WaterNet: The NASA Water Cycle Solutions Network

WaterNet Project Team:

P. Houser(GMU/CREW), D. Belvedere(CREW), W. Pozzi(CREW), B. Imam(UCI), R. Schiffer(UMBC), C.A. Schosser(MIT), H. Gupta(UA), C. Welty(UMBC), C. Vorosmary(UNH), D. Matthews(HydroDSS), R. Lawford(UMBC)

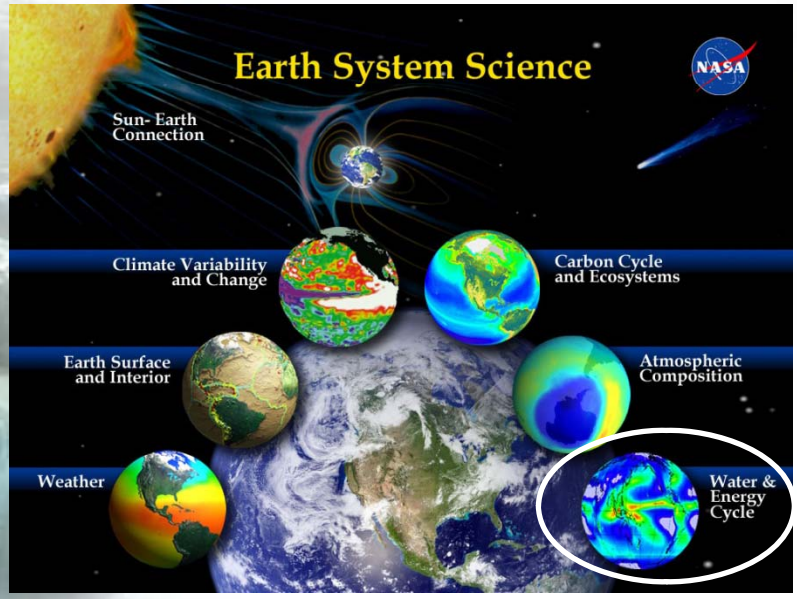
CREW Center for Research on Environment and Water

GEORGE MASON UNIVERSITY

Water Cycle Research Making a Difference

http://crew.iges.org

The Water and Energy Cycle



1. Water exists in all three phases in the climate system and the phase transitions are a significant factor in the regulation of the global and regional energy balances

2. Water vapor in the atmosphere is the principal greenhouse gas and clouds at various levels and composition in the atmosphere represent both positive and negative feedback in climate system response

3. Water is the ultimate solvent and global biogeochemical and element cycles are mediated by the dynamics of the water cycle

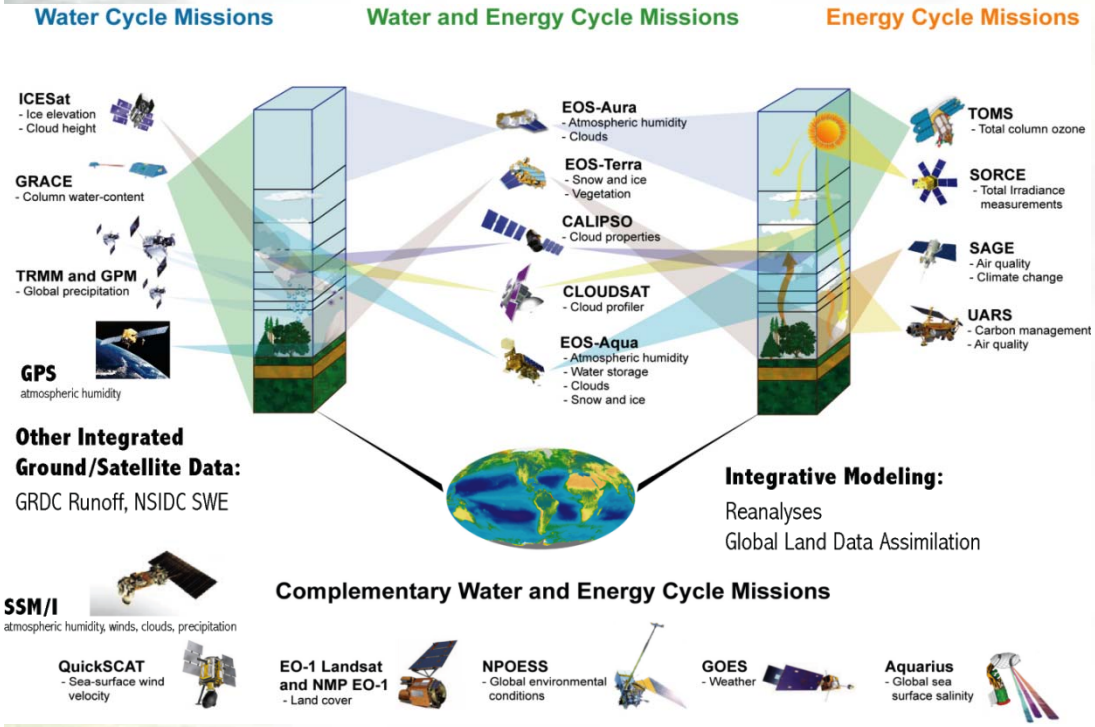
4. Water and carbon are linked in terrestrial vegetation through the evapotranspiration of water and assimilation of carbon dioxide into plants through leaves, linking water and carbon cycles.

