Water Resource Status and Forecast Methods Of the Western Region RFC's

- How does the RFC make water supply forecasts?
- What is our current status and projection?
- Where can I find this water resource information?

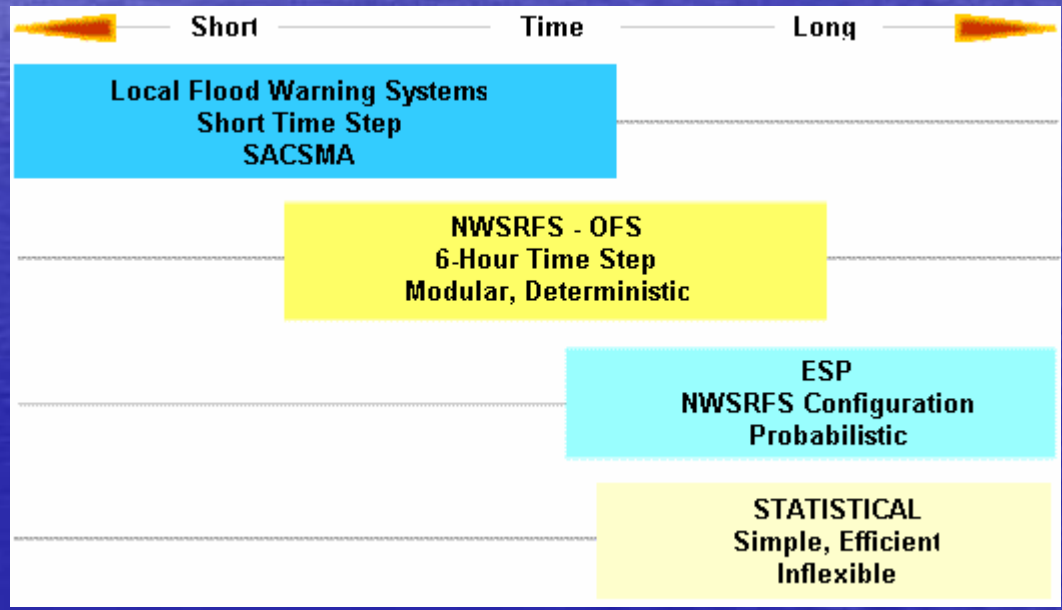
The Process of Making Water Supply Forecasts

Two fundamental methods

- statistical regression – equations to relate observed data to a future seasonal streamflow volume
- ESP – using the current states of our continuous conceptual daily river model as the initial conditions then applying various schemes of future weather

Current RFC Forecast Tools

- Sacramento Soil Moisture Accounting (SACSMA) commonly used at RFCs
- 6 hour time step for routine flood forecasting operations
- Ensemble Streamflow Prediction used for longer time scales
- Statistical regression equations used for seasonal streamflow prediction



Statistical Regression

- Multivariate regression equations created using principal component analysis (PCA)
  - Data sites used in snowmelt regression equations tend to be highly inter-correlated. PCA gets beyond this and allows us to calculate optimal coefficients
- Can be non-linear which helps with the extremes

Equation # 4

Y 1 LPHC2/QCMRZZZ,Ap-Jl,LA PLATA - HESPERUS

= 3.711
+ -0.918 X1 SOI--/CIIRZZZ,Ja,
+ 1.966 X3 HSPC2/PPMRZZZ,Ja,FORT LEWIS
+ 0.859 X5 MNCC2/SWIRMZZ,Fe,MANCOS
+ 0.600 X6 LPLC2/SWIRZZZ,Fe,LA PLATA SNOWCOURSE

