

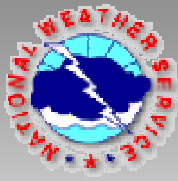
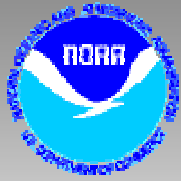
Scientific Development in Support of Advanced Hydrologic Prediction Services (AHPS)

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BIOGRAPHICAL SKETCH

Robert Hartman is the Hydrologist in Charge at the California-Nevada River Forecast Center. Mr. Hartman has 22 years of federal flood and water supply forecasting experience including 8 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.



Scientific Development in Support of Advanced Hydrologic Prediction Services (AHPS)

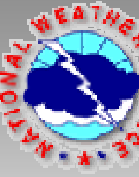
Rob Hartman

Hydrologist in Charge

NOAA/NWS California-Nevada River Forecast Center
Sacramento, CA



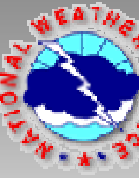
AHPS - Defined



A congressionally funded program through which the National Weather Service will improve the quality, relevance, and delivery of hydrologic information and forecasts to customers and partners.



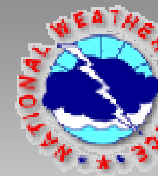
AHPS Deliverables



- Better forecast accuracy
- More specific and timely information on fast-rising floods
- New types of forecast information
- Longer forecast horizons
- Easier to use products
- Increased, more timely, and consistent access to products and information
- Expanded outreach



AHPS



Multi-Year Budget Summary

			PB Request						
	Prior Years	FY02	FY03	FY04	FY05	FY06	FY07-12	Total	
<u>Acquisition</u>									
Implementation	1,024	519	3,900	3,900	3,900	3,900	17,937	35,080	
<u>Recurring</u>									
Science Infusion	270	215	980	980	980	980	5,880	10,285	
Software Enhancement	400	506	810	810	810	810	4,860	9,006	
Data		80	300	300	300	300	1,800	3,080	
Verification	150	50	80	80	80	80	480	1,000	
Training/Outreach	150	130	130	130	130	130	780	1,580	
Total Recurring	970	981	2,300	2,300	2,300	2,300	13,800	24,951	
Total for FY	1,994	1,500	6,200	6,200	6,200	6,200	31,737	60,031	
<u>Cumulative</u>									
Forecast Locations	162	275	325	828	1,331	1,834		4,011	



AHPS



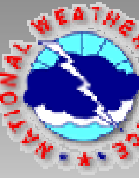
Potential Annual Benefits (\$M)

River Forecast Center	Flood Mitigation	Navigation	Hydro-electric	Water Supply	Total
North Central	32	24	2	10	68
Southeast	11	20	5	19	55
California-Nevada	19	0	14	49	82
Total for 13 RFCs	243	169	81	273	766

Source: 2002 Report, National Hydrologic Warning Council



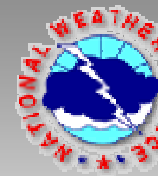
AHPS Improvements



- New products and information
- **Science and technology**
- Expanded delivery and accessibility
- Outreach, training, and service evaluation
- Establishing new partnerships



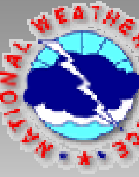
Science and Technology



- Distributed hydrologic modeling
- Hydraulic modeling
- Integration of water, weather, and climate information
- Short-, Medium, and Long-range probabilistic forecasts
- Operational forecast system upgrade
- Computational systems
- Hydrometeorological data systems



Distributed Hydrologic Modeling



Evaluation

- DMIP
 - Distributed Model Intercomparison Project
 - Results suggest that DM is not necessarily better
 - Forcing (input) issues... particularly in complex terrain
 - Scale issues
 - Potential ancillary benefits (timing, interior points, ungaged locations)
- DMIP II
 - Planned for 2006
 - Will address complex terrain issues in the West

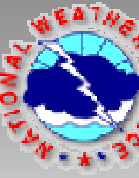
RMS (distributed Sacramento Model)