5. Water is the element of the Earth system that most directly impacts and constraint human society and its well-being.

CREW Center for Research on Environment and Water

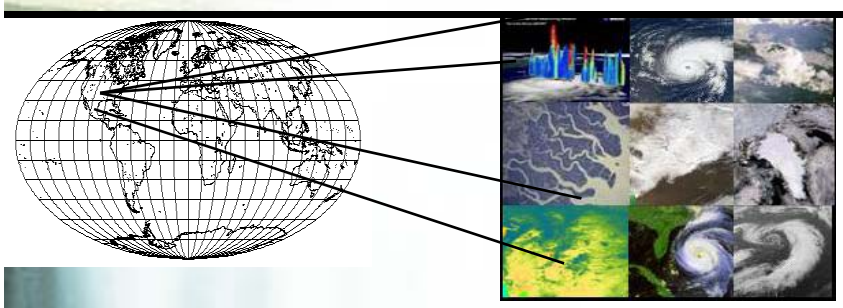
Water in the climate system functions on <u>all</u> time scales: From hours to centuries

NASA Water & Energy Cycle Observation Capabilities & Modeling and Prediction Capacities



The need for understanding water cycle variability and its relationships with water availability & water-related natural hazards are well documented.

This has provided a justification for wide ranging efforts to promote adequate observations to quantify the variability of water & energy components.



Each Climate model grid-box can only represent "average" conditions of its area, however, controlling processes of the water cycle (e.g. precipitation) vary over much smaller areas

Developing Advanced Process-Resolving Models

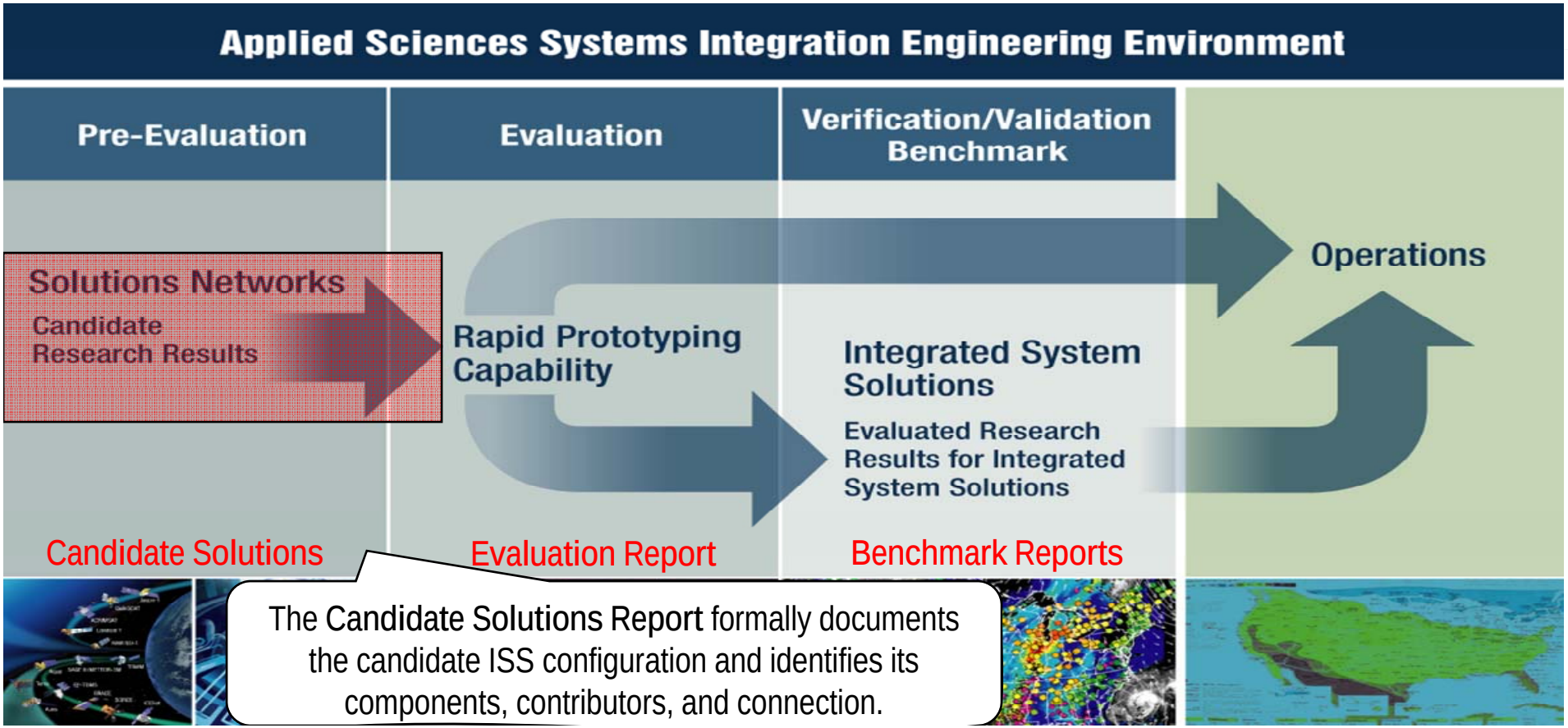
- Useful prediction is critical – it is the link to stakeholders.
- We must move towards a new paradigm of climate models that produce useful weather-scale, process-scale, and application-scale prediction of local extremes (not just mean states).
- We must more fully constrain climate models with observations, to improve their realism and believability.

