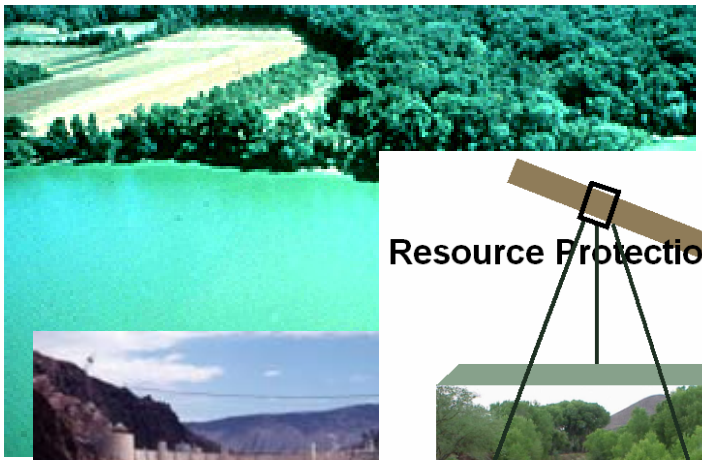
Water Resources Forecasting Challenges and Opportunities

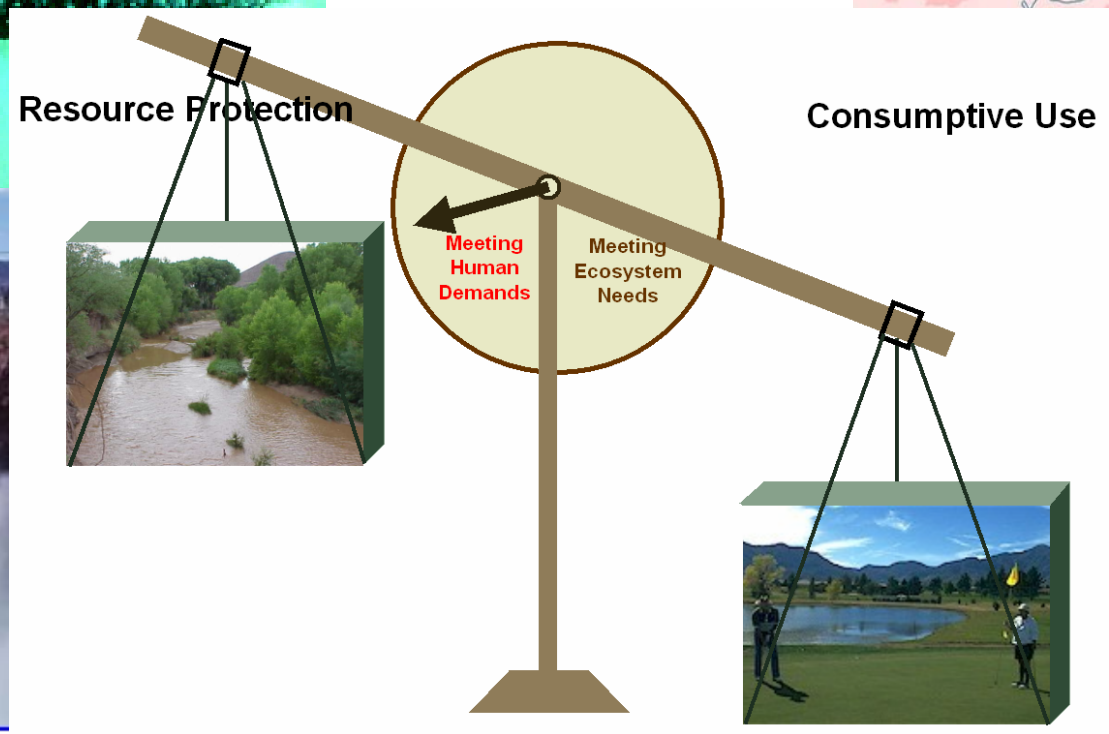
"Leveraging Partnerships"

