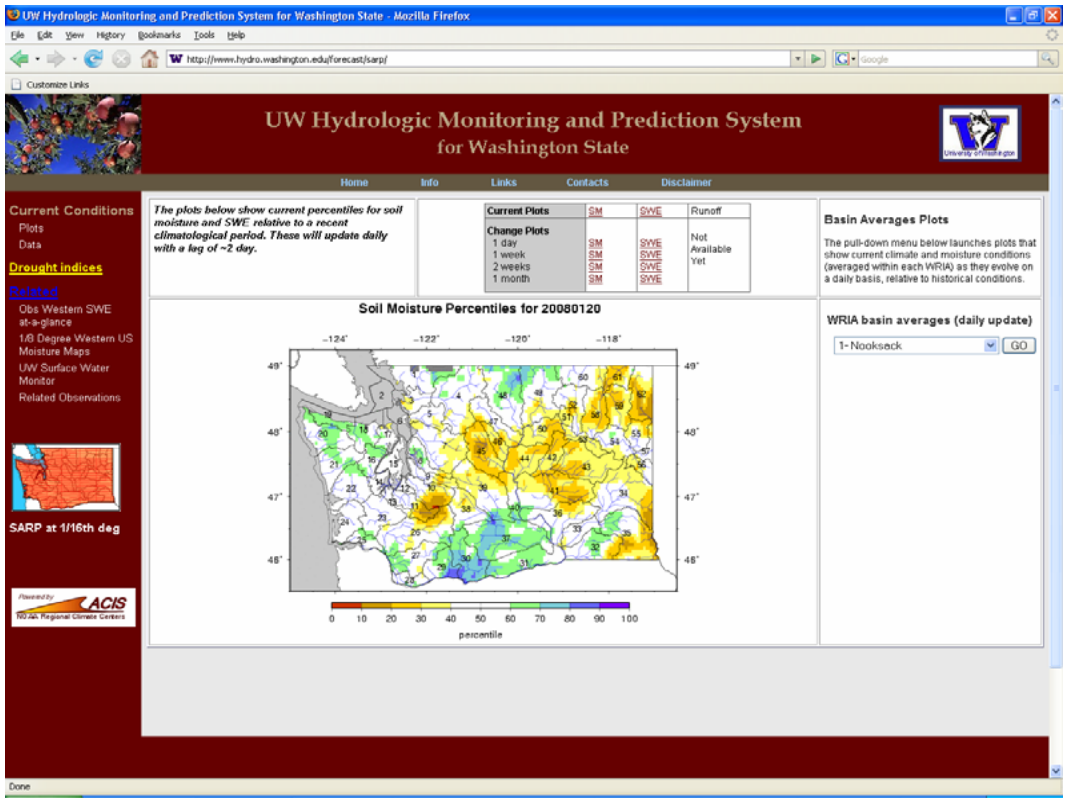
Application of A Land Surface Model For Drought Monitoring And Prediction In Washington State



Shraddhanand Shukla

Andrew W. Wood

University of Washington, Dept. of Civil and Environmental Engineering

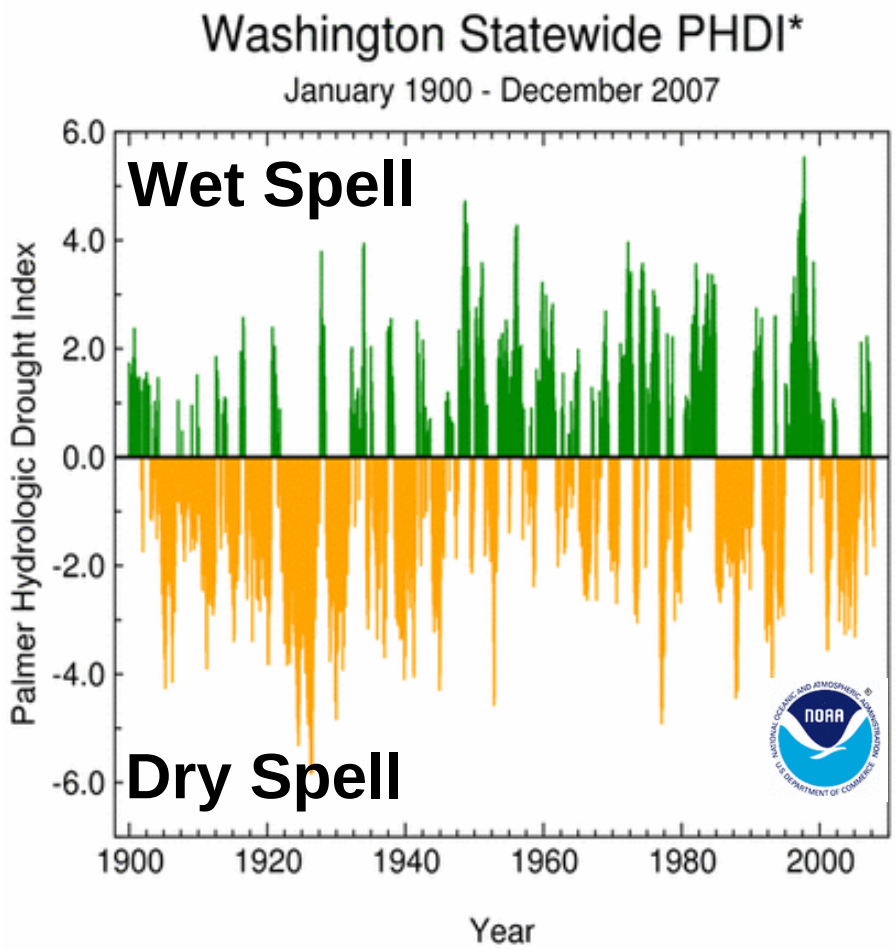
Water Center Annual Review of Research, Seattle, February 14, 2008

Outline

- Introduction
- Issues
- Methodology
- UW Hydrologic Monitoring System
- Performance Evaluation
- Summary and Future work

Drought: The Creeping Disaster

- 20 major drought events since 1900
- $400 million lost in 2001 and $300 million lost in 2005, mostly in the agricultural sector



Motivation:

Provide objective measures of climate and hydrology to help characterize and predict drought in Washington State.

