*The Colorado Basin River Forecast Center*
*Welcomes*
*Yellow River Conservancy Commission*
*Ministry of Water Resources of China*

*Water Supply Forecast*

*Flash Flood Forecasts*

*Recreational Forecasts*

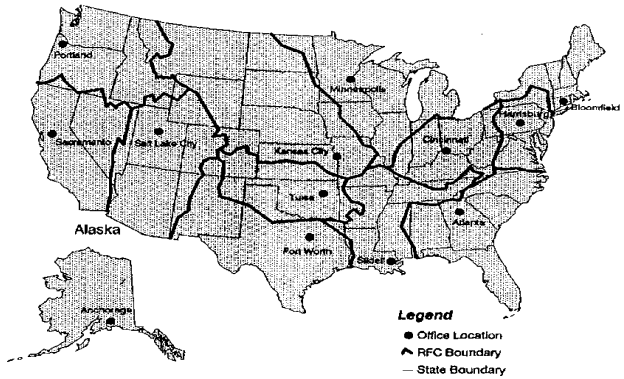
*River Forecasts*

*National Weather Service Salt Lake City, Utah*
*November 21, 2002*

# THE COLORADO BASIN RIVER FORECAST CENTER WELCOMES

## YELLOW RIVER CONSERVANCY COMMISSION
## MINISTRY OF WATER RESOURCES ON CHINA

November 22, 2002




NWS RIVER FORECAST CENTERS

## CBRFC AREAL STATISTICS

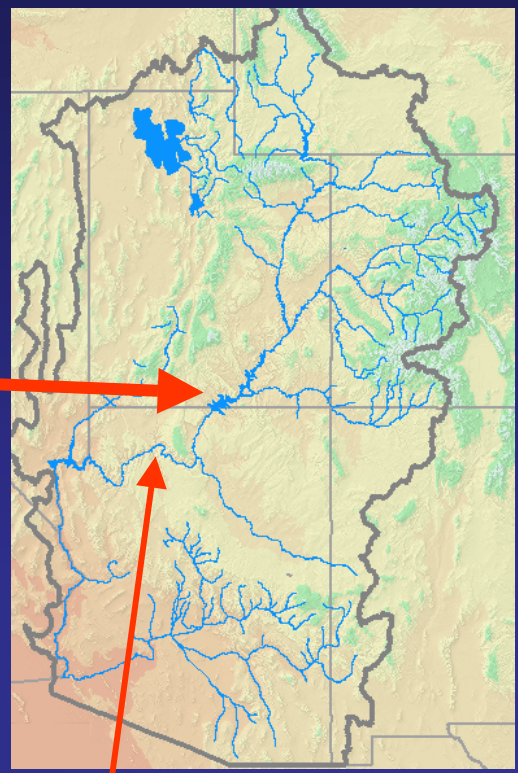
| | | |
|---|---|---|
| **AREA** | **=** | **303,450 SM (RANK 5TH)** |
| **COUNTIES** | **=** | **558** |
| **STATES** | **=** | **7** |
| **HSAs** | **=** | **13** |
| **NEXRADS** | **=** | **16** |

## HYDROLOGIC FEATURES

**80% RUNOFF FROM SNOWMELT**
**LARGEST EVAPORATION RATES**
**SMALLEST PRECIPITATION AMOUNTS**
**DESERTS TO ALPINE CLIMATES**
**ELEV RANGE: 200 FT - 14,200 FT (MSL)**

# Glen Canyon Dam
# Colorado River

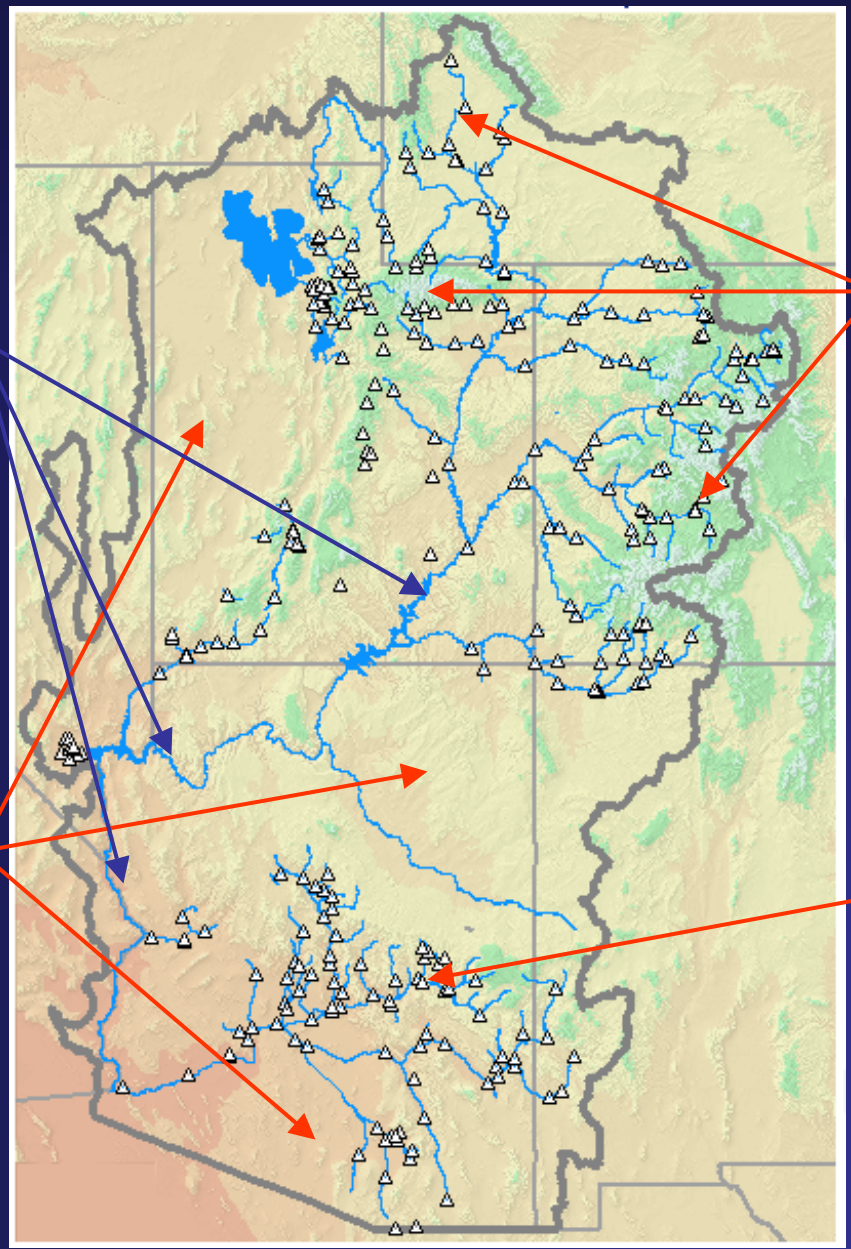
Colorado and Great Basins



Grand Canyon

Colorado River

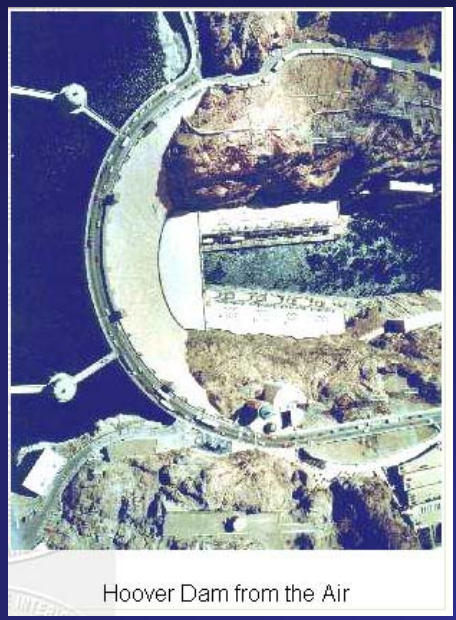
High Elevation
Mostly Snow



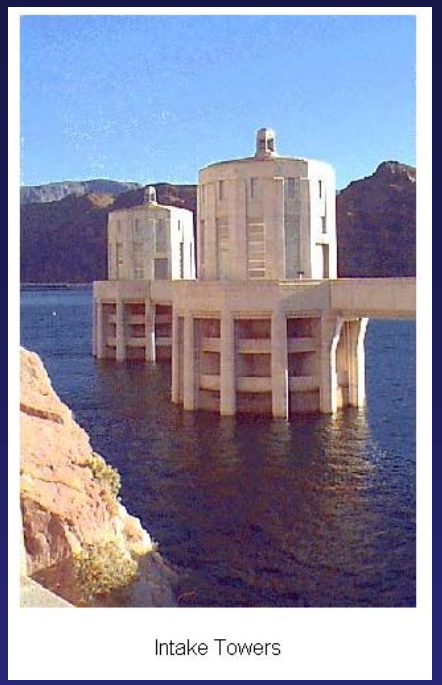
Mostly Desert
Low Precipitation

Some High
Elevations
Rain/Snow Mix

# Hoover Dam
# Colorado River

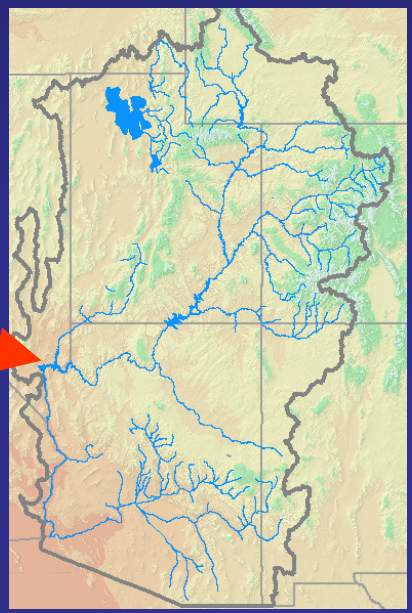


Hoover Dam from the Air



Intake Towers

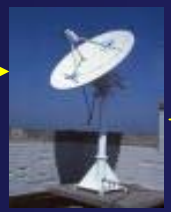
Hoover Dam



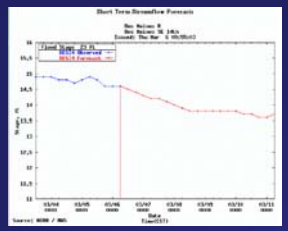
# End-to-End Forecast Process

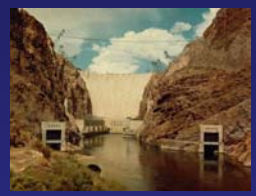
## Flood Mitigation and Integrated Water Management

