Long-Range Hydropower Forecasts for the Columbia River, Colorado River, and Sacramento/San Joaquin Systems

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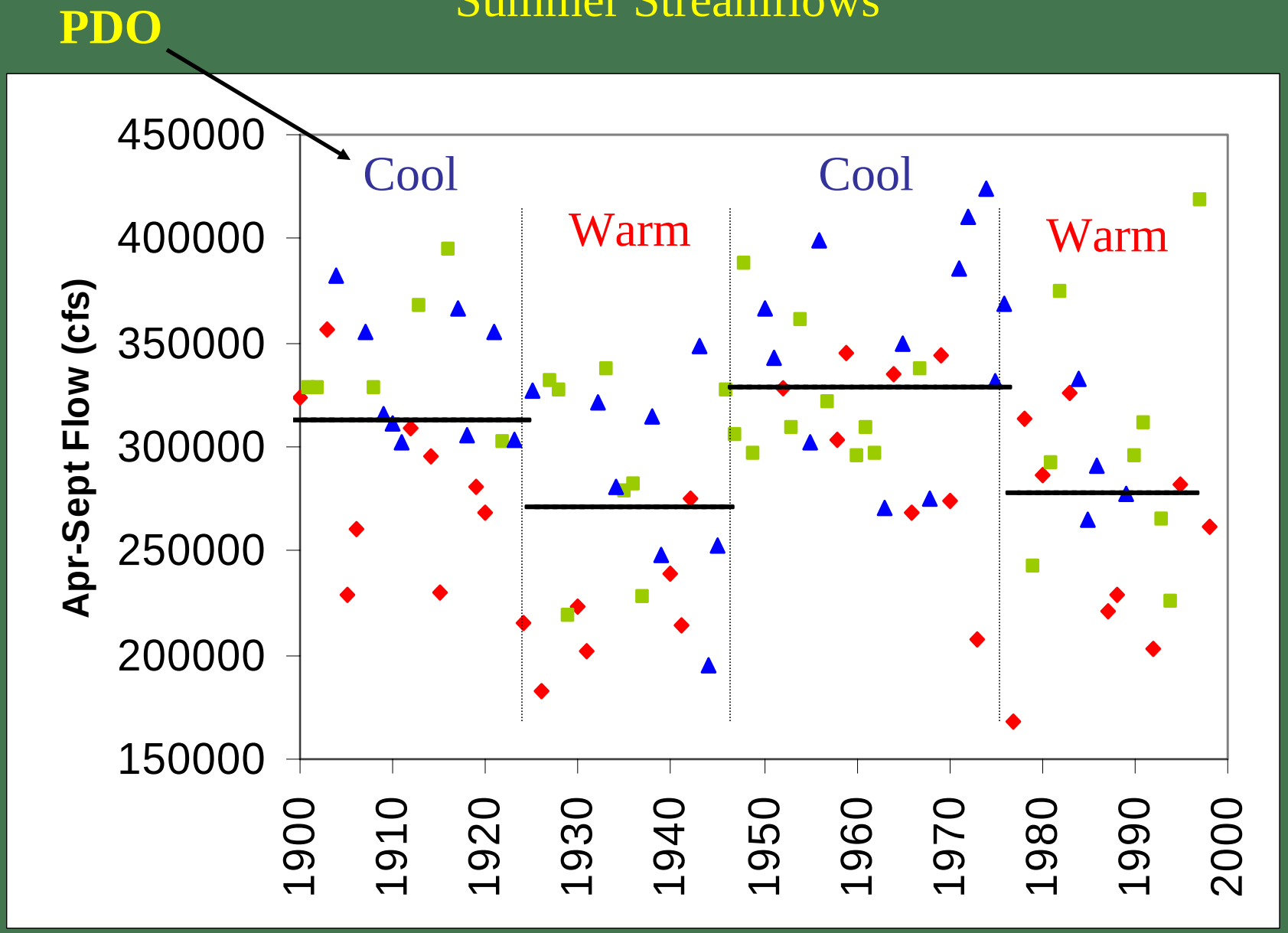
Background

