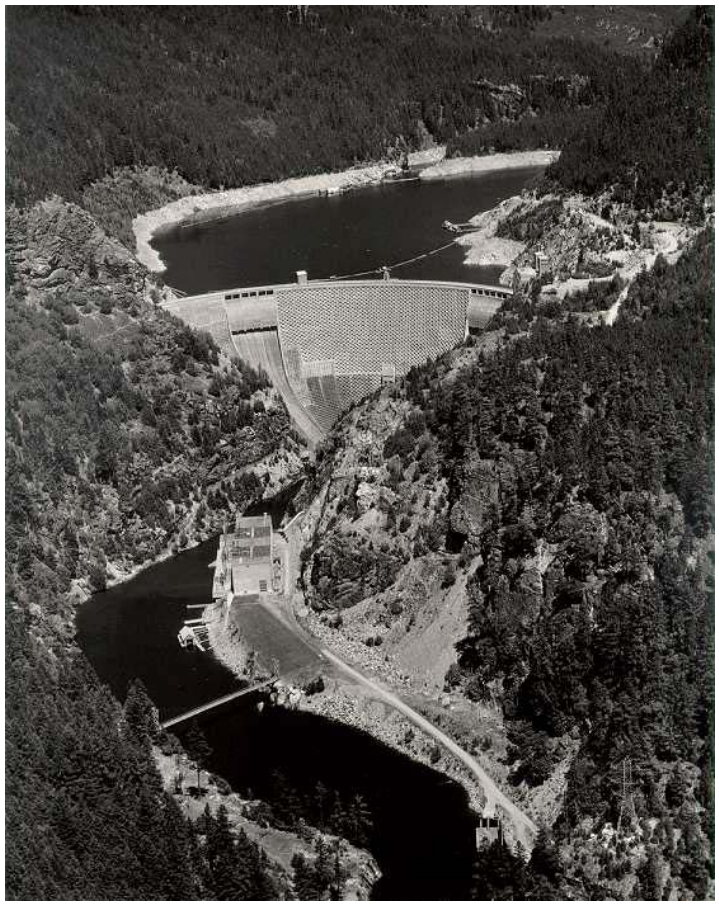
Advanced Methods in Short- and Long-Term Streamflow Forecasting



Amy Sansone

3Tier Environmental Forecast Group, Inc

WMIG Conference - November, 2004

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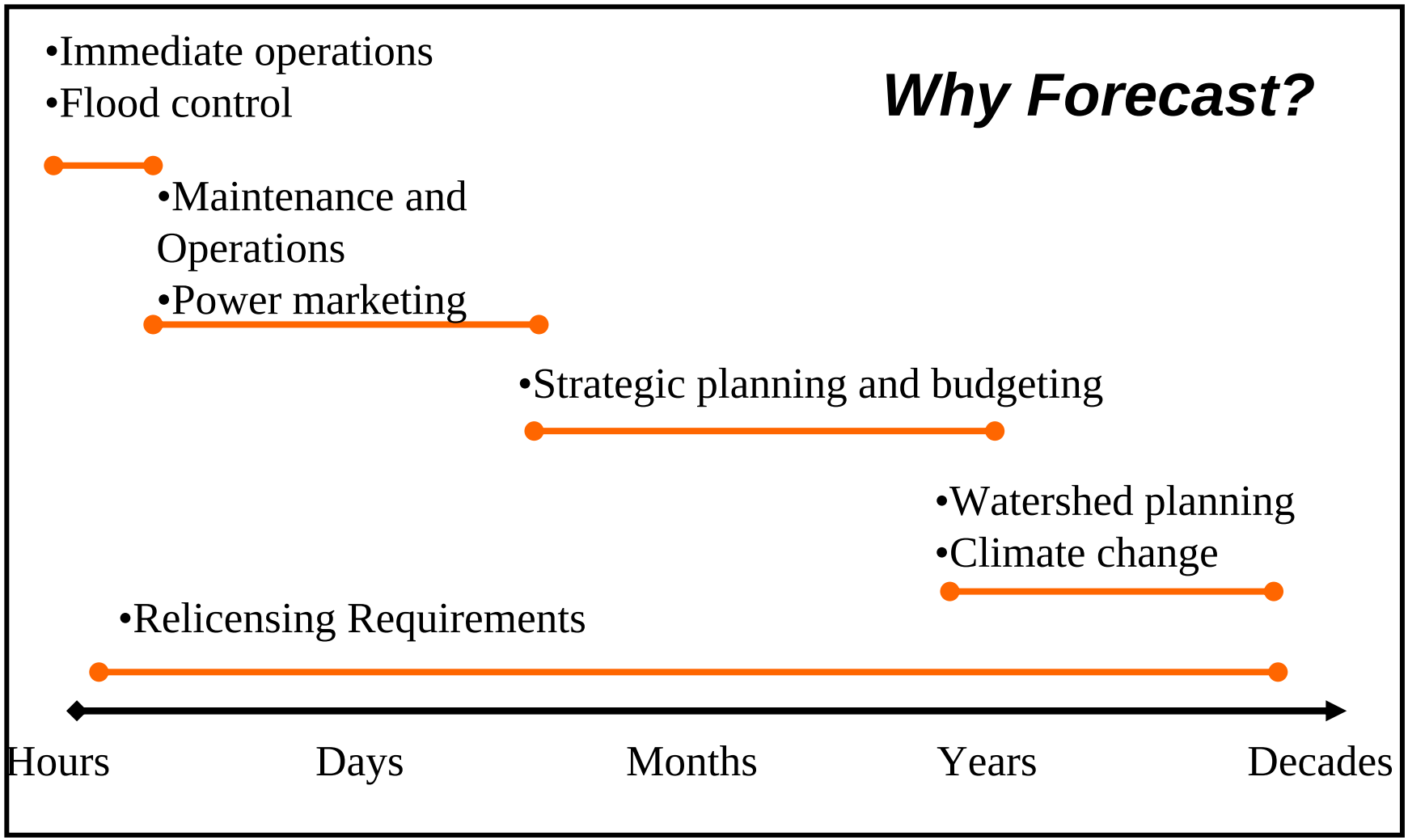
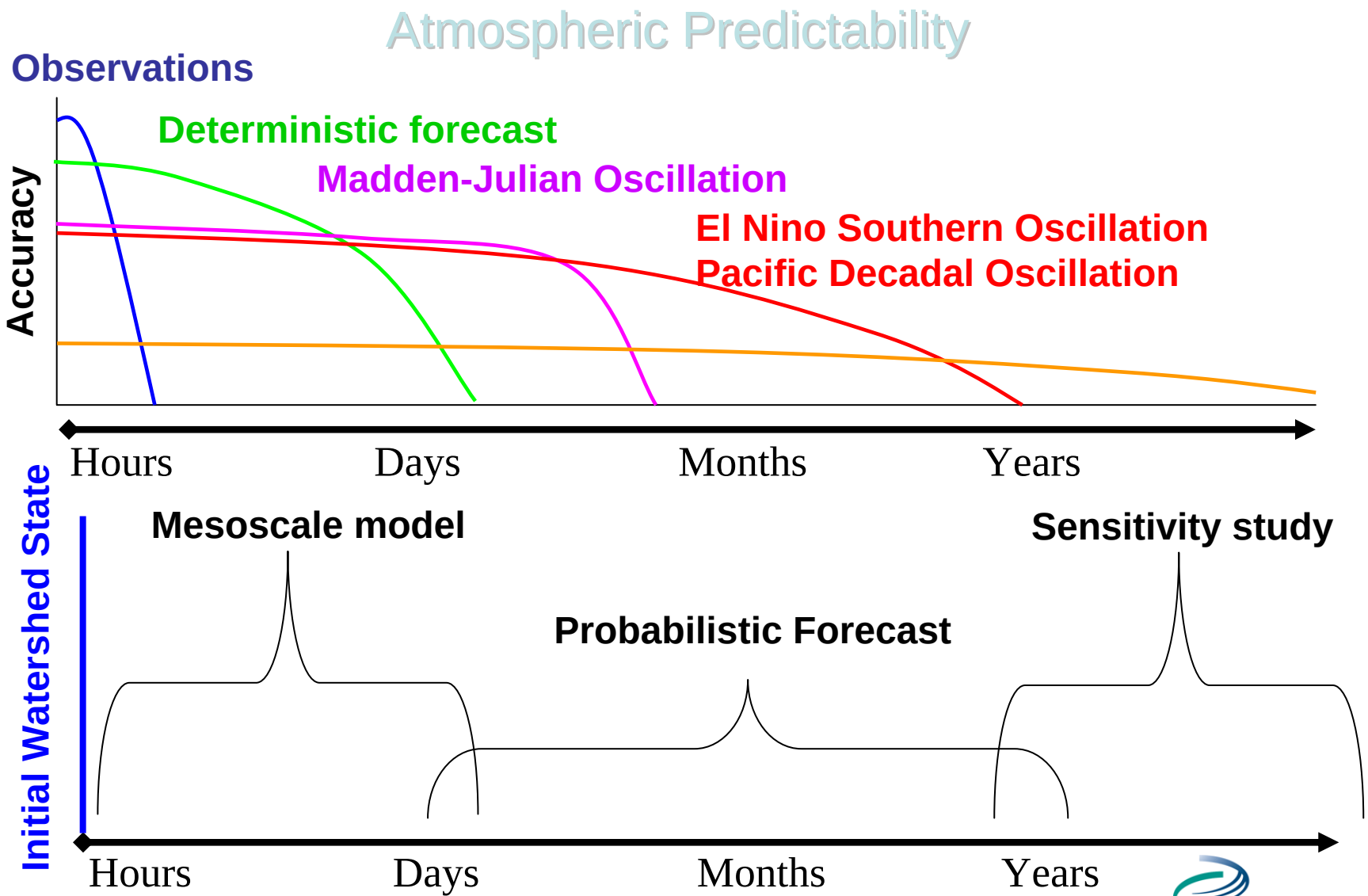
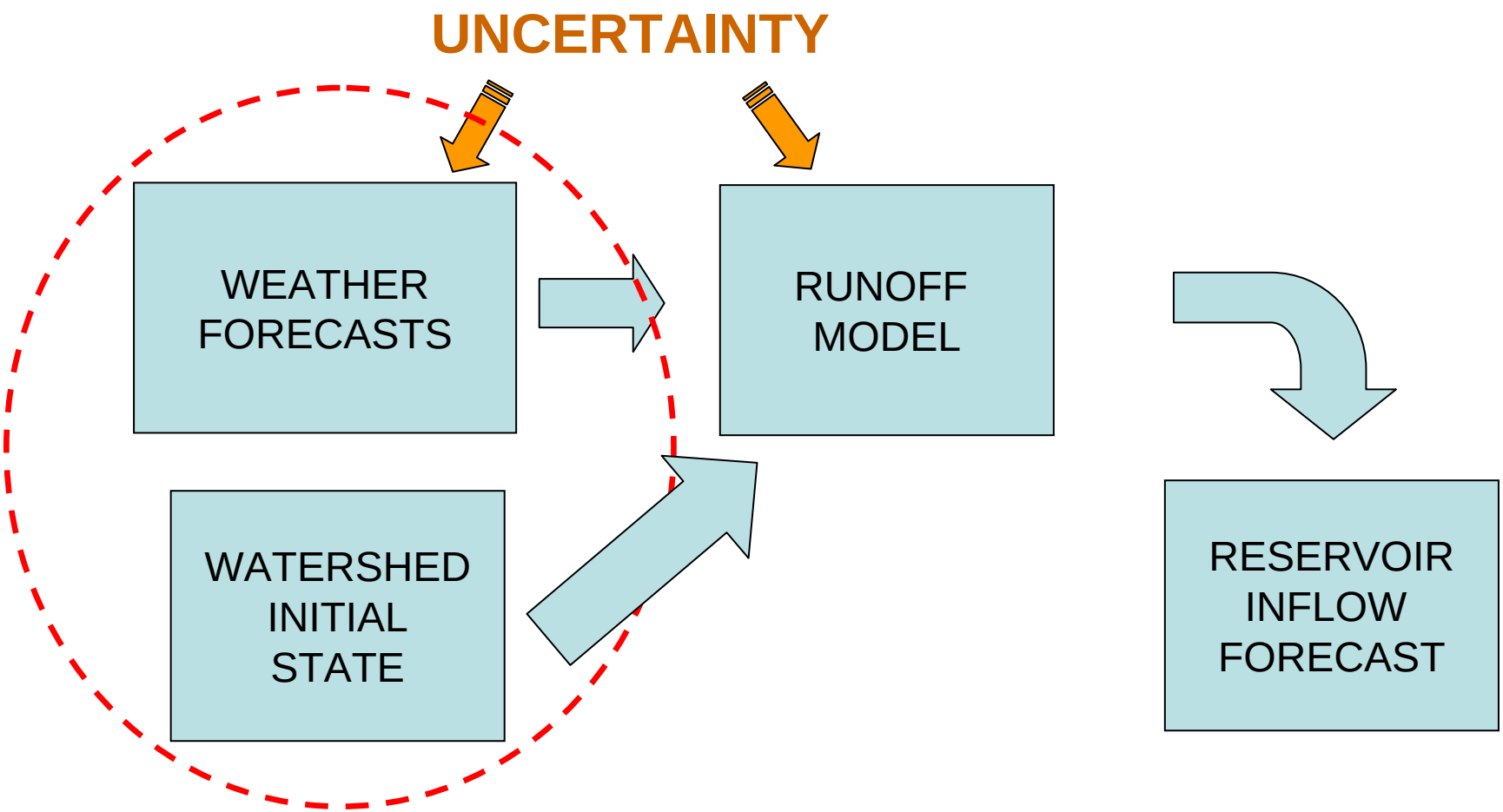
Hydro Forecasting: Relevant Time Horizons



