California-Nevada River Forecast Center

Forecast Operations and the American River

American River, Folsom Dam

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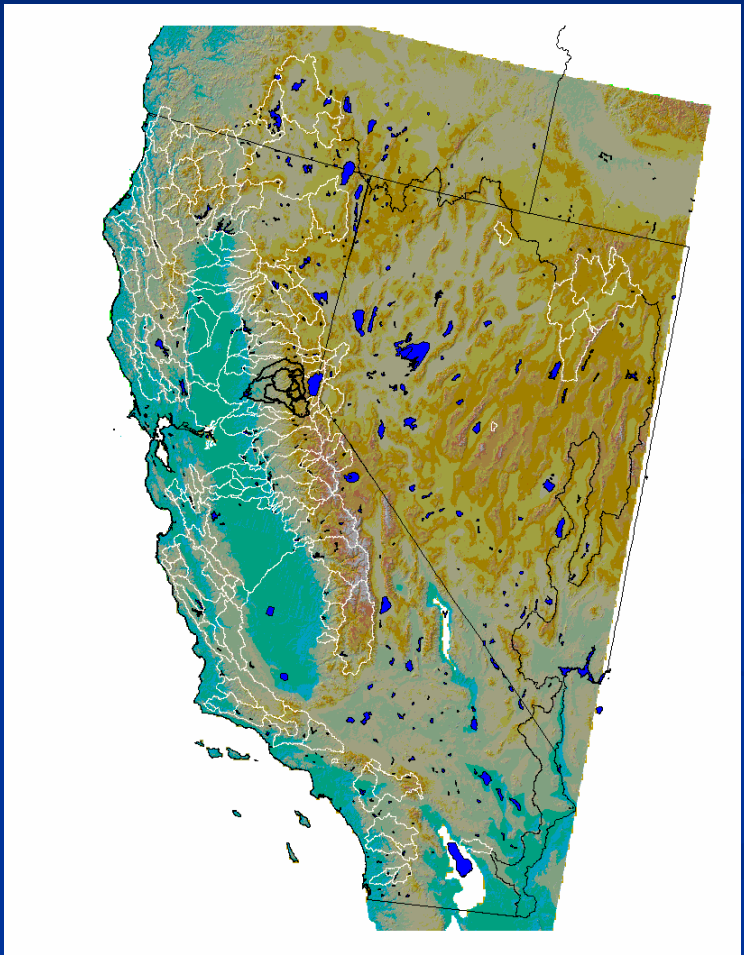
CNRFC hydrologist

American River Basin



Three Phases of RFC Operations

- Calibration of Hydro Model, SAC SMA
- Operational…The Observed Periods
- Operational…The Forecast or Future Periods