Effects of the PDO and ENSO on Columbia River Summer Streamflows



Red=warm ENSO Green=ENSO neutral Blue=cool ENSO

Value of Long-Range Streamflow Forecasts for PNW Hydro Marketing

~ $150 million/yr

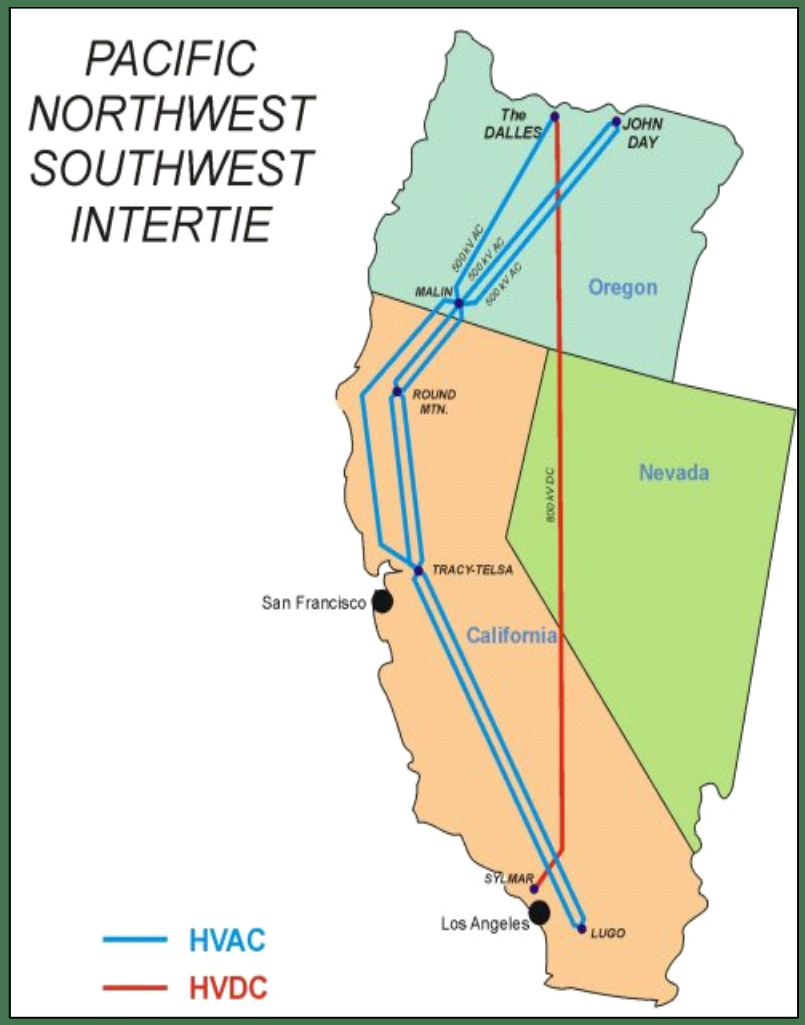
This value is created in part by marketing additional energy in late summer (when energy is more valuable) in expected wet years.

Hamlet, A.F., Huppert, D., Lettenmaier, D.P., 2002, Economic Value of Long-Lead Streamflow Forecasts for Columbia River Hydropower, ASCE J. of Water Res. Planning and Mgmt, 128 (2), pp 91-101

~8000 MW Intertie Capacity

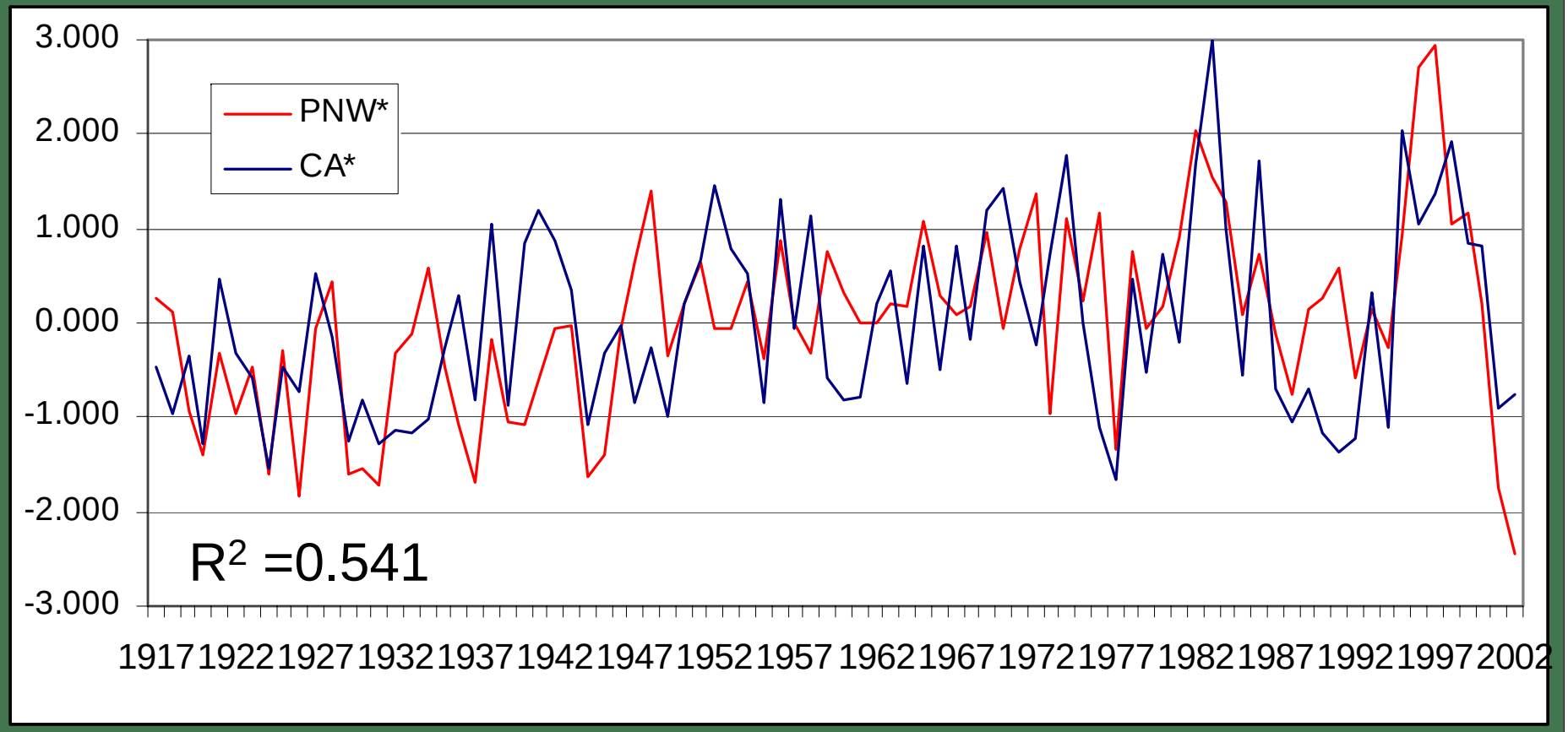
In normal or above normal water years in the PNW, net transfers are typically from PNW to CA