ISSUES

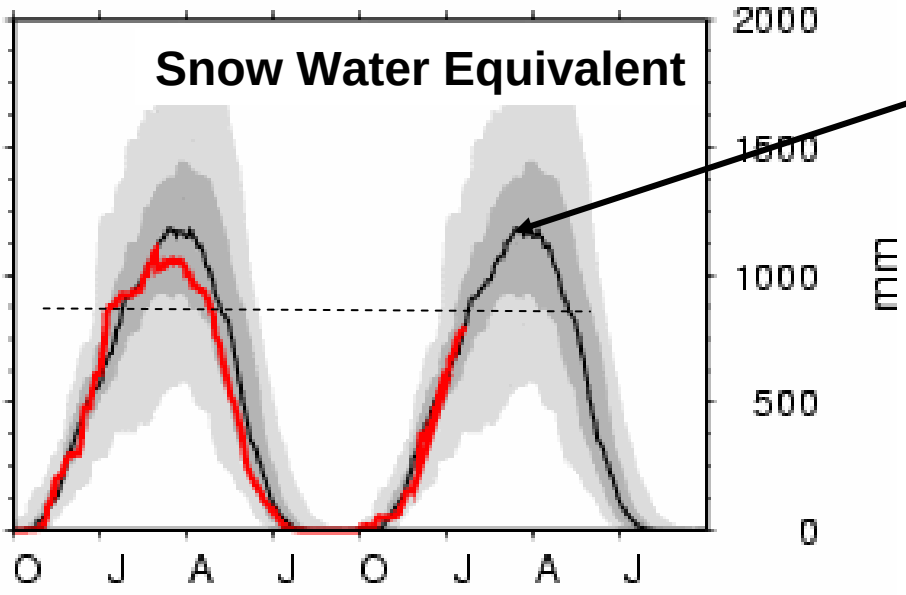
Drought Declaration Policy

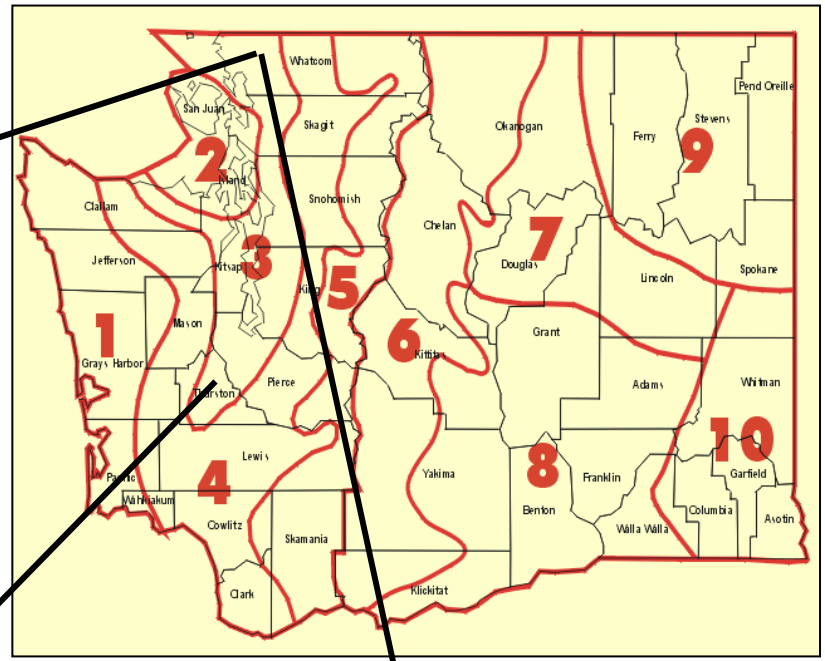
Current WA State policy defines drought as occurring when