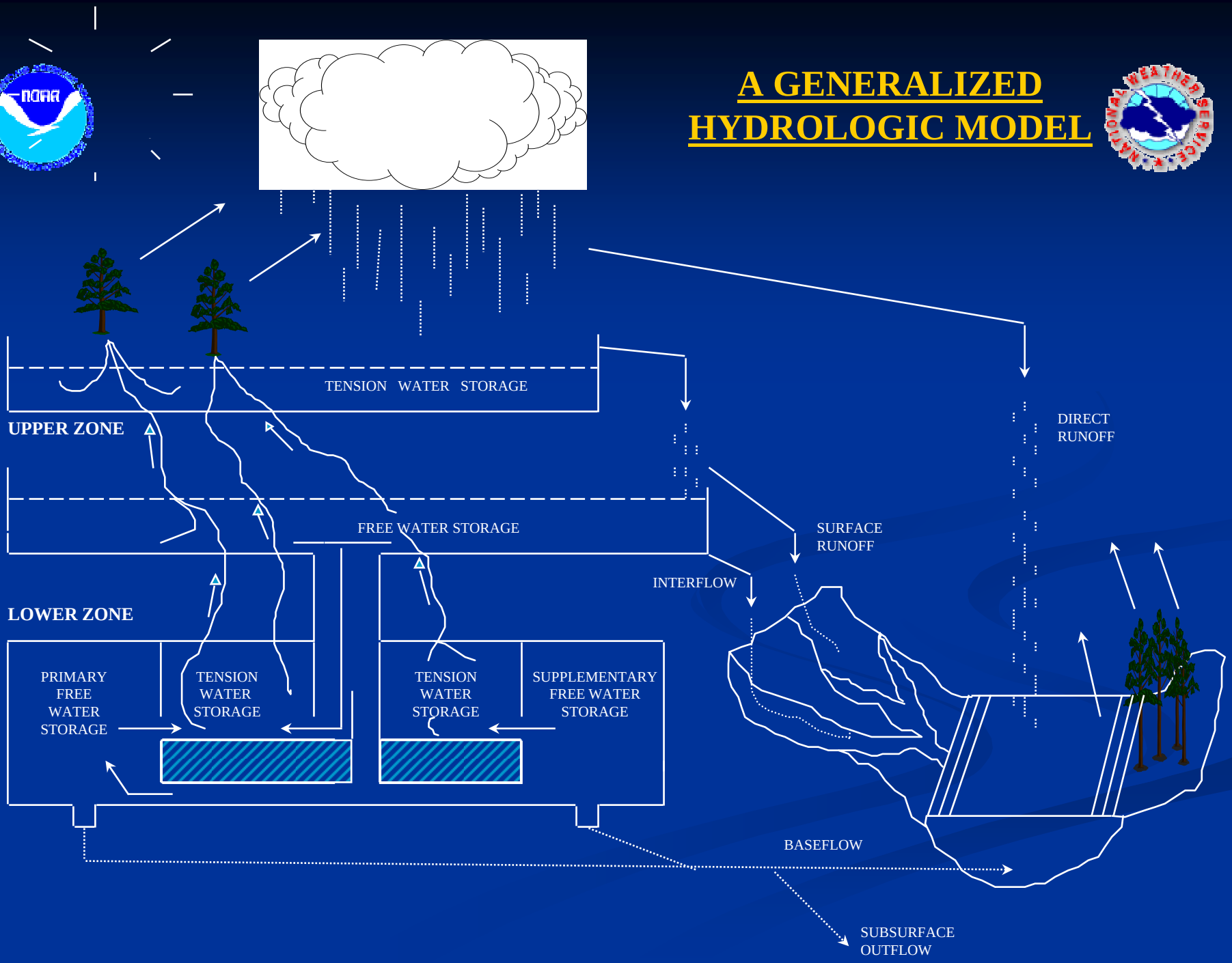
Calibration of the Model

- Long term precipitation gage data, ~20-40 years
  - Hourly and daily -> 6 hour time step MAP, Mean Areal Precip
- Long term temperature gage data
  - Max/min -> 6 hour time step MAT, Mean Areal Temp
  - Melt level derived from MAT
- Long term river flow data, mean daily
- Usually divide basin into upper and lower sub-basins at “normal” snow line, 5000 ft in American

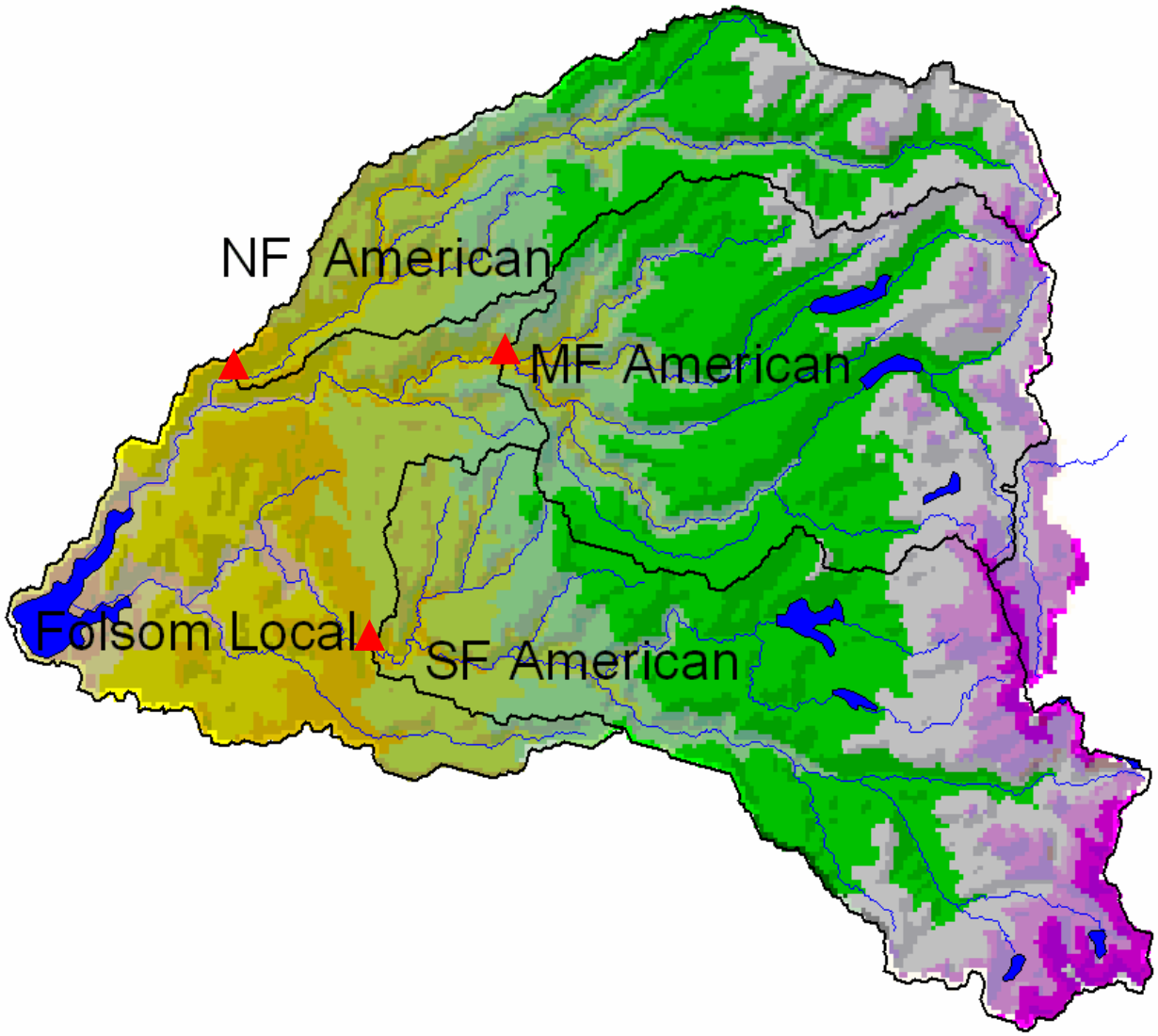
Calibration

- Assume precip evenly distributed over the sub-basin, in time and space
- Subdivision of basin dependent on availability of river gages for calibration

