

# **Standards-based CyberInfrastructure for HydroMeteorology (SCIHM):**

**A collaborative project funded by the U.S.  
National Science Foundation and the  
European Union**

## **U.S. Project Team:**

National Center for Atmospheric Research

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

San Diego Super Computing Center

Rutgers University



# Challenges to Improving Predictions:

- **Scientific:** Complexities of multiple physical processes occurring at a range of spatial and temporal scales require new approaches to predictive modeling of high impact hydrometeorological events
- **Cyberinfrastructure:** Heterogeneous data structures and semantics limits efficient discovery, processing and ingest of critical environmental data. There is significant unrealized potential in distributed (cloud) computing resources for predictive modeling.

# SCIHM Project Goals:

- Overarching: Foster a standards-based hydrometeorological infrastructure where users can predict extreme weather events and their hydrological, environmental and societal impacts, *taking advantage of scalable, on-demand high-performance cloud-based computational resources and shared data space*
- Specifically: Develop and deploy standards-based multi-layered infrastructure for dynamic distributed data to:
  1. Discover, manage and integrate dynamic distributed data via standard service interfaces, and within a data grid environment
  2. Link distributed data with high-resolution simulation models
  3. Manage large computational problems on distributed high-performance computing architectures

# Project Team:

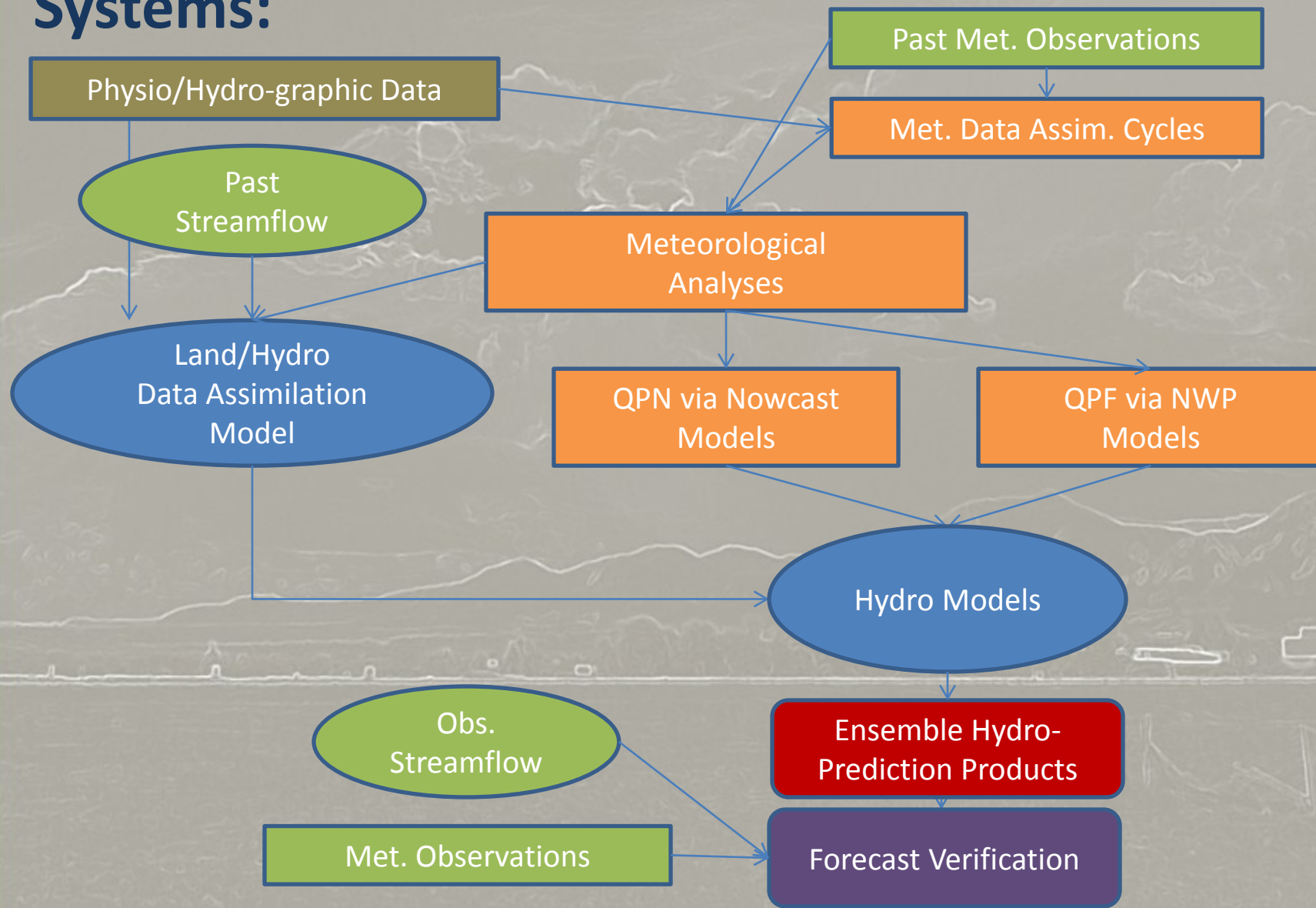
- Rick Hooper, CUASHI : Community engagement liaison for project and CUAHSI community
- Shantenu Jha, Rutgers U. : Integrating standards-based compute and data cyber-infrastructure, e.g., SAGA-iRODS; interoperable XSEDE-PRACE solutions
- Ilya Zavslosky, San Diego Super Computing Center : CUAHSI HIS architect and co-developer of WaterML standard
- David Gochis, National Center for Atmospheric Research : Hydrometeorologist, co-developer of WRF-Hydro system