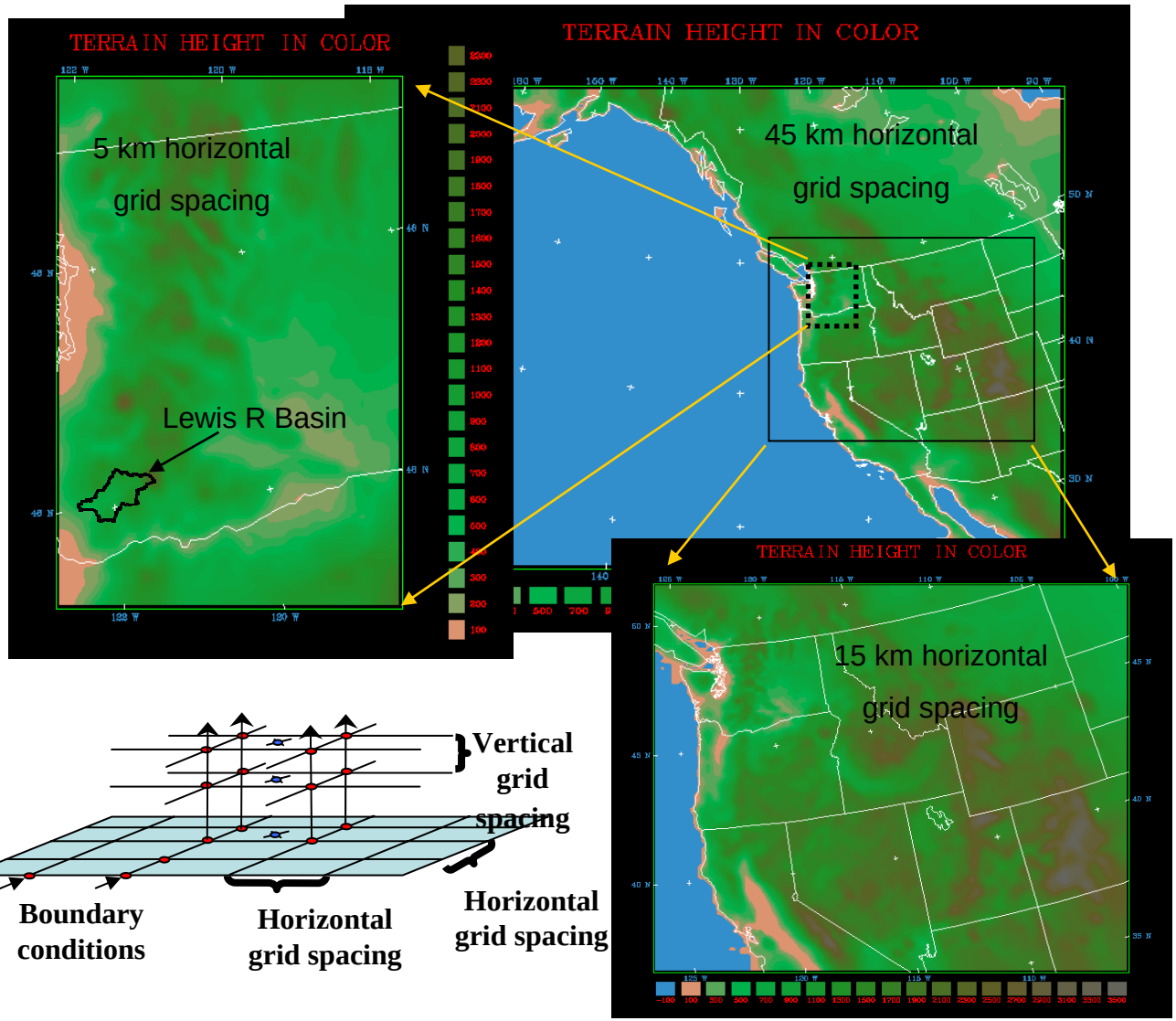
How We Forecast



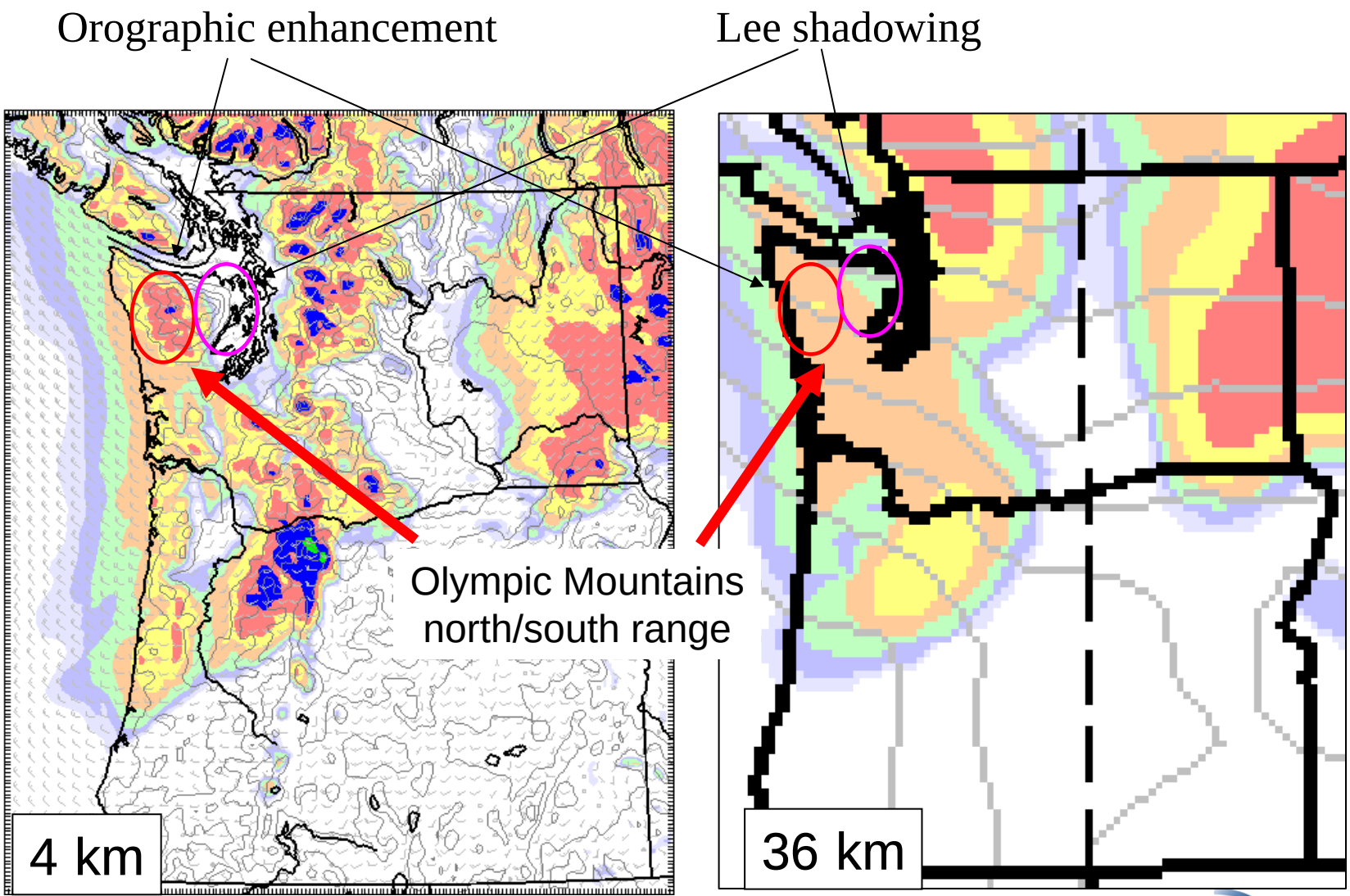
Short-Term Streamflow Forecasting - Hours to Days



High Resolution NWP Model (MM5)



