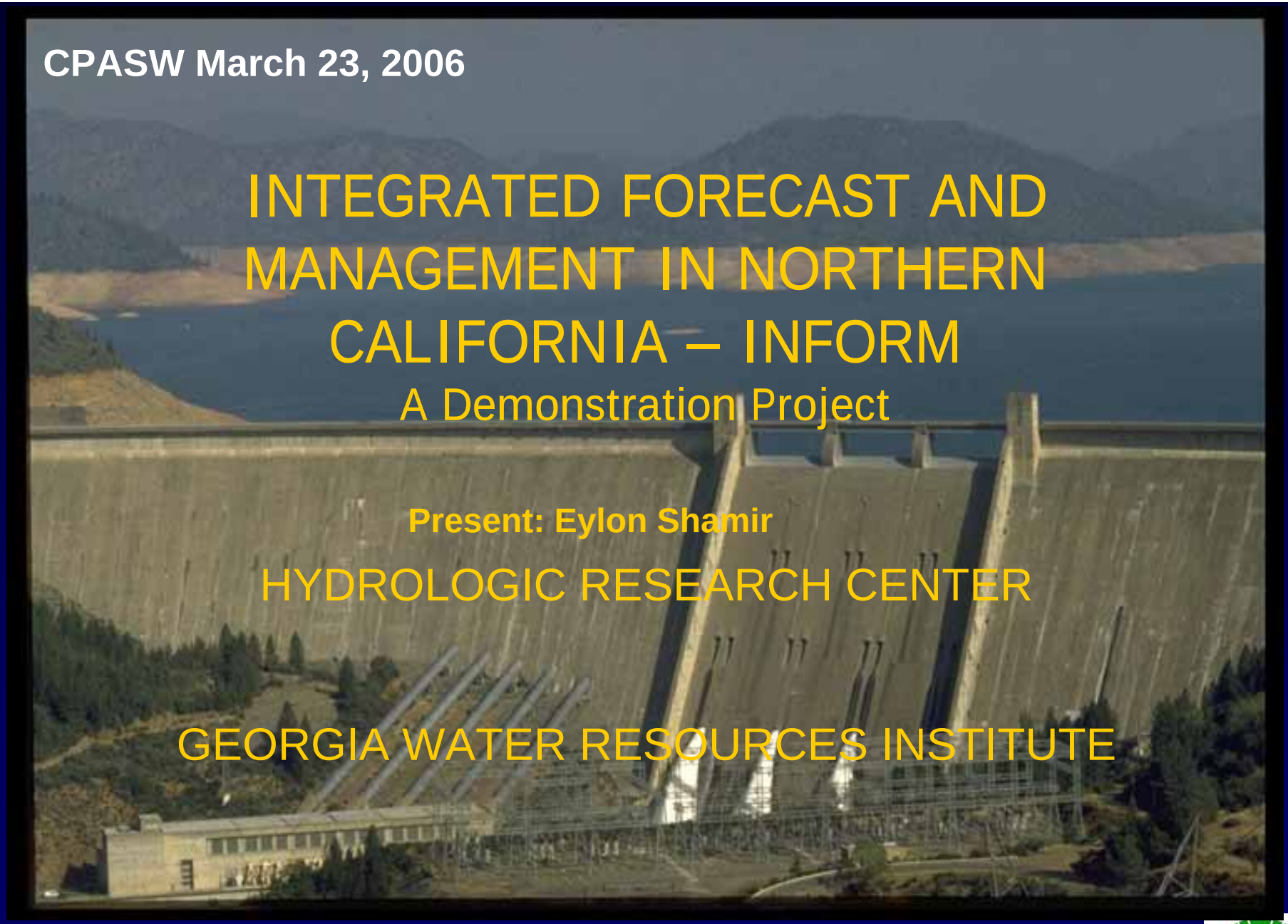

CPASW March 23, 2006

INTEGRATED FORECAST AND MANAGEMENT IN NORTHERN CALIFORNIA – INFORM

A Demonstration Project

Present: Eylon Shamir

HYDROLOGIC RESEARCH CENTER

GEORGIA WATER RESOURCES INSTITUTE

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INFORM:

Integrated Forecast and Management in Northern California

Hydrologic Research Center & Georgia Water Resources Institute

Sponsors:

CALFED Bay Delta Authority
California Energy Commission
National Oceanic and Atmospheric Administration

Collaborators:

California Department of Water Resources
California-Nevada River Forecast Center
Sacramento Area Flood Control Agency
U.S. Army Corps of Engineers
U.S. Bureau of Reclamation

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Vision Statement

- Increase efficiency of water use in Northern California using climate, hydrologic and decision science

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Goal and Objectives

- Demonstrate the utility of climate and hydrologic forecasts for water resources management in Northern California
- Implement integrated forecast-management systems for the Northern California reservoirs using real-time data
- Perform tests with actual data and with management input

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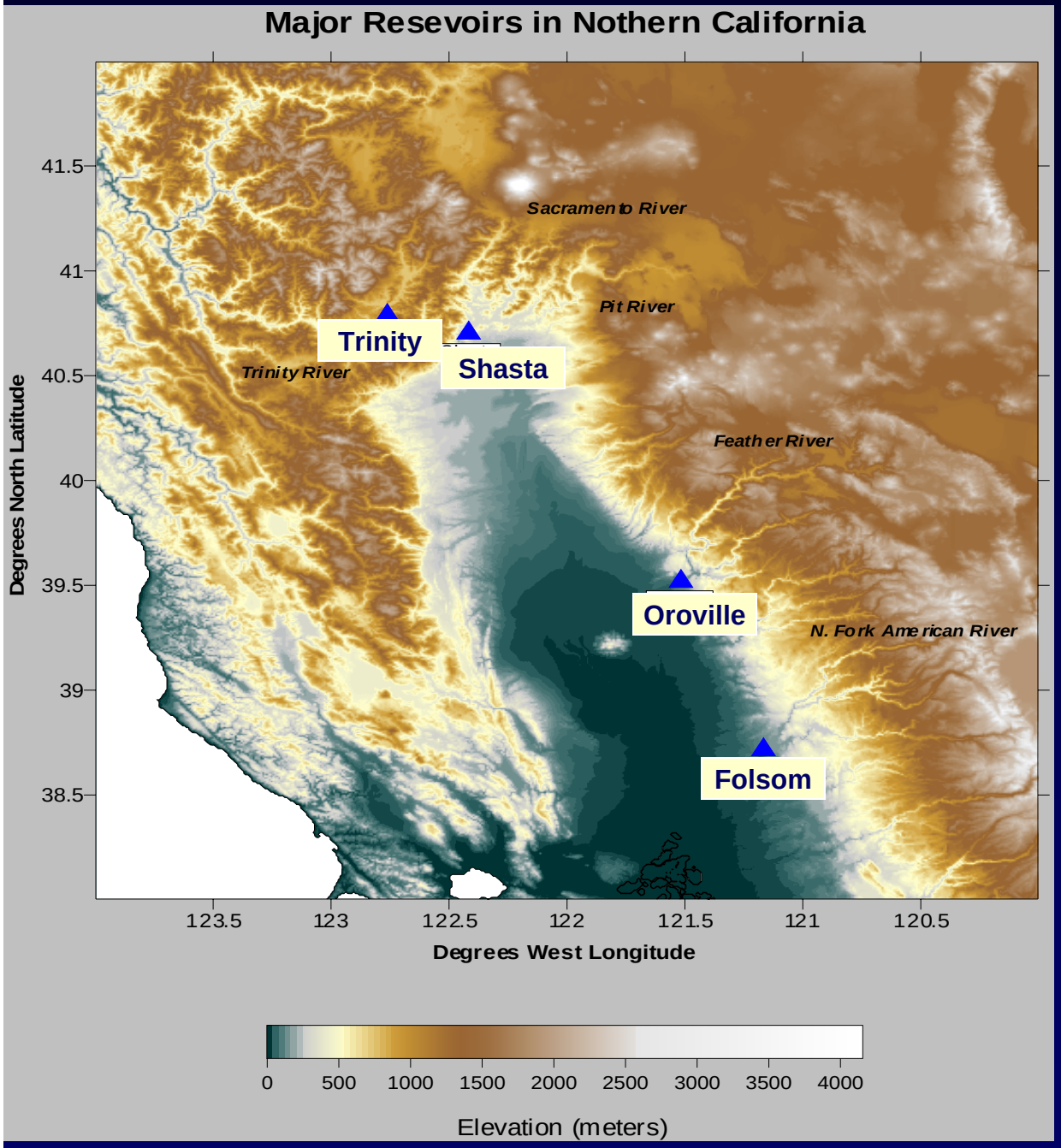

