

NOAA Efforts to Improve Precipitation and Flood Forecasting by Studying American River

Robert K. Hartman, Hydrologist-in-Charge
NOAA, National Weather Service
California-Nevada River Forecast Center
3310 El Camino Avenue, Suite 227
Sacramento, CA 95821

Tel: 916-979-3056, x322
Fax: 916-979-3067
Email: Robert.Hartman@noaa.gov
Web: <http://www.wrh.noaa.gov/cnrfc>

BIOGRAPHICAL SKETCH

Robert Hartman is the Hydrologist-in-Charge at the California-Nevada River Forecast Center. Mr. Hartman has 23 years of federal flood and water supply forecasting experience including 9 years in his current position. Mr. Hartman's experience includes all aspects of RFC operations, development, and management obtained in positions at three National Weather Service River Forecast Centers, the USDA/Soil Conservation Service, and the NWS Office of Hydrology. Mr. Hartman has a B.S. degree in Forestry from Utah State University and an M.S. degree in Watershed Management from the University of Arizona.

ABSTRACT

The National Oceanic and Atmospheric Administration (NOAA) plans to undertake two related research efforts to improve precipitation, flood, and water resources forecasting. The presentation will briefly describe the Hydrometeorological Testbed (HMT) and the Distributed Model Intercomparison Project: Phase 2 (DMIP 2) with emphasis on the research being proposed for the North Fork of the American River.

The HMT program is being developed for the purpose of advancing water resources data assimilation. The general strategy of this effort is to conduct research and development to deploy advanced systems for observed information to support critical decision making for flood mitigation, hydropower energy generation, water resources control, and fisheries management. More specifically, high resolution atmospheric and hydrometeorologic observations (precipitation, soil moisture, snowpack, winds, temperature, and moisture) will be collected and analyzed for several key water resource applications such as distributed hydrologic model validation, quantitative precipitation forecast (QPF), and estimation (QPE) validation.

DMIP 2 continues the work begun under DMIP 1 to conduct research into advanced hydrologic models for river and water resources forecasting. Twelve groups from the hydrologic research community participated in DMIP 1, resulting in a wealth of knowledge for the scientific community and valuable guidance for the National Weather Service (NWS) research program. DMIP 2 is designed around two themes: 1) continued investigation of science questions pertinent to the DMIP 1 test sites, and 2) distributed and lumped model tests in hydrologically complex basins in the mountainous Western US.



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NOAA/NWS/CNRF



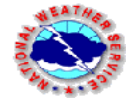
A Two Part Episode...

- NOAA Hydrometeorological Testbed
 - David Kingsmill
 - University of Colorado / CIRES and NOAA Environmental Technology Laboratory - Boulder, CO
- Distributed Model Intercomparison Project 2
 - Mike Smith
 - NOAA – NWS – Office of Hydrologic Development – Silver Spring, MD



Why an HMT?

- Integrated Planning Team for Hydrological Services Report (September 2002)
 - Key Information Gaps
 - Quantitative Precipitation Information (QPE & QPF)
 - Unbiased Precipitation Estimates with Reliability Information
 - Reliable 0-6 Hour Precip. Nowcasts
 - Longer-term, Unbiased Model QPFs
 - Hydrologic Forecasting
 - High-resolution Flash Flood Forecasts & Warnings
 - Probabilistic River Forecasts Using 0-3 day QPF and Seasonal Precipitation Forecasts
 - Outstanding R&D Needs
 - Implement Hydrometeorological Testbeds to Demonstrate & Evaluate Next-Generation Datasets, Forecast Techniques, & Models