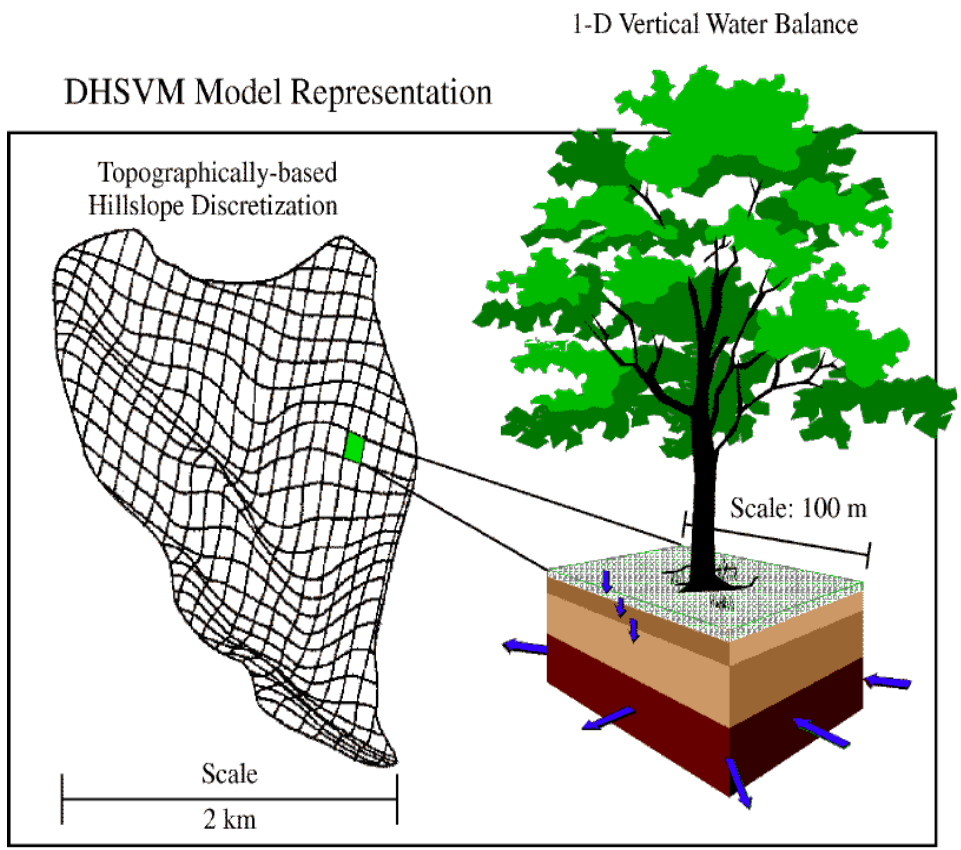
Model Resolution



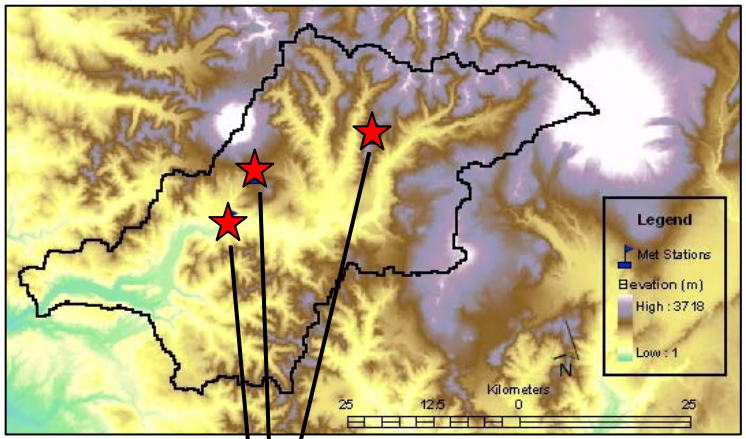
Spatially Distributed Hydrology Model (DHSVM)

Advantages over Lumped Models

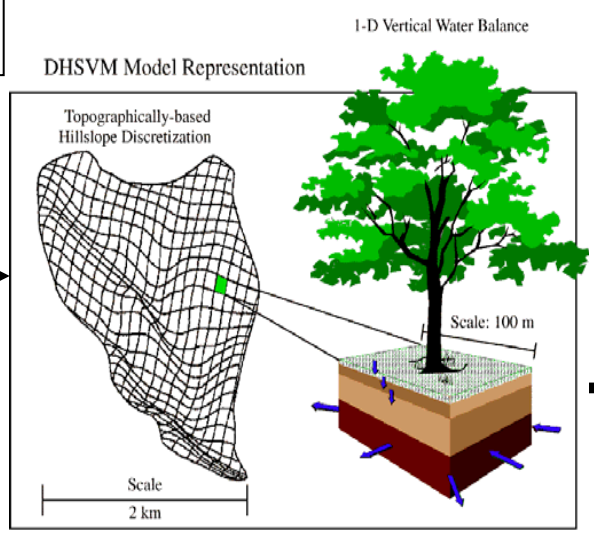
- *Important physical processes explicitly represented (Not Parameterized)*
  - Energy balance, Snow processes
  - Evapotranspiration
  - Soil moisture, Subsurface flow
- *Met parameters spatially distributed*
  - Critical in basins with
    - complex terrain
    - complex weather patterns
- *Lends itself to additional analyses*
  - Effects of climate change
  - Probable maximum flood

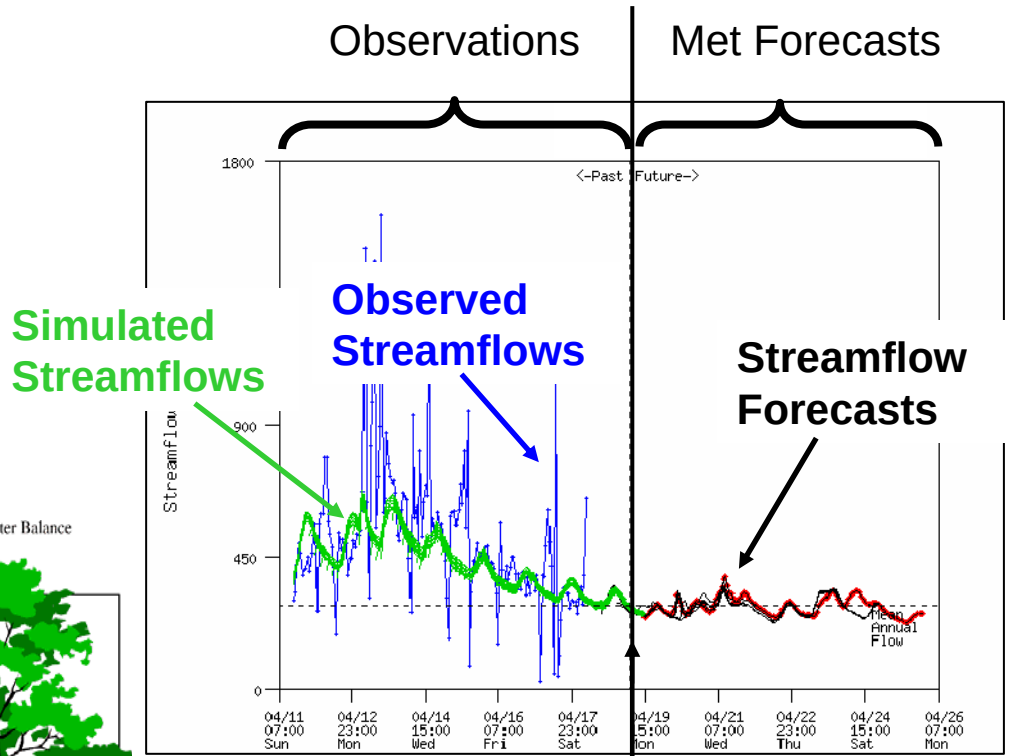


Parallel Observation Based System



Hourly Real-Time Met Observations





Current Watershed Conditions

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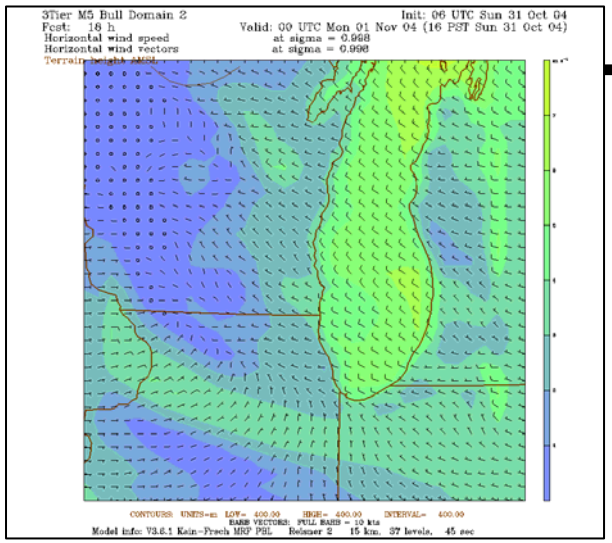
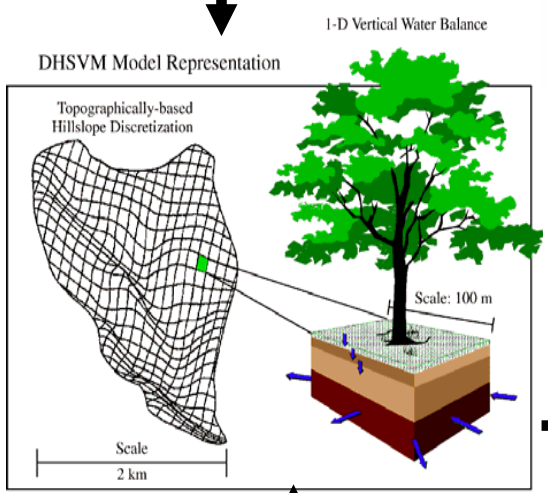
Streamflow Forecast System

