



# Field Project to Assess Data/Observations necessary for Distributed Modeling in *Mountainous* Terrain

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- Summary of  
FY06 CNRFC AHPS Project; Ongoing  
Field Experiments
- DOH/RDM Science Workshop Presentation
    - June, 2004



# CNRFC/UCD AHPS Project

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Application and Assessment of Forecast  
Resolution Enhancements:  
an RFC Mesoscale Validation Project in Mountainous  
Terrain



# Outline

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- FY06 AHPS Project
  - Introduction
    - Objectives
    - Need
    - Background
      - Ongoing Seed Projects
      - **CNRFC Experiment Summary**
  - Plans
    - Collaboration and Expansion of Seeds
  - Anticipated (short-term) Benefits
    - Meso-scale Hydromet Validation Capability in the Mountains
- Potential (long-term) Outcomes
  - Ability to Assess Data requirements for Operational Distributed Watershed Modeling?

# Introduction

## Objectives

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- Develop a watershed with AHPS validation capability in the Sierra Nevada that allows for accelerated development and prototyping of *high resolution* atmospheric/hydrologic analyses and models over mountainous terrain
- Take advantage of inexpensive, simple, reliable technology and materials for hydromet input validation

# Introduction

## Need

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- Gridded analyses of hydrometeorologic variables are limited in the mountainous West primarily due to:
  - High Spatial Variability/non-stationarity
  - NEXRAD beam blockage
  - Dominance of QPE techniques ill-suited to the above
- Lack of gridded analyses
  - Constrains development of Spatially Distributed hydrologic models
  - Limits Verification of current gridded NWS forecasts(QPF, QTF, FLF)
- Alternative datasets and techniques needed for QPE/QPF in West
- Adequate instrumentation over a complex Basin of RFC operational dimension and interest needed to develop and validate current and proposed mountainous QPE/QPF techniques: a **high resolution hydromet validation capability**

# Introduction

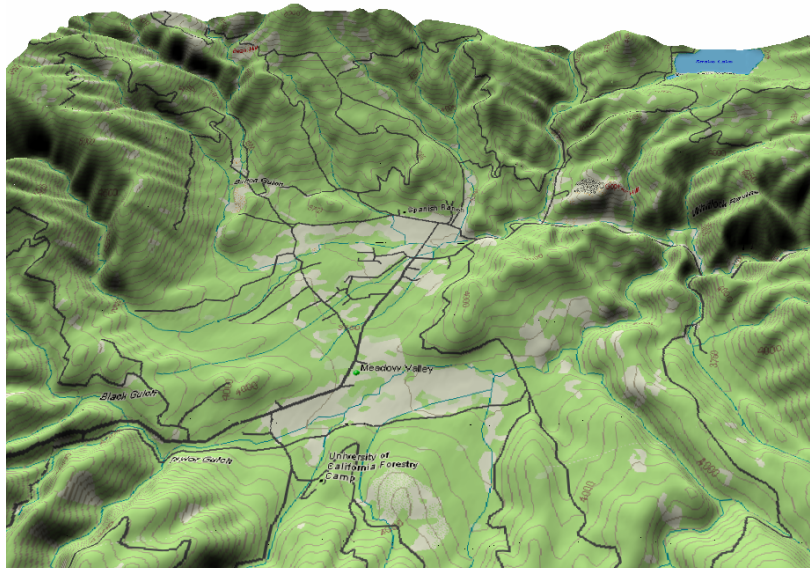
## Background

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- Ongoing Seed Projects
  - CNRFC Feather River Field Experiment
  - UCD Studies (Indian Ck, Butte Ck)
- AHPS Project proposal grew out of and around the ongoing CNRFC Experiment
  - Project involves expanded dimension, scope, and focus of the Experiment
- Reviewing Experiment provides context for Project

## Sampling the Fine Scale Variation in Precipitation over Complex Terrain

Field Experiments in the Feather River Basin of Sierra Nevada for Water Years 2003, 2004



© 2001 DeLorme. Topo USA® 3.0; Zoom Level 12-0 Datum: WGS84.

**Objectives:** Deploy a small network of temporary recording rain gauges (10) at cooperator sites to sample storm scale variation in precipitation catch. Gain an improved understanding of the finer (meso-) scale variation in precipitation over a mountainous Sierra Nevada watershed. Develop methods for analyzing and forecasting precipitation at hourly and gridded scales.



For information, contact:

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Tel: 916-979-3056, ext. 337; E-mail: [Arthur.Henkel@noaa.gov](mailto:Arthur.Henkel@noaa.gov)

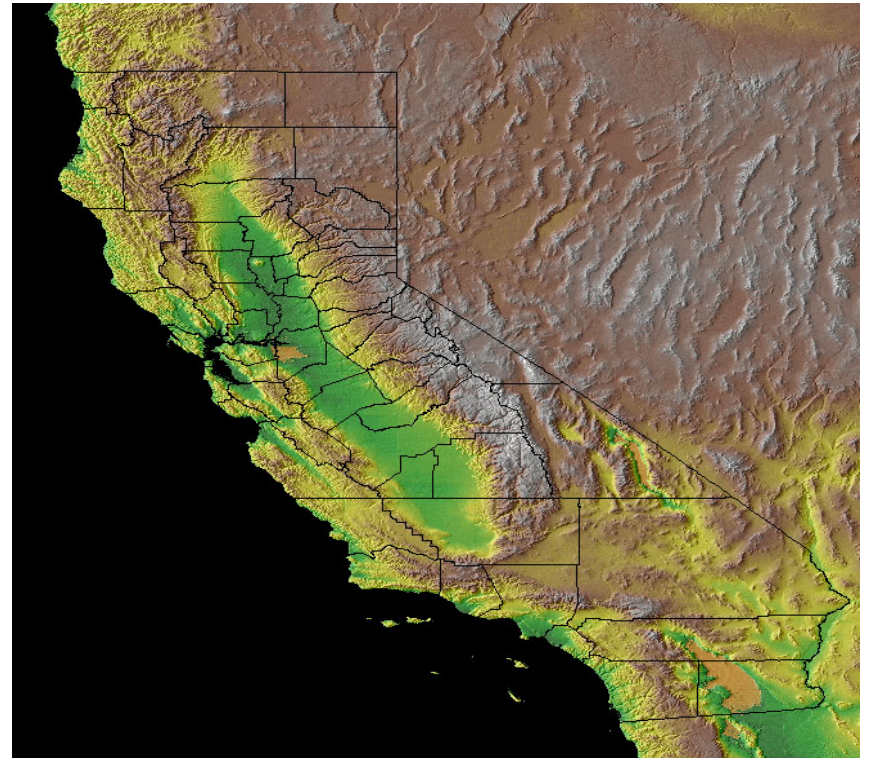
# CNRFC Experiment in the Feather River Basin