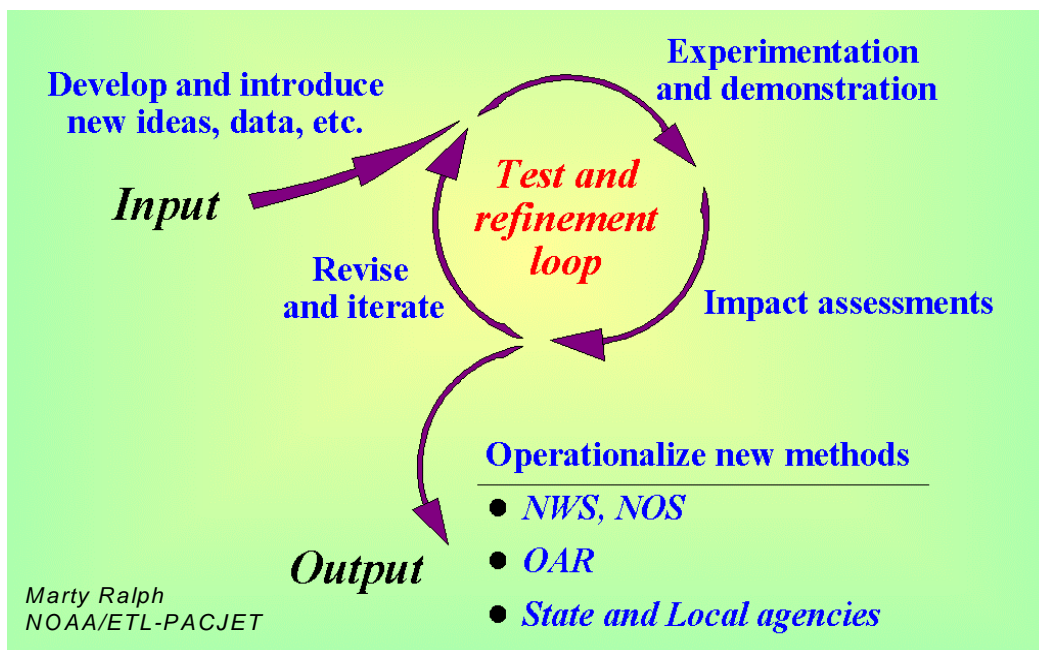


HMT Goals

- Systematically evaluate promising new methods that can influence both NWP and nowcasting using the man-machine mix forecasting paradigm.
- Assess their value in terms of improved regional performance on Flood/Flash Flood Warning and QPF GPRA measures.
- Use these results as an objective basis for decisions on transitions to operations both in the test region and nationally.



HMT Concept



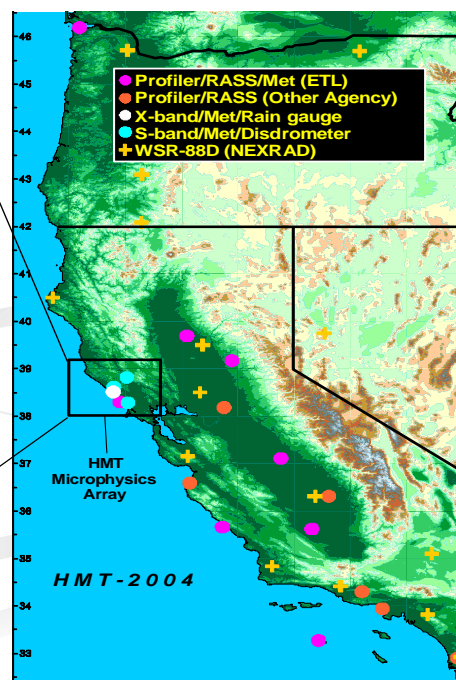
HMT-2004 Russian River



HMT-2004 Microphysics Array

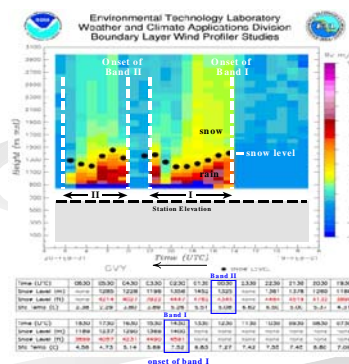
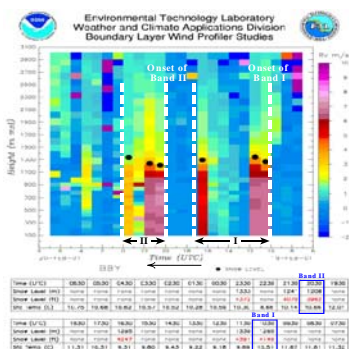
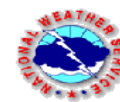


- | | |
|------------------------|-------------------|
| BBY = Bodega Bay | HBG = Healdsburg |
| BSC = Big Sulfur Creek | HLD = Hopland |
| CVD = Cloverdale | LSN = Lake Sonoma |
| CZC = Cazadero | ROD = Rio Dell |
| FRS = Fort Ross | SPT = Salt Point |
| GRK = Goat Rock | |