In below normal water years in the PNW, transfers from CA to PNW can occur in winter and transfers from PNW to CA in spring and summer may be reduced or suspended.



http://www.abb.com/global/abbzh/abbzh251.nsf!OpenDatabase&db=/global/gad/gad02181.nsf&v=17EA&e=us&m=100A&c=C1256D71001E0037C1256B8000371E41

Covariation of Normalized PNW and CA Hydropower Production



Voisin, N., A. F. Hamlet, L. P. Graham, D. W. Pierce, T. P. Barnett, and D. P. Lettenmaier, 2006: The role of climate forecasts in western U.S. power planning, Journal of Applied Meteorology (in press).

Predictability of Seasonal Demand in the PNW and CA

•Winter demand in the **PNW** is predictable with long lead times via ENSO forecasts:

Warm ENSO = lower winter electrical demand
Cool ENSO = higher winter electrical load

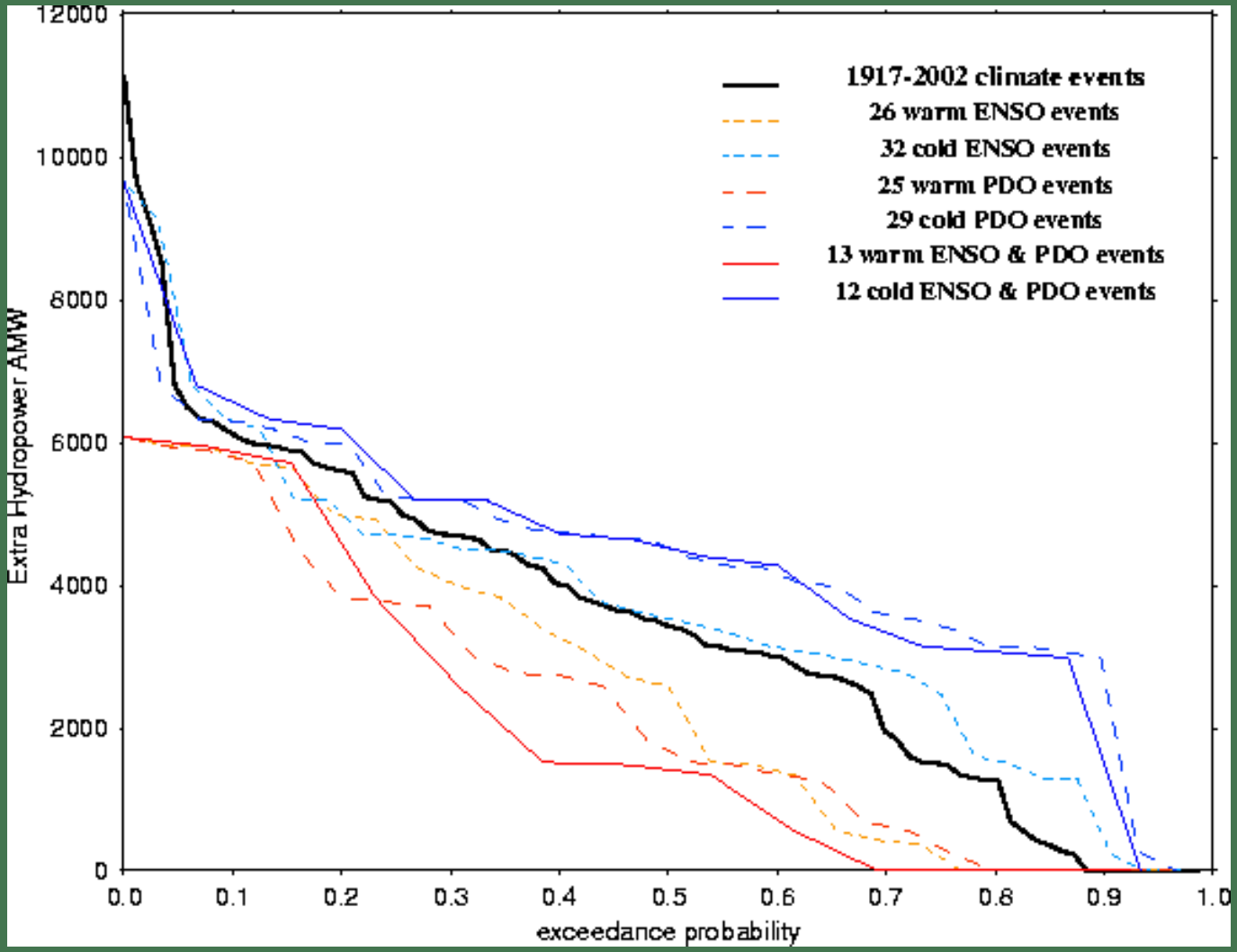
•Load is *in phase* with water availability.