"**water supply falls below 75% of normal**" (**CHAPTER 173–166 WAC)**

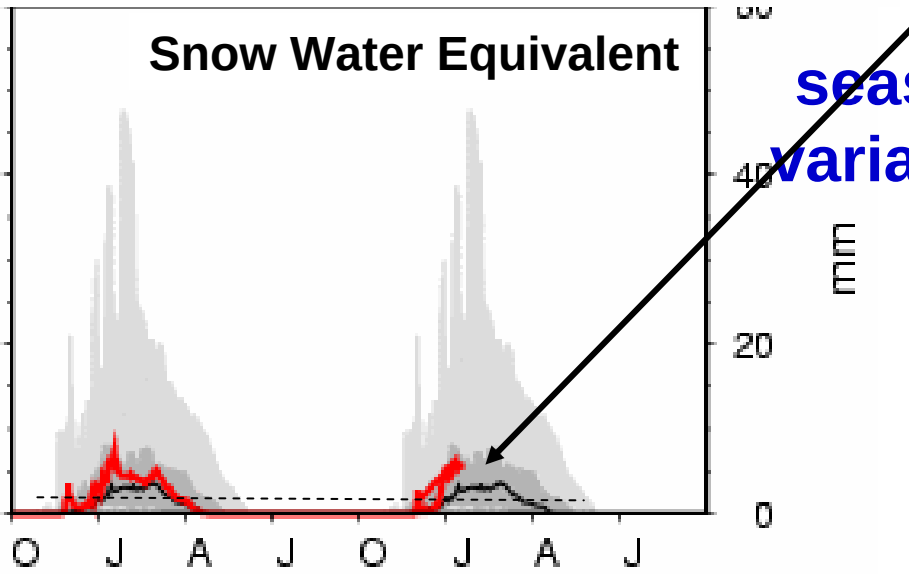
Drought: The 75% Rule

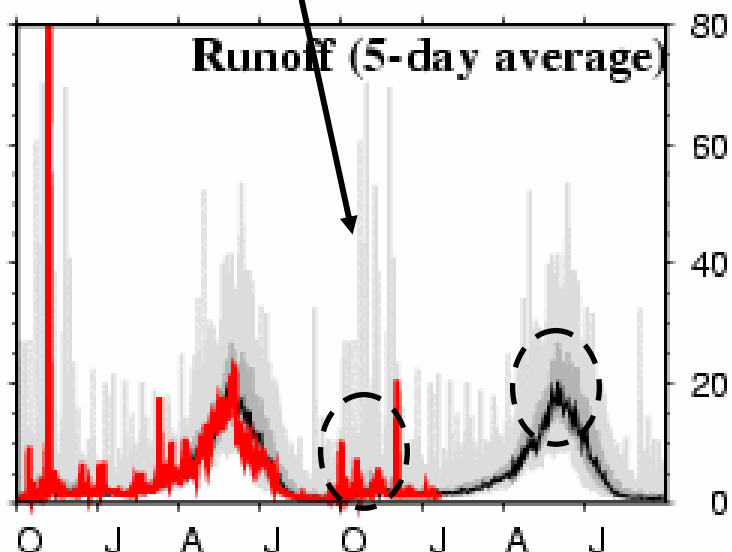
spatial variability





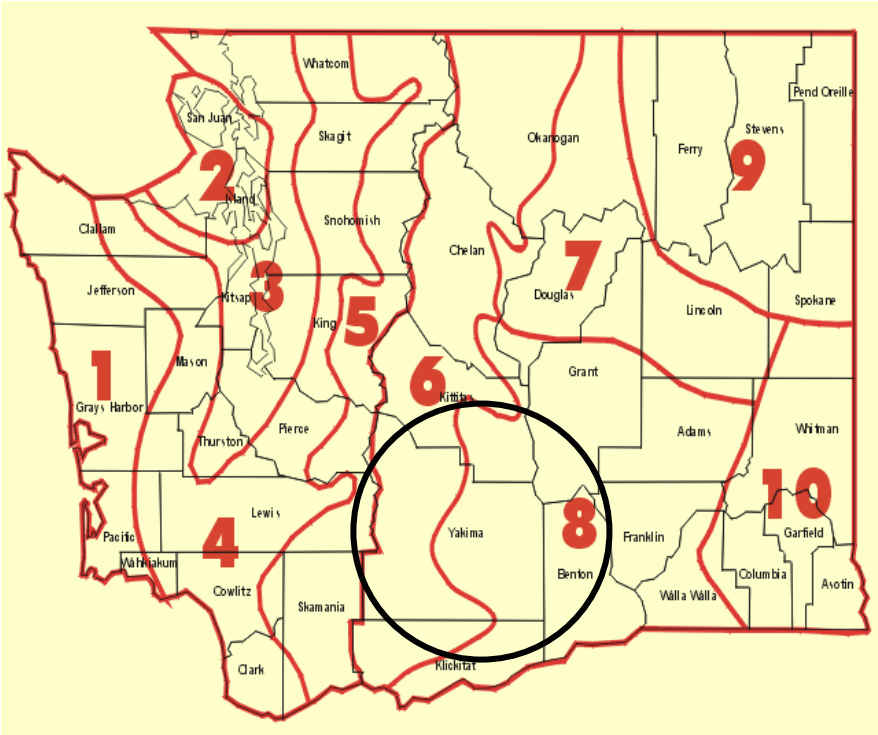
seasonal variability

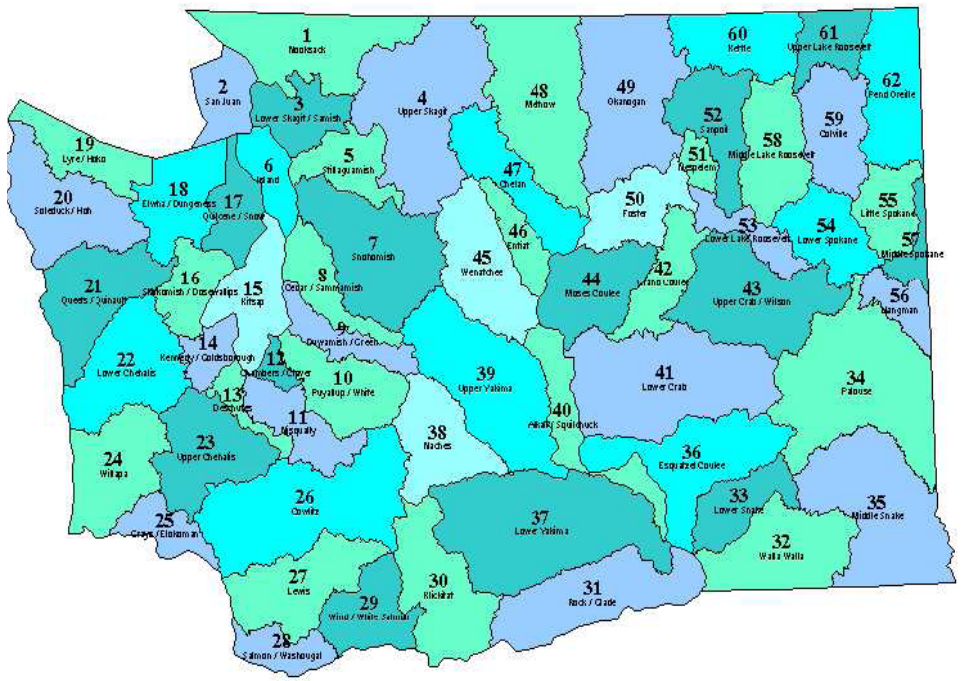




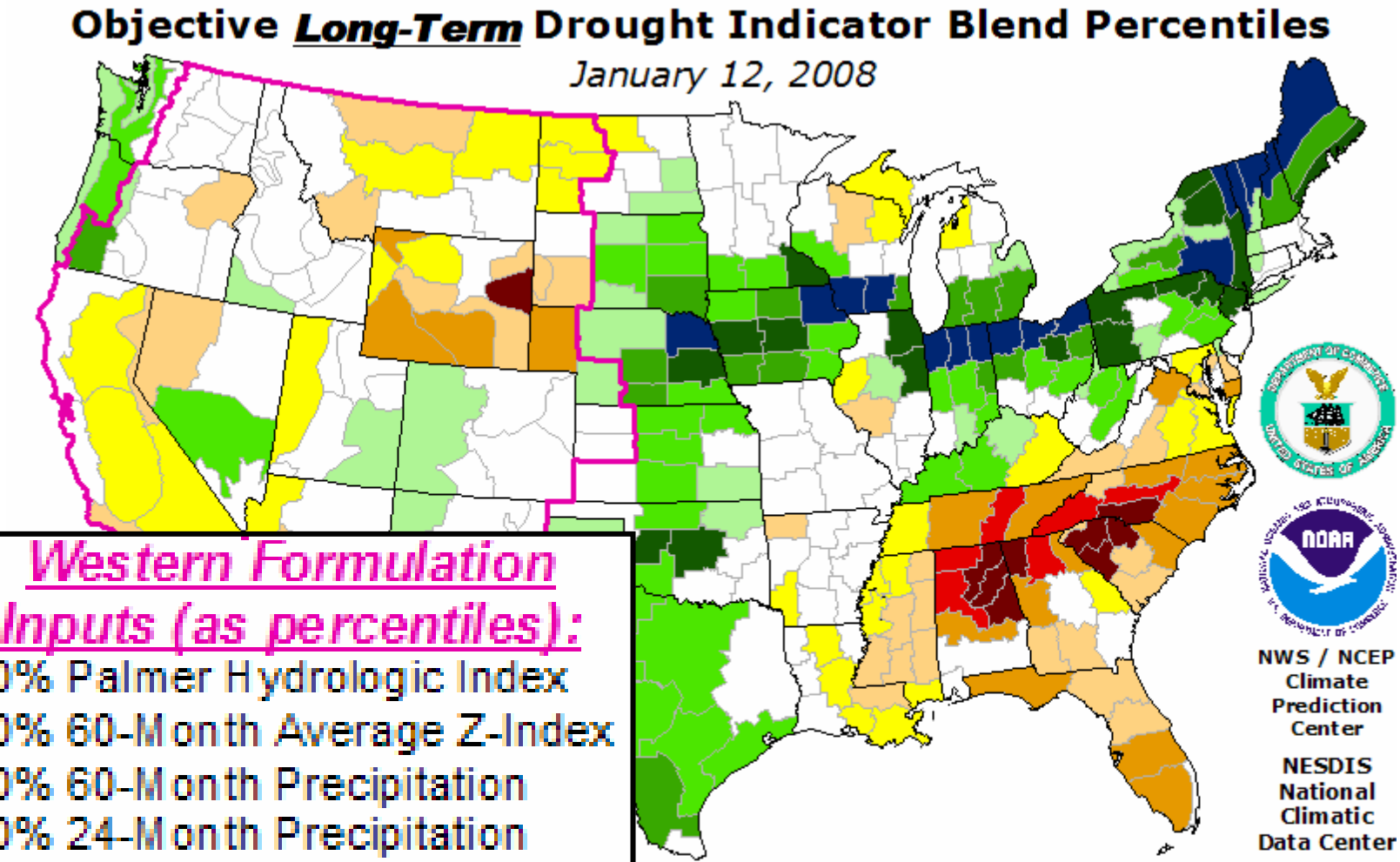
Current Drought Assessment: Coarse Spatial Scales

10 Climate Divisions *vs* **62 Water Resources Inventory Areas (WRIAs)**





Current Drought Assessment: Large Weight to Traditional Drought Indices



15% 6-Month Precipitation
10% 60-Month Precipitation
10% CPC Soil Moisture Model
10% 24-Month Precipitation
10% 12-Month Precipitation
10% CPC Soil Moisture Model

- Drought Severity depends on
  - ❑ **Precipitation**
  - ❑ **Temperature**
  - ❑ **Hydrological condition**
  - ❑ **Socio-Economic Condition**