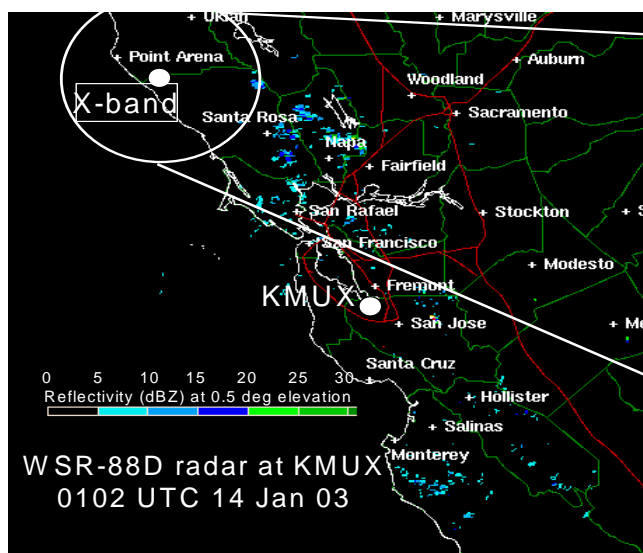




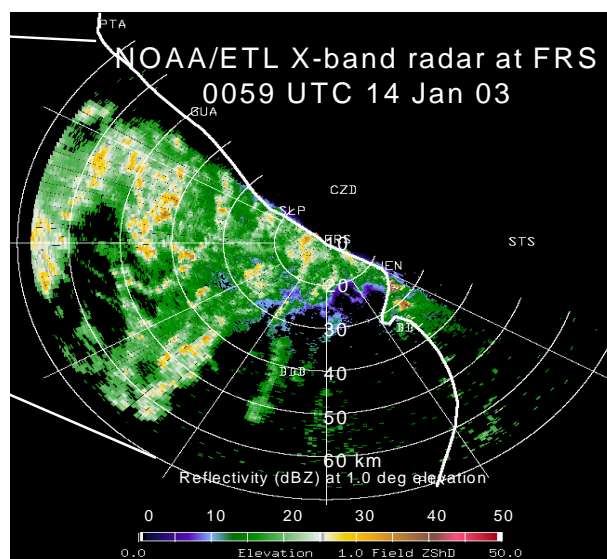
Russian River HMT Bodega Bay vs. Grass Valley Winder Profiler Data



Gap-Filling X-band Radar vs. WSR-88D



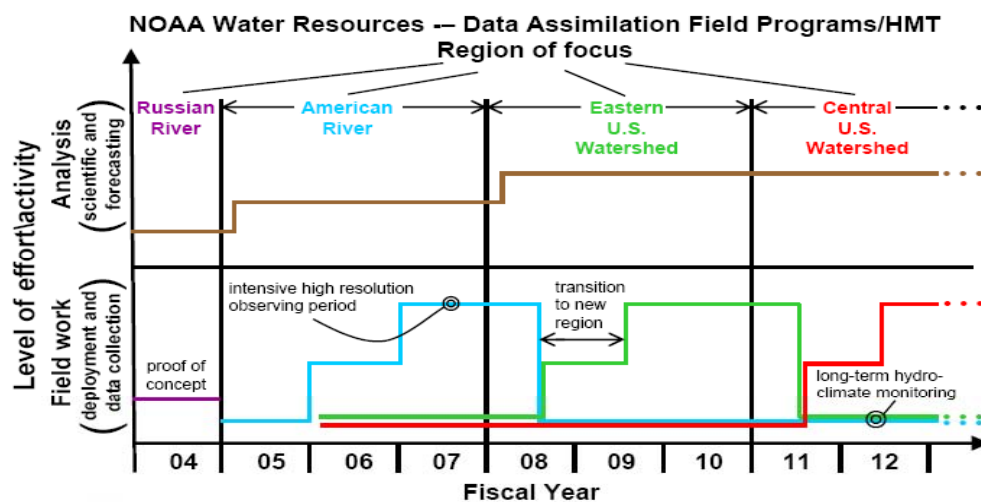
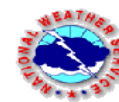
- Nearest NEXRAD radar sees no significant echoes approaching flood-prone watershed