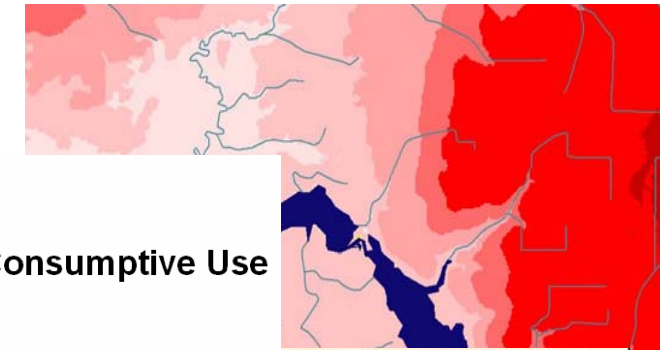
Gary Carter

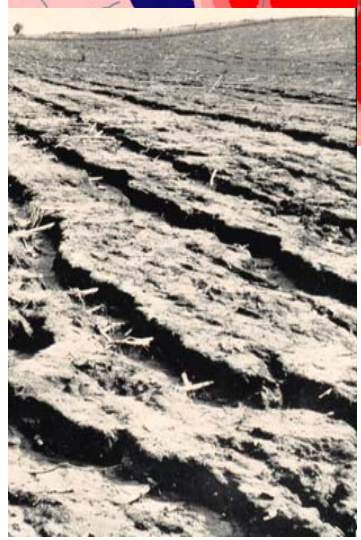
NOAA's Hydrology Program Manager

October 4, 2005



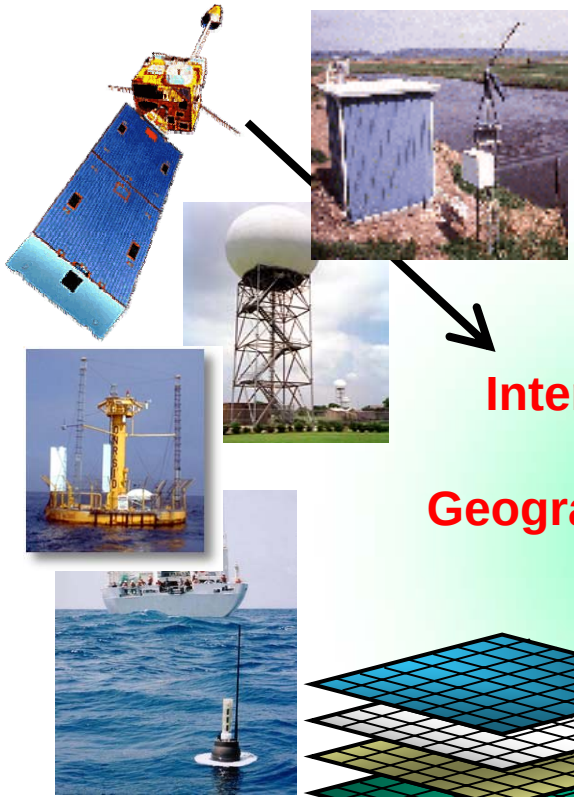




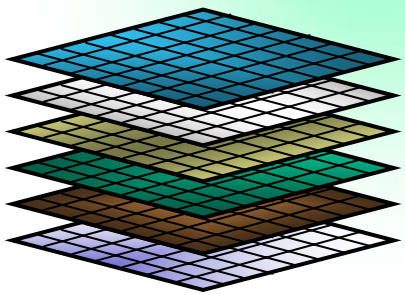


NOAA's Integrated Water Services

Observations



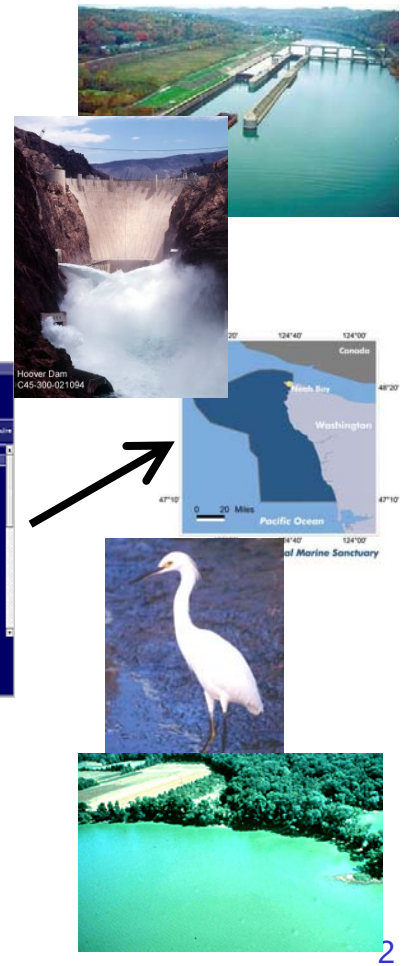
Internet Delivery via Geographic Forecast Layers



- River flow
- Snowpack
- Precipitation
- Soil Moisture
- Coastal Water Conditions

Georeferenced Products

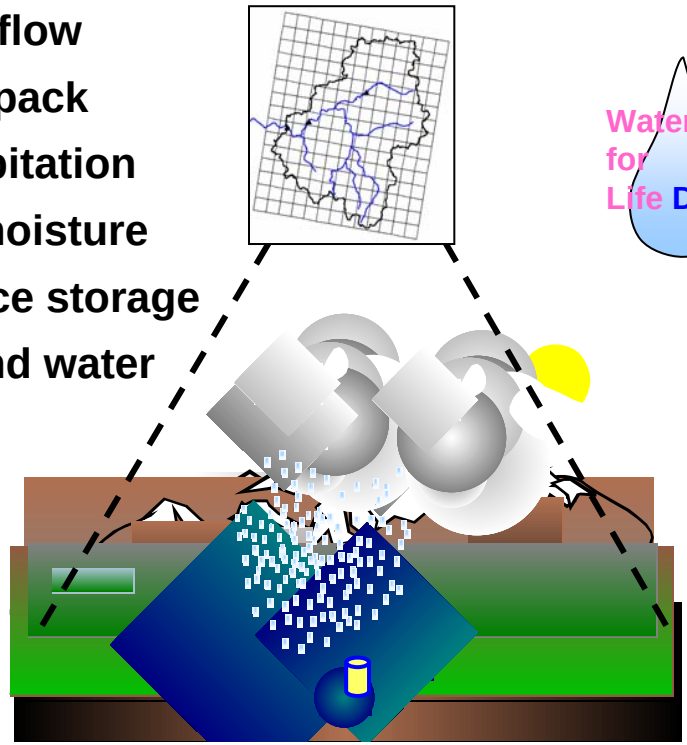
Sound Decision Making



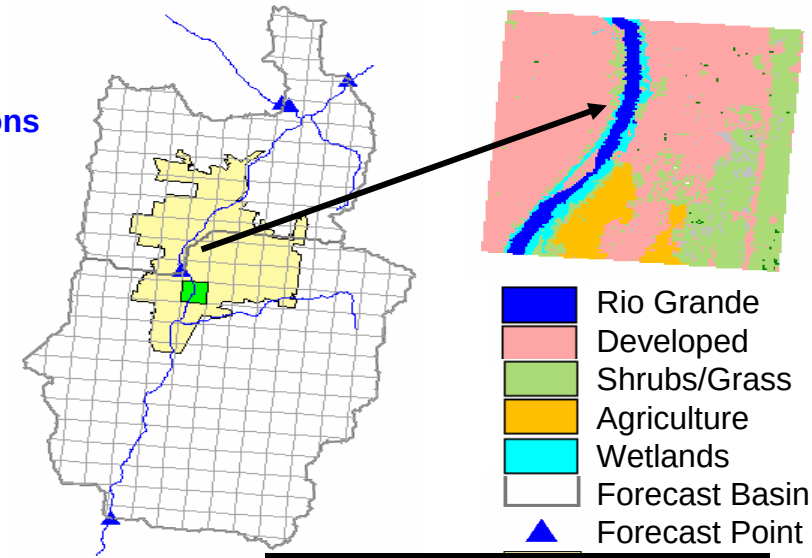
NOAA's Water Resources

Water Forecasts: Where you are and when you need them

- **River flow**
- **Snowpack**
- **Precipitation**
- **Soil moisture**
- **Surface storage**
- **Ground water**



Water Predictions for Life Decisions



Flood warnings for local communities

Critical hydrologic information for neighborhoods and watersheds

Water supply and soil condition forecasts for drought risk management

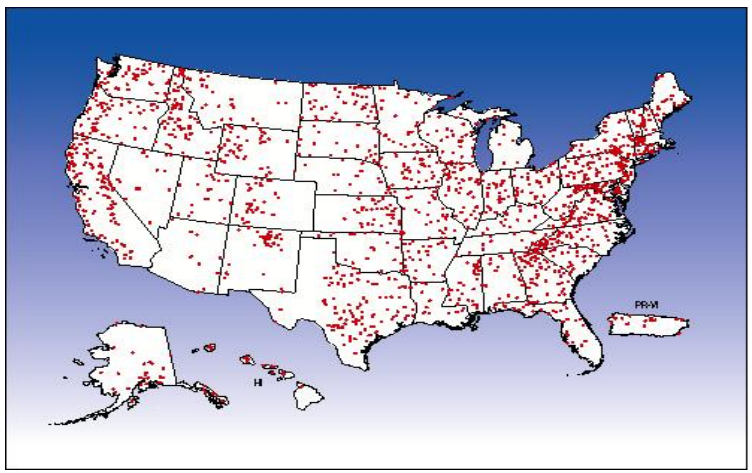
Working Together:

Federal, Tribal, State, and Local Agencies
Private Sector and Academia

Hydrologic Services - Current Forecasts and Water Resources Capabilities

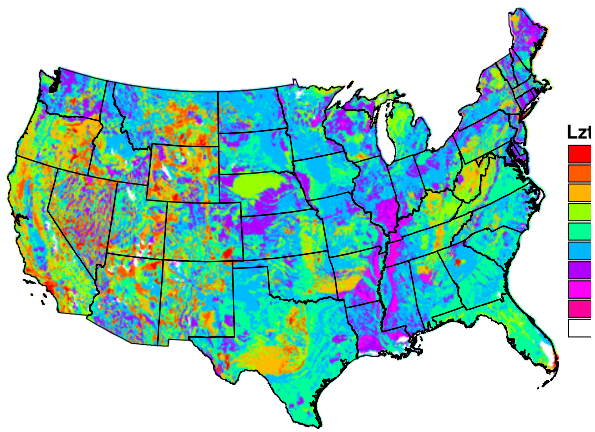
River Forecast Services

- River flow and height
- Location specific information and products
- 4000 river locations nationwide
- 870 square miles per forecast point
- False alarms because of large geographic area warned
- Emergency managers determine where in forecast region to deploy resources



