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Advancing Flood Detection and Preparedness through GEOSS Water Services

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Acknowledgements: David Maidment, Simon Cox, Stefano Nativi, Peter Salamon, Albert Kettner, Cedric David, Fernando Salas, Gonzalo Espinoza

Research & development sponsored by NASA, NSF, Esri, Kisters AG, Microsoft Research

Context

Multiple agencies are developing models & approaches that can be used in detection and prediction of flooding

- NASA GRACE
- NASA GLDAS/NLDAS
- NWS Precipitation
- USGS National Water Information System
- ECMWF/JRC Global Flood Awareness System
- Numerous local, regional & national flood early warning systems

Essential model results and observational data **need to be shared** with key emergency response staff as **quickly & clearly** as possible

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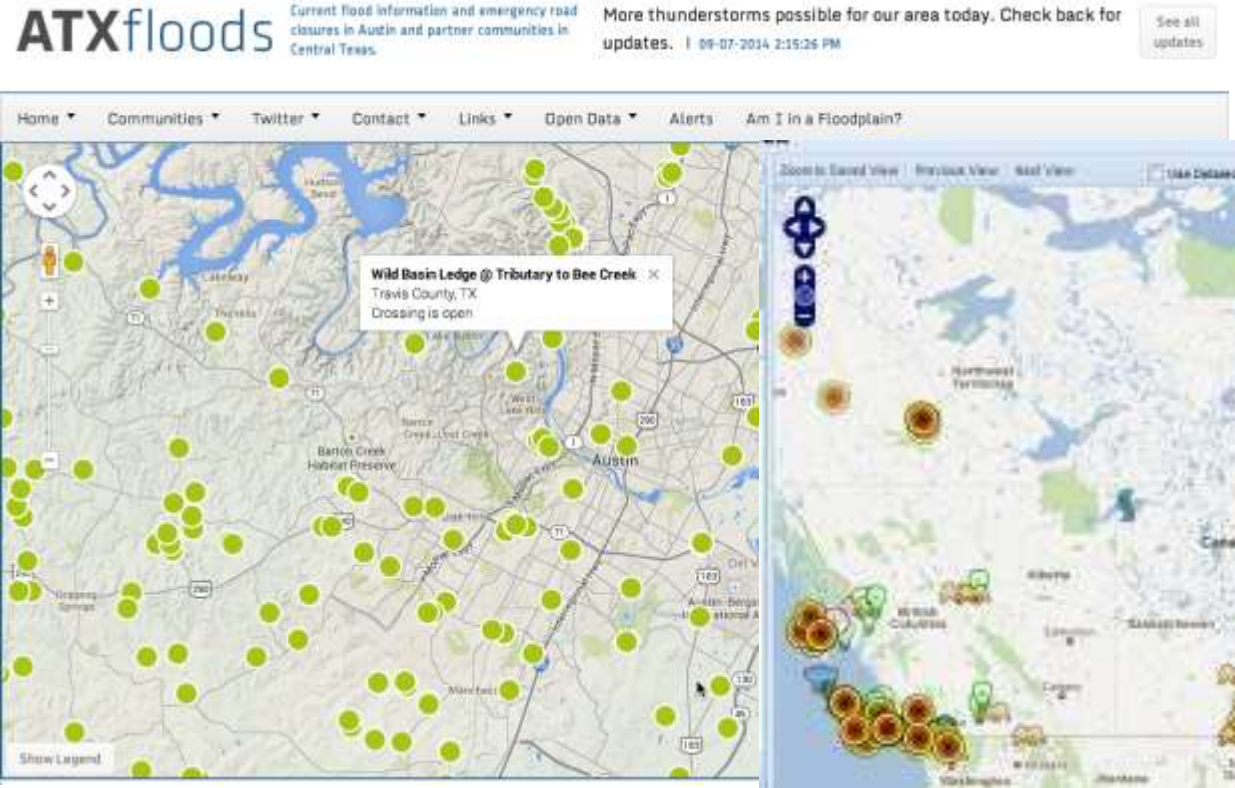
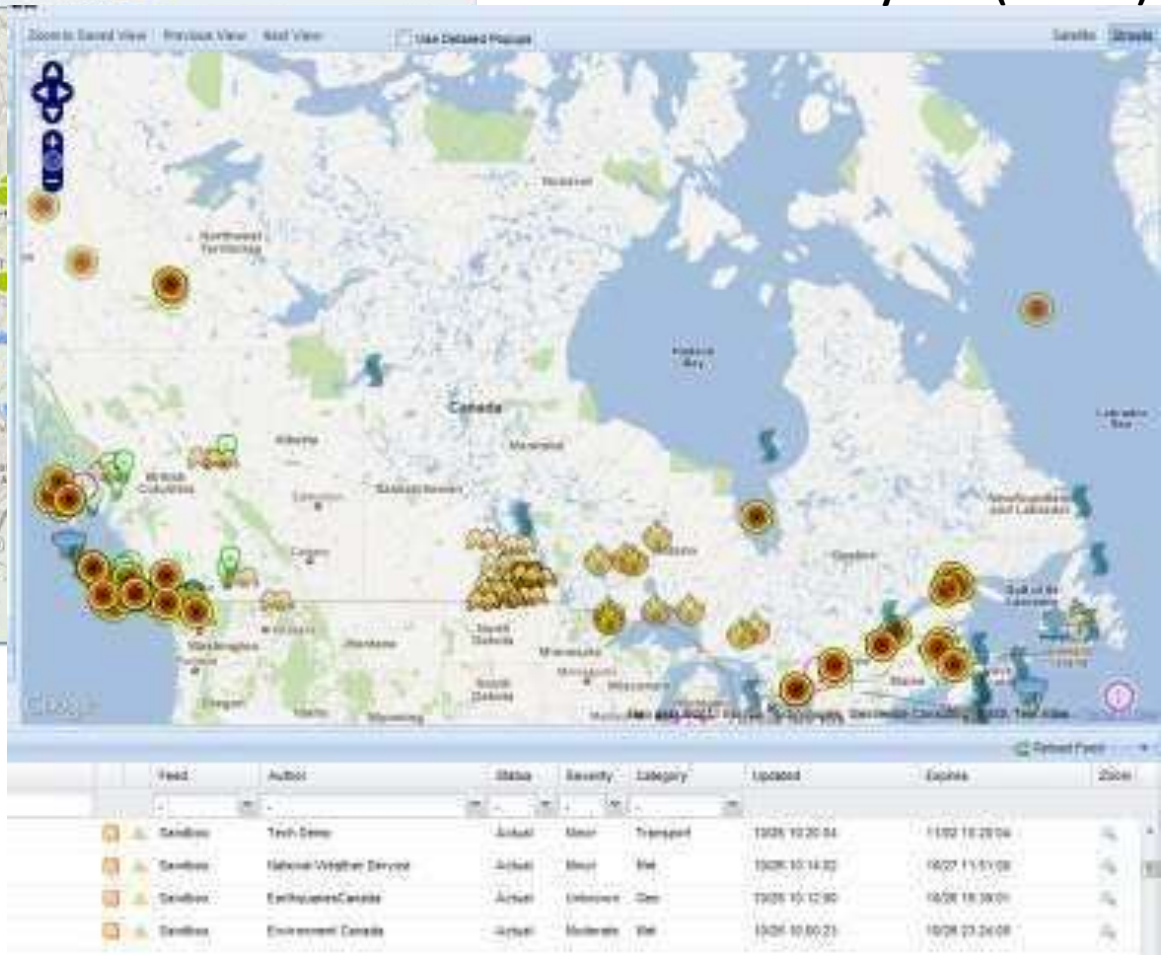
For timely, accurate situational awareness…



Austin's Flood Early Warning System

Canada's Multi-Agency Situational Awareness System (MASAS)



More context

- An essential aspect of sharing this kind of information is that it **needs to work consistently across institutional and political boundaries**
  - Local, state, national, continental, global, and fields of science

- This does not make the development of tools easier, but **complicates** it: more & different stakeholders need to come to the table, share ideas & agree on decisions

- Regardless, we really have to do it… so we start somewhere:
  - by ***making basic water data (streamflow, stage, soil moisture, precipitation, runoff) consistently available in as many countries as we can reach***

How do we do that?