- NOAA/ETL's Coastal X-band radar fills NEXRAD gap



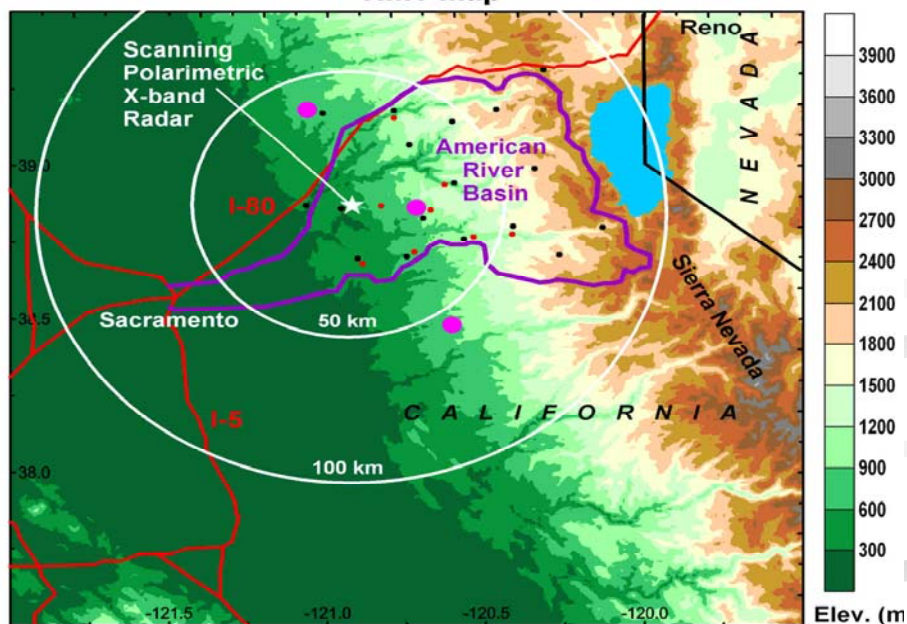
Proposed HMT Timeline



Science, Technology and Infusion
Hydrology
Local Forecasts and Warnings



American River Basin HMT 2005-2008



● profiling radar ● soil moisture probe ● precipitation gauge
(The number of instruments and their locations are not yet specified)



American River Basin HMT 2005-2008



- Focus on QPE (observations) and short-term QPF (forecasts). Also freezing level and snow level information.
- Focus on North Fork American
 - Concentration of data collection effort to develop a “truth set” upon which solid research, development, and direction can be based.



HMT Participation



- Project Management
 - David Kingsmill – NOAA/OAR/ETL
- NOAA Partners
 - OAR(ETL,NSSL,FSL,CDC,AOML)
 - NWS(OHD,HPC,NOHRSC,WR,ER,EMC)
 - NESDIS(ORA)
- Other Partners



Distributed Model Intercomparison Project GOALS

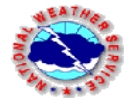


Engage the hydrologic modeling community to:

- Improve our understanding of the capabilities and limitations of distributed hydrologic models when forced by operational quality meteorological data
- Guide research and development in support of the NOAA's NWS mission to forecast river and stream conditions.



DMIP 1 Participants

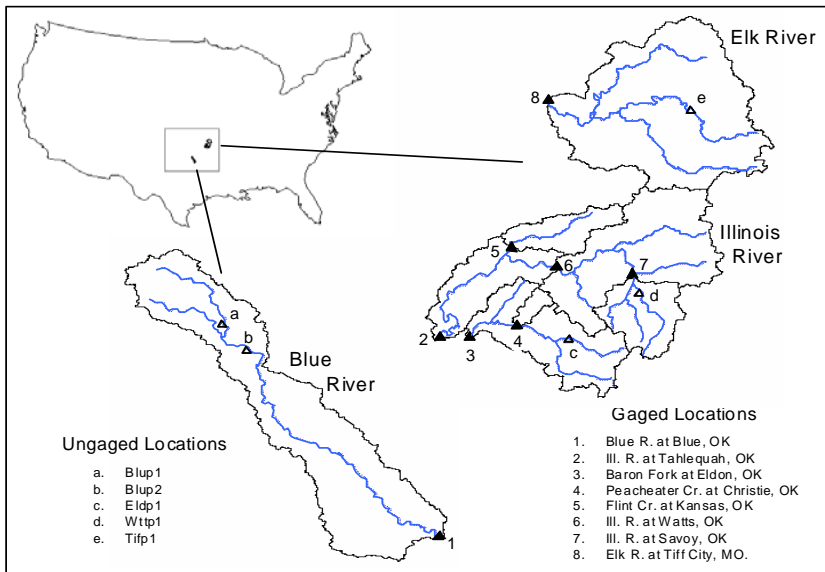
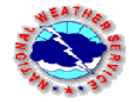