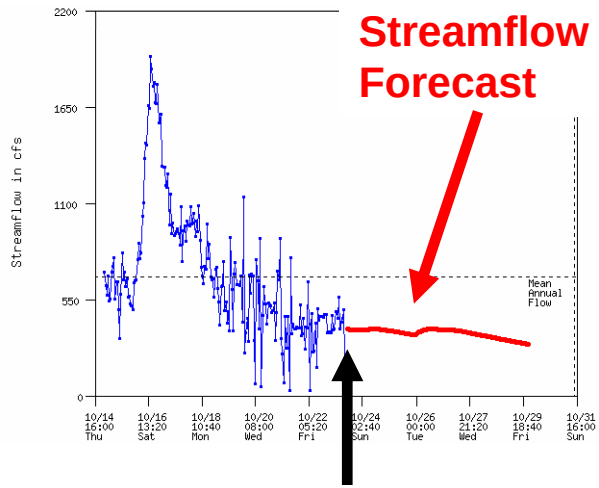
MM5 Weather Prediction Model



Hourly Meteorological Forecasts

Bias Corrections

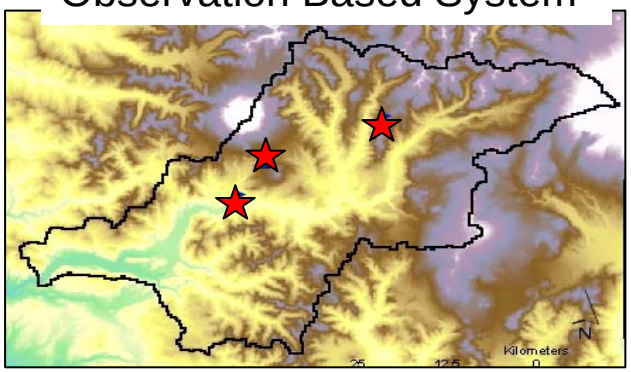




Physically Based Bias Corrections

Raw Streamflow Forecasts

Observation Based System



Initial Watershed State

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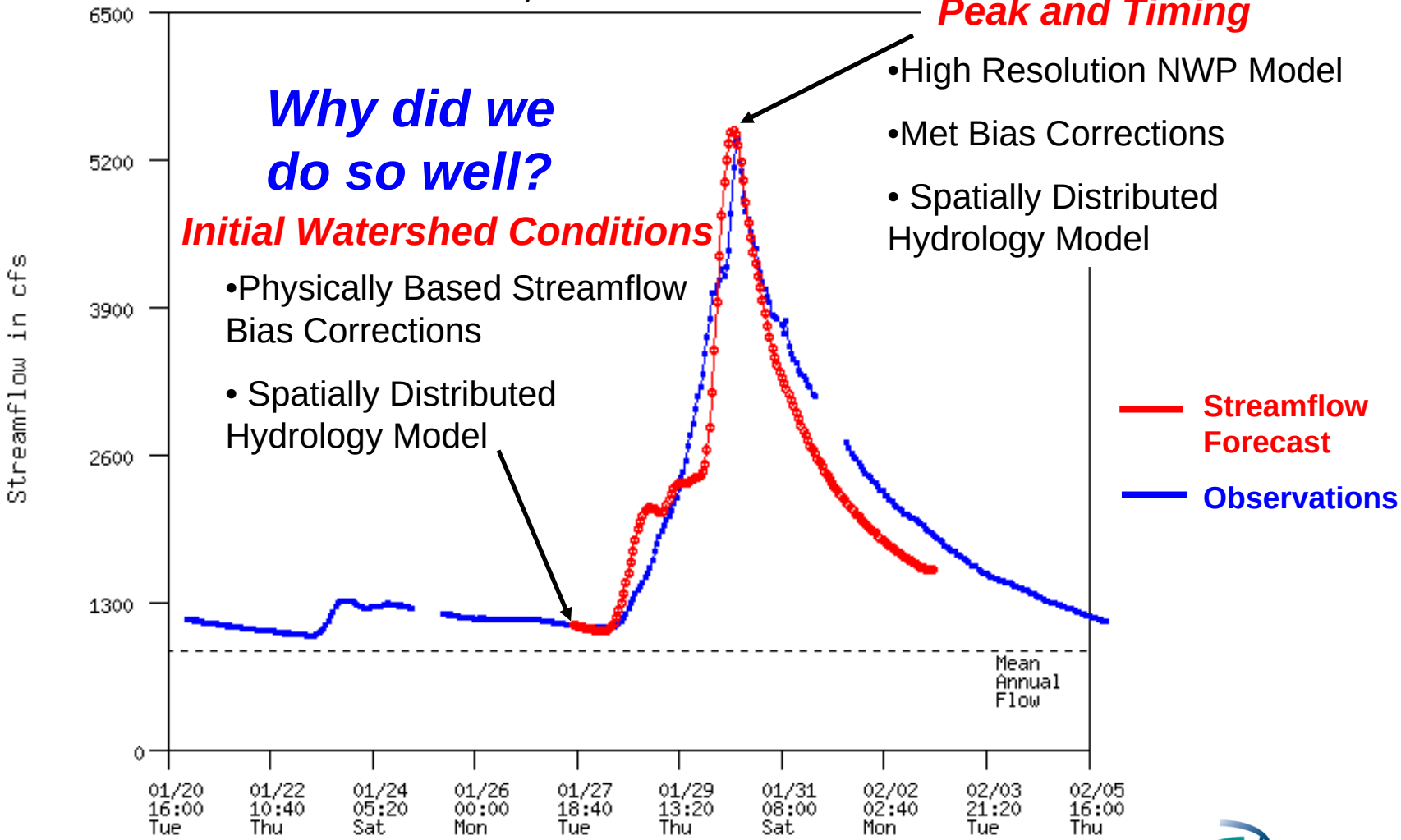
Actual Streamflow Forecast

Muddy Creek (Lewis River Basin, WA)

Jan 27, 2004 Forecast



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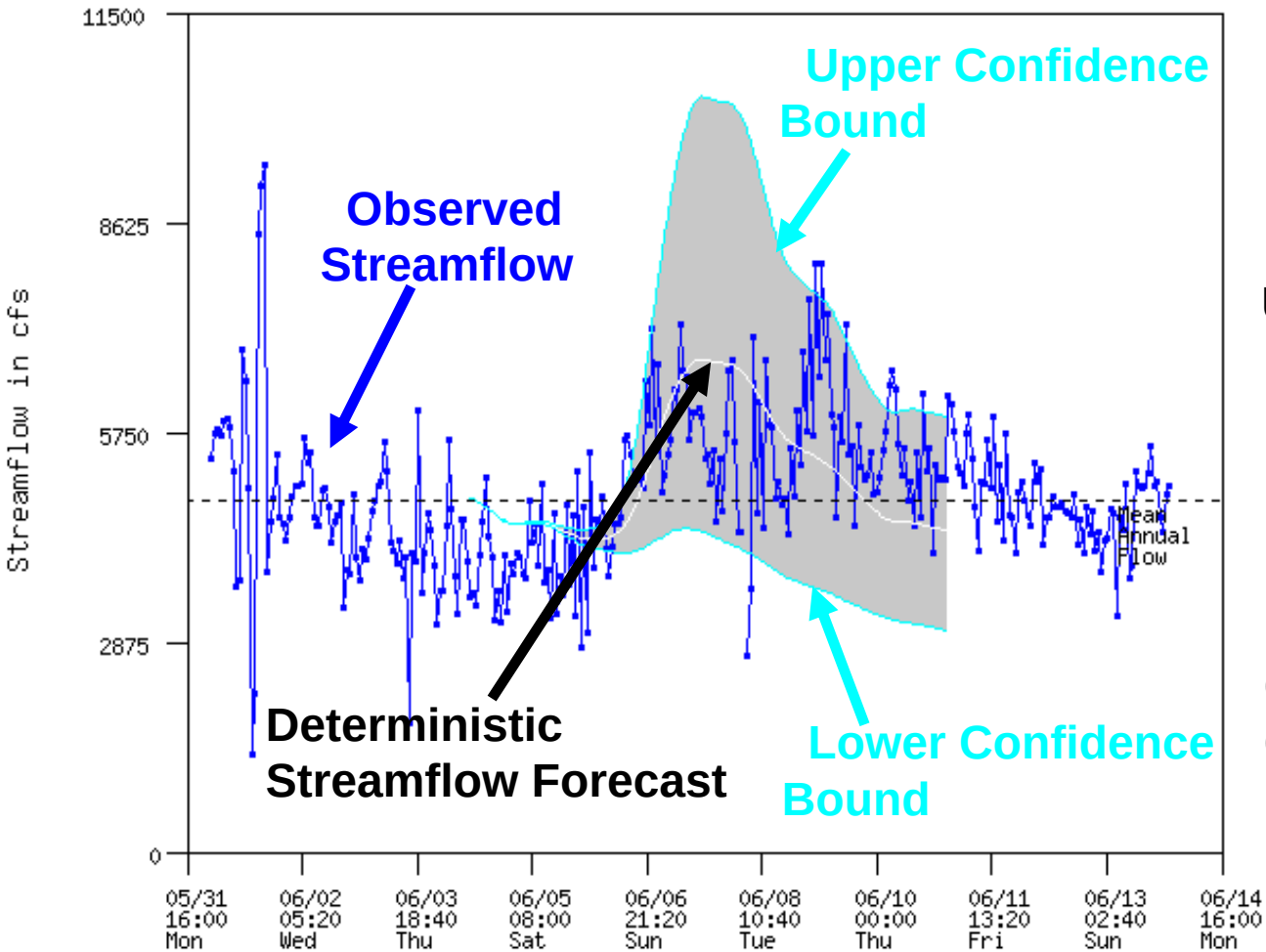
Probability Forecasts

Merwin Reservoir Natural Inflow (Lewis River Basin, WA)

Jun 4, 2004 Forecast



Why Probability Forecasts?

