Integrated Modeling & Data Access — CUAHSI HIS HydroModeler

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CUAHSI HIS
Sharing hydrologic data

http://his.cuahsi.org

NSF
Support EAR 0622374

CSDMS Meeting

Boulder, CO - October 28-30, 2011

Consortium of Universities for the Advancement of Hydrologic Science, Inc.

universities allied for water research

CUAHSI supports the water science community by (among other things):

- developing, supporting, and operating research infrastructure;
- improving and promoting access to data, information and models

125 University Members

www.cuahsi.org

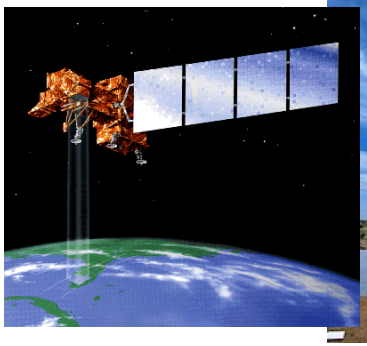
Support from NSF

Problem Statement

We need new ways of handling the growing quantity of diverse data resources

Sensor Networks

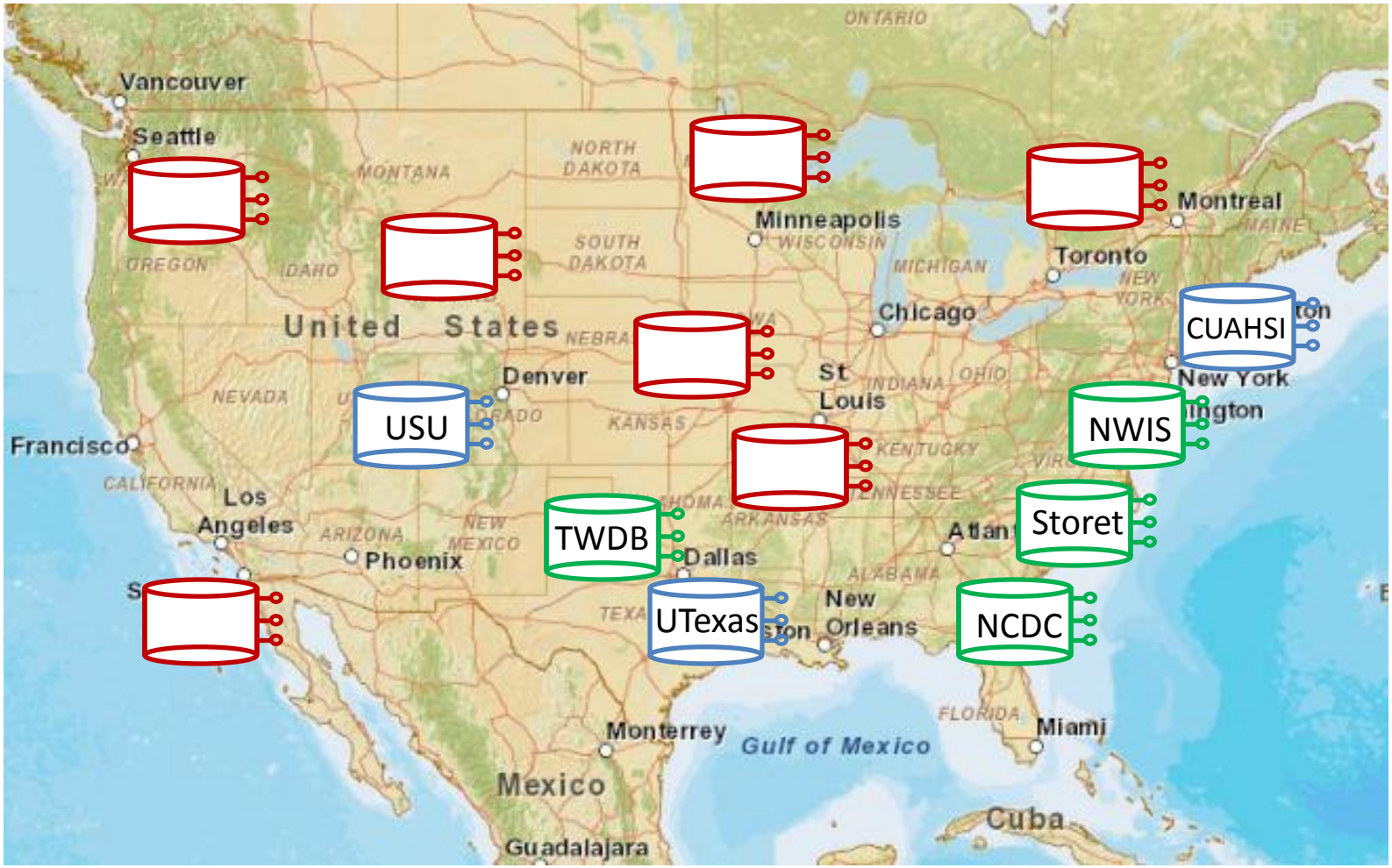
Remote sensing



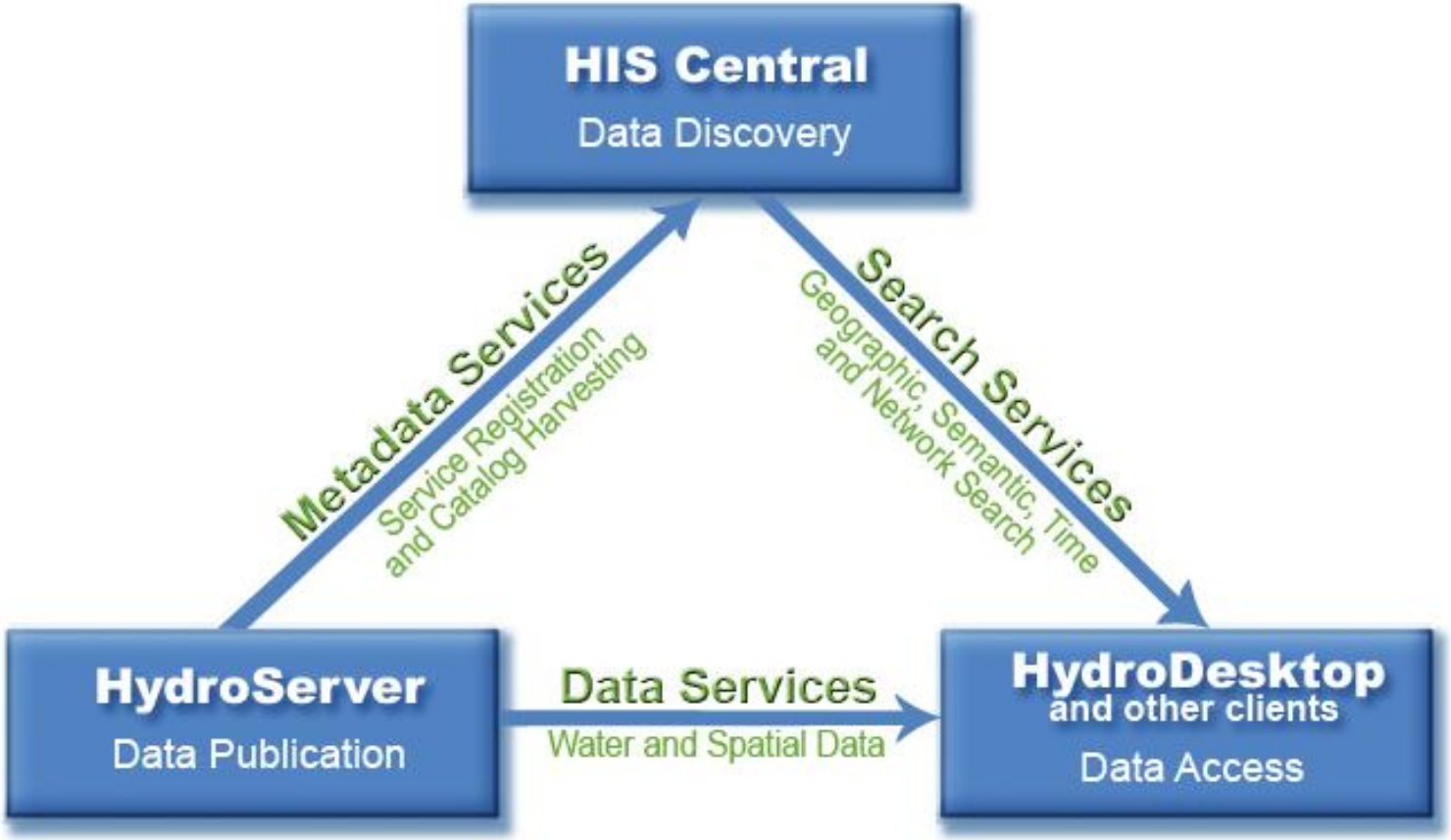
Model Output

CUAHSI HIS Goal

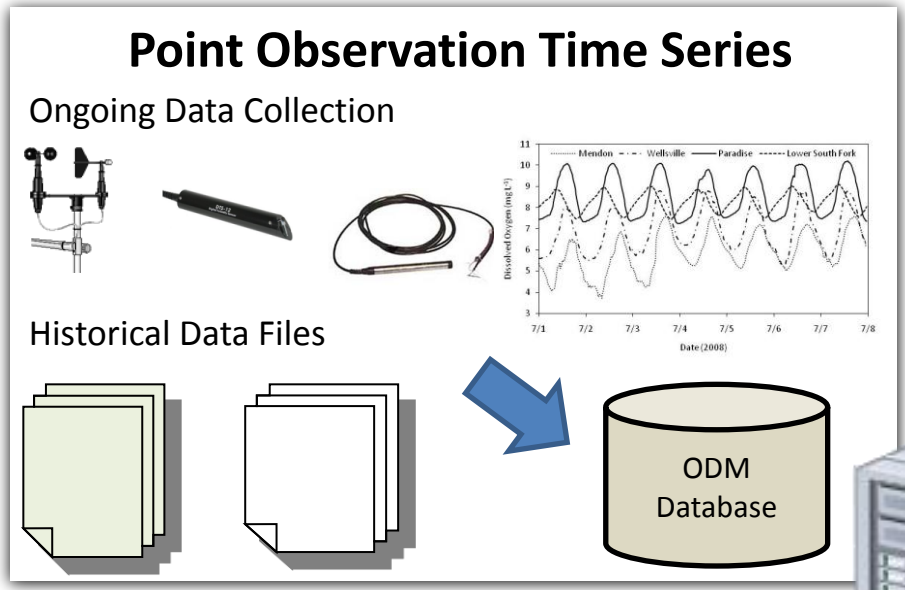
To enhance hydrologic science by facilitating user access to more and better data for testing hypotheses and analyzing processes

