U.S. DEPARTMENT OF ENERGY | Office of Science

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Workshop Overview: The Broad Challenges of Predicting the Integrated Water Cycle

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DOE Workshop on Community Modeling and Long-Term Predictions of the Integrated Water Cycle

Washington DC
September 24 – 26, 2012

Why Water?

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- Water underlies and influences many important climate processes and feedbacks – a leading cause of uncertainty in projecting future climate

Water vapor and cloud feedback

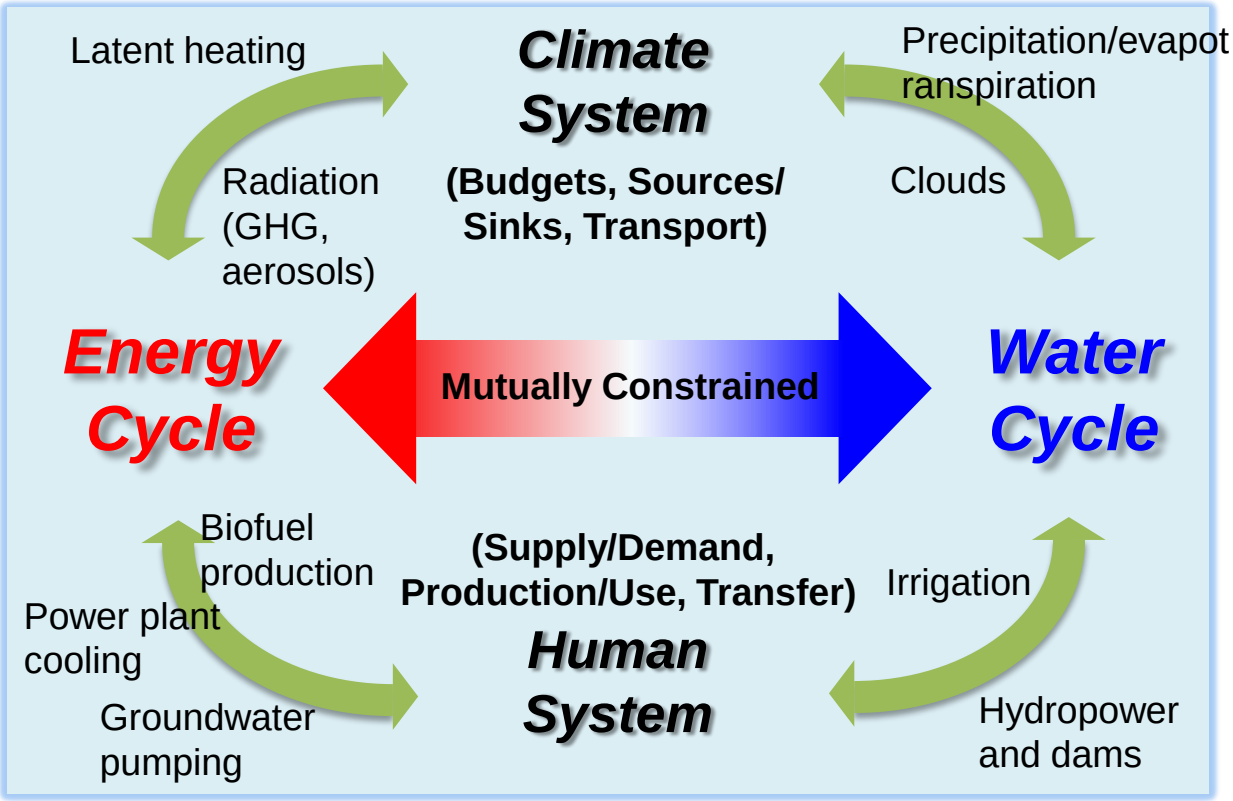
Snow-albedo feedback

Aerosol-cloud interactions

Carbon-water interactions

- Water is essential for energy systems, ecosystem services, and a wide range of life sustaining and other critical human activities

The Water Cycle is Projected to Intensify Under Global Warming



- How will global and regional precipitation as well as land surface hydrology (runoff, soil moisture, snowpack) change?
- How will the above changes affect energy production and use? What are the potential feedbacks to the water cycle?