- Deploy a small network (10) of temporary recording rain gauges at cooperator sites to sample storm scale variation in precipitation catch.
- Gain an improved understanding of the finer (meso-) scale variation in precipitation over a mountainous Sierra Nevada watershed.
- Develop Validation for sharp gradients revealed in high-resolution MM5 regional atmospheric model
- Improve methods for analyzing and forecasting precipitation at hourly and gridded scales in the RFC environment
- Provide input for Distributed Hydrologic Modeling research



# Within CNRFC area, Experiment focused over the Northern Sierra

- Extreme Spatial Variability in Precipitation
- Very Strong orographic modulation of transitory atmospheric dynamics
- Good Skill/Experience here with MM5 Regional Atmospheric model



# But Speaking of MM5 Data

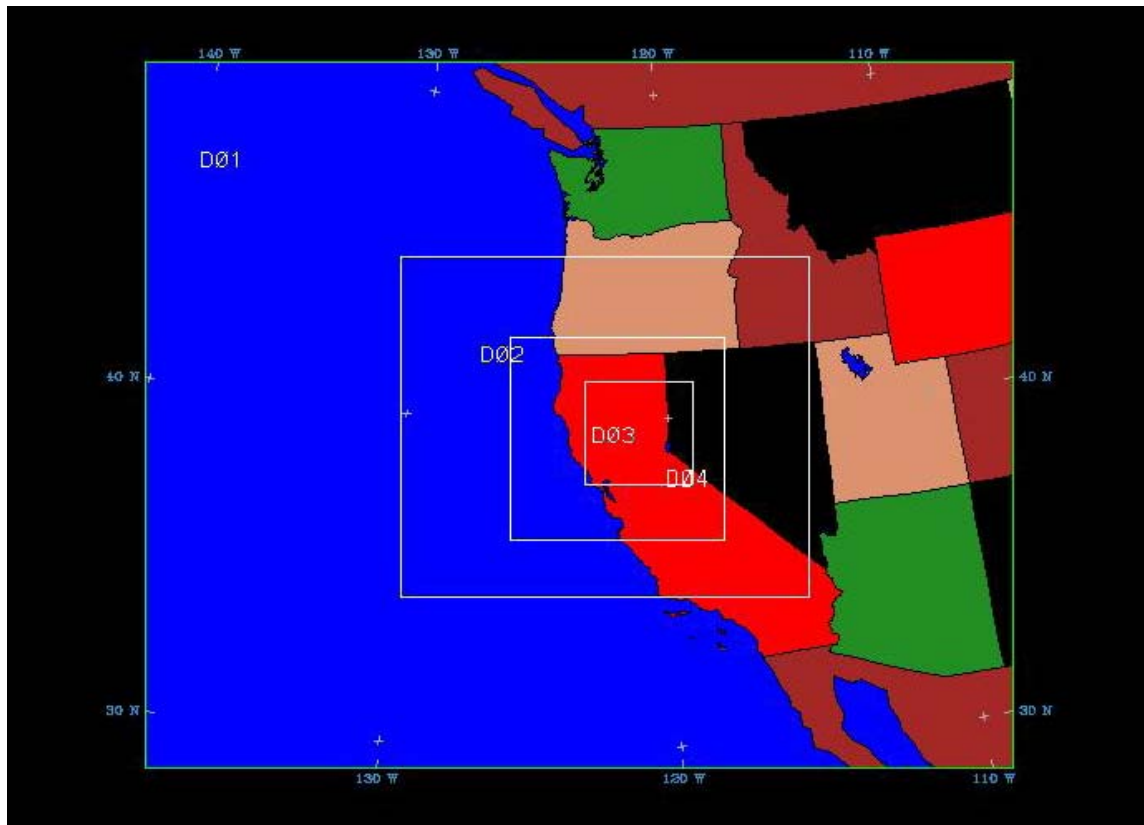
- PSU-NCAR MM5 Regional Atmospheric Model
- What is an *RFC* doing running an atmospheric model locally?
- With Remotely Sensed data limited, dynamic simulation data is more important
- Local Research suggests output from High Resolution MM5 is useful for *analysis* of observed, as well as short-term *forecast* of future, precipitation
- Local experimental QPE/QPF algorithms for Northern Sierra utilize MM5 data

# Operational availability of Local MM5 Model Data

- Computational/communications requirements are extreme
- Domain limits imposed by local Comms, CPU available
  - Use for small spatial domains, short-term forecasts only
- Spatial domain
  - Multiple 2-way nested domains
  - Finest: 3km nest centered over N Sierra (115x115 nodes)
  - Coarsest: 27 km domain initialized with 40 km eta
- Temporal domains
  - Output at *any* timestep, for short-term integrations
  - Current set-up only provides 12-24 hour forward look