- Under evaluation at 3 RFCs

Envisioned solution for improved Flash Flood Guidance



Hydraulic Modeling



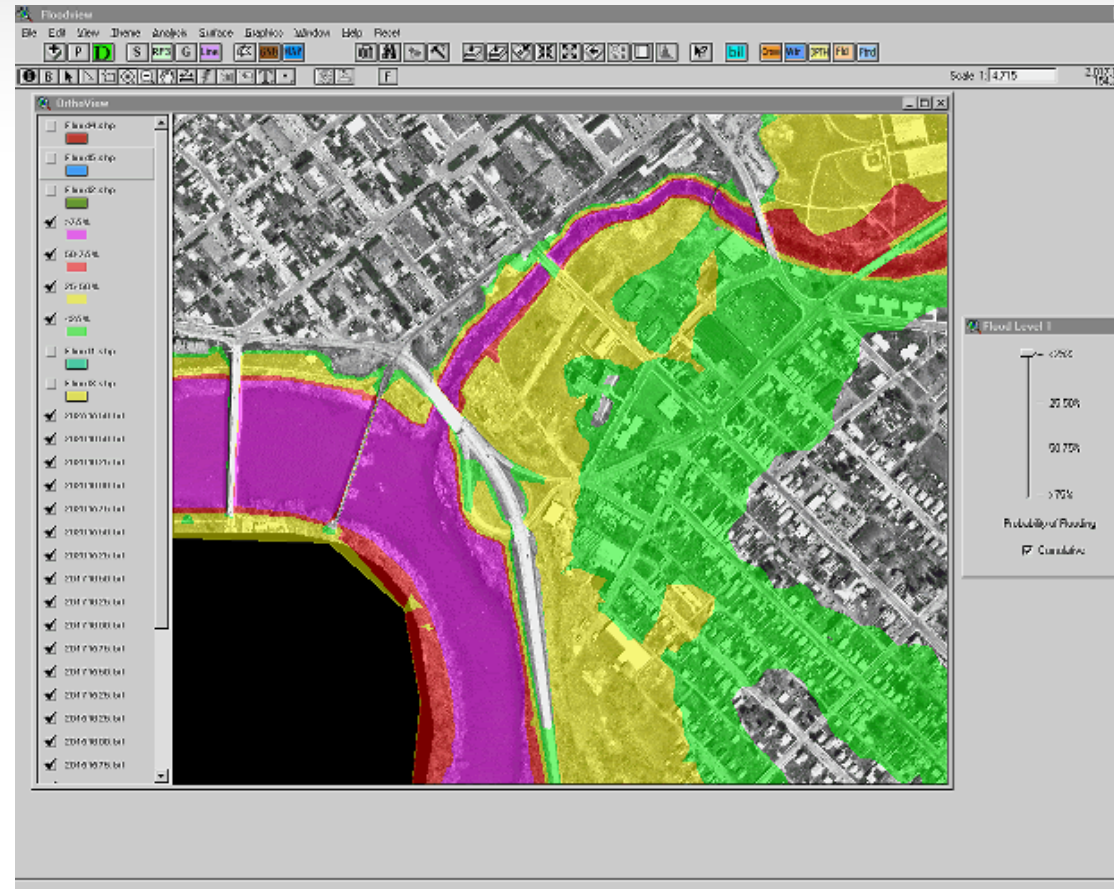
- Model and forecast complex stream reaches
 - Tidal, backwater, obstructions (bridges), levees, levee breaches
 - Simulate and forecast flood inundation
- Current Models
 - FLDWAV
 - SHM (simple hydraulic model)



Hydraulic Modeling for Flood Inundation Mapping



- Partnered activity
 - Requires high definition terrain data
- Hydraulic simulation
 - Water surface elevation





Integration of Water, Weather, and Climate Information



- Mesh forcing from short, medium, and long range techniques.