The Integrated Water Cycle

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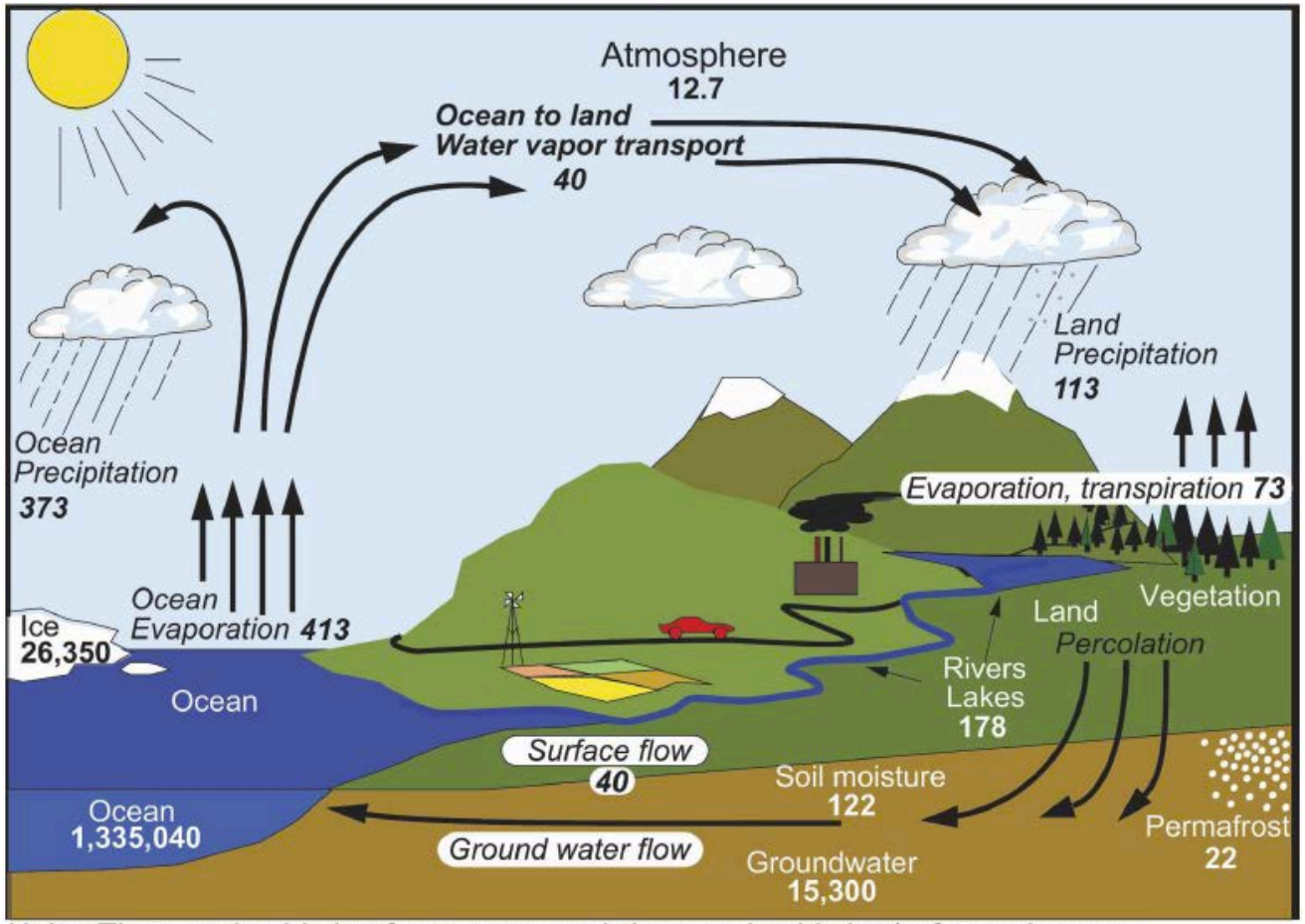
Our questions drive the needs for understanding and prediction of the "Integrated Water Cycle"



Units: Thousand cubic km for storage, and *thousand cubic km/yr* for exchanges

(Trenberth et al. 2007, JHM)

- How well can we quantify the budgets at global and regional scales and predict their evolution?
- How do human systems come into play?

What are the Challenges?