All Forecasts Contain Uncertainty

Regulators Interested in Quantifying Uncertainty

This Technique Allows Client to Specify Confidence Limits

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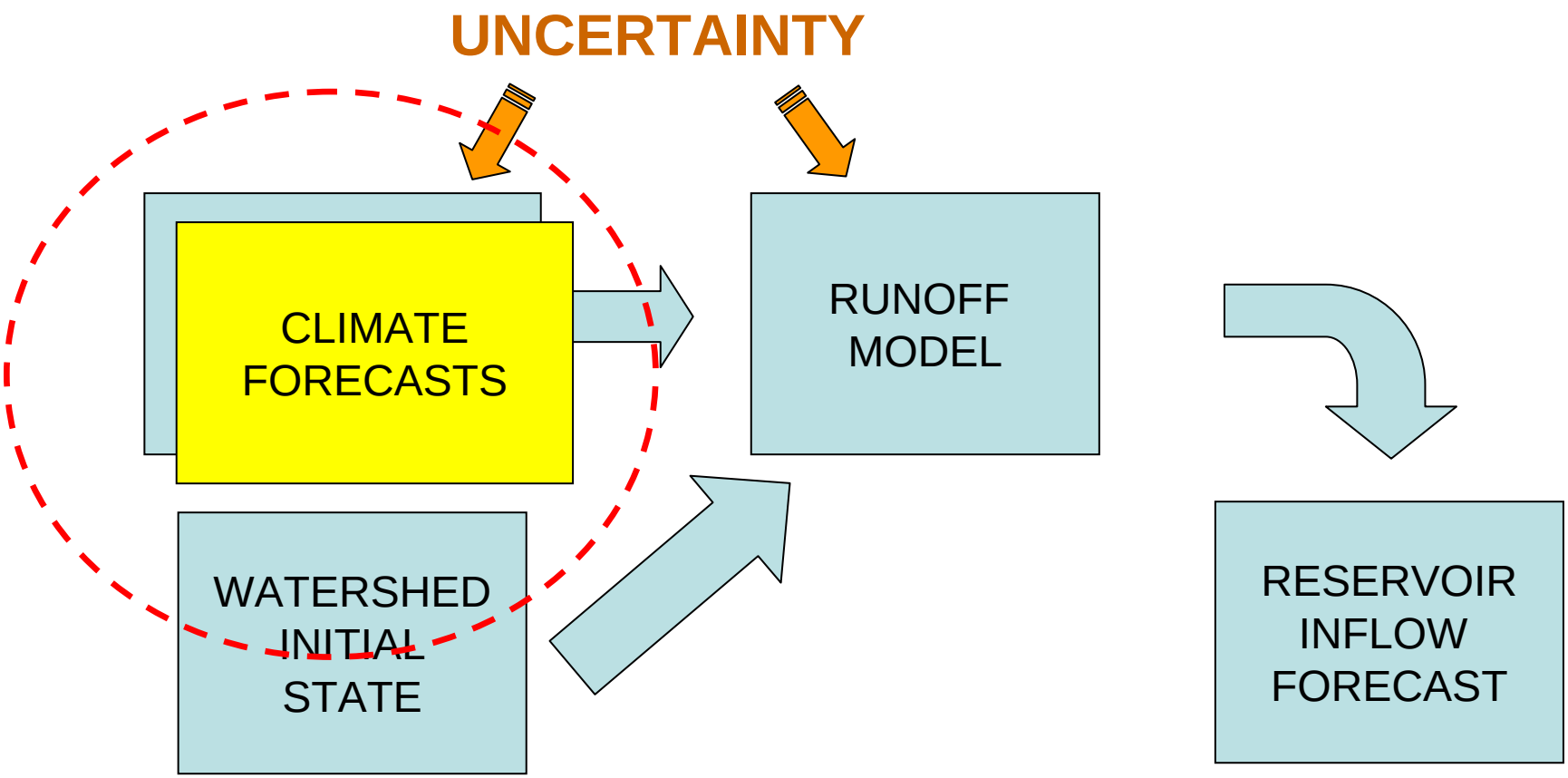
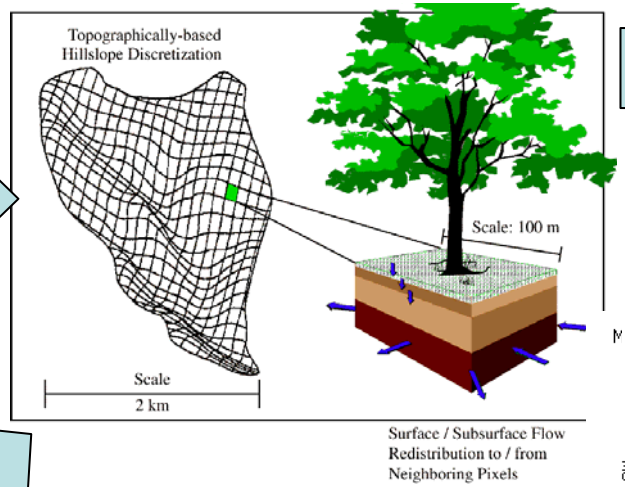
Long-Term Streamflow Forecasting - Months to Years



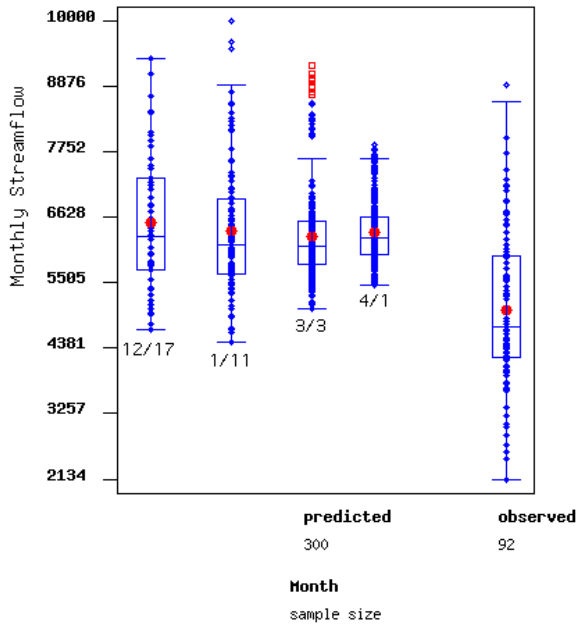
3TIER's Approach

Climate Forecasts

DHSVM Hydrology Model



Probabilistic Inflows



Initial State

Snow Survey + Met Record

Updating with **accurate initial hydrologic conditions** based on observed meteorology and SWE data *as the season progresses*.

- Retain full uncertainty of future weather based on climate forecasts.

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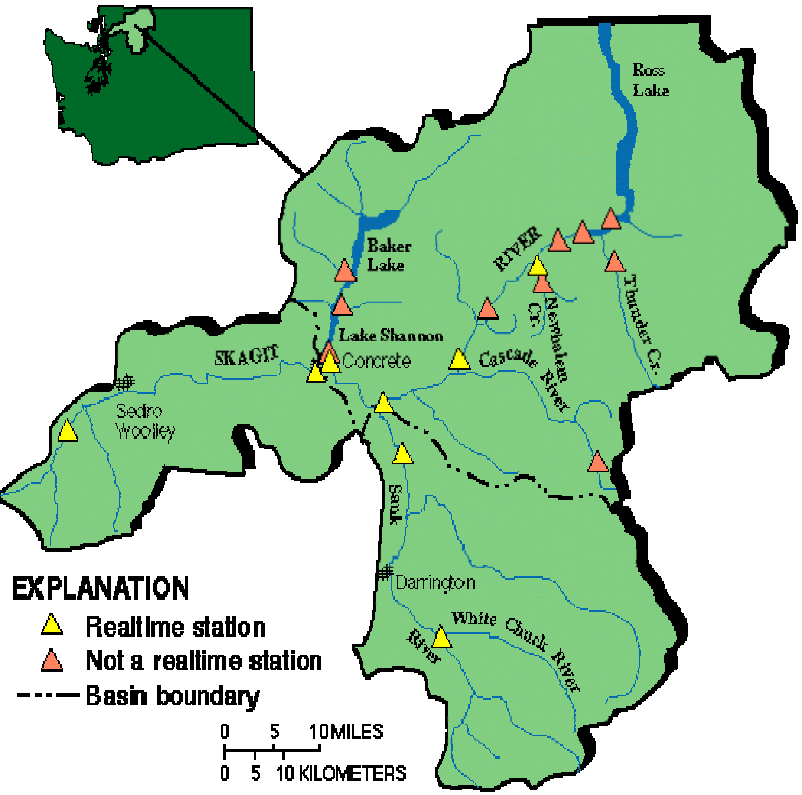
Results for Water Year 2003



Courtesy USGS

Skagit River Basin

- 3 Reservoirs - 680MW installed capacity
- Snowmelt dominated inflow
- Snowpack over the watershed - key to forecasting