Number of observations used = 26
Number of principal components used = 1

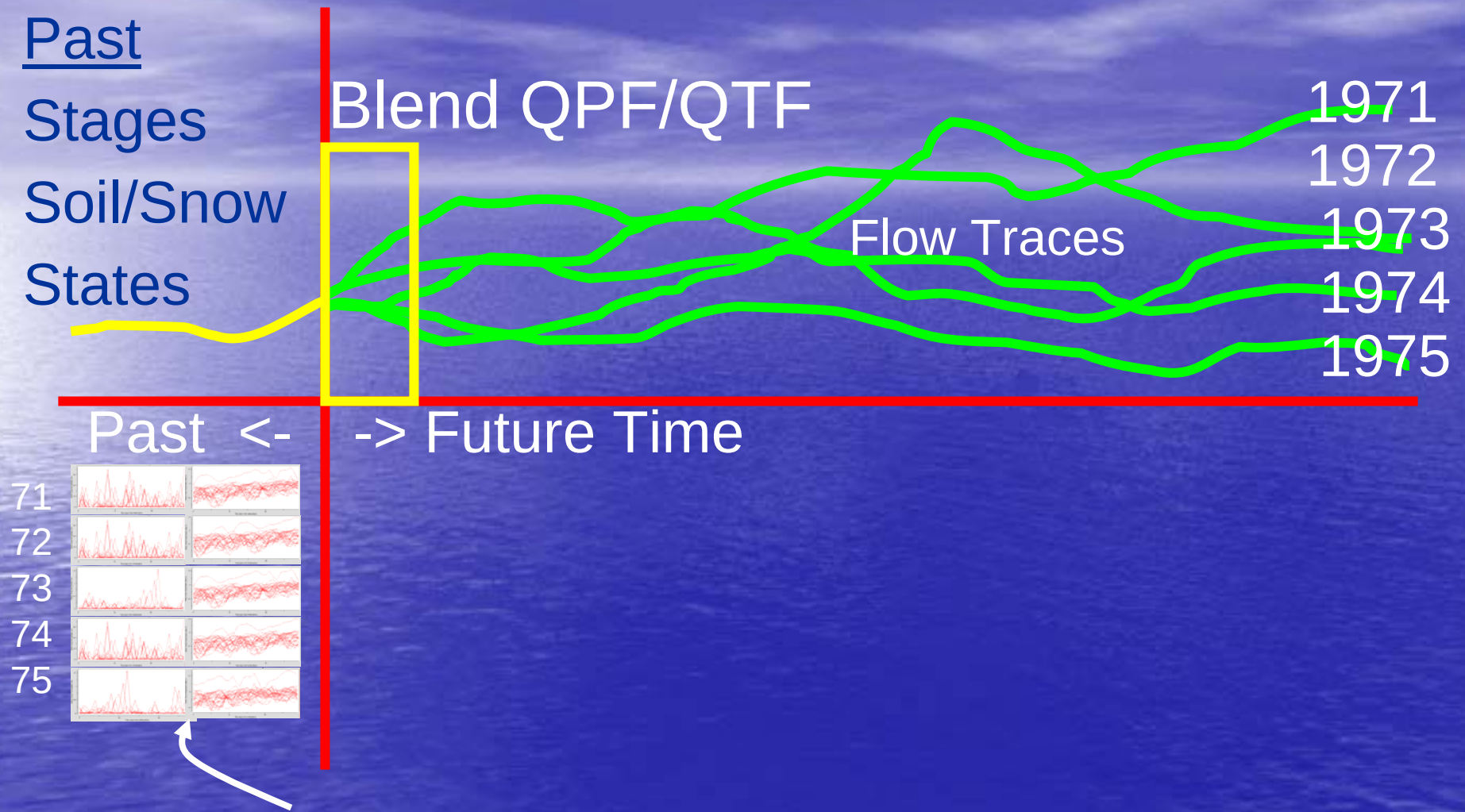
CORRELATION COEFFICIENT (R) = 0.862
STANDARD ERROR = 6.351 (rank = 10)
JACKKNIFE CORRELATION COEFFICIENT = 0.838
JACKKNIFE STANDARD ERROR = 6.851
JACKKNIFE BIAS: above average flow = -2.994 (12 obs.)
below average flow = 2.991 (14 obs.)

YEAR	OBSERVED	COMPUTED	ERROR	JACKKNIFE COMPUTED	JACKKNIFE ERROR
76	15.85	11.20	-4.65	11.85	-4.00
77	3.68	11.81	8.13	12.74	9.06
78	26.99	27.84	0.85	27.88	0.89
79	44.28	44.10	-0.18	44.29	0.01

ESP

- Ensemble Streamflow Prediction (ESP)
  - Uses current model states of soil moisture, modeled snowpack and current flow
  - Various methods of data assimilation are in use at the RFC's to update the seasonal snowpack with observed data