Hydrologic Model-Based Indices

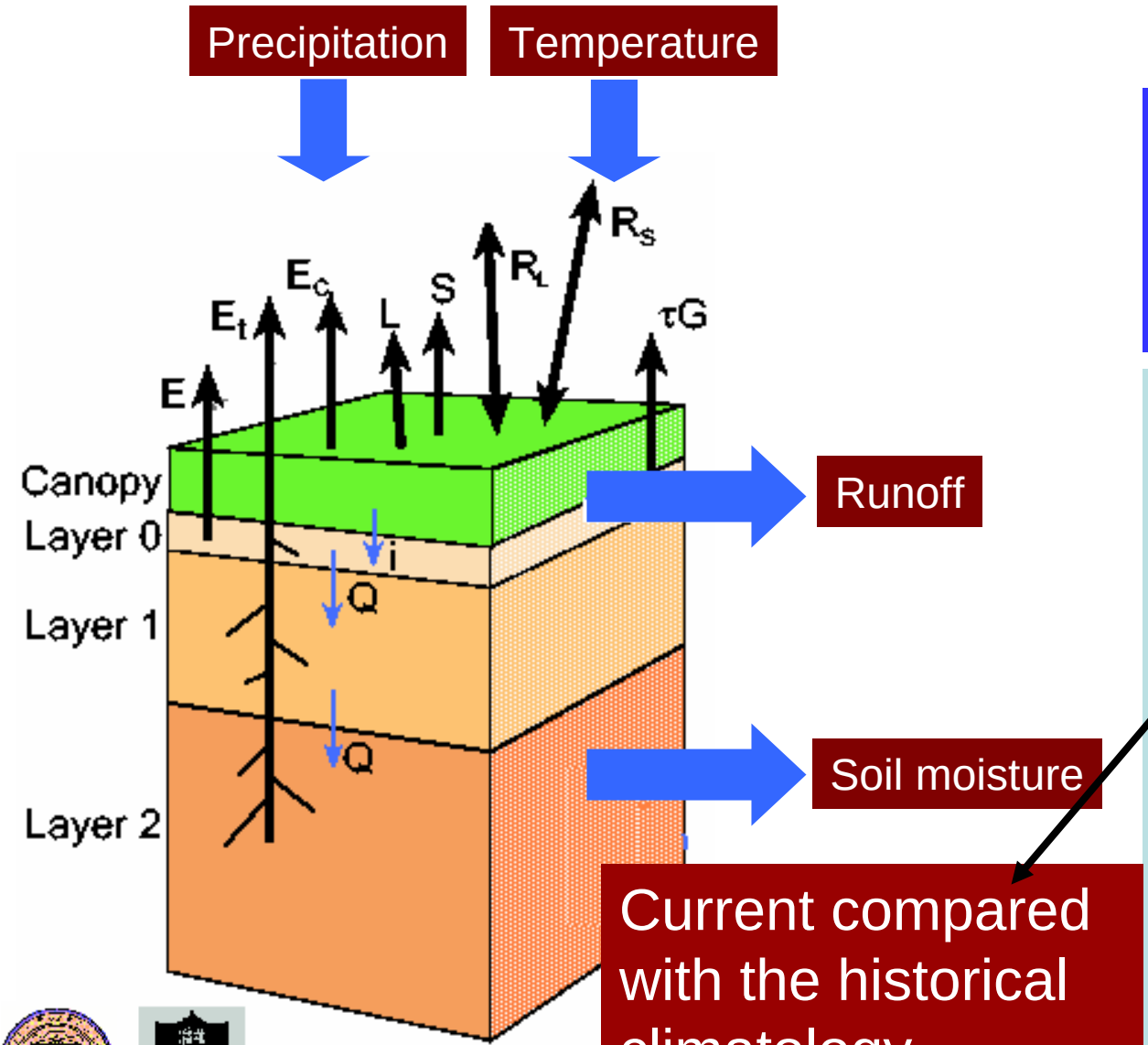
✓ **Complex Water Balance Model**

X **Simplified Water Balance Model**

✓ **Cold Season Process**

Methodology

Variable Infiltration Capacity (VIC) Model



Current compared with the historical climatology (1915-2005)

Hydrologic Model Based Indices

- **Soil moisture and runoff percentiles** (Scheffield 2004, 2007; Andreadis 2005, 2006)
- **Standardized Runoff Index** (Shukla and Wood, 2008)

UW Hydrologic Monitoring and Prediction System for Washington State - Mozilla Firefox

File Edit View History Bookmarks Tools Help

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

Customize Links

UW Hydrologic Monitoring and Prediction System for Washington State

University of Washington

Home | Info | Links | Contacts | Disclaimer

Current Conditions
- Plots
- Data

Drought indices

Related
- Obs Western SWE at-a-glance
- 1/8 Degree Western US Moisture Maps
- UW Surface Water Monitor
- Related Observations

SARP at 1/16th deg

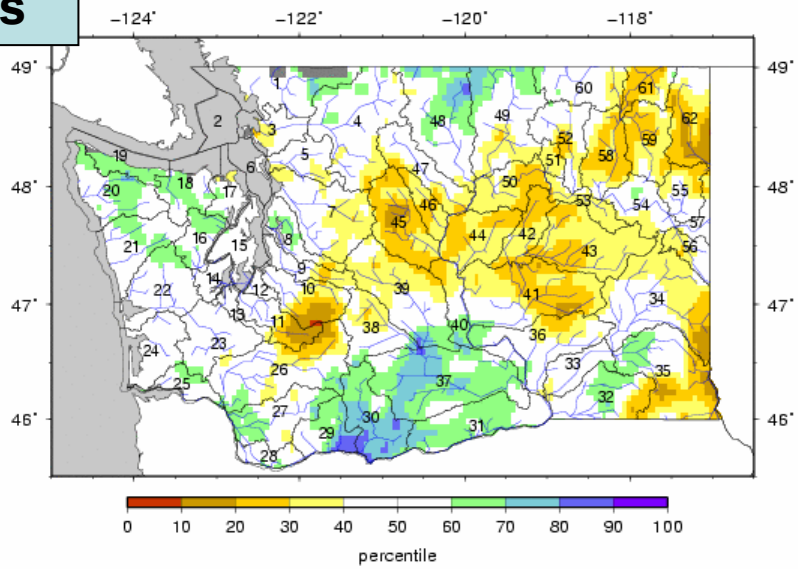
Powered by ACIS NOAA Regional Climate Centers

The plots below show current percentiles for soil moisture and SWE relative to a recent climatological period. These will update daily with a lag of ~2 day.

Current Plots	SM	SWE	Runoff
Change Plots			
1 day	SM	SWE	Not Available Yet
1 week	SM	SWE	
2 weeks	SM	SWE	
1 month	SM	SWE	

Drought Indices

Soil Moisture Percentiles for 20080120



Basin Averages Plots

The pull-down menu below launches plots that show current climate and moisture conditions (averaged within each WRIA) as they evolve on a daily basis, relative to historical conditions.

WRIA basin averages (daily update)