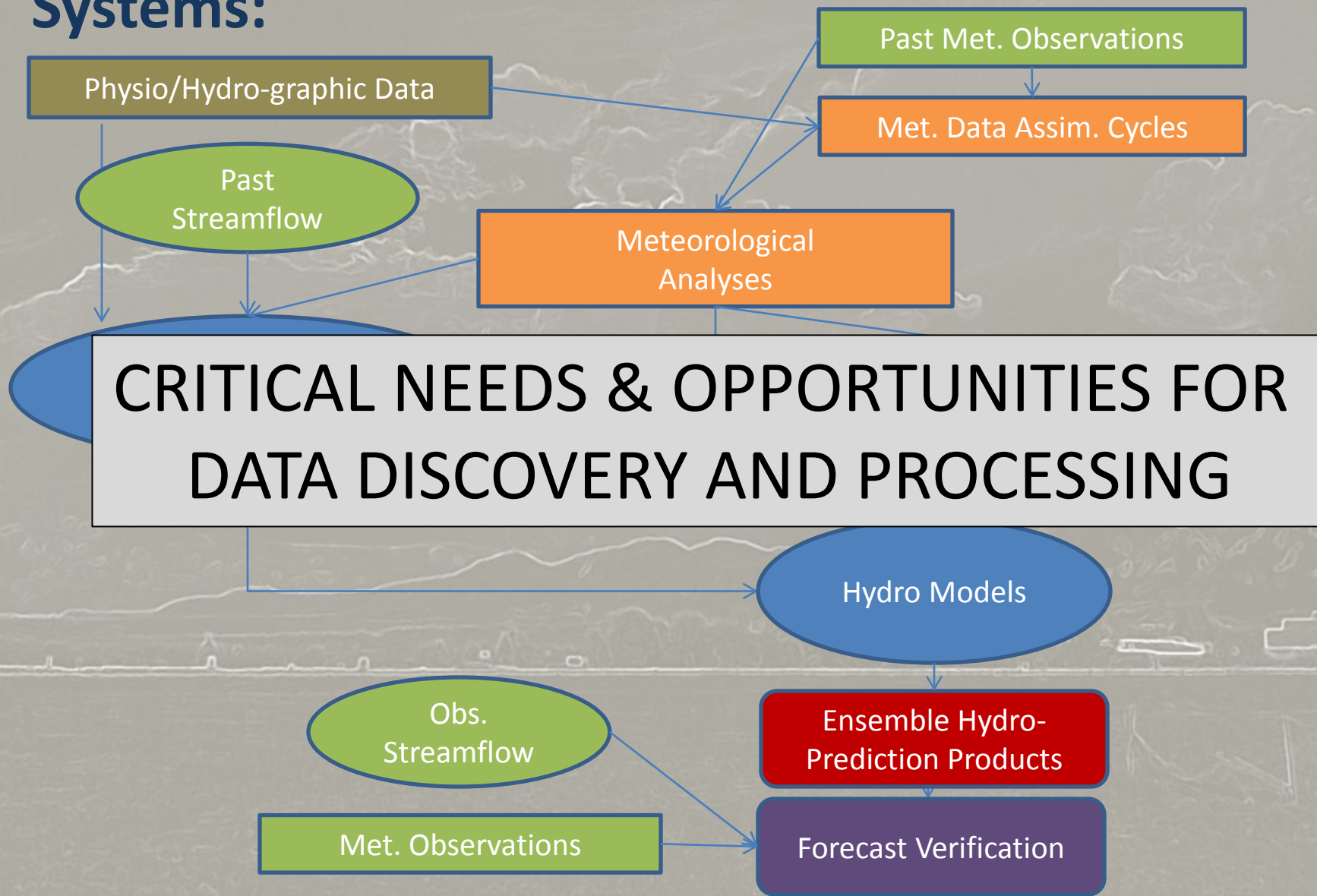
# Outline:

- Background
- Prediction System Workflows
- Description of Computational Models
- Standards-based Data Discovery and Processing
- Utilizing High Performance Computing Capabilities
- Prediction System Test Cases

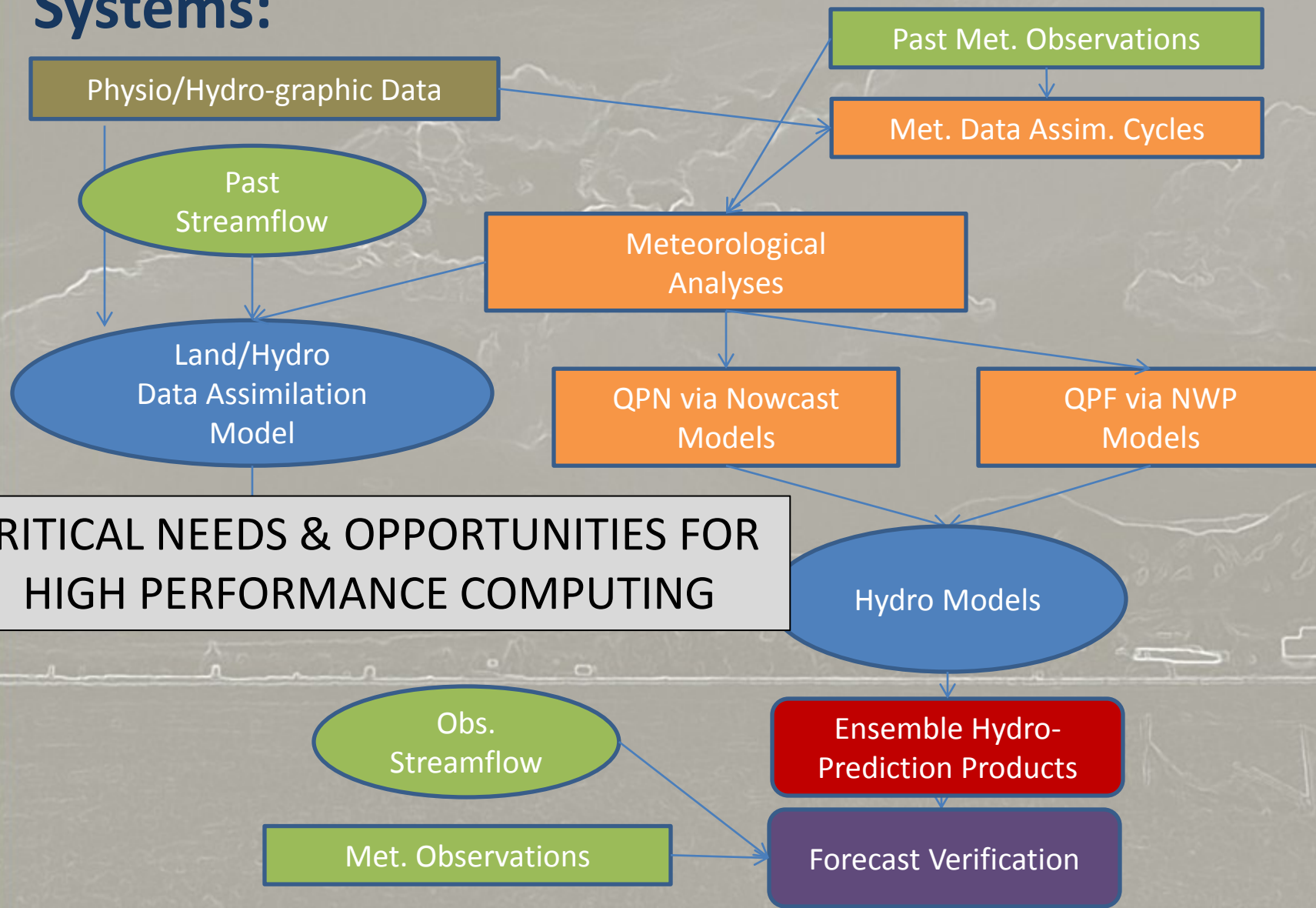
# Navigating Hydrometeorological Prediction Systems:



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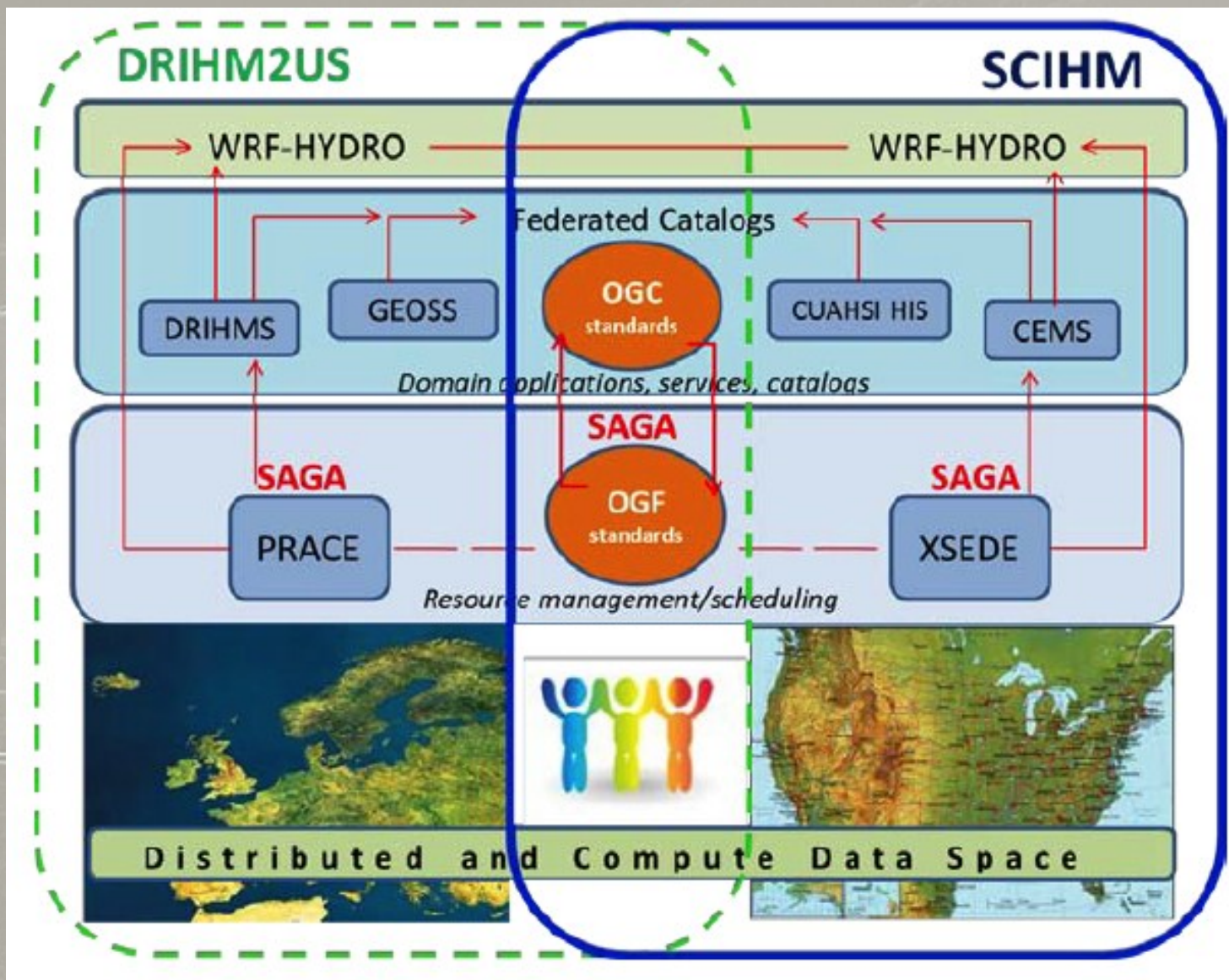