Data



Communication





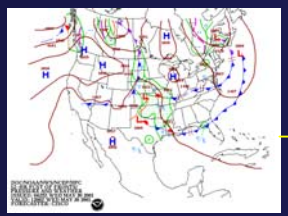
River/Flood Forecast

Decision Support

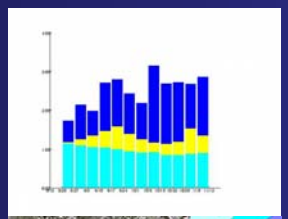
Notify

Coordinate

Action



Forecast

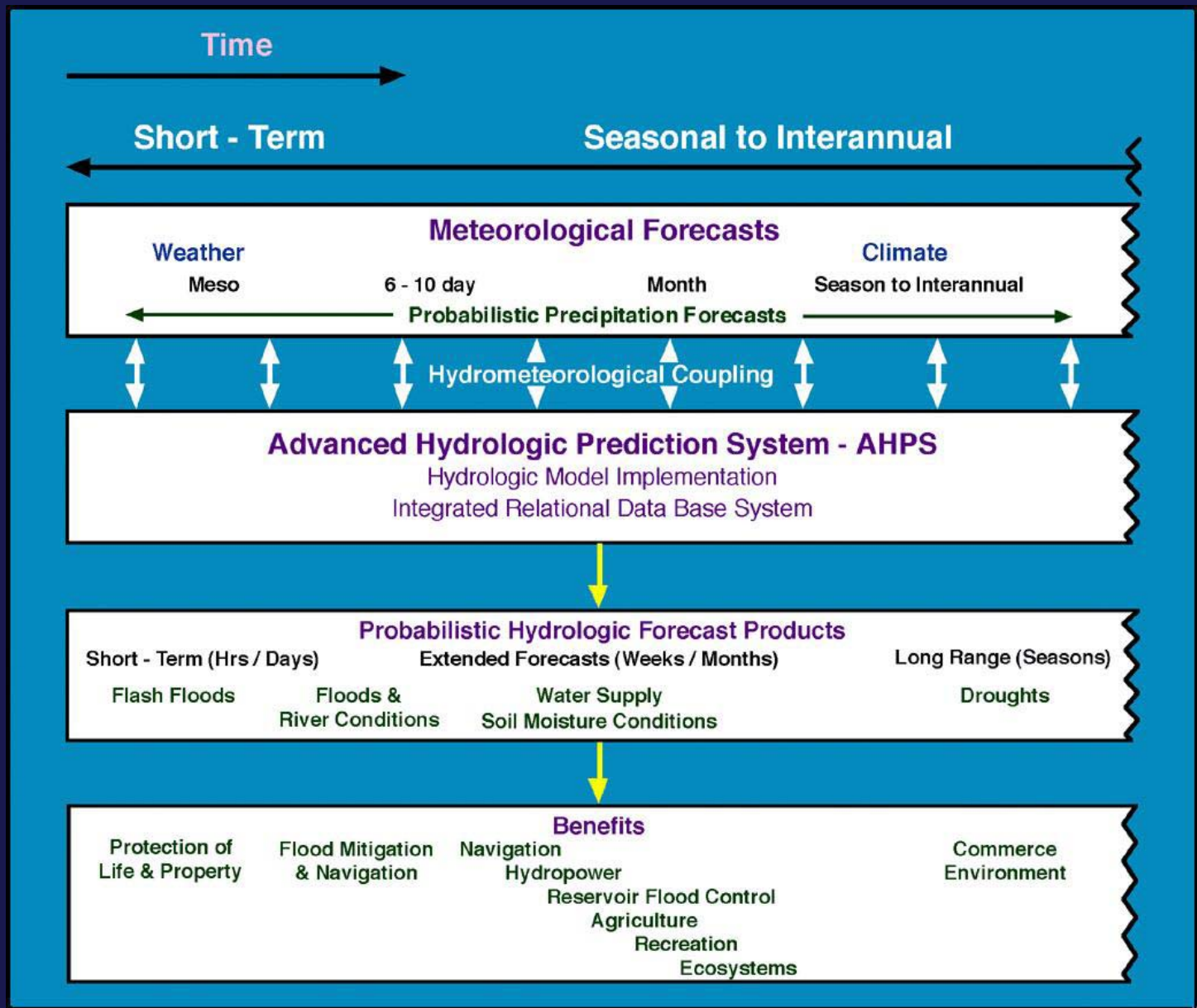


# National Weather Service Hydrometeorological Data Sources

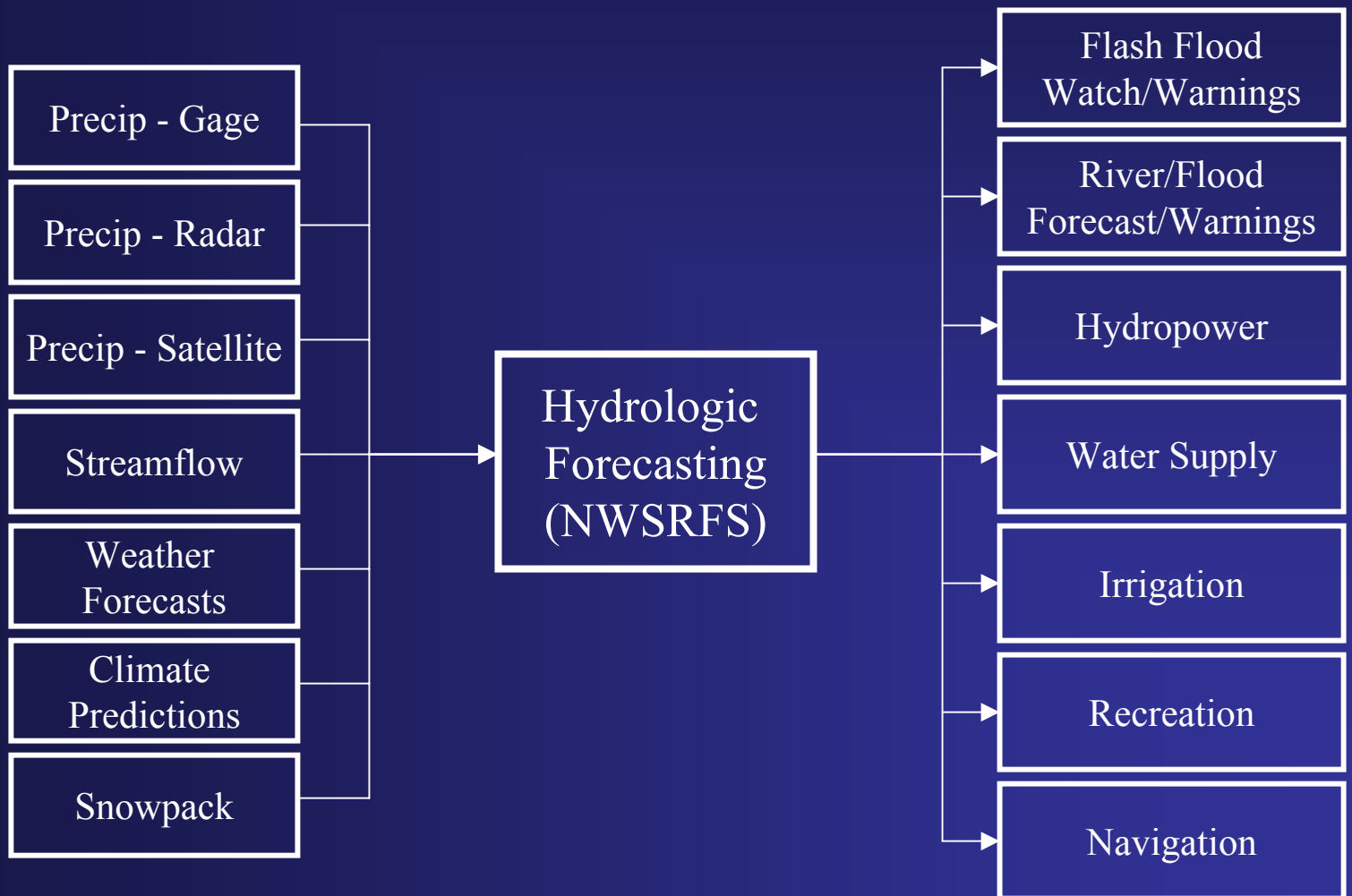
- SNOTEL - high elevation snow measurement
- Volunteer observers - touch-tone
- Cooperative federal water agencies
- Synoptic surface observation network (ASOS)- meteorological data
- Automated flood warning systems
- GOES satellite data collection platform
- Limited area remote collector streamgages
- Satellite rainfall estimates
- NEXRAD radar derived rainfall estimates
- IFLOWS - interactive flood observing and warning system