We bridge socially across:

- communities of data providers
- communities of domain scientists
- communities of emergency response professionals & policy makers

And technologically across:

- disparate, agency-dependent data collection regimes
- different data formats, data quality, spatial & temporal resolution, IT architectures

This type of work cannot be done simply, quickly, or unilaterally… but it is happening!

One key development group…

- **OGC/WMO Hydro DWG** started in 2008
  - Conducted 2 interoperability experiments, leading to…
  - Water Markup Language (WaterML Part 1), adopted as international standard in 2012 for **exchange of water data time series**
  - Now working on exchange of **rating curves, gagings and cross-sections** (WaterML Part 2, 95% complete)
  - And **water quality** (WaterML Part 3, just starting)
    - One variable per time series
  - WaterML is a based on the OGC Observations & Measurement (O&M) Standard, also an ISO standard…

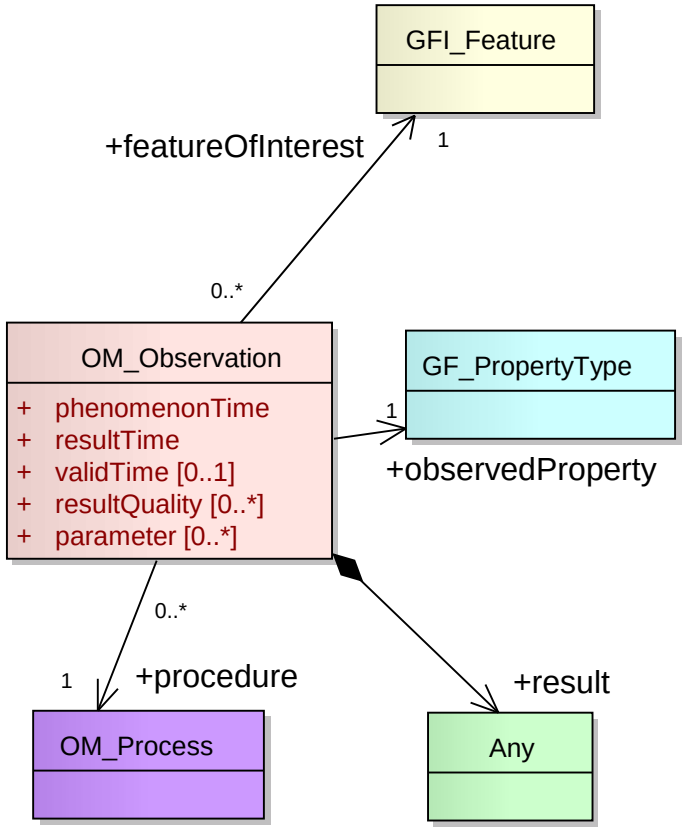
INTERNATIONAL STANDARD

ISO 19156

First edition
2011-12-15

Geographic information — Observations and measurements

Information géographique — Observations et mesures



An Observation is an action whose result is an estimate of the value of some property of the feature-of-interest, obtained using a specified procedure

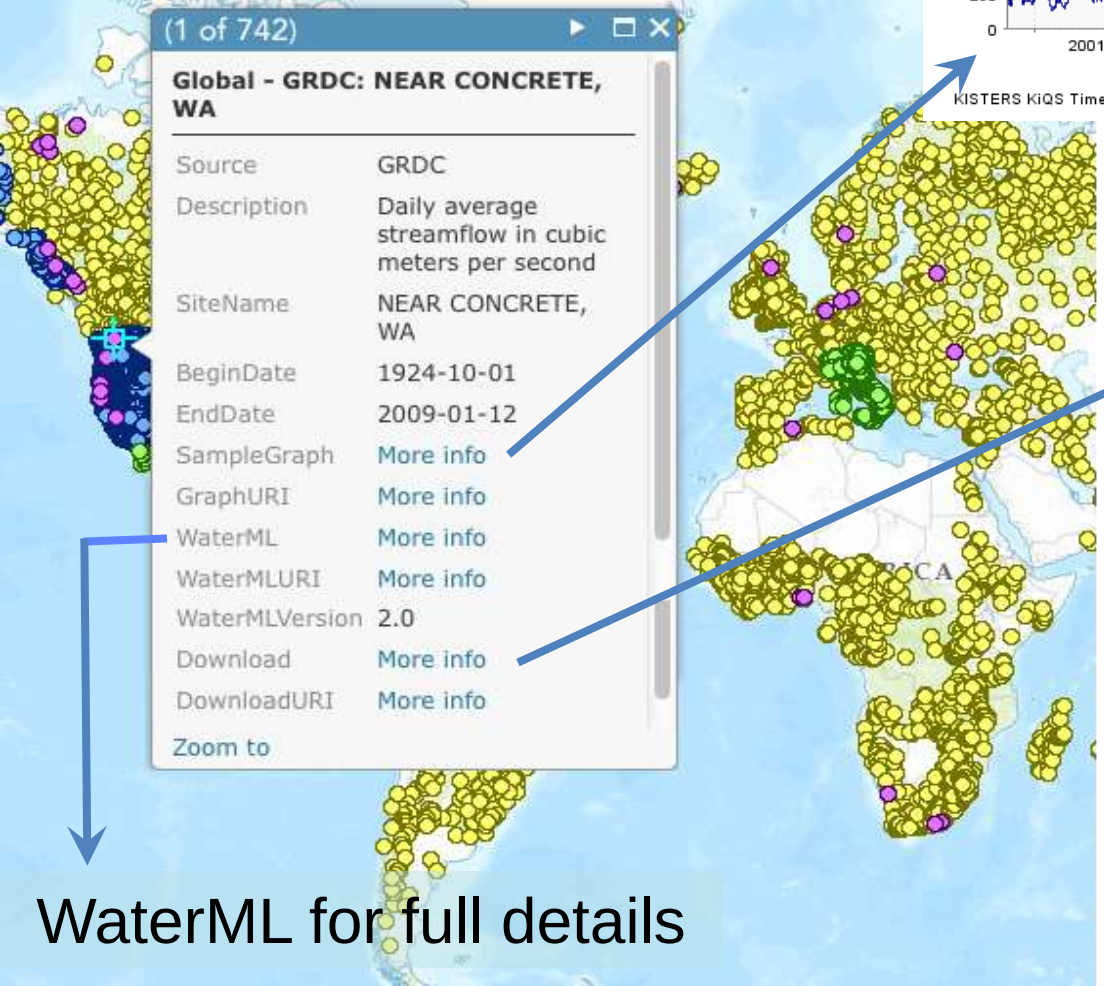
So where are we?

