

# Seasonal Hydrologic and Streamflow Forecasting: A Western U.S. Experiment

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for

**15<sup>th</sup> Annual Review: Water and Sustainability in the Region**  
UW Center for Water and Watershed Studies

*February 17, 2005*

## Presentation Outline

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### 1. Introduction

- hydrologic forecasting in the western U.S.
- seasonal climate prediction
- experimental hydrologic forecasting system

2. Results: Last Water Year and Current Water Year


3. Future Directions

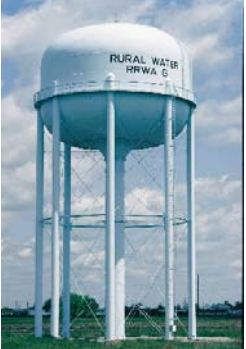
# The Big Picture: Importance of Hydrologic Forecasts

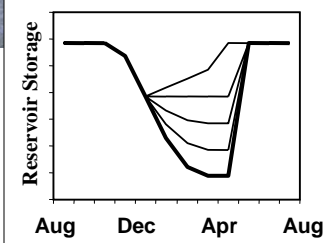



**water management**

- hydropower
- irrigation
- flood control
- water supply












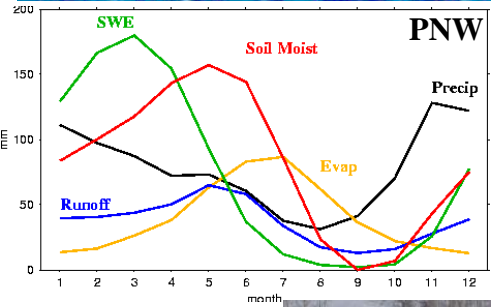
- fisheries
- recreation
- navigation
- water quality

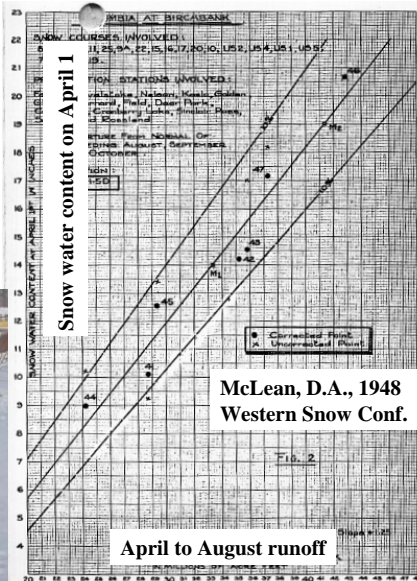








# Introduction: Hydrologic prediction and NRCS





SNOTEL Network





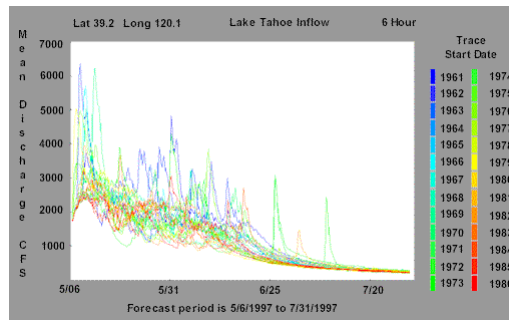
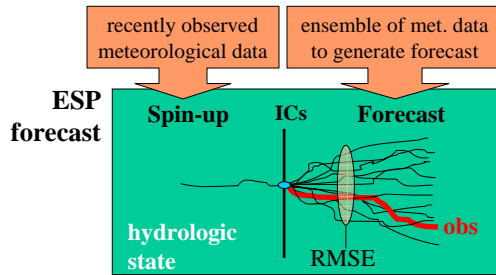
## Introduction: Hydrologic prediction and NWS

NWS River Forecast Center (RFC) approach:  
rainfall-runoff modeling  
(i.e., NWS River Forecast System, Anderson, 1973  
offspring of Stanford Watershed Model, Crawford & Linsley, 1966)

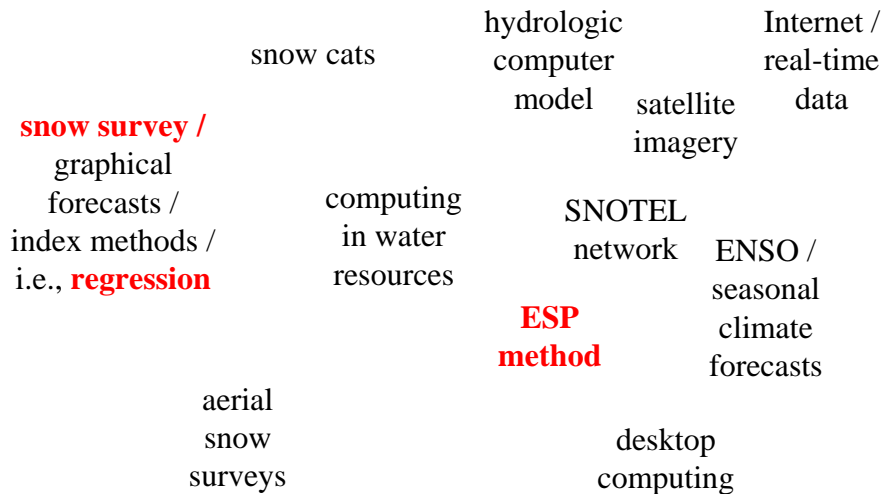
Ensemble Streamflow Prediction (ESP)

- used for shorter lead predictions;
- ~ used for longer lead predictions

Currently, some western RFCs and NRCS coordinate their seasonal forecasts, using mostly statistical methods.