Application Area

Capacity of Major Reservoirs (million acre-feet):

Trinity - 2.4
Shasta - 4.5
Oroville - 3.5
Folsom - 1

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The hydrologic objectives complexity

- Objectives
  - **Comply with water supply to the delta**
  - **Flood mitigation and control**
  - **Water resources (2/3 of California potable water)**
  - **Fishery (Salmon hatching) (manage water temperature)**
  - **Agriculture in the Central Valley (7 million acres of irrigated AG)**
  - **Hydro power generation**
  - **In-stream ecology**
  - **Recreation**

- **Issues**
  - **Increasing Demand (California's Growing economy)**
  - **Aging infrastructure**
  - **Climate Change in the Sierra Nevada**
  - **Environmental Regulations**

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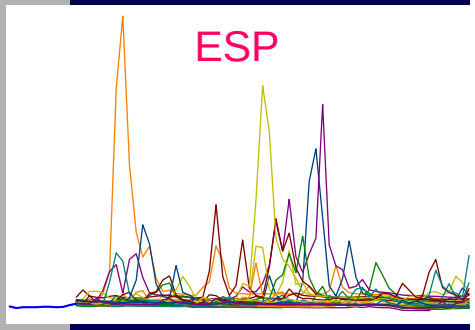
Utility of hydrologic forecast: A retrospective study for Folsom Lake

- **Compare between:**
  - **current operational rules (nowcast with no forecast) and 1970-1992 forecast was generated every 5-day with daily resolution for 2-month horizon from:**
  - **NWS procedure for Ensemble Streamflow Prediction (ESP)**
  - **Monthly estimates of precipitation and temperature from two Global Climate Models (GCM)**
    - **a) Canadian model (CGCM)**
    - **b) Max Plank Institute of Meteorology (ECHAM)**
  - **Perfect forecast scenario (retrospective) data**



- Georgakakos et al. 2005 EOS
- Carpenter and Georgakakos 2001 J. of Hydrology
- Yao and Georgakakos 2001 J. of Hydrology

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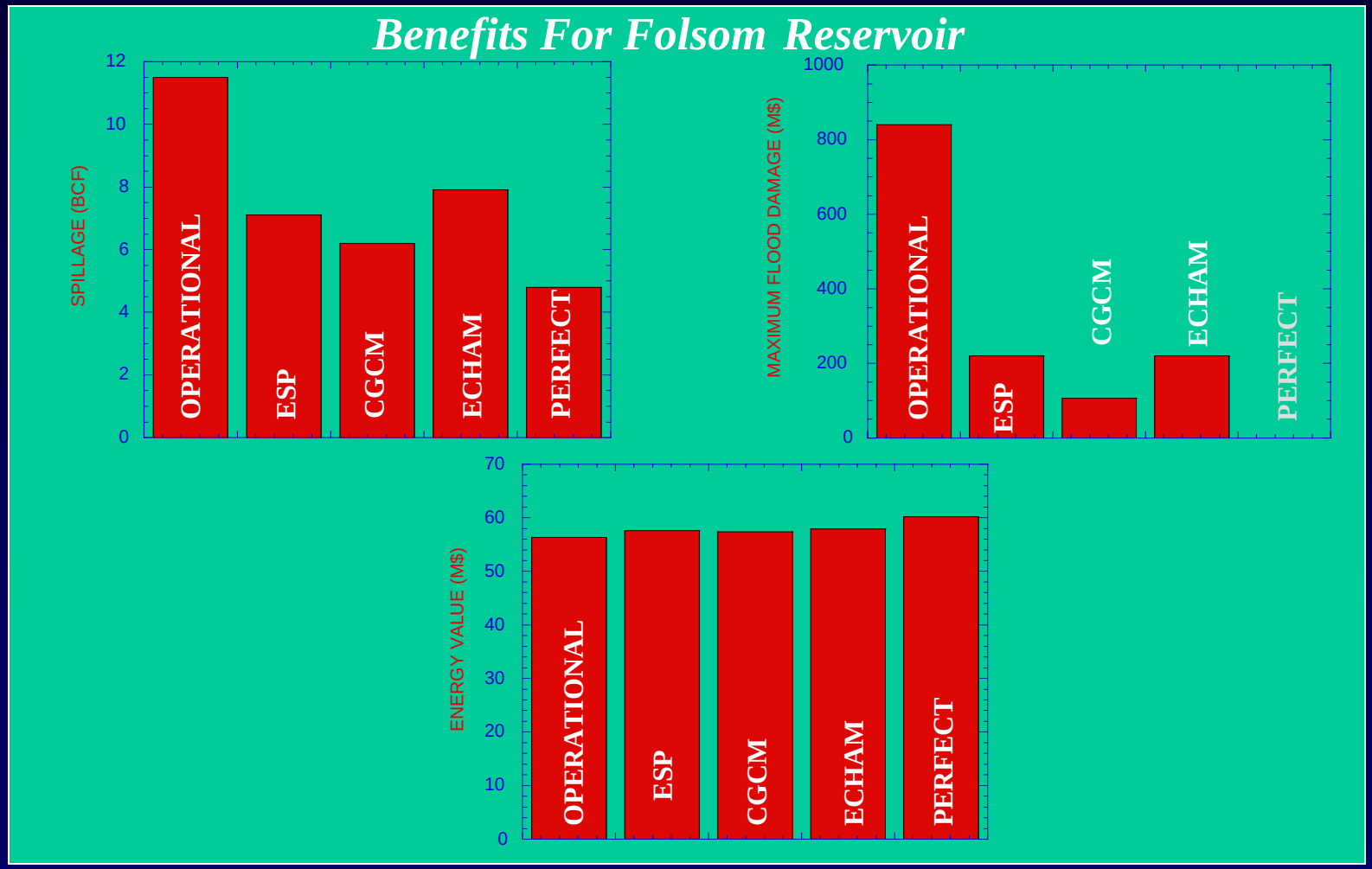
Results of operation based on rigid operational rules



Carpenter and Georgakakos (2001); Yao and Georgakakos (2001); Georgakakos et al., (2004)

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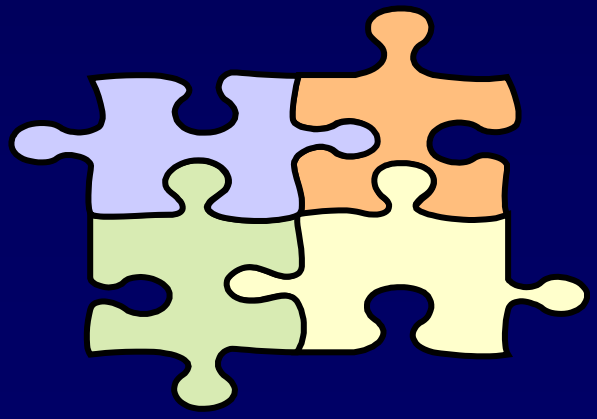
The problem

- Synoptic and climatic forecast contain uncertainty
  - The effective use of these needs to explicitly account for the uncertainty both in the forecast and the operational management
- Reservoir is operated based on nowcast information and under institutional constrains
  - Rigid rules that provide list of actions based on current information