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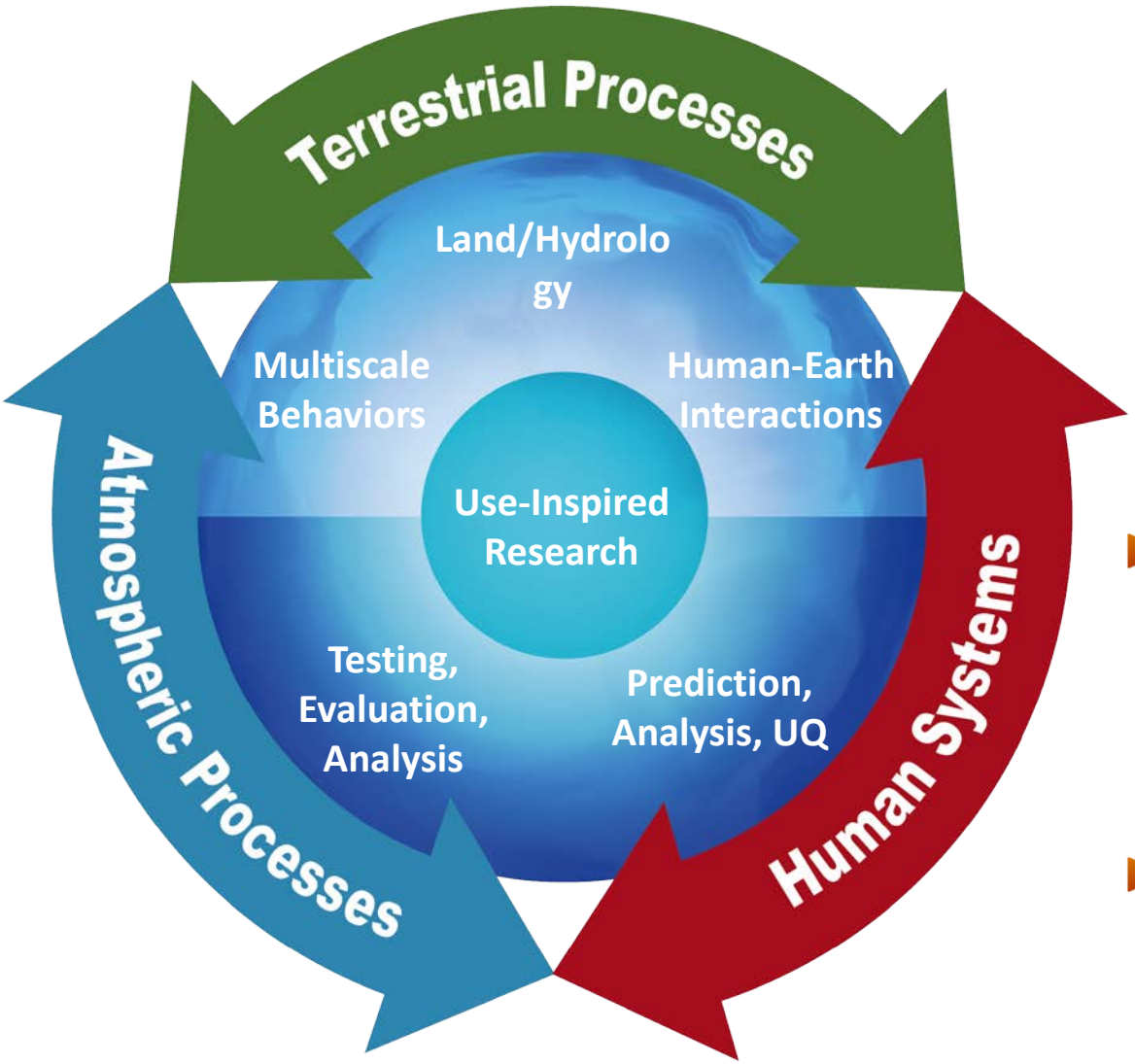
- Water is governed by multi-scale processes that are inherently difficult to model and predict
- The dynamics of human-earth interactions require integrated models that are only beginning to be developed
- The climate and hydrologic communities focus on different approaches and scales of interests
- The multi-scale and integrative nature poses new challenges for model development, evaluation, analysis, and predictions
- With increasing water stress, there is a growing need for science to support decision making

Workshop Topics



- Leveraging on current community modeling efforts, this workshop focuses on <u>modeling research to improve understanding and long term prediction of the integrated water cycle</u>
- Modeling includes all aspects related to the development, evaluation, analysis, and use of models
- Observations will be driven by modeling needs

Human-Earth Interactions

- At the longer time scale, the dynamics of system interactions or feedbacks dominate system behavior and predictability
- What human systems need to be included and how they should be represented? What are their role in prediction?
- What modeling approaches can be used to take advantage of different sources of predictability of the integrated water cycle?