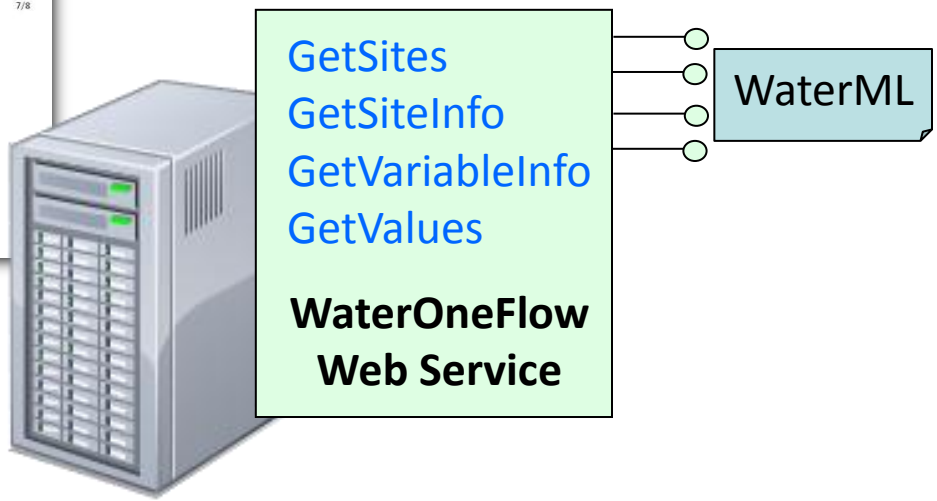


HIS Overview



HydroServer



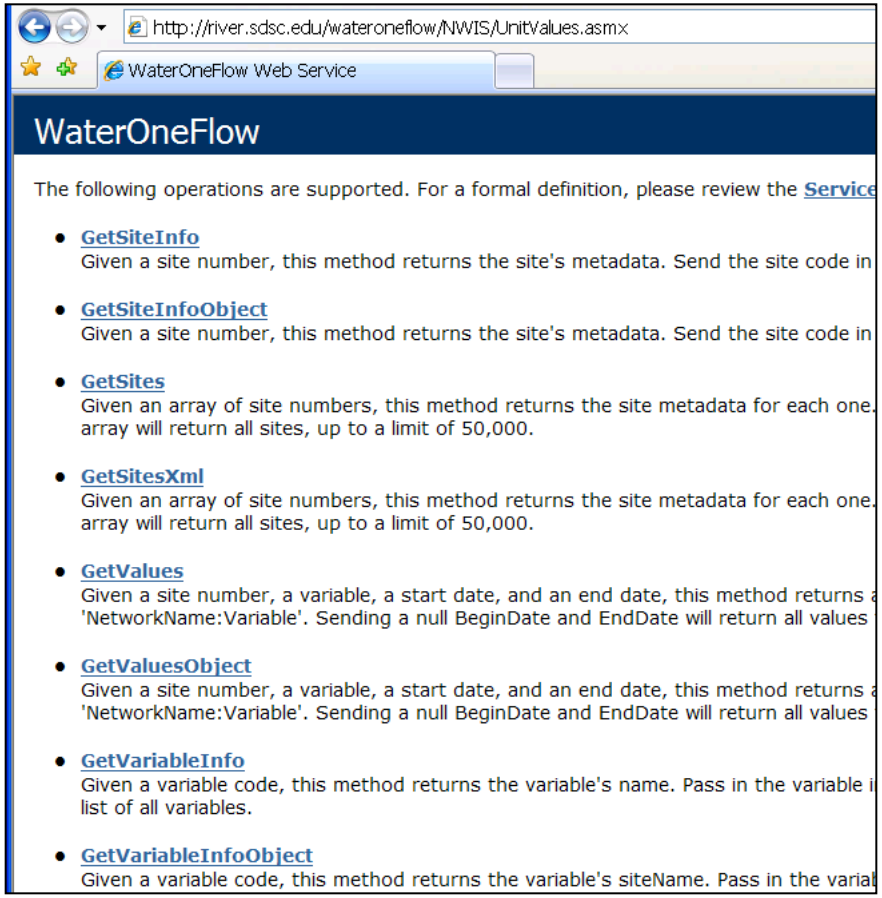


Horsburgh, J. S., D. G. Tarboton, D. R. Maidment and I. Zaslavsky, (2008), A Relational Model for Environmental and Water Resources Data, *Water Resour. Res.,* 44: W05406, doi:10.1029/2007WR006392

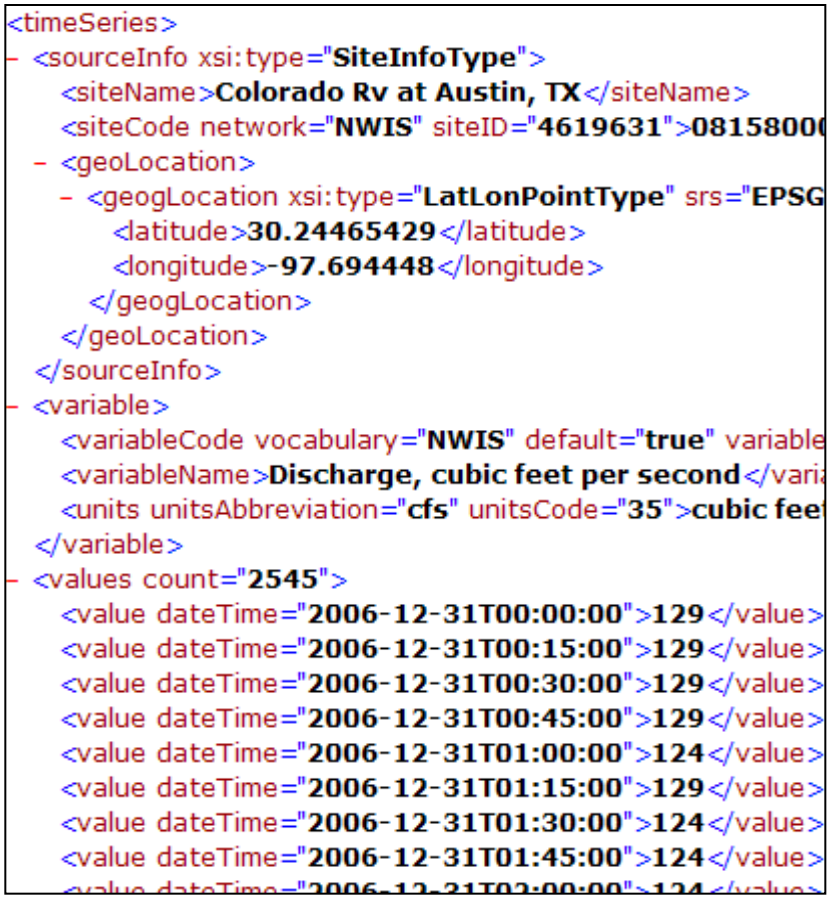
WaterML and WaterOneFlow

WaterOneFlow is a set of web services that return data in a WaterML format

- Set of query functions (API)



- Returns data in WaterML



GetVariables

```
<variablesResponse xmlns="http://www.cuahsi.org/waterML/1.0/">
- <variables>
  - <variable>
      <variableCode vocabulary="NWIS" default="true"
        variableID="12578">00060</variableCode>
      <variableName>Discharge, cubic feet per second</variableName>
      <units unitsAbbreviation="cfs" unitsCode="35">cubic feet per second</units>
    </variable>
  </variables>
</variablesResponse>
```

GetValues

```
<values count="15">
  <value qualifiers="A" dateTime="2006-01-01T00:00:00">237</value>
  <value qualifiers="A" dateTime="2006-01-02T00:00:00">252</value>
  <value qualifiers="A" dateTime="2006-01-03T00:00:00">154</value>
```

qualifier

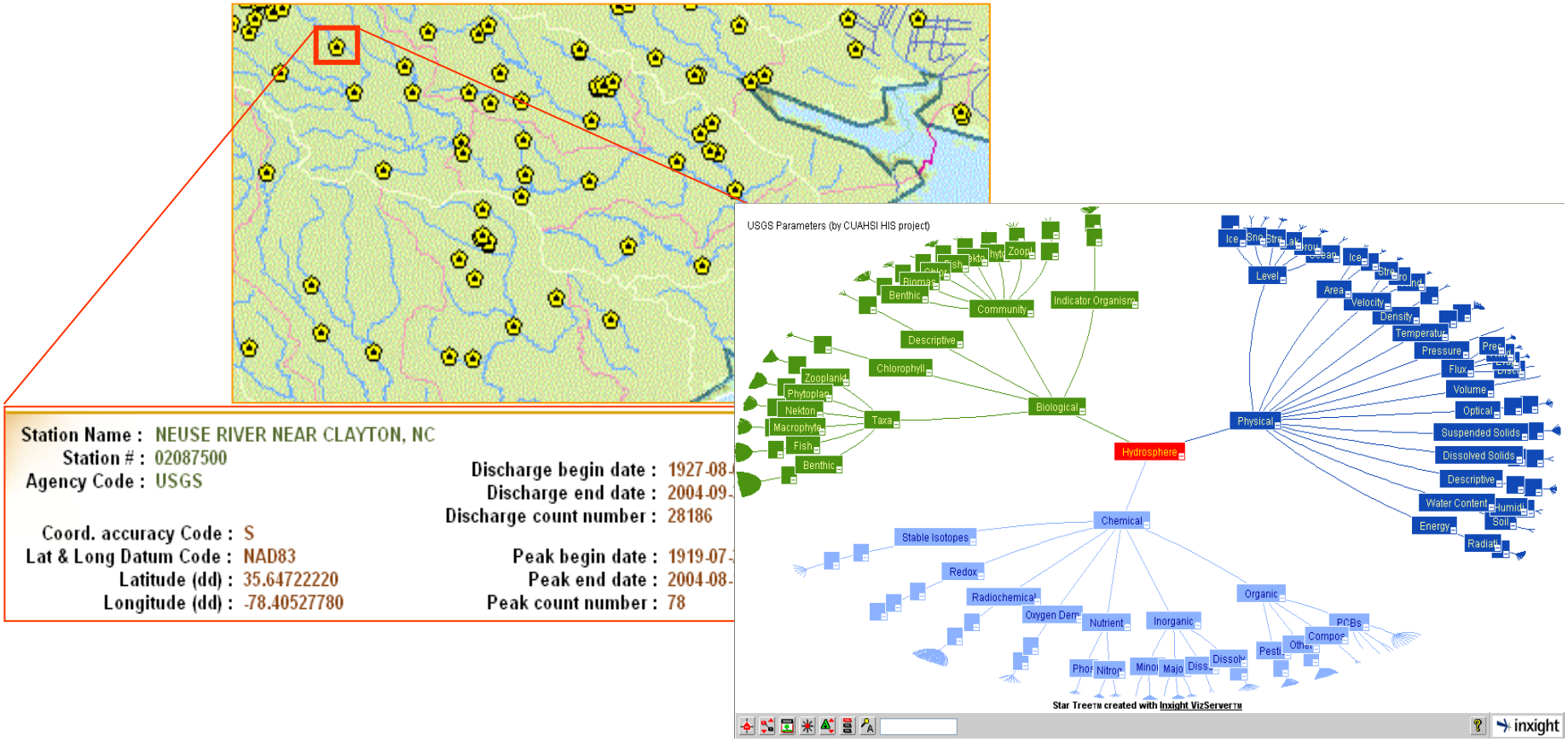
ISO Time

value

HIS Central

Centralized Observation Catalog with semantic mediation to enable search web services