# MM5 operational nests

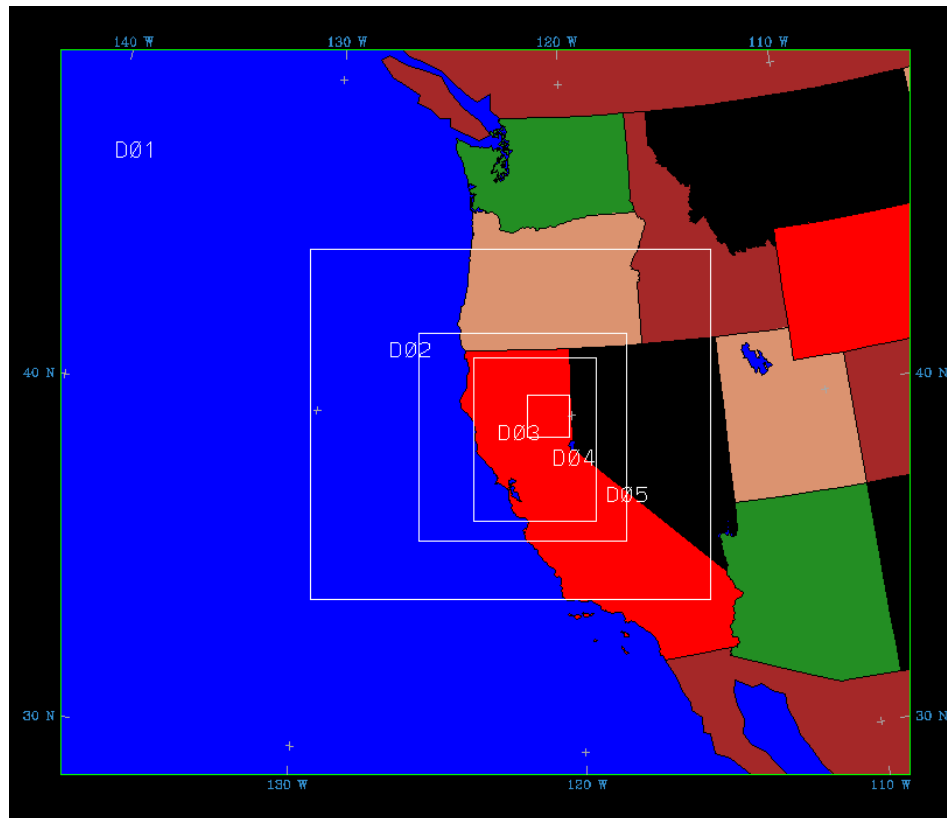
(N. Sierra "oper1" configuration)  
(81, 27, 9, 3 km grid spacings)



# MM5 reanalysis nests

(N. Sierra "hist1" configuration)

(81), 27, 9, 3, (1) km grid spacings



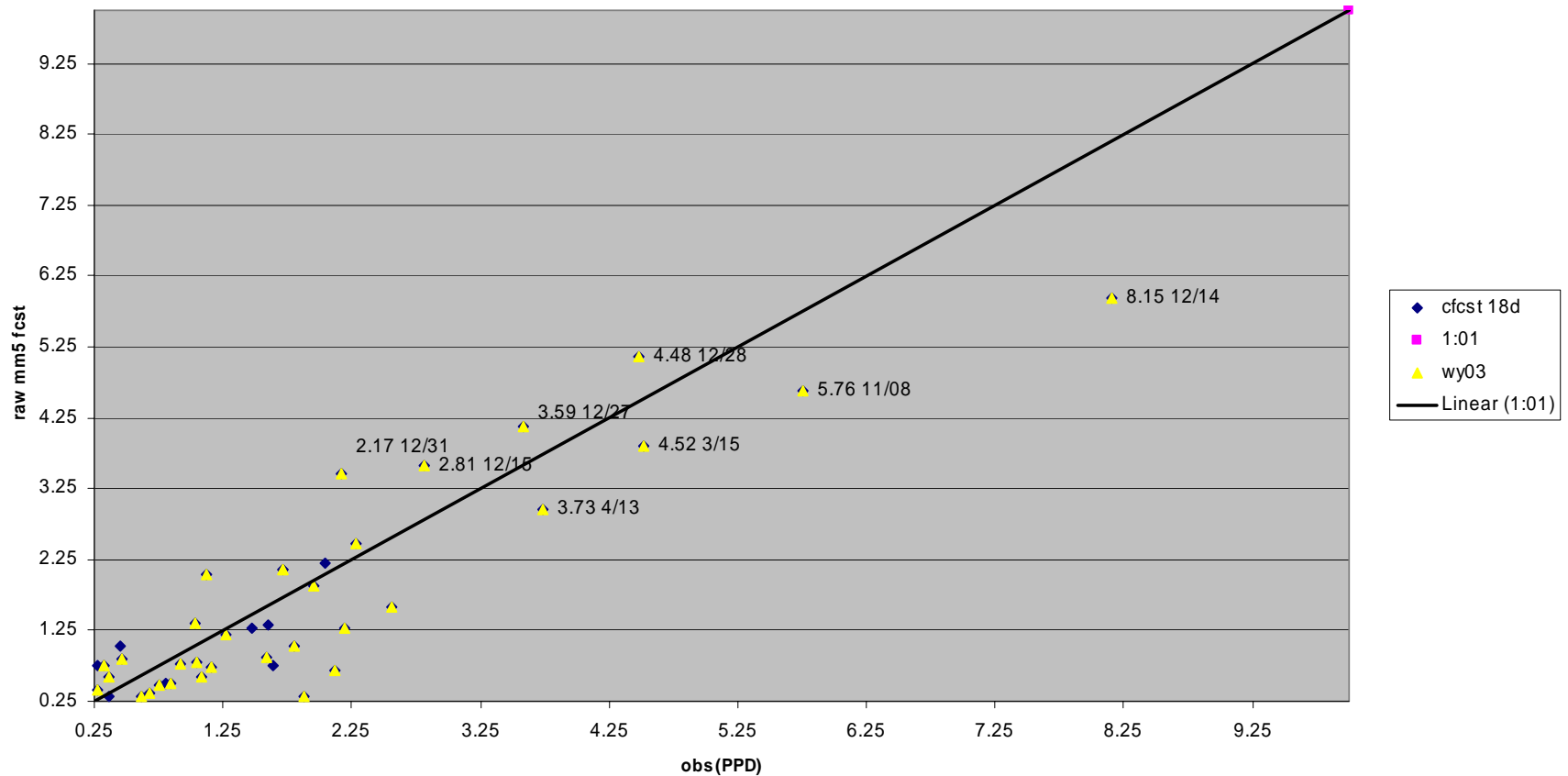
# MM5 Operational Performance

- Executed operationally at CNRFC/UCD since WY02
- Good conditional forecaster of large catches over complex terrain of Northern Sierra
  - Even in current HAS *point* QPF paradigm, often provides the best numerical estimate for Brush Creek gage
  - Finer Terrain resolution makes sampling from grids to gages more tenable
  - But sometimes plagued by many of the usual biases and problems with upslope flow in high resolution models