mesoscale
wx models

medium range
wx models

long range
global circulation models

downscaling

downscaling

downscaling

time

variable

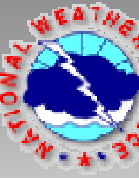
downscaling

forecaster skill

climate forecasts and indexes



Short-, Medium-, and Long-range Probabilistic Forecasts



- Ensemble technique
 - Facilitates integration of short-, medium, and long-range forcing from various sources
 - Allows for spatial and temporal coherency
 - A history of use and experience for water supply forecasting at several RFCs



Probabilistic Forecasts

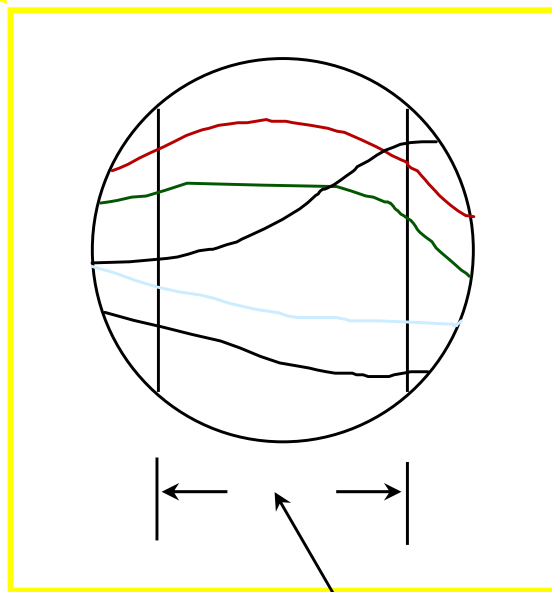
Ensemble Streamflow Prediction

**NWSRFS
Model States**

**NWSRFS
Model
Parameters**

**(Pre-adjusted)
Historical
Temperature
& Precipitation**

**Trace Generation
Statistical Analysis**



**Analysis
Window**

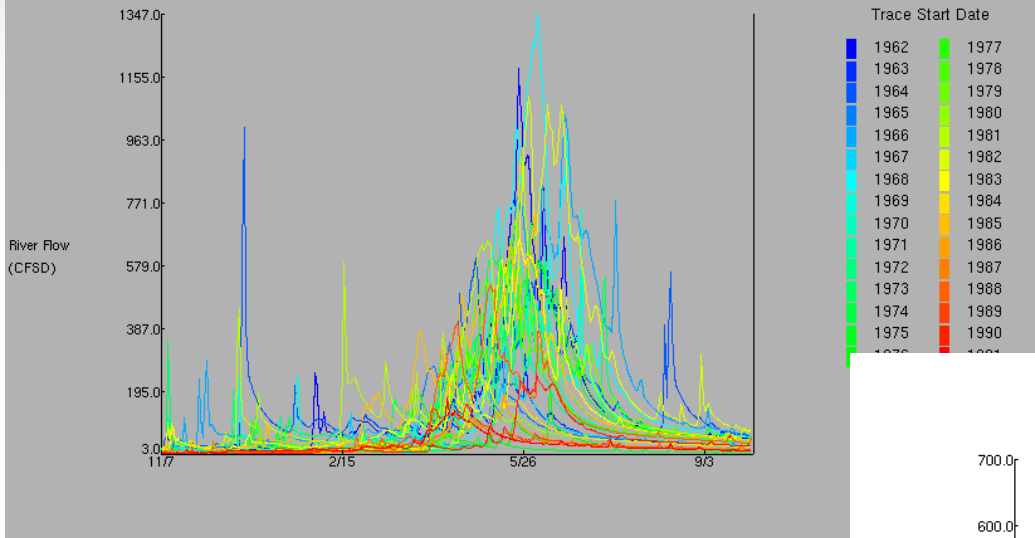
**Probabilistic
Forecast**



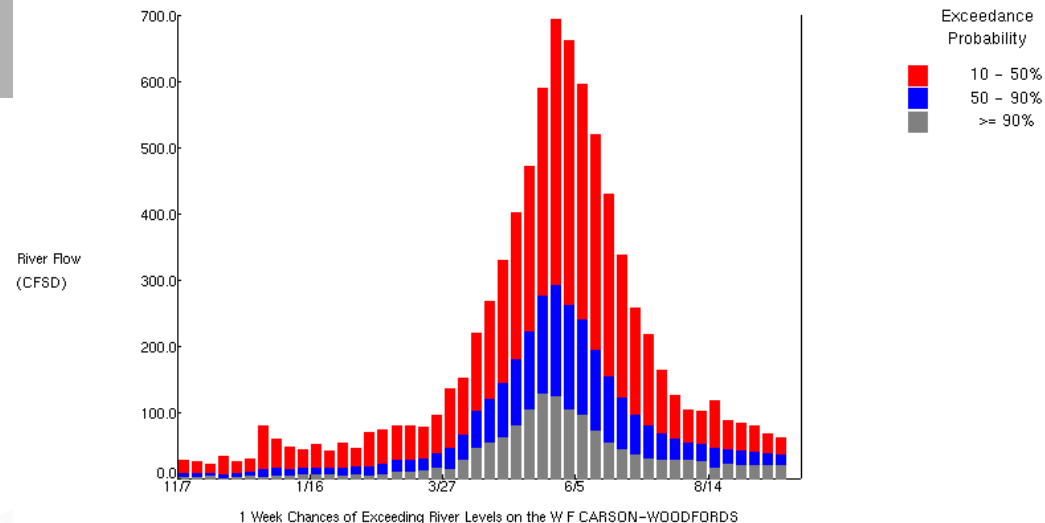
ESP Traces and Analysis

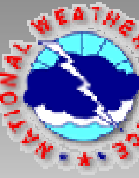


ESP Trace Ensemble of W F CARSON-WOODFORDS
Latitude: 38.8 Longitude: 119.8
Forecast for the period 11/7/2001 24h - 9/29/2002 24h