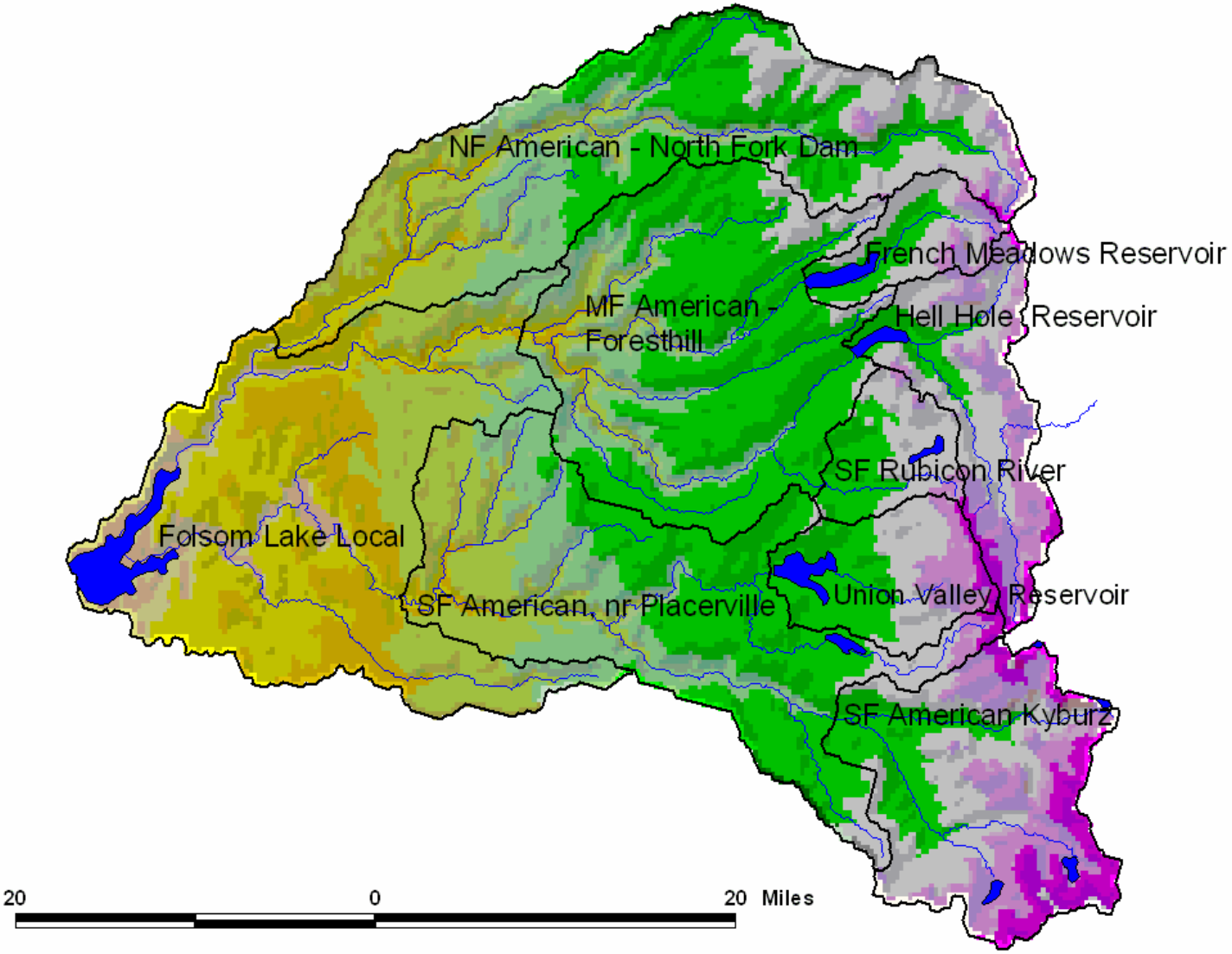
A GENERALIZED HYDROLOGIC MODEL



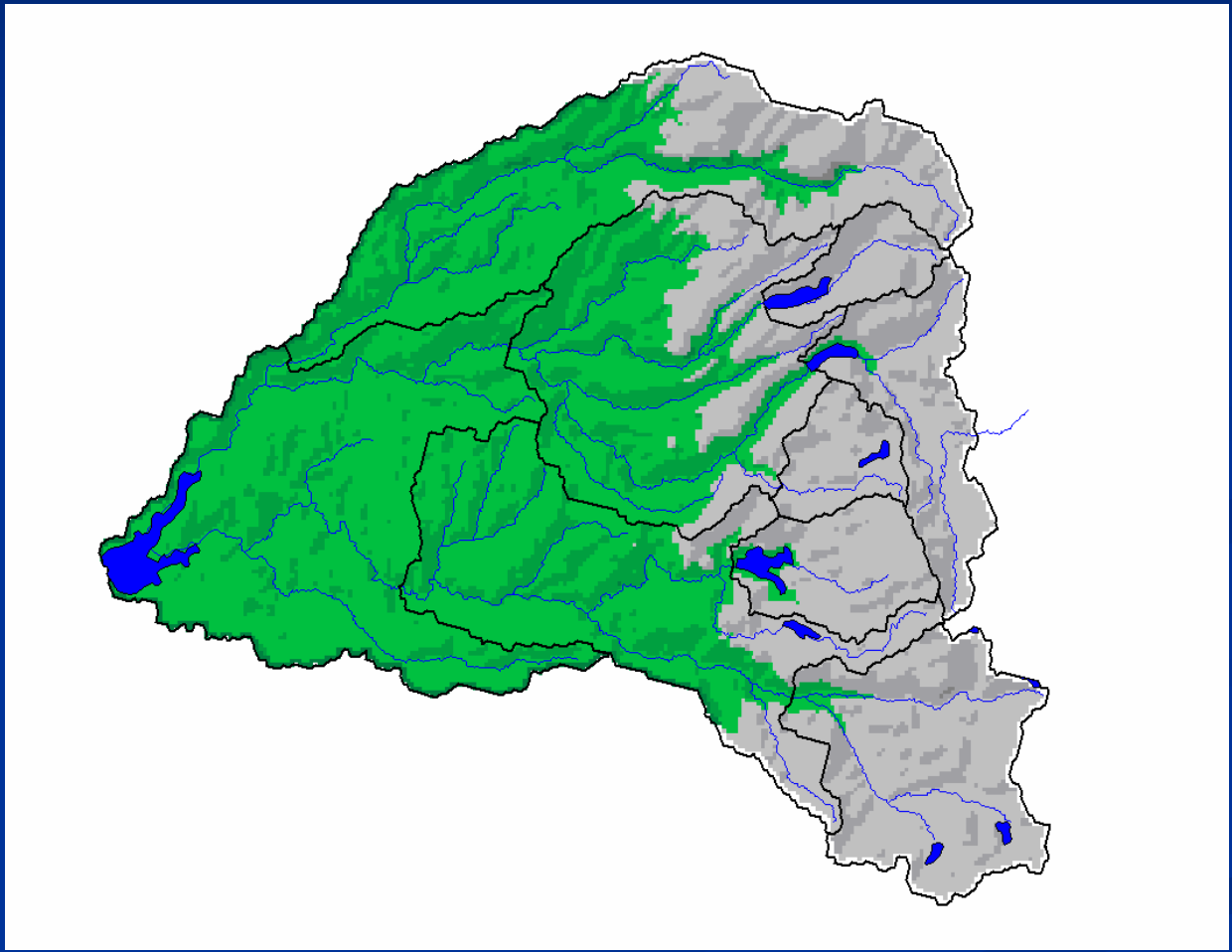
Previous American Watershed Model