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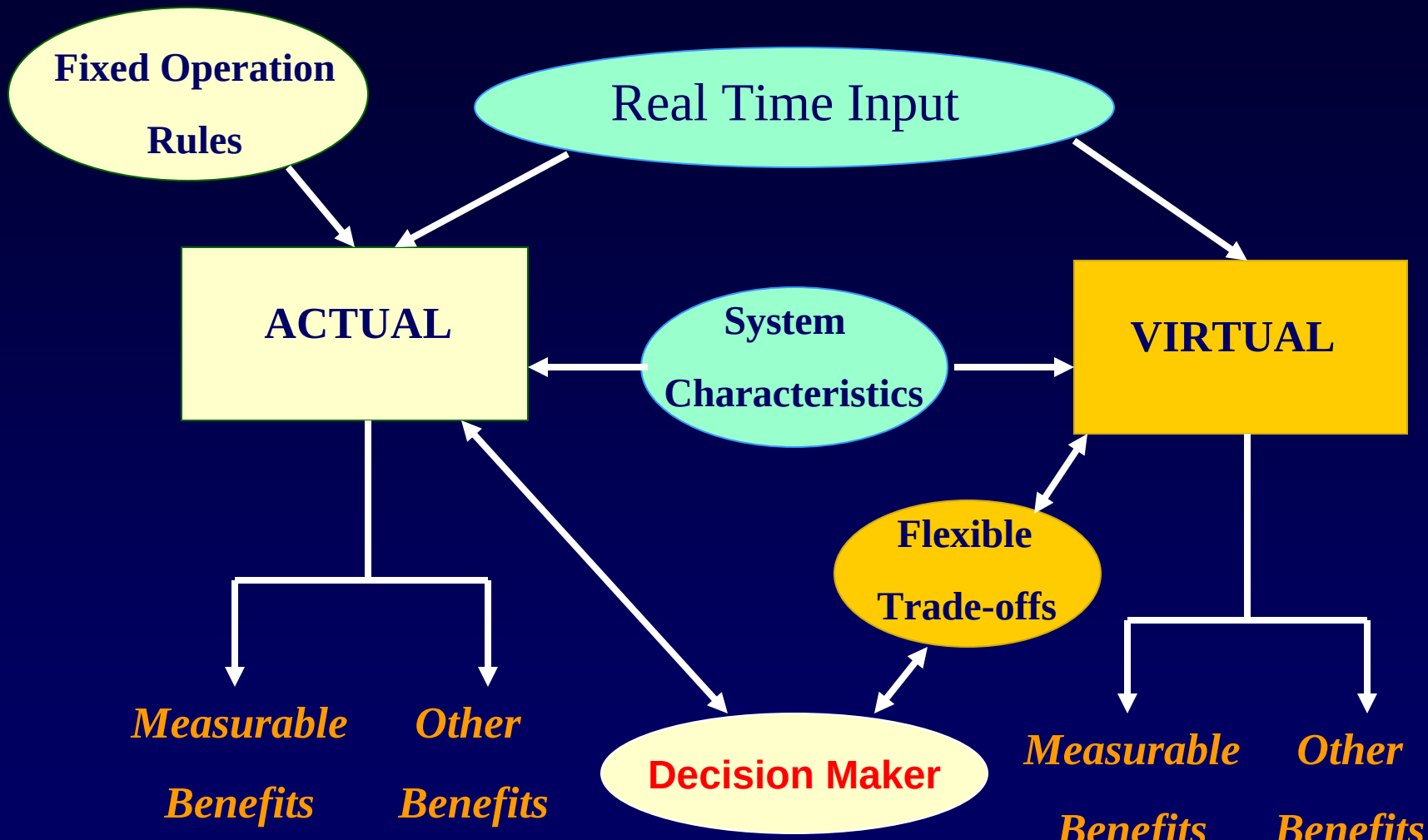
Demonstration Concept



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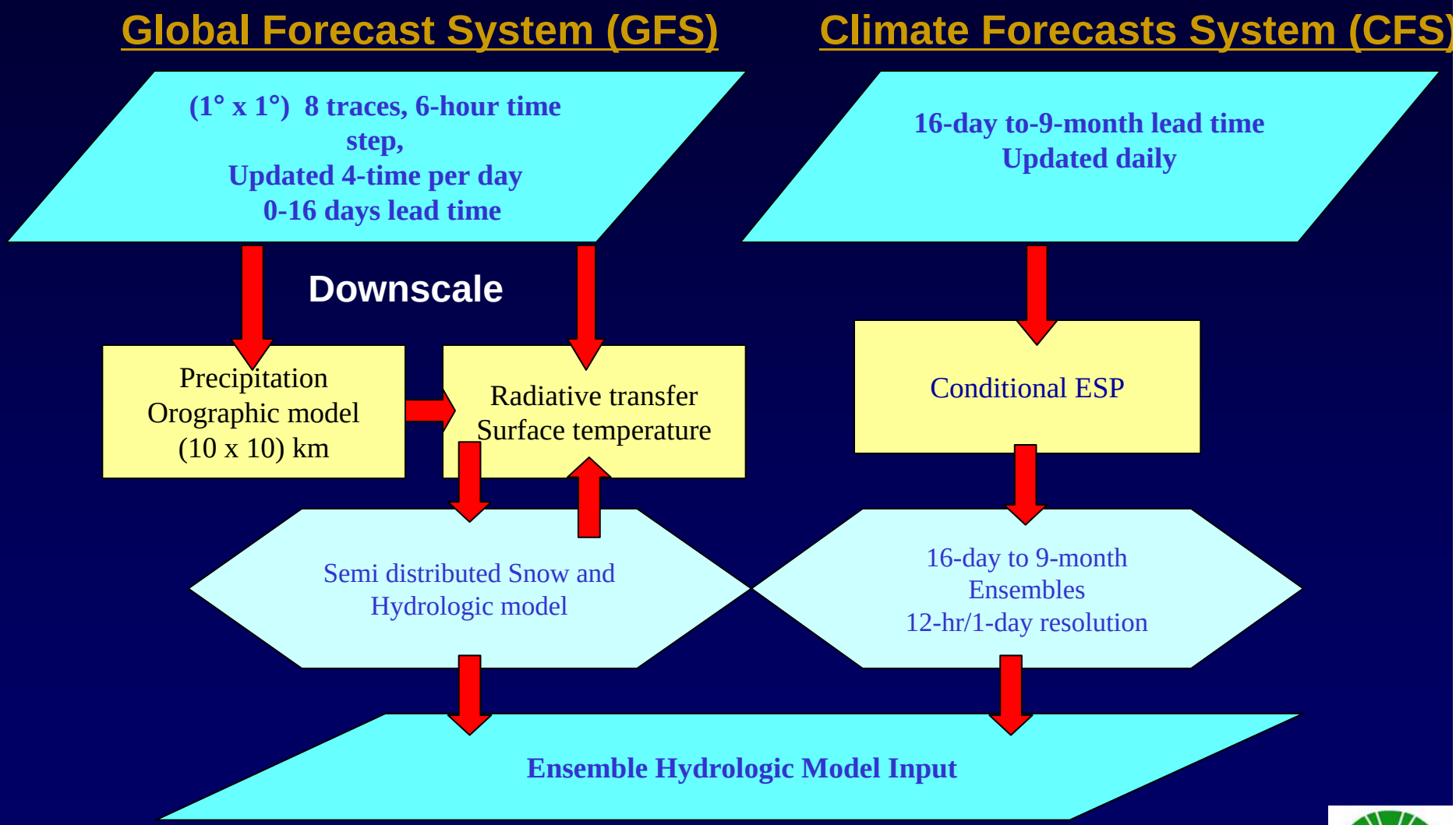
The modeling Components



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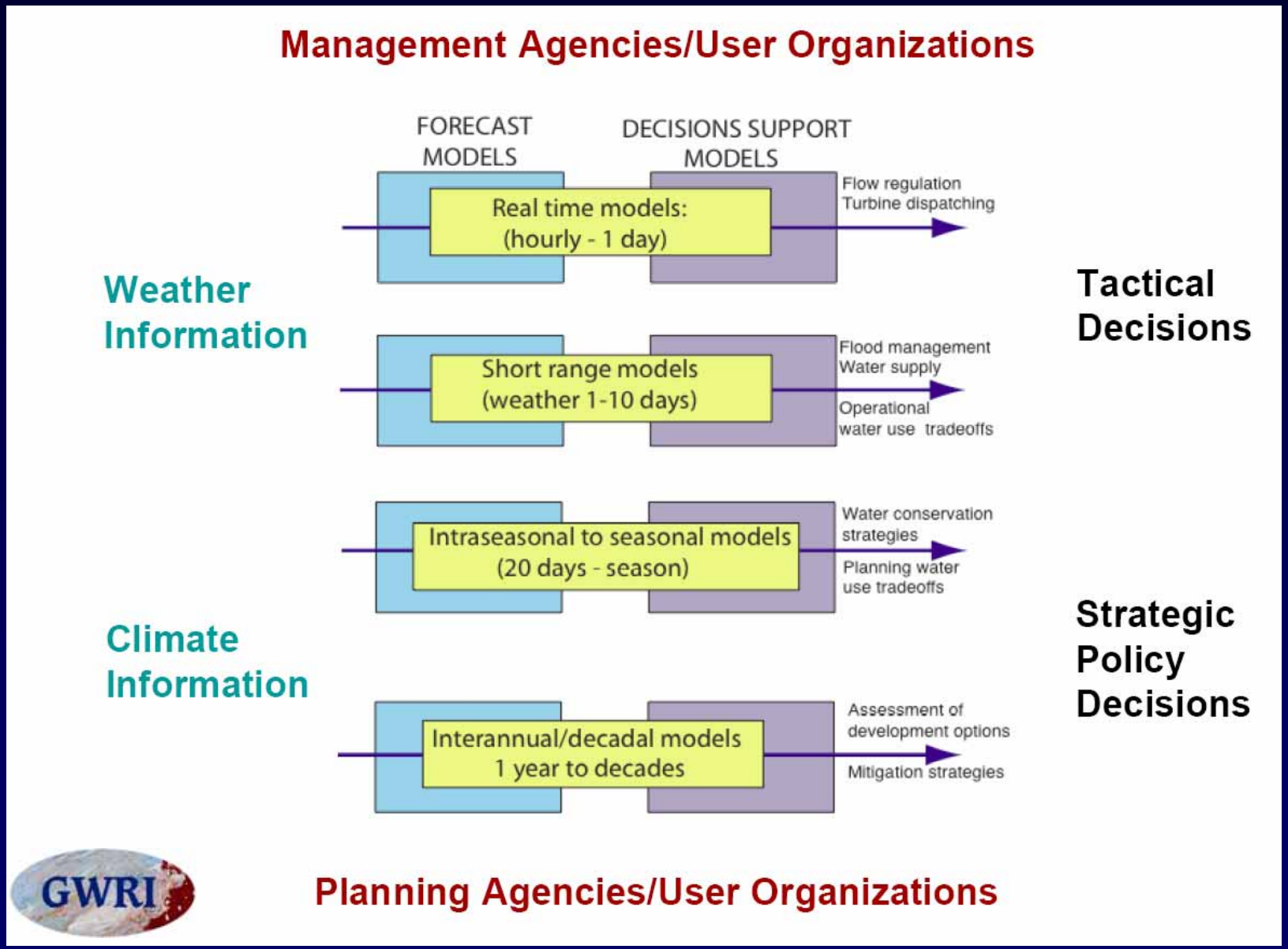
DSS – Multi Objective and temporal scale