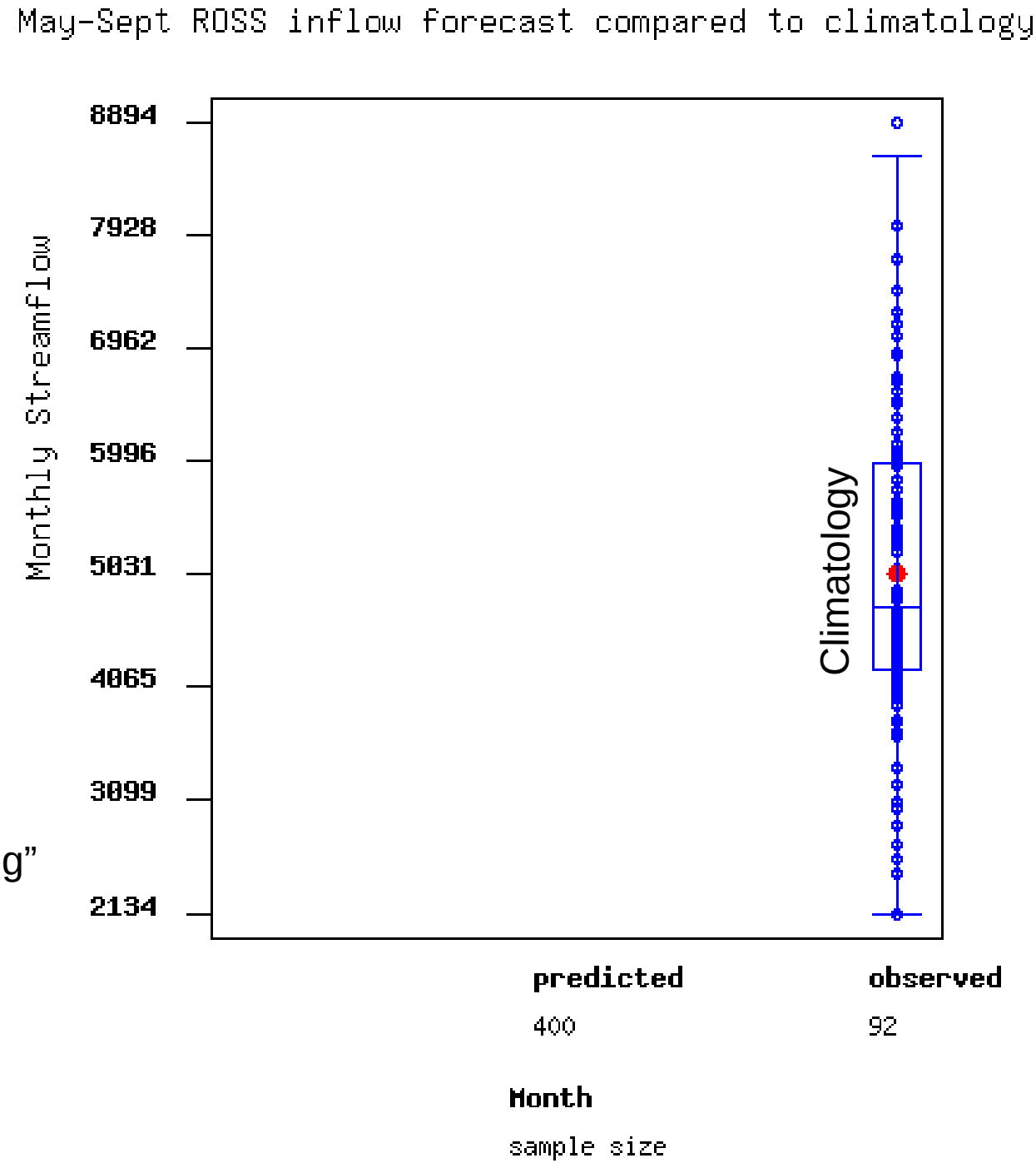
Water year 2003

Climate forecast

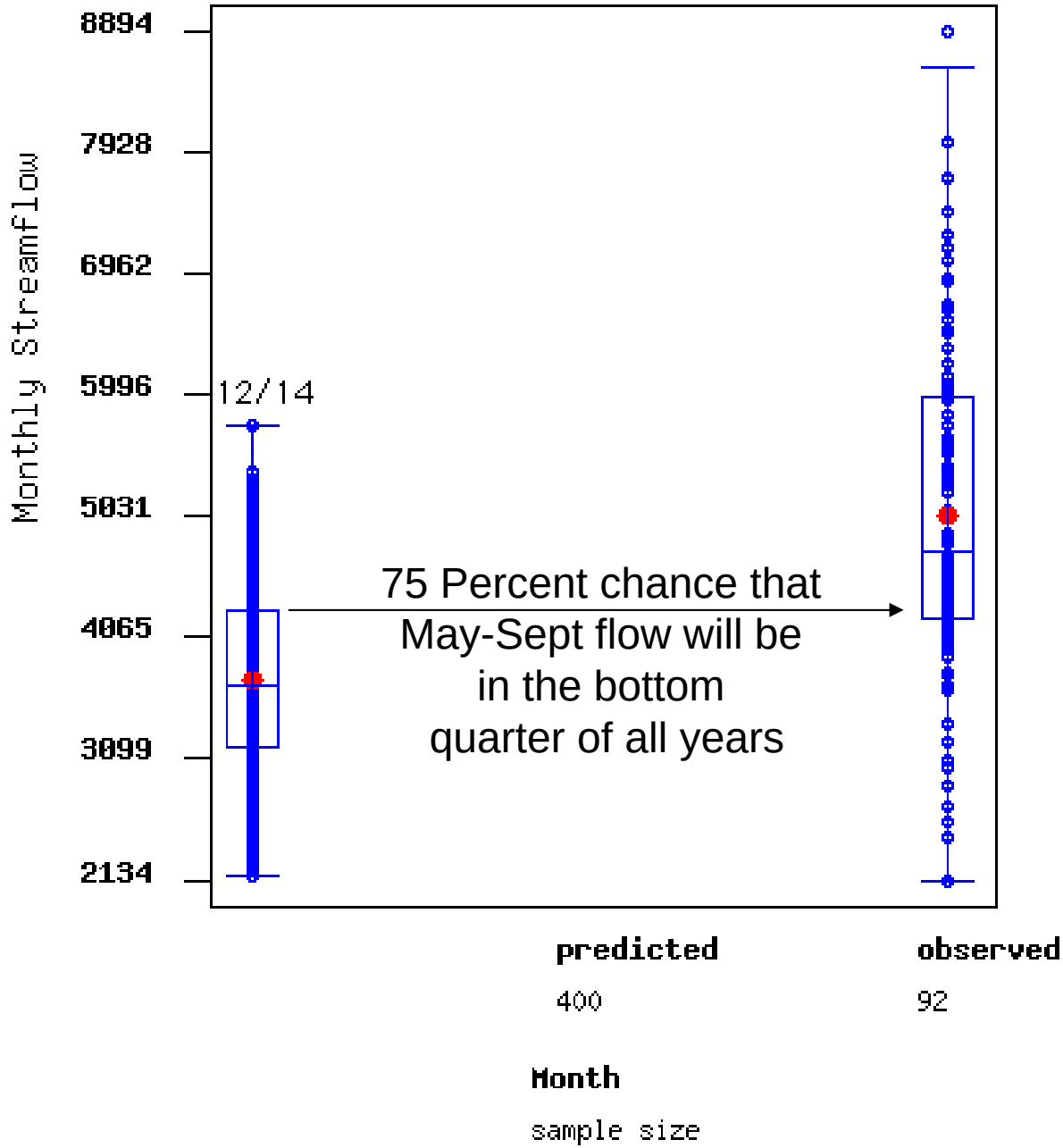
El-nino:
Hedge toward below

Negative PDO:
Hedge toward above

The climate
forecast is not in a “strong”
Category



May-Sept ROSS inflow forecast compared to climatology



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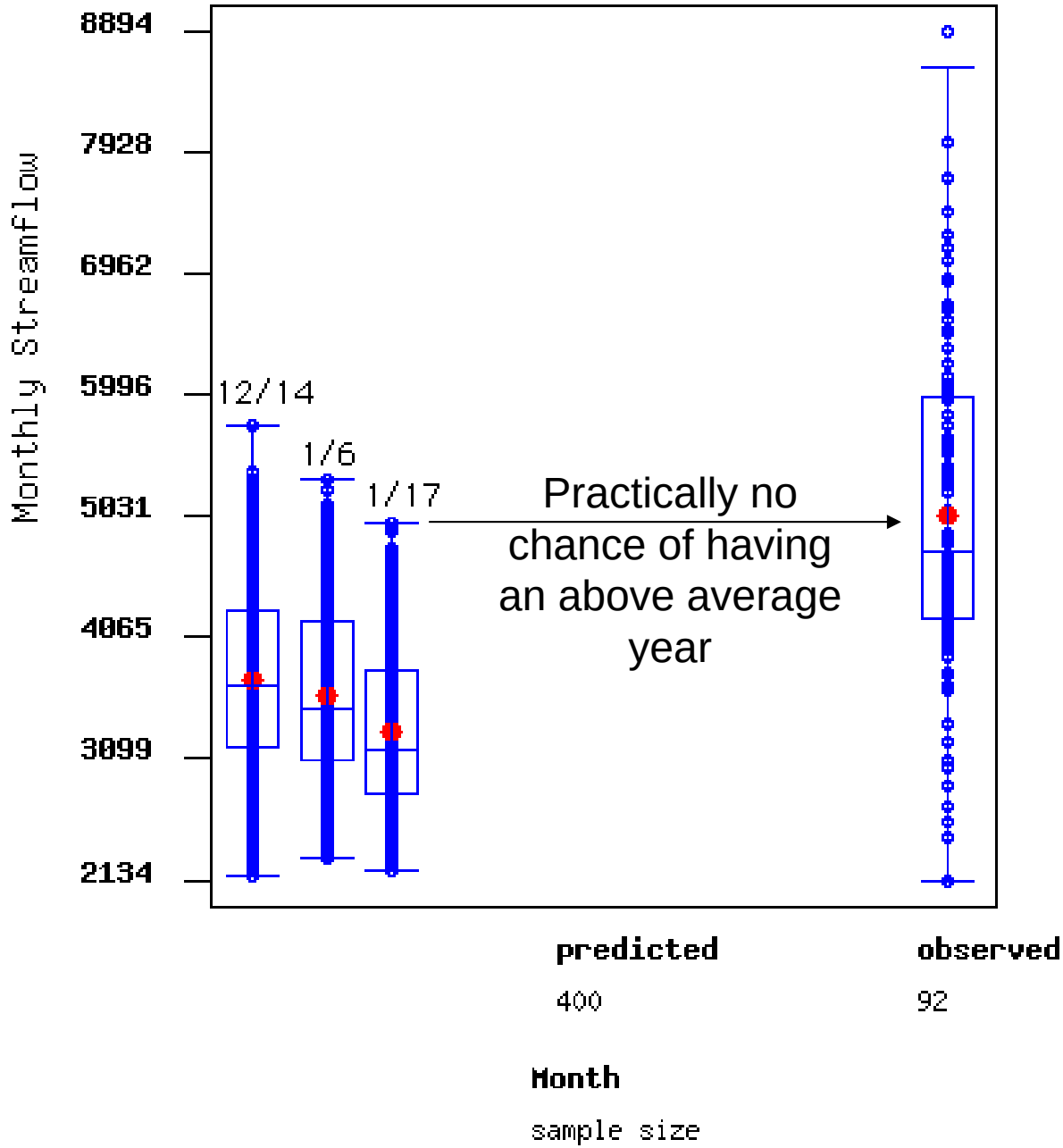