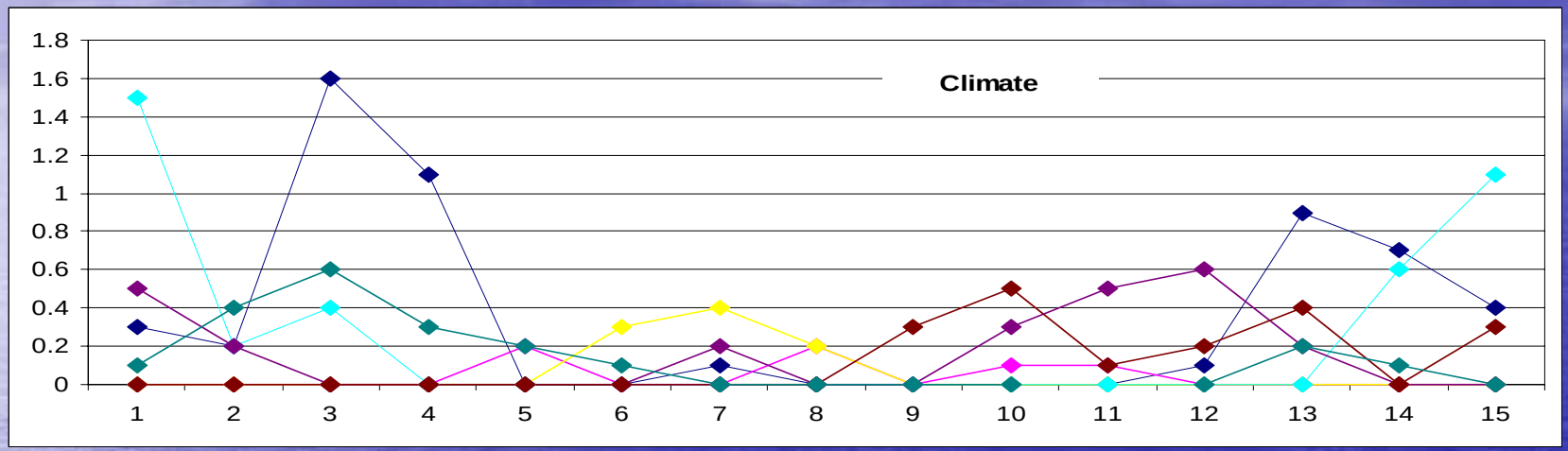
Making an Ensemble Forecast Using ESP

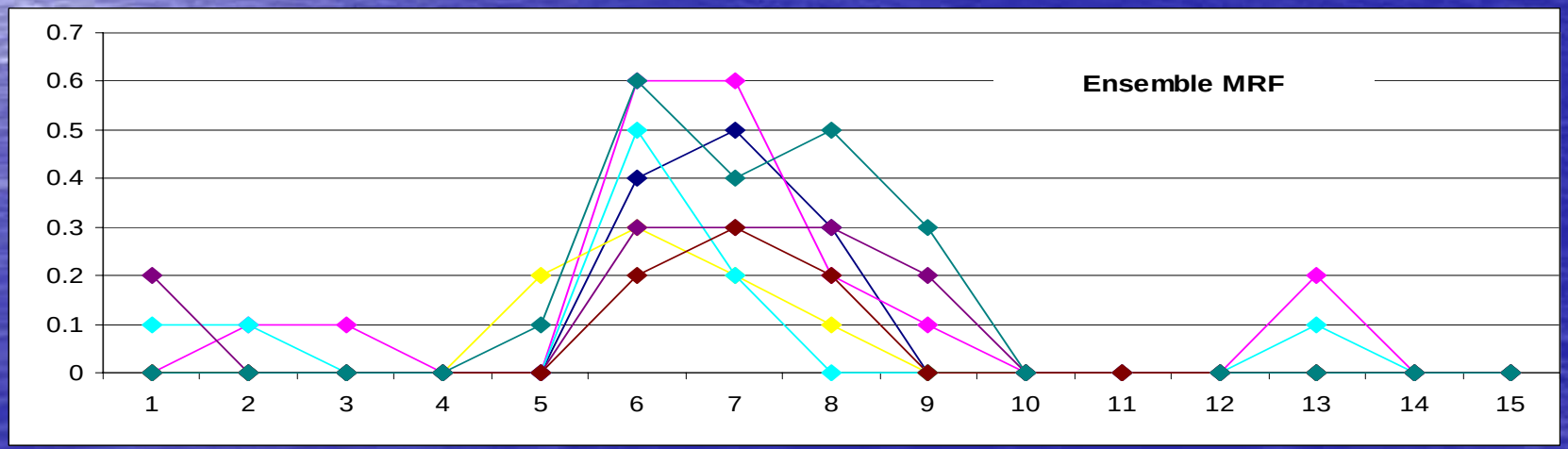


Historical Precip/Temps for Past Years

Creates a Flow for Each Year

Why climate forcing in the short-term is a bad idea

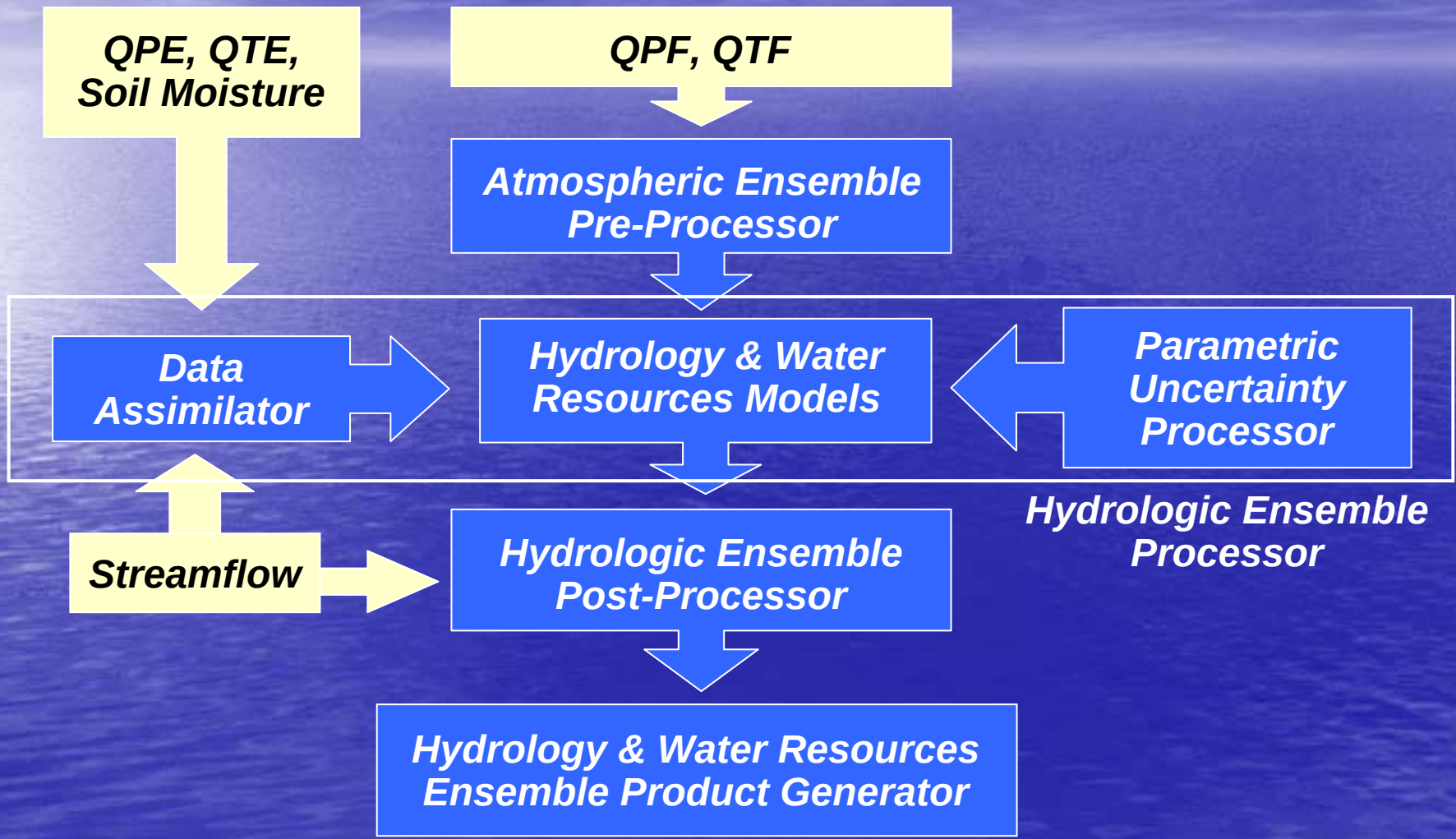




Current ESP Capabilities

- OHD's Ensemble Pre-Processor (EPP):
  - Testing and development at 4 RFCs: CN, CB, AB, MA
  - Currently leverages:
    - Historical HAS QPFs
    - CDC's frozen GFS
    - Basin climatologies
- Local efforts at other RFCs:
  - NC using HPC confidence intervals
  - OH using geospatial statistics
- CPC Pre-adjustment technique