# Navigating Hydrometeorological Prediction Systems:





# U.S. – E.U. Data and C-I Integration:



# Description of Models:

## Meteorological Modeling Systems

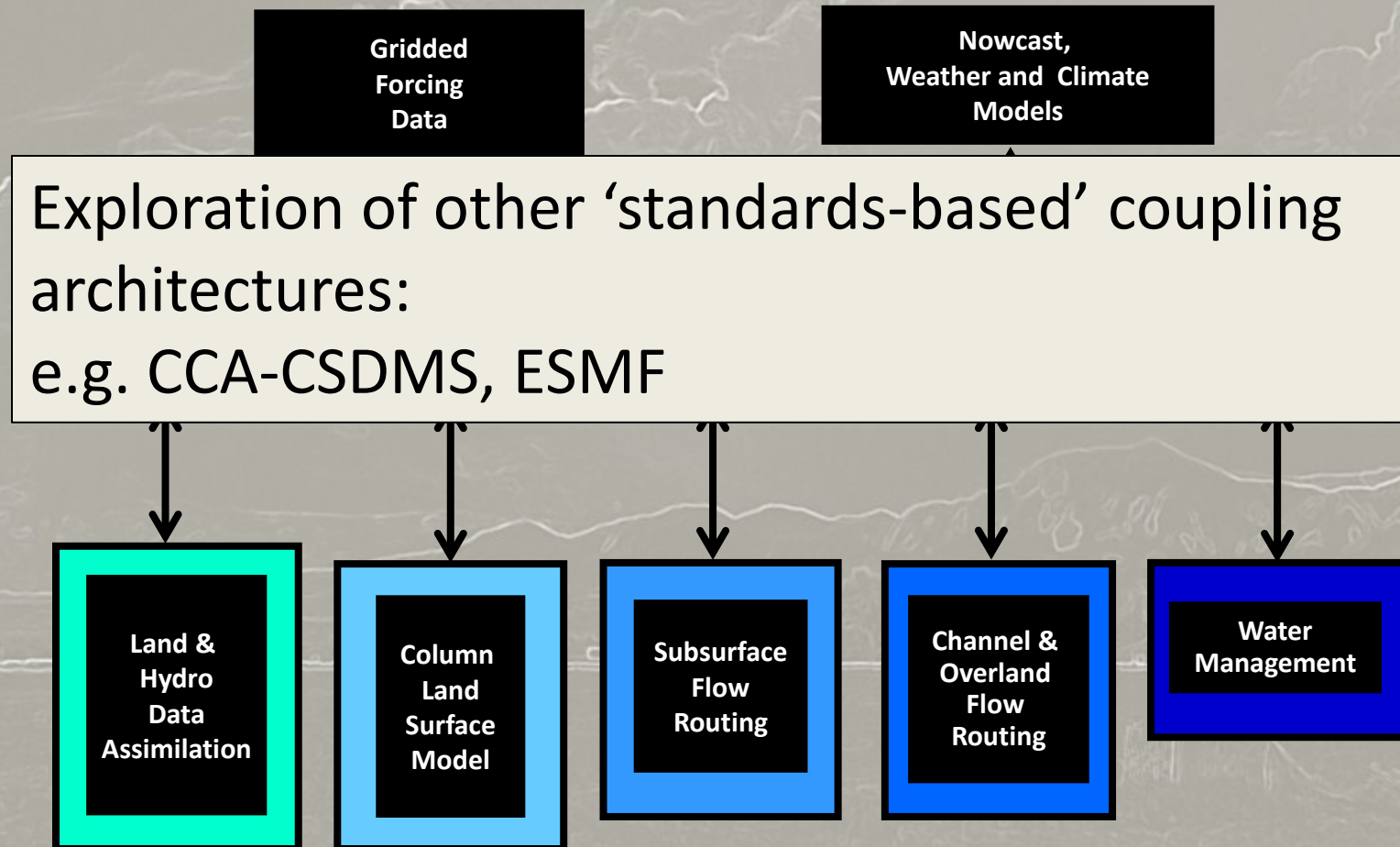
- Weather Research and Forecasting Model (WRF):
  - Non-hydrostatic regional model
  - Multiple physics options
  - Modestly extensible
  - Complete but 'limited' suite of pre/post processors
  - High-performance computing enabled, moderately portable