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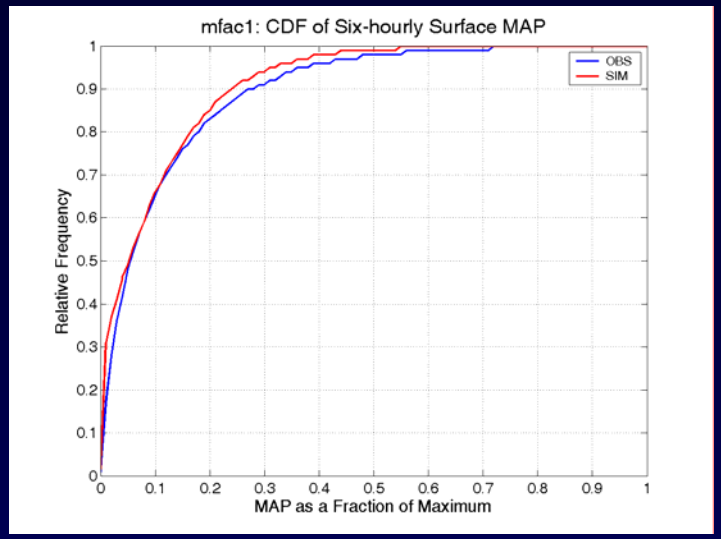
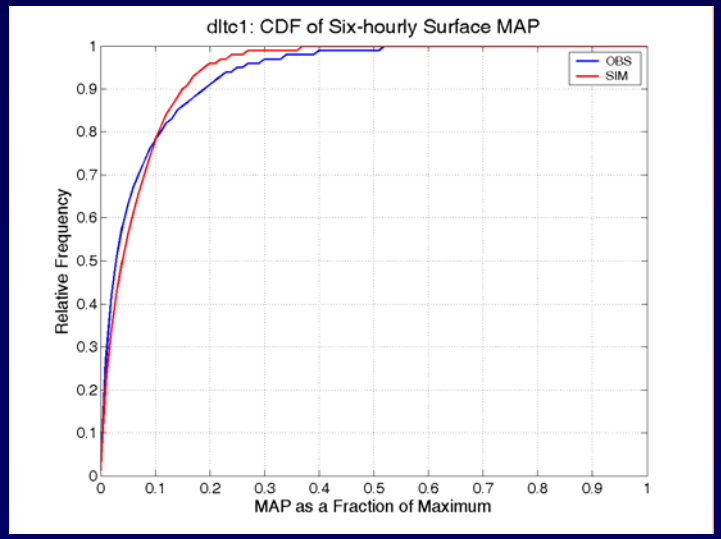
Precipitation Downscaling – Performance Measures





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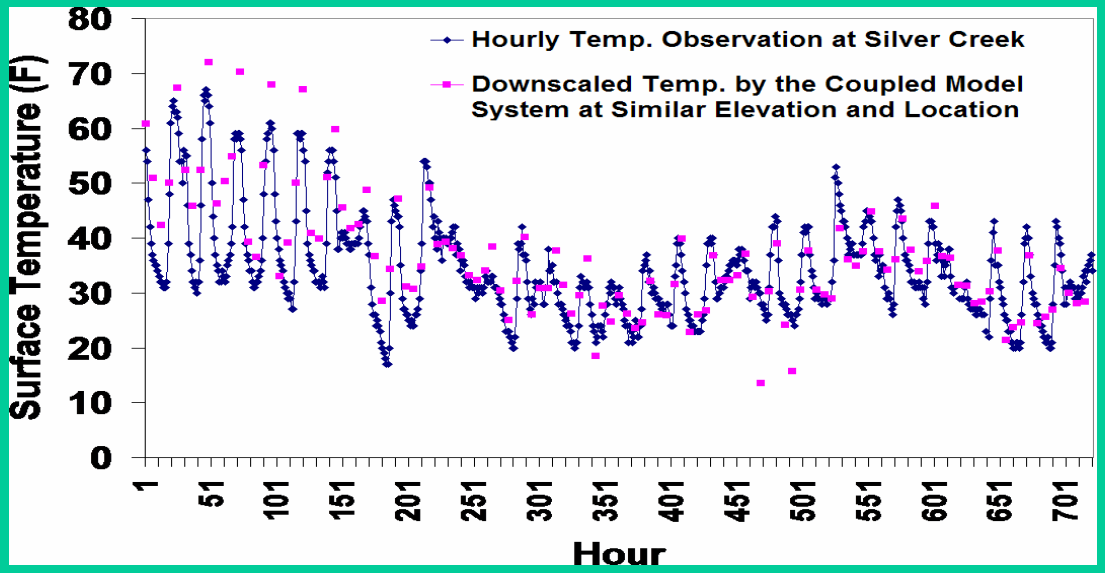
Temperature Downscaling - Tests



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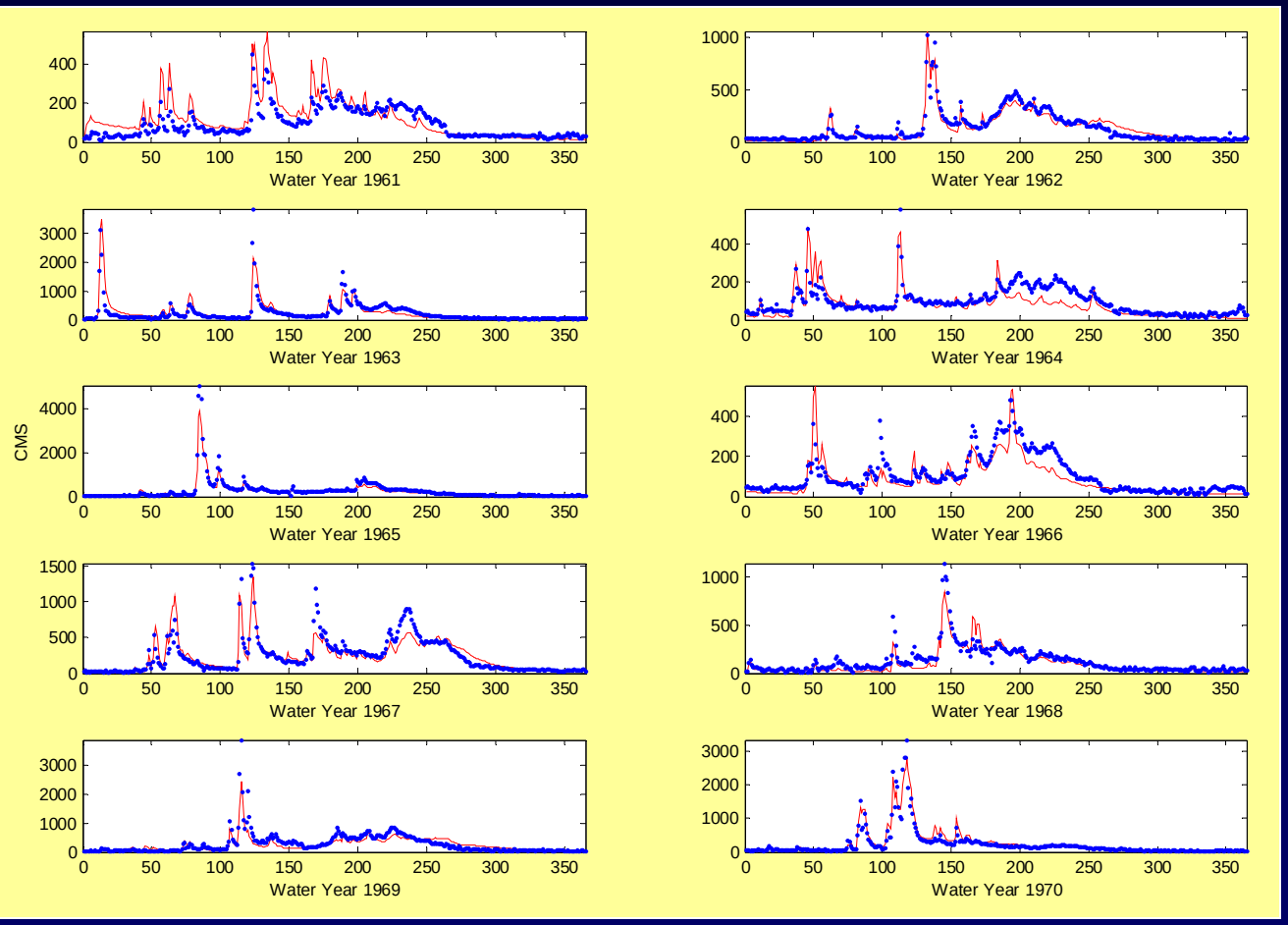
Examples of Hydrologic Performance Analysis – Time Series