Elements of a Hydrologic Ensemble Prediction System

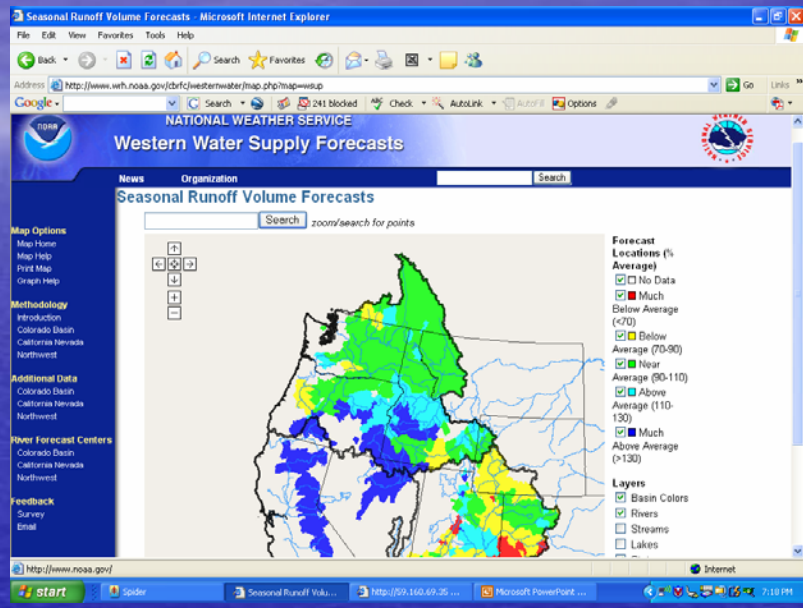


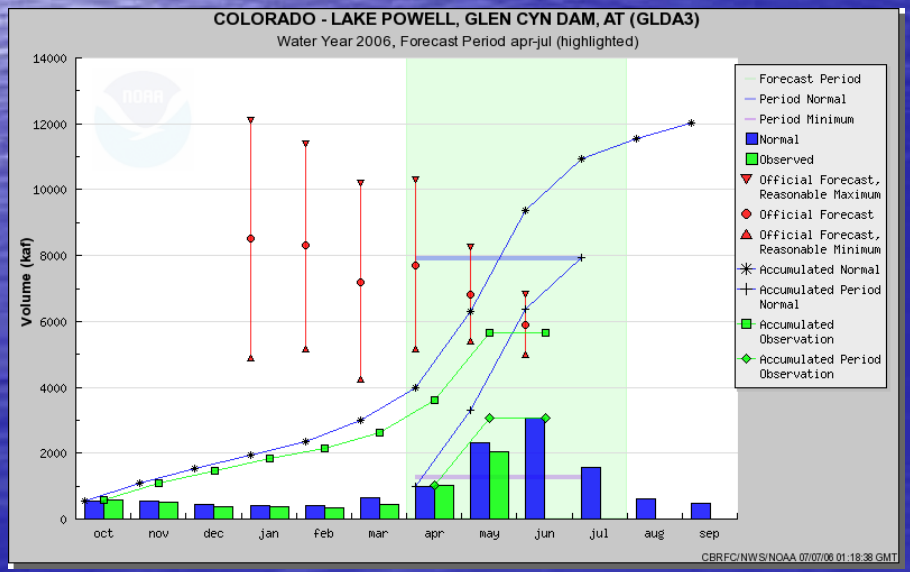
Advancements in forecast dissemination

- Western Water Supply
- NWRFC's ESP graph

Western Water Supply

- Color coded water supply map for all NWS water supply forecasts
- Forecast point specific plots depict current year forecast evolution and month by month climatologies





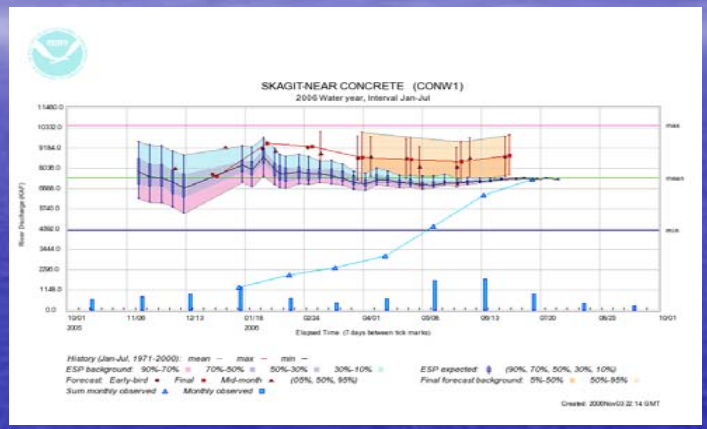
- Development began in 2005
- Includes participation from each RFC

Goals and Motivation (for Western Water Supply page)