## Introduction: Potential Advances since regression / ESP

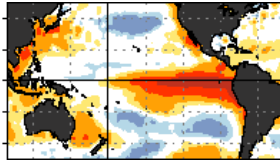


## Introduction: Seasonal climate prediction

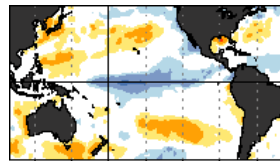
Climate prediction has markedly advanced in the last several decades

- better monitoring of oceans and atmosphere
- deeper understanding of ocean-atmosphere teleconnections
- Monthly / seasonal climate forecasting has become operational at a number of research centers

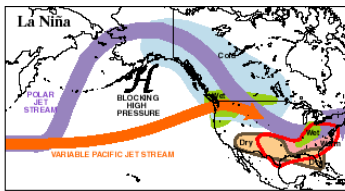
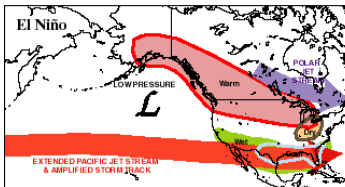
### Sea Surface Temps



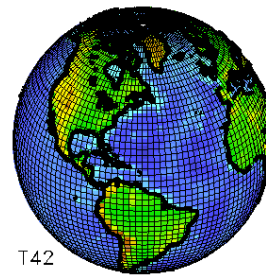
e.g. El Niño / La Niña



### Circulation Features



Typical climate model spatial resolution



T42

## Introduction: Seasonal Climate Prediction

National Weather Service  
Climate Prediction Center

Site Map
News
Organization

CPC Search

Map Explanations  
 Official Fests  
 Fest Tools

About Us  
 Our Mission  
 Who We Are

Contact Us  
 CPC Information  
 CPC Web Team

HOME > Outlook Maps > Monthly to Seasonal Outlooks > Seasonal Outlooks

# Seasonal Outlooks

OFFICIAL Forecasts

PROPOSED 1 & 3 MONTH SERVICE CHANGE

OUTLOOKS (click title for maps)	Skill	Normals	Prob of Exceed
<a href="#">0.5 Month Outlook for Aug-Sep-Oct 2003</a>	X	X	X
<a href="#">1.5 Month Outlook for Sep-Oct-Nov 2003</a>	X	X	X
<a href="#">2.5 Month Outlook for Oct-Nov-Dec 2003</a>	X	X	X
<a href="#">3.5 Month Outlook for Nov-Dec-Jan 2004</a>	X	X	X
<a href="#">4.5 Month Outlook for Dec-Jan-Feb 2004</a>	X	X	X
<a href="#">5.5 Month Outlook for Jan-Feb-Mar 2004</a>	X	X	X
<a href="#">6.5 Month Outlook for Feb-Mar-Apr 2004</a>	X	X	X
<a href="#">7.5 Month Outlook for Mar-Apr-May 2004</a>	X	X	X
<a href="#">8.5 Month Outlook for Apr-May-Jun 2004</a>	X	X	X
<a href="#">9.5 Month Outlook for May-Jun-Jul 2004</a>	X	X	X
<a href="#">10.5 Month Outlook for Jun-Jul-Aug 2004</a>	X	X	X

e.g., precipitation


PRECIPITATION OUTLOOK  
 0 LL SEASONAL  
 1 JUL 2004

# Introduction: Seasonal climate prediction

N. American Precip forecasts made: 1Jul2003

Method	ASO	SON	OND	NDJ
<a href="#">CCA Method</a>				
<a href="#">NCEP Model</a>				
<a href="#">IRI Model</a>				
<a href="#">LIM Model</a>				
<a href="#">NSIPP Model</a>				
<a href="#">CPC Constructed Analog</a>				

# Introduction: Experimental Hydrologic Forecasting



## WEST-WIDE SEASONAL STREAMFLOW FORECASTING PROJECT


FORECASTS 12/25/03:

**Current Forecast Status:**

- Initial conditions (SWE/SM) done
- ESP runs done
- GSM/NSIPP-1 runs done

[FCST SUMMARY](#)