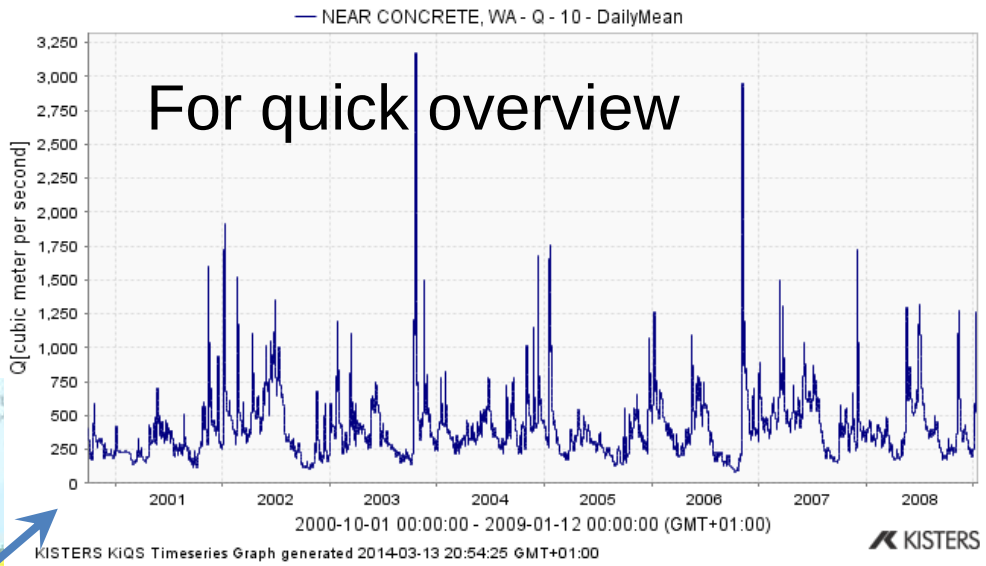
- We have a core information model for observations (**OGC O&M**)
- Extended & profiled to represent water data (**WaterML**)
  - A means of requesting & receiving it over the web (**Sensor Observation Service, SOS**)
- A means of mapping station point locations for easy discovery (**Web Feature Service, WFS**)
- A set of interfaces for cataloguing these data services (**Catalog Service for the Web, CSW**)

And these are all international standards

Gauge description and data links…

http://geoss.maps.arcgis.com/home/webmap/viewer.html?webmap=5efcdfb27d744e3ea65eaf58c06f9d0c





For quick overview

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8	2008-01-15T09:00:00.000+01:00;450.946
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24	2008-01-23T09:00:00.000+01:00;310.42325
25	2008-01-23T09:00:00.000+01:00;310.42325

For easy analysis

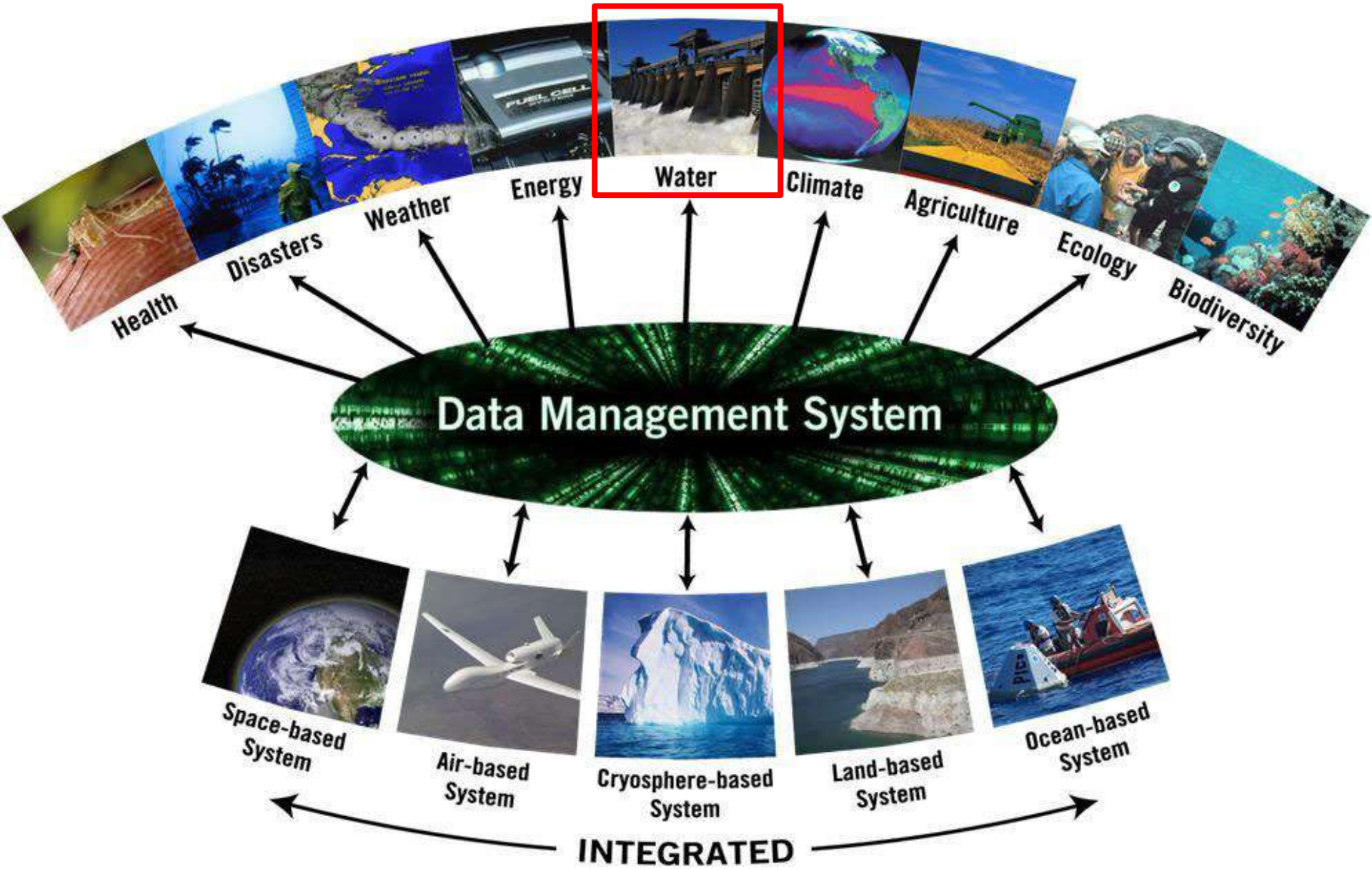
WaterML for full details


WaterML 2.0
Document metadata
Observation description
- Phenomena time
- Result time
- Procedure
- Observed property
- Feature of interest
- Result
- Time series metadata
- Time series data
Time series data, cont'd

GEOSS: An approach to socializing the technology

- **GEOSS: Global Earth Observation System of Systems**
  - Hosted by GEO (Group on Earth Observations) to publish Earth observation datasets from 92 member countries
  - GEO home page: http://www.earthobservations.org/
  - GEOSS search portal: http://www.geoportal.org/
  - Enables distributed search among dozens of catalogs, accessing millions of data services, **following international data exchange standards (ISO, WMO, OGC, …)**
  - Data is organized around **9 Societal Benefit Areas (SBAs)**: **Water, Weather, Climate, Biodiversity, Ecosystems, Energy, Agriculture, Health, Disasters**

- **GEOSS AIP (Architecture Implementation Pilot)**
  - Series of 1-year project cycles to implement GEOSS, started in 2007; AIP-6 complete in 2013; AIP-7 in progress.