This is a conditional simulation based on the current conditions as of 11/7/2001



1 Week Chances of Exceeding River Levels on the W F CARSON-WOODFORDS
Latitude: 38.8 Longitude: 119.8
Forecast for the period 11/7/2001 - 9/25/2002
This is a conditional simulation based on the current conditions as of 11/7/2001





Probabilistic Forecasts

- Long-range information
 - Not too tough...
 - Uncertainty dominated by climate
 - Integration of climate forecast information
- Short- and Medium-range information
 - Tougher!
 - Many important and complex sources of uncertainty
 - **The Brass Ring!**
 - Prototyping efforts at several RFCs including CNRFC.



Short- and Medium-term Ensemble Challenges



- Appropriately integrate the uncertainty introduced from model, data, and human sources.

OBSERVATIONS

precipitation
air temperature
streamflow

MODEL STATES

snow
soil moisture
basin routing

MODELLING SYSTEM

simplifications
temporal issues
scale issues

???

MODEL PARMS

snow
soil moisture
basin routing

HUMAN INPUT

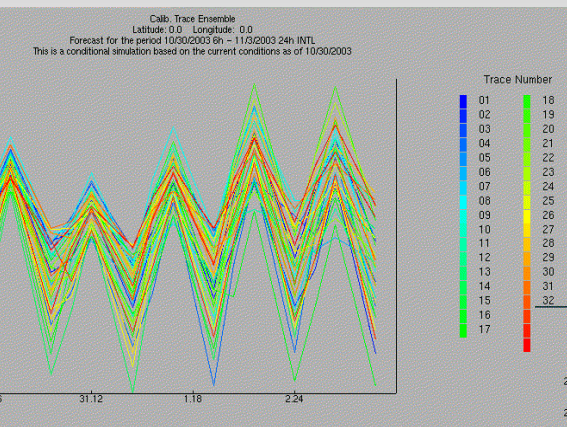
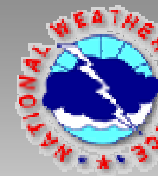
education
training
experience
mental state