# Raw oper MM5 performance

## Buck's Lake gage daily totals

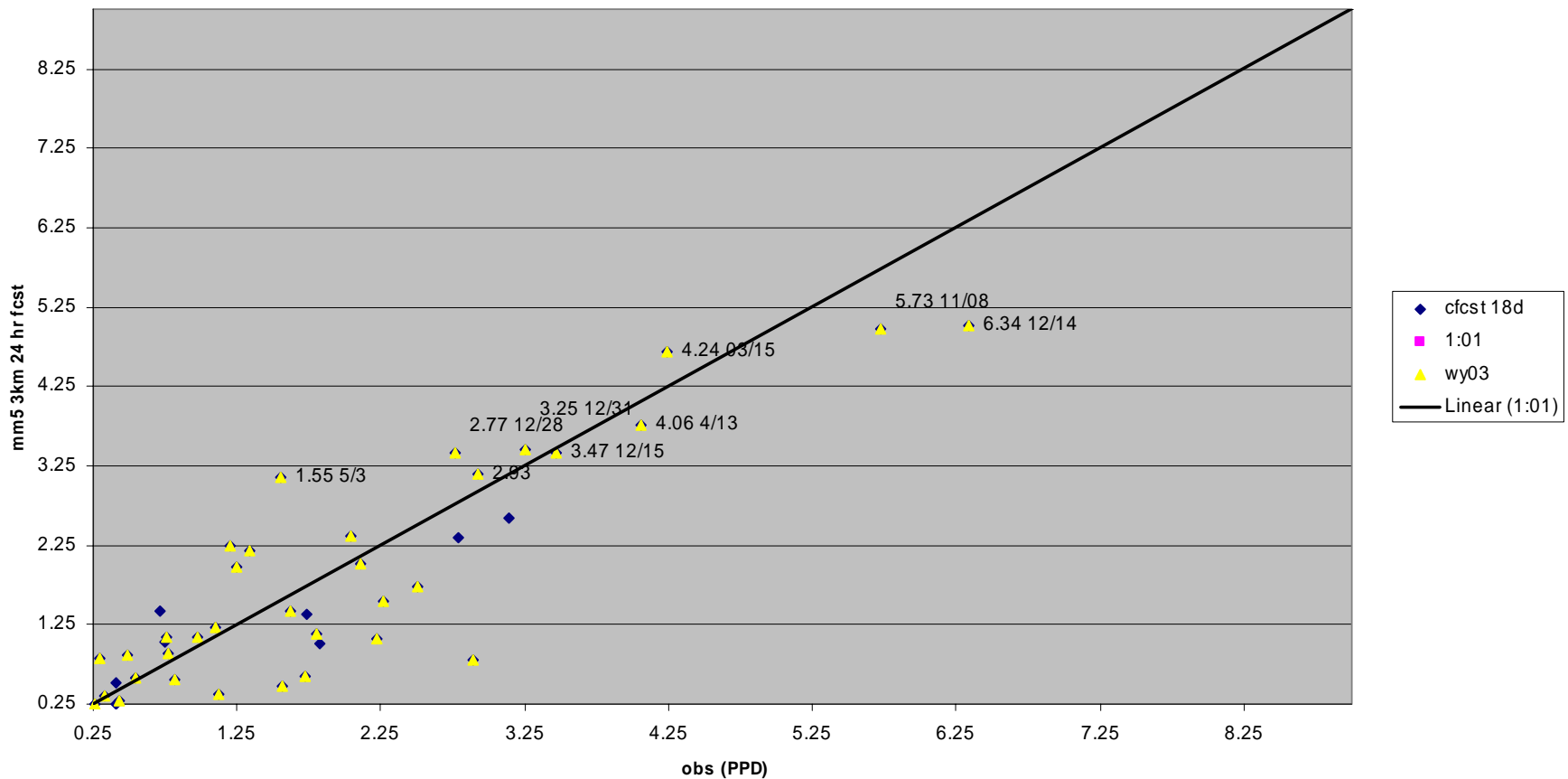
Raw MM5 forecast results for BKLC1 (WY03/02)