# Data Collection Platform (DCP)

# Hydrometeorological Coupling



# NWSRFS
# Hydrologic Forecasting Data Inputs and Applications



# National Weather Service River Forecast System (NWSRFS)

NWSRFS

Modular

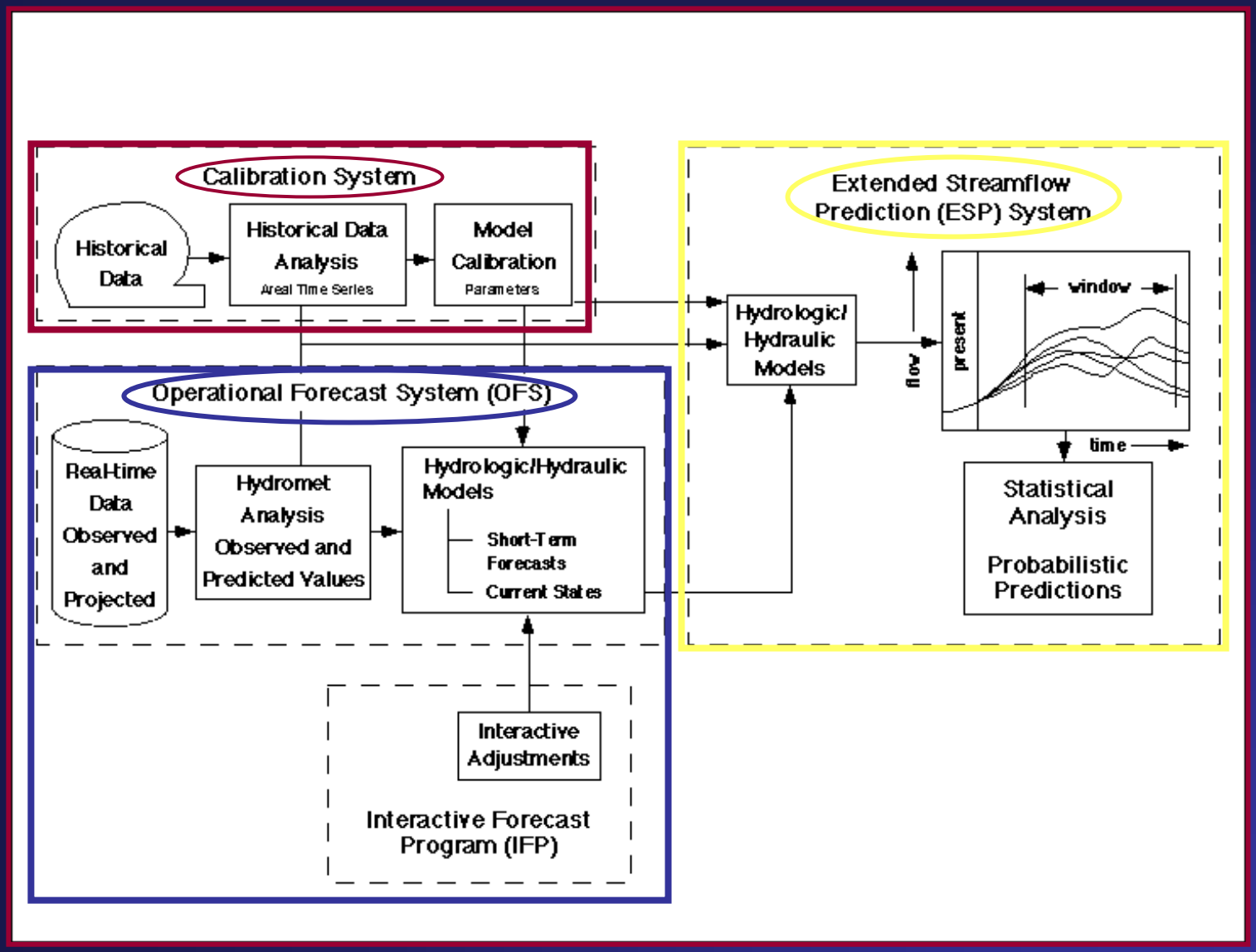
Hydrologic/hydraulic operations

# Collection of Models and Processes

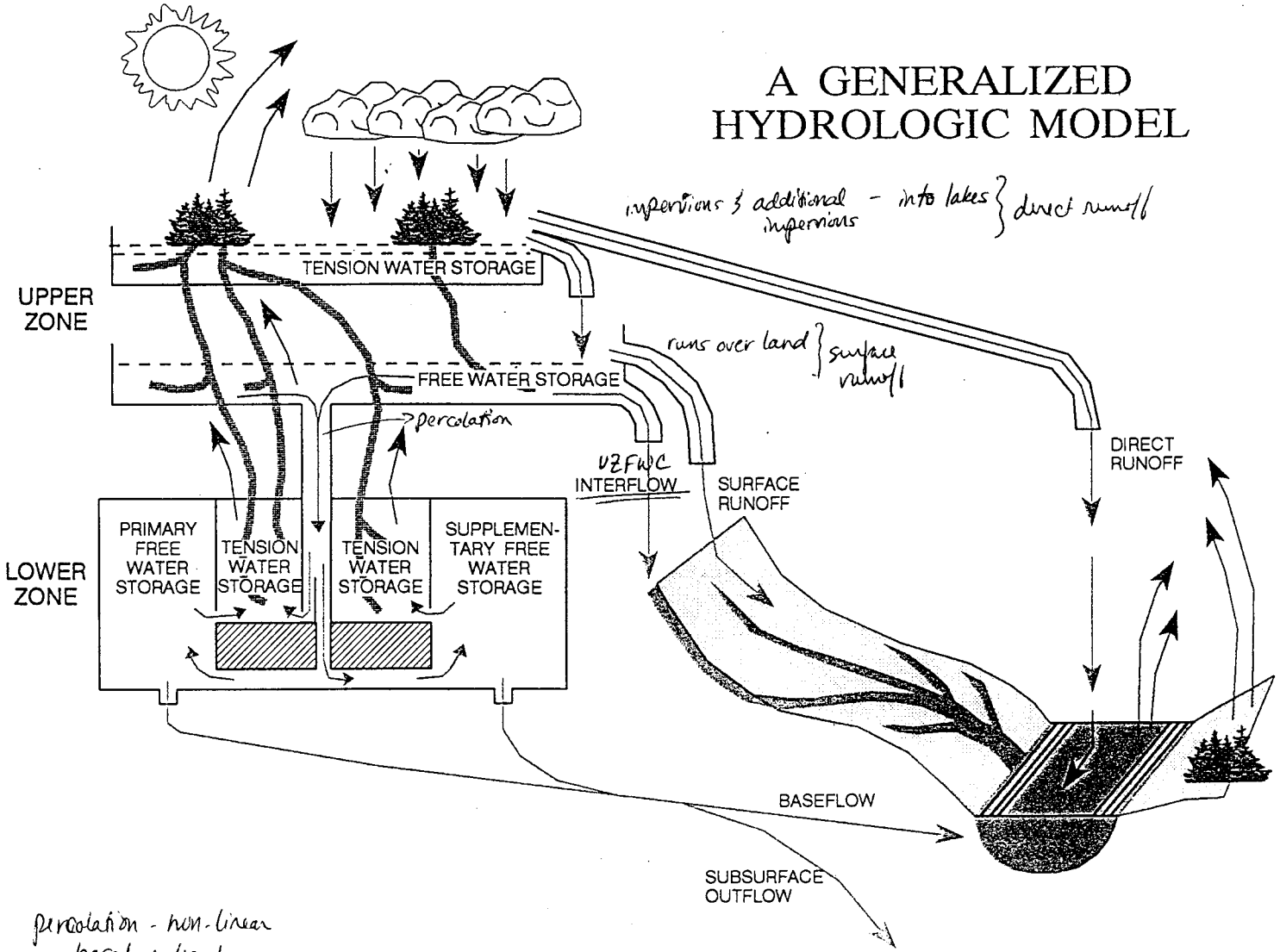
- Simulate snow accumulation and ablation
- Compute runoff
- Distribute runoff temporally from within basin to basin outlet
- Channel and/or reservoir route streamflow