•Summer demand in **CA** has been recently demonstrated to be predictable with several months lead time using the NPO (PDO) index in spring (Alfaro et al. 2005). Even longer lead times may be possible.

B.Normal NPO (MAM) = lower CDD in S. CA. (JJA)
A.Normal NPO (MAM) = higher CDD in S. CA. (JJA)

•Load is *out of phase* with PNW water availability.

Probability of Exceedance for Spring Surplus Energy Resources in the PNW



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A Forecast Timeline

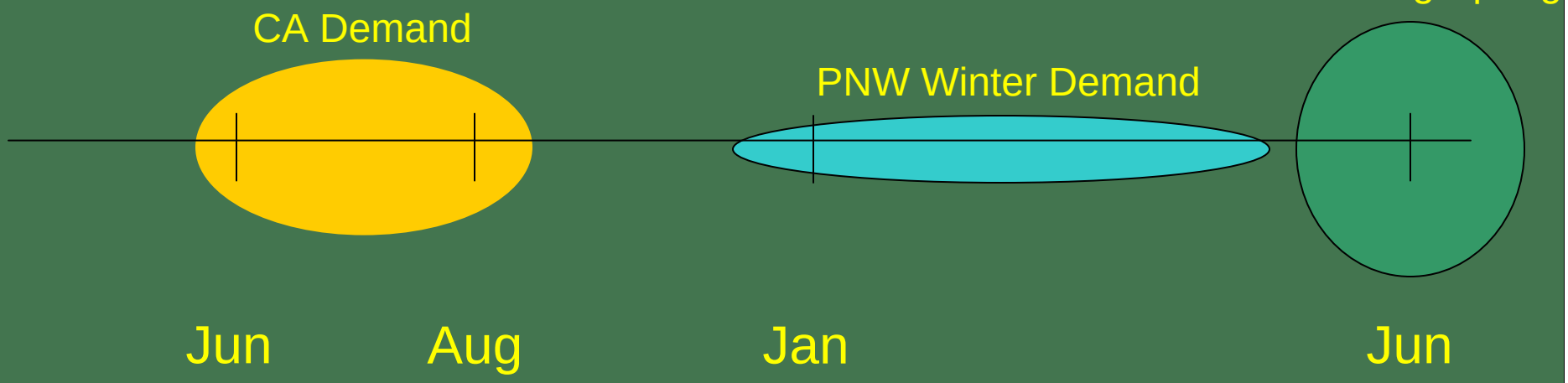
On ~July 1 we have:

- Current Reservoir Contents (PNW and CA)

- Current Summer Streamflow Forecast (PNW and CA)

Forecasts:

- ENSO forecast
- PDO forecast

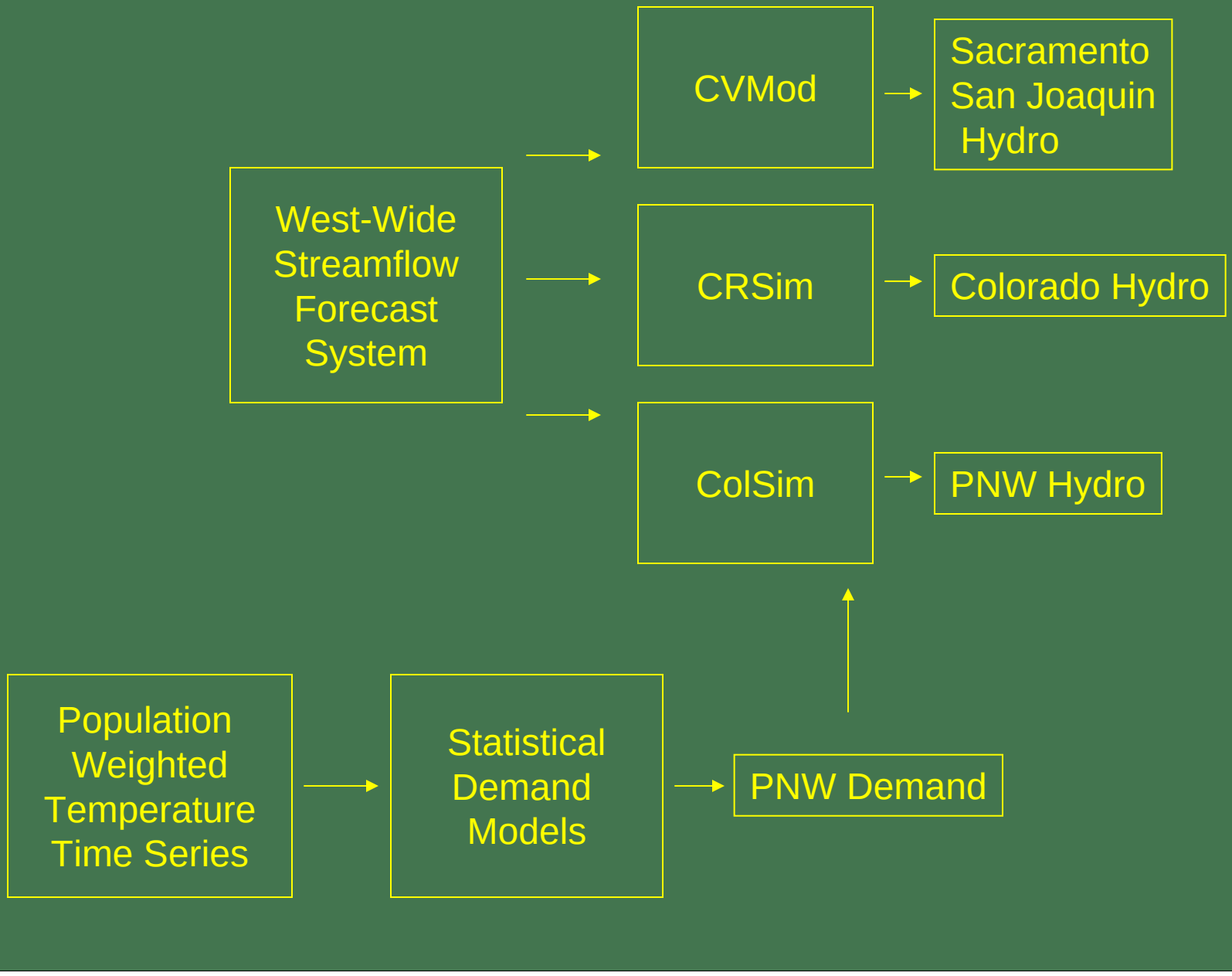


Overview of Research Objectives

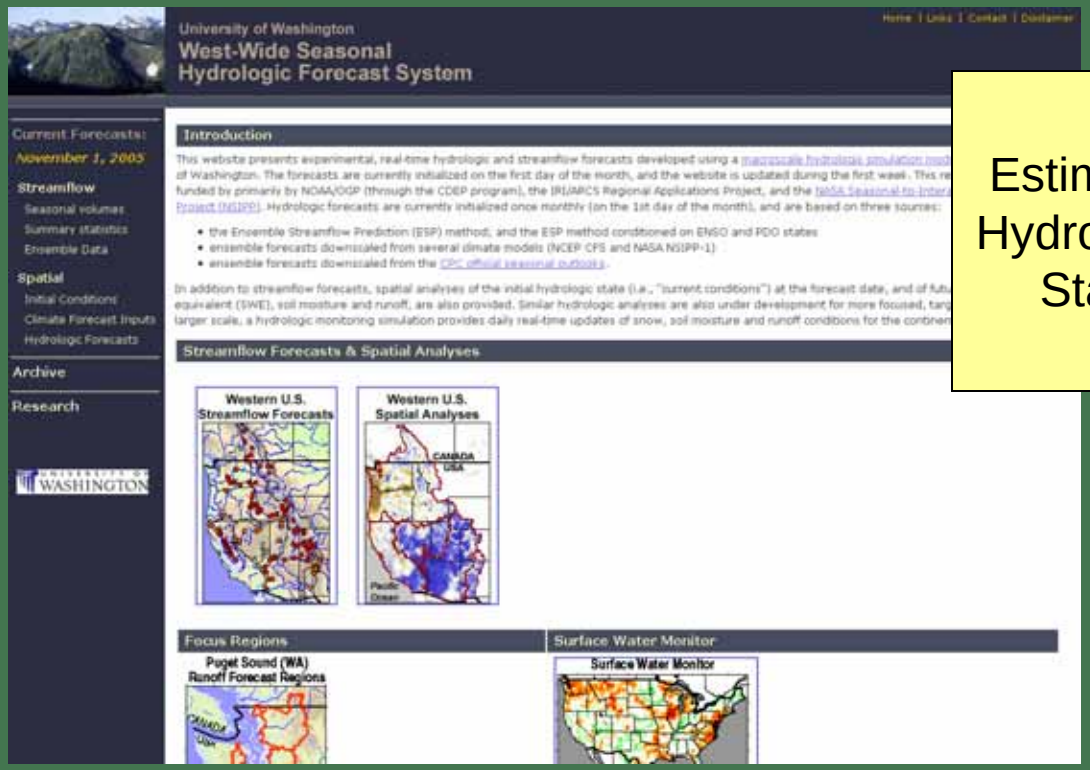
- Validate hydropower simulation approaches using several levels of model complexity
- Produce long retrospective simulations of hydropower for the three major western hydropower systems
- Produce ensemble streamflow and hydropower production hindcasts using methods comparable to the UW West-wide forecasting system
- Understand the nature of both physical and water management constraints on energy transfers in the West
- Understand the capability to use both “passive” and “active” management frameworks using climate-driven hydropower and load forecasts as decision support inputs