FORECASTS

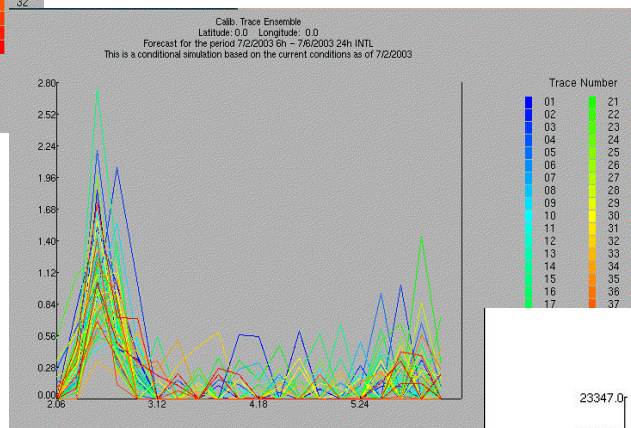
precipitation
air temperature
regulation



American River Short-term (5 day) Ensemble Prototype

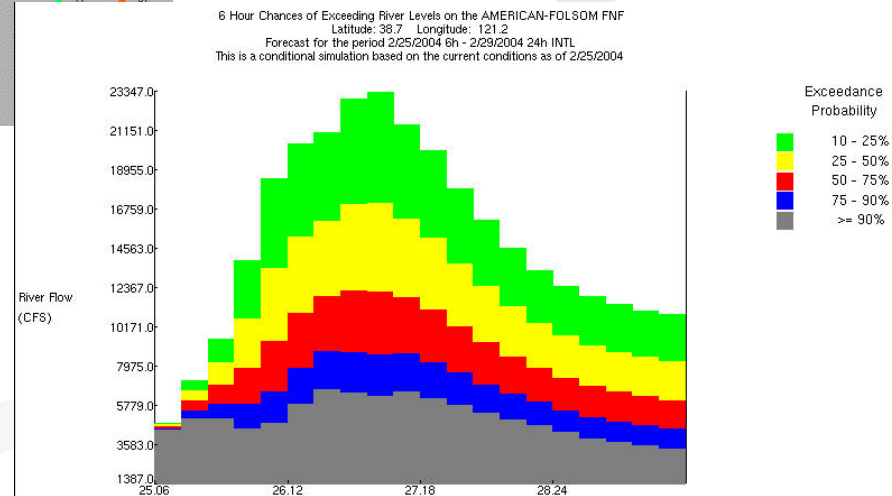


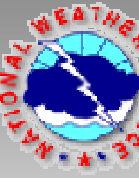
Forecast Temperature Ensembles



Forecast Precipitation Ensembles

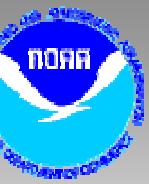
Probabilistic Reservoir Inflow



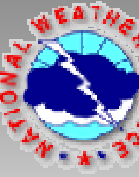


Forecast System Upgrade

- Improved calibrations and calibration techniques
 - Elimination of regional parameters
 - Optimization and forecaster tuning
- Improved historical data handling
- Community Hydrologic Prediction System (CHPS)
 - Service-based architecture
 - Rapid integration and sharing of models and techniques
 - Hasten research to operations
 - Improved collaboration with other agencies, groups, etc.



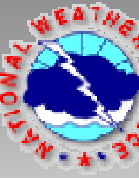
Computational Systems



- Meet processing requirements
 - Ensemble computations
 - Hydraulic modeling
- Archival requirements
 - Historical
 - Geographical
 - Verification



Hydrometeorological Data

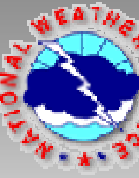


- Support data collection partnerships
 - Federal, state, local (USGS, USACE, USBR, NRCS, USFS, local mesonets, others)
- Improve and develop model forcing
 - Gridded hourly inputs
 - True multisensor precipitation products (QPE)
 - Complex terrain, all seasons
 - Substantial work to understand time and space scale issues.