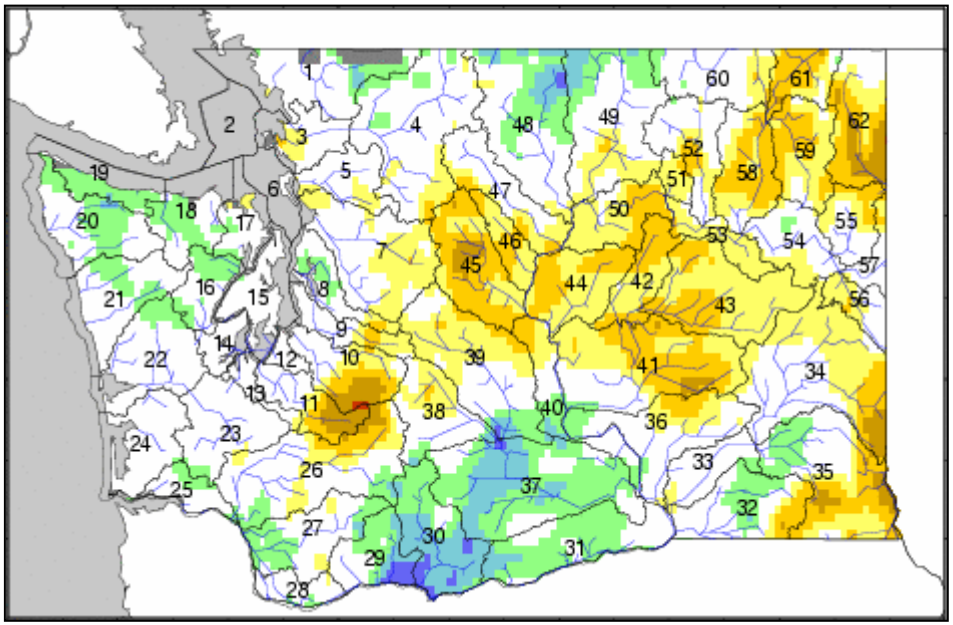
1- Nooksack GO

Real-time Water balance plots

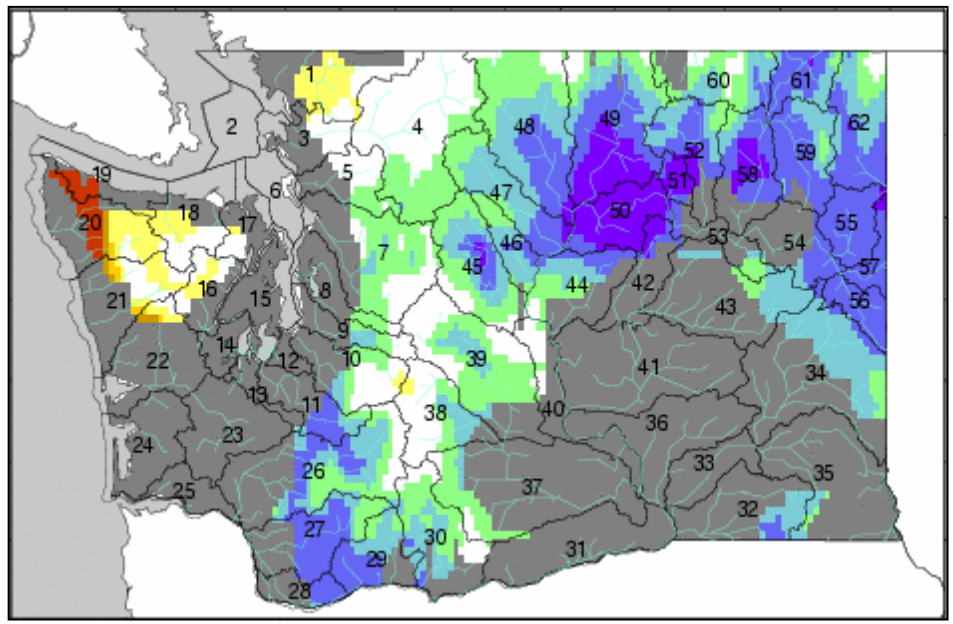
http://www.hydro.washington.edu/forecast/sarp/

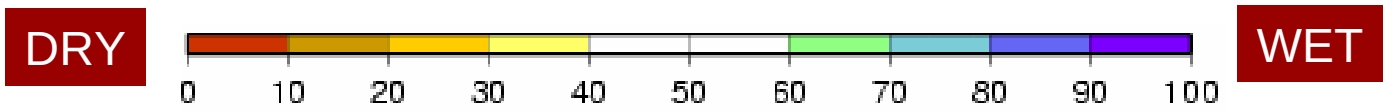
Soil Moisture & SWE Percentile Plots

Soil moisture percentile



Snow Water Equivalent* percentile

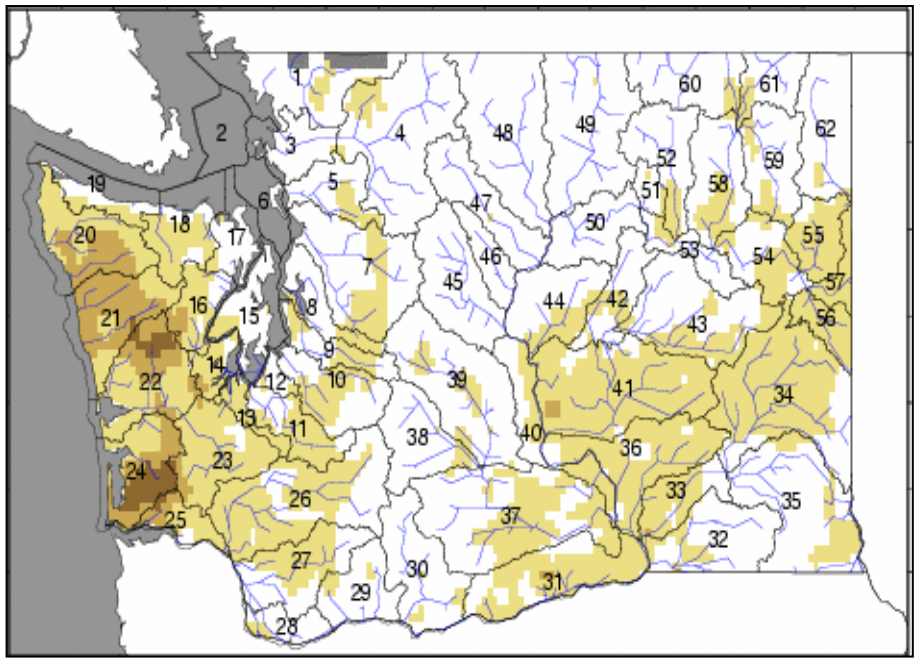




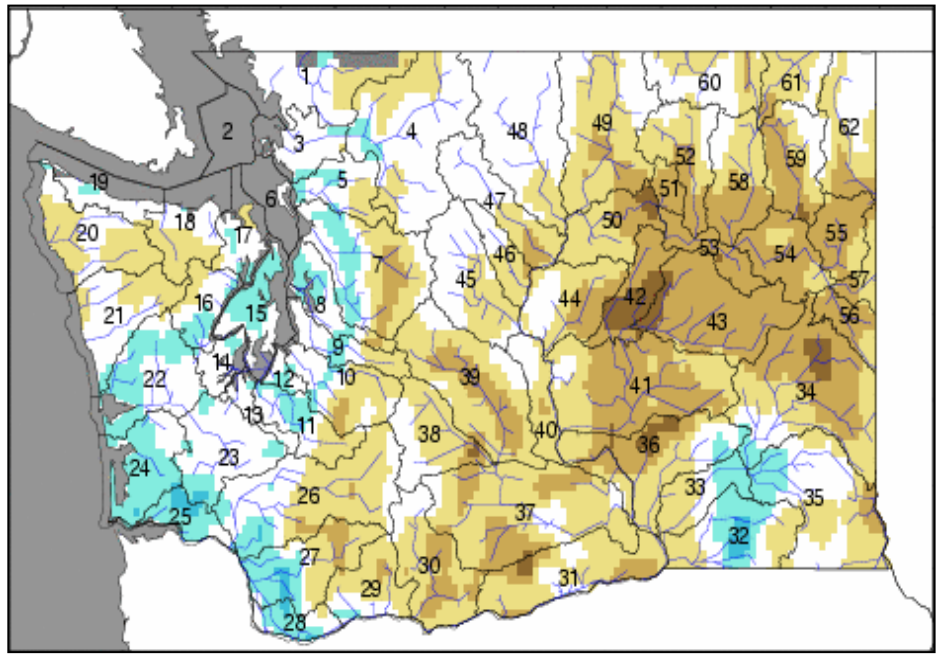
* Amount of water contained in the snowpack