Metadata catalog



66 services; 18,000 variables; 1.9 million sites; 29 million series; 5.1 billion data Values … and growing

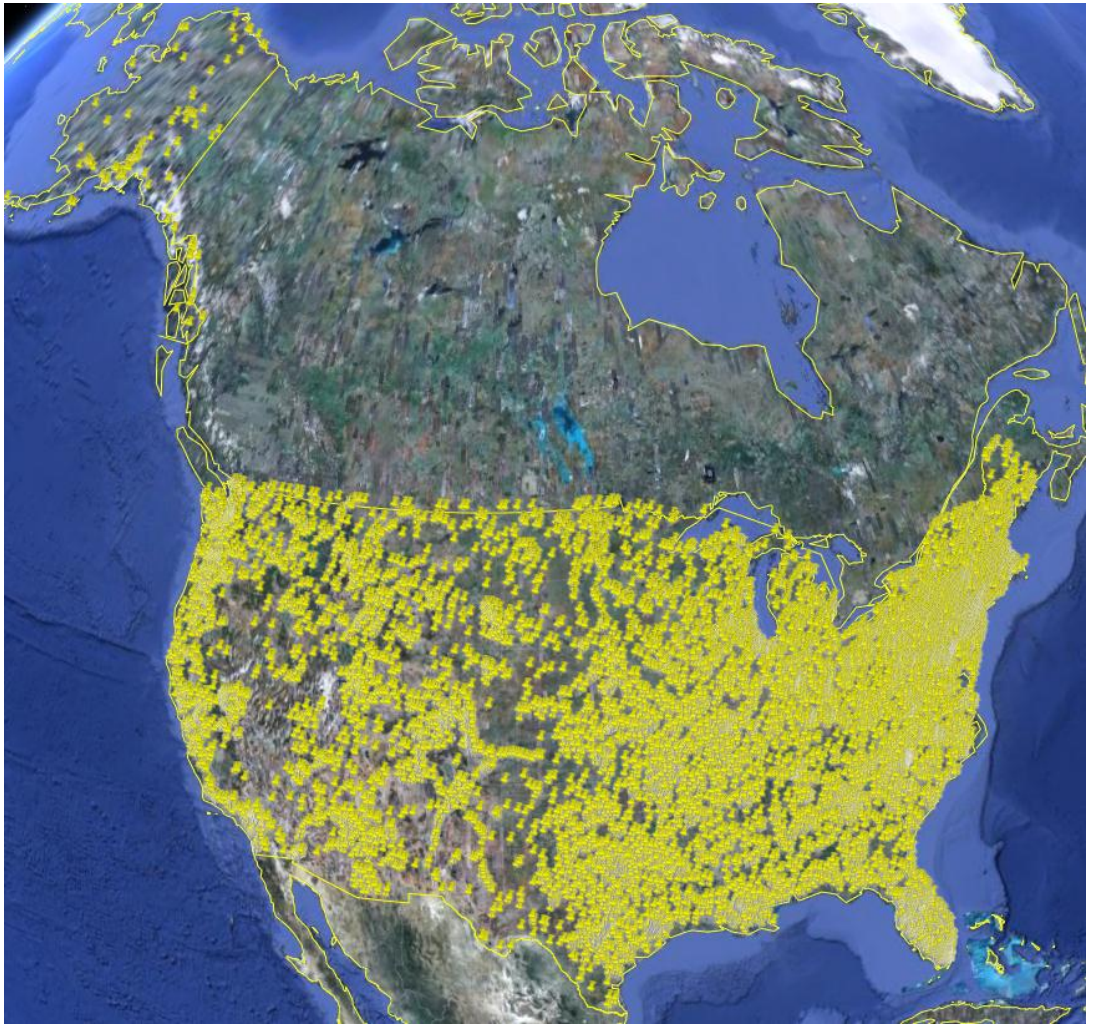
USGS Instantaneous Data

Real time, instantaneous data over the last 60 days

11188 sites, nationally for the US

80 variables

Published by USGS National Water Information System



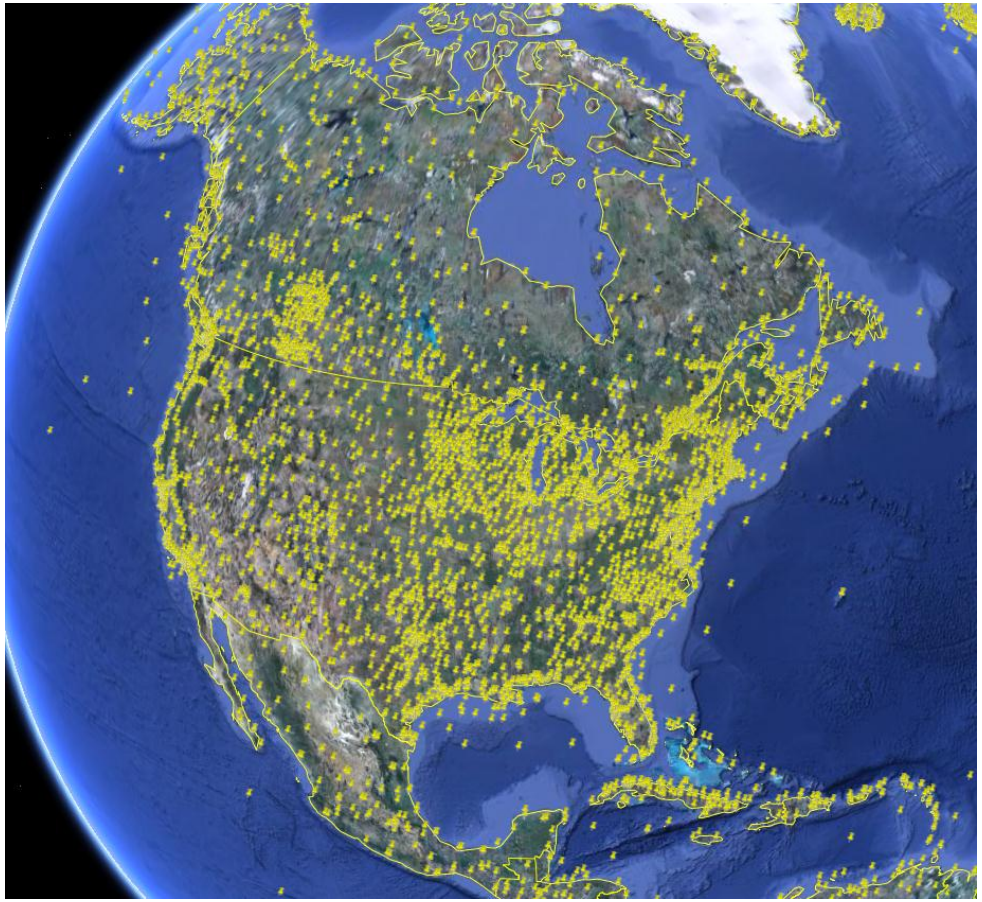
NCDC Integrated Station Hourly Data

National Climatic Data Center

Hourly weather data up to 36 hours ago

13,628 sites across globe

34 variables



Published by National Climate Data Center and populated with weather observations from national weather services

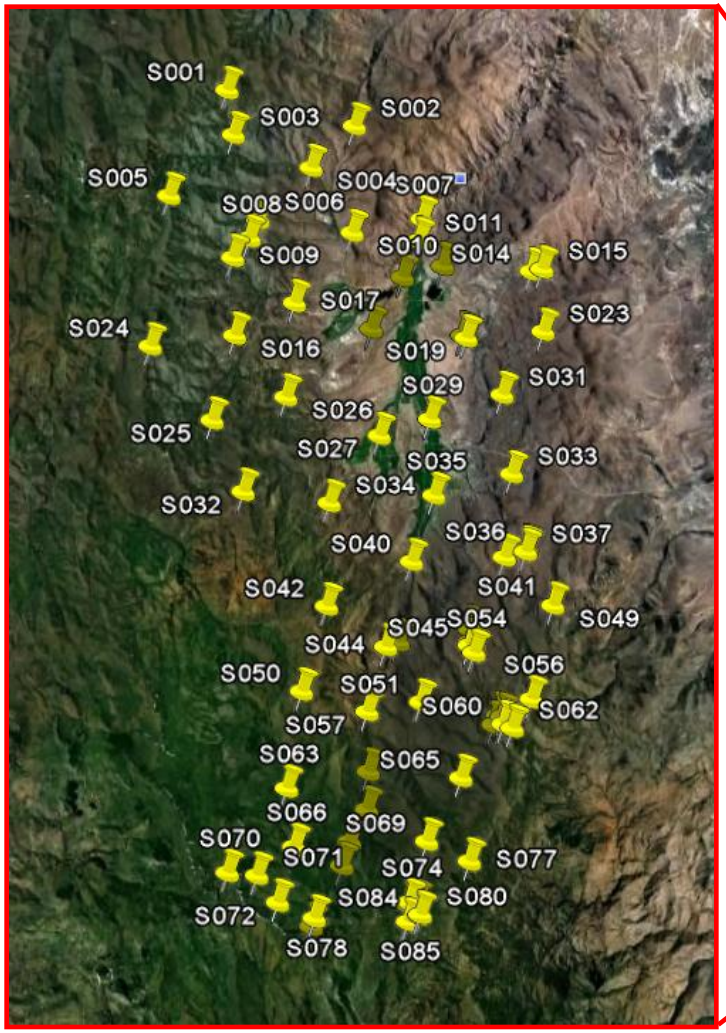
http://water.sdsc.edu/wateroneflow/NCDC/ISH_1_0.asmx?WSDL