CREW Center for Research on Environment and Water

NASA Applied Science Approach

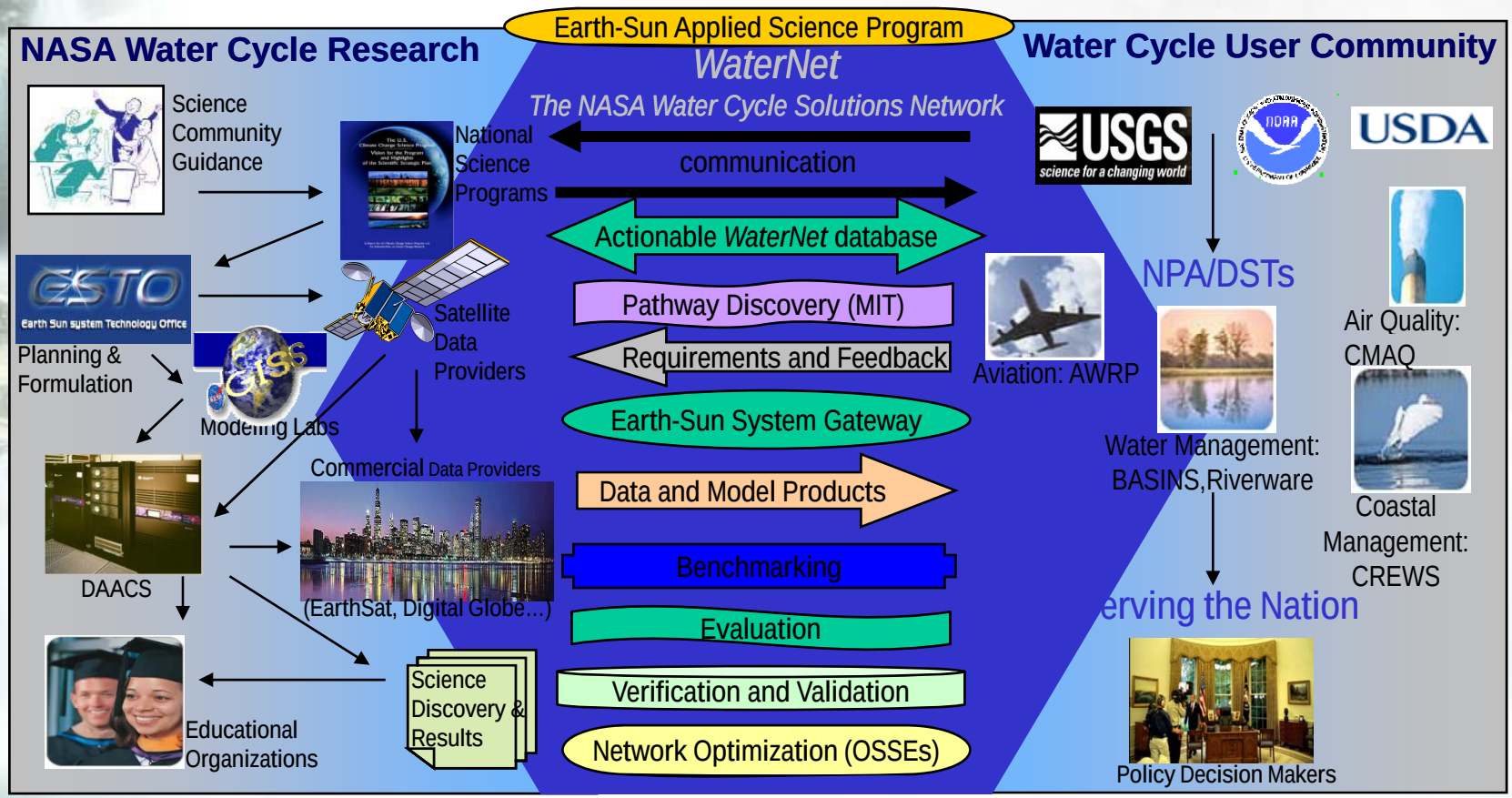
Solutions Networks harvest and explore research capabilities and support needs to identify candidate solutions. Thus, the role of *Solution Networks* is to

1. Harvest NASA ***research results*** and identify/understand relevant ***decision support needs***.
2. Analyze this information to ***identify candidate solutions***, and ***determine the configuration required to build the solution*** *(documented in Candidate Solutions Reports)*
3. ***Optimize the network*** to improve the fidelity of the candidate solutions.