Tools and Methods

Overview of Forecast Approach

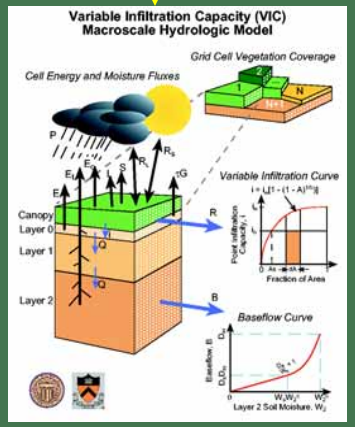


UW West-Wide Seasonal Hydrologic Forecast System



Temperature and Precipitation Forecast

Estimated Hydrologic State

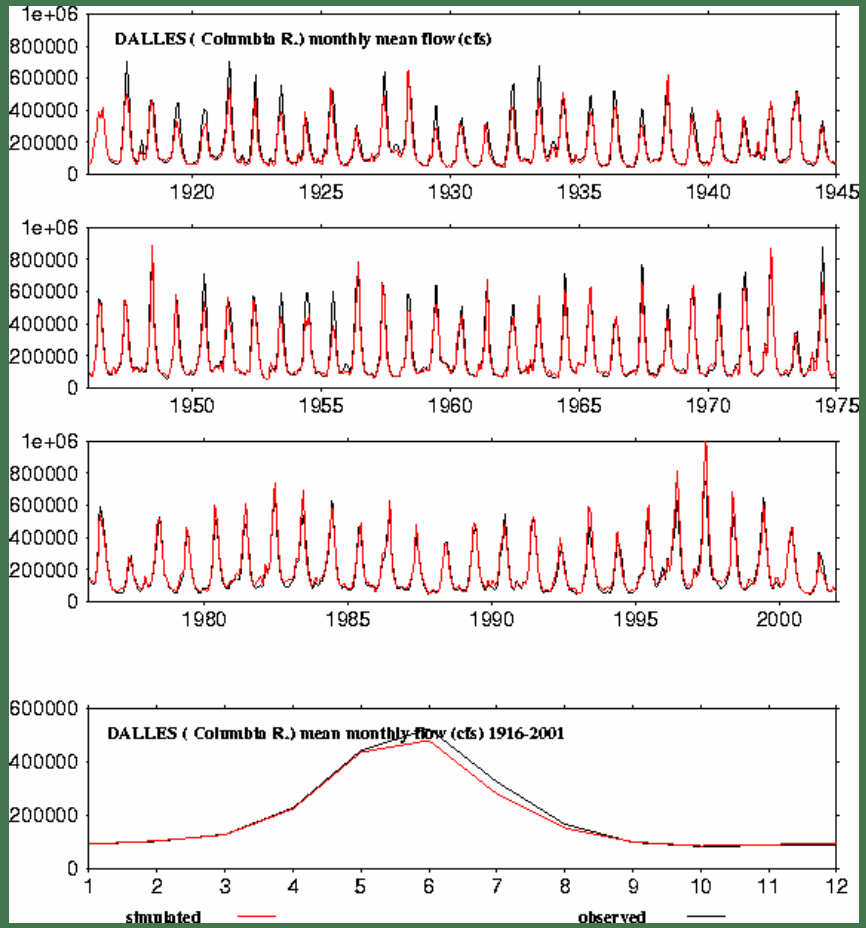


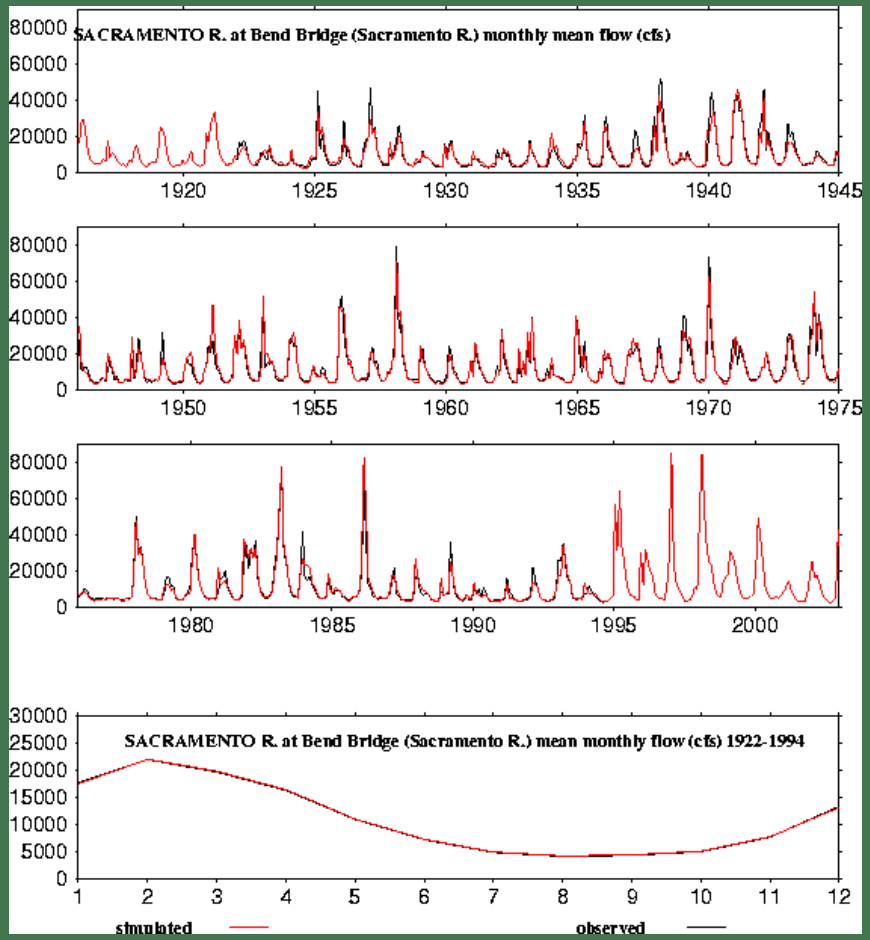
VIC Hydrologic Model

Hydrologic Forecast

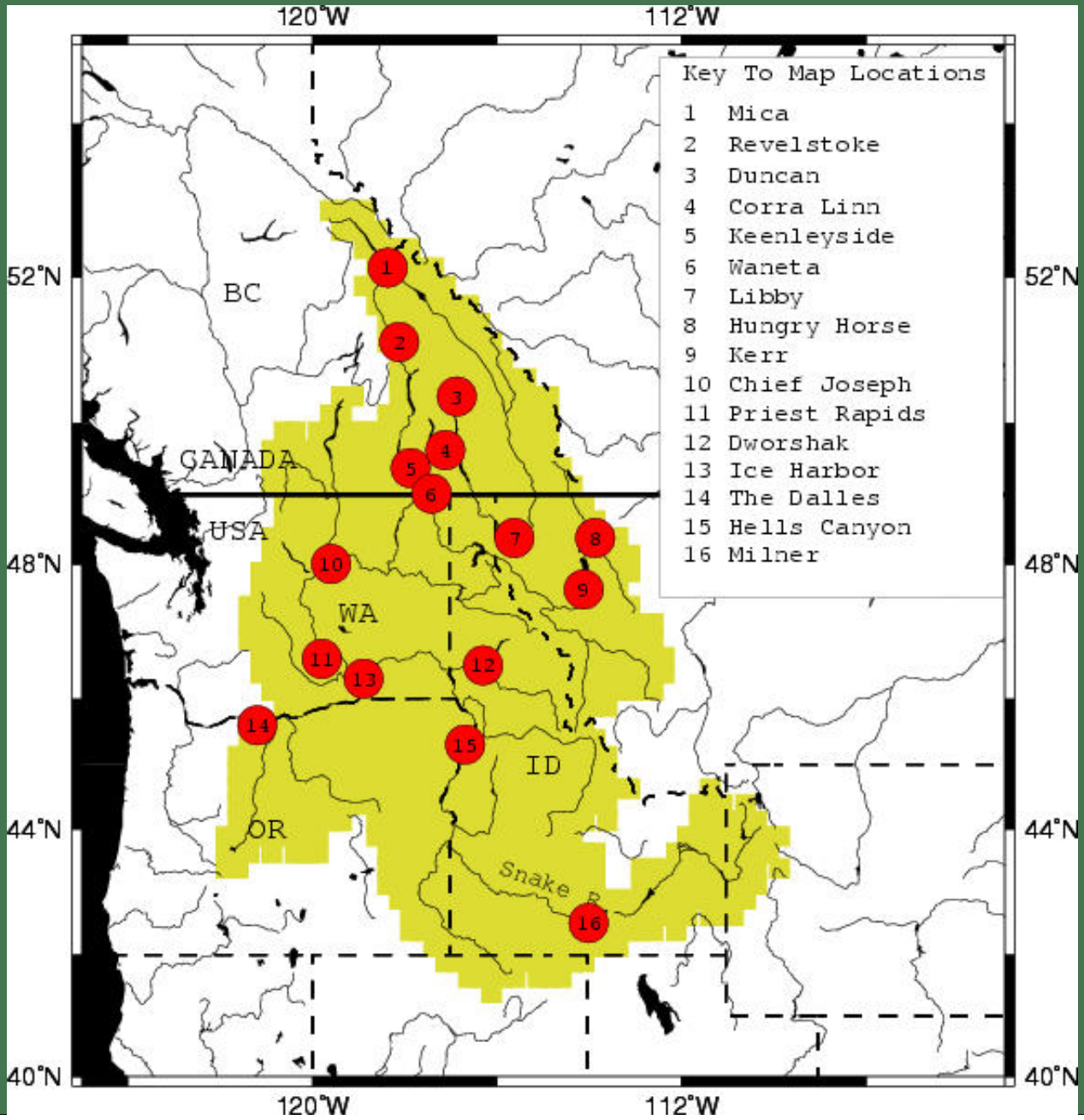
http://www.hydro.washington.edu/forecast/westwide/