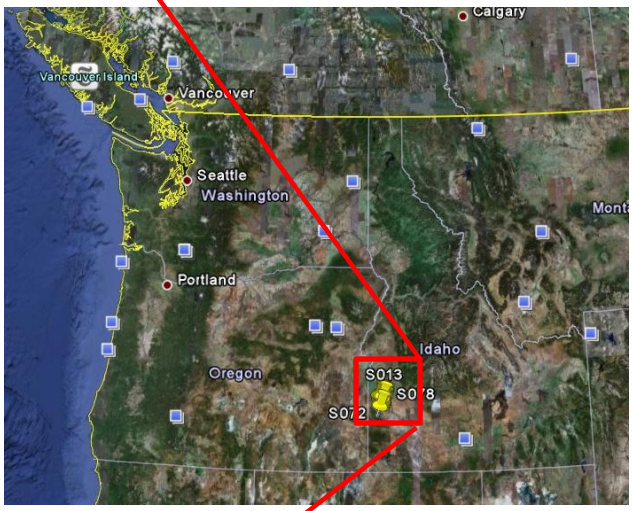
Reynolds Creek Experimental Watershed

United States Department Of Agriculture
Agricultural Research Service

1 data service
84 sites
65 variables
372 series
17.8 million data

Published by USDA-ARS as part of an Idaho Waters project

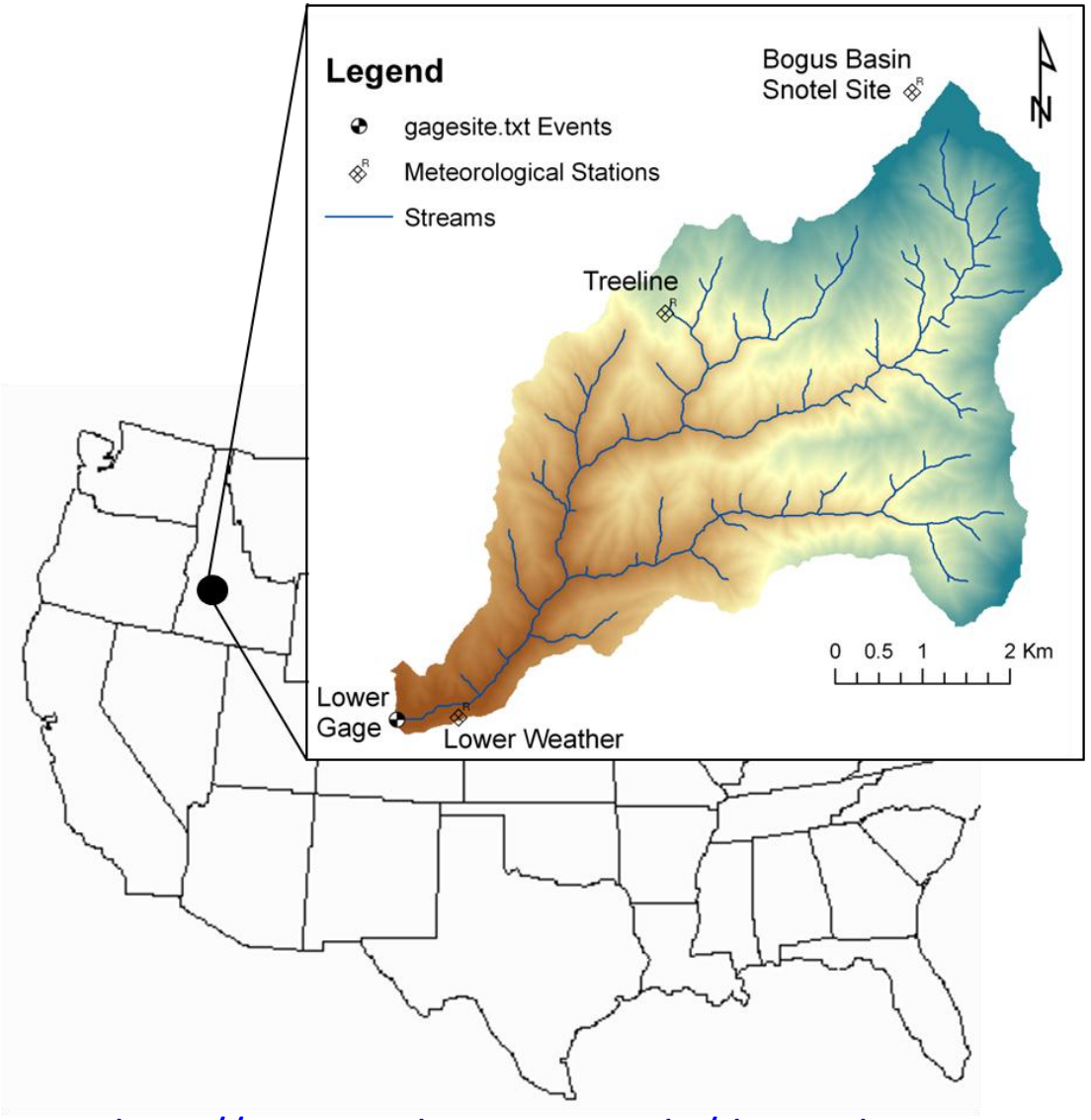


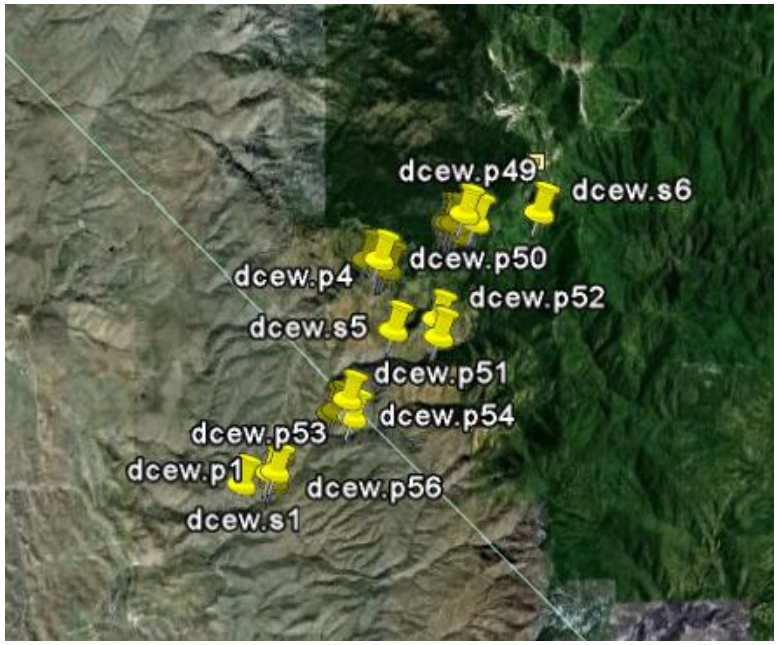


http://idahowaters.uidaho.edu/RCEW_ODWS/cuahsi_1_0.asmx?WSDL

Dry Creek Experimental Watershed (DCEW)

(28 km^2 semi-arid steep topography, Boise Front)