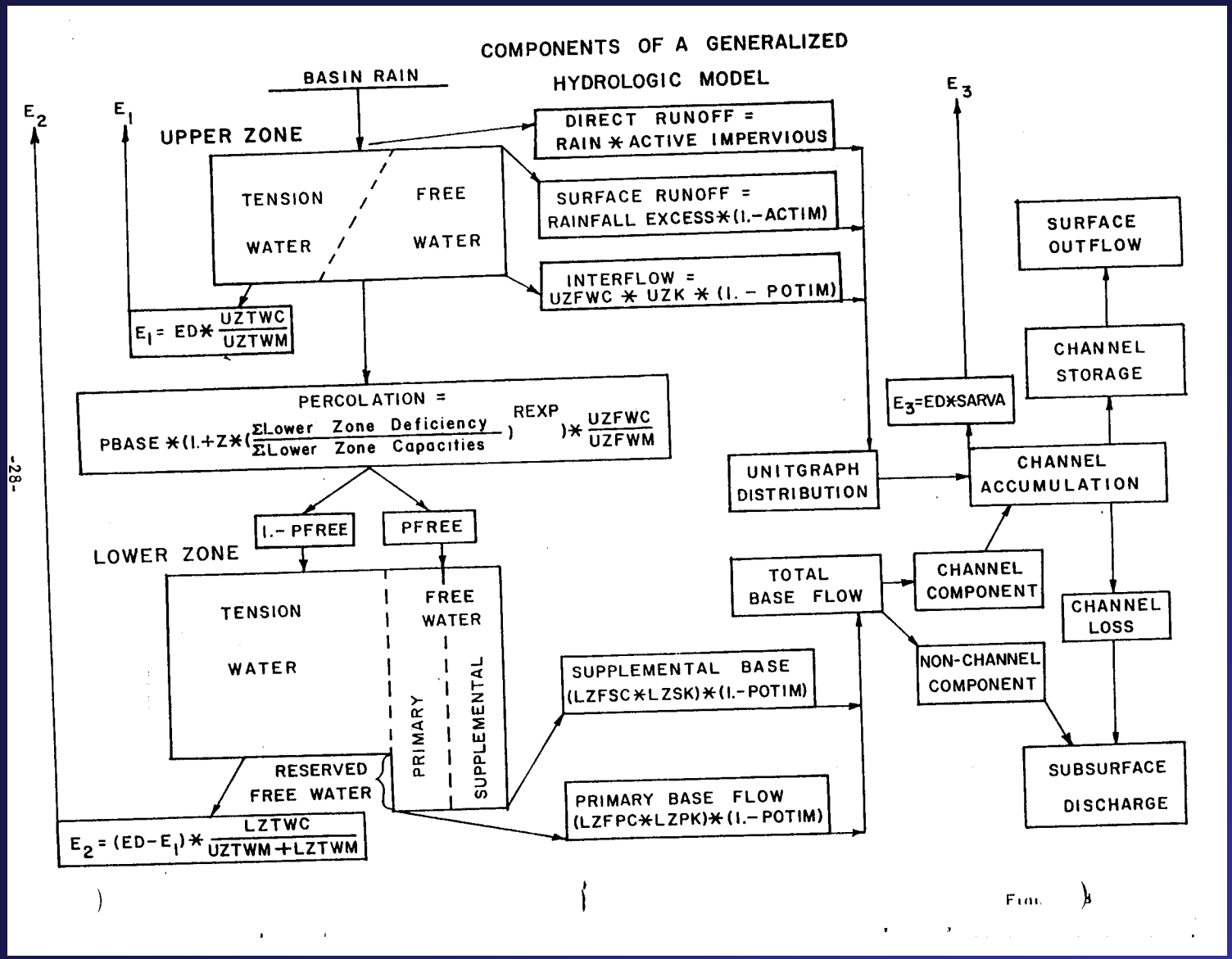
  – Data Management operations

# NWSRFS-Three Components

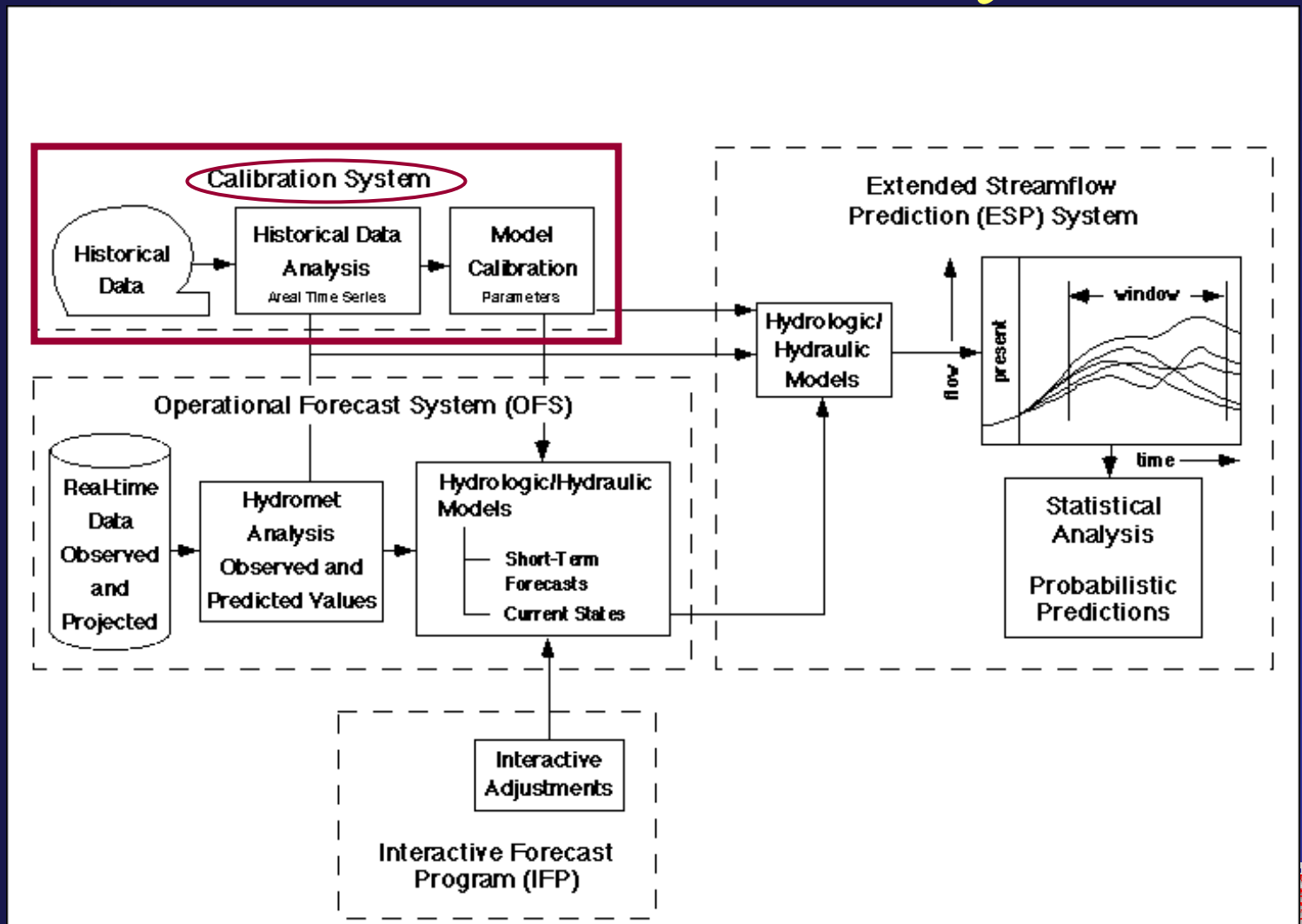


# A GENERALIZED HYDROLOGIC MODEL




COMPONENTS OF A GENERALIZED HYDROLOGIC MODEL
BASIN RAIN
E2
E1
E3
UPPER ZONE
TENSION WATER
FREE WATER
DIRECT RUNOFF = RAIN * ACTIVE IMPERVIOUS
SURFACE RUNOFF = RAINFALL EXCESS*(1.-ACTIM)
INTERFLOW = UZFWC * UZK * (1. - POTIM)
E1 = ED* UZTWC / UZTWM
PERCOLATION = PBASE *(1.+Z*(ΣLower Zone Deficiency / ΣLower Zone Capacities) REXP )* UZFWC / UZFWM
1.- PFREE
PFREE
LOWER ZONE
TENSION WATER
FREE WATER
PRIMARY
SUPPLEMENTAL
RESERVED FREE WATER
E2 = (ED-E1)* LZTWC / UZTWM+LZTWM
SUPPLEMENTAL BASE (LZFSC*LZSK)*(1.-POTIM)
PRIMARY BASE FLOW (LZFPC*LZPK)*(1.-POTIM)
E3=ED*SARVA
SURFACE OUTFLOW
CHANNEL STORAGE
UNITGRAPH DISTRIBUTION
CHANNEL ACCUMULATION
TOTAL BASE FLOW
CHANNEL COMPONENT
CHANNEL LOSS
NON-CHANNEL COMPONENT
SUBSURFACE DISCHARGE