Evaluation of VIC Streamflow Simulations

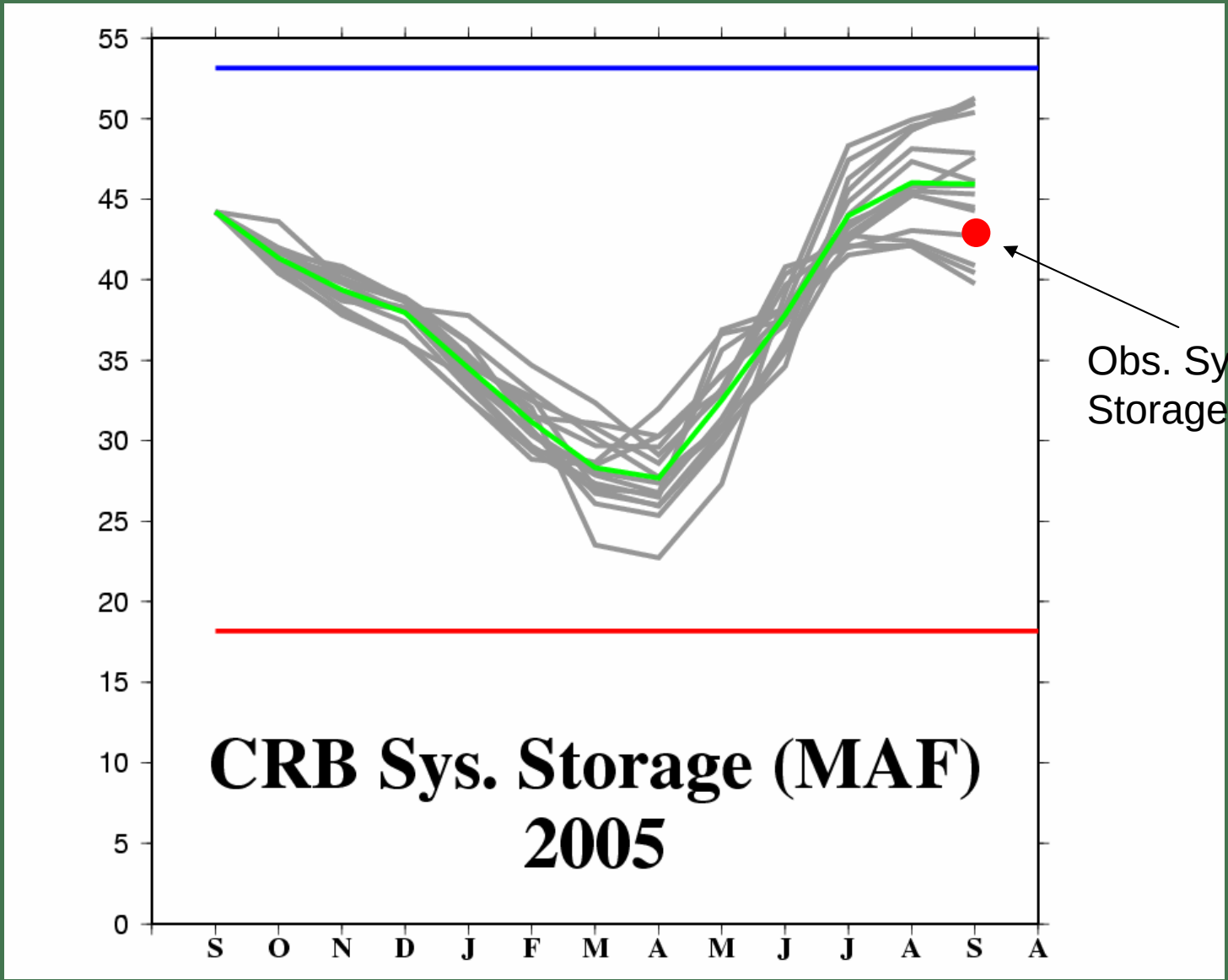




ColSim Reservoir Model



All Years from 1950-2003 for which J. Nino3.4 Anom. >= 0.2 AND <=1.2



Sources of Long-Lead Hydropower Forecast Skill (July 1 Forecast Date)

	PNW	CA	CRB
Long-range Climate Forecast	O	o	
Hydrologic Initial Conditions	o	o	O
Reservoir Initial Conditions	O	O	O
Long-Range Load Forecast	o	o	?

Sources of Long Lead Hydropower Forecast Skill (April 1 Forecast Date)

	PNW	CA	CRB
Long-range Climate Forecast	o	o	
Hydrologic Initial Conditions	O	O	O
Reservoir Initial Conditions	O	O	O
Long-Range Load Forecast		o	?