OROVILLE DAILY FLOW - CMS



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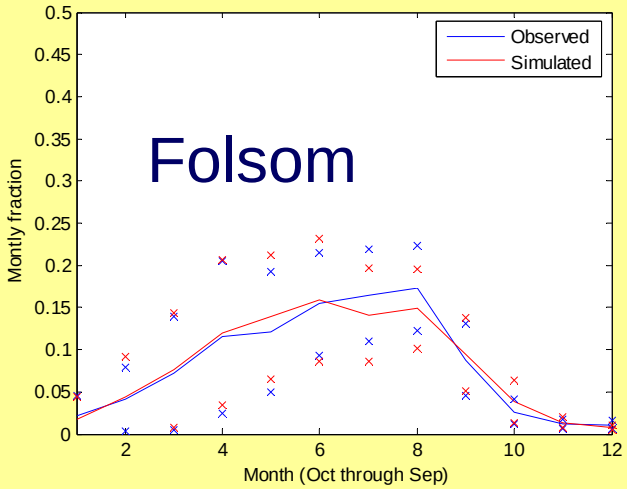
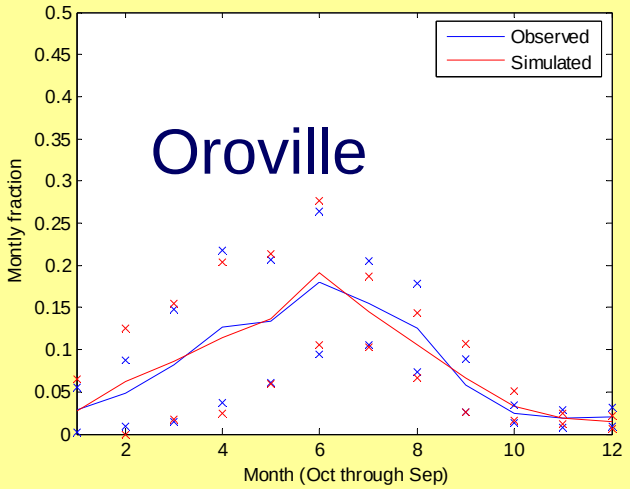
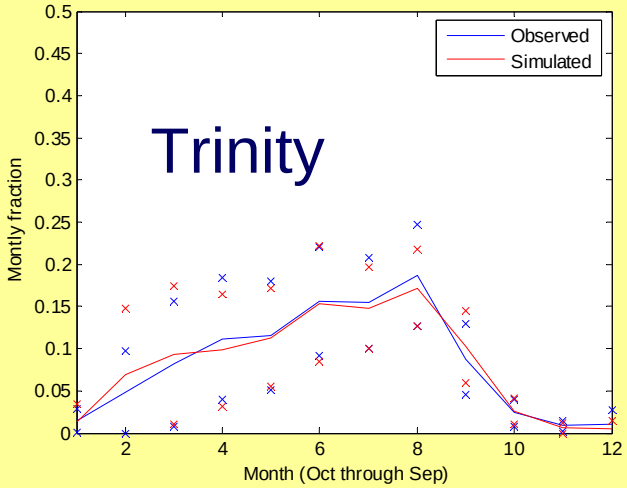
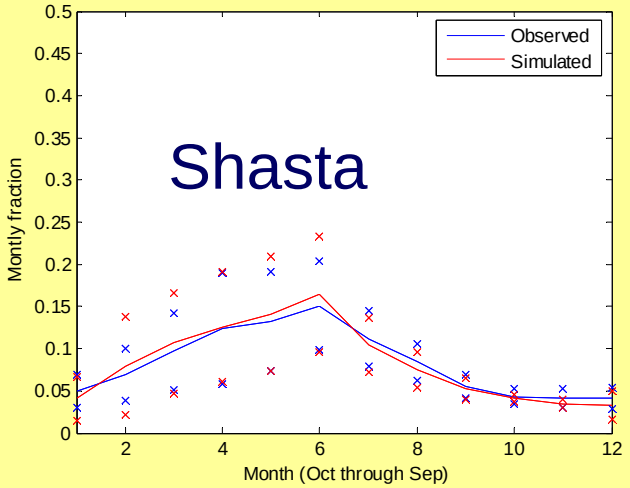
Examples of Hydrologic Performance Analysis – Monthly Climatology









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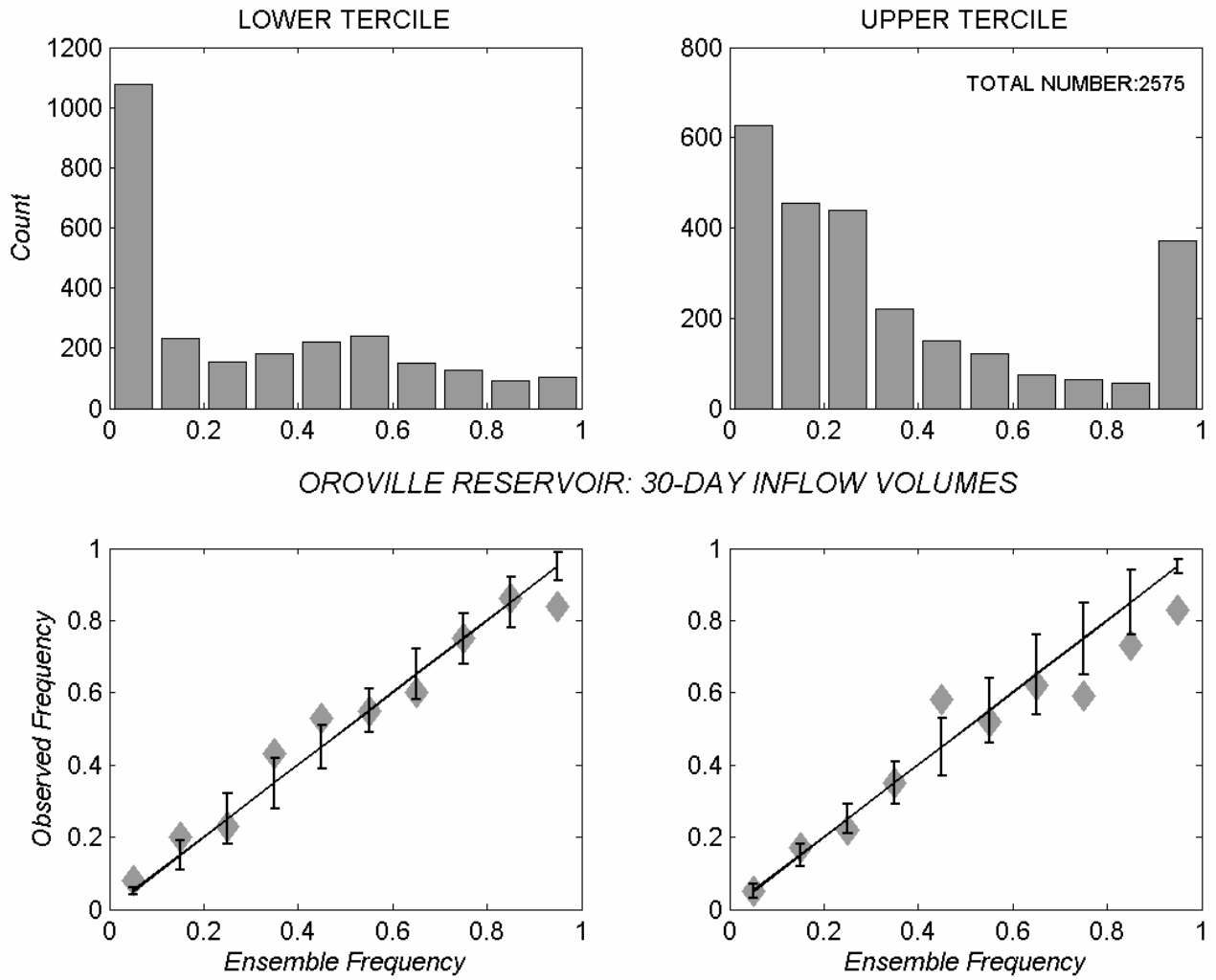
SAMPLE RELIABILITY DIAGRAMS