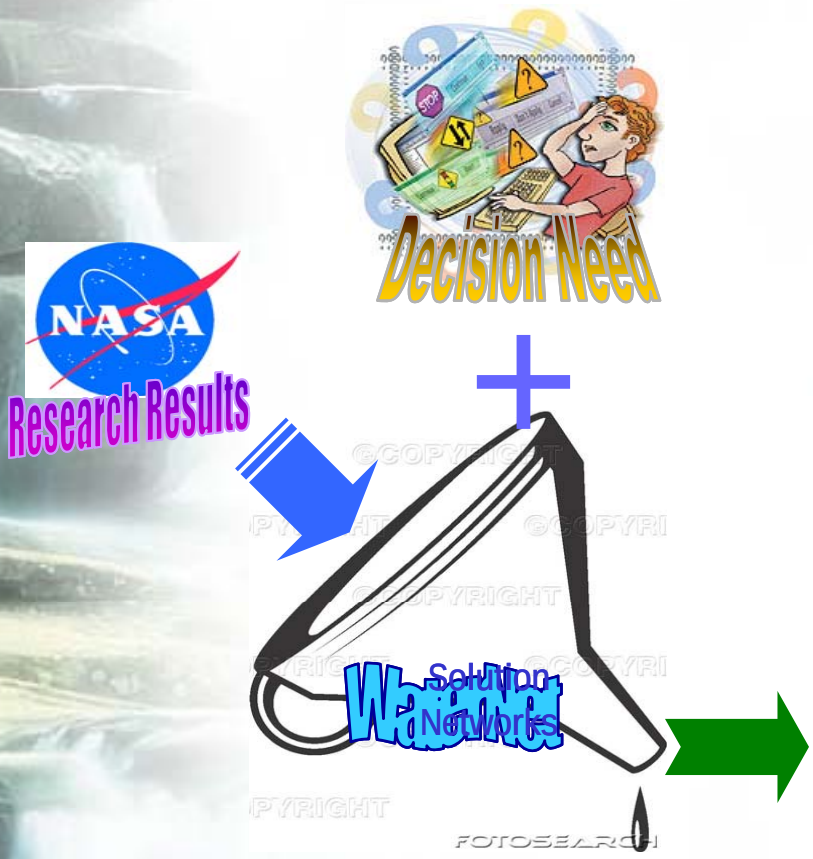
WaterNet: Concept

WaterNet GOAL: 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.



WaterNet: Simplified

Given a water cycle decision need, what NASA research results can be useful?