New American Watershed Model



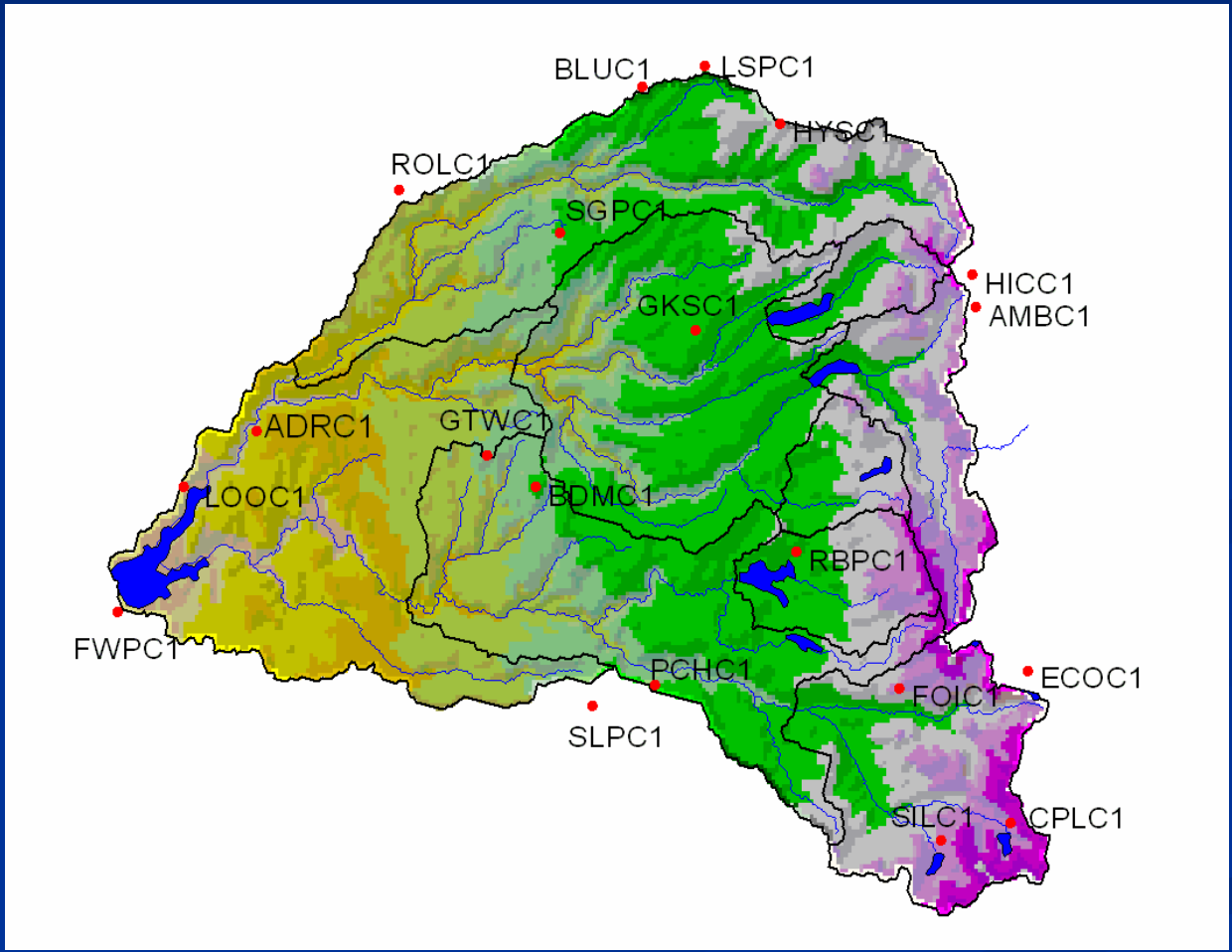
Approx 60% below 5000 ft
Approx 40% above 5000 ft