**Western US Forecasting Domain**



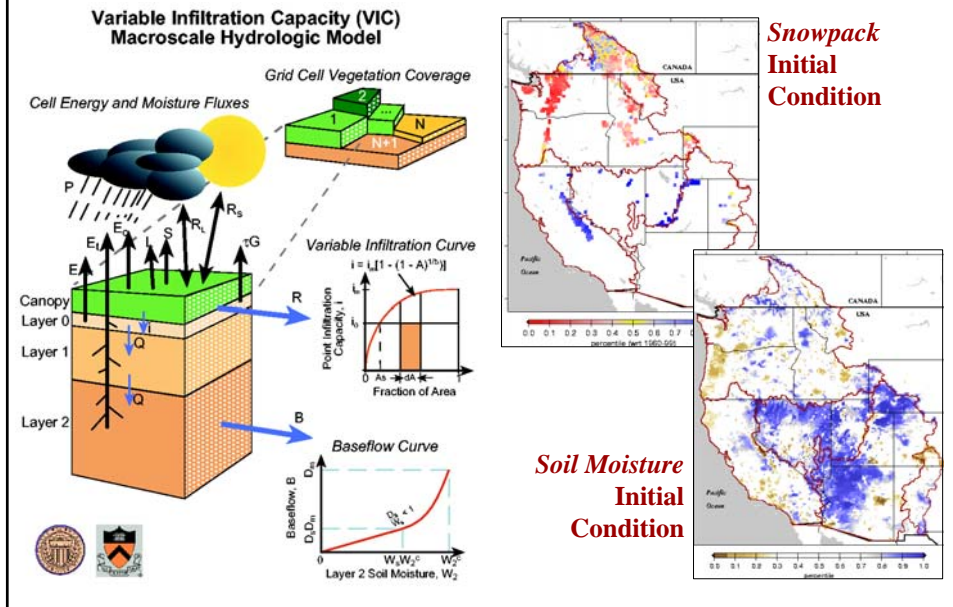
This website presents current monthly-to-seasonal hydrologic, streamflow and reservoir system forecasts for the western U.S. The experimental effort is funded by primarily by NOAA/OGP, the [IRI/ARCS Regional Applications Project](#), and the [NASA Seasonal-to-Interannual Prediction Project \(NSIPP\)](#).

Currently, two forecast approaches are used, both centering on the use of macroscale hydrologic simulation with the [VIC model](#):

- the Ensemble Streamflow Prediction (ESP, formerly Extended Streamflow Prediction) method; and the ESP method conditioned on ENSO and PDO states
- ensemble forecasts downscaled from several climate models (NCEP GSM and NASA NSIPP-1)

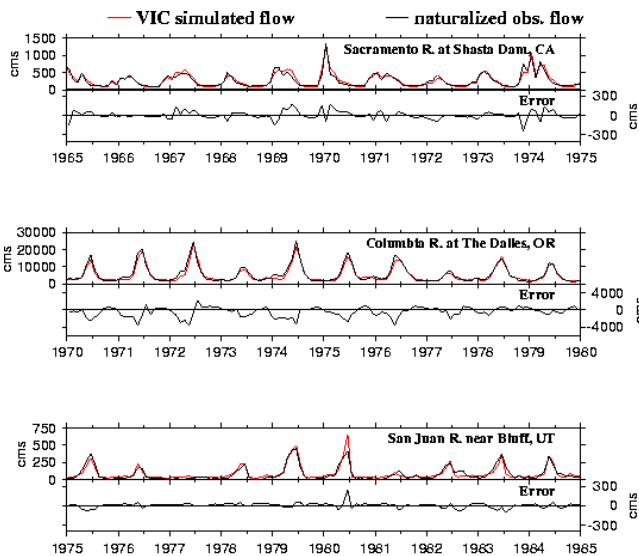
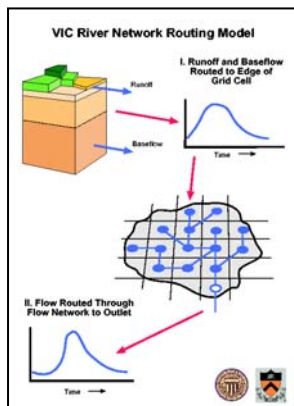
Forecast outputs include monthly streamflow ensembles, spatial distributions of snow water equivalent (SWE), soil moisture and runoff, and (*not yet active*) reservoir system storage and flow forecasts. In addition, the analyses of the initial hydrologic state at the forecast date constitute a nowcast of SWE and soil moisture conditions throughout the domain, based on observed meteorology.