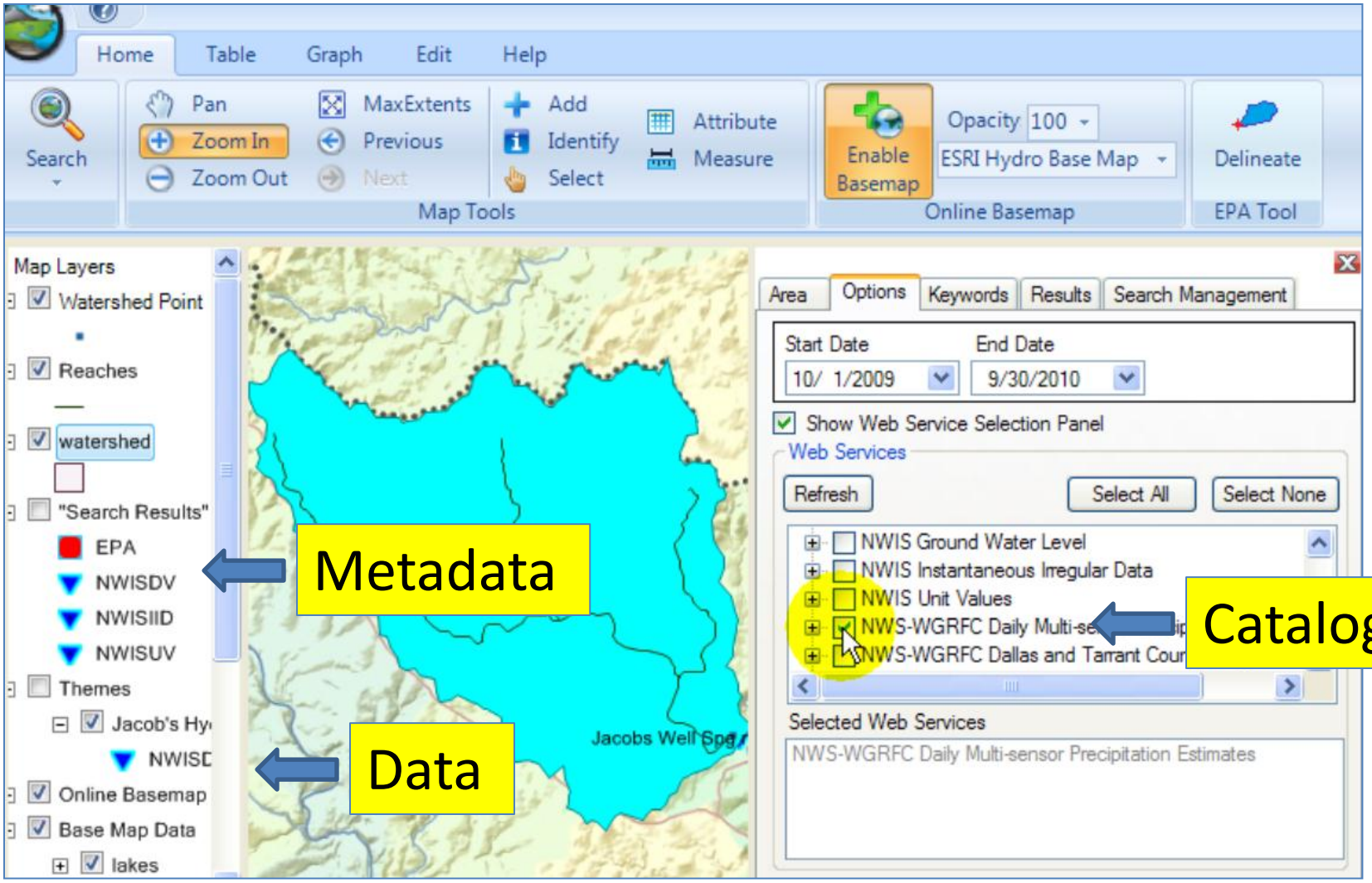


68 Sites
20 Variables
5924511 values

Published by Jim McNamara,
Boise State University

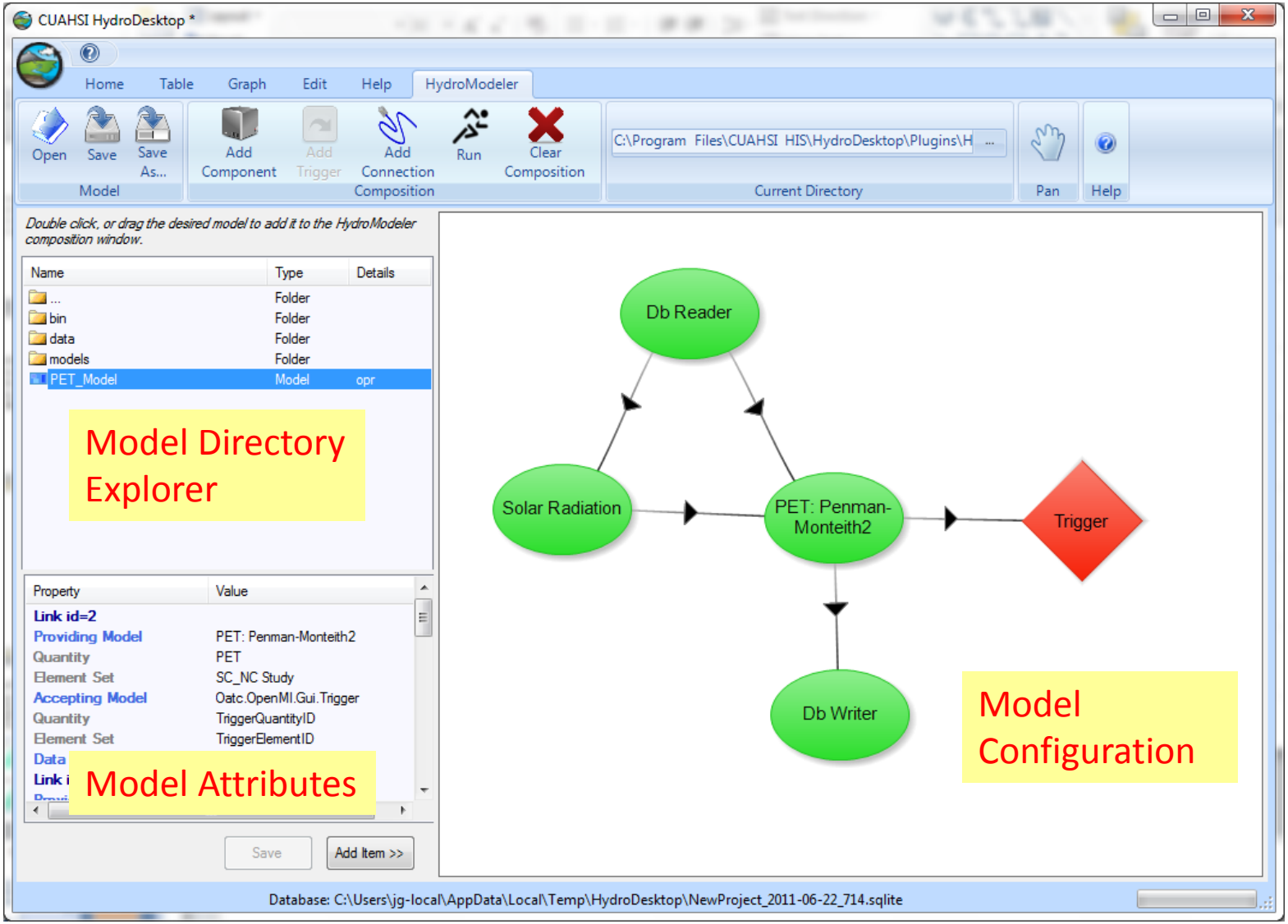
http://icewater.boisestate.edu/dcew2dataservices/cuahsi_1_0.asmx?WSDL

HydroDesktop



www.hydrodesktop.org

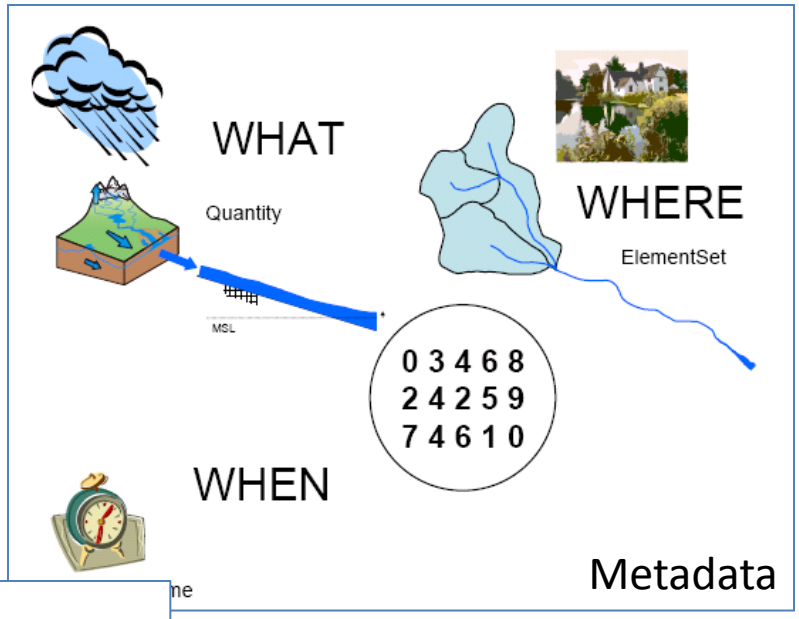
HydroModeler: A HydroDesktop Plug-in

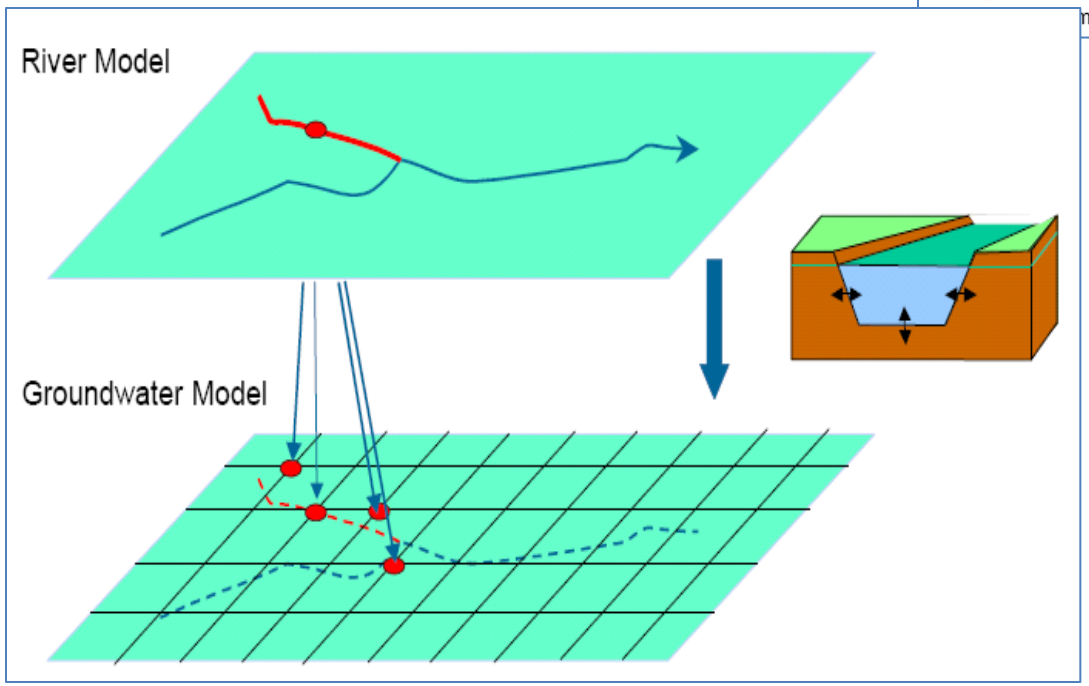


Open Modeling Interface

allows models to exchange on a time basis

- standard
- Software Development Kit (SDK)