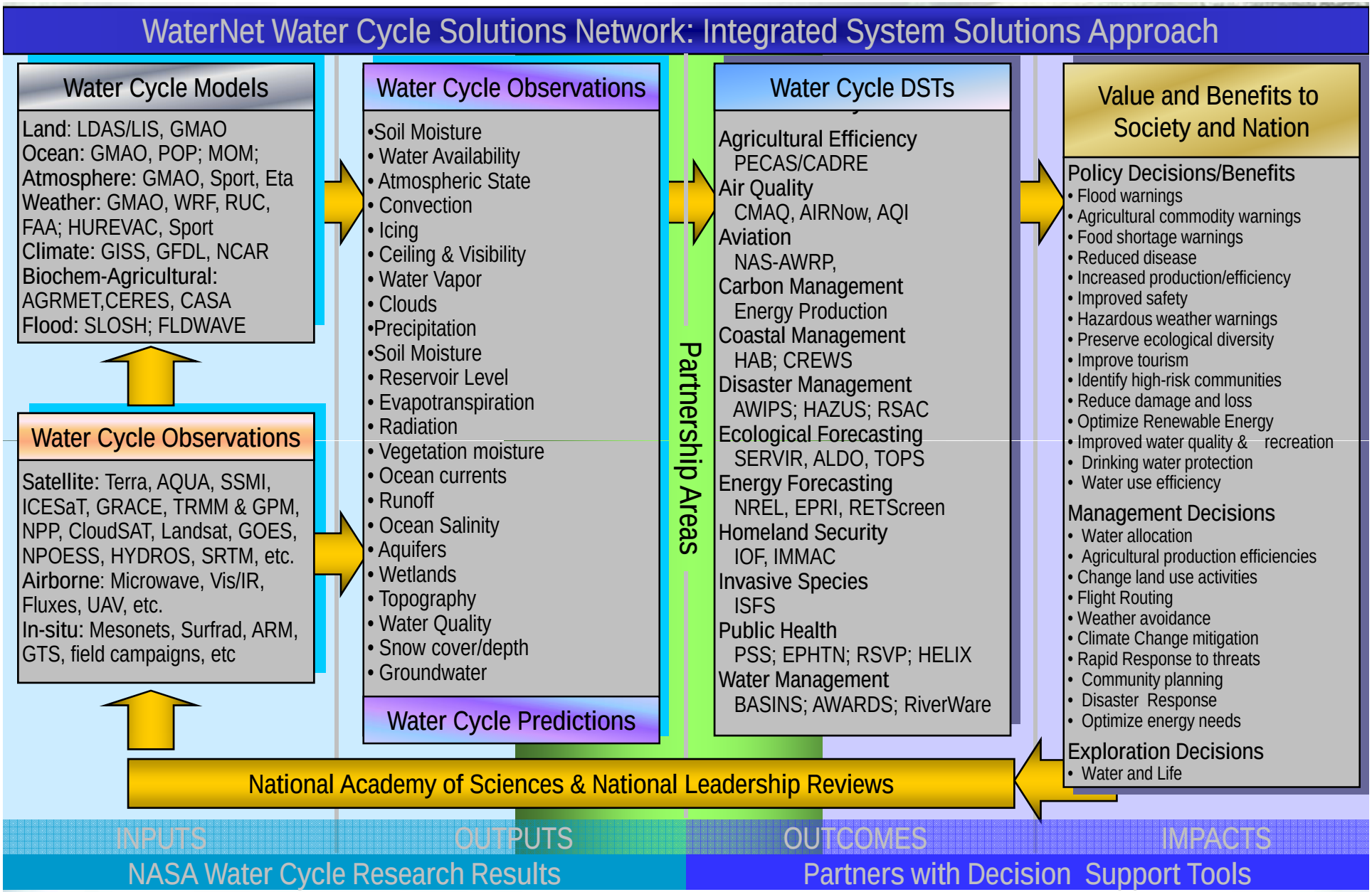
Vision: WaterNet is the catalyst for the discovery and sharing of creative solutions to water problems.

Mission: To improve our collective ability to routinely interact with and harness the results of scientific research so as to address water assessment, prediction and management challenges.

Candidate
Solution
Reports

Now repeat <automate> the process for a large number of decision needs = WaterNet

CREW



CREW Center for Research on Environment and Water

WaterNet is an extensive "solution network of networks and nodes", encompassing and interconnecting a large number of water-relevant existing networks, research results, and decision support tools. Here we summarize the statements of commitment we have received –this is only a small sample of the potential partners.

Org.	Name
NASA	NASA Energy & Water cycle Study (NEWS); NASA's Geosciences Interoperability Office (GIO); Earth-Sun System Gateway (ESG); Geospatial Applications & Interoperability (GAI); Global Learning and Observations to Benefit the Environment (GLOBE); EOS Clearing HOuse (ECHO); Distributed Active Archive Center (DAAC)
Academic	Consortium of Universities for the Advancement of Hydrologic Science (CUAHSI) 100+ members; Universities Council on Water Resources (UCOWR) 86 Universities in US & World; Collaborative Large-Scale Engineering Analysis Network for Environment Research (CLEANER); Long-Term Ecological Research (LTER); National Ecological Observatory Network (NEON)
	Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA); Hydrology Web
Industry	Terrapin Asset Management, LLC; Risk Management Solutions (RMS); AMEC; AMEC Natureserve
Gov't	NOAA's National Climate Data Center (NCDC) Worlds largest archive; US Bureau of Reclamation (USBR); US Army Corps of Engineers and Development Center (USACE/ERDC); NWS/California Nevade River Forecast Center (NWCNRFC); USDA Agriculture Research Service (USDA/ARS); National Weather Service (NWS); National Water & Climate Center (NWCC); USDA Natural Resources Conservation Services/West, National Technology Support Center (NRCS); DHS Interagency Modeling & Atmospheric Assessment Center (IMAC)
DSTs	Coral Reef Early Warning System (CREWS); EPA/Community Multiscale Air Quality Model (CMAQ) RetScreen-Energy; Invasive Species Forecasting System (ISFS); Malaria Modelling & Surveillance (MMS) Terrestrial Observation & Prediction System (TOPS); Carbon Query & Evaluation Support Tools (CQUEST)
Labs	NCAR; NCAR's Research Application Laboratory (RAL)
Non-Profit	Earth Science Information Partners (ESIP) Federation Includes more than 80 member orgs; US Nat'l Academies Water Information Network (100+ peer reviewed reports)
Int'l	UN Educational, Scientific & Cultural Organization (UNESCO); World Climate Research Programme (WCRP) Global Water System Project (GWSP); Global Energy & Water Experiment cycle (GEWEX) EU AWARE (Available Water Resource); Hydrology for the Environment, Life & Policy (HELP); Environmental Agency of the Republic of Slovenia (EARS); Graz University of Technology (TUG)

WaterNet: *Work Plan*

- Phase 1: Develop Candidate Solution Reports in a manual discovery mode
- Phase 2: Partially automate discovery process using database and knowledge mining tools.
- Phase 3: Evaluate phase-1 report fidelity (demo projects), produce numerous partner reports, optimize network.