# Introduction: Experimental Hydrologic Forecasting

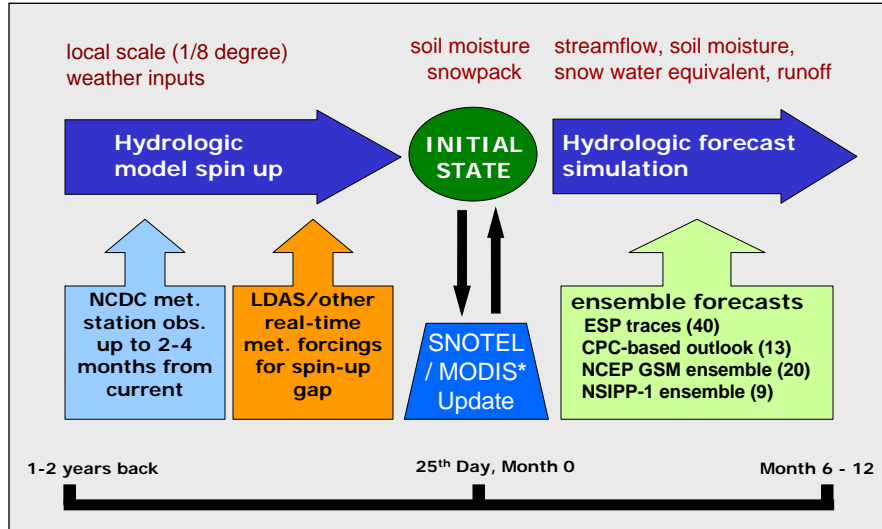


# Introduction: Experimental Hydrologic Forecasting

**VIC model runoff is routed to streamflow gauges, and verified against observations**

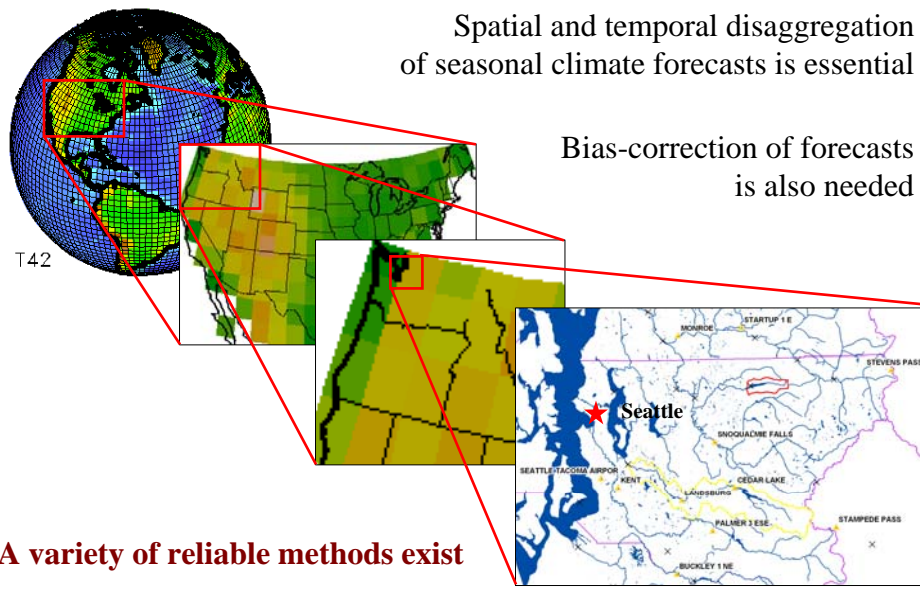


## Introduction: Experimental Hydrologic Forecasting

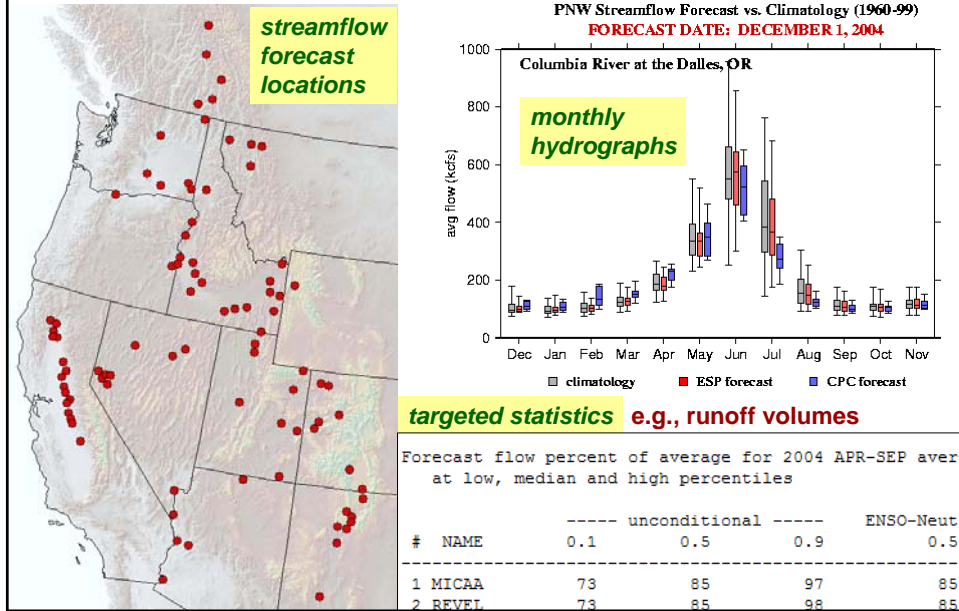


\* experimental, not yet in real-time product

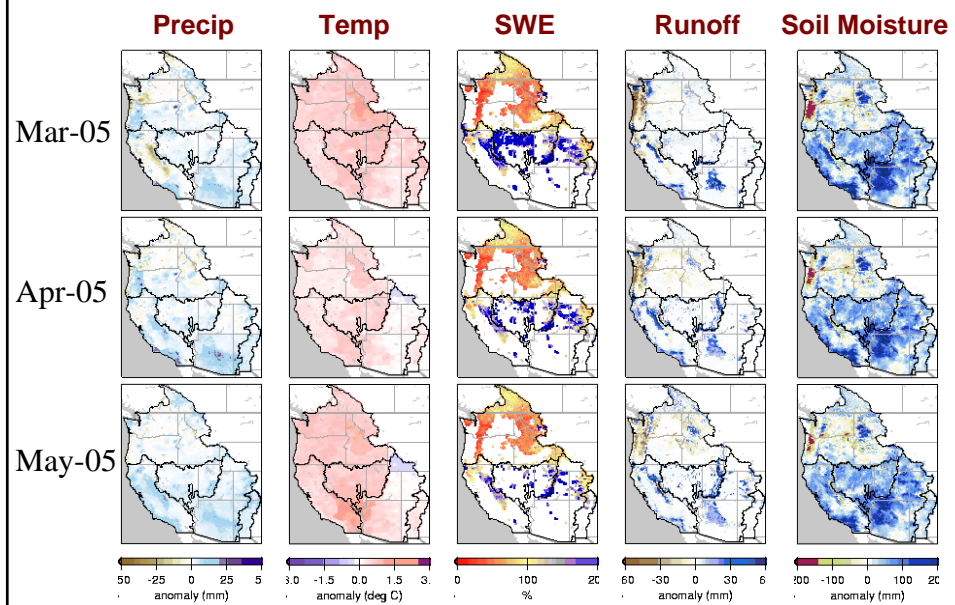