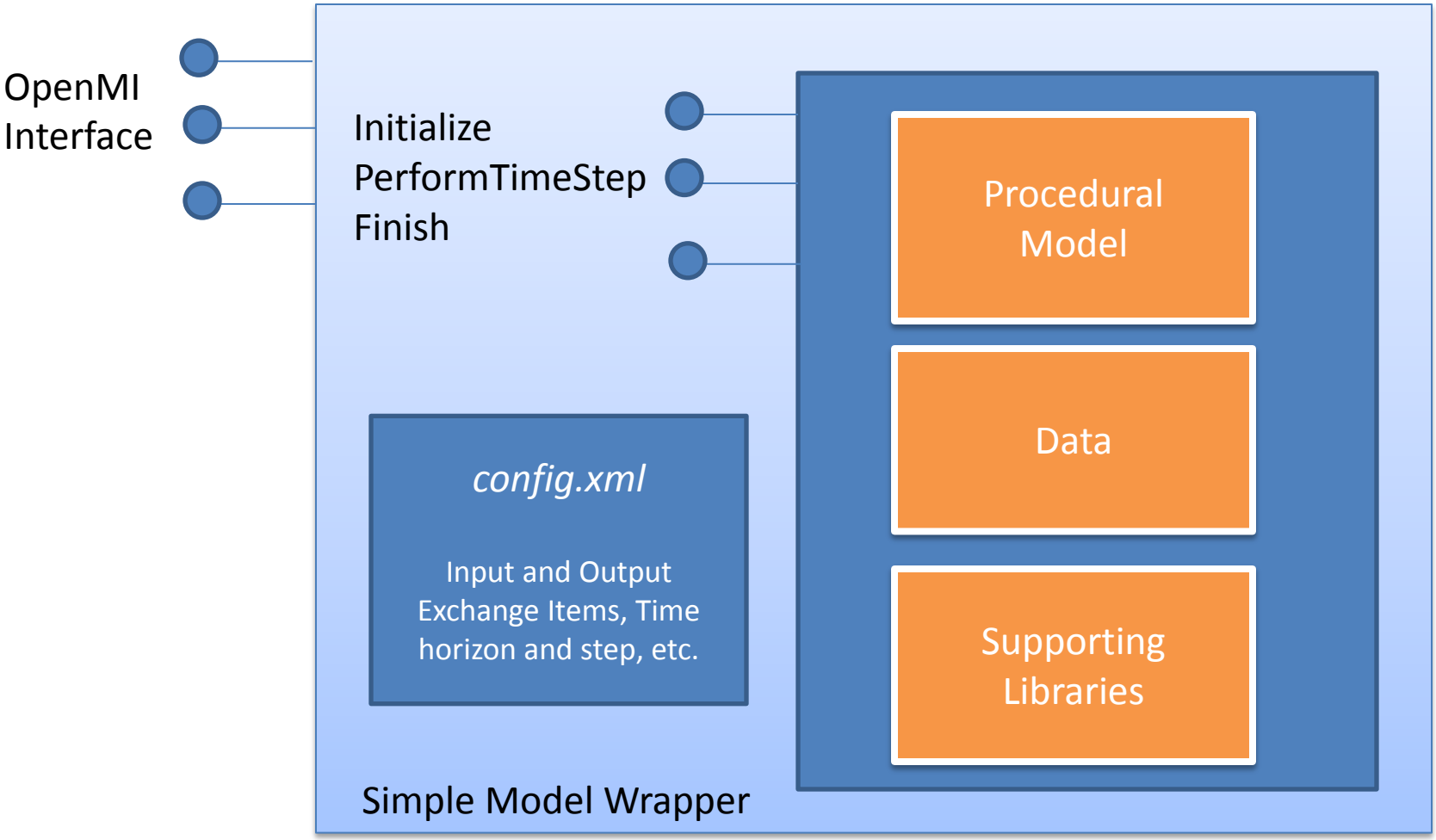




OpenMI

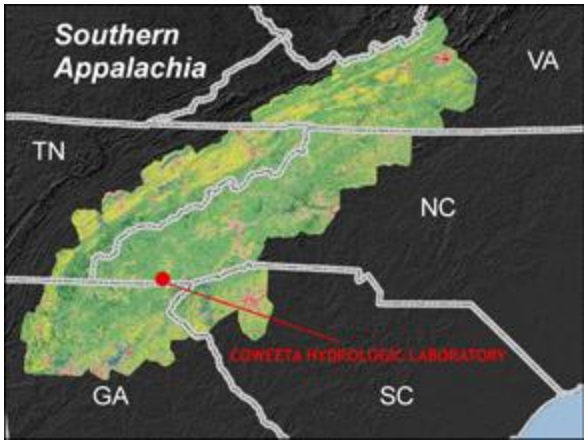
www.openmi.org

The Architecture of a Model Component



Castronova and Goodall, 2010, Environmental Modelling & Software

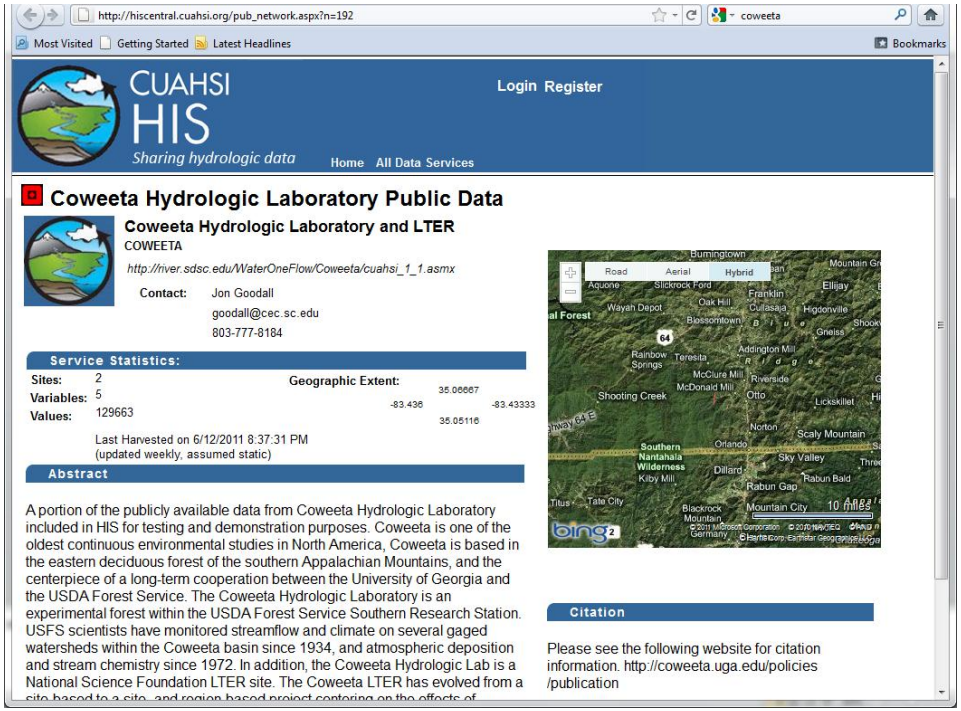
Example Application



- Modeling rainfall/runoff for Coweeta Watershed #18

- HIS Server includes publically available Coweeta data
  - Precipitation: daily accumulated
  - Air temp: daily min, max, and mean
  - Stream discharge: daily average

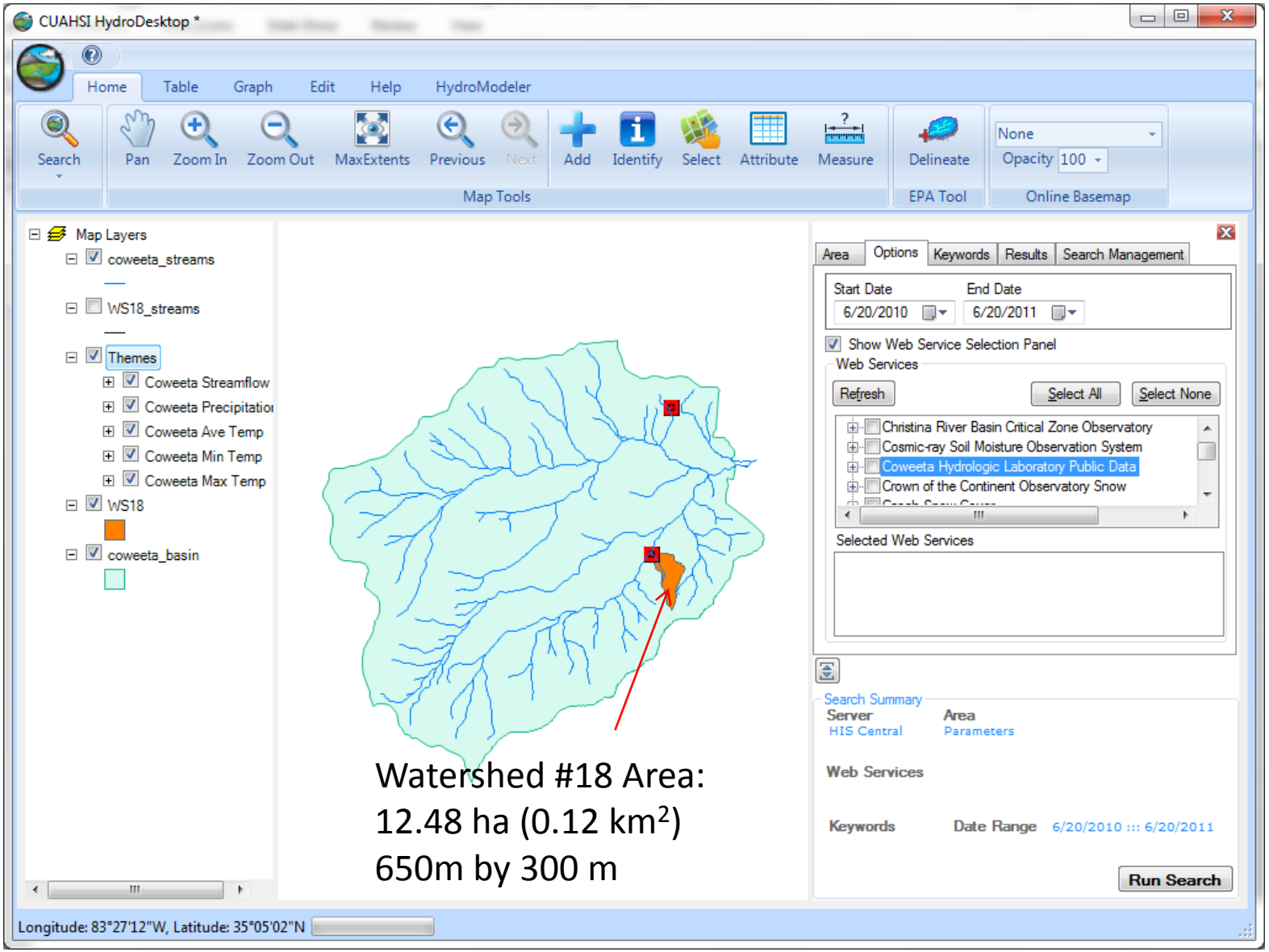
Coweeta HIS Server



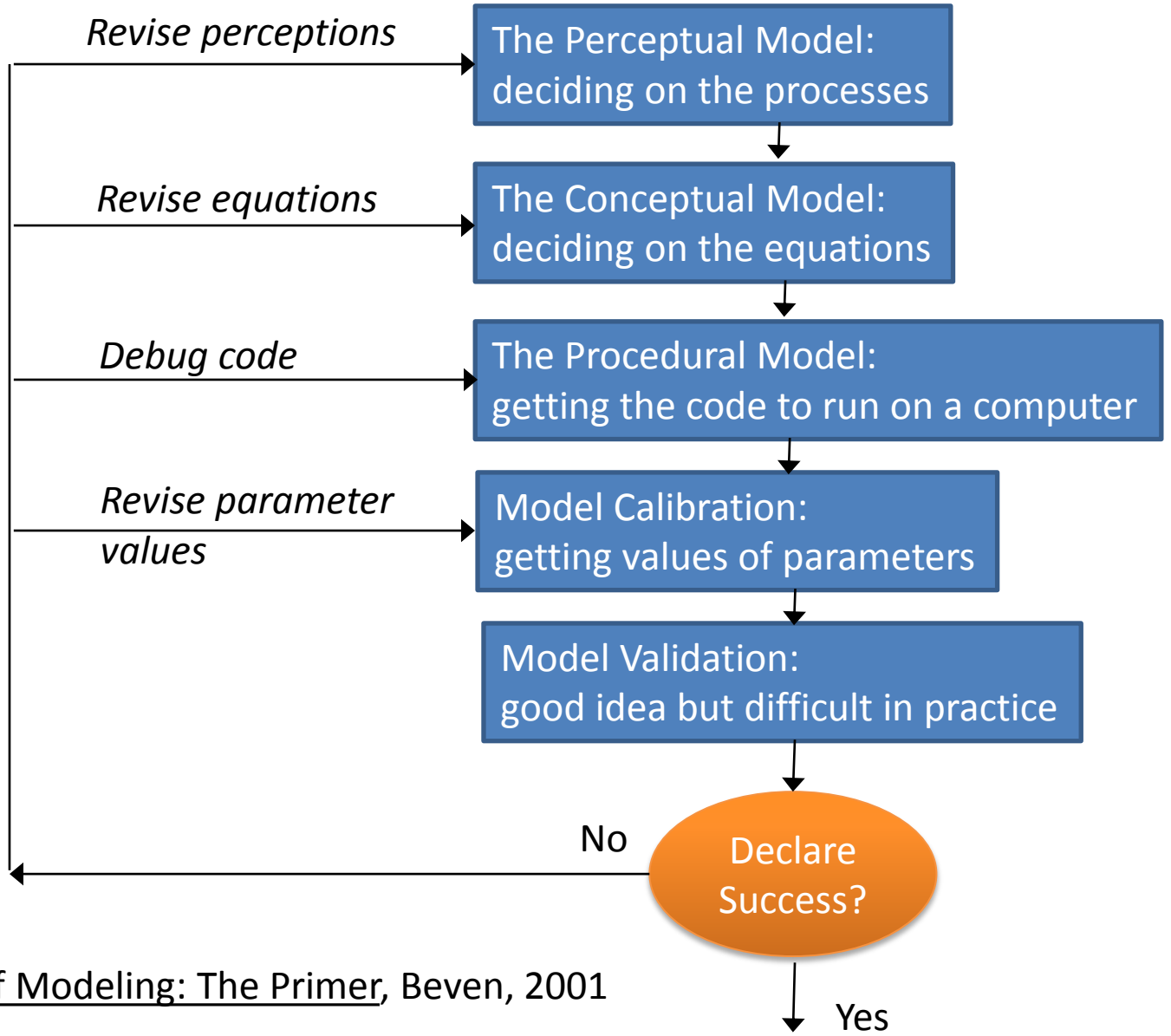
http://river.sdsc.edu/WaterOneFlow/Coweeta/cuahsi_1_1.asmx?WSDL