Water Resources Services

- River and watershed information (soil moisture and temperature, snowpack, evaporation…)
- Land surface covered with 4 km grid
- 6 square miles per forecast location
- Warnings provided at scale of event
- First response resources can be targeted precisely
- Nationwide information available digitally for value added processing



NOAA Hydrology Program

Program Team Composition

- River Forecast Centers
- National Operational Hydrologic Remote Sensing Center
- Office of Climate, Water, and Weather Services, Hydrologic Services Division
- Office of Hydrologic Development

Program Customers

- Federal Water Agencies
- Commercial Waterway Navigation
- Emergency and Water Resource Managers
- General Public

Councils associated with the Hydrology Program

- Research, Platform Allocation, Observing Systems, CIO, Education, International Affairs

Hydrology Program Objectives

Outcomes

- Improved Ecosystem Management

  Contribute mercury concentration predictions for the Gulf of Mexico Mercury Contamination Project (collaborating NOAA Programs: ER, EO, FM, AQ, EM)

- Increased Economic Benefits using Water Forecasts and Information

  Contribute gridded forecasts of soil moisture and temperature for the National Integrated Drought Information System (STI, LFW, EM, RDS, COA, CPP, CE)

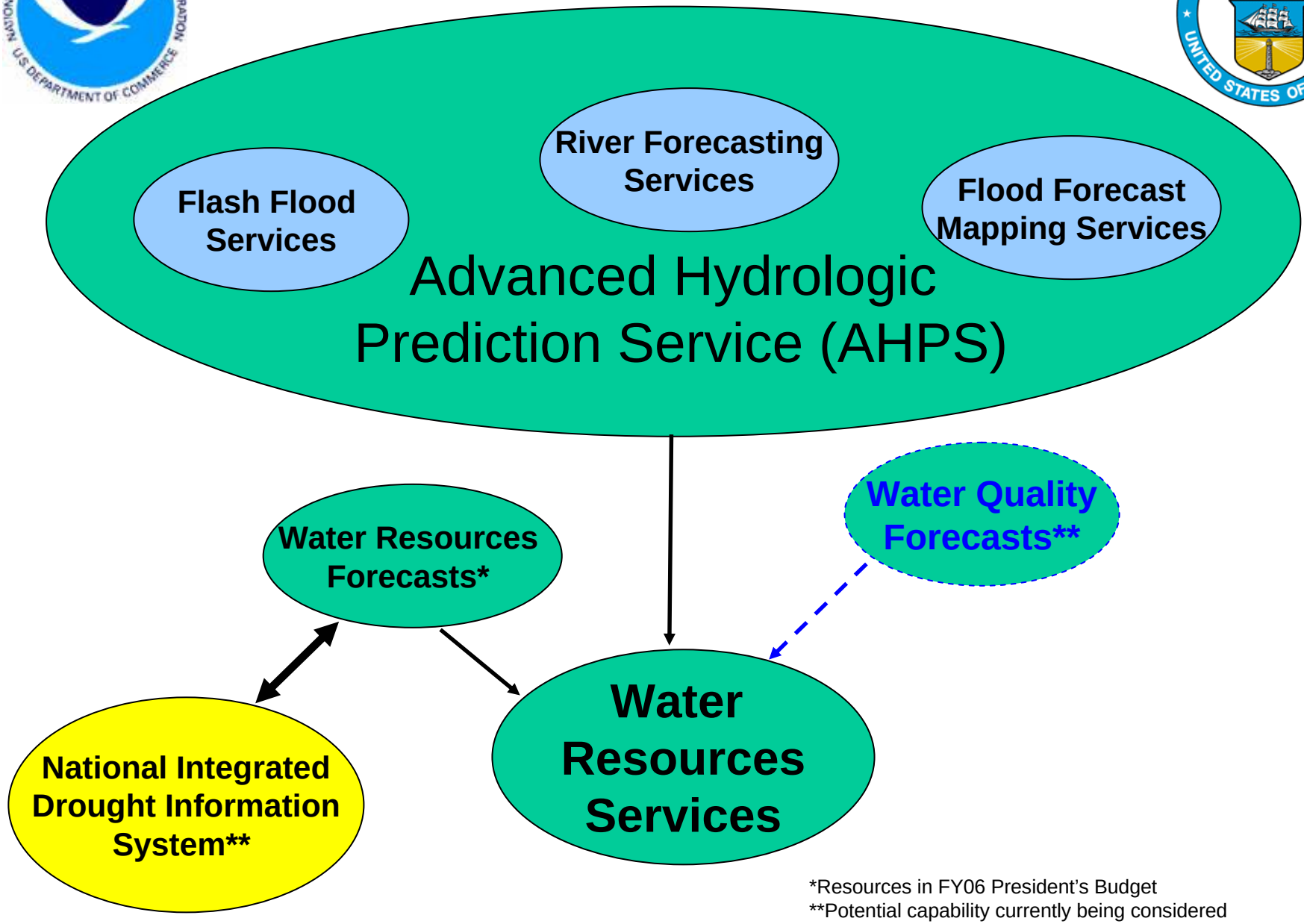
- Reduced Losses due to Floods

  Contribute more accurate flood forecasts and warnings via the Advanced Hydrologic Prediction Service (LFW, CEO, STI)

Hydrology Program Assessment

Current Program Priorities

- Extend Hydrologic Forecasting Service to Include:
  - Community Hydrologic Prediction System (CHPS)
  - Data Assimilation
- Meet Customer Needs, e.g., National Integrated Drought Information System (NIDIS)
- Provide Infrastructure for Water Quality Forecasts

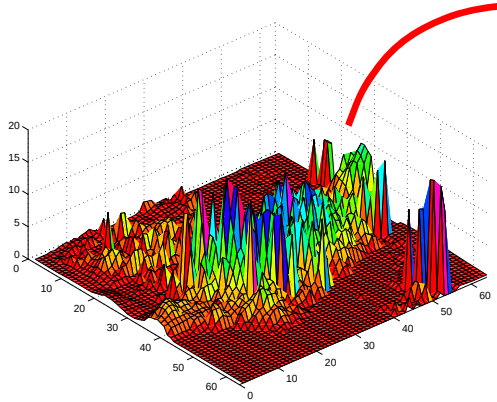


*Resources in FY06 President's Budget
**Potential capability currently being considered

