WaterNet: The NASA Water Cycle Solutions Network

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Why study the water cycle?

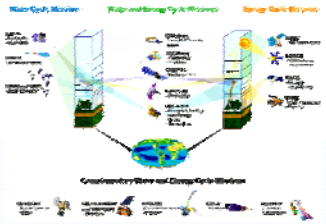
Earth is a unique, living planet due to the abundance and vigorous cycling of water throughout the global environment. Water in the climate system functions on all time scales: from hours to centuries, and is the element of the Earth system that most directly impacts and constrains human society and its well-being. Even though variations in greenhouse gases, aerosols, and solar activity force changes in climate, it is the *consequences of climate change that are realized through the water cycle*. Water and energy is linked to all 12 science application themes, therefore we must characterize, understand and predict variations in the global water cycle.

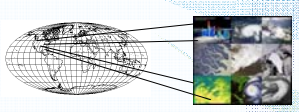
WaterNet

The WaterNet goal is to *improve and optimize the sustained ability of water cycle researchers, stakeholders, organizations and networks to interact, identify, harness, and extend NASA research results to augment decision support tools and meet national needs*.

Figure 1: The WaterNet will identify nodes & relationships

The need for *understanding water cycle variability* and its relationships with water availability and water-related natural hazards are well documented. This has provided a justification for wide ranging efforts to promote adequate observations (and historic reconstructions) to quantify the variability of water and energy cycle components.





Useful prediction is critical – it is the link to stakeholders

Figure 2: NASA's Water & Energy Cycle Observation Capabilities (left) , and Figure 3: Model and Prediction Capacities (right)

Since the water cycle is fundamental to virtually all twelve NPAs, we envision a wide range of water-related WaterNet partners. A *sampling of the DSTs used by the water cycle community* is shown in Table 1 below. *WaterNet also has* many existing water cycle related science and *stakeholder networks* that will be engaged.

Table 1: A Selection of water-cycle relevant DSTs and the potential value of NASA water cycle research

WaterNet Integrated System Solutions Approach

The NASA Applied Science Approach: **Solutions Networks**

harvest and explore research capabilities and support needs to identify candidate solutions. Therefore, the role of WaterNet is to:

1. Harvest water-cycle research results and water-cycle relevant decision support needs
2. Analyze this information to identify candidate solutions, and determine the configuration required to build the solution (pre-evaluation report)
3. Optimize the network to improve the fidelity of the candidate solutions

The pre-evaluation report formally documents the candidate ISS configuration and identifies its components, contributors, and connections.

Figure 4: NASA's Applied Sciences Systems Integration Engineering Environment

Given a research need, what NASA research result can be useful?

Now repeat (automate) the process for a large number of decision needs

Figure 5: WaterNet simplified

Sample of existing portals

Global Change Master Directory: enables users to access & obtain Earth Science data and services

Earth-Science Gateway: streamlines access to remote data , imagery, models and visualizations

Earth Sun Science System Knowledge Component Base: Catalogues standard NASA research products and specific partner decision support tools

Federation of Earth Information Partners: Brings partners together to make Earth Science information available to broader community

Work Plan

We adopt an end-to-end systems engineering strategy to establish pathways and partnerships between NASA's water cycle focus area research investments and various decision support needs, as follows:

1) Evolve a network of water cycle partners: identify and analyze water cycle community-of-practice organizations, DSTs and their requirements and develop well-constructed teams and partnerships to define collaboration pathways.

2) Routinely identify, prioritize mine and communicate relevant NASA water cycle results that address NPA's, and develop operational information system pathways to provide timely user-community access.

3) Optimize water cycle partner access to NASA water cycle research, through developing prototypes, evaluation methods, verification procedures, and benchmarking standards to create an evolving and self-sustaining network.

4) Analyze and document

5) Education and Outreach

Demonstration Projects/Progress

• *SAHRA/USBR Western Rivers Water Management:* SAHRA will participate by developing strategies to assimilate *WaterNet* database and linkage tools into its multi-resolution integrated modeling, process study and stakeholder interaction activities for the Rio Grande, San Pedro & Northern Mexico regions. Identification of improvements to snowmelt runoff models to improve melt waters spring forecast. Linking NASA/GSFC HSB model results on evapotranspiration to upgrade DSTs.

•*Coral Reef Early Warning System (CREWS):* A DST operated by NOAA's Office of Oceanic and Atmospheric Research as part of its Coral Reef Watch program in response to the deteriorating global state of coral reef and related benthic ecosystems. CREWS can be augmented from a localized phylon-sited system mounted on the seabed to a regional oceanographic forecast system using data assimilation within NASA remote sensing capability in US Navy and developing NOAA real-time ocean forecasting systems, part of the Integrated Ocean Observing System.

•*CUAHSI-Hydrologic Information System (HIS):* We will link the CUAHSI-HIS tools to the *WaterNet*, and analyze the performance with respect to generating input required for BASINS/HSPF, the existing DST for the Chesapeake Bay watershed.

•*State-of-the-Water-Cycle Demonstration:* The emergence of a State-of-the-Water-Cycle (SWC) initiative coordinated through the NEWS Integration Team provides a tangible focal point to exercise NASA investments in water cycle information provision in a fully global context. The UNH team is focusing on enabling its existing Water Balance/Transport modeling framework as Decision Support Tool to directly tap into NASA information resources. The goal for the first year is to demonstrate the use of WBM/WTM as a decision support tool for the assessment of water resources globally with respect to sustainability of current water use practices

•*CNRFC-Water and Emergency Management Demonstration:* The NWS California-Nevada River Forecast Center provides an ideal demonstration of state-of-the-technology networking in human and technology dimensions. The modernization of the NOAA NWS River Forecasting System from a lumped basin watershed model at 6 hour forecast interval is being transitioned to a distributed, spatially varying watershed at hourly forecast intervals through an infusion of NOAA OHD and NASA technology, in which more accurate precipitation distribution across the watershed will replace over-simplistic distance-weighted scheme using regional meteorological modeling, along with improved snowmelt runoff forecasting to improve seasonal water supply forecasting.

•*NCAR's Research Applications Lab (RAL):* The RAL has extensive knowledge of the aviation industry's needs from aircraft icing microphysical studies to microburst safety procedures at airports during landings and take-offs.

•*Integrated Global Systems Analysis:* An experimental strategy will be set up along the lines of an OSSE (Observation System Simulation Experiment). Numerical experiments and/or econometric analyses that could gauge the effect of knowledge gained (or uncertainty lost) in hydrologic change (under uncertain climate warming) under the constraint of an optimal path of damage minimization - or by avoiding a climate-change threshold .

Future Success The projects success hinges on building a community of engaged research, end-users, industry, government, non-profit, networks, and academic partners. If you are interested in being a WaterNet partner, please contact us.

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