Health
Disasters
Weather
Energy
Water
Climate
Agriculture
Ecology
Biodiversity
Data Management System
Space-based System
Air-based System
Cryosphere-based System
Land-based System
Ocean-based System
INTEGRATED

GEOSS was started with millions of datasets from remote sensing…
Now working to add water time series data

Water Quantity

Rainfall

Soil Water

Water Quality

Meteorology

Groundwater

Time series data at point locations

GEOSS Water Services Team

(new members)*

Academic

- University of Texas at Austin, USA
- Brigham Young University, USA
- University of Saskatchewan, Canada
- Feng Chia University, Taiwan *

Community Labs, Portals

- CUAHSI Water Data Center, USA
- Dartmouth Flood Observatory, USA *
- NASA Goddard Hydrological Science Lab, USA
- NASA Goddard Earth Sciences DISC, USA
- Federal Institute of Hydrology, Germany * (supporting GRDC, GEMS/Water)
- EC Joint Research Centre (JRC), Italy
- European Centre for Midrange Weather Forecasting (ECMWF), UK
- Centre for Ecology and Hydrology, UK *
- CEOS Water Portal (JAXA), Japan

GEOSS Water Services Team, cont'd

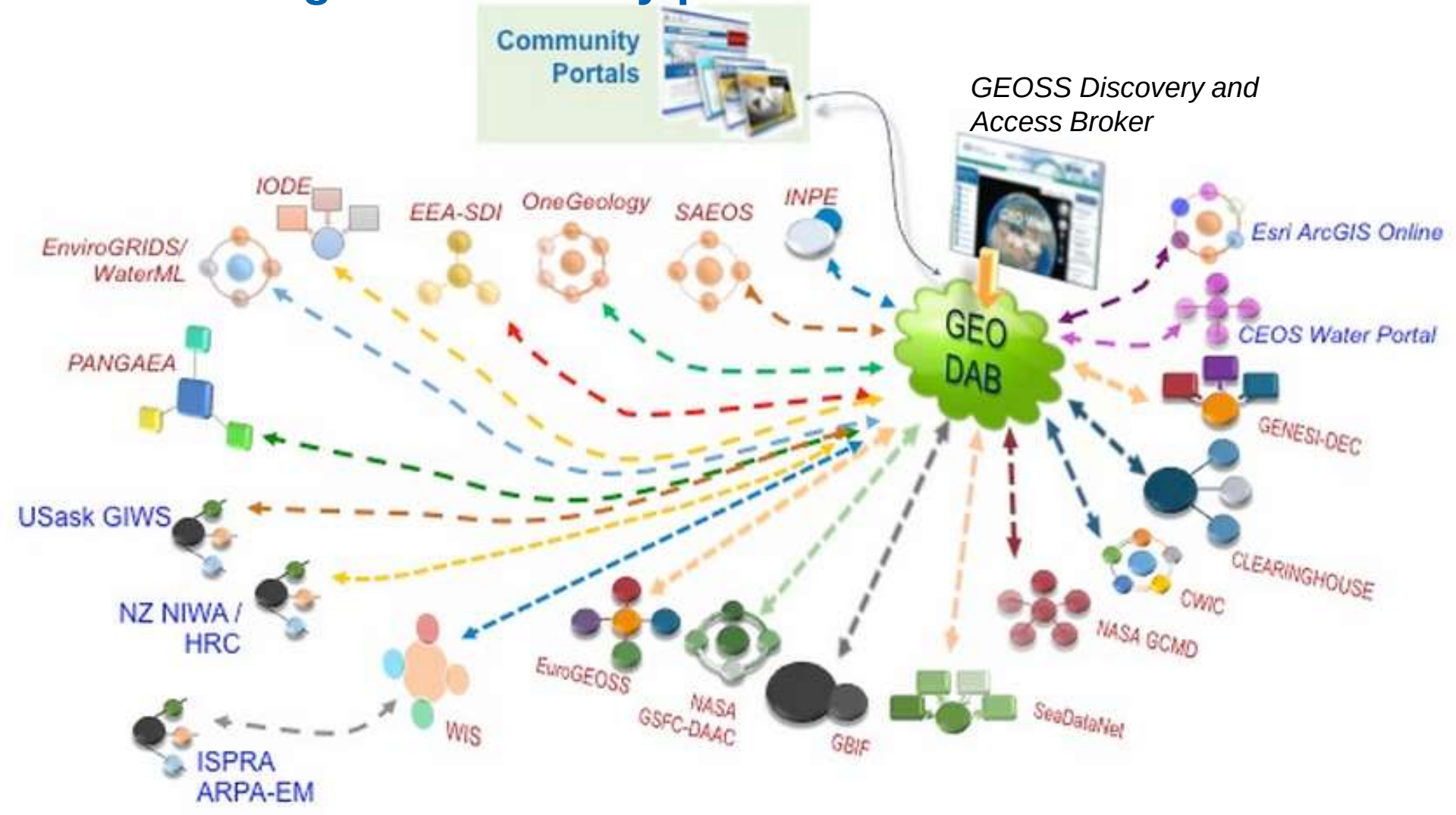
National and regional agencies

- Italian National Institute for Environmental Protection and Research (ISPRA)
- Regional Agency for Environmental Protection in Emilia-Romagna (ARPA-ER), Italy
- New Zealand National Institute of Water and Atmospheric Research (NIWA)
- Horizons Regional Council (HRC), New Zealand