## Hydrological Modeling Systems

- WRF-Hydro modeling system:
  - Model coupler for various column and routing physics components
  - Multiple physics options
  - Multi-scale capabilities
  - High-performance computing enabled, moderately portable
- CSDMS via EarthCube project
  - More general surface dynamics coupling framework
  - Limited portability at present

# WRF-Hydro System:

- Multi-scale/Multi-physics modeling...





# Data Discovery and Processing:

- Ilya : Will lead and advise on the use of CUAHSI Hydrologic Information System (HIS) infrastructure and WaterML standards data
- Main goal: Foster increased use of standards-based data discover and data mining tools
- Main tools/capabilities:
  - HIS databases
  - OGC standards



# High Performance Computing Job Management:

- Shantenu: Leads team of 2 Graduate Students (Mark, Ashley), 1 undergraduate researcher (Vishal)
  - See <http://radical.rutgers.edu/people>
- Main Goal: (i) Developing iRODS-SAGA adaptors to provide standards-based and integrated compute-data CI; (ii) Enabling data-intensive high-performance, high-throughput ensemble simulations on XSEDE and PRACE
- Main tools/capabilities:
  - SAGA [<http://saga-project.org>]
    - SAGA-SLURM, SAGA-SGE and SAGA-BES(?) SAGA-iRODS
  - BigJob [<https://github.com/saga-project/BigJob/wiki>]