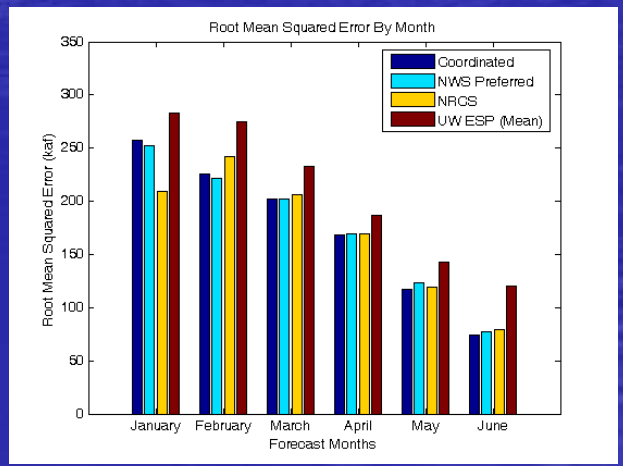
- A “one stop shop” for NWS water information at the seasonal timescale
- Consistent presentation of products between RFCs
- Harness collective innovation from multiple offices

Western Water Supply Web: FY07 Developments

- Incorporate water supply points east of the Continental Divide (MB, AB, and WG RFCs)
- Add ESP forecasts to forecast plot – prototype developed at NWRFC
- Add forecast verification information – prototype developed at WRH/SSD
- Develop database capabilities for website