- Demonstration Projects:
  - *SAHRA/USBR Western Rivers Water Management (UA).*
  - *Coral Reef Early Warning System (CREW):*
  - *CUAHSI-Hydrologic Information System (UMBC)*: EPA BASINS/HSPF – for Chesapeake Bay watershed.
  - *State-of-the-Water-Cycle Demonstration (UNH):*
  - *CNRFC-Water and Emergency Management Demonstration (HydrometDSS):* NOAA NWS River Forecasting System.
  - NCAR's Research Applications Lab (HydrometDSS/UMBC): Aviation iaircraft icing, microburst safety, etc.
  - OSSEs: MIT Integrated Global System Model (MIT)

CREW Center for Research on Environment and Water

CNRFC Demonstration Project

Goals:

- Demonstrate value added to National Weather Service Decision Support Tools (DSTs) by various remote sensing and land surface modeling research applications to improve flood forecasting, snow pack and rainfall runoff, stream flow and water supply forecasts.
- Evaluate impacts of improved forecasts on water management Decision Support Tools
- Focus future NASA resources on gaps identified

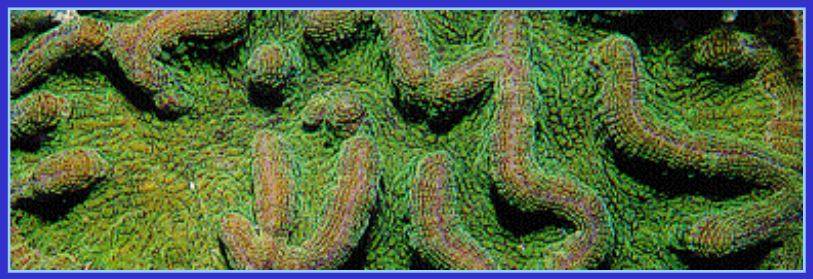
The Coral Reef Early Warning System (CREWS) Network:

marine environmental monitoring to support research and marine sanctuary management

A CREWS Station is a "smart" meteorological and oceanographic monitoring platform installed near coral reef areas, software-configured to ensure the gathering of high quality data and the eliciting of automated alerts when specified environmental conditions occur (e.g., those thought to be conducive to coral bleaching)

...*and* information synthesis products

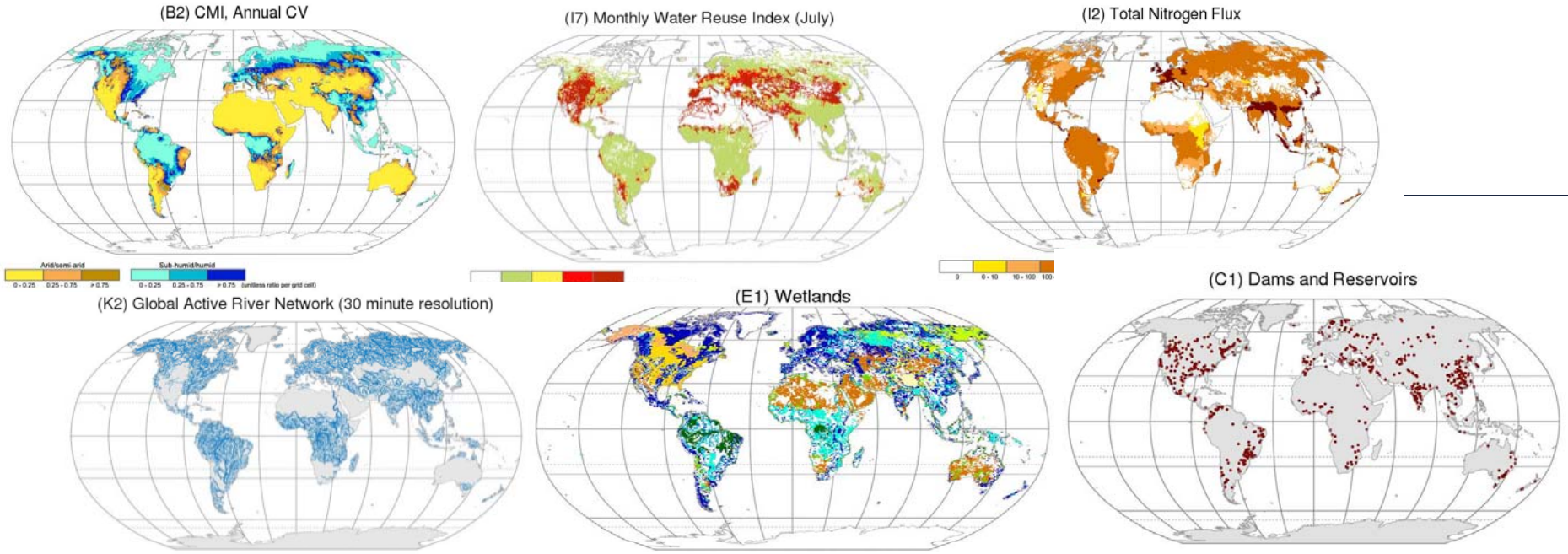
Surface-truth for satellite products, coral bleaching alerts, data quality alerts; and matching patterns as proscribed by biologists, oceanographers and the public (fish & invertebrate spawning, migration, bloom conditions, good fishing and/or diving conditions, etc.)