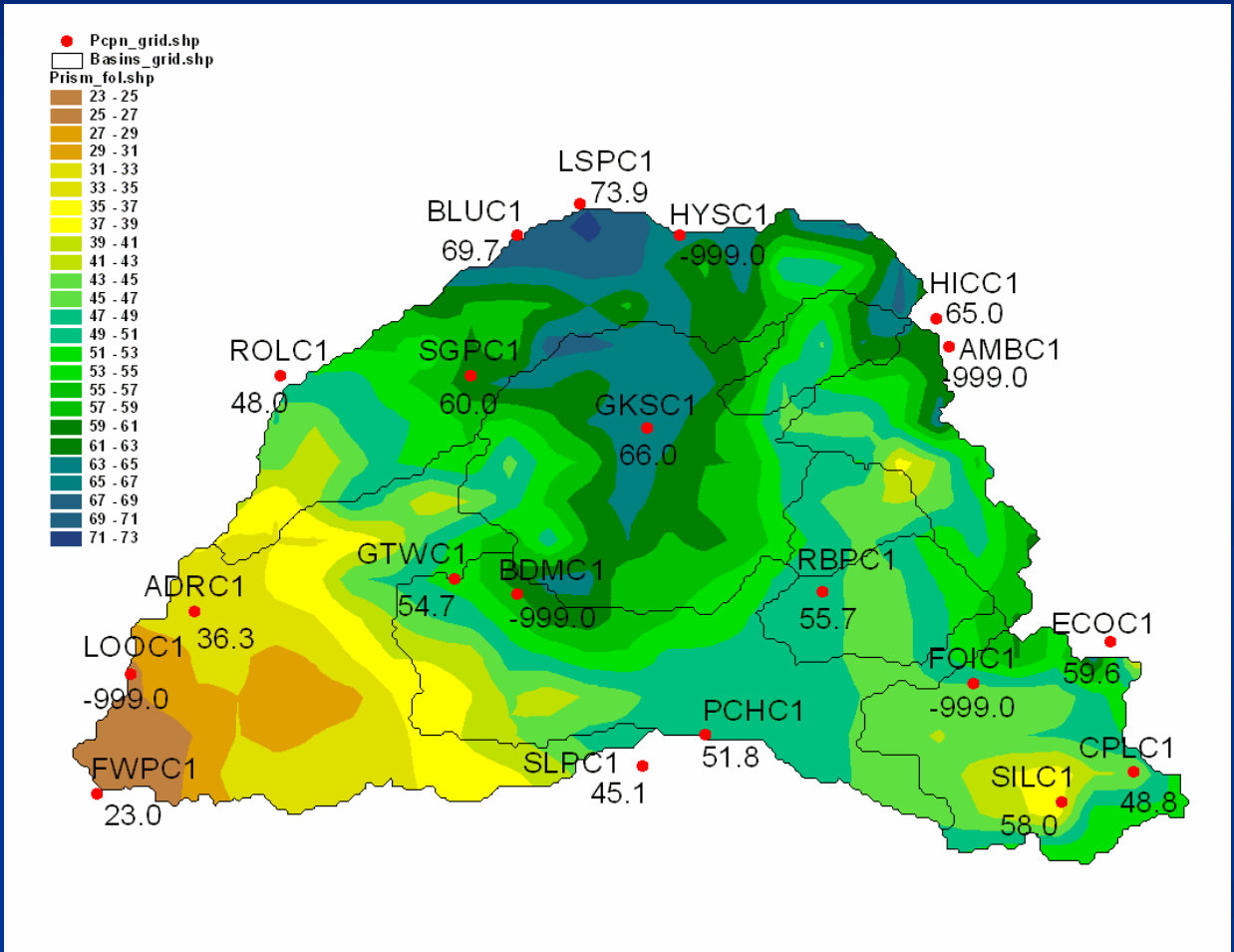
Operational Forecasting
The Observed Periods

- Inputs
  - 6 hour MAP computed from raingage data
  - 6 hour MAT computed from temperature gage data
  - Melt level derived from MAT
    - very limited observed melt level data, MFR, OAK, VBG, RNO
    - HMT melt level obs will be immediately useful here
  - Observed river flow data
- MAP and MAT -> Snow Model -> Rain plus melt
- Rain plus melt -> SAC SMA
- Correct inputs are critical to maintaining soil moisture accounting, precip typing, and snow accumulation/melt in the model

Precipitation Gages



Gages with annual normal precip PRISM background



Operational Forecasting
The Future Periods

- Forecast Precip, QPF
  - 72 hours from HPC, days 4 and 5 Rhea orographic
  - HPC -> CNRFC HAS -> hydro model sub-basins
- Forecast temp, WFO fcst and MOS
- Freezing level, HPC -> HAS -> hydro model
  - Based on model forecast of freezing level
  - -1500 ft to get melt level
- 6 hour time-steps

Partners and Customers

- CNRFC, COE, USBR project to permit Folsom pre-release based on CNRFC inflow forecasts
  - The first attempt to permit operation of a reservoir in our area based on forecast inflows… it is very important that we provide accurate forecasts, along with an indication of uncertainty
  - COE spending $250M for low level outlets for pre-release
  - Considering 7' raise of dam
  - COE spent many $ on American levee slurry walls
  - Levee breach could affect more than 450K people
- CNRFC, COE, California DWR, YCWA Forecast coordinated operations, Feather R and Yuba R
- Partners/customers…NWS, CADWR, COE, USBR, SAFCA, Amer R Flood Cntrl, Friends of the River

Science Challenges

- Current modeling is limited by
  - availability of river gaging
    - Long term record needed for calibration
    - Solid real time river data needed as well, this is a real problem
  - Sparse raingage network
    - Current network will not support finer scale simulation
    - Better all-weather gages would be useful in rain/snow areas
    - Finer scale multi-sensor precip estimation would support advanced hydro modeling
  - Uncertainty in observed and forecast melt level
    - Snow level derived from HMT sensors will be immediately useful