CNRFC

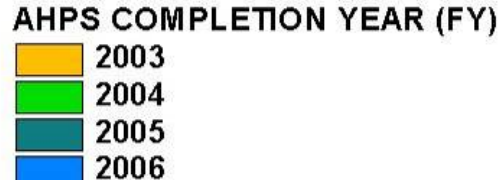
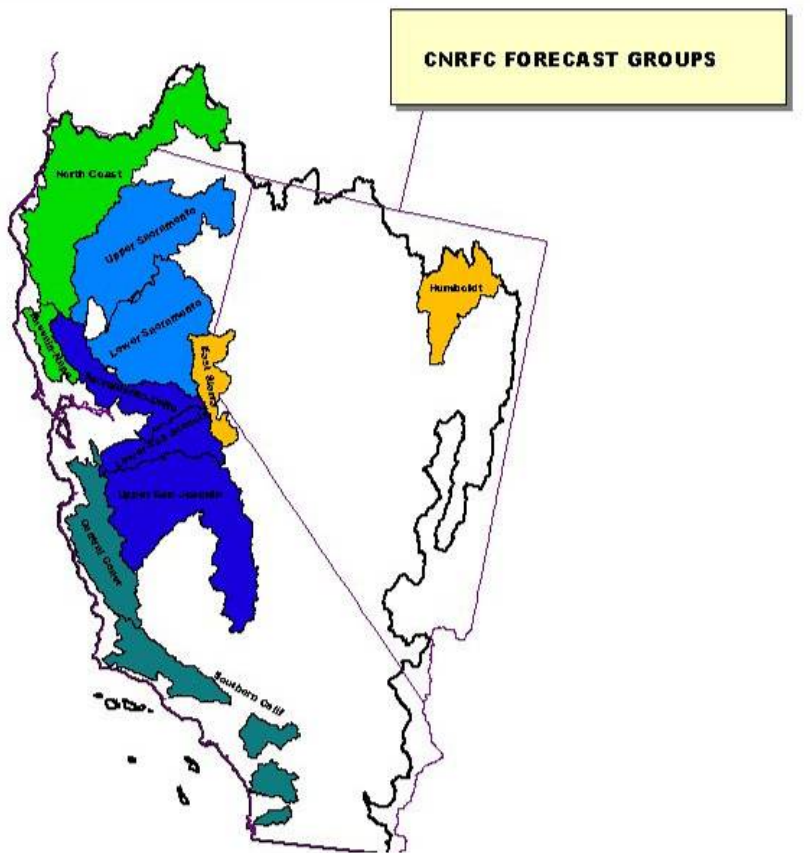
AHPS Implementation



- Three phases
 - Medium and long-range ESP
 - Headwaters and unregulated points. (FY03-07)
 - Medium and long-range ESP
 - Regulated points (FY06-10)
 - Short-term ESP
 - All flood forecast points and reservoirs (FY08-12)
- Imbedded 5-year model recalibration cycle
- Development of custom (user) product generation