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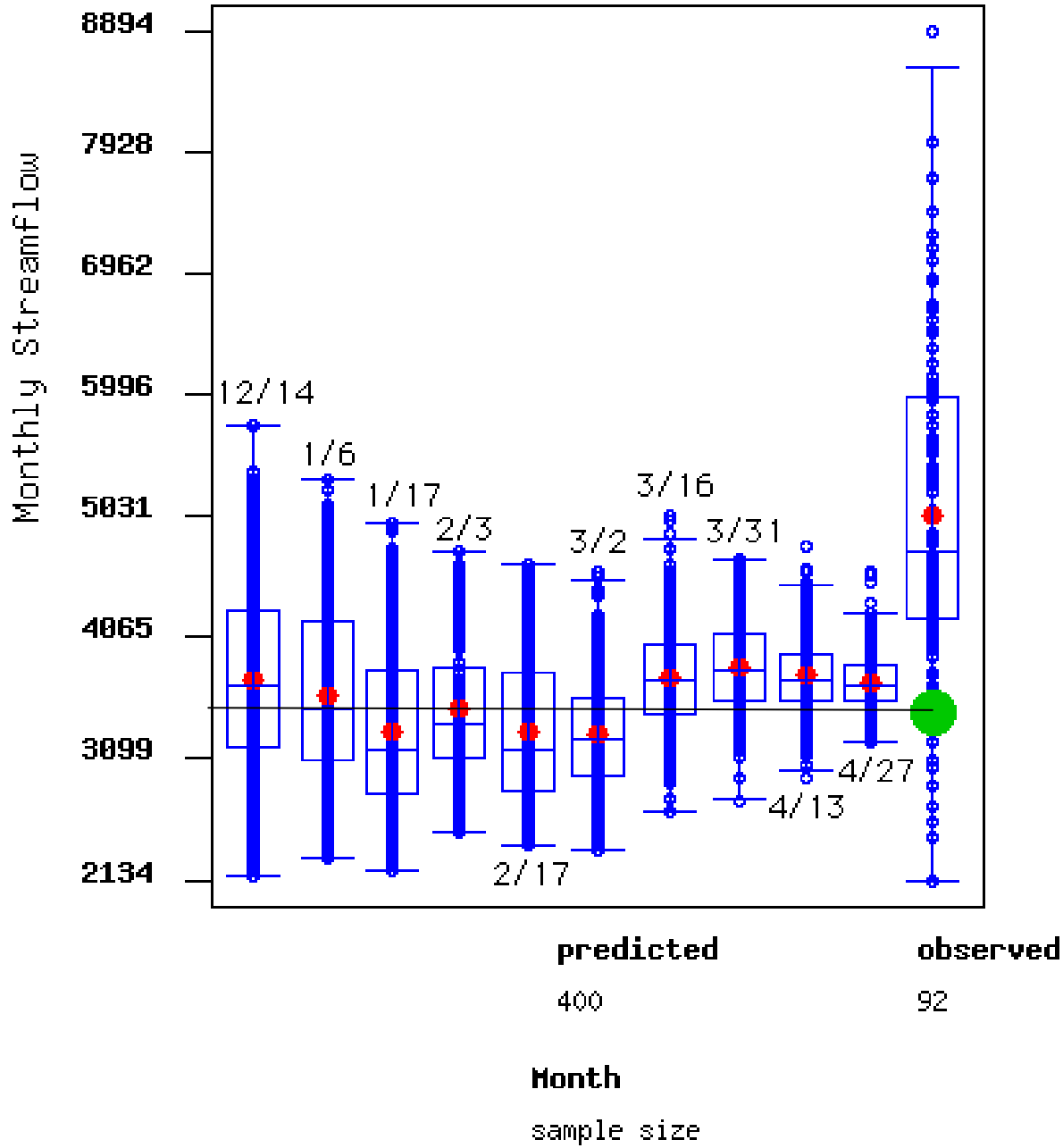
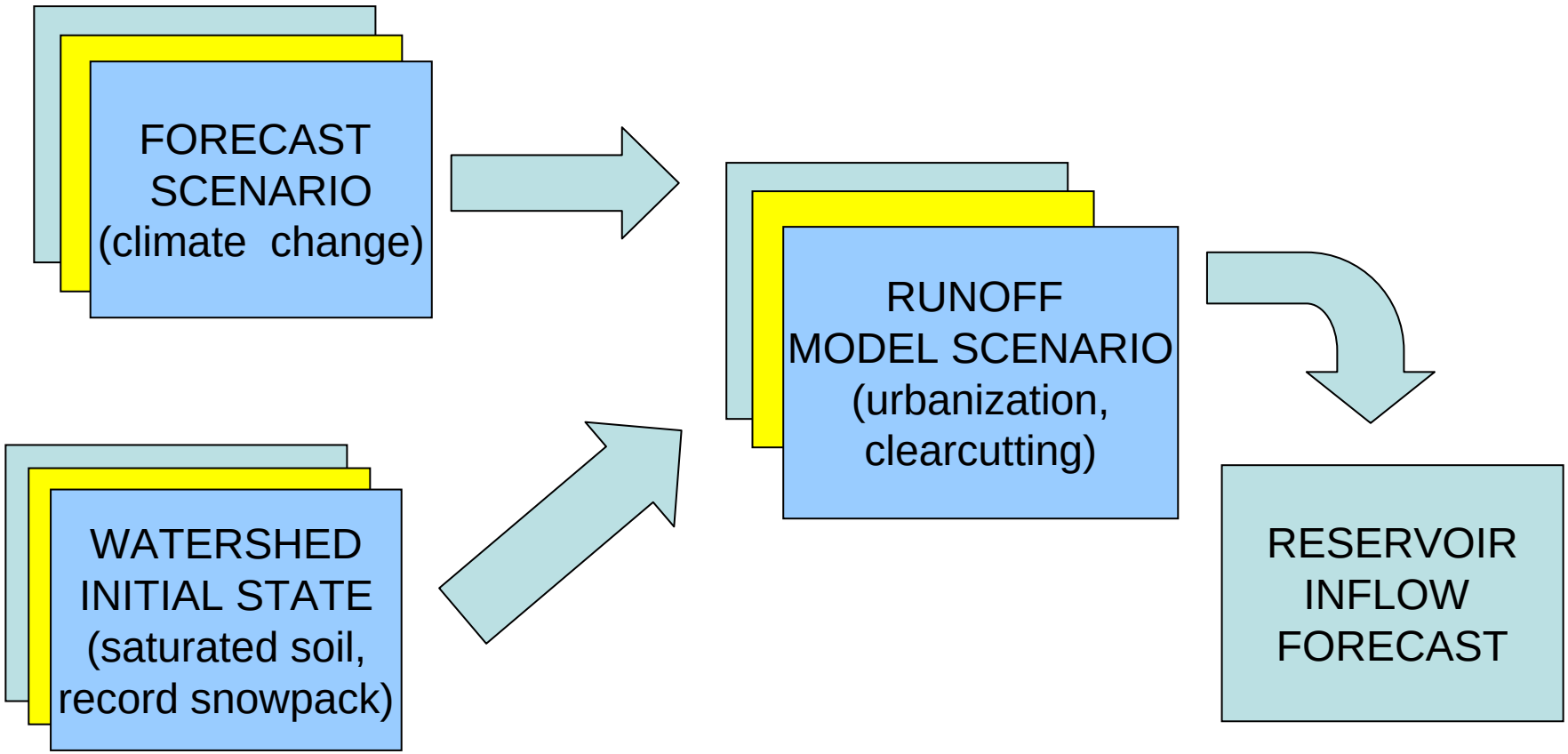
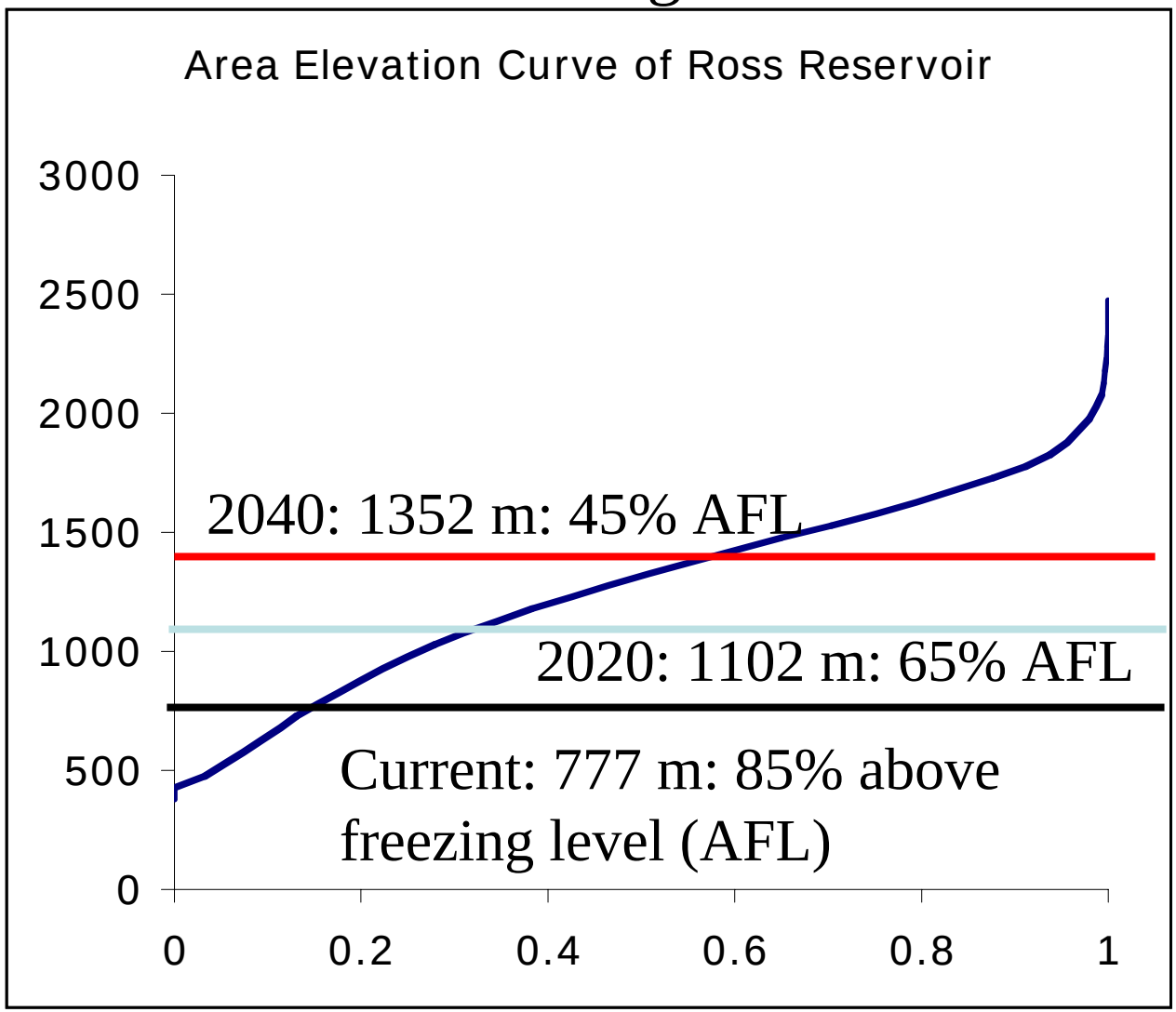


Watershed Planning - Years to Decades



Effect of Climate Change on Average Winter Freezing Level

By 2040 a net loss of 40% of basin for snow accumulation



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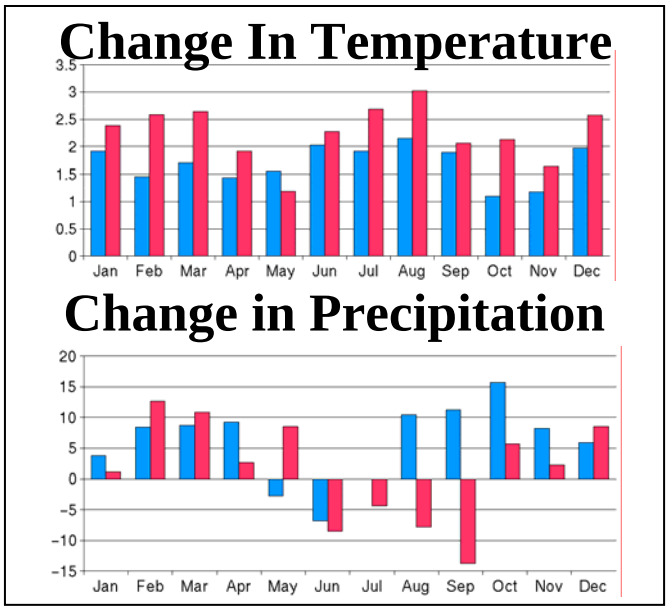
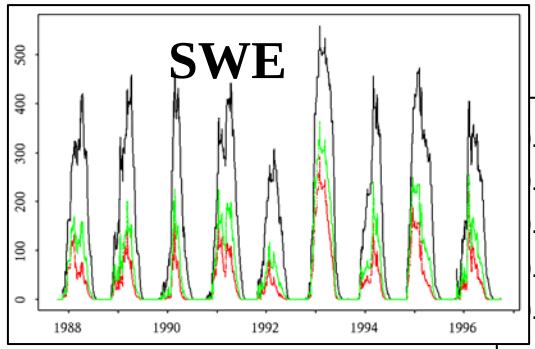
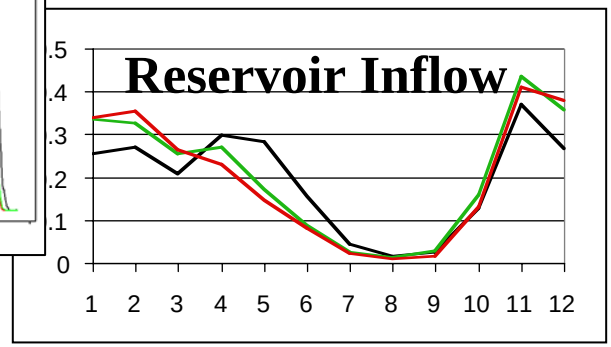
3TIER's Approach