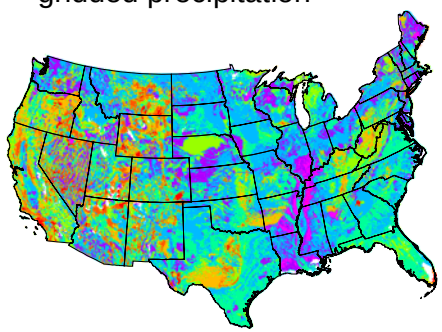
High Resolution Soil Moisture Forecasts – near term activities

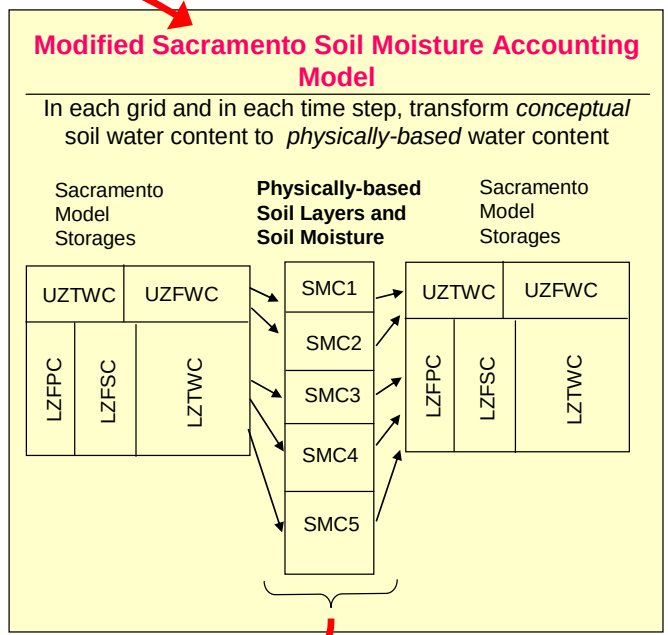
- Test prototype version of soil moisture products from CONUS runs of HL-RMS and compare with other models
- Conduct economic impact analyses and case studies to identify the potential benefits of soil moisture forecasts

CONUS Physically-based Soil Moisture Fields at 4km Grid Scale



gridded precipitation

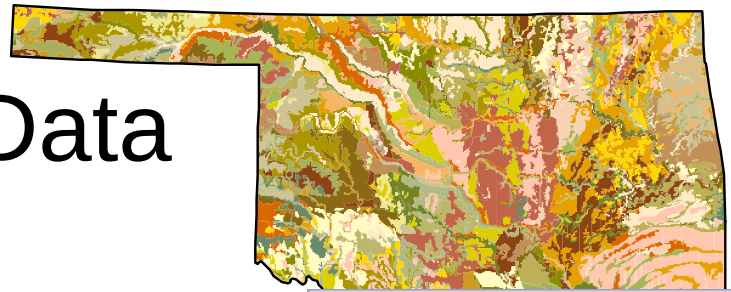




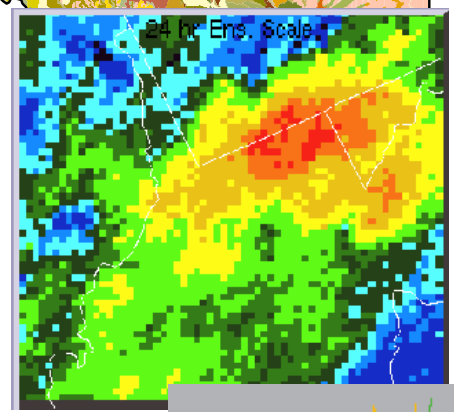
CONUS-scale 4km gridded soil moisture and temperature prototype products