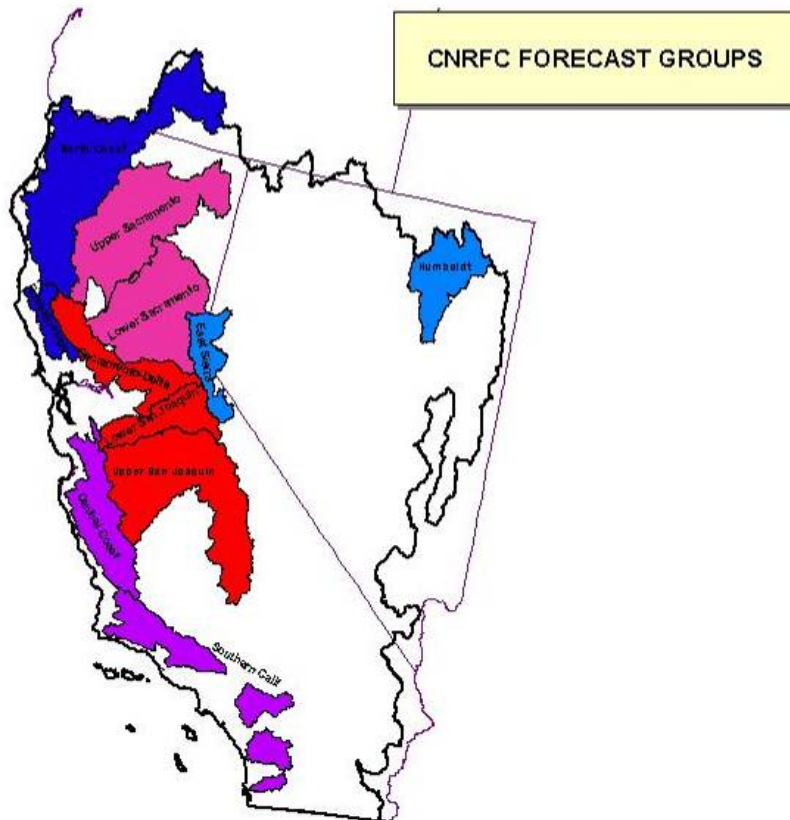
CNRFC Implementation Schedule Headwaters/Unregulated Points



- Calibrations in place.
- Uses Weather and CPC forecasts.
- Already in use for water supply and snowmelt forecasts.
- Update to standard historical period.
- Establish 5-year recalibration cycle.



CNRFC Implementation Schedule Regulated Points



Assume ESP tools for regulated sites available by end of FY05

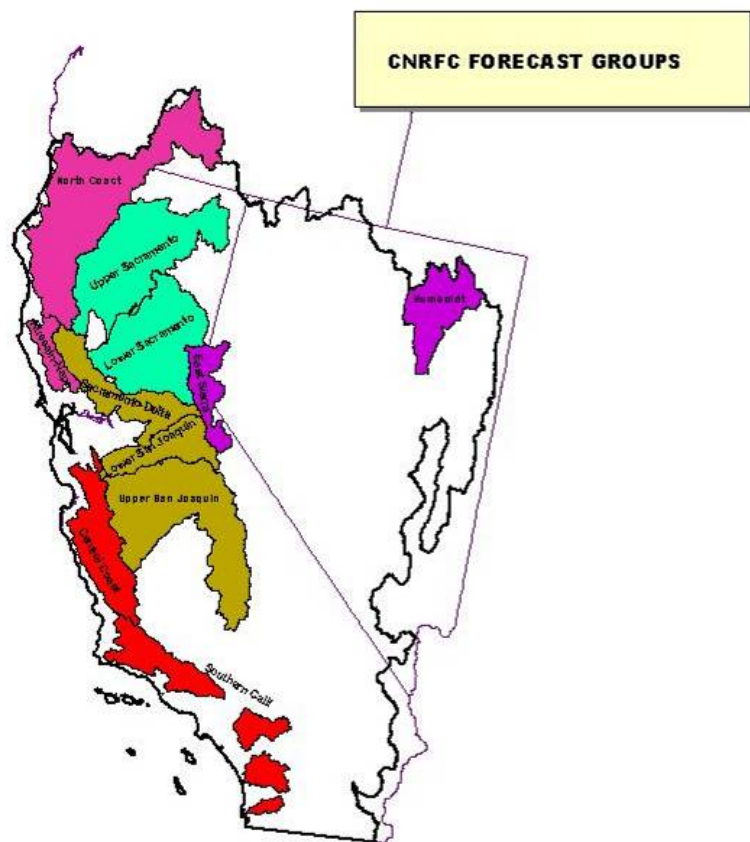
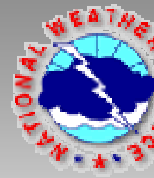
AHPS COMPLETION YEAR (FY)



- Assumes that tools and techniques needed to simulate regulation activities will be developed and operationally available by end of FY05.
 - Reservoir regulation
 - Diversions
 - Consumptive use



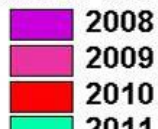
CNRFC Implementation Schedule Short-term Probabilistic Forecasts



- Assumes that tools and techniques needed to simulate short-term uncertainty will be developed and operationally available by the end of FY07.
- OHD/CNRFC project to prototype this function.