# NWSRFS-Calibration System



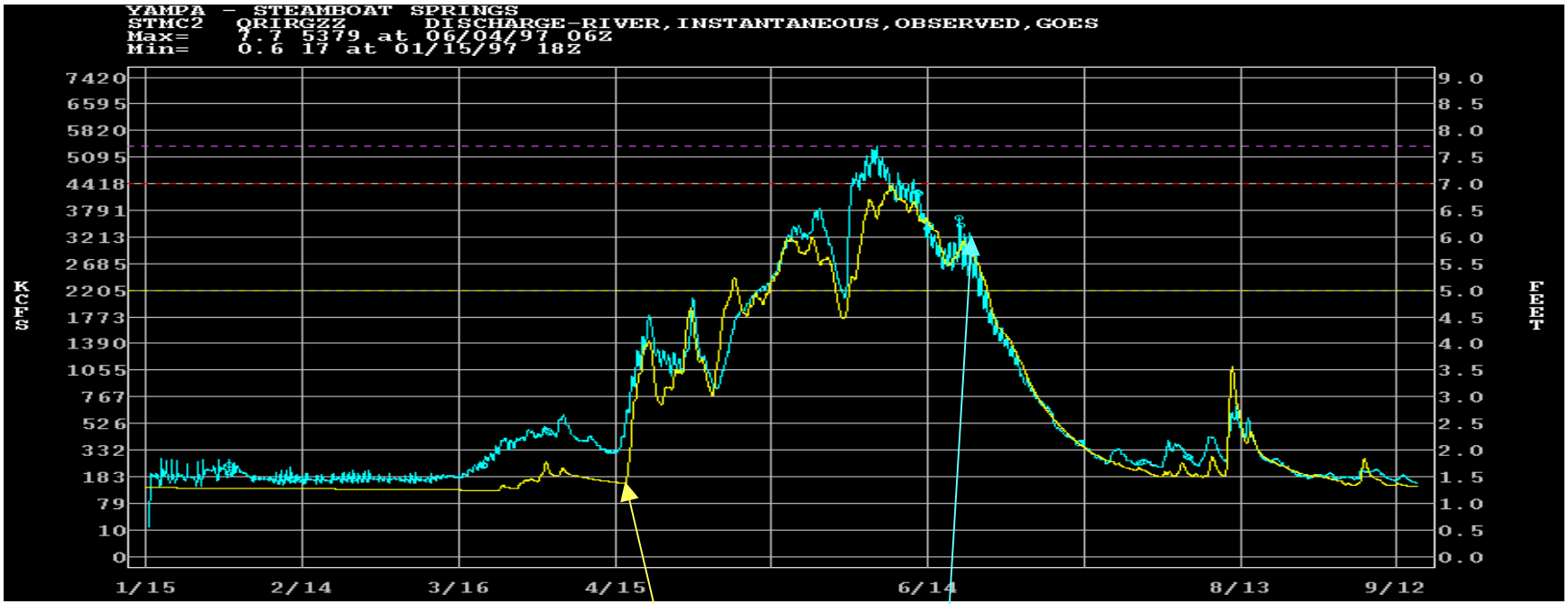
# Calibration System (CS)

- Inventory of historical data
- Analysis of historical data
- Time series based on historical data
- Model Selection
- Calibration of model parameters