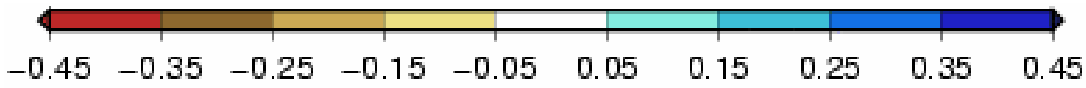
Change Plots

Weekly Changes



Monthly Changes



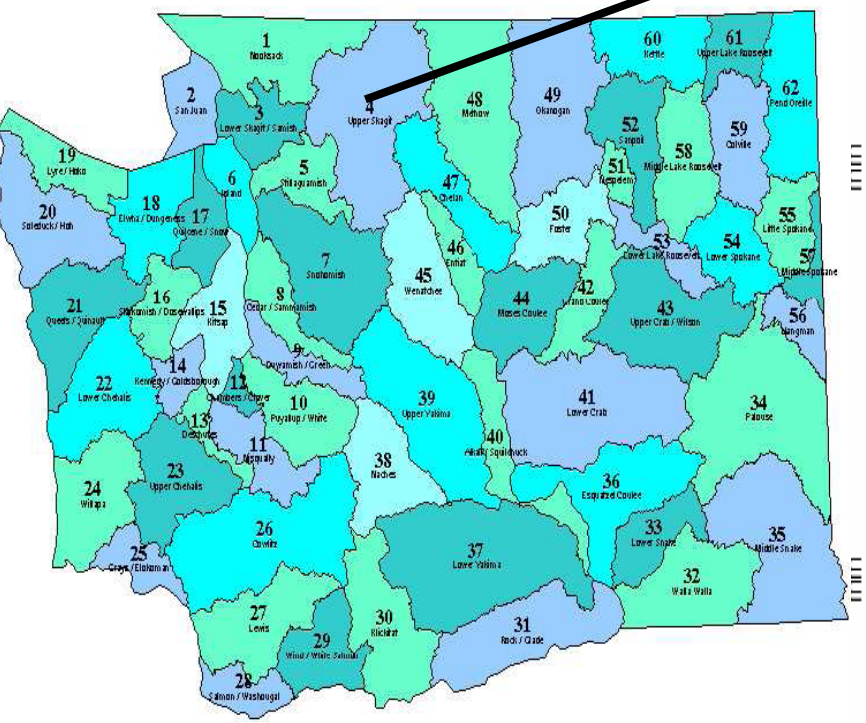


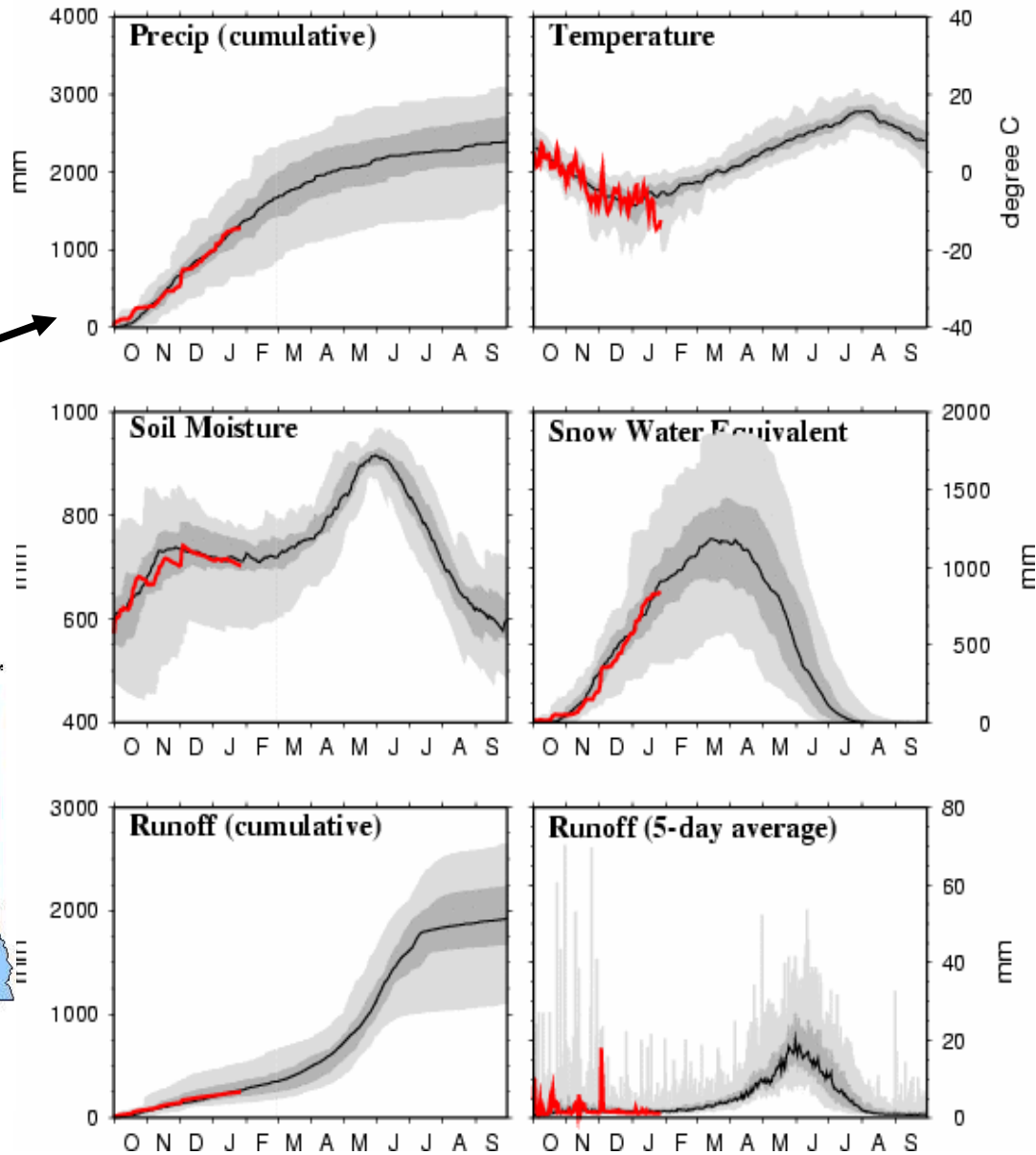
Water Balance Plots

Current conditions and minimum, maximum, and quartiles from 1971-2000

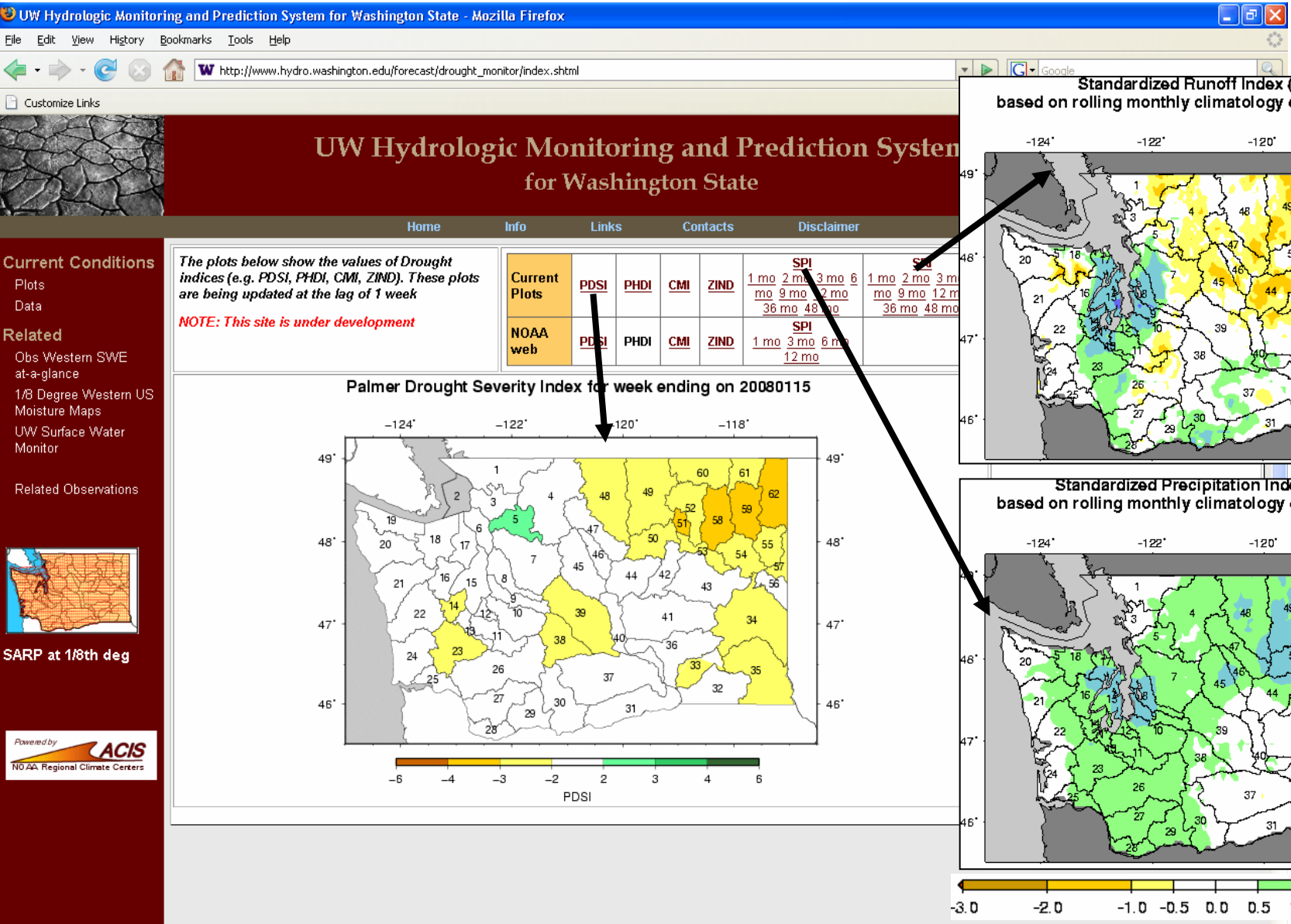
Current Water Year

Long term median





Drought Indices



Performance Evaluation

Statewide 2005 Drought

Local News: Thursday, March 10, 2005

E-mail article Print view

Warning signs point to a wilting summer

By Hal Bernton
Seattle Times staff reporter

ZILLAH, Yakima County — Ric Valicoff and his Yakima Valley neighbors live on the **drought** frontline, reliant on Cascade snowmelt to grow apples, cherries, grapes and other fruit.