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Conclusion of Hydrologic Performance Analysis

- INFORM hydrology model performed well and captured the hydrologic response with respect to timing and magnitude, and for various temporal scales
- Performance analogous to what was found for the operational CNRFC hydrology forecast model running with the same parameters
- Ensemble Streamflow Predictions (ESP) have been validated over the historical horizon for all reservoir sites

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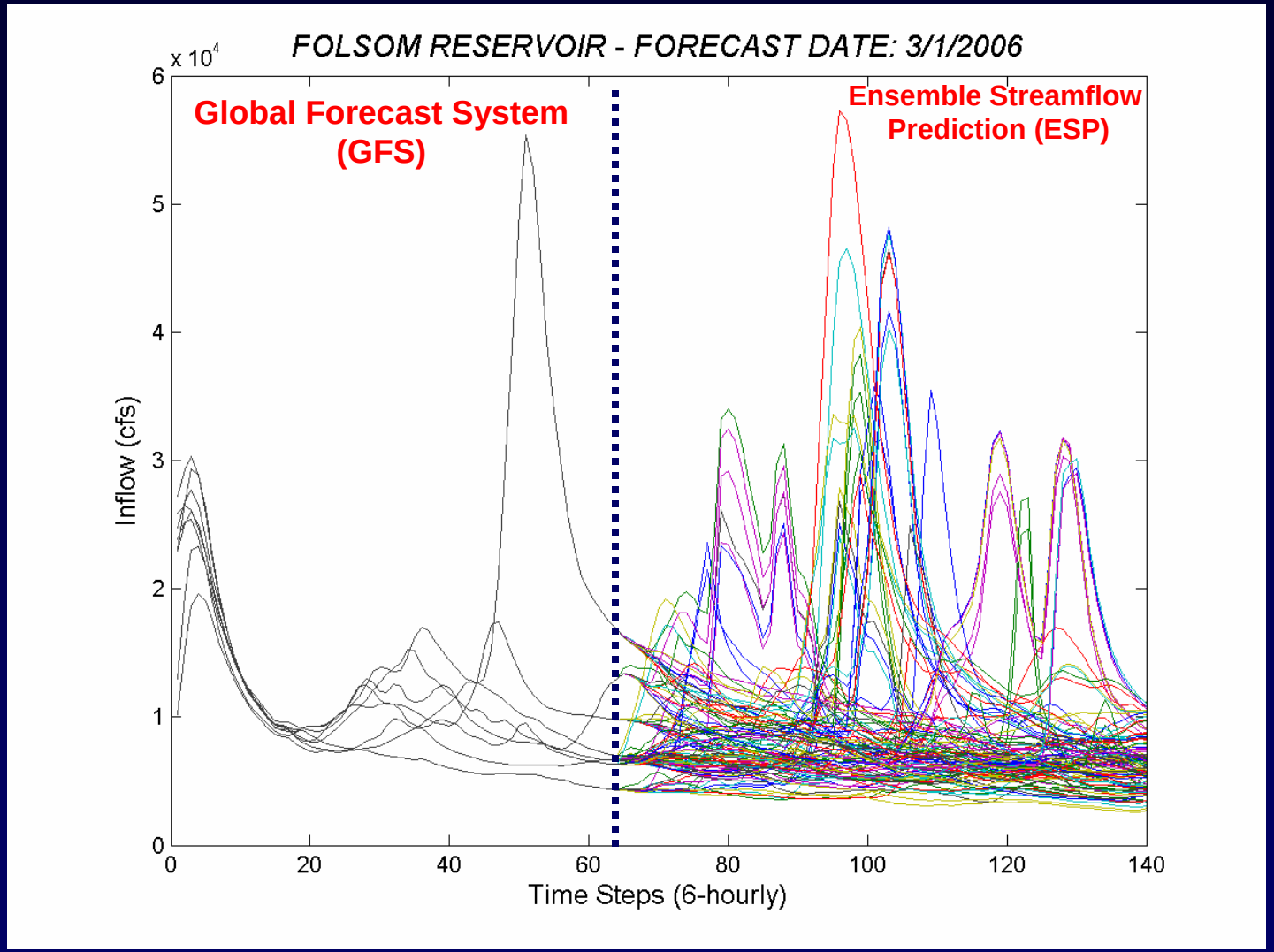
Sample of INFORM Product



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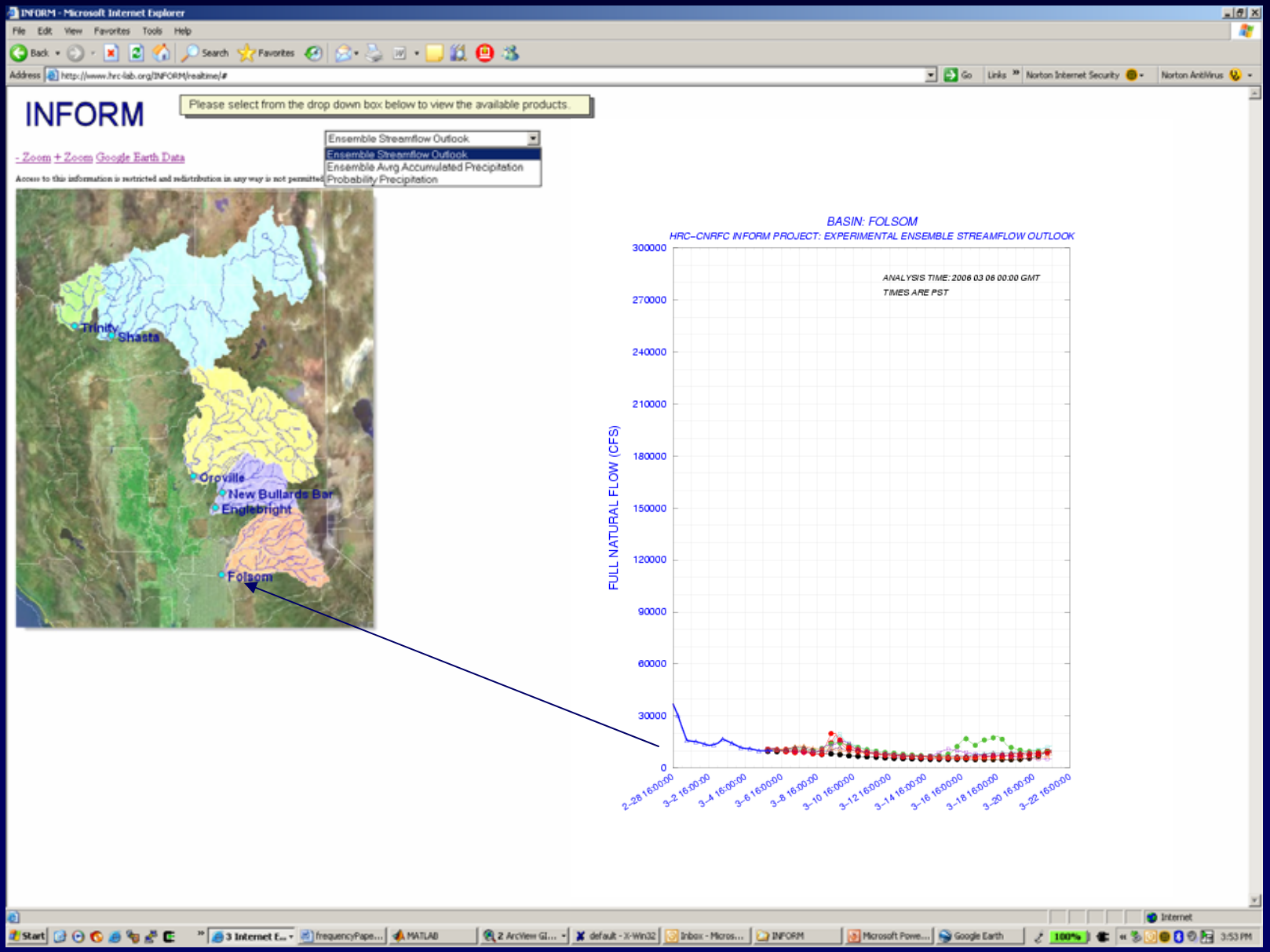
Web Dissemination



