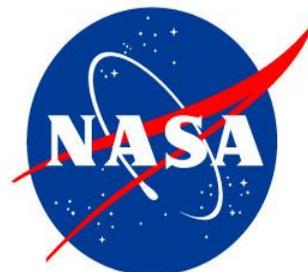


# Integrated Hydro-Terrestrial Modeling (IHTM): Development of a National Capability

Tim Scheibe  
Pacific Northwest National Laboratory  
IHTM Workshop Chair

Report of an Interagency Workshop Held  
September 4-6, 2019 with support from the National  
Science Foundation, the U.S. Department of  
Energy, and the United States Geological Survey



# Integrated Hydro-Terrestrial Modeling (IHTM)



- ✓ The science underlying water resources management is complex and crosses agency mission boundaries
- ✓ Similarly, the applied and operational aspects of water resources management do not fit neatly into agency missions

# Integrated Hydro-Terrestrial Modeling (IHTM)

Multi-agency data and simulation products that provide the basis for understanding and managing complex water systems (R2O2R).



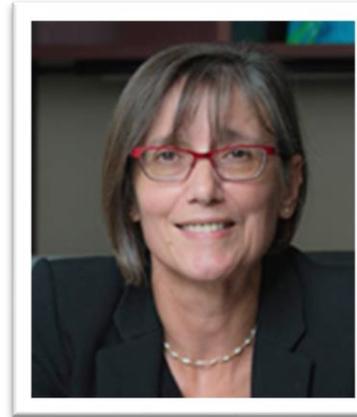
- ✓ Enhance national capability for prediction and scenario-building;
- ✓ Advance the water-related missions (collectively and individually) of the water mission agencies;
- ✓ Advance science through integration of best process understanding

# Workshop Organizers and Participants

## Scientific Organizing Committee



Tim Scheibe  
PNNL  
Chair



Efi Foufoula-Georgiou  
UC Irvine  
Co-Chair



Harry Jenter  
USGS  
Co-Chair

## Plus...

- 26 members of the Technical Steering Committee representing nine agencies and three universities
- 100 other participants representing 14 agencies and 17 universities

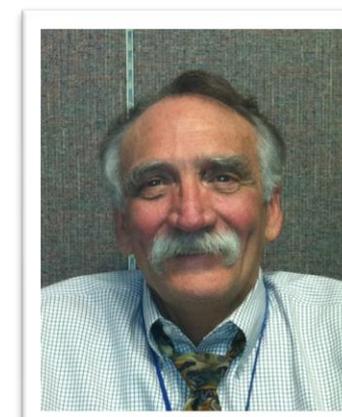
## Interagency Steering Committee



Bob Vallario  
DOE-BER



David Lesmes  
USGS



Tom Torgersen  
NSF



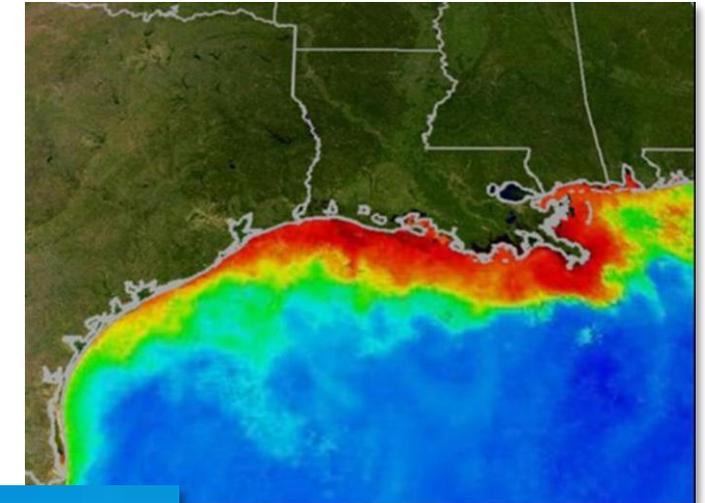
Jessica Moerman  
DOE-BER (AAAS)



# Workshop Motivation and Objectives

- **Reduce fragmentation** of hydro-terrestrial modeling and data infrastructure across Federal agencies
- Enhance integrated and multi-scale problem-solving of **priority water resources challenges**, including sustaining water resources in water stressed areas and supporting water sub-cabinet foci.
- Organize a workshop to socialize the vision, **develop the computational and data requirements**, and identify agency roles and coordinating principles for the IHTM community.