This year, the snowpack is a bust, and the bare mountain slopes may offer an unsettling peek into the future.

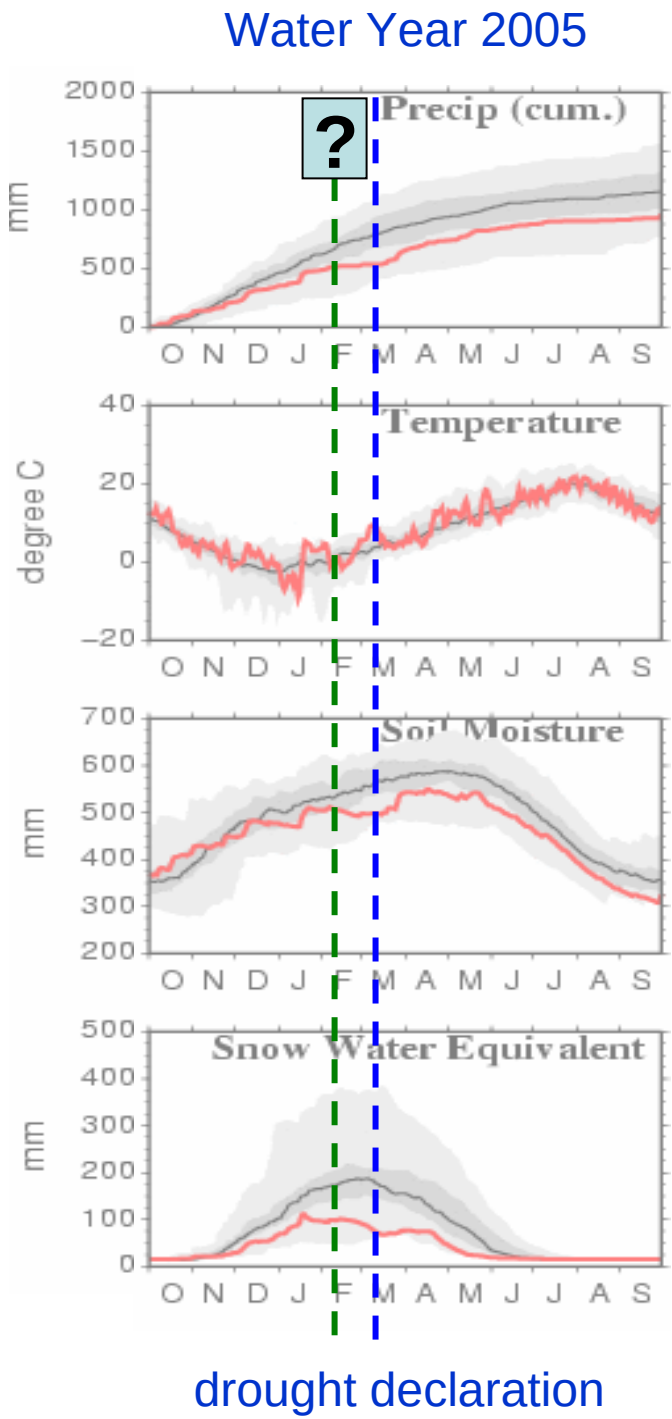
March 10, 2005

Today, Washington Gov. Christine Gregoire declared a statewide **drought** emergency, directing her Emergency **Drought** Committee to gear up an emergency command center, track and coordinate responses by state agencies and make sure state resources reach where they are needed, according to the Associated Press.

2005 Drought: Water Balance analysis

- Snow pack was 26% of average as of April 1st
- Precipitation was between 51 and 76% of average
- Streamflows were between 22 and 90% of average

(Source: WSDA, http://agr.wa.gov/Environment/Drought/)