# Raw oper MM5 performance

## Laporte gage daily totals

Raw MM5 forecast results for LPTC1 for WY03/02



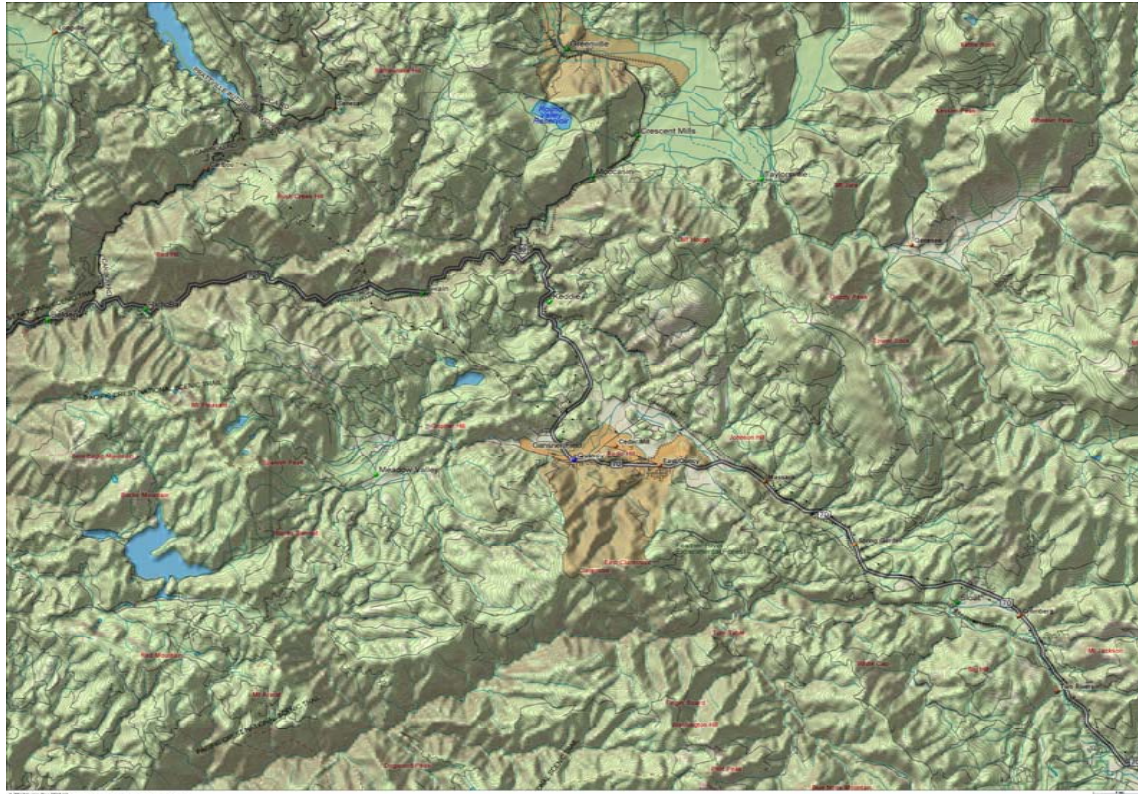


The CNRFC Experiment was defined to easily fall within the finest MM5 nests, including along and between the deeply incised canyons of the North and Middle forks of the Feather River Basin

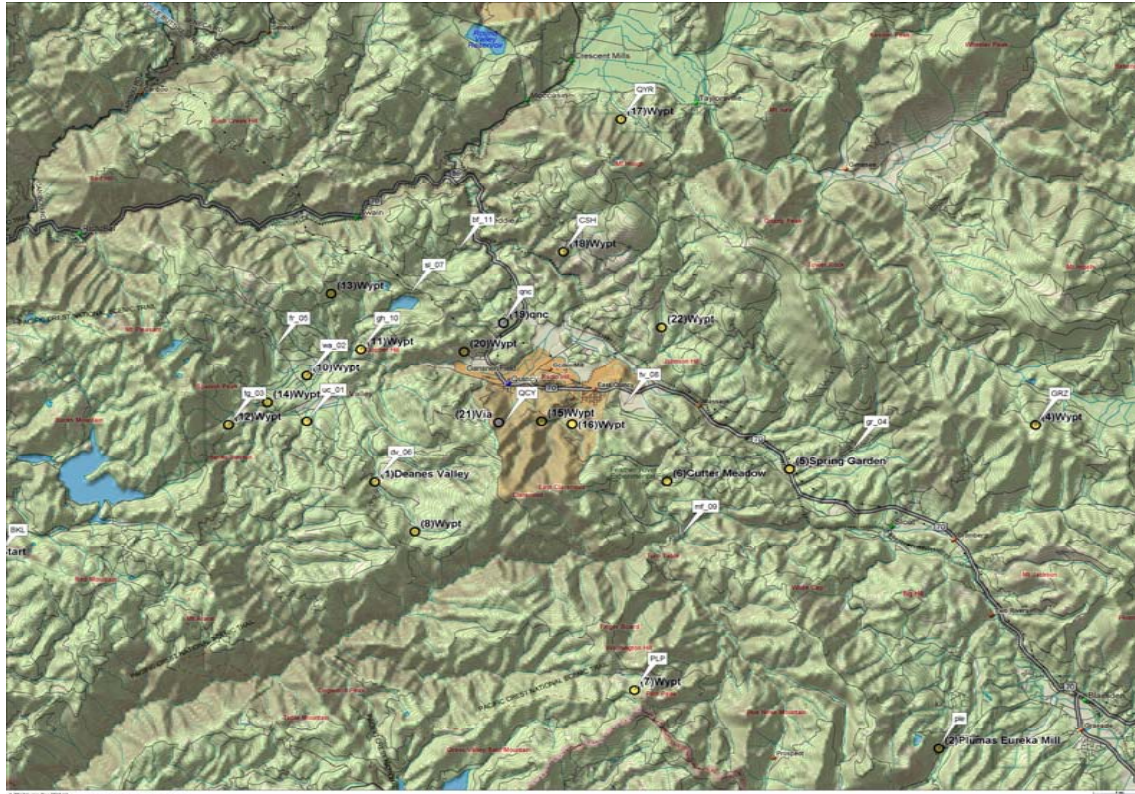


© 2001 DeLorme, Topo USA® 3.0  
Scale: 1 : 480,000 Zoom Level: 9.9 Datum: WGS84 Map Relation: 0° Magnetic Declination: 15.4°E