Excess Nutrients,  
Hypoxia and  
Harmful Algal  
Blooms



Water Availability  
in the Western US

Extreme Water  
Hazards



# Preparation for the IHTM Workshop

Participating agencies and others provided input to guide workshop planning:

- Hydro-Terrestrial Modeling Survey
- Use Cases (~60)
- Definition of three national Priority Water Challenges

### Nutrient Loading in the Mississippi Basin

**Scenario/Place:** Mississippi River Basin  
**Problem:** The hypoxic zone in the Gulf of Mexico forms every summer and is a result of excess nutrients from the Mississippi/Atchafalaya River and seasonal stratification (layering) of waters in the Gulf.  
**Potential Stakeholders:** Communities, States, Industry, Agriculture.  
**IHTM Role:** Integration of hydrologic and hydraulic models, groundwater, ecosystem models, and plant growth and agricultural management models across agencies could allow integrated solutions to develop policy to reduce the size of the hypoxic zone.  
**Potential IHTM Customers:** USDA, EPA, USACE, State Environmental Agencies, and the Mississippi River/Gulf of Mexico Hypoxia Task Force.  
**IHTM Impacts:**

- *Scientific:* New basin scale ecohydrological models that simultaneously consider geographic, environmental, and land management factors.
- *Societal:* Coordinated tools to develop comprehensive agricultural management policy to mitigate hypoxia.
- *USDA mission:* Tools for use in Farm Bill debate and in setting national conservation policy.

**IHTM Needs:**

- National dataset of agricultural management practices.
- Seamlessly couple/develop surface, groundwater, and land management components and data types
- Flexibility to transfer output and visualize key information of interest by different stakeholders.

**Scientific and Technical Challenges for IHTM Development:** Parallelization and optimization of coupled codes, Standardized I/O, Model coupling and validation, Access and linking to forcing and assimilation data

### Integration of Coastal and Hydrologic Models

**Scenario/Place:** US Gulf and Atlantic Coasts  
**Problem:** Hurricanes bring heavy inland rainfall and coastal surges that impact watershed drainage. Models are not fully integrated.  
**Potential Stakeholders:** State and local agencies, and first responders  
**IHTM Role:** Integration of coastal and hydrologic models allows for identification of optimal solutions for flood management and flood risk reduction.  
**Potential IHTM Customers:** National Hurricane Center, USACE Water Managers, FEMA, DHS, State and local agencies, and first responders  
**IHTM Impacts:**

- *Scientific:* Coupled models that integrate storm surge and watershed runoff to optimize the system for coordinated objectives.
- *Societal:* Reduced flooding impact through better planning, design and emergency management.
- *USACE Mission:* Improved flood risk management (inland and coastal)

**IHTM Needs:**

- Accurately represent combined effects from storm surge & rainfall/runoff
- Provide timely information for emergency response
- Make information comprehensible and accessible

**Technical Barriers:**

- Parallelization and optimization of coupled codes
- Standardized I/O
- Model coupling and validation
- Access and linking to forcing and assimilation data

**Potential IHTM "Developers":** USACE (ERDC, IWR-HEC), NOAA National Water Center, USGS, Oak Ridge National Laboratory, NASA

**Key Milestones:**

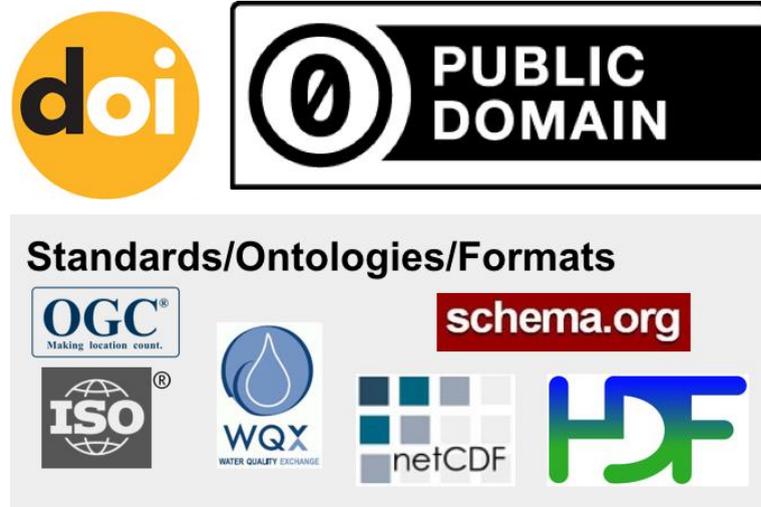
- Near-Term (0-2 yrs): Off-line, loose coupling of surge & runoff models
- Mid-Term (2-5 yrs): tightly coupled framework
- Long-Term (5-10 yrs): operational coastal hazards system that accounts for both surge and runoff