Science Challenges for Hydrologic Prediction

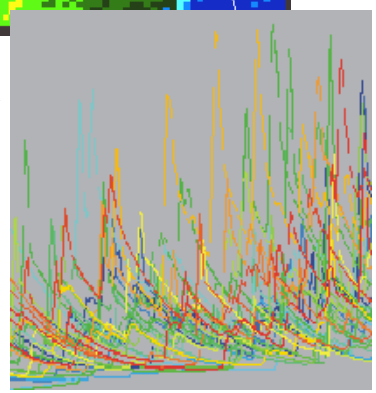
- Data

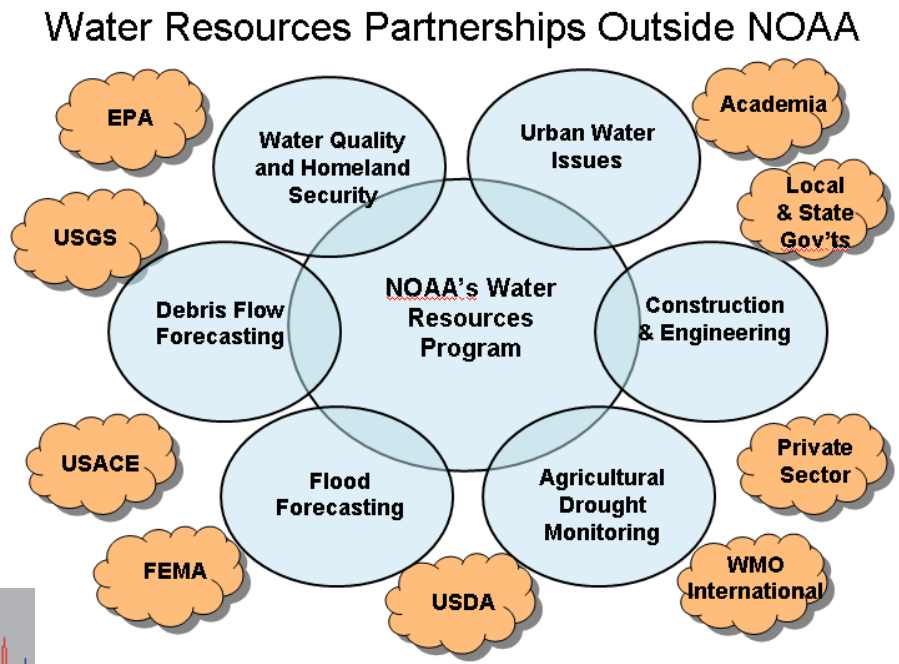


- Scale



- Uncertainty

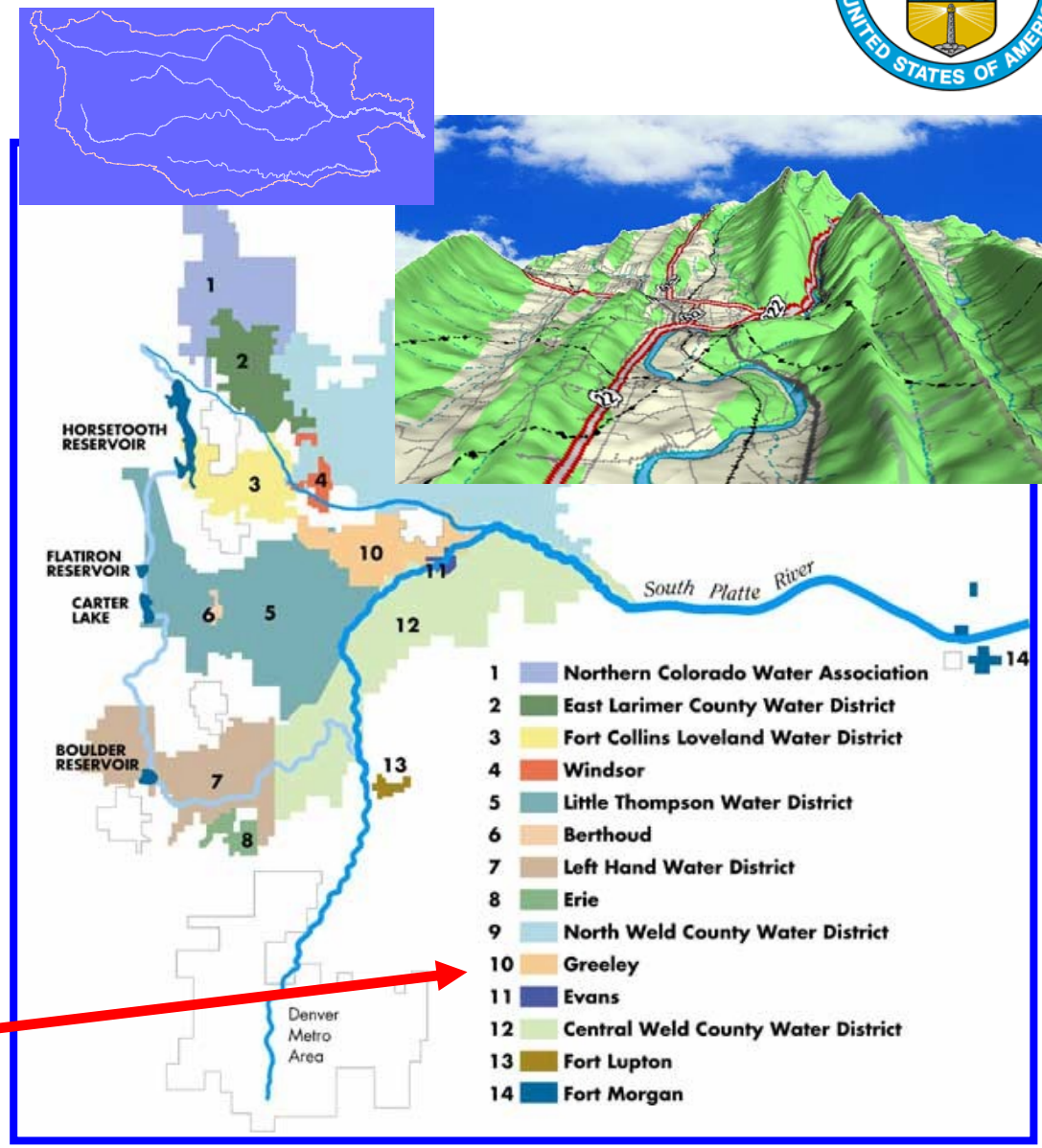




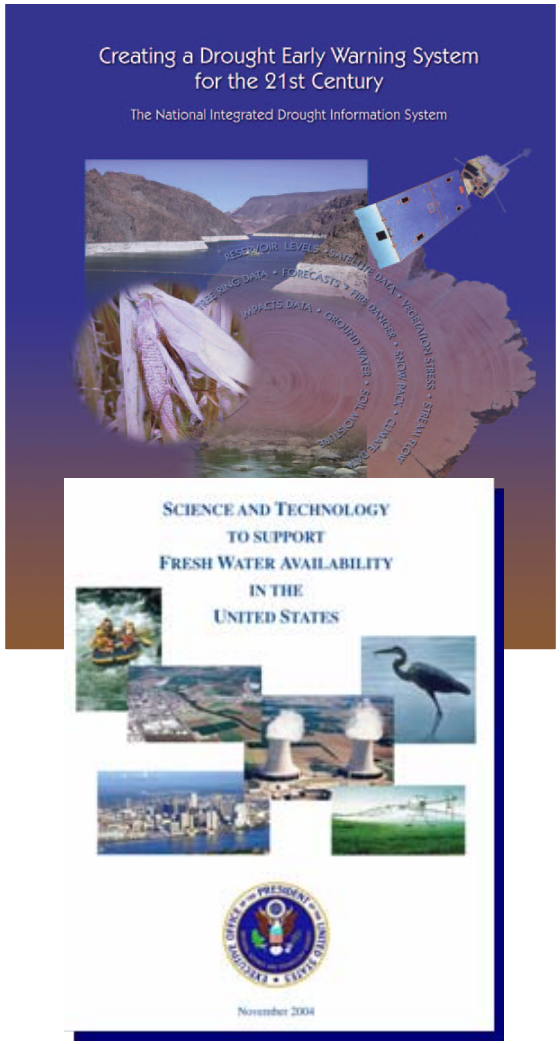
Hydrologic Modeling

Physical, Institutional, & Legal Features

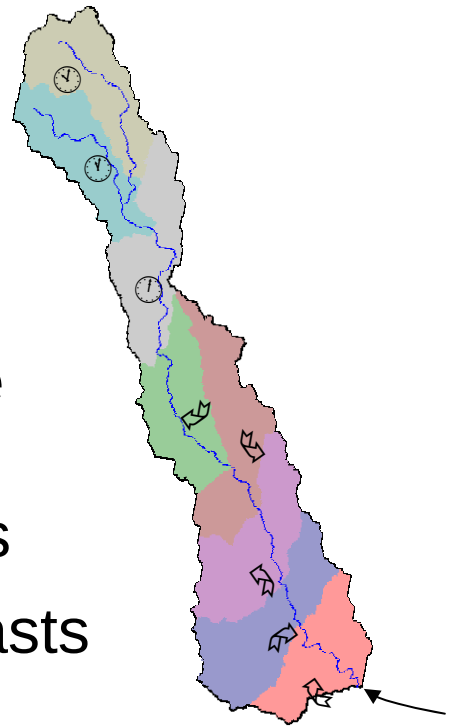
- Meteorological inputs
- Topography
- Vegetation, land use
- Lakes, glaciers
- Dams, locks, levees
- Reservoir operations
- Soil properties
- Irrigation, drains
- River channel shape
- River depth/flow relationships
- Water rights
- Ground water



Potential Focus Areas for Collaboration via Distributed Modeling

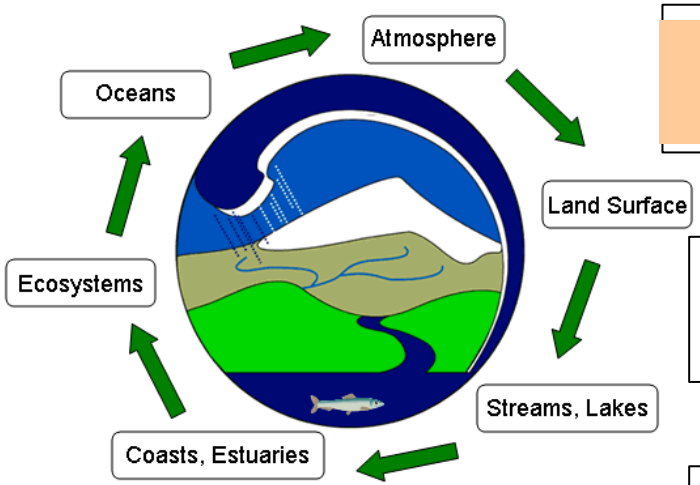


- Model parameterization techniques
- Multi-objective automatic calibration
- Spatial and temporal scale sensitivity studies
- Model complexity tradeoffs
- Basin-wide, gridded forecasts for flash flood applications
- Predictive information and decision tools for drought risk management