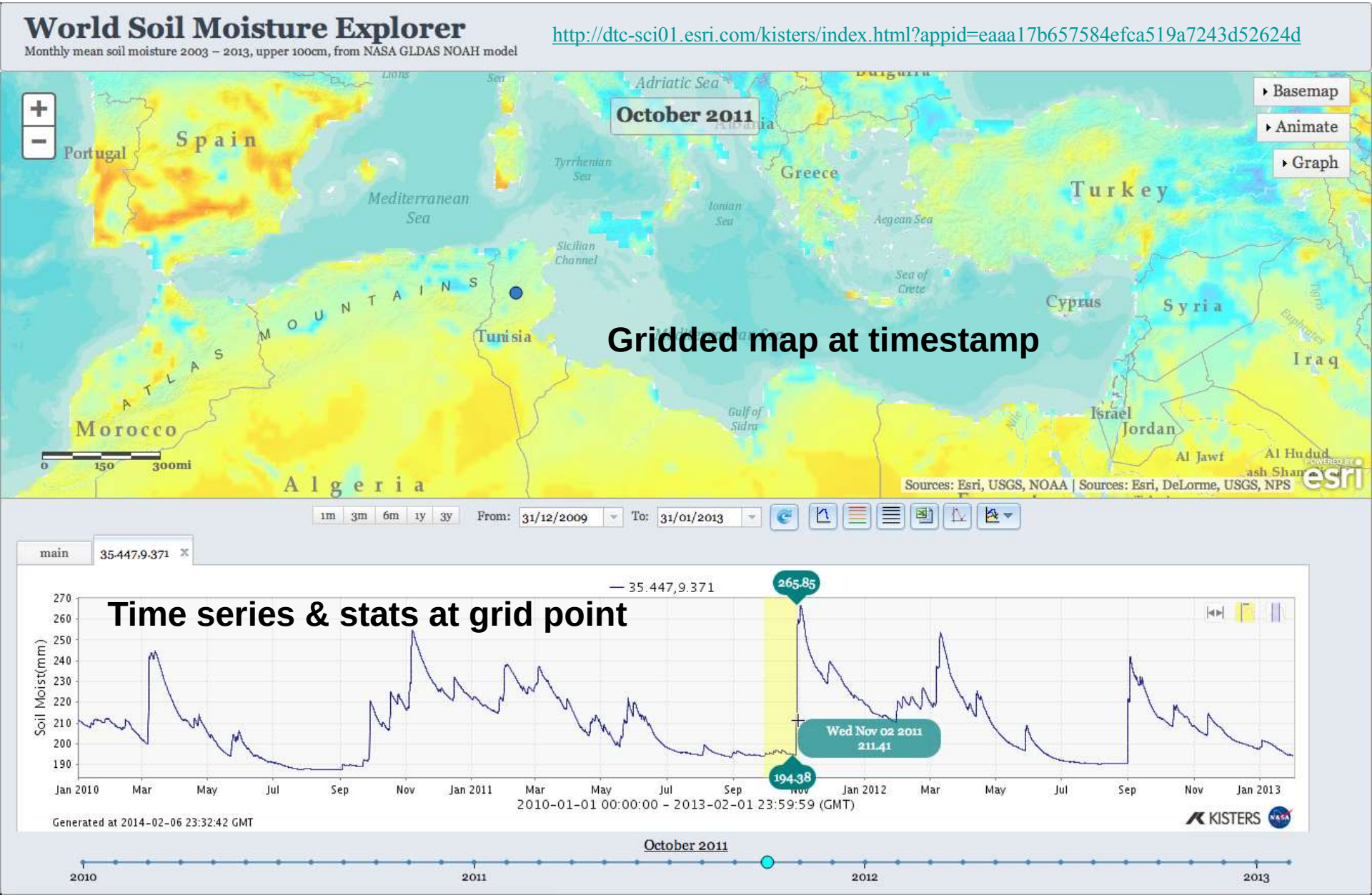
Commercial Engineering & Software

- Esri, USA
- Kisters AG, Germany
- Microsoft Research, USA

GEOSS Portal:
connecting to community portals and other resources

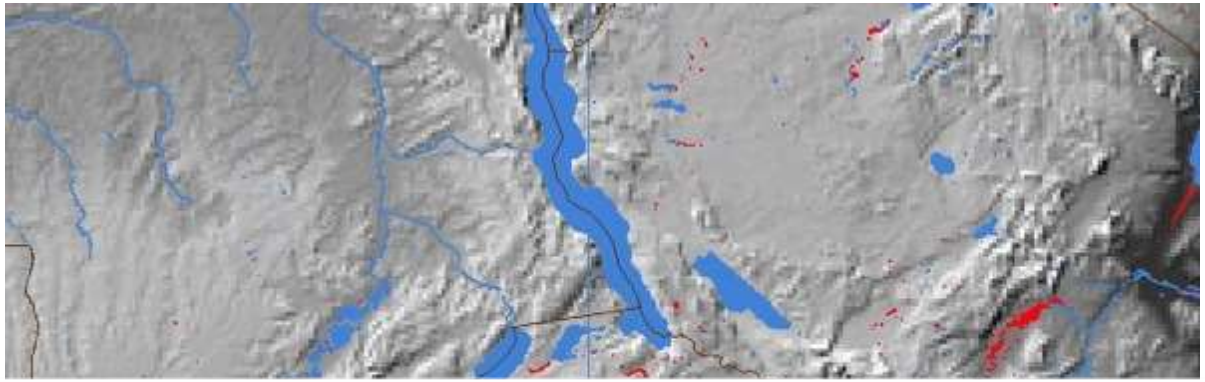


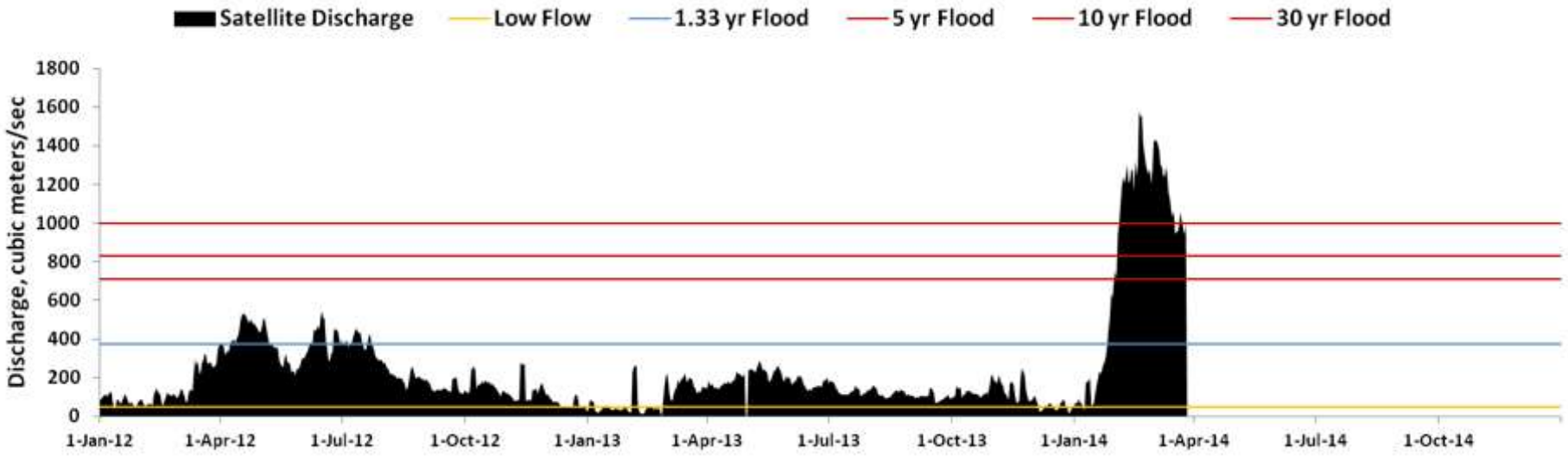
Viewing & comparing time series values



Flood Monitoring

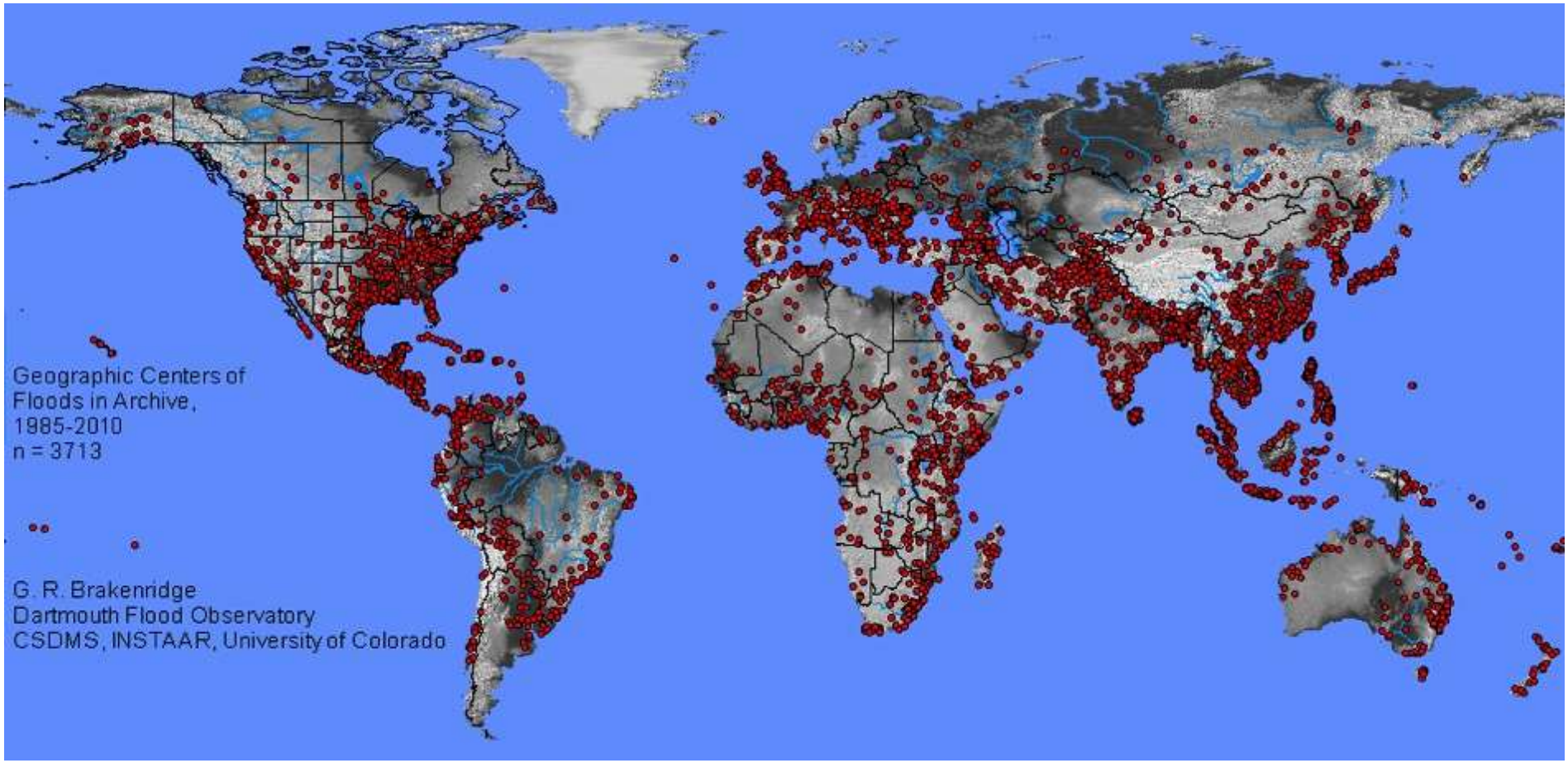
The Dartmouth Flood Observatory maps flood extents globally, based on pre- and post-event imagery from NASA MODIS