Mostafa Elag and
Tony Castronova, USC

Coweeta Watershed #18



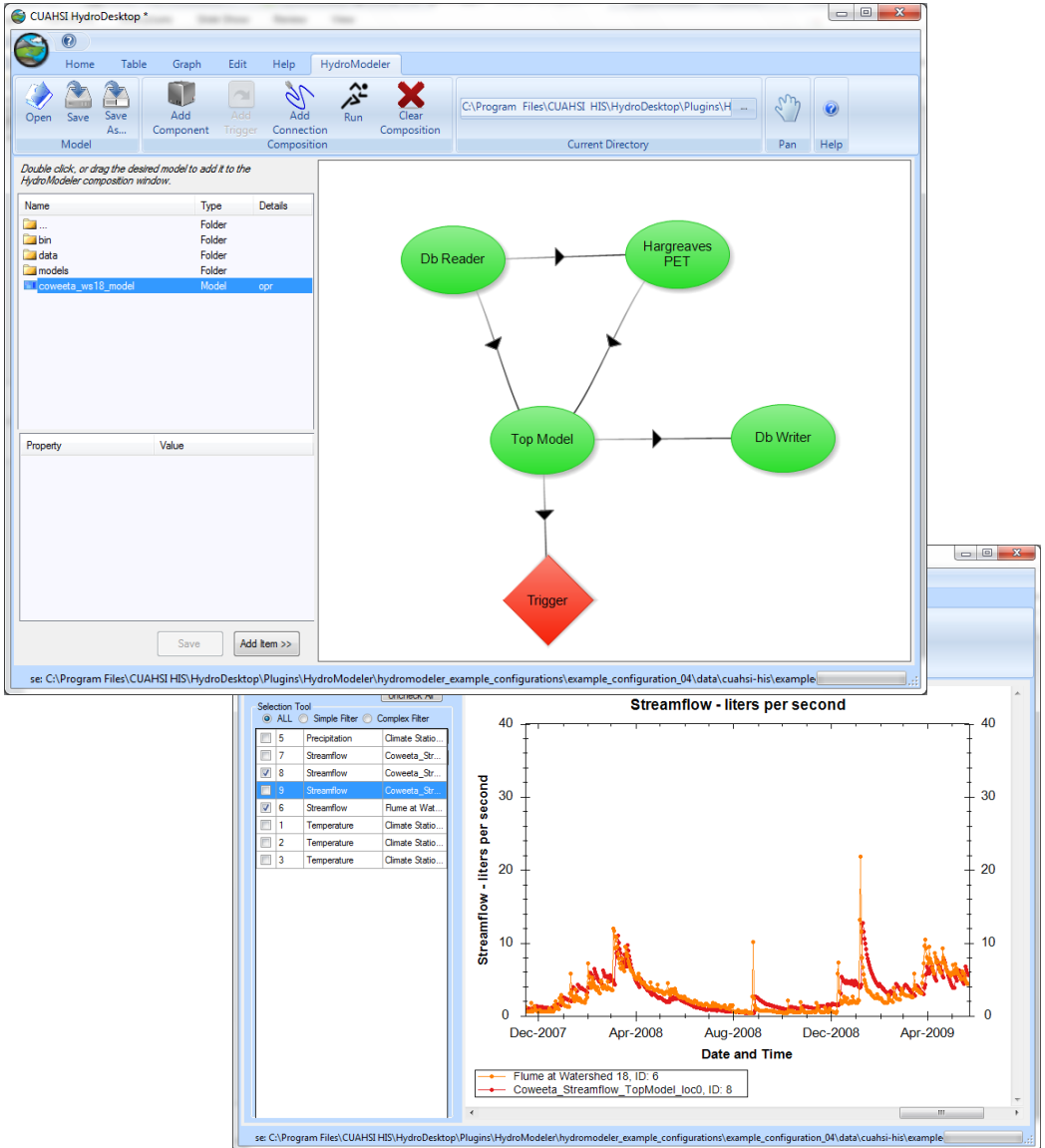
Steps in the Hydrologic Modeling Process



Rainfall-Runoff Modeling: The Primer, Beven, 2001

Model Development and Application

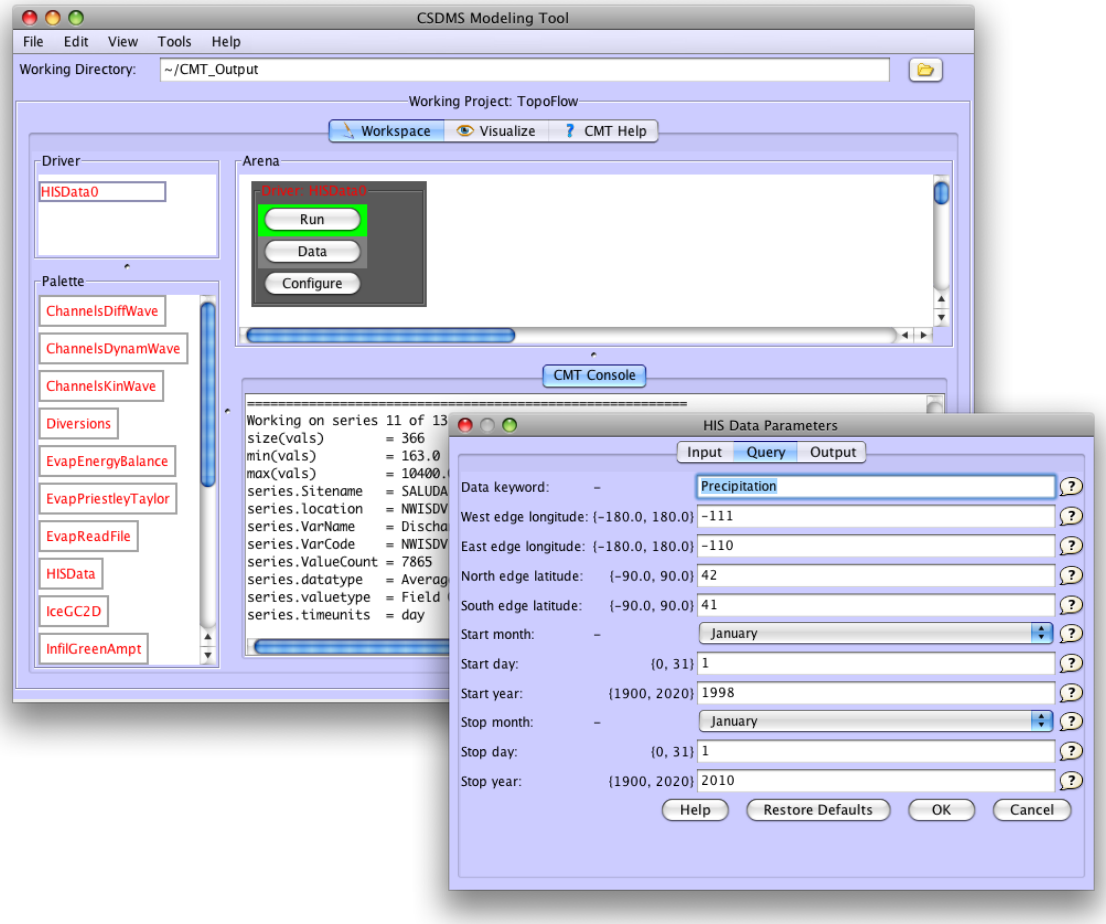
- Do I have the important processes?
- Is my mathematical representation of processes sufficient?
- Are there bugs in my numerical solution?
- Do I have an acceptable parameterization?



HIS Data can be used in other Modeling Systems

Object Modeling System v3.0

Example: Accessing HIS Data from within CMT



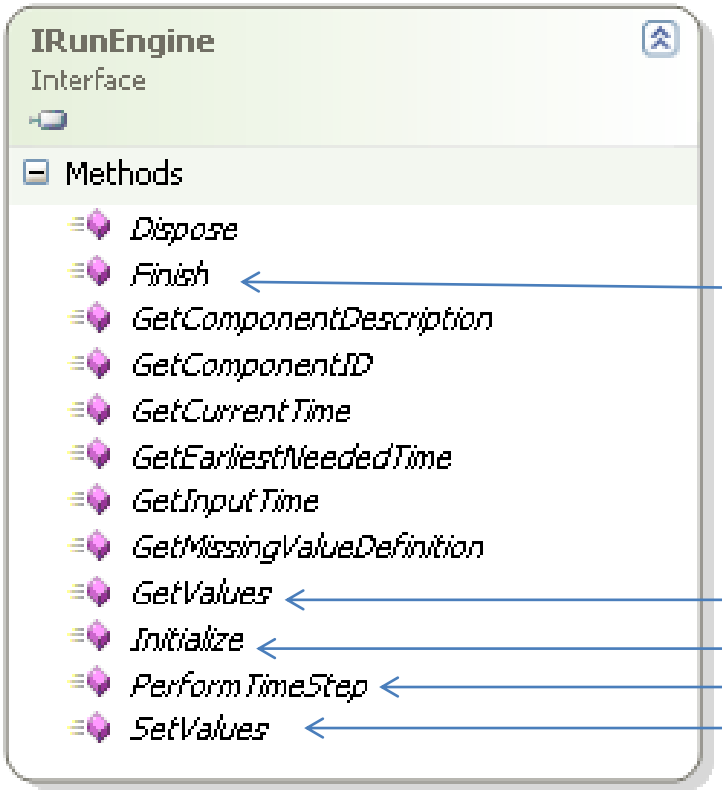
- HISData is a CMT component that can search HIS Central and download data from WaterOneFlow web services
- It allows HIS data to serve as input to CMT models

Peckham and Goodall, Computers & Geosciences, Submitted.