Transforming Weather/Climate Predictions into Useful Information

Linked Forecast Models of the Water Cycle



Global Circulation Model

Weather/Climate Ensemble Pre-processor

Parametric Ensemble Processor

Hydrology and Water Resources Models

Hydrologic Ensemble Post-Processor

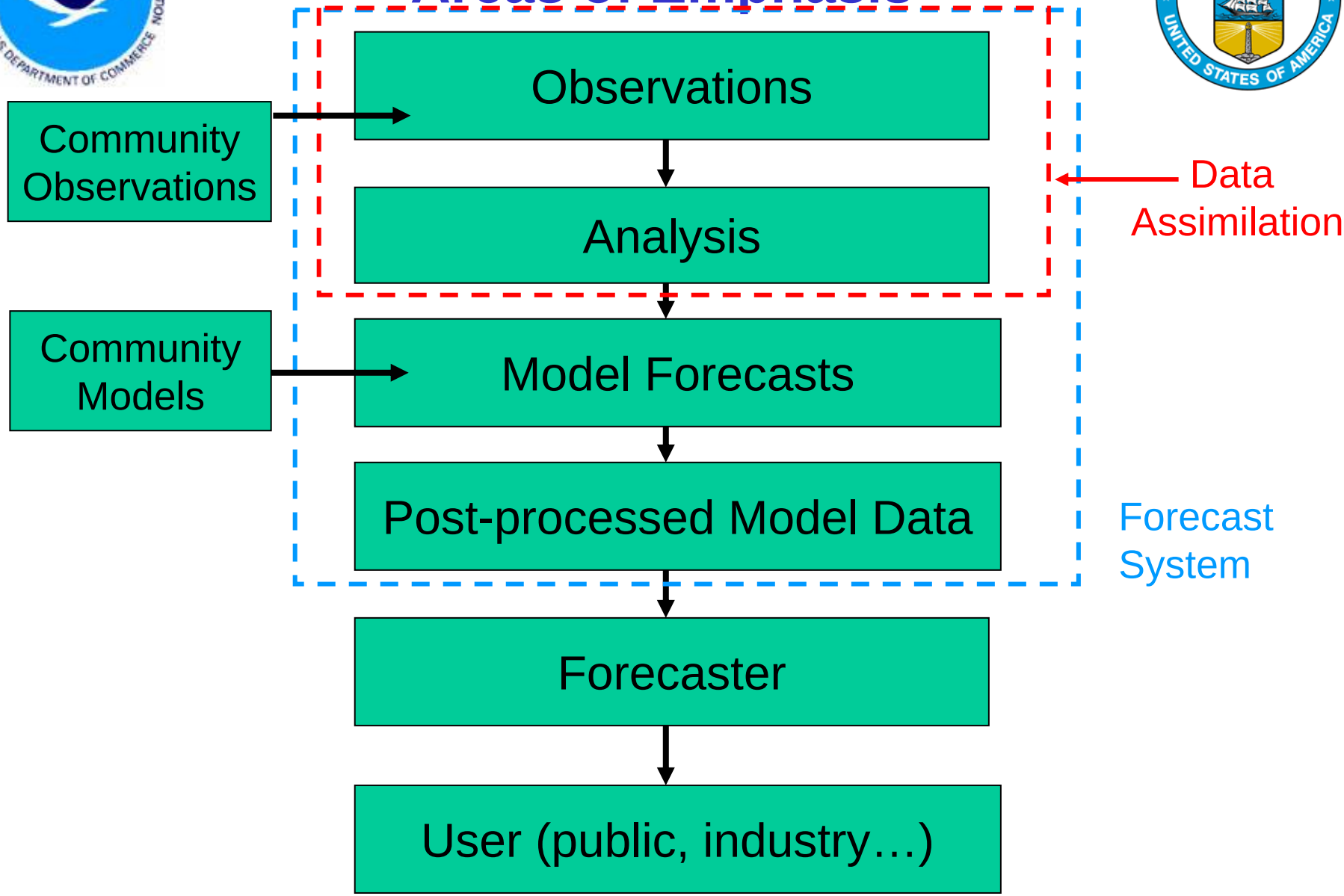
Hydrology and Water Resources Ensemble Product Generator

Water and Soil Conditions

Forecast Periods of Hours to Seasons

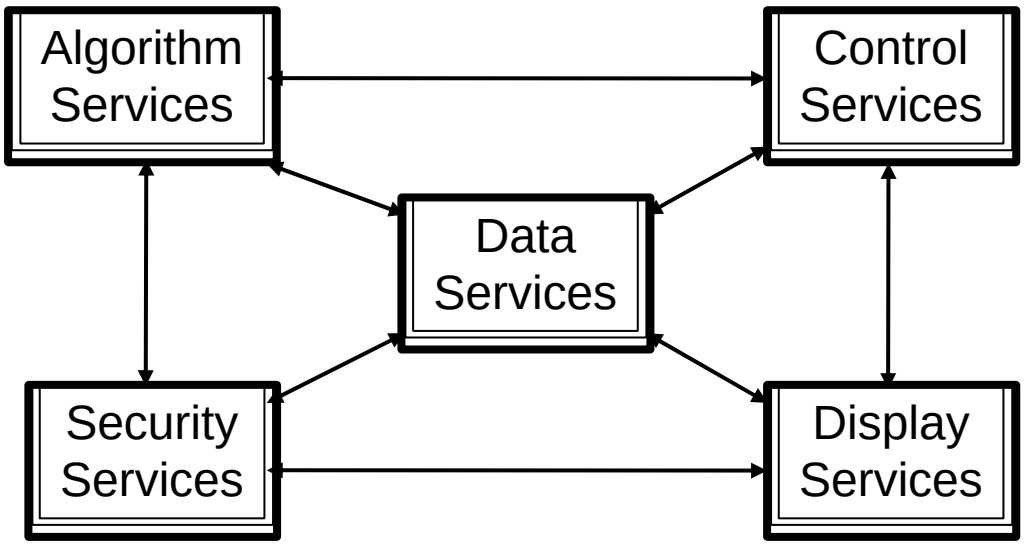
Digital Database

Collaborative Research Areas of Emphasis



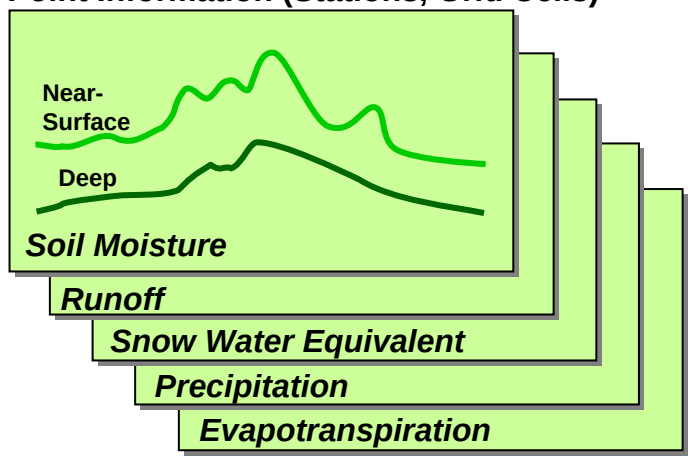
Community Hydrologic Prediction System (CHPS)