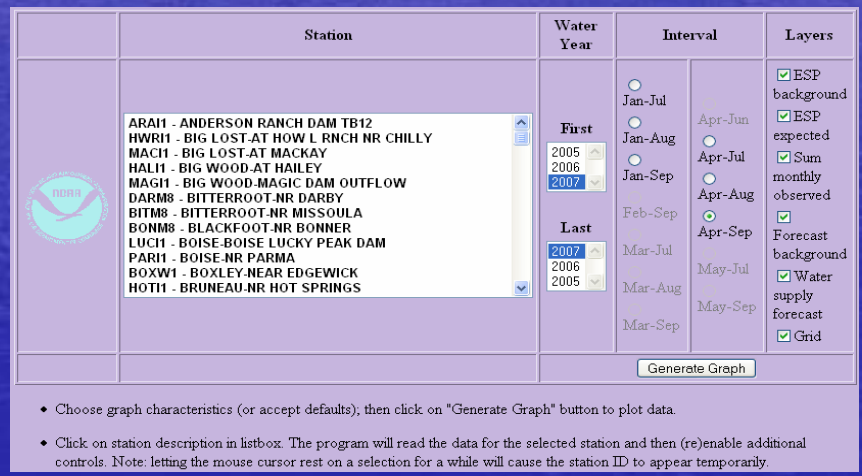
ESP prototype plot



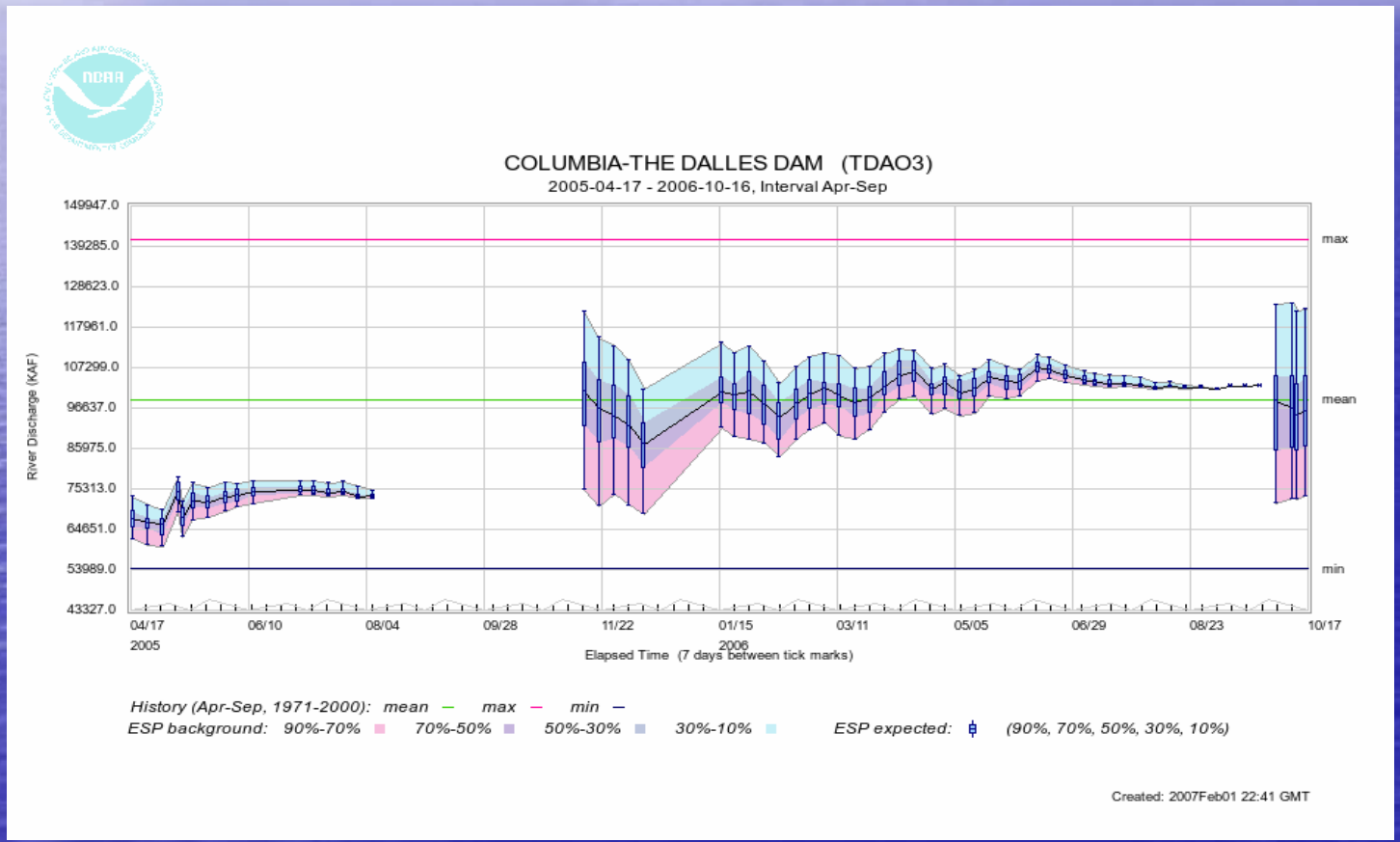
Verification prototype plot

ESP Services

- Prototype multi-year ensemble based plot developed at NWRFC
- Dynamically generated plots based on selectable
  - Start and end year
  - Forecast window
  - Background layers

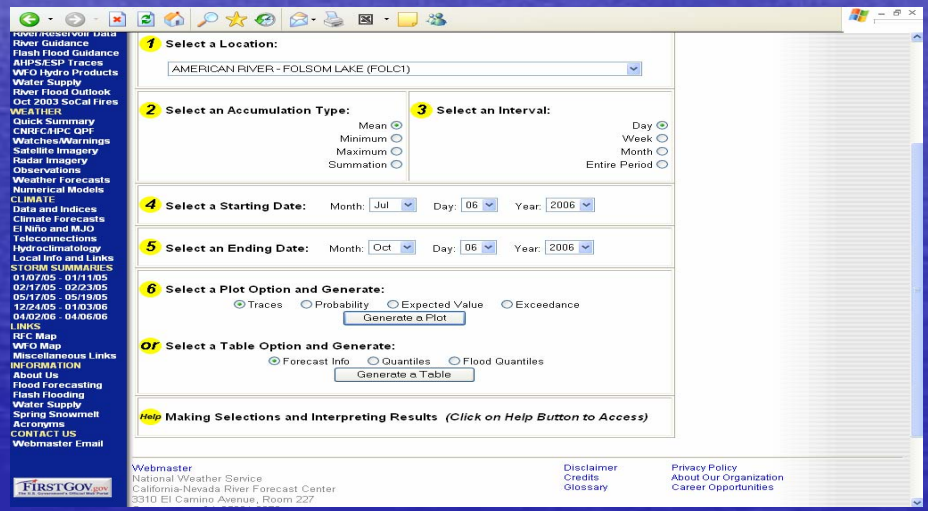


ESP Service (con't)



ESP Service (con't)

- Ensemble analysis software prototype
  - Developed at CBRFC and improved by CN and NW
  - Allow web user access to NWS ensemble software (ESPADP)
  - Manipulation of raw ensemble



Current Status

- CBRFC's snow data page
- National Operational Hydrologic Remote Sensing Center
- Nationwide precip analysis interface
- Western Water Supply
- Drought Monitor

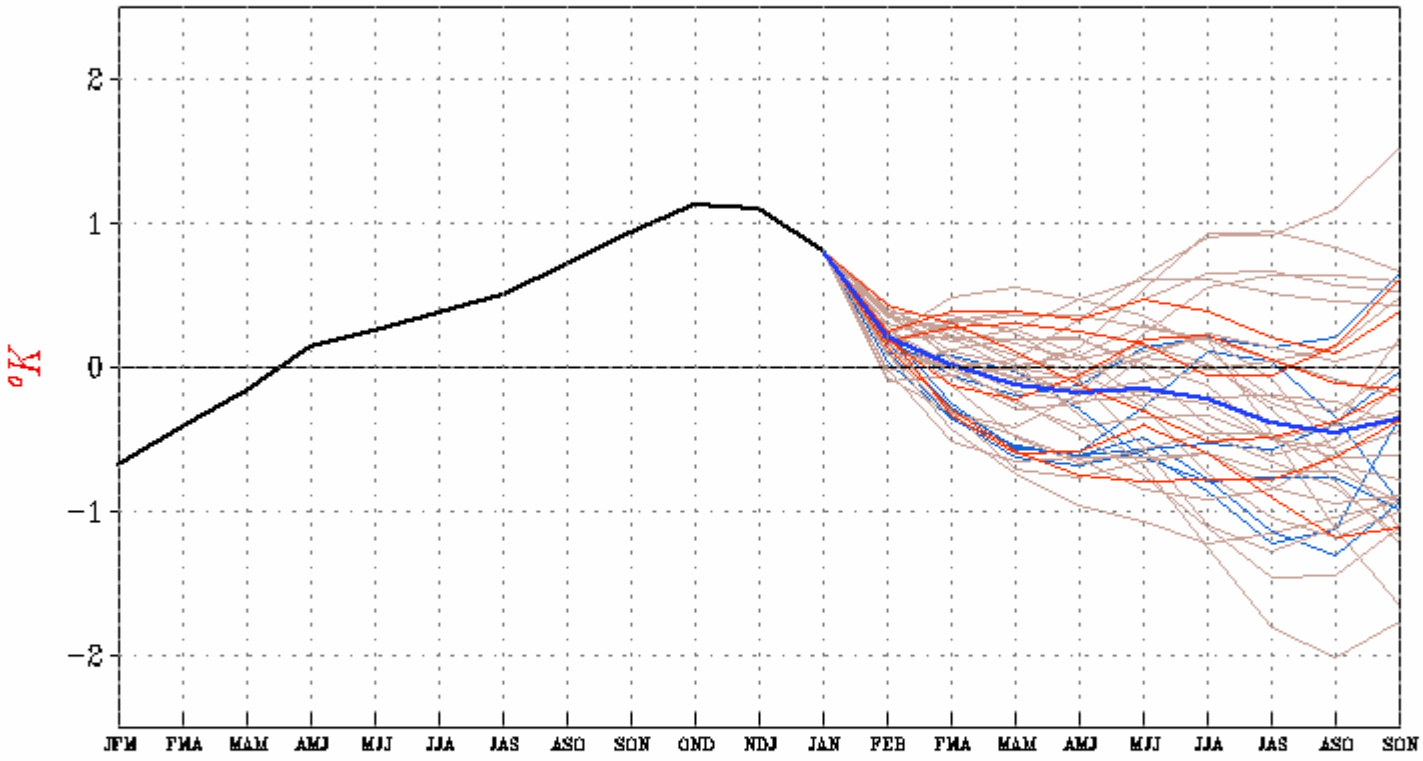
Water Supply Forecast Release Schedule For 2006-2007 Water Year