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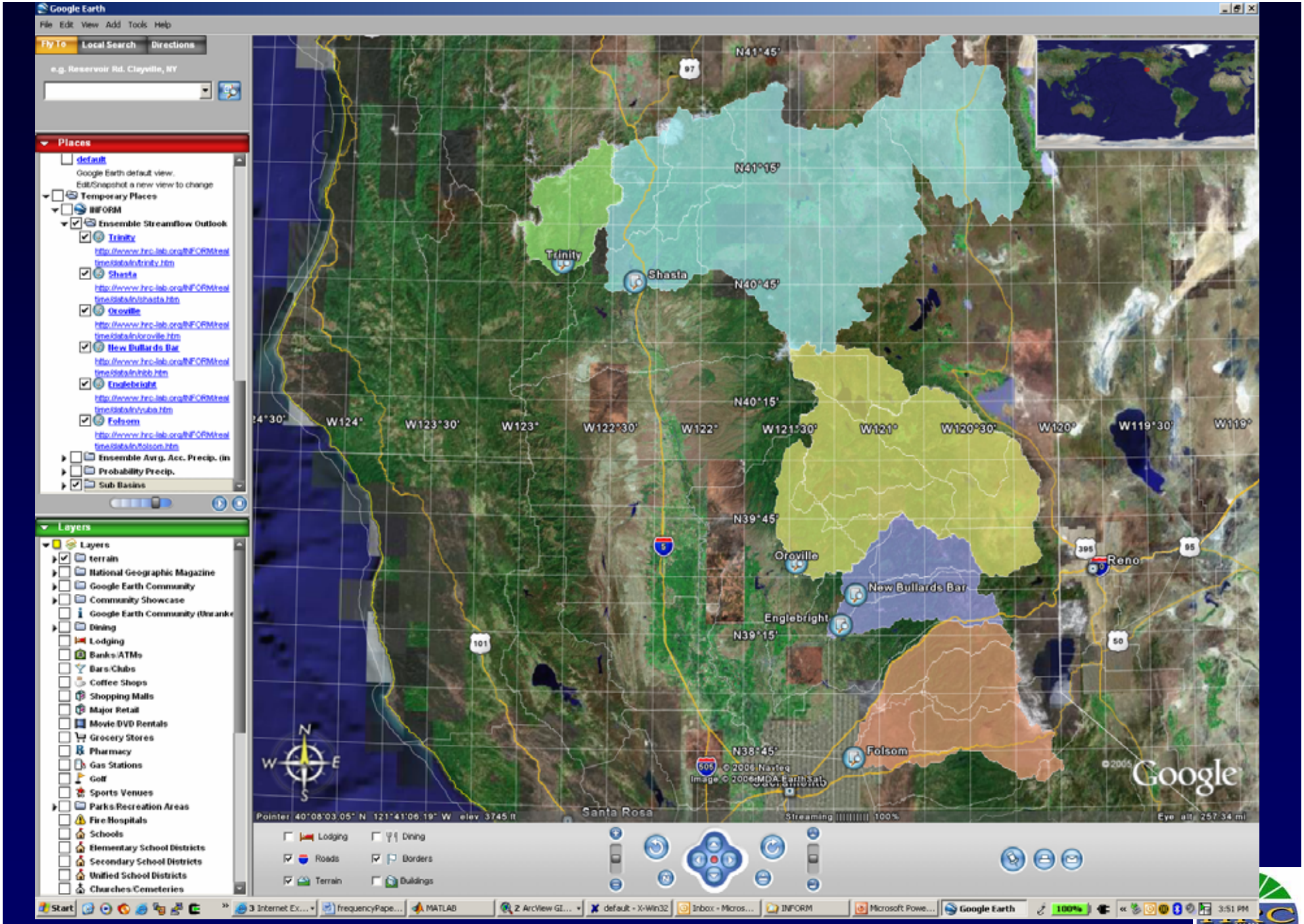
Google Earth
File Edit View Add Tools Help
Fly To
Local Search
Directions
e.g. Reservoir Rd. Clayville, NY
Places
default
Google Earth default view.
Edit/Snapshot a new view to change
Temporary Places
INFORM
Ensemble Streamflow Outlook
Trinity
Shasta
Oroville
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Sub Basins
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terrain
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Google Earth Community
Community Showcase
Dining
Lodging
Banks/ATMs
Bars/Clubs
Coffee Shops
Shopping Malls
Major Retail
Movie DVD Rentals
Grocery Stores
Pharmacy
Gas Stations
Golf
Sports Venues
Parks/Recreation Areas
Fire/Hospitals
Schools
Elementary School Districts
Secondary School Districts
Unified School Districts
Churches/Cemeteries
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Oroville
New Bullards Bar
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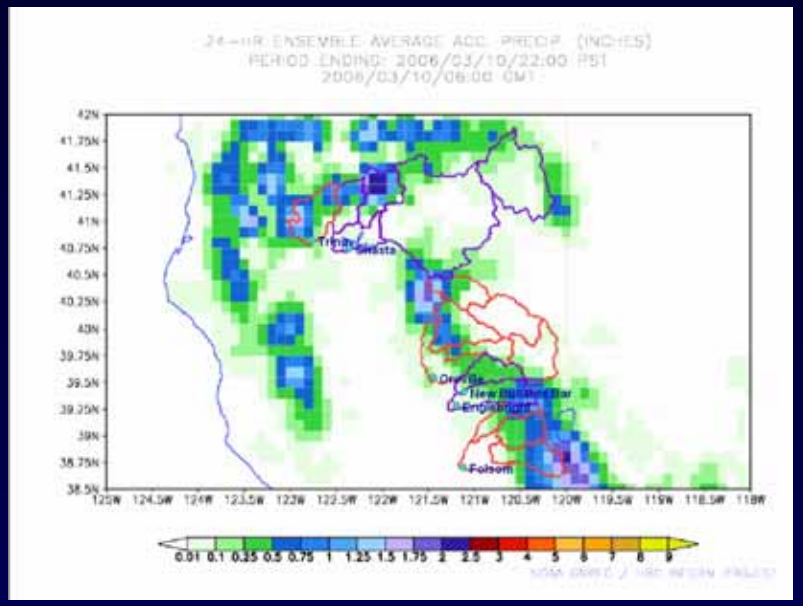
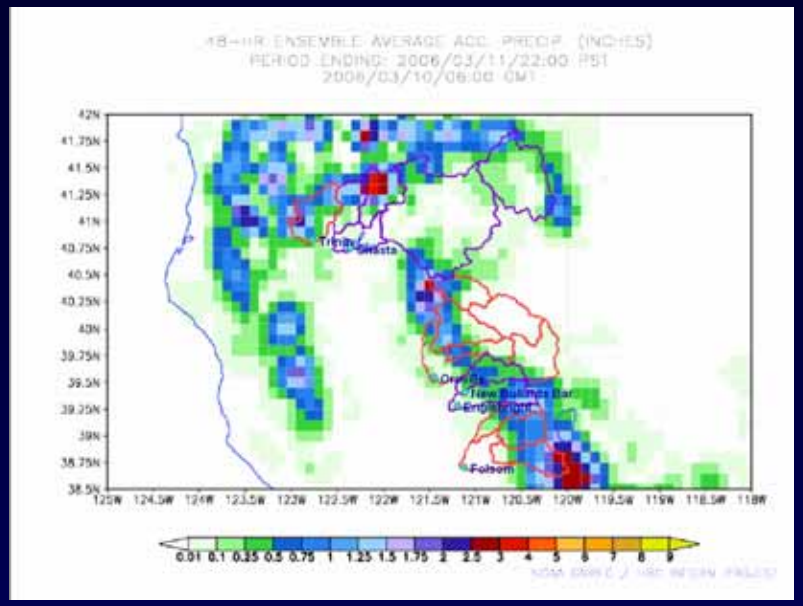
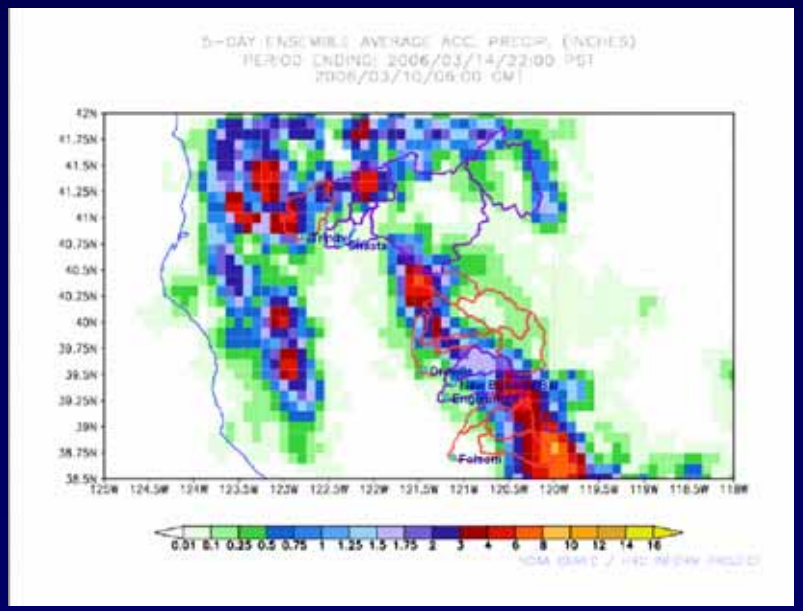
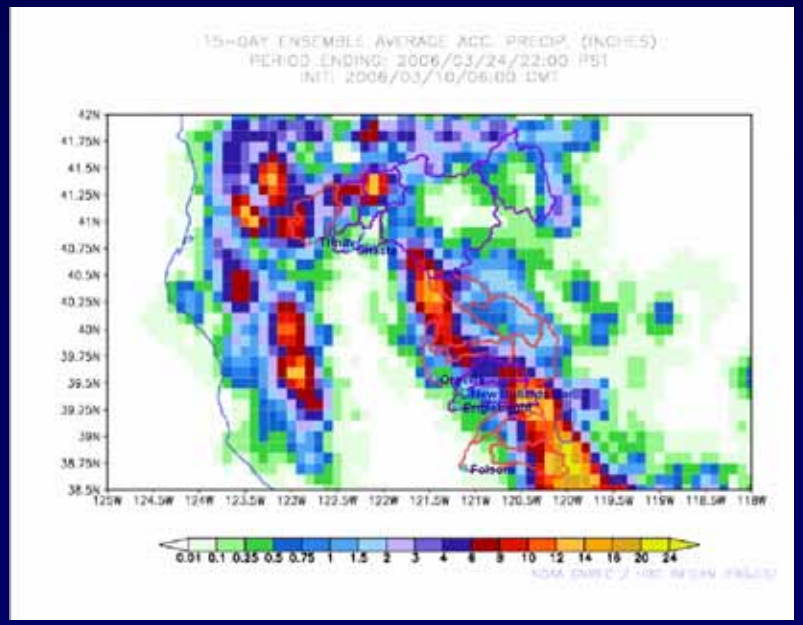
Google Earth