# Poorly Calibrated Basin

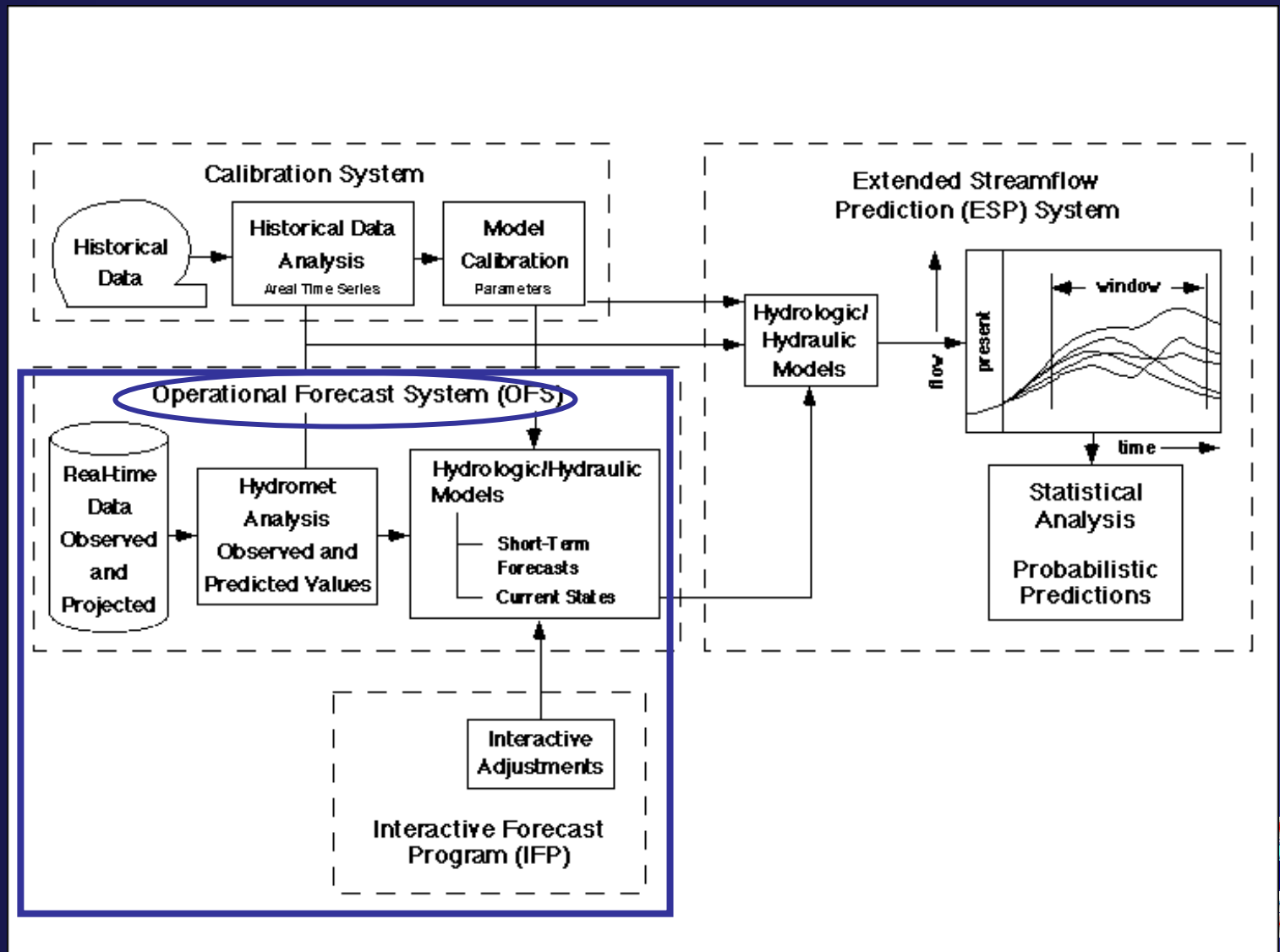

Simulated Observed

# Much Better Calibrated Basin




Simulated Observed

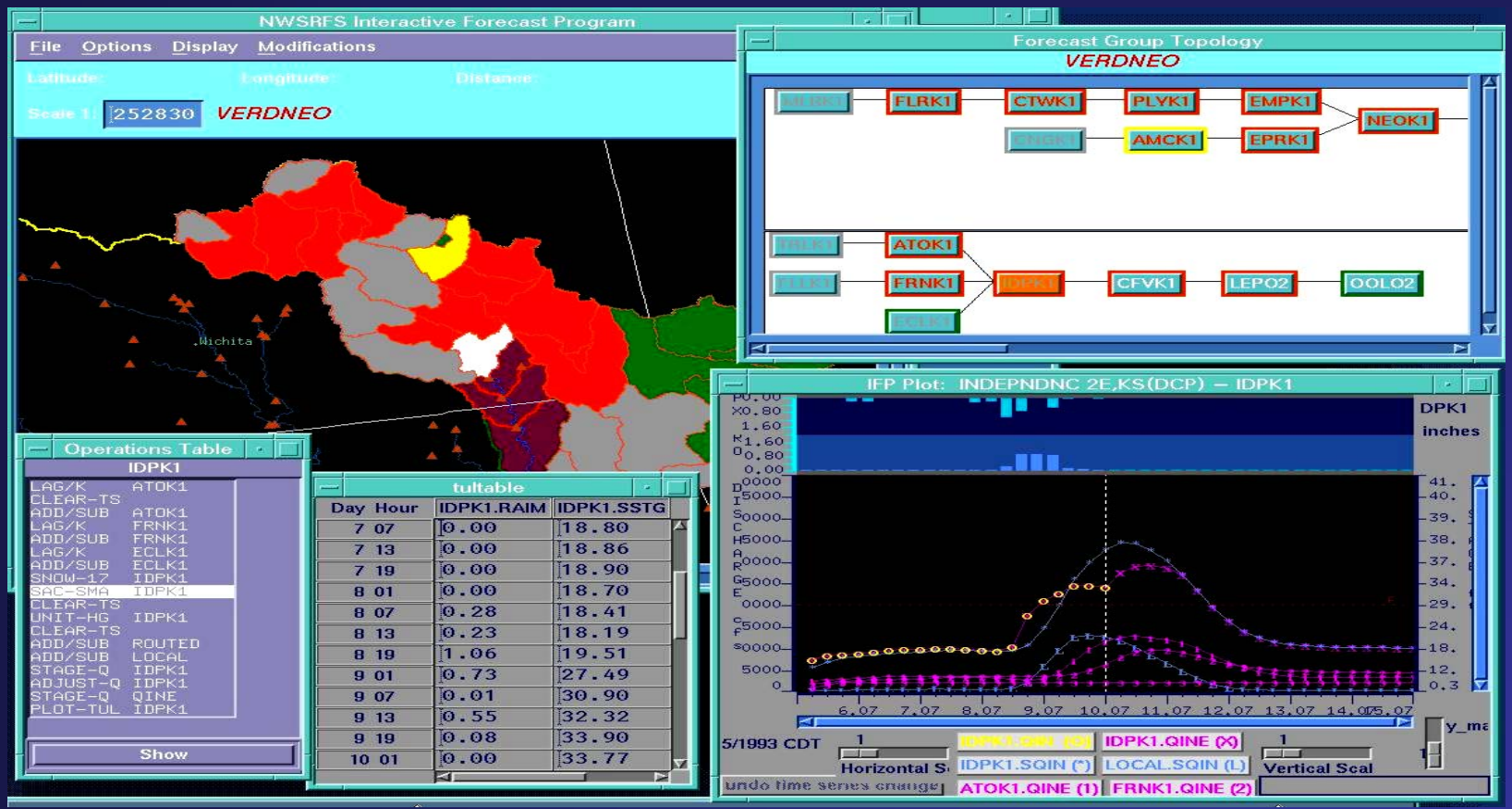
# NWSRFS-Operational Forecast System



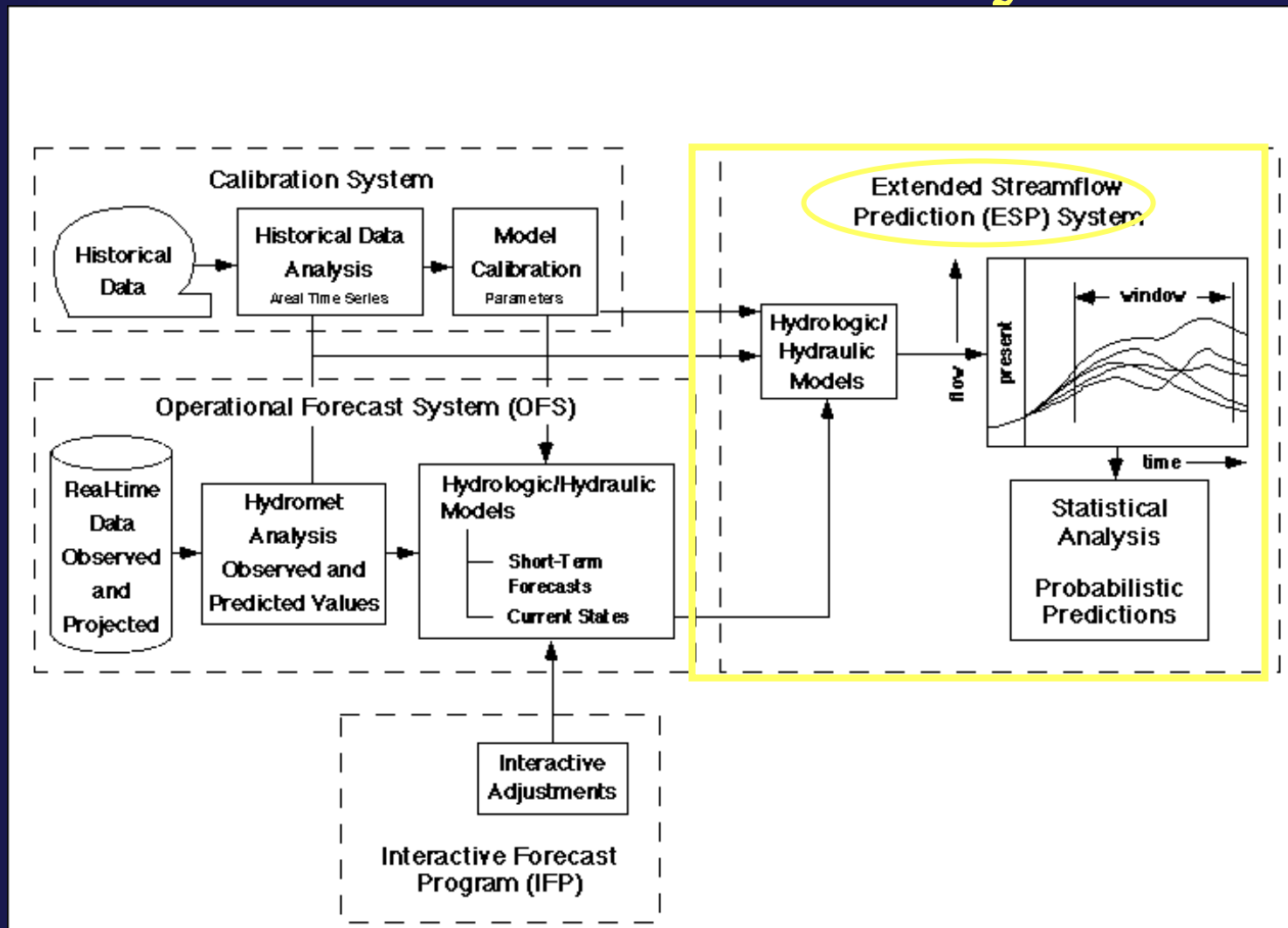
# Operational Forecast System (OFS)

- Preprocesses observed and future data
- Updates model state parameters
- Provides short-term river and flood forecasts

# Interactive Forecast Program



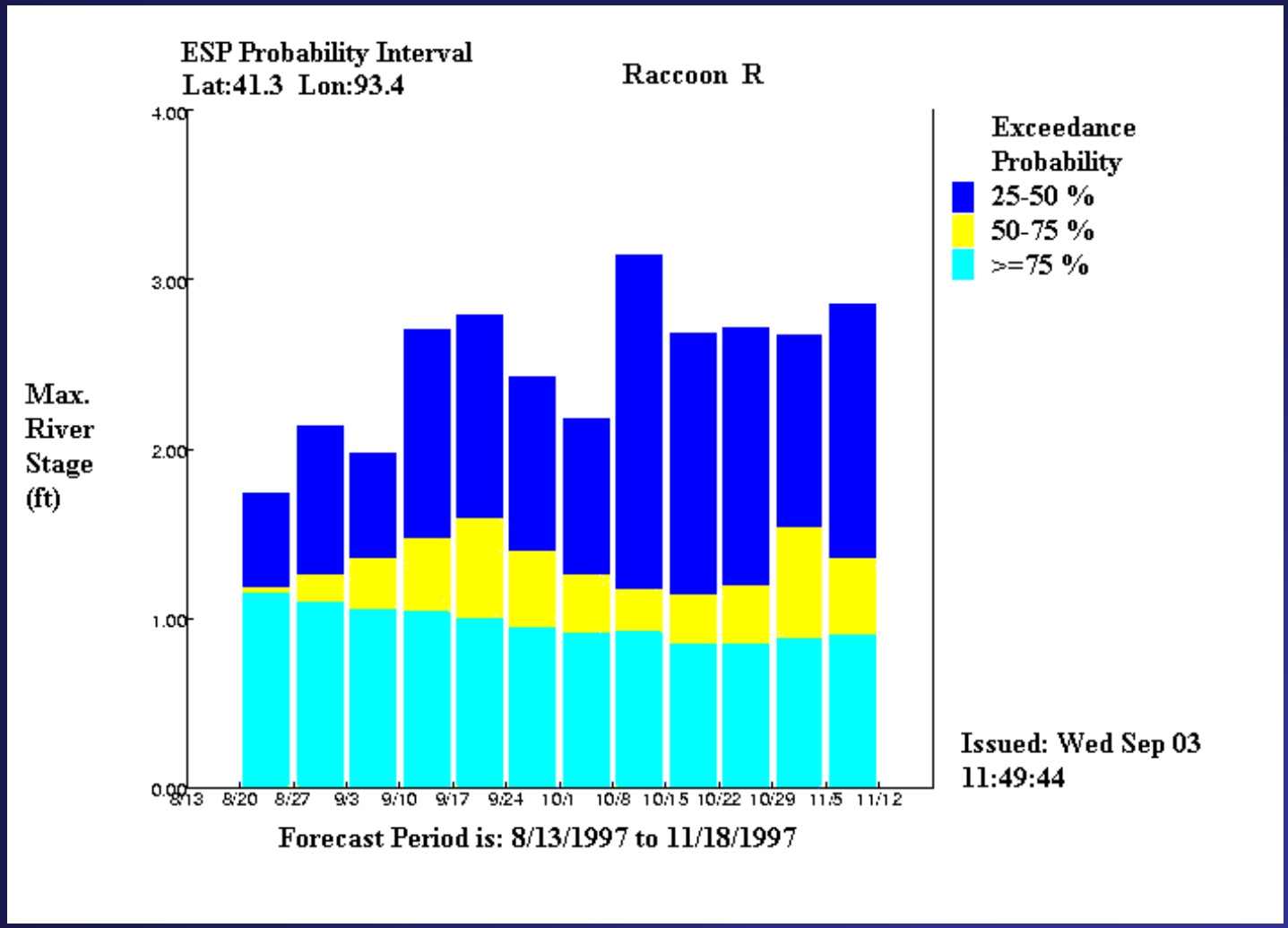
# NWSRFS-Ensemble Streamflow Prediction System