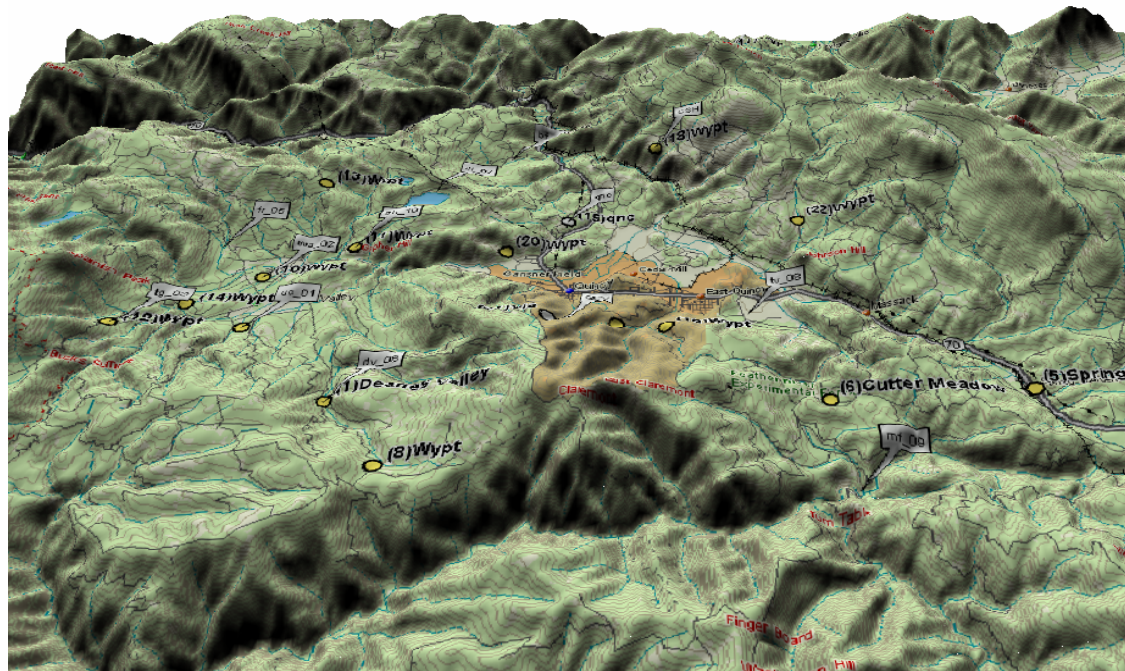
In particular,  
Experiment was centered over the sub-basin of  
Spanish Creek



Over which the operational observation network was enhanced with a temporary mesonet of 10 recording raingages and temperature sensors

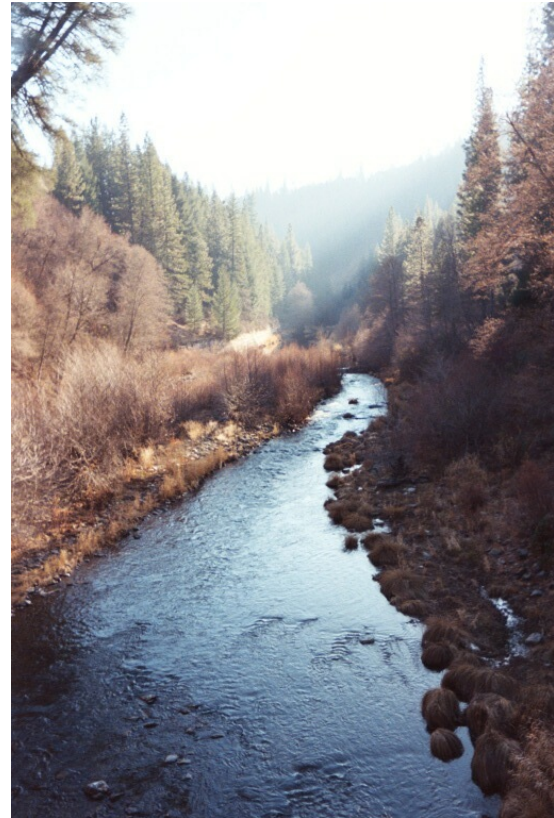


# The headwaters of which look something like

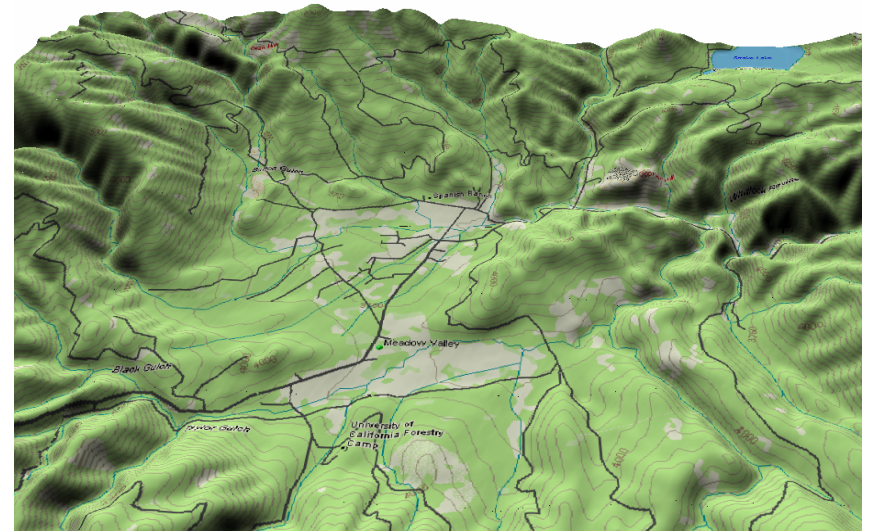


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Or ...



# With a control and project base camp in Meadow Valley



With other sites on ranches, along lakes, in gulches, camps, gravel pits, and even a dump.



at locations exposed but discrete.