Forecast issued: March 9, 2006 22:00 PST









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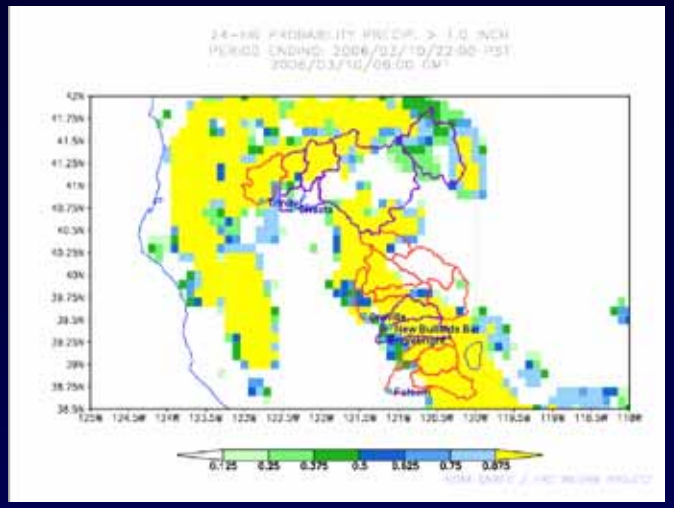

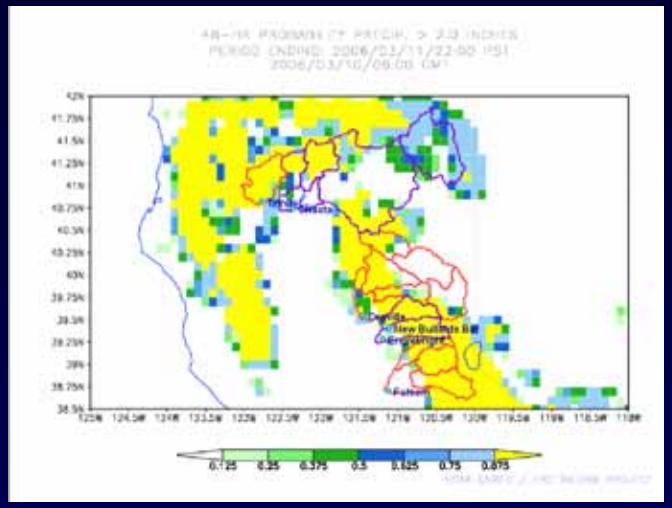

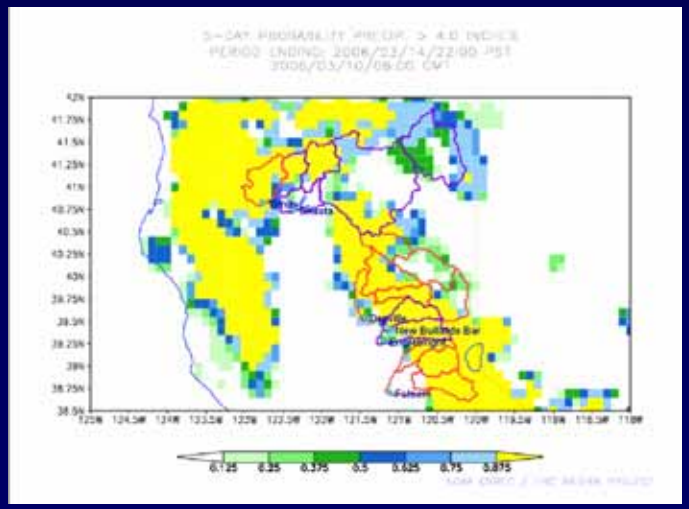

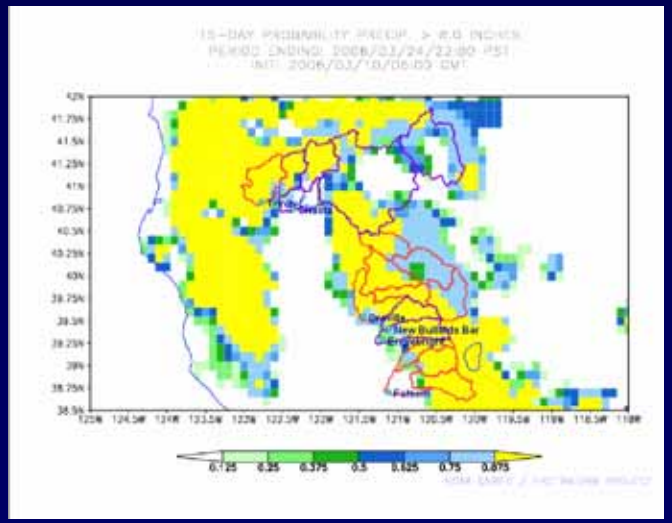

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FUTURE PLANS

- INFORM quasi-operational testing during Winter 2005 and performance assessment
- Use the INFORM structure for assessing climate and demand change impacts on management for conservation, flood control, downstream objectives and energy production
- What-if simulations for training, preparation and modification of current operational procedures

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