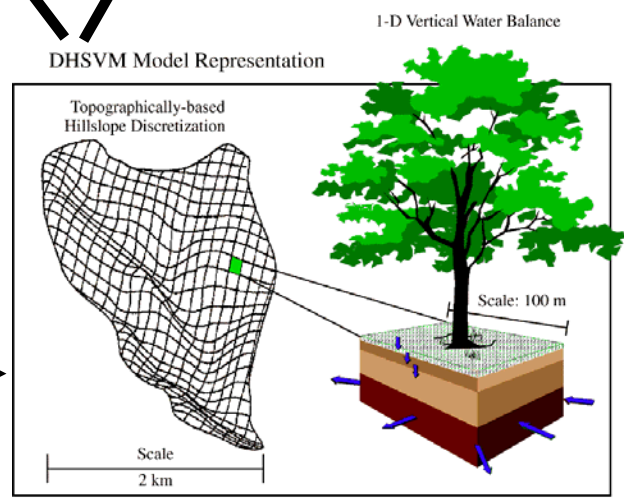






Observed Meteorology Over Watershed

Synthetic "Observed" Record:
Talt=Tobs + Delta T
Palt = Pobs*(Delta P)



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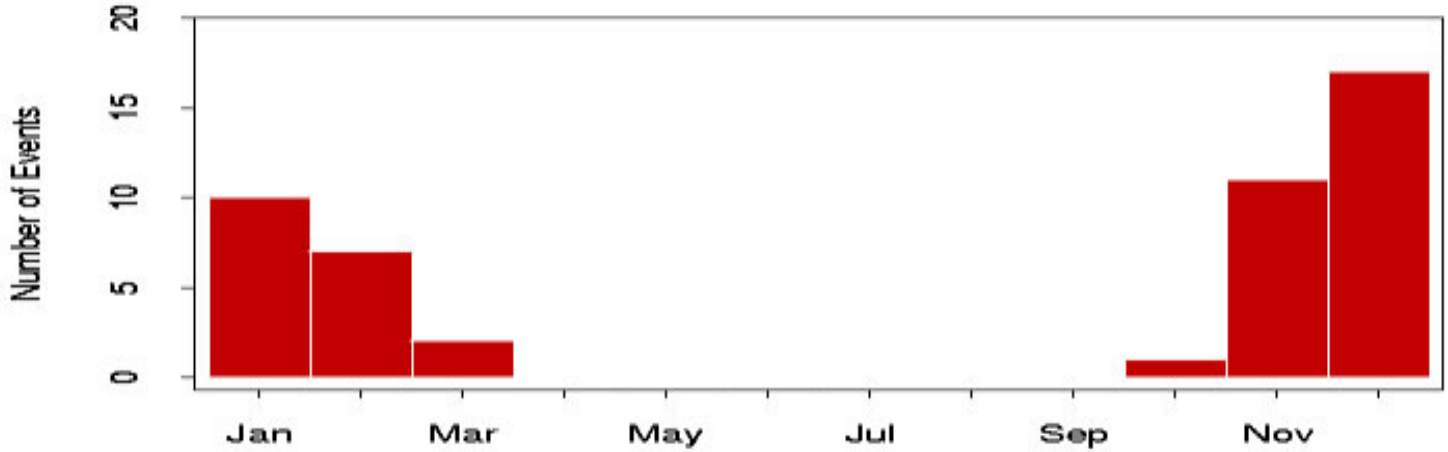
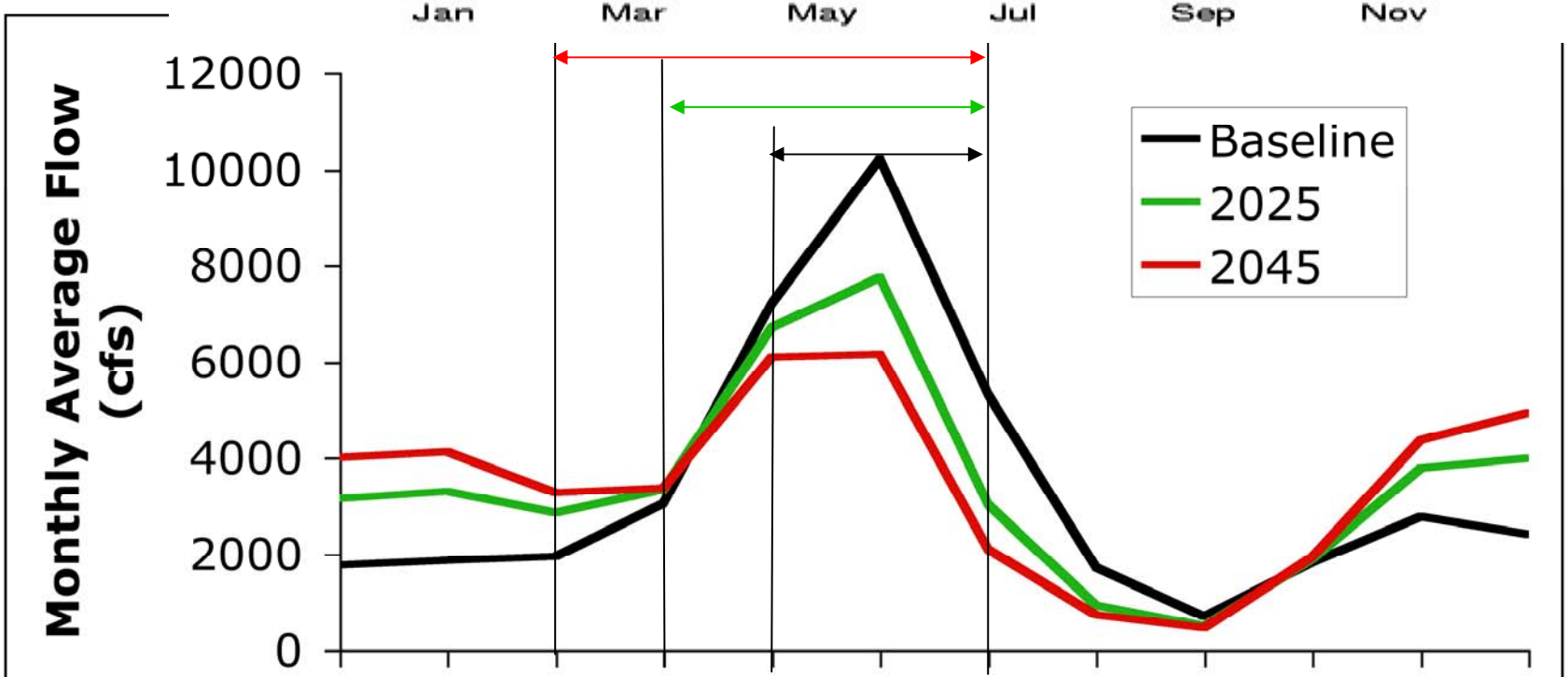
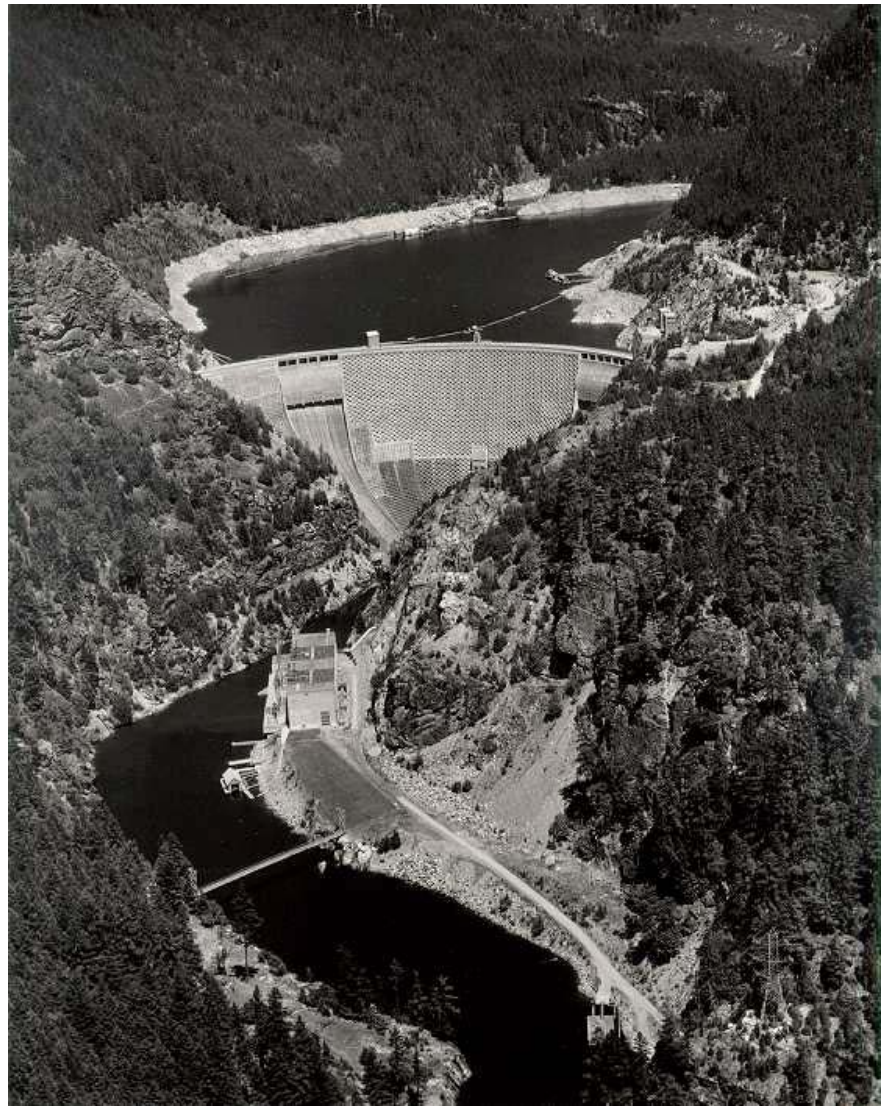




We're pushing the start of the refill period into the traditional NW flood season - We will have to operate closer to the margins in the future

Summary/Questions

- ***3 Key Components to Any Advanced Forecasting System***
  - High Resolution NWP Model
  - Spatially Distributed Hydrology Model
  - **Expertise**
- ***Advantages of using an Advanced Forecasting System***
  - Allows for Forecasting at Multiple Time Horizons
  - Reliable Streamflow Forecasts
  - Additional Analyses (climate change, PMF, vegetation change)



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