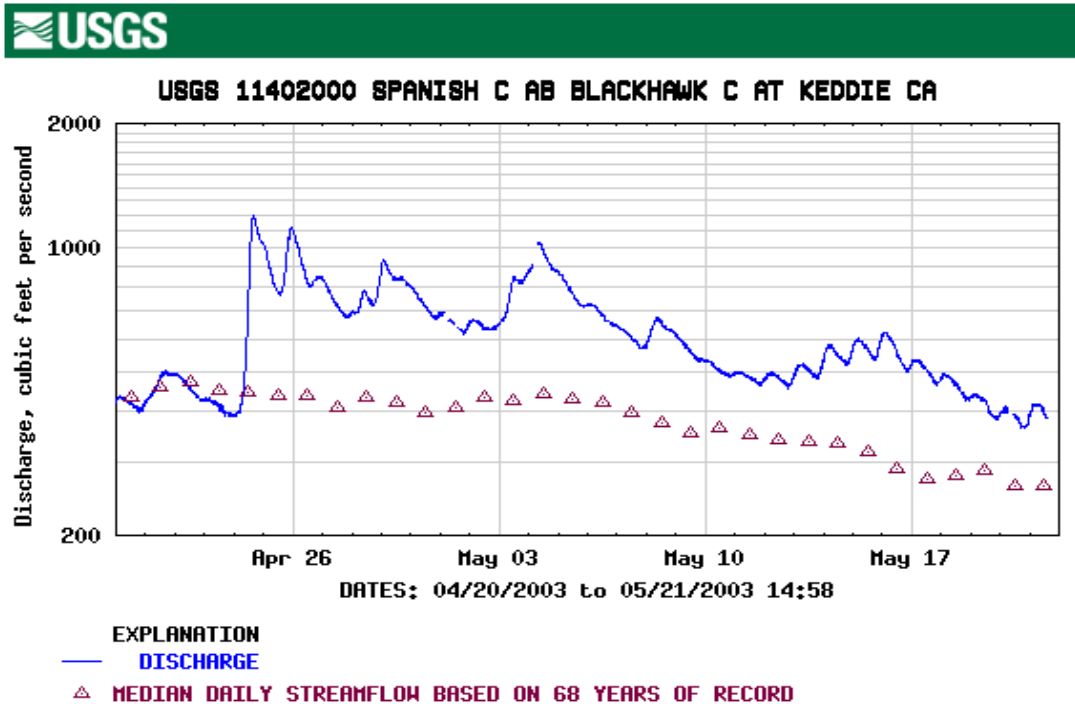




With inexpensive, portable, simple sampling hardware and data storage & collection tools



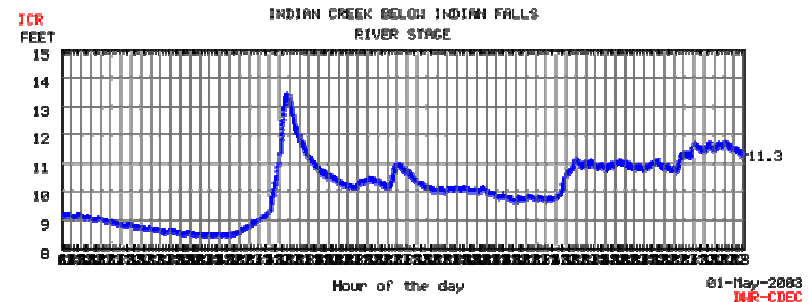
# Both rainfall and snowmelt induced runoff event characteristics important over area, as indicated at Spanish Ck sub-basin



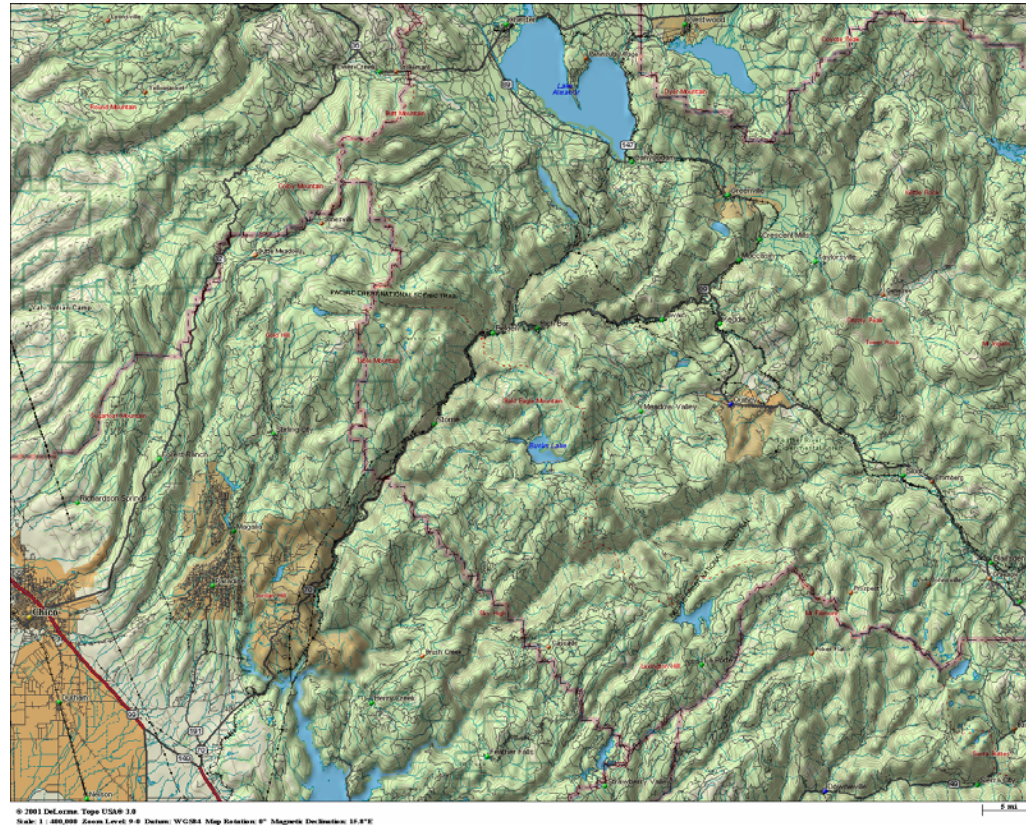
Provisional Data Subject to Revision

# And similarly with adjacent basins under intensive investigation by UCDHRL

- Indian Creek
  - Further East, downslope, heavily rainshadowed
  - Drier, colder
- Butte Creek
  - Further West, Upslope, strongly orographic
  - Wetter, warmer



# AHPS Project proposes broadening Domain over the Feather River Basin to include UCD Study sites





# AHPS Project Plans

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- Combine, Expand, Collaborate, Database with UCD-HRL, OHD, WRH
  - Combine & expand intensive ongoing data collection and sampling experiments by the CNRFC and UCD over adjacent basins in the Northern Sierra
  - Jointly develop high resolution analyzed & forecast hydrometeorologic fields
  - Collaborate on watershed modeling approaches and results with physically-based research and conceptualized operational models
  - Jointly produce high resolution database of hydromet/hydrologic observations suitable for meso-scale validation studies