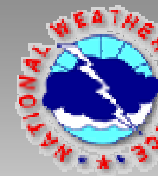
Assume tools for short term 0-14 day, probabilistic forecasts available end of FY07

AHPS COMPLETION YEAR (FY)





ESP Custom Product Generation



CNRFC
implemented
AHPS locations

Starting in FY05!

ESP Trace File

Blue Mesa 24hr Conditional.
Fontenelle 24hr Conditional.
Powell 24hr Conditional.
Flaming Gorge 24hr Conditional.
Navajo 24hr Conditional.
Green - Warren Bridge 24hr Cond.

Accumulation Type	Interval	Analysis Window
Mean <input checked="" type="radio"/> Max <input type="radio"/> Min <input type="radio"/> Sum <input type="radio"/>	Day <input checked="" type="radio"/> Week <input type="radio"/> Month <input type="radio"/> Entire Period <input type="radio"/>	16 Jun 2004 16 Sep 2004

Plot Options:

Traces Probability Expected Value Exceedance

Show a Plot

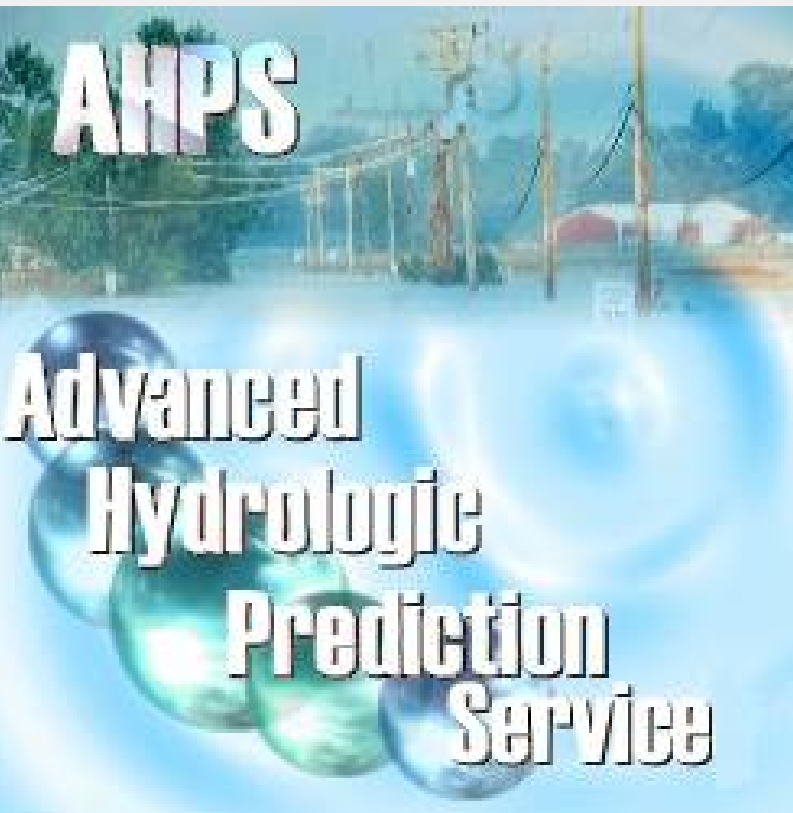
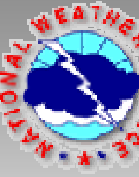
Table Options:

Forecastinfo Quantiles Floodquantiles

Show a Table



Additional AHPS Information



- CNRFC Website
 - www.wrh.noaa.gov/cnrfc
- NWS AHPS Website
 - www.nws.noaa.gov/oh/ahps
 - Background information
 - Presentations and videos
 - Quarterly implementation status reports