Type of fcst	Month							
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Official Forecast		8	7	7	6	7	7	9
Peak Flow Forecast		9	8	8	9	8	8	10
Mid-month update	21	19	15	15	19	17	21	

NWS/NCEP

Last update: Sun Feb 4 2007
Initial conditions: 8Jan2007–27Jan2007

Forecast *Nino3.4* SST anomalies from CFS



Latest 6 forecst members
Earliest 6 forecst members
Other forecast members
Forecast ensemble mean
OIv2 observation

Forecast initial conditions: 8Jan2007 to 27Jan2007.

Base period for climatology is 1971–2000. Base period for bias correction is 1982–2003.

Verification

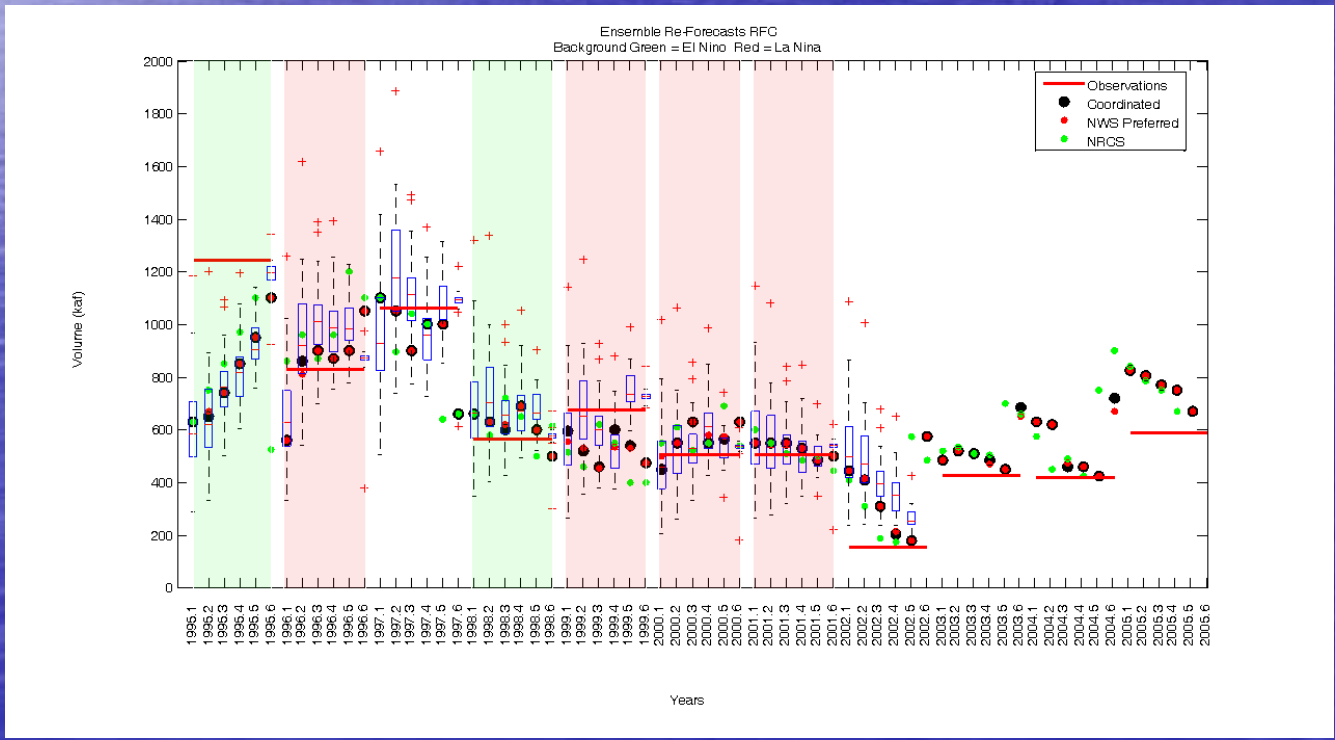
> "Hydrologic forecast verification must be conducted in the terms by which the forecasts were created. This requires that researchers become knowledgeable of operational forecasting procedures."
>
> – Bisher Imam and Holly Hartmann, AHPS verification report 2006