## Introduction: Experimental Hydrologic Forecasting



## Introduction: Experimental Hydrologic Forecasting



## Introduction: UW Experimental Hydrologic Forecasting



## Presentation Outline

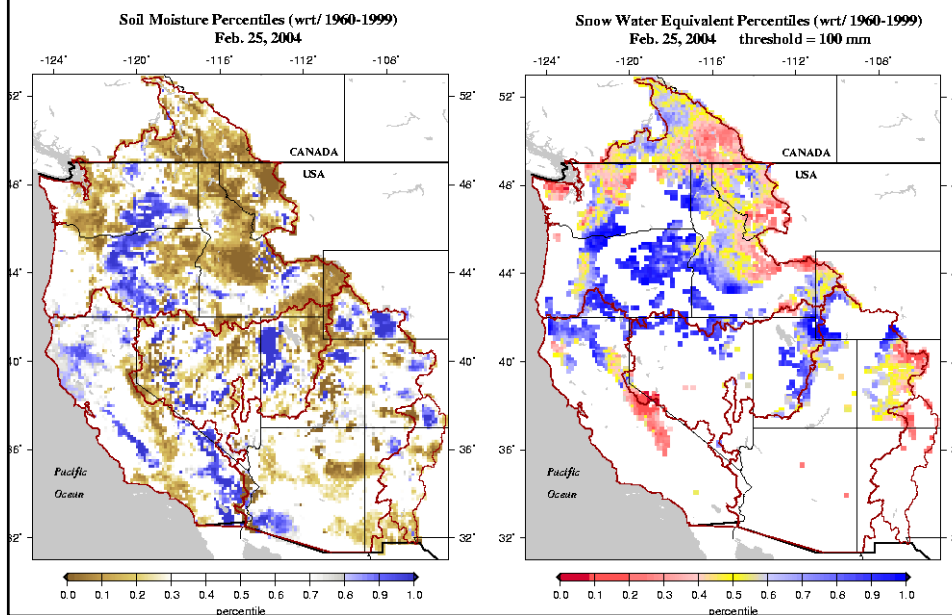
### 1. Introduction

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- UW experimental hydrologic forecasting system

### 2. Results: Last Water Year and Current Water Year

### 3. Future Directions

## Results: WY2004, late February hydrologic conditions



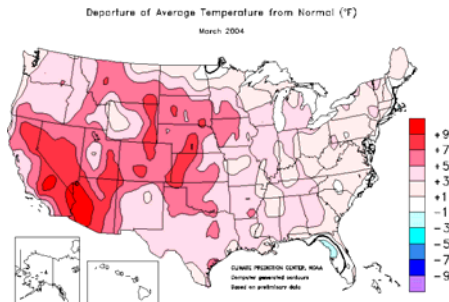
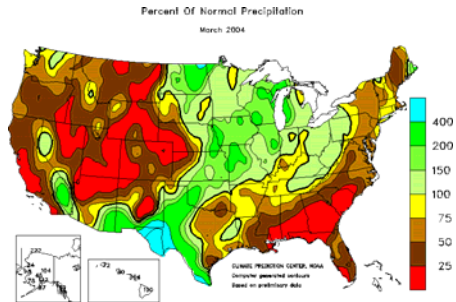
## Results: WY2004's, March climate