Flood Monitoring

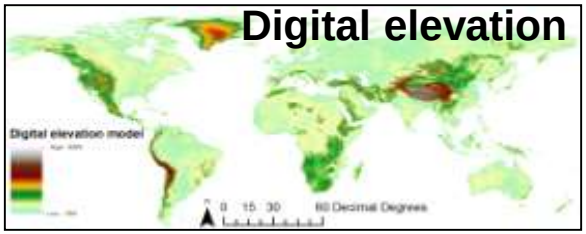
The Dartmouth Flood Observatory preserves the record of each major flood event, for posterity and for use in global flood hazard modeling, to help identify severity of current flooding

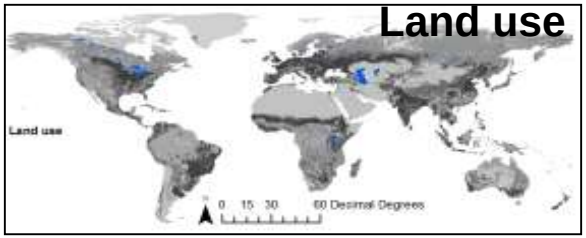


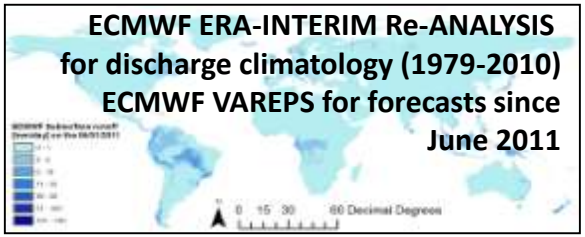
Flood Prediction

Global Flood Awareness System (GloFAS) from the European Centre for Medium-Range Weather Forecasting (ECMWF) and the Joint Research Centre (JRC)

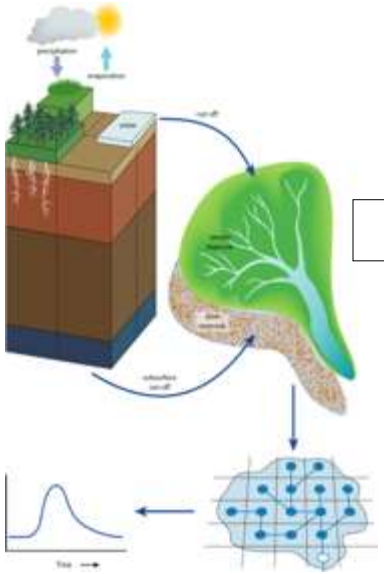
Inputs: global spatial data



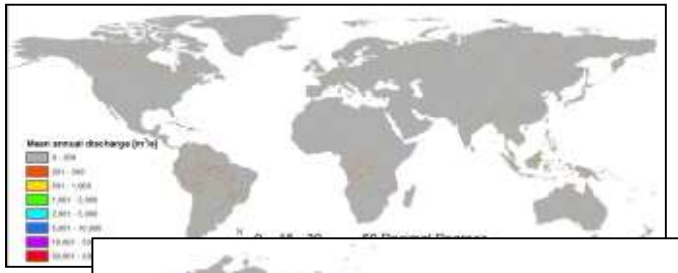




Hydro-Meteo model with grid-based routing (**LisFlood**)



Output: global daily discharge



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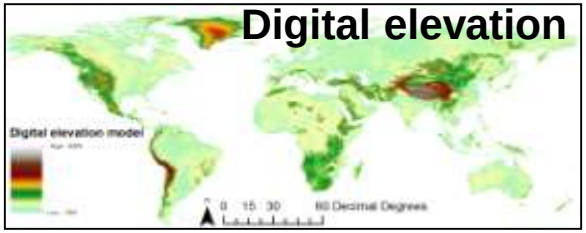

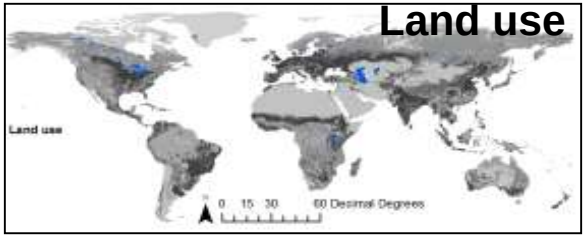

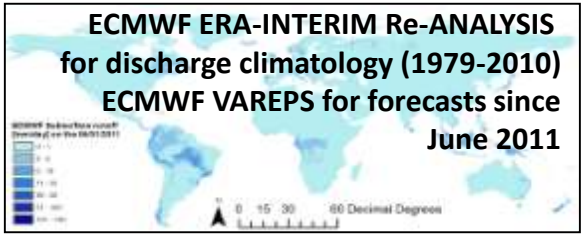

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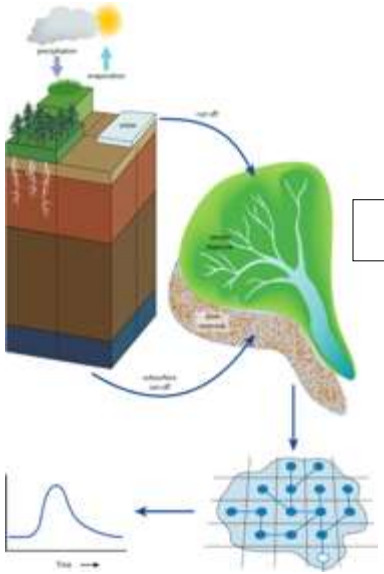
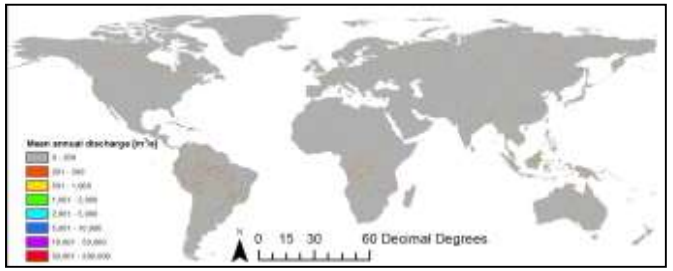
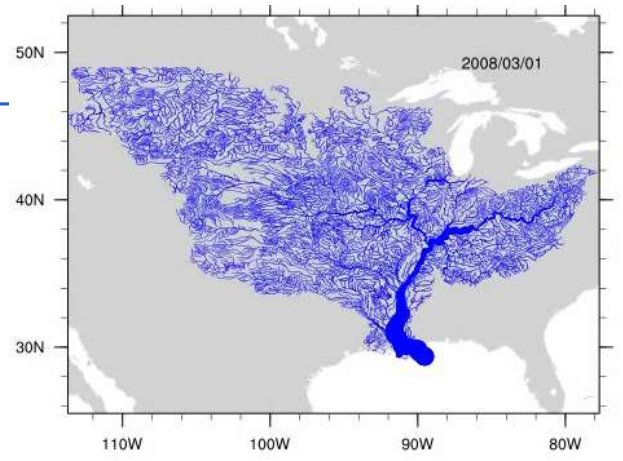