- 1) Massachusetts Institute of Technology (MIT)
- 2) Hydrologic Research Center (HRC)
- 3) DHI Water and Environment
- 4) Univ. of Arizona
- 5) National Centers for Environmental Prediction (NCEP)
- 6) Univ. of Oklahoma
- 7) Univ. of Waterloo, Ontario, Canada
- 8) Utah State Univ. and National Institute of Water Research (NIWR), New Zealand
- 9) U.S. NOAA National Weather Service Office of Hydrologic Development (OHD)
- 10) U.S. Department of Agriculture (USDA) Blackland Research Center
- 11) Univ. of California at Berkeley
- 12) The Hydraulic and Electrical College of WuHan Univ., China



DMIP 1 Basins and Timeline

<http://www.nws.noaa.gov/oh/hrl/dmip/>



2000

Jan – Jun: DMIP plan developed

2001

Dec: DMIP officially begins, web set open

Jan: Data available on web

2002

March: Participants submitted simulations

August: DMIP workshop at NOAA's NW S/OHD

2003

2004

Oct: DMIP Special Issue, *Journal of Hydrology*, 298

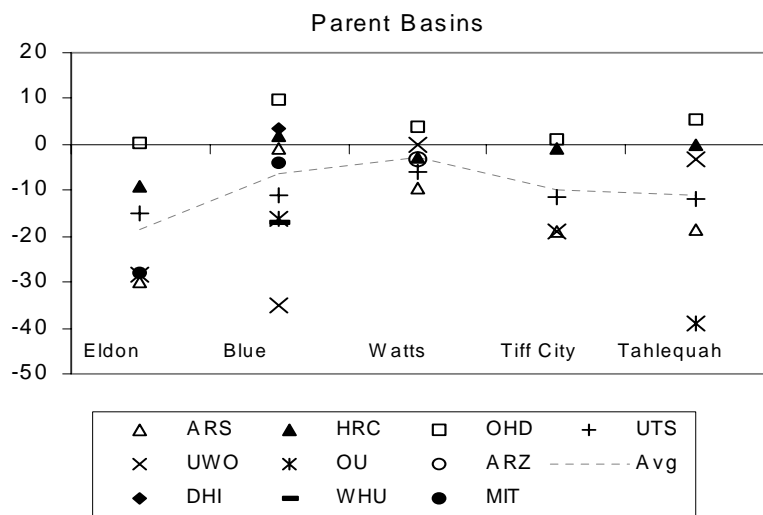
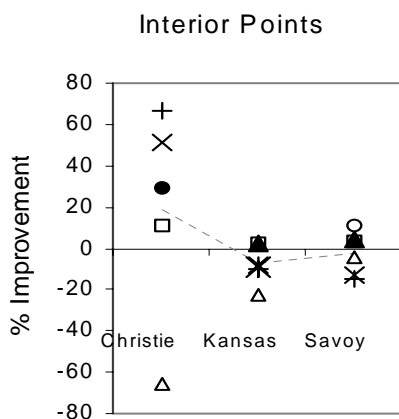
8 Gauged Basins Ranging in Size from 65 – 2500 km²



DMIP 1 Results



Percent improvement in flood peak prediction from calibrated distributed hydrologic models compared to the lumped model



Δ	ARS	▲	HRC	◻	OHD	+	UTS
×	UWO	×	OU	○	ARZ	---	Avg
◆	DHI	-	WHU	●	MIT		



DMIP 1 Conclusions

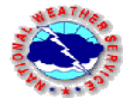


- Some distributed hydrologic models can produce simulations comparable to or better than lumped models. Many cannot.
- Distributed model parameters derived from physical data provide reasonable initial guesses but parameter calibration significantly improves outlet simulations.
- The most significant gains from distributed models over lumped models were seen for a long, narrow basin, the Blue River (1233 km²), and a small interior gage, Peacheater Creek (65 km²).

(See Journal of Hydrology, Volume 298, 2004, Special Issue for details)



DMIP 1 Conclusions



- Distributed models produced reasonable results at interior points but not as good statistically as those from parent basins.
- Models that combined conceptual rainfall-runoff techniques with physically-based routing techniques showed the best performance (HL-RMS is an example).
- The mean of selected model ensembles compares favorably with that of the single best distributed model

(See Journal of Hydrology, Volume 298, 2004, Special Issue for details)



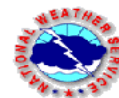
DMIP 2 Science Goals



- Confirm basic DMIP 1 conclusions with a longer validation period and more test basins
- Improve our understanding of distributed model accuracy for small, interior point simulations
- Evaluate new re-analysis forcing data sets
- Evaluate the performance of distributed models in prediction mode
- Use available soil moisture data to evaluate the physics of distributed models