CPC estimates of seasonal precipitation and temperature

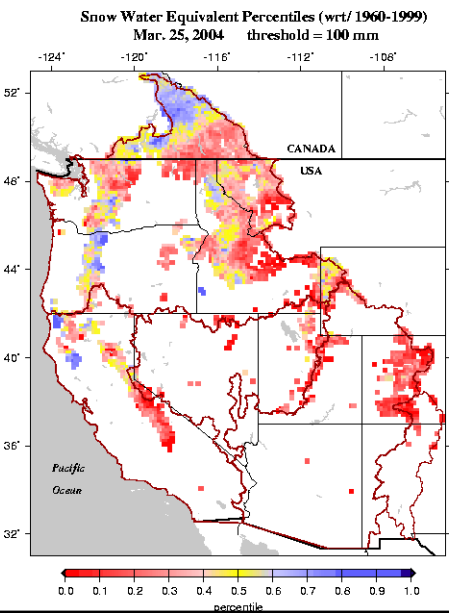
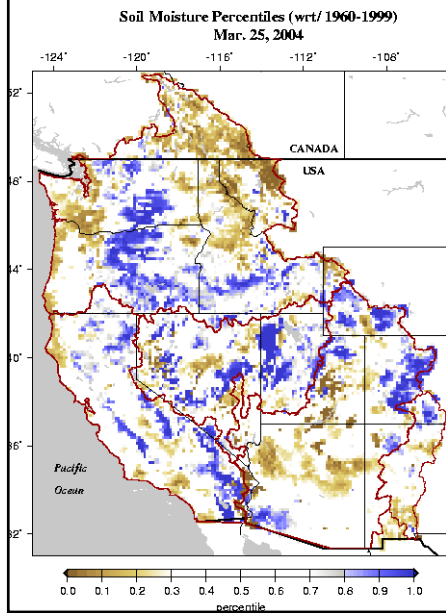
March