Output: global daily discharge





Downscaling the river routing through integration with RAPID

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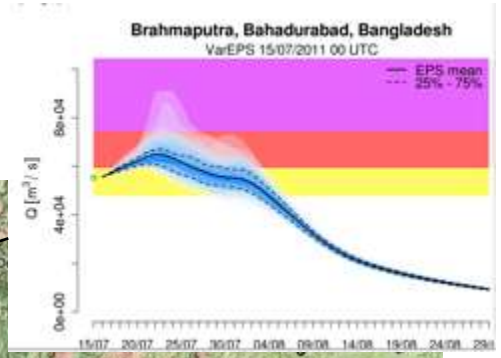
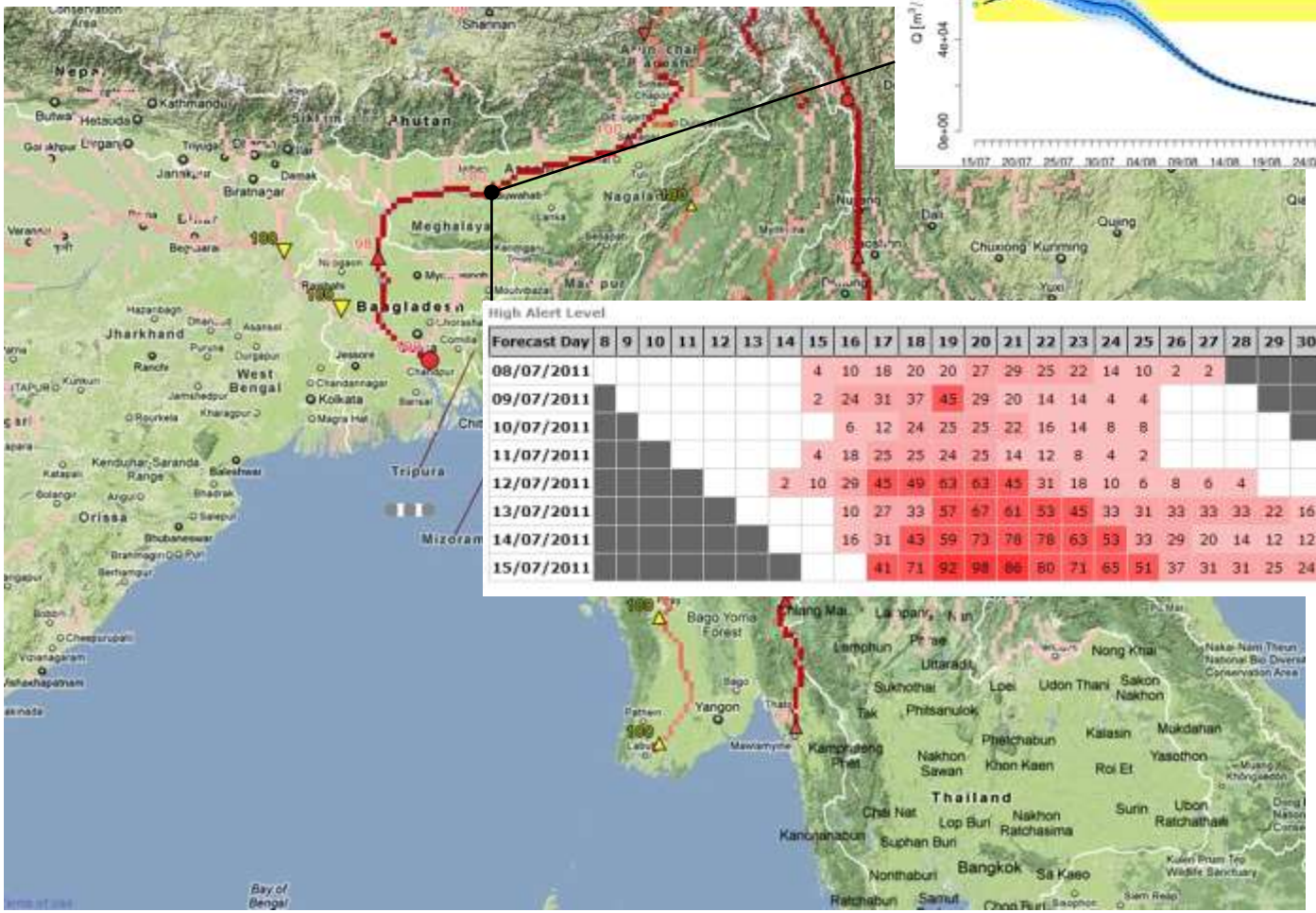
Target: 2-week advance forecasting of major floods