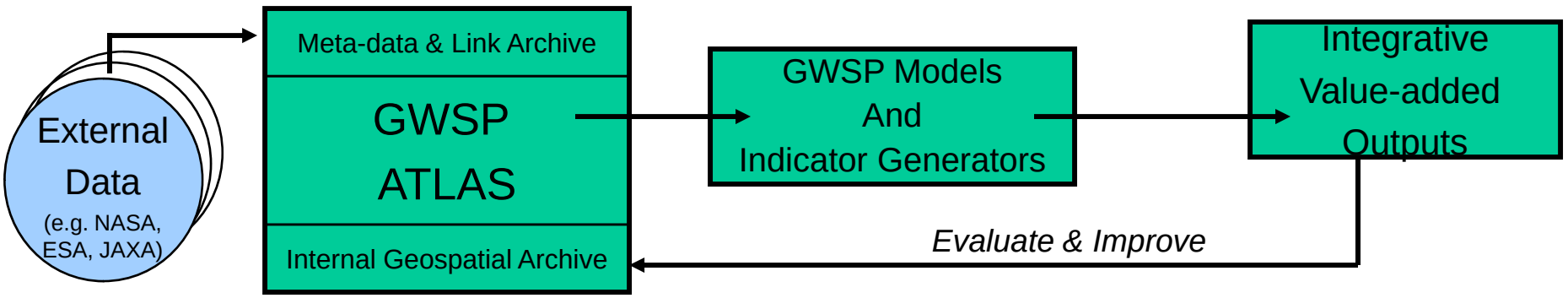


State of the Water Cycle as an Solution Network Demonstration

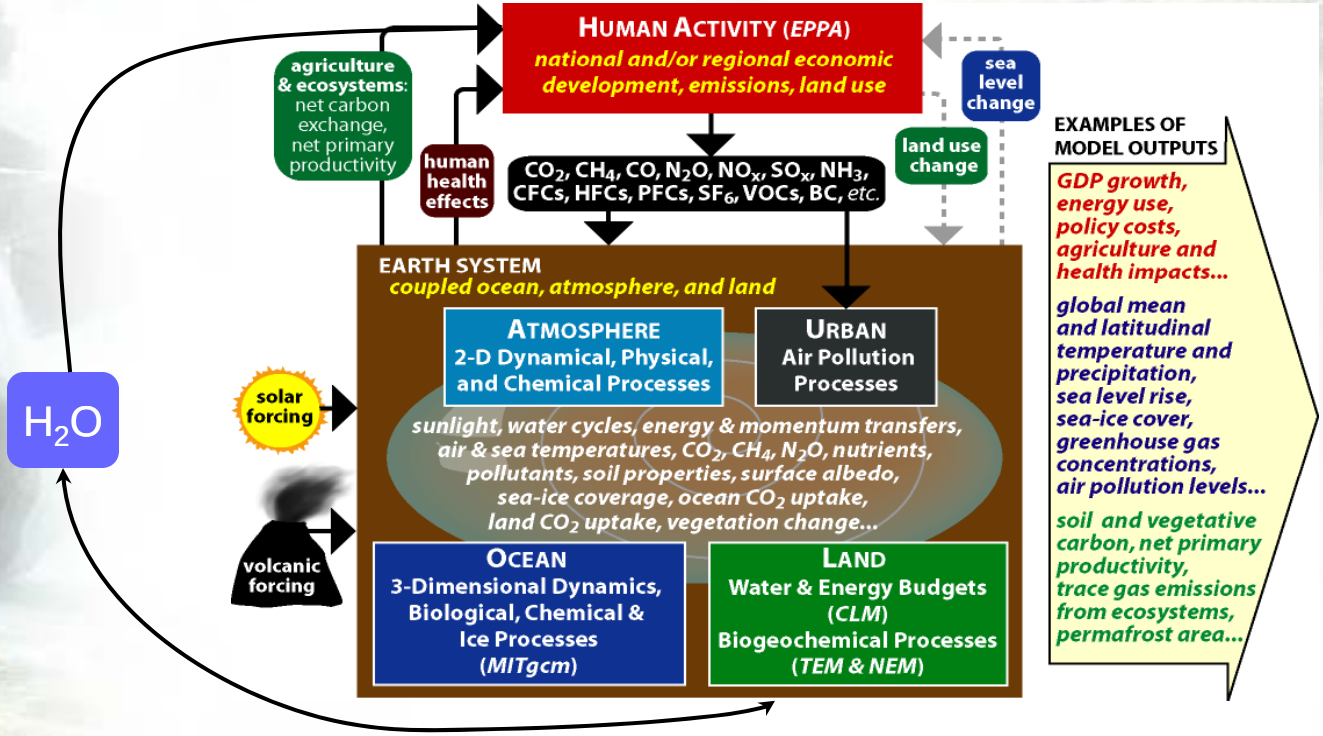
Links Geophysics of H20, Governance, Vulnerability, Supply Limitation Imposed by Pollution, Ecosystem Flow Requirements