very dry

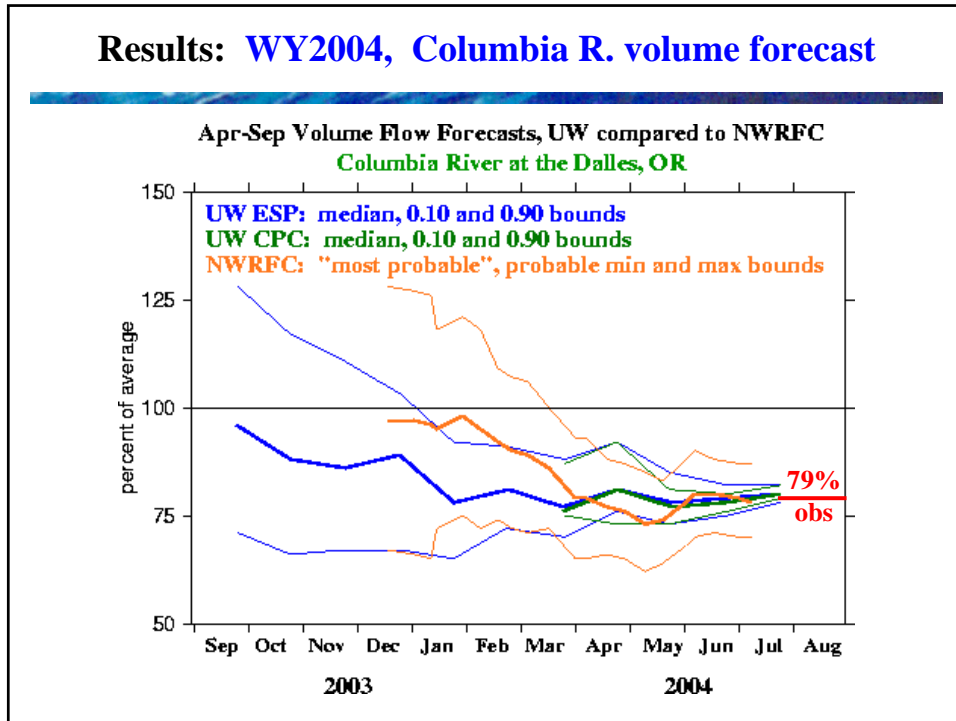
hot



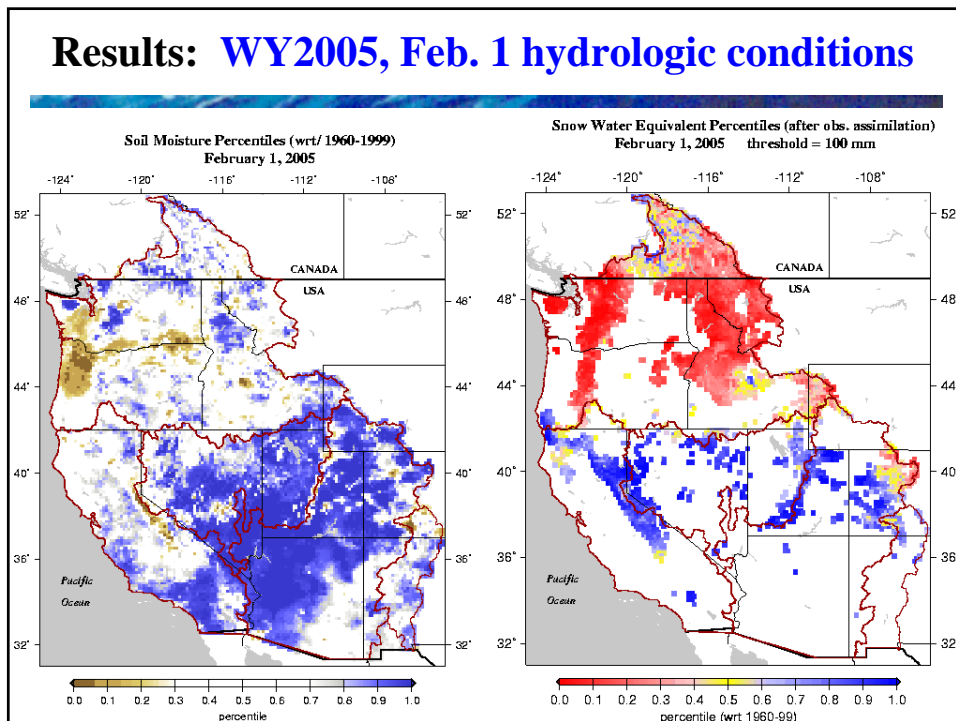
## Results: WY2004, late March hydrologic conditions



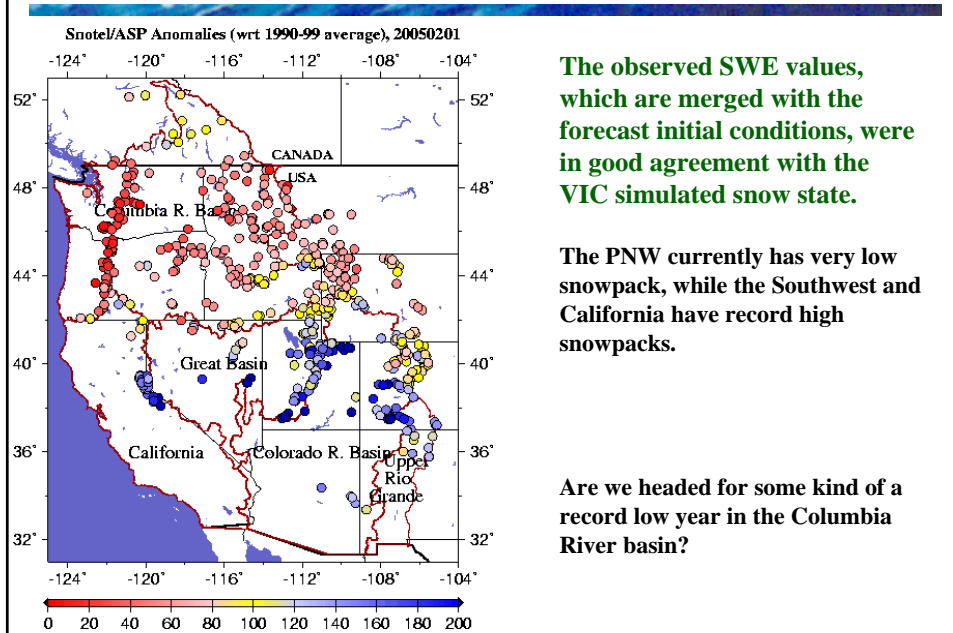
## Results: WY2004, Columbia R. volume forecast



## Results: WY2005, Feb. 1 hydrologic conditions



## Results: WY2005, Feb. 1 SWE observations



## Detour: Headlines from February, 1977

**The Seattle Times**  
 C.I.A. may have paid other leaders  
 Soccer 93  
 Nets 88  
 Stanford 74  
 Huskies 69

**The Seattle Times**  
 Snow 'unbares' ski slopes  
 Dons 112, Chief  
 Celtics 102, Sonic  
 \$30 million I  
 due for Seat