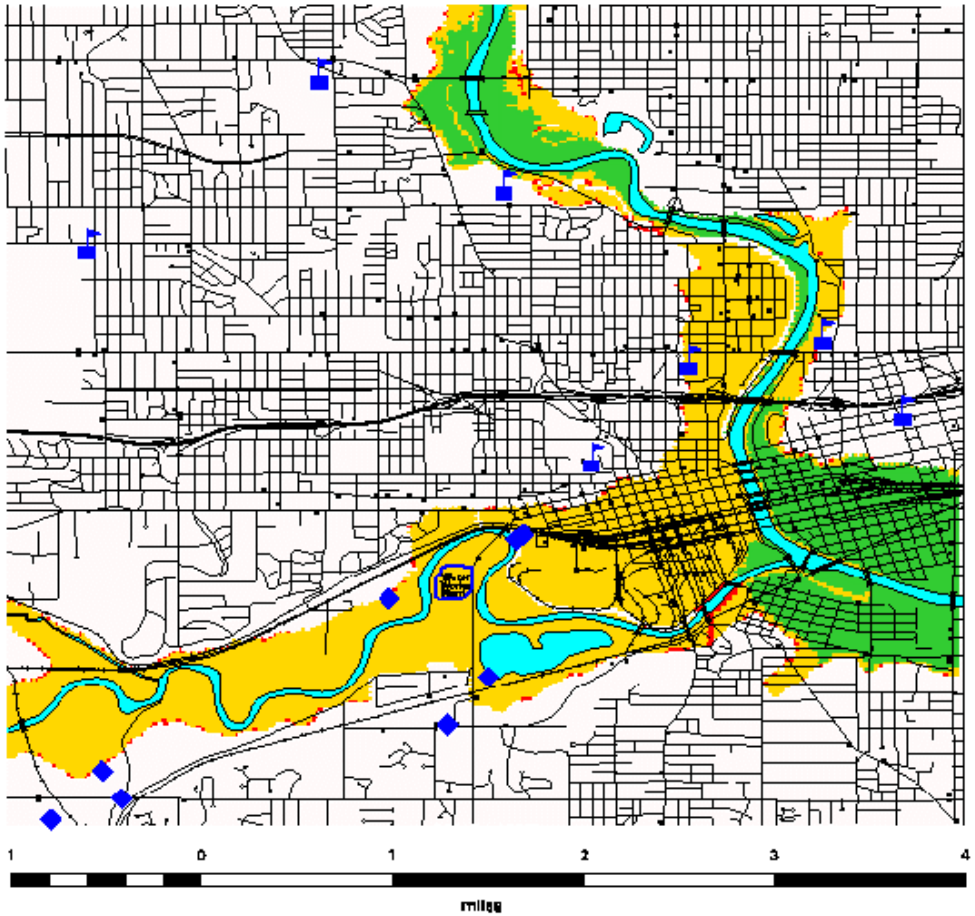
# Ensemble Streamflow Prediction (ESP)

- Uses historical precipitation, temperature and evaporation data
- Uses current model states
- Produces mid- to long-range probabilistic forecast (weeks to months into the future)

# ESP Probability Interval



# AHPS Flood Inundation Map — Des Moines, Iowa



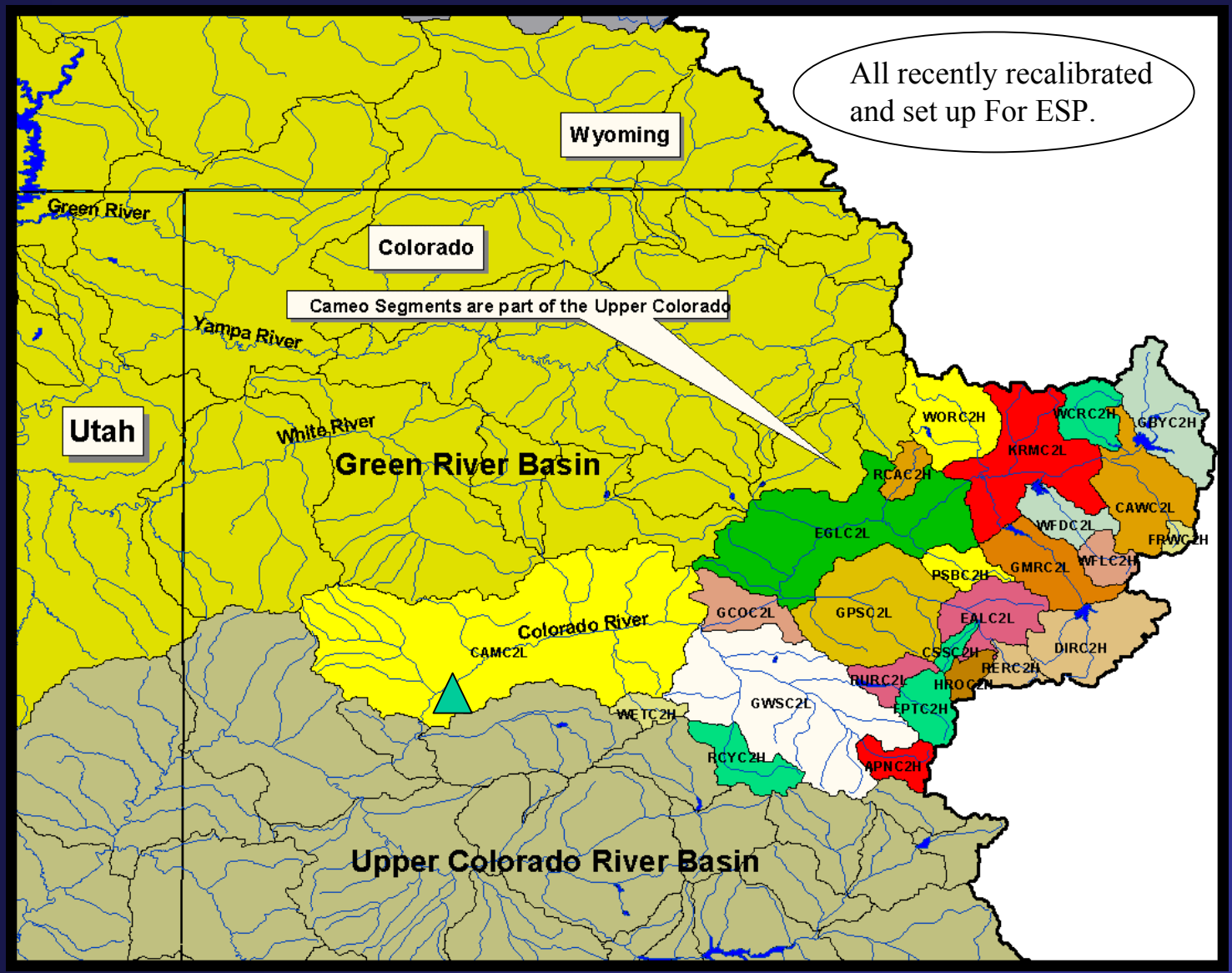

## Probability of flooding at reference datum plus 9 feet

Reference datum of March 27, 1997

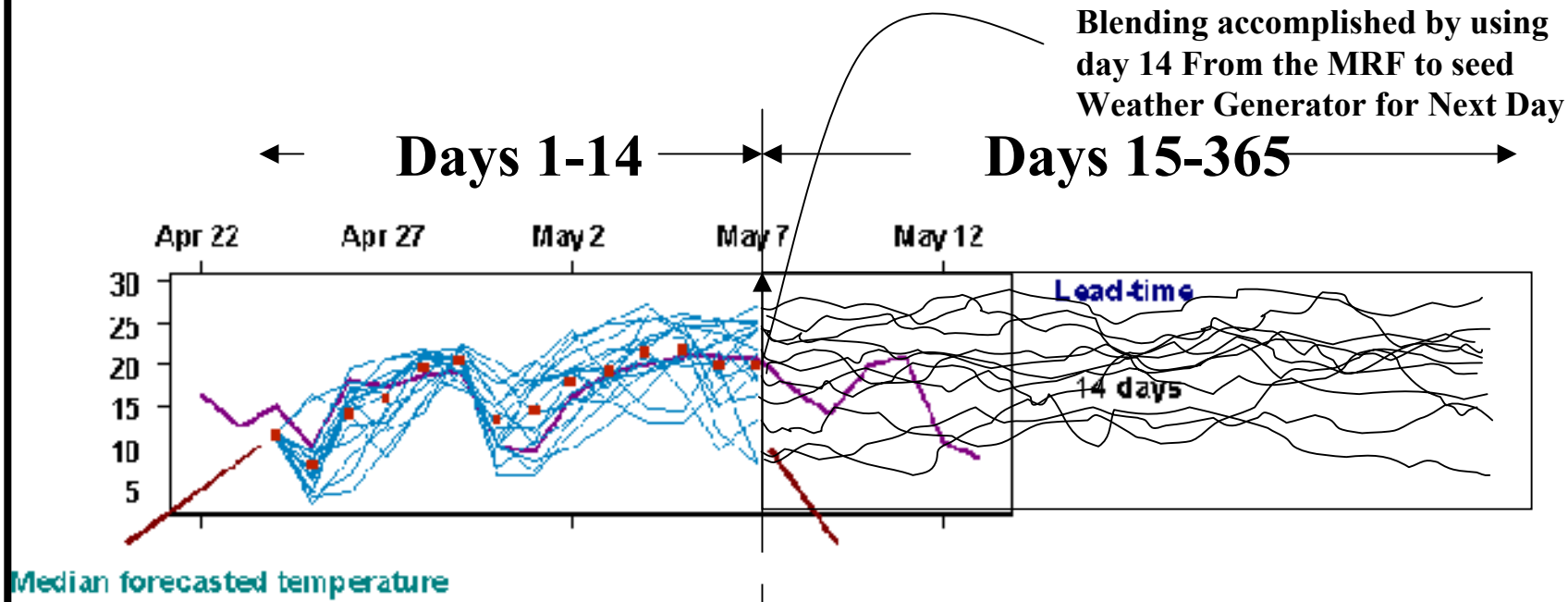
| | |
|---|---|
| less than 25 percent | natural rivers and ponds |
| 25 to 50 percent | underground storage tanks |
| 50 to 75 percent | hospitals |
| greater than 75 percent | industrial facilities |