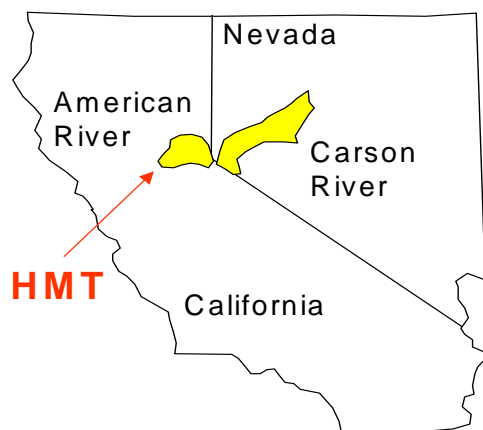
DMIP 2 Science Goals



- Improve our understanding of the way routing schemes contribute to the success of distributed models by designing an experiment that uses a common routing model
- Continue to gain insights into the interplay among spatial variability in rainfall, physiographic features, and basin response, specifically in mountainous basins
- Improve our understanding of scale issues in mountainous area hydrology
- Improve our ability to characterize simulation and forecast uncertainty in different hydrologic regimes



DMIP 2 - Scope



Tests with Complex Hydrology

1. Snow, Rain/snow events
2. Soil Moisture
3. Lumped vs. Distributed
4. Mountain Terrain

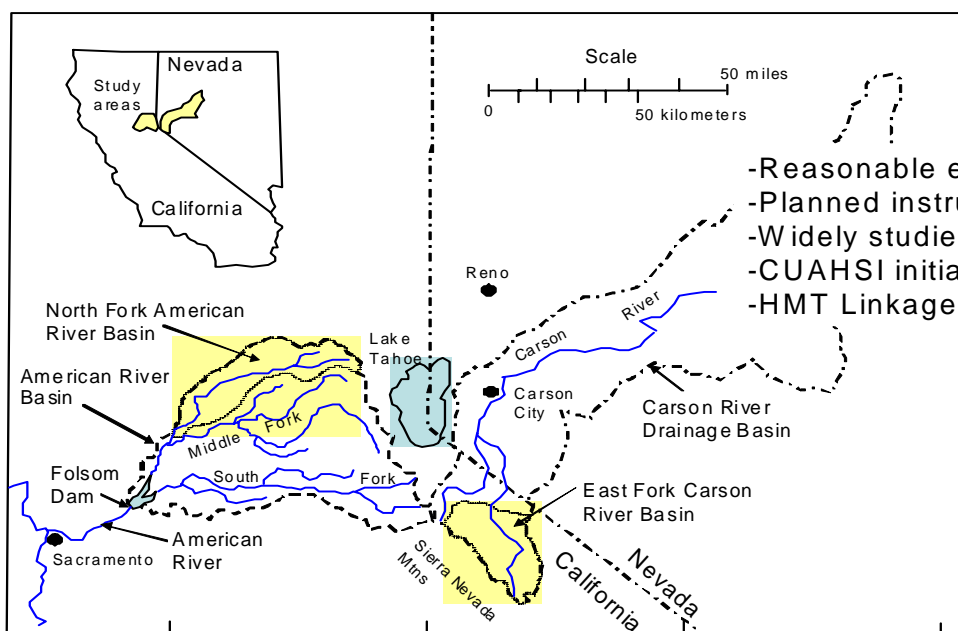


Additional Tests in DMIP 1 Basins

1. Routing
2. Soil Moisture
3. Lumped vs. Distributed
4. Prediction mode



DMIP 2 - Sierra Nevada Basins





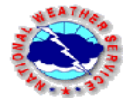
Proposed DMIP 2 Timeline



- March 2005 -- Distribute Science Plan for review
- October 2005 – Project start, basic data available on web (not ETL data)
- October 2006 – Oklahoma simulations due
- July 2007 – Sierra Nevada basic simulations due
- October 2007 -- Summary workshop



DMIP 2



The following have already shown interest in participating:

- Konstantine Georgakakos, HRC
- Kenneth Mitchell, NOAA/NWS/NCEP
- Mario DiLuzio, Texas A&M
- Witold Krajewski, U. Iowa
- Praveen Kumar, U. Illinois
- Eldho Iype, Indian Tech. Institute, Bombay
- Sandra Garcia, U. Cartagena, Spain