**Straub declares state drought 'critical'**

**The Oregonian**  
 Forecast: Fair;  
 high, 40; low, 35;  
 report on Page B19

**The Seattle Times**  
 'Won't end drought'  
 Normal weather expected

**Farmers thirst for drought end**

**Uhlman says conserve now or pay later**

**Angry judge c  
 delayed drug**

**Parents, student  
 to attend magne  
 meeting in Dall**

# Detour: Headlines from February, 1977

**Drought relief**  
**Cloud-seeding measure passed**

**B.C. to release water to U.S.**

**second front page** **The Seattle Times**

**Governors seek federal funds for drought aid**

**Vance ends Midwest tour**

**O'Neill defends Congress pay raise**

**Vikings' Williams scores 71 in win; see Sports Section**

**The Oregonian**

**Dry weather causes aluminum layoffs**

**Engineers hold back river flow**

**Willamette River flow may hit 100-year low**

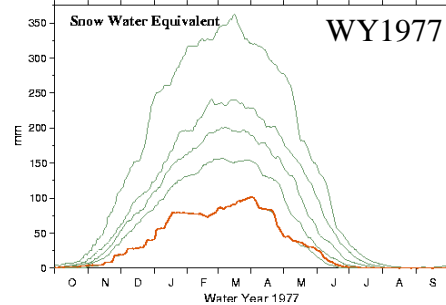
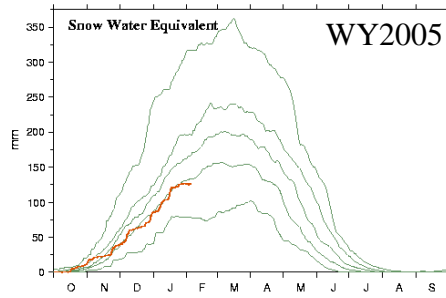
**Oakland area on rations**

**New water cutbacks ordered**

## Results: WY2005 vs. WY1977 SWE

How does the PNW current year compare to the worst in the last 50 years?

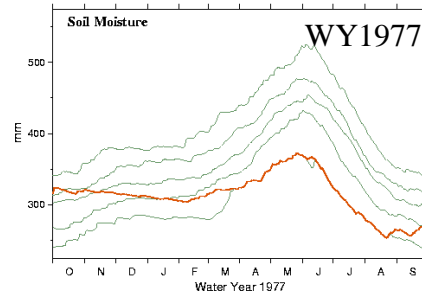
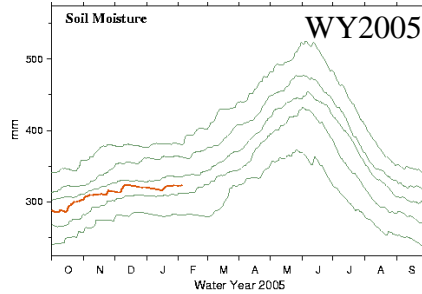
Columbia R. basin upstream of The Dalles, OR



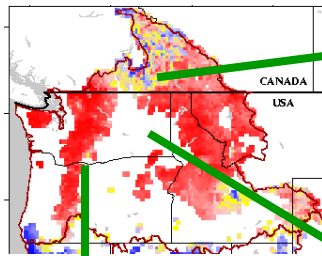
## Results: WY2005 vs. WY1977 Soil Moisture

How does the PNW current year compare to the worst in the last 50 years?

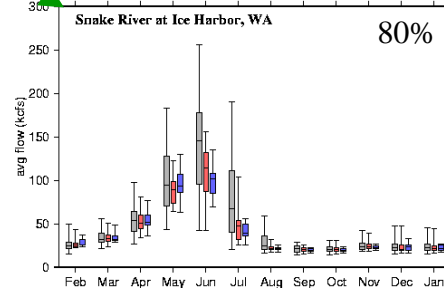
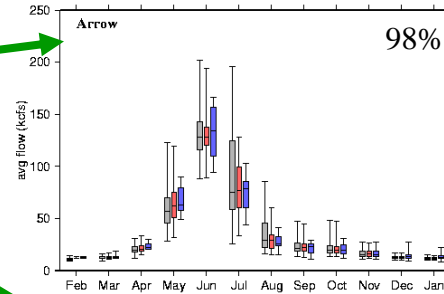
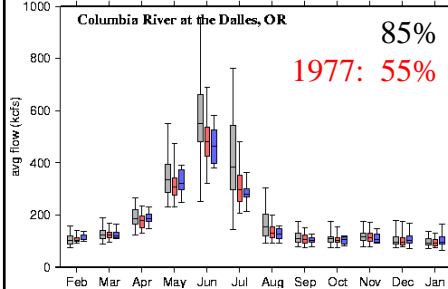
Columbia R. basin  
upstream of The Dalles, OR



## Results: WY2005, Feb. 1 streamflow forecasts



■ climatology   
 ■ ESP forecast   
 ■ CPC forecast



## Future Directions

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- Move from monthly to weekly forecast updates
- Incorporate other hydrologic models
- Add more flow forecast points, particularly west of the Cascades
- Work with NRCS on their current exploration of model-based forecasting
- Improve use of satellite imagery, particularly for snow covered area

## Questions?

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website:

[www.hydro.washington.edu / Lettenmaier / Projects / fcst /](http://www.hydro.washington.edu/Lettenmaier/Projects/fcst/)