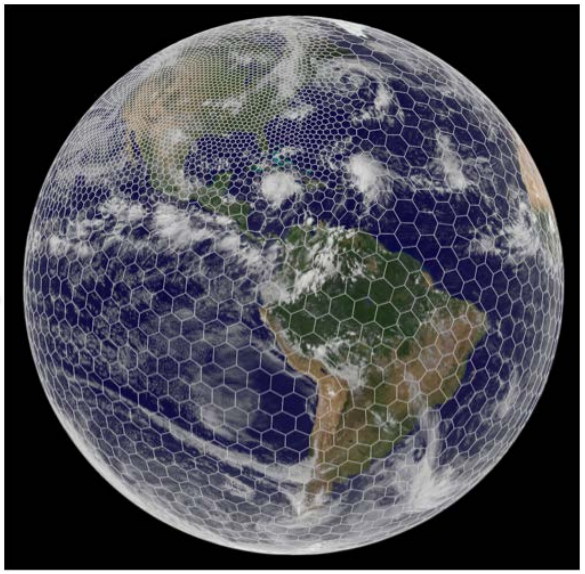
How these systems interact?

What human systems are important and how?

Complexity of representation?

Multi-tiered prediction approach?

Sources of predictability?



Hierarchical/multi-scale modeling?

Model Testing and Evaluation

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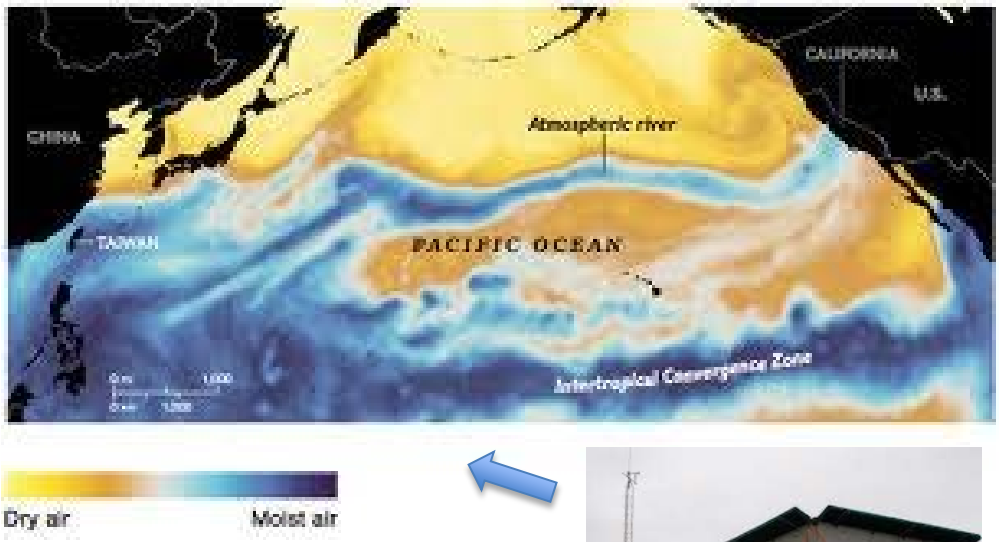
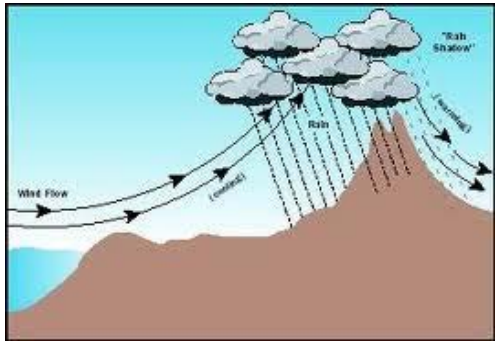
- How to quantify model errors at multiple scales? What model evaluation strategies may work best in the weather-climate continuum characteristics of extreme events?
- How to diagnose compensating errors across systems?
- What observations are needed in modeling testbed?





Observational needs

Extremes and impacts on human systems