Water supply verification overview

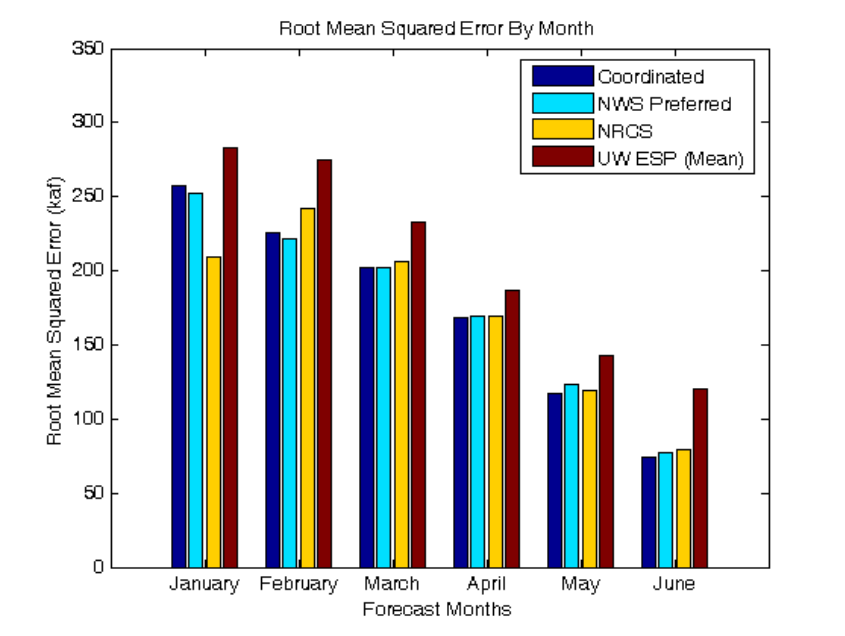
- Verification should allow comparisons between current and new forecast methodologies
- Error, skill, and categorical statistics
- Conditional statistics based on lead time, year, etc
- Side-by-side comparison of multiple forecast sources
- Dynamic, user specifiable plots created from database
- Deterministic (e.g. single value) and probabilistic (e.g. ensemble) forecast verification

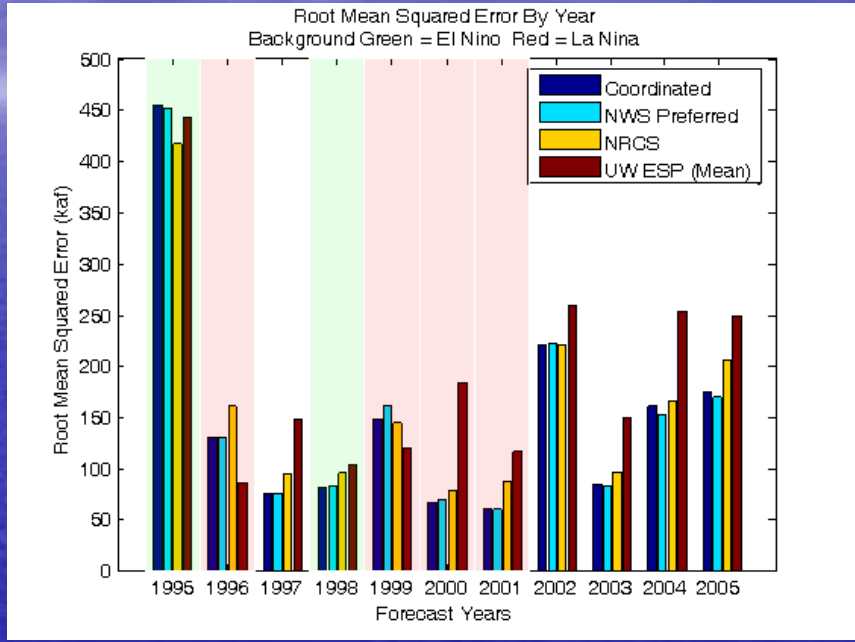
Verification: Archive visualization

- Historical forecast and reforecast examination
  - Visually compare archived forecasts and reforecasts to observed volumes



Verification: Error statistics



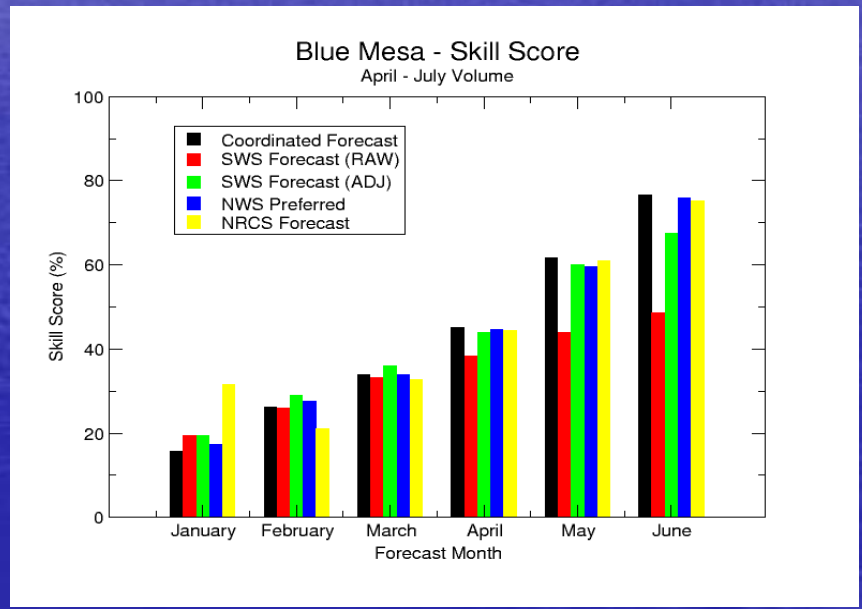


Error Statistics

- **RMSE, MAE, ME for deterministic, RPS for ensemble**
- **Conditional on lead-time (left) and year (right)**
- **Dynamically generated**

Verification: Skill

- Skill Scores
  - RMSE-SS for deterministic; RPSS for probabilistic
  - Reference forecast = climatology
  - Conditional statistics based on lead time and year
  - Dynamically generated



Verification: Categorical

- Traditional (NWS) verification including:
  - False Alarm Ratio (FAR)
  - Probability of Detection (POD)
- Category definitions tied to climatology values (e.g. mean flow, terciles, etc.) or user definable