevant research results and inform decisions around water cycle extremes calls for **a multi-scale perspective** when considering the global change effects on the integrated water cycle, including its alterations, impacts, and interactions across scales



Other Themes and Interagency Efforts

- NOAA National Water Model (<http://water.noaa.gov/about/nwm>)
- Thriving on our Changing Planet: NASA Decadal Survey (http://sites.nationalacademies.org/cs/groups/depssite/documents/webpage/deps_183919.pdf)
- Many agencies were involved in the process of [Looking Forward: Priorities for Managing Freshwater Resources in a Changing Climate National Action Plan Update](#) (November 2016)
- Agency and Program Strategic Plans and Updates



THANK YOU

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