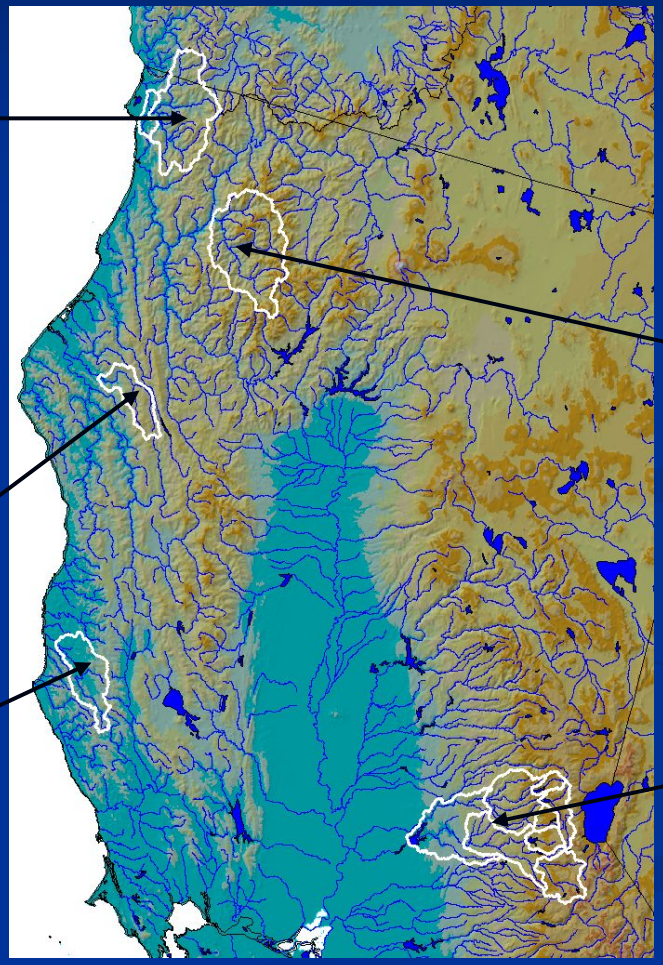
Science Challenges

- QPF
  - 1-5 day probabilistic QPF to support short term probabalistic hydro forecasts
  - Quality…can HMT investigation provide the knowledge or tools to improve QPF?
- Mesoscale modeling
  - Import HMT data set into RUC model to provide HAS with better short term wx model guidance
- Distributed hydro modeling
  - Gridded multi-sensor precipitation inputs necessary
  - Gridded QPF and temp, smaller temporal and spatial scale necessary

So What?

- We need to provide our users with hydro forecasts which are
  - Timely
  - Accurate
  - Include uncertainty
  - Short term, hours
  - Long term, months
- Where?
  - Reservoir inflow forecasts?
  - Small streams?

Short-term Ensemble Prototype



Smith River

Salmon River

Van Duzen River

Navarro River

American River

(11 basins)

Short-term Ensemble Prototype

- 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

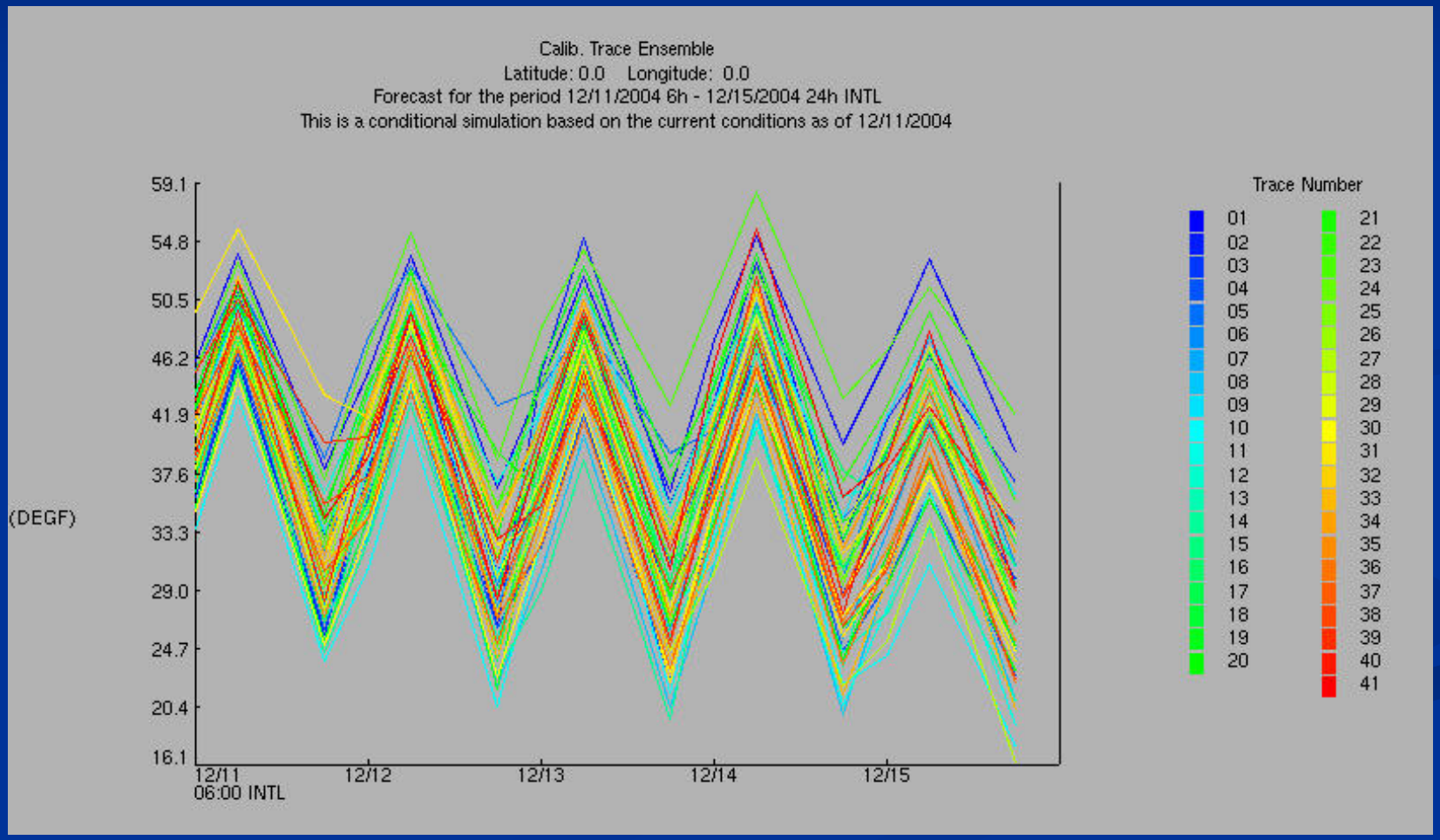
HUMAN INPUT
education
training
experience
mental state

FORECASTS
precipitation
air temperature
regulation

Short-term Ensemble Prototype

NF American (upper subarea)