Federal agencies
State, regional, and local cooperators
Universities
Private sector
International organizations

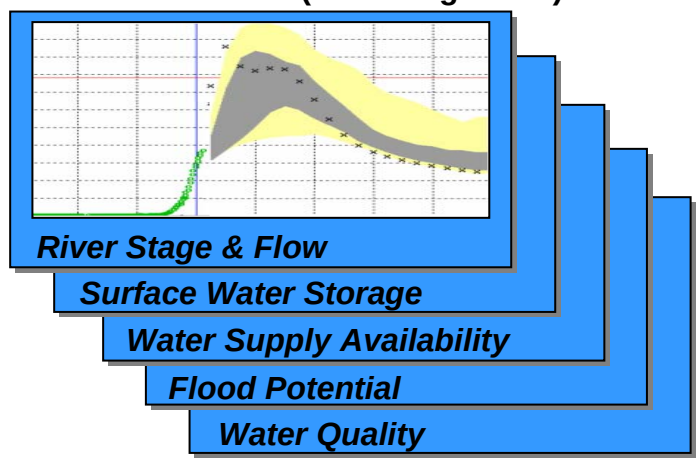


Hydrology XML Consortium
http://www.weather.gov/oh/hydroxc/index.html

Point Information (Stations, Grid Cells)



Vector Information (River Segments)



Community Hydrologic Prediction System (CHPS) – next steps

NWSRFS Data Service – deliver via AWIPS Operational Build 7 a new capability to run the River, Reservoir, and Snow (RRS) preprocessor by accessing data (flat files or relational database) through a CHPS Data Service

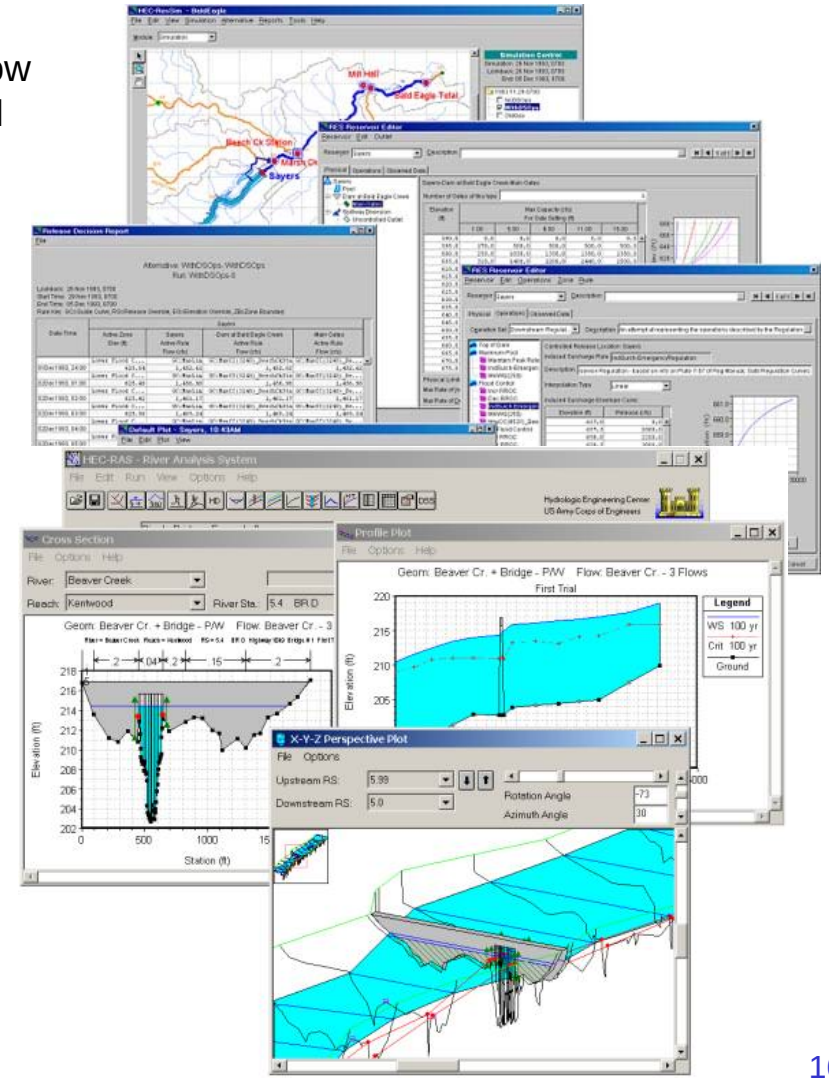
Hydrology XML Consortium - develop common dictionary, revise schema with partner data sets, document RFC XML projects

Future NWSRFS Enhancements –

Reservoir model: provide RFCs with a CHPS service to run the USACE Hydrologic Engineering Center's Reservoir System Simulation program (HEC-ResSim) as an integral part of NWS operations