# Community Engagement: CUAHSI

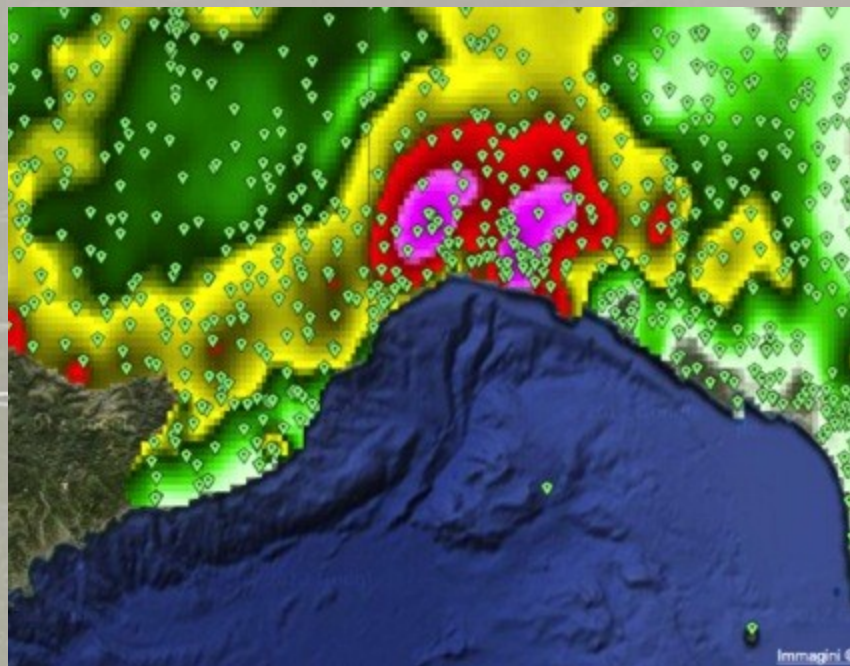
- Focus groups to define & refine functionality needed by hydrologists, hydrometeorologists, atmospheric scientists
- Promulgation of 'best practices' for standards-based modeling
- Workshop on hydrological & meteorological 'informatics' as final event (2014)



# Description of Use Cases:

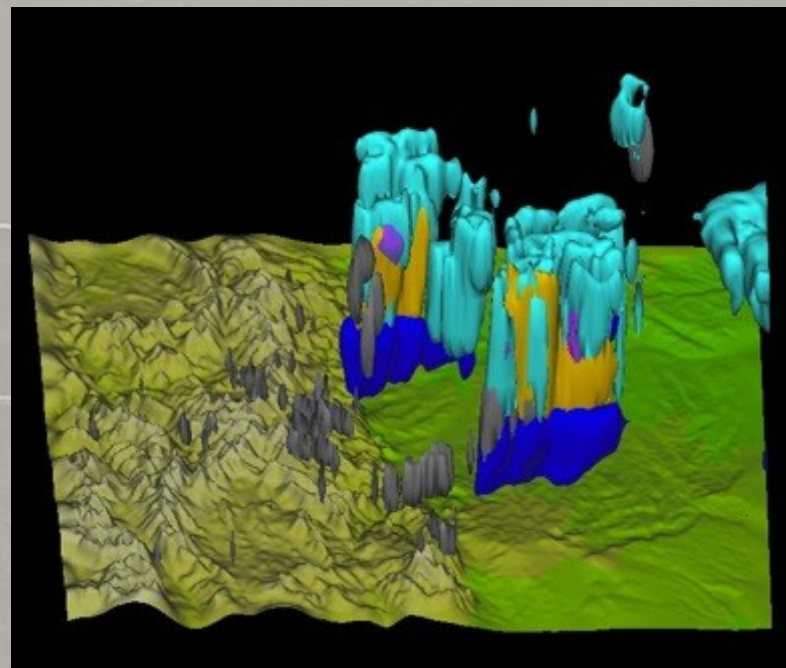
## Synoptically-forced Extreme Flood: Genoa, Italy

- > 450mm in 8 hrs
- Event occurred over steep coastal Appenine Mountains
- Several perished and millions of Euros in damage



## Isolated Heavy-rainfall Flash Flood Event: Colorado Mountain Front

- > 25 mm in 1 hr with instantaneous rates > 100mm/hr
- Event occurred on previous forest fire burn in steep terrain
- Large debris flow





# Project Timeline:

Project Activities	Year 1				Year 2			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1. Modeling CI								
2. Service and catalog interoperability								
3. Compute and data management infrastructure								
4. System testing								
5. Community engagement			X				X	
Joint EU-US Project Meetings	X				X			
US Project Meetings			X			X		



**END**