(Links to NASA NEWS, GWSP, GEWEX/HAP, IGWCO, ICSU Socioeconomics Group)





WaterNet Implementation – MIT IGSM OSSEs



Econometric analyses:

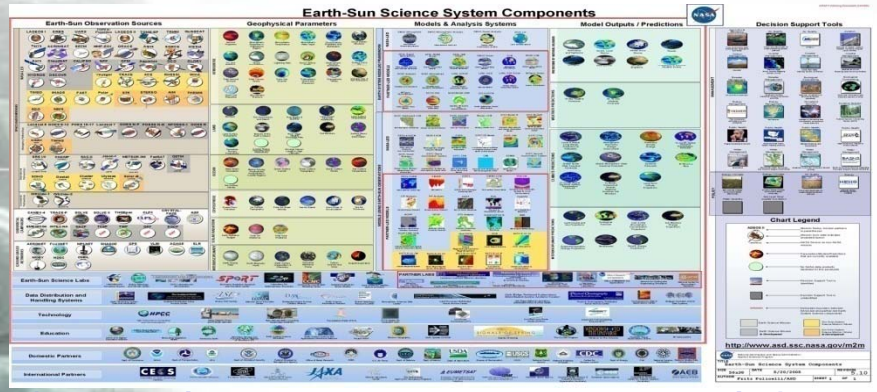
- Combine global observations of precipitation to population data and projected urban growth.

OSSE-type experiments with the MIT IGSM:

- To what extent does improved prescription of precipitation frequency derived from satellite-based precipitation measurements impact modeled global trace gas emissions and pollutants?
- Conduct "value of information" experiments that assess the impact of adding hydrologic-economic linkages, which reflect societal efforts to minimize the costs and damages of climate change.

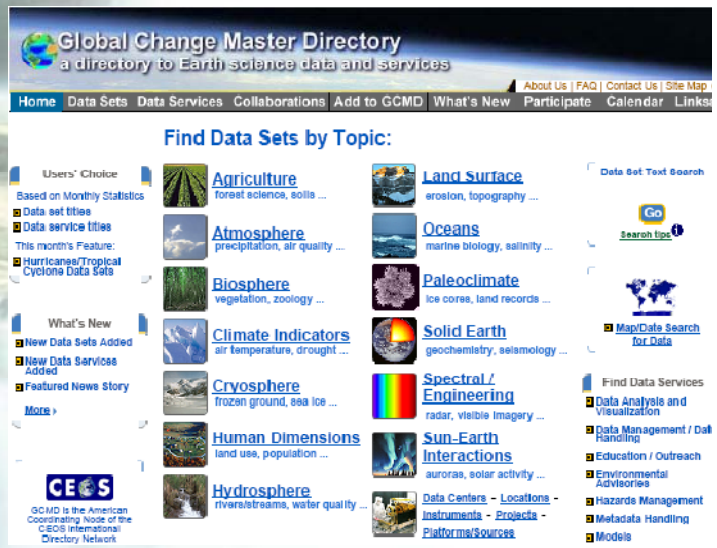
CREW Center for Research on Environment and Water

Existing Solution Network Resources



Earth-Sun Science System Components Knowledge Base
Catalogs standard NASA research products & specific partner DSTs

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



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

ESIP Federation brings partners together to make ES information available to broader community

WaterNet

Vision: WaterNet is a catalyst for the discovery and sharing of creative solutions to water problems.

Mission: To improve our collective ability to routinely interact with and harness the results of scientific research so as to address water assessment, prediction and management challenges.

We do this by developing a prototype mechanism that enables awareness of the existence and potential of new and existing scientific research results, facilitates a discovery process and enables and encourages sharing.

Near-Future Work: Web based, pubic portal, meta-database, glossary, ontology of concepts are represented by keywords and relationships, tool for designing & refining (powerful) queries, storage of successful query patterns, ranking of results, report generation, strategies for acquiring knowledge not in the public domain.

CREW