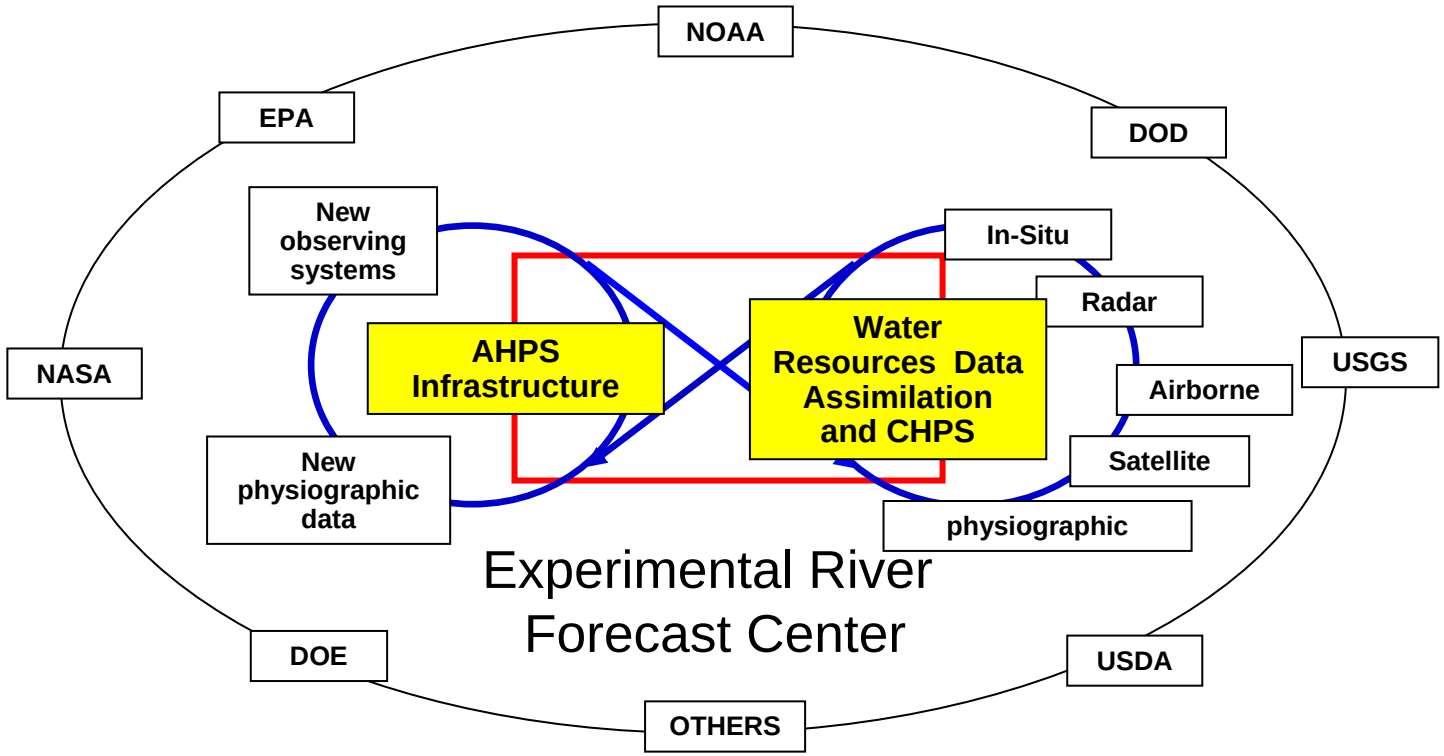
Additional Hydraulic Models: identify the potential applications and feasibility for operational use of the USACE River Analysis System (HEC-RAS)

Rapid Prototype Opportunity: examine WL/Delft Flood Early Warning System (FEWS) infrastructure to expedite migration to CHPS



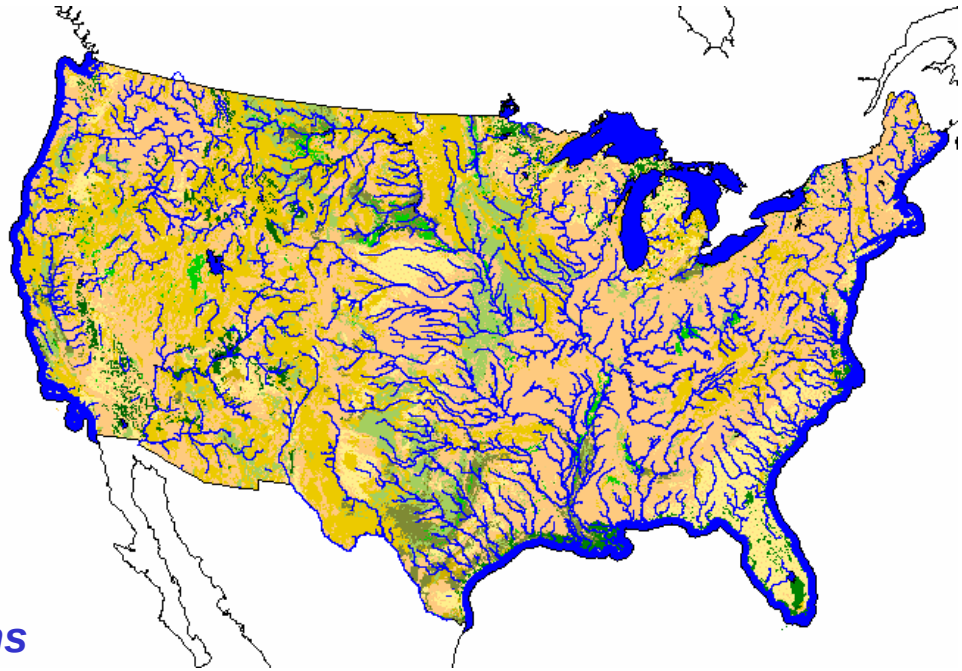
Hydrologic Testbed

- **Enable Full Utilization of Existing Observing Systems**
  - Development of data processing and assimilation capabilities
- **Science-to-Operations**
  - Test new stream flow prediction models and forecasting techniques for time scales of hours to months



Water Resources Across NOAA

- **Satellite and Environmental Data**
  - ***Water surface conditions***
  - ***Land cover/land use***
- **Oceans**
  - ***Biological monitoring***
  - ***Estuarine models***
- **Research**
  - ***Earth system models***
  - ***Environmental observing systems***
- **Fisheries**
  - ***Socio-economic assessments***
  - ***Protecting living marine resources***
- **Weather**
  - ***Weather, water, and climate monitoring and prediction***



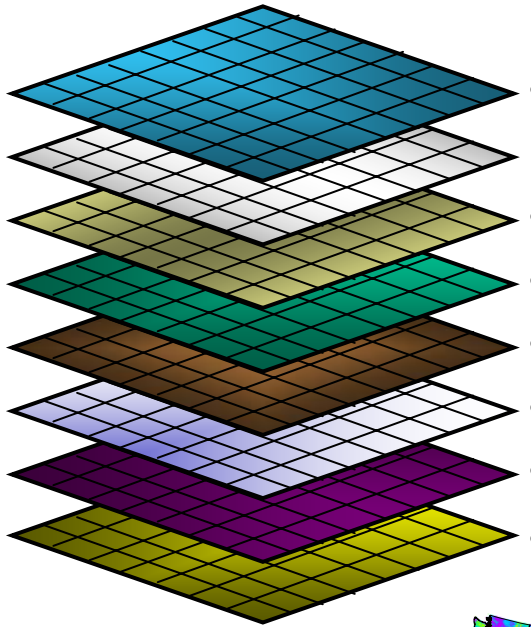
Forecasting Infrastructure and Service Centers:

Rivers & Streams; Reservoirs & Lakes

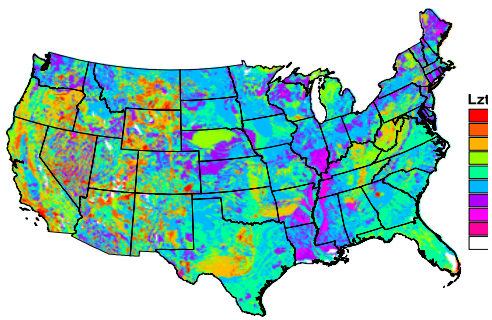
The Great Lakes

Wetlands; Estuaries; Coasts

NOAA's Integrated
High-Resolution Gridded Water Resources Product Suite



- River Flow
- Snowpack
- Precipitation
- Evaporation
- Groundwater
- Soil Moisture
- Surface Storage
- Water Temperature



Applications

Drought

Flood Management

Flash Flood Prediction

Water Supply

Transportation

Emergency Management

Agriculture

Debris Flows

Ecosystems Management

Research

Partners

NOAA

Federal Agencies

Tribal Agencies

State Agencies

Local Agencies

Private Sector

Academia