**USACE POC(s):**

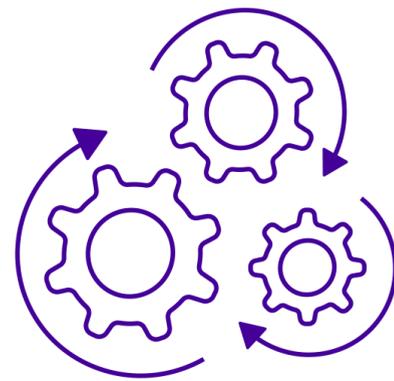
- Mark Wahl, ERDC-RDE-CHL, 937.255.8309, [Mark.D.Wahl@usace.army.mil](mailto:Mark.D.Wahl@usace.army.mil)
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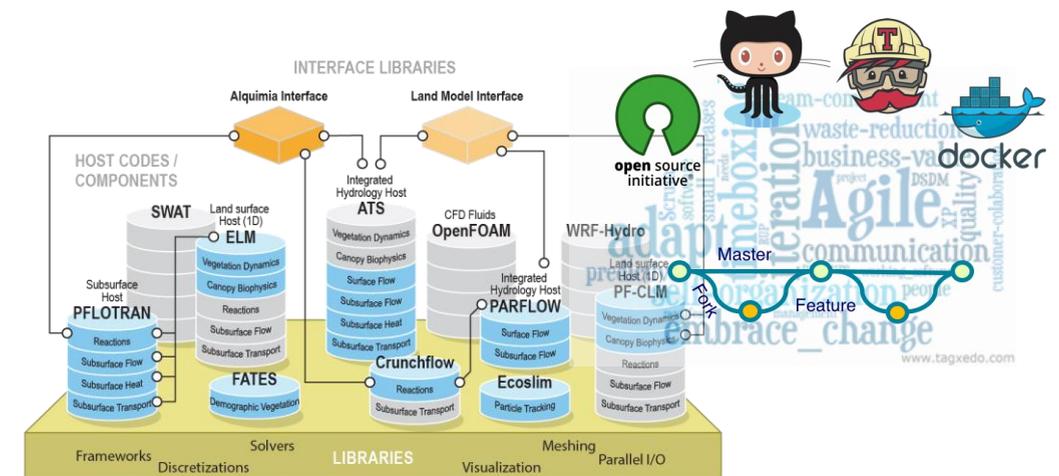
# The Priority Water Challenges Helped Identify Critical Needs in Four Key Technical Areas



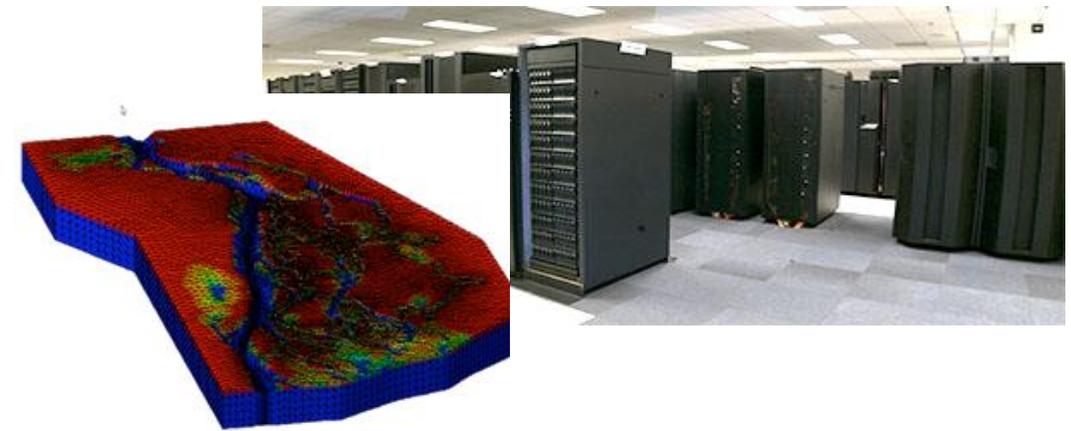
Data Management, Community Platforms, and Standards