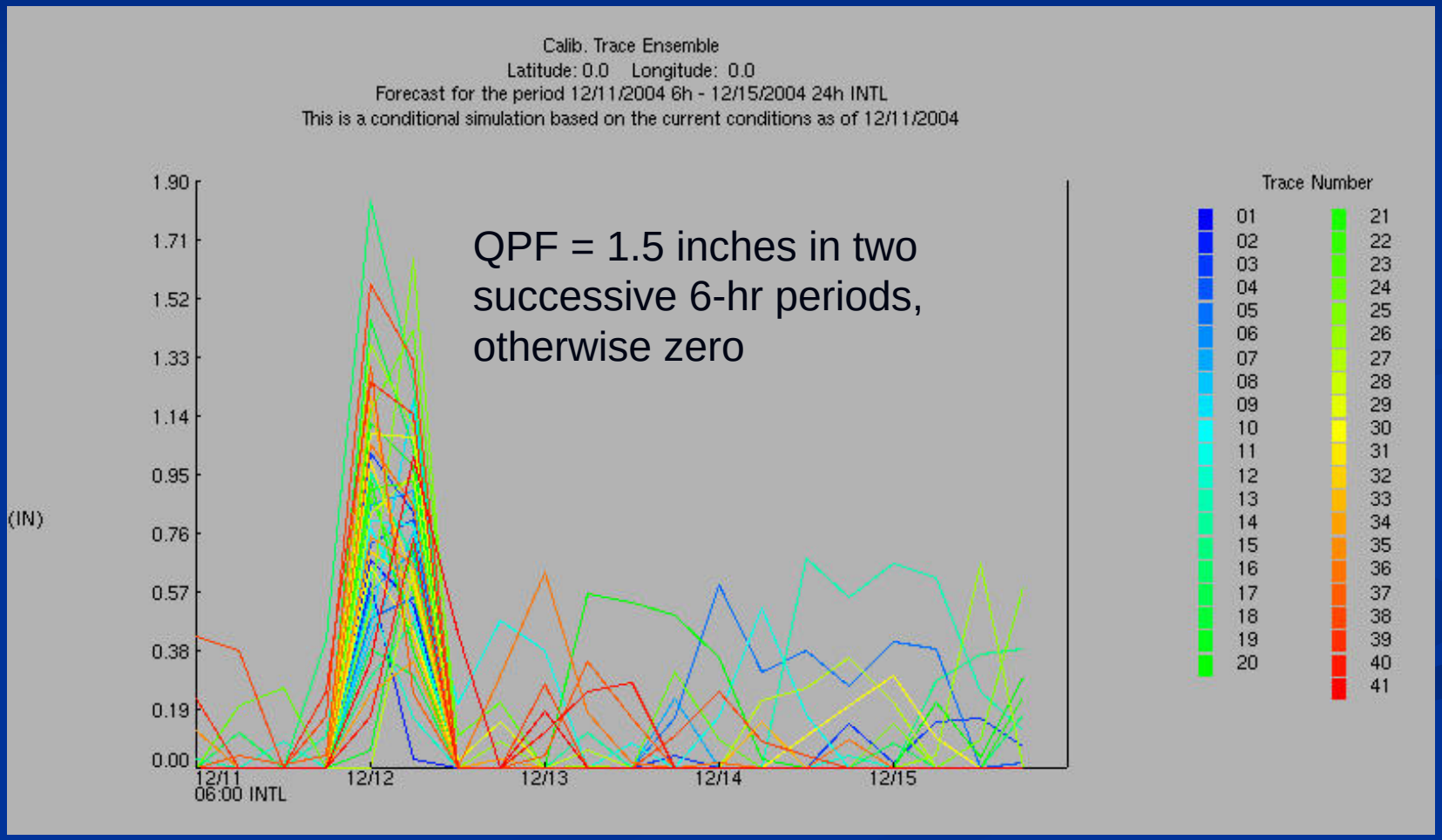
5-day Temperature Ensembles



Short-term Ensemble Prototype

NF American (upper subarea)