Path Forward

- Cross-disciplinary science: Interoperability across modeling systems

OpenMI Model Interface



CSDMS Basic Modeling Interface (BMI)

Finalize

Getter

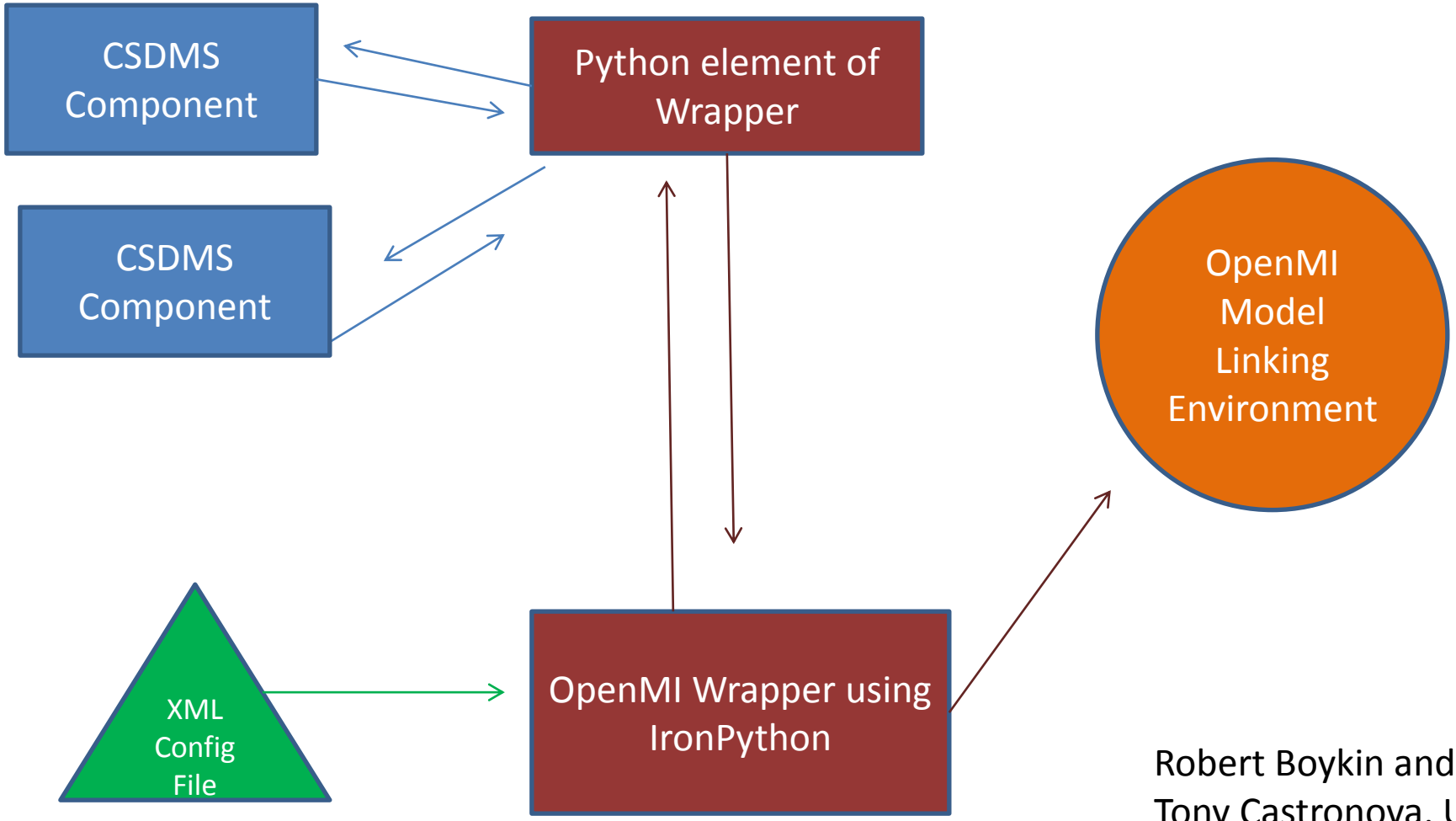
Initialize

Run

Setter

CSDMS/OpenMI Interoperability

Goal: Import CSMDS Components into an OpenMI modeling environment



Robert Boykin and
Tony Castronova, USC

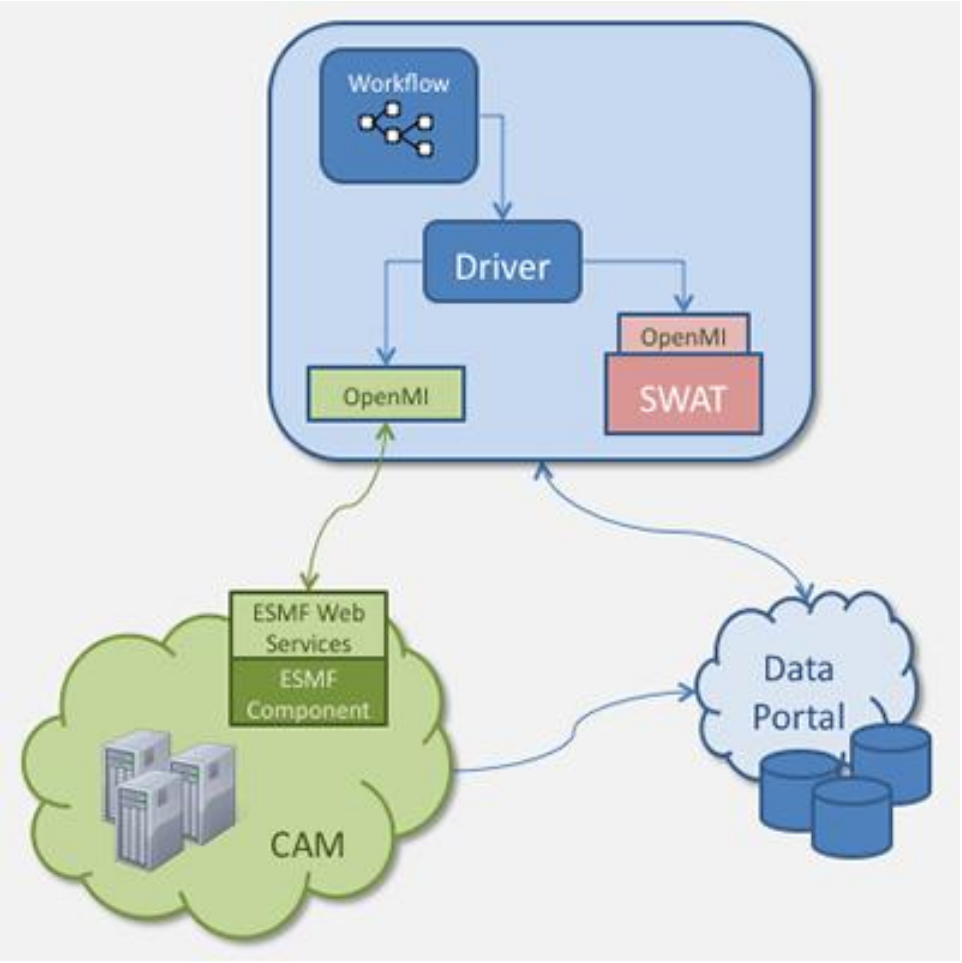
ESMF/OpenMI Interoperability

Goal:
Scientific Workflow that couples desktop hydrologic models (wrapped using OpenMI) with HPC climate models (wrapped using ESMF) through web services

Project Team:
Kathy Saint, Sylvia Murphy, and Cecelia DeLuca -- ESMF Core Team

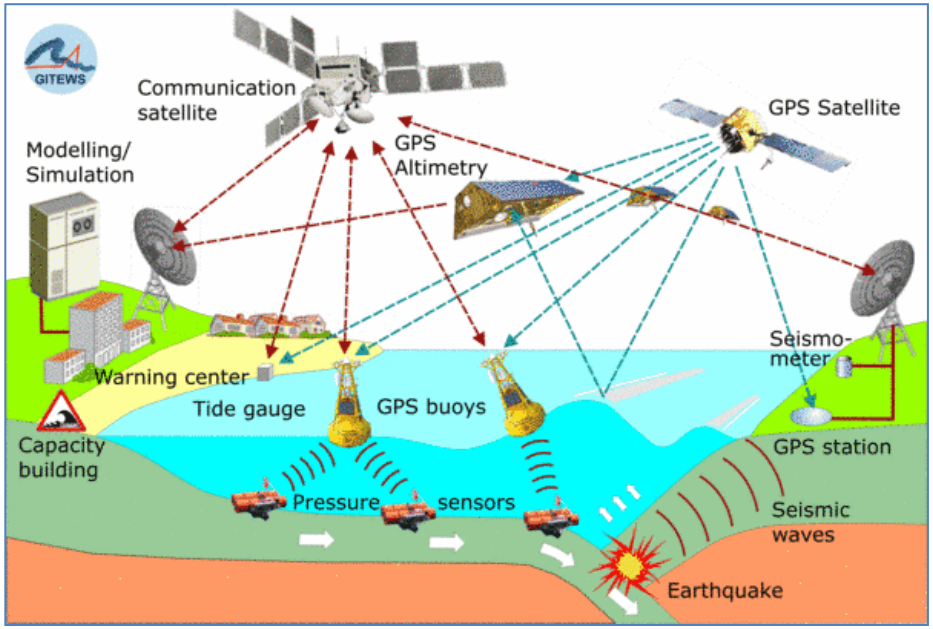
Jon Goodall and Mehmet Ercan -- University of South Carolina

Ricky Rood and Laura Briley -- University of Michigan



Common Standards across Earth Science Modeling and Information Systems

Open Geospatial Consortium (OGC)



- Observations and Measurements Model
- Sensor Web Enablement (SWE)
- Sensor Observation Service (SOS)

The Open Geospatial Consortium (OGC®) and the **OpenMI Association** announced that they recently signed a memorandum of understanding (MOU) to cooperate in standards development and promotion of open standards related to computer modelling.

http://www.opengeospatial.org/pressroom/pressreleases/1450

WaterML 2.0 is a candidate Open Geospatial Consortium encoding standard for the representation of in-situ hydrological observations data.
http://www.opengeospatial.org/projects/groups/waterml2.0swg

The **THREDDS Data Server (TDS)** is a web server that provides metadata and data access for scientific datasets, using OPeNDAP, **OGC WMS and WCS**, HTTP, and other remote data access protocols.
*www.**unidata**.ucar.edu/projects/**THREDDS***

Summary

- HIS provides
  - *standards* for accessing hydrologic observational data
    - WaterML, WaterOneFlow API, ODM
  - *software* to simplify access and use of hydrologic observational data
    - HydroServer, HydroCatalog, HydroDesktop, HydroModeler

- Agreed upon standards and protocols for component interfaces and data exchanges will facilitate interoperability across earth science modeling and information systems