Cross-Disciplinary Workflows: Analysis and Evaluation



Software Engineering for Interoperability and Sustainability



Building Computational Testbeds

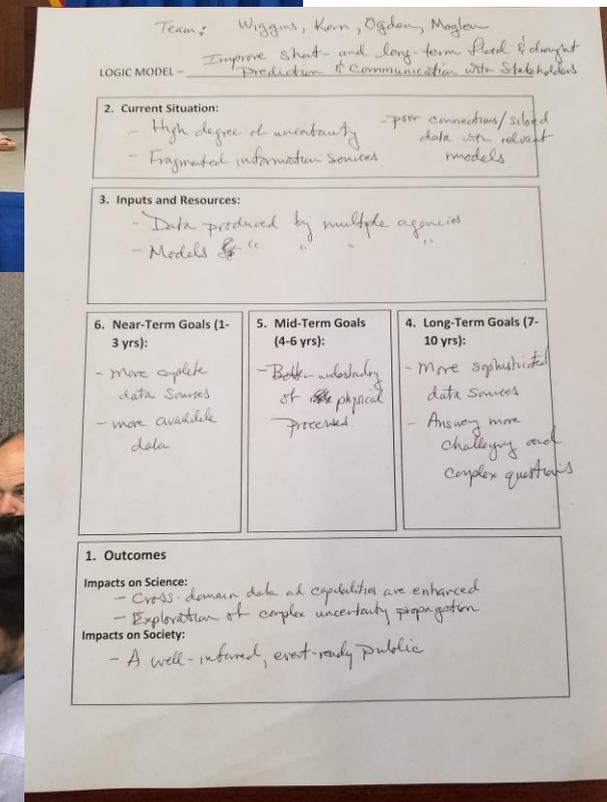
# Three Days of Intensive Interaction

- **Plenary Presentations:**

- Vision and Keynote Lectures
- Framing Presentations – Setting the Stage for Breakouts

- **Breakout Sessions:**

- **WHY** Priority Water Challenges
- **HOW** Shepherds and Carpenters: Building and Maintaining Community Capacity
- **MAKING IT HAPPEN** Organizational Challenges: Building a Sustainable IHTM Community



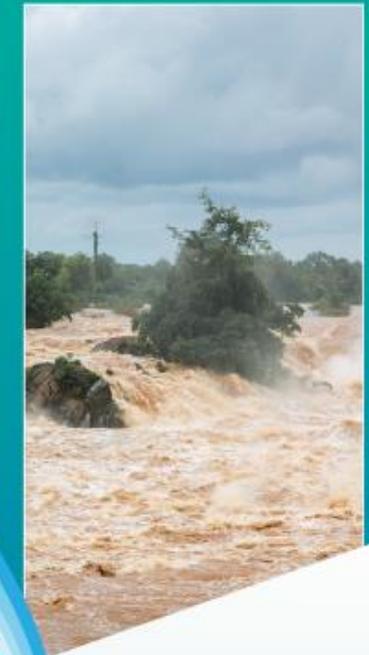
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## Workshop Report

Ron Bingner (U. S. Department of Agriculture)  
Laura Condon (University of Arizona)  
Brian Cosgrove (National Oceanic and Atmospheric Administration)  
Carlos Del Castillo (National Aeronautics and Space Administration)  
Charles Downer (U. S. Army Corps of Engineers)  
John Eylander (U. S. Army Corps of Engineers)  
Michael Fienen (U. S. Geological Survey)  
Nels Frazier (National Oceanic and Atmospheric Administration)  
David Gochis (National Center for Atmospheric Research)  
Dave Goodrich (U. S. Department of Agriculture)  
Judson Harvey (U. S. Geological Survey)  
Joseph Hughes (U. S. Geological Survey)  
David Hyndman (Michigan State University)  
John Johnston (U. S. Environmental Protection Agency)  
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Katherine Skalak (U. S. Geological Survey)  
Charuleka Varadharajan (Lawrence Berkeley National Laboratory)  
Roland Viger (U. S. Geological Survey)  
Nathalie Voisin (Pacific Northwest National Laboratory)  
Mark Wahl (U. S. Army Corps of Engineers)