# Summarizing the attributes for the Northern Sierra Domain

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- **Data-rich:** well-studied, sampled, and archived by research and operational investigators
  - Densely-instrumented already
    - Cost increment to meet validation threshold is small(est)
      - Network of real-time/calibration gages
      - Ongoing Research sampling by UCD/CNRFC
  - Intensely modeled and analyzed with
    - Atmospheric models
      - historical and real-time meso-scale atmospheric model (MM5) and local orographic diagnostic models
    - Hydrologic Models
      - Operational NWSRFS
      - Research: UCDHRL physically-based Watershed model, disaggregated NWSRFS
- **Extreme Variability:** maximal Complexity/Heterogeneity wrt
  - topography, hydrometeorology, hydrologic response
    - Classic orographic regime
  - place where accounting for spatial variability should matter
- **Relevant:**
  - RFC-scale; abundant unregulated rainfall-runoff events; snow-level sensitive; high stakeholder importance



# Anticipated Project Benefits

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- By creating a hydromet watershed 'laboratory' over Mountainous terrain
  - Gain ability to assess
    - Current reliability of gridded/hourly hydromet inputs
      - Analyses
      - Forecasts
  - Produce a database suitable for
    - Gridded Precipitation/Temperature Forecast validation
    - Observational Analysis technique comparison (MPE, others) and development
    - Distributed Hydrologic Model Intercomparison (DMIP) and development



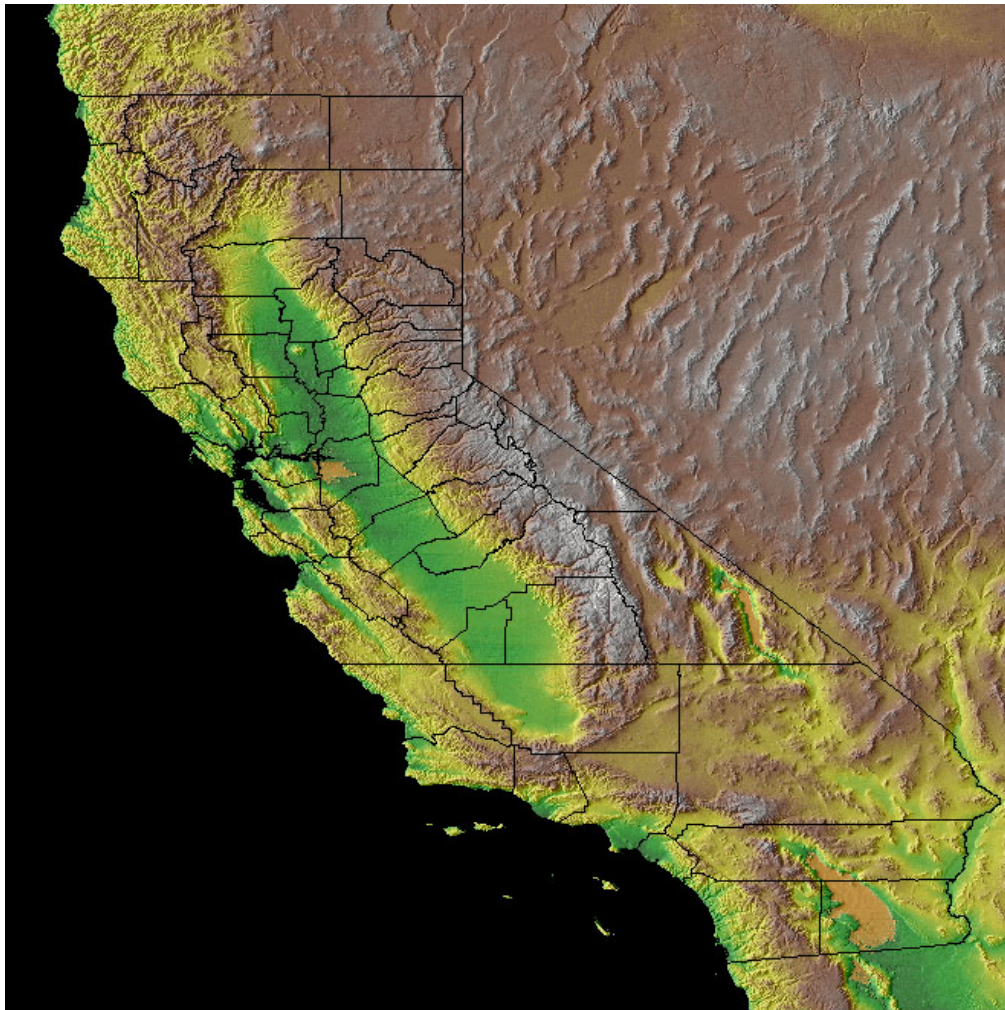
# Potential Outcomes

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- New algorithms for multi-sensor precipitation estimation
  - Estimates of a reasonable density threshold for gridded validation
- Alternative strategies for short-term forecasting/updating of precipitation
- Modifications of HAS forecaster mode of data interaction
- Data on the capability of conceptualized hydrologic models to mimic responses of more physically-based models
  - Sensitivities to data density
- Insight for modifying conceptualized models such as NWSRFS
- Strategies for Extrapolation and application outside of watershed laboratory
  - Census sampling?
- Recommendations for future data sampling in mountainous terrain



# Data/Technique Transfer from heavily sampled laboratory to... and beyond?





# Summary

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- It's the Gages



The end

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# Addendum: UCD Collaborators Experience/Expertise

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- Early Pioneers in Stochastic Averaging of Conservation Equations in Hydrologic models
- Developed Physically-based Watershed Model utilizing above technology; previously applied to small watersheds in Sierra Nevada and elsewhere
- Detailed work underway sampling, processing, and modeling of Landscape, Soils data in Feather Basin
- Experience with retrospective downscaling of atmospheric data with dynamic/statistical models and coupling with hydrologic models