**National Operational Hydrologic Remote Sensing Center**

# Project Area: 27 Segments Above Cameo, Colorado River



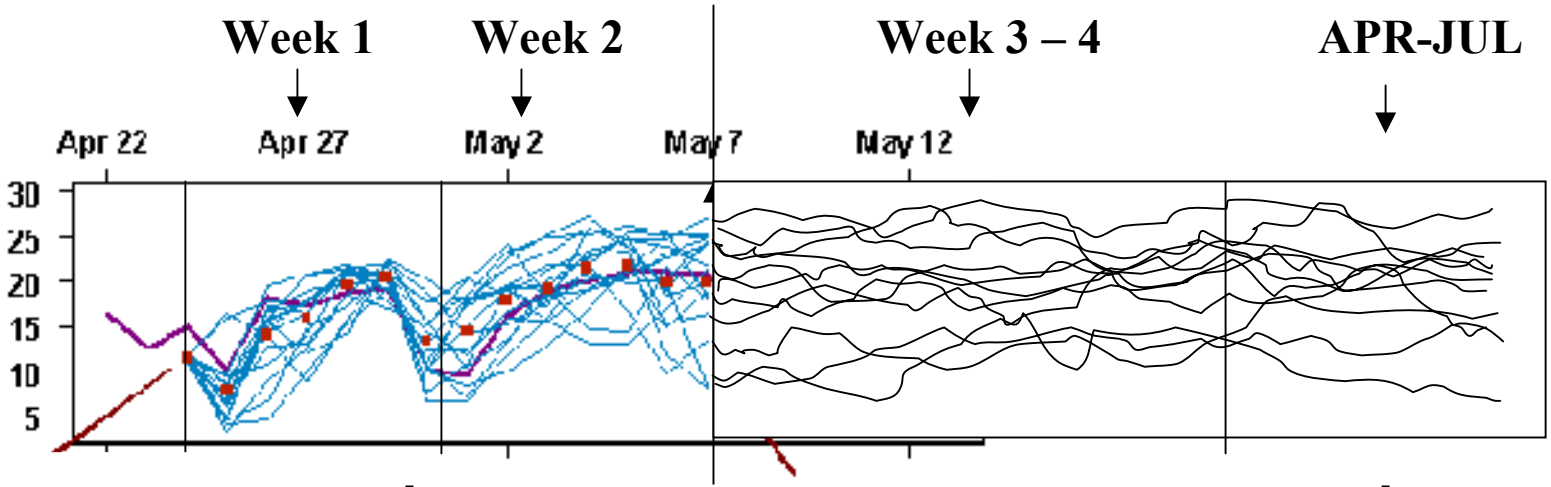
# Schematic of Using Ensembles from MRF(day 1-14) and WxGenerator(15-365) As Input to ESP




**Ensembles From The 'Frozen' MRF**

**Ensembles From Regional Weather/Climate Generator Capturing Signals From Historical MAPs/MATS**

# Information We Will Verify

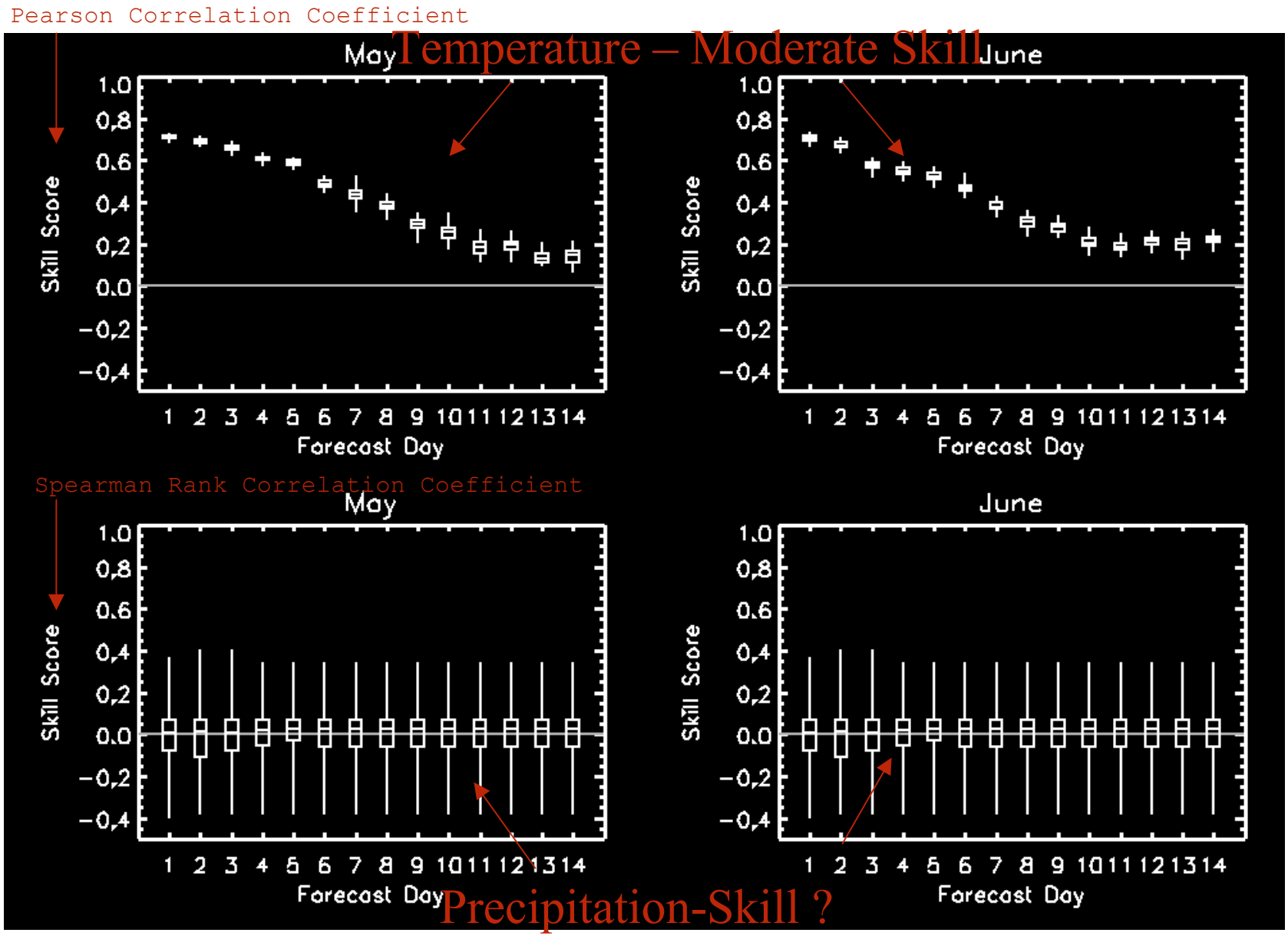


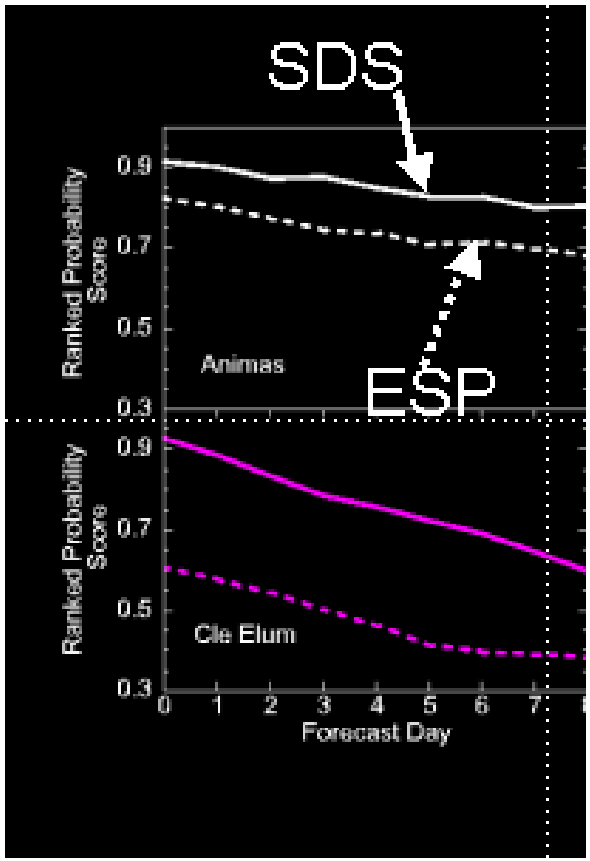

**Instantaneous Flow:**
**6 hour time step**
**Volume**
**Peak**
**21 probability levels**

**Volume**
**Peak**
**21 probability levels**

**Seasonal Volume**
**Seasonal Peak**
**21 probability levels**

# Eagle River – Avon, Co (Ealc2luf)






**An example of the skill in producing streamflow runoff from using temperatur and precipitation downscaled from the MRF (SDS) vs historical precipitation and temperature (ESP).**

**This was an experimental case using the USGS Modular modeling system for two Snowmelt driven basins.**

**It shows by using temperatures from the downscaled MRF in lieu of historical information that streamflow forecasts can be improved.**