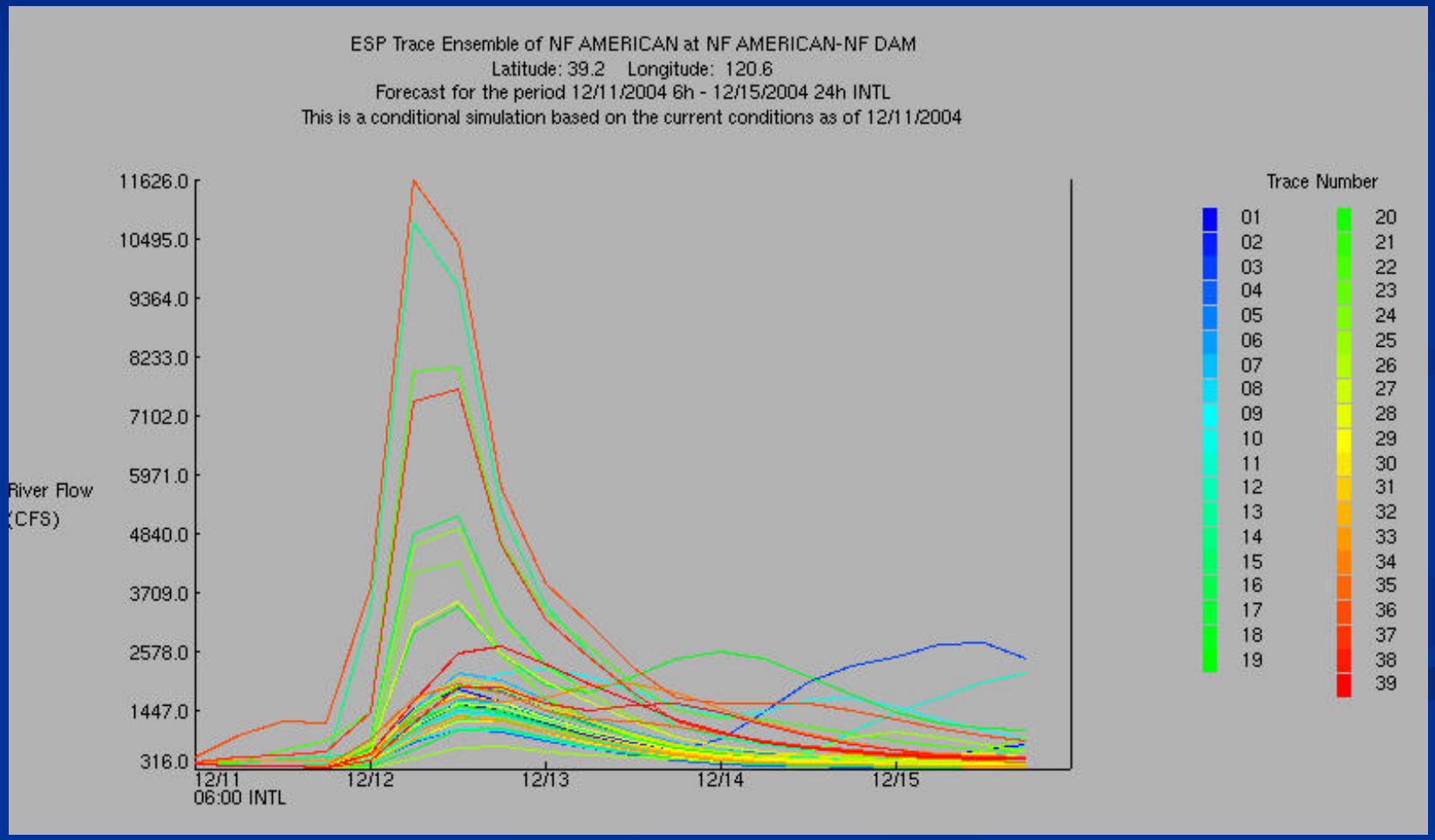
5-day Precipitation Ensembles



Short-term Ensemble Prototype

NF American

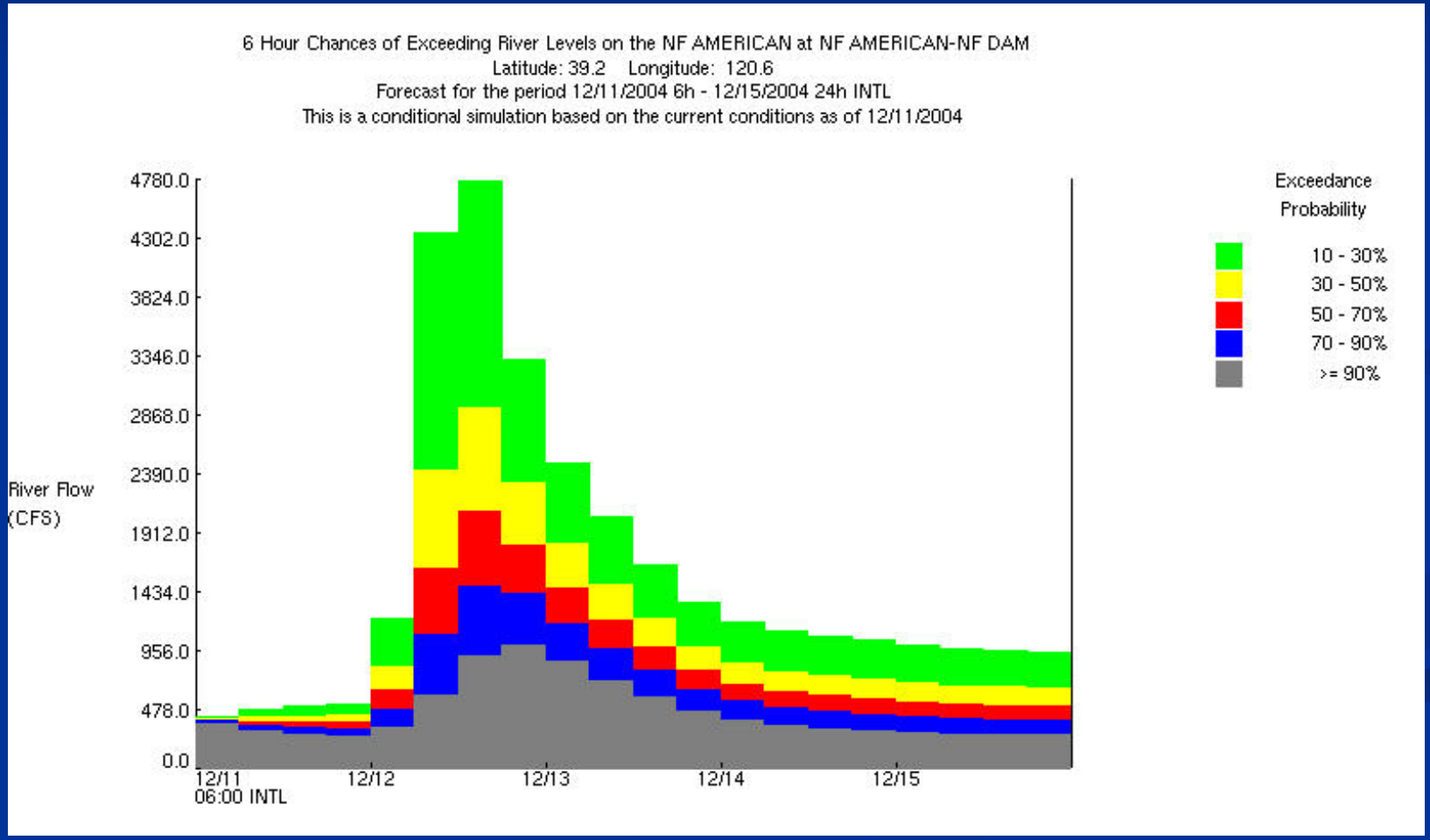
5-day Streamflow Ensembles



Short-term Ensemble Prototype

NF American

5-day Streamflow Distribution



Short-term Ensemble Prototype Next Steps

- Gain experience from more active (coastal) watersheds
- Validate outcomes
  - Are the distributions reasonable (accurate)?
    - More experience.
    - Retrospective (historical) analysis needed.
- Begin addressing other sources of uncertainty and operational systemization
- Begin addressing the need for education and training
  - Internal and external
  - Interpretation of probabilistic information