GloFAS provides probabilistic forecasts of flooding events for large basins





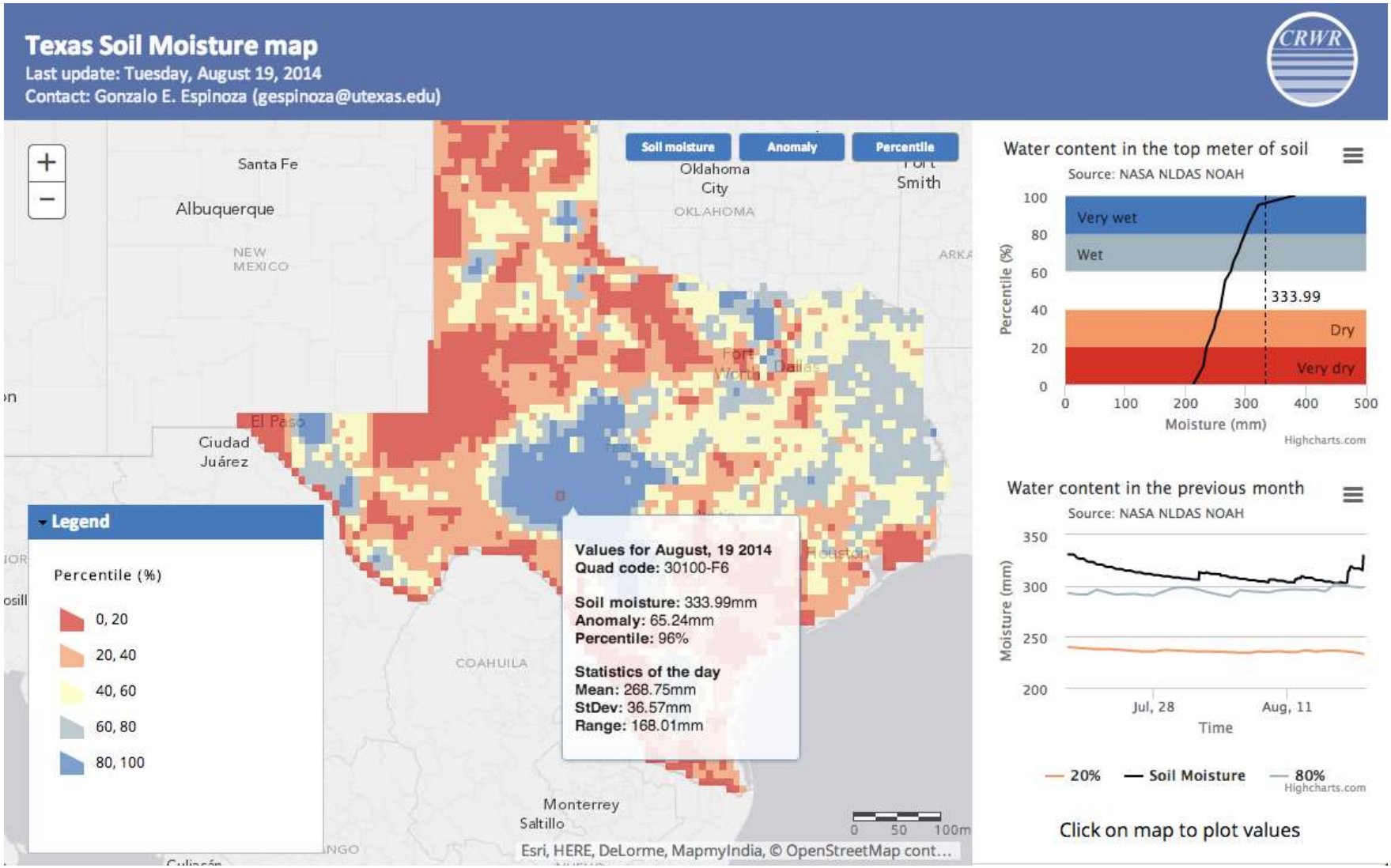
High Alert Level

Forecast Day	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
08/07/2011								4	10	18	20	20	27	29	25	22	14	10	2	2				
09/07/2011								2	24	31	37	45	29	20	14	14	4	4						
10/07/2011									6	12	24	25	25	22	16	14	8	8						
11/07/2011								4	18	25	25	24	25	14	12	8	4	2						
12/07/2011							2	10	29	45	49	63	63	45	31	18	10	6	8	6	4			
13/07/2011									10	27	33	57	67	61	53	45	33	31	33	33	33	22	16	4
14/07/2011									16	31	43	59	73	78	78	63	53	33	29	20	14	12	12	10
15/07/2011										41	71	92	98	86	80	71	65	51	37	31	31	25	24	25

One more application for soil moisture

- Working with NASA NLDAS model output for soil moisture, Gonzalo Espinoza (UT Austin) has developed a statistical analysis tool
  - Displays soil moisture grid cells colored by percentile, relative to historical averages from 1979 to present
- This can provide useful context to emergency response managers, preparing for new rain events in a given area
- Current work is to add runoff (useful in flood analysis) & evapo-transpiration (useful for drought analysis); and extend to all USA

Soil Moisture Statistics

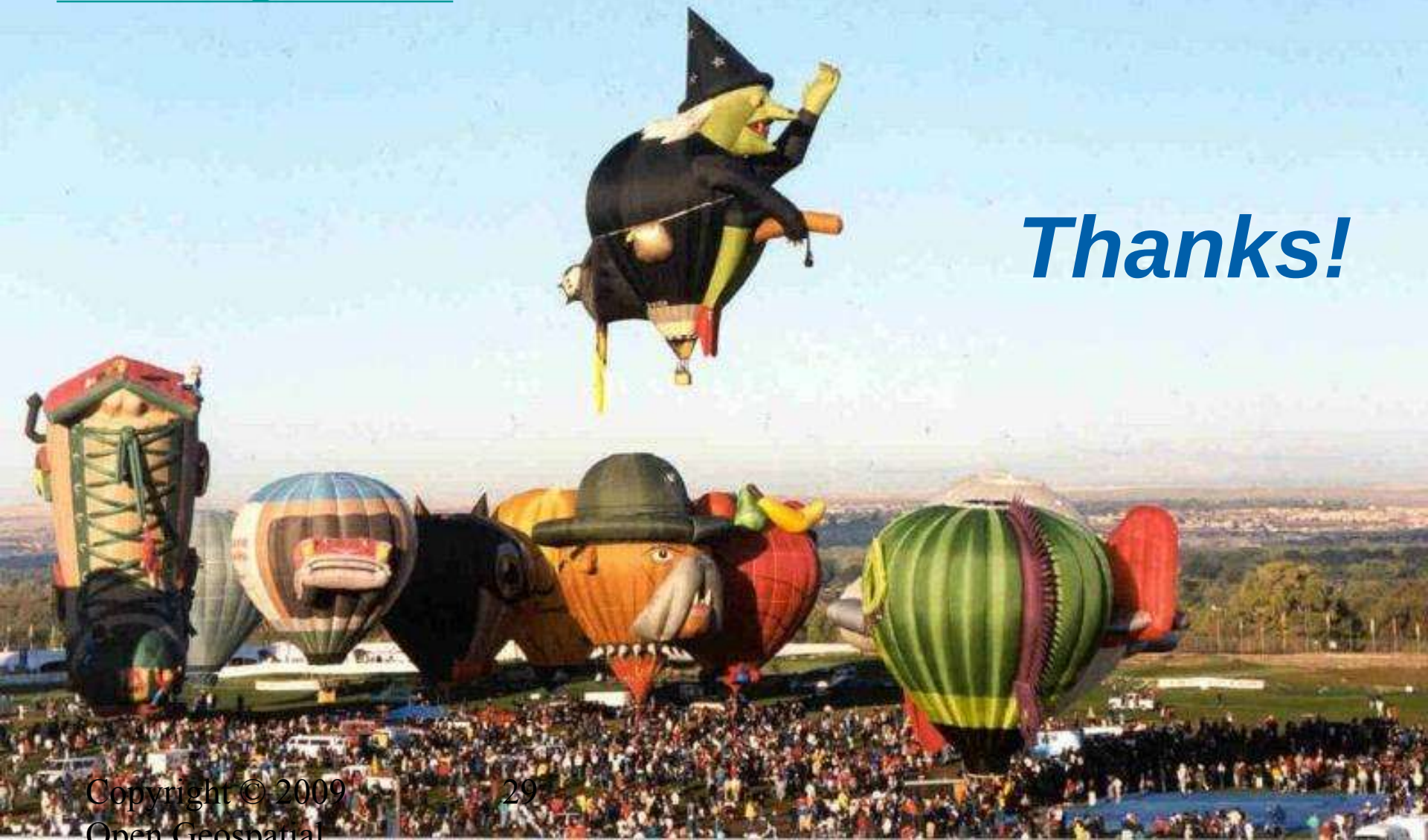


Summary

- **WMO Information System** (WIS)
  - Global network of authoritative national agencies' data
  - WIS is being integrated with GEOSS for distributed search
- **OGC/WMO Hydrology Domain Working Group** develops core standards through OGC Interoperability Experiments & Pilots
- **GEO/GEOSS** provides an organizing principle for implementing data and map catalogs and services that works across boundaries between nations, institutions, and scientific / societal domains.
- **Crowdsourcing** is coming into use, taking advantage of citizen event monitoring.

A federated web of portals, data and tools for consistent data services is emerging – now we need to make this accessible and useful for emergency response in extreme events!

David Arctur
david.arctur@utexas.edu



Thanks!