## INTEGRATED HYDRO-TERRESTRIAL MODELING

Development of a National Capability



Community Coordinating  
Group on Integrated  
Hydro-Terrestrial  
Modeling

Report prepared  
September 1, 2020

Report of an Interagency Workshop Held September 4-6, 2019 with support from the National Science Foundation, the U.S. Department of Energy, and the United States Geological Survey



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- Introduction
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- Cross-Disciplinary Workflows: Analysis and Evaluation
- Building Computational Testbeds
- Open Science by Design
- Mission Alignment, Business and Funding Practices
- A Roadmap for Integrated Hydro-Terrestrial Modeling

**INTEGRATED HYDRO-TERRESTRIAL MODELING**  
Development of a National Capability

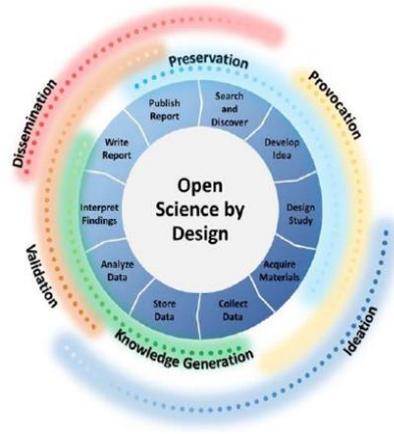
Community Coordinating Group on Integrated Hydro-Terrestrial Modeling

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Logos: USGS, NSF, NASA, NOAA, US Army Corps of Engineers, USDA, EPA

# Roadmap to a Sustainable IHTM Capability and Community



## Long Term

Transform culture towards sharing data, co-developing models, and generating timely, coordinated forecasts for stakeholders

Agencies evolve business and funding practices and mission alignment for optimal impact

## Near Term

Multi-agency working group to generate community buy-in, create incentives, and co-design a pilot project.

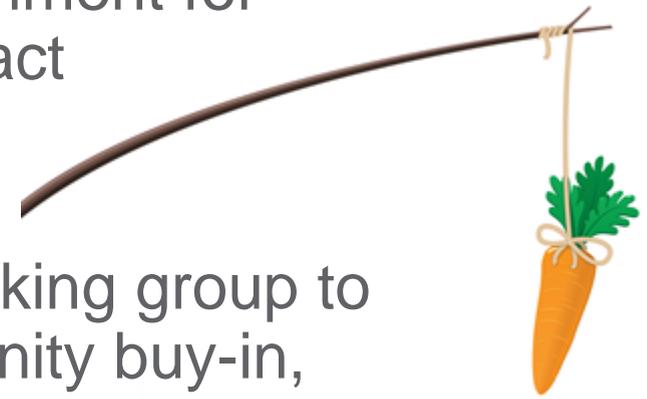
Skin-in-the-game for early wins and pilot projects using flexible approaches



## Mid Term

Determine and implement common data and model standards through communities of practice.

Interagency coordination (e.g., working group) on mission alignment, business & funding practices



## IHTM Continued...

- **Integrated Modeling Workshop Oct/Nov 2020**
  - Led by USGS with DOE and academic participation
- **Joint C-IHTM and Multi-Sector Dynamics Workshop - Mondays in November**
  - Coastal Focus Area of USGCRP
  - Bob Vallario (DOE), Jeff Arnold (USACE), John Weyant (Stanford)
- **ESS Cyberinfrastructure Working Groups, IDEAS and ExaSheds Projects**

**Thank You!**



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Logos: U.S. Environmental Protection Agency, USGS (science for a changing world), NSF, NASA, NOAA (NATIONAL OCEANOGRAPHIC ADMINISTRATION), US Army Corps of Engineers, USDA, U.S. DEPARTMENT OF THE INTERIOR (NATIONAL PROTECTION)