USDM vs. Soil Moisture-Based Drought Analysis

Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

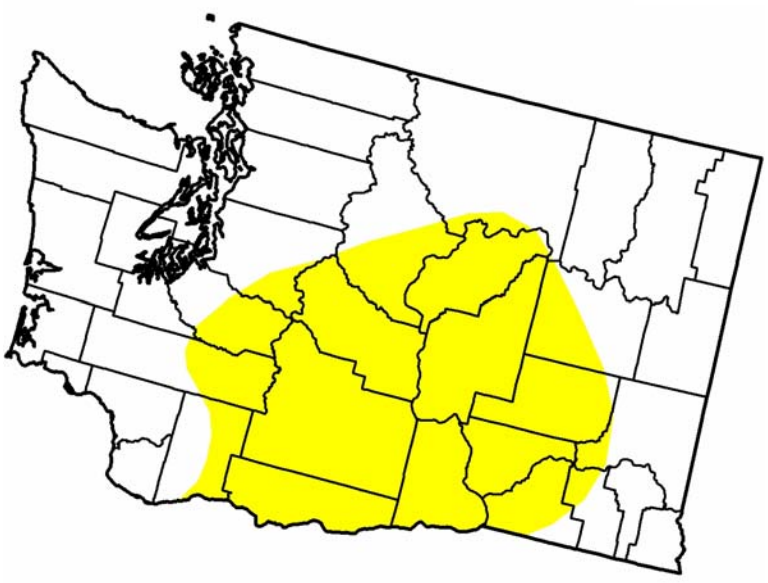
SM percentiles

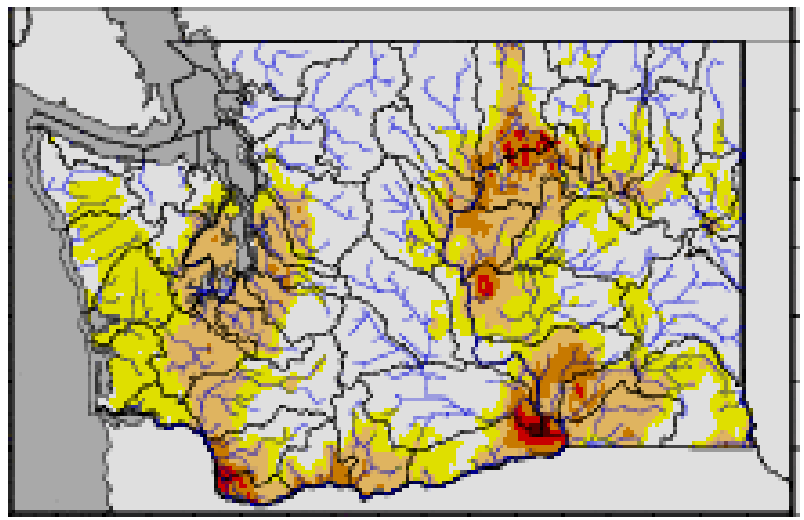
11-20% D1
6-10% D2
3-5% D3
<2% D4

Drought Monitor

Jan-2005

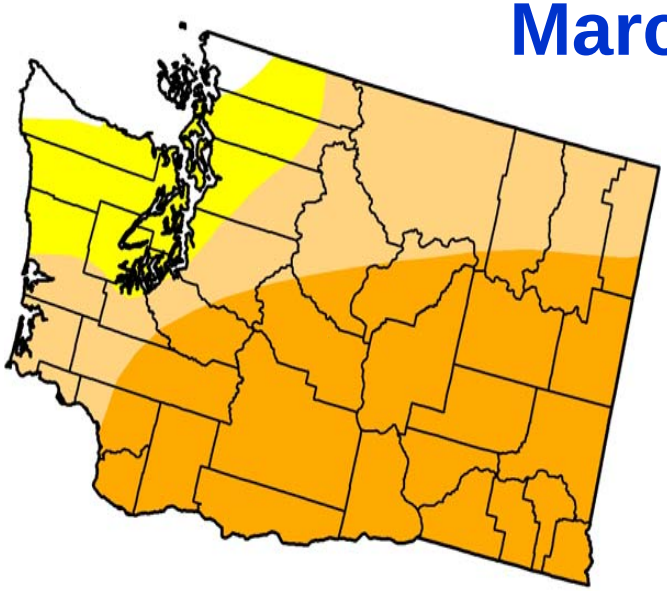
Soil moisture Percentile

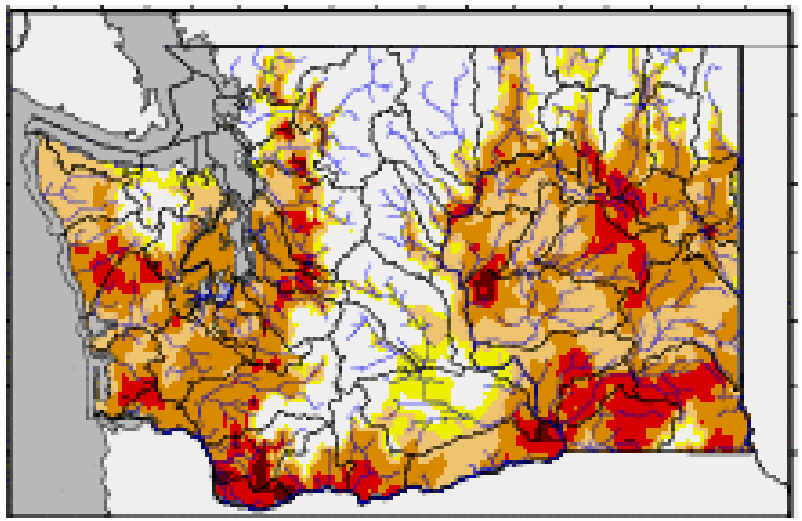




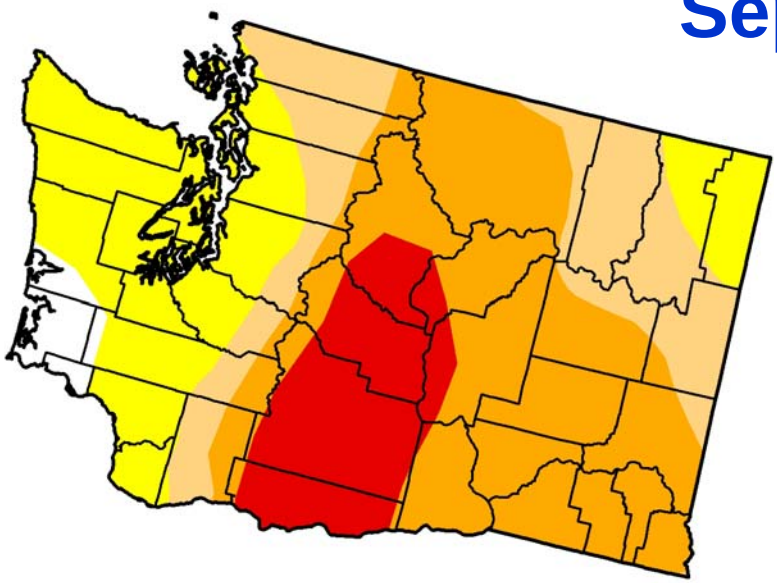
USDM vs. Soil Moisture-Based Drought Analysis

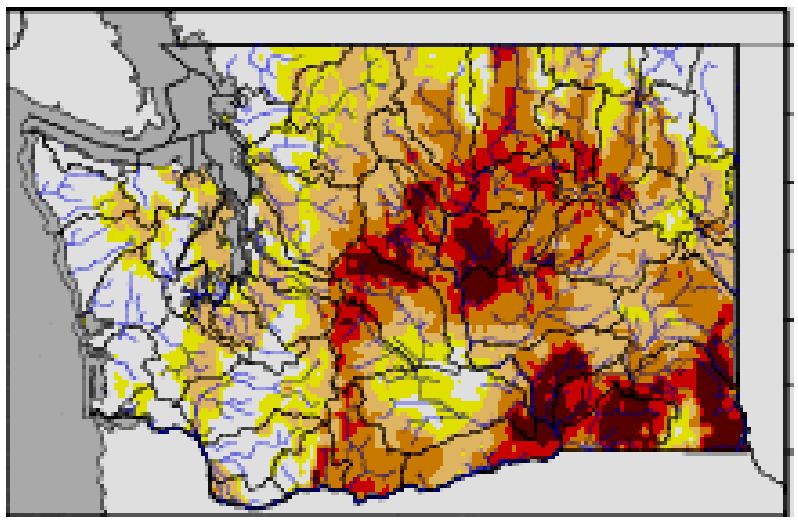
March-2005





Sep-2005

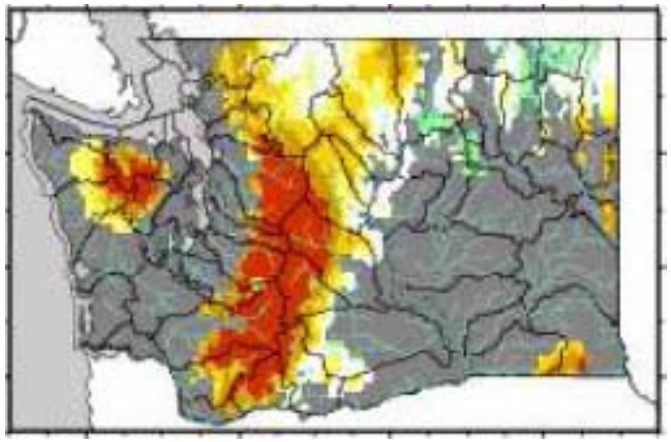


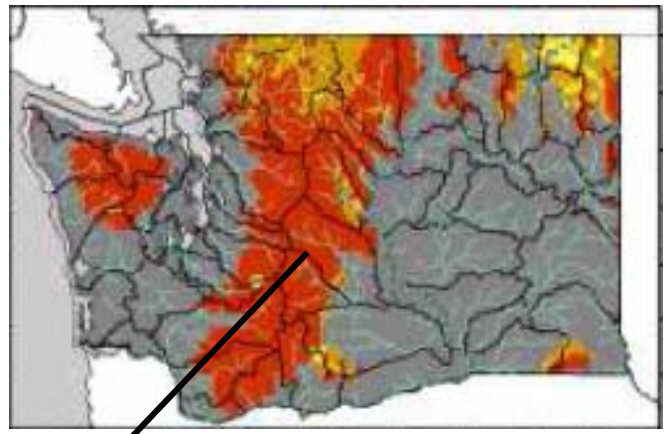


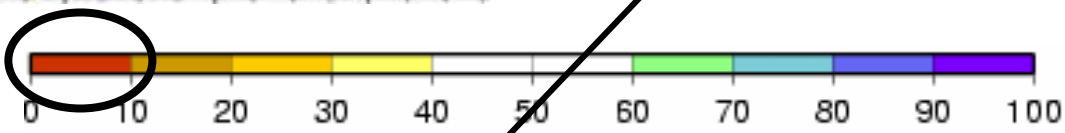
Snow Pack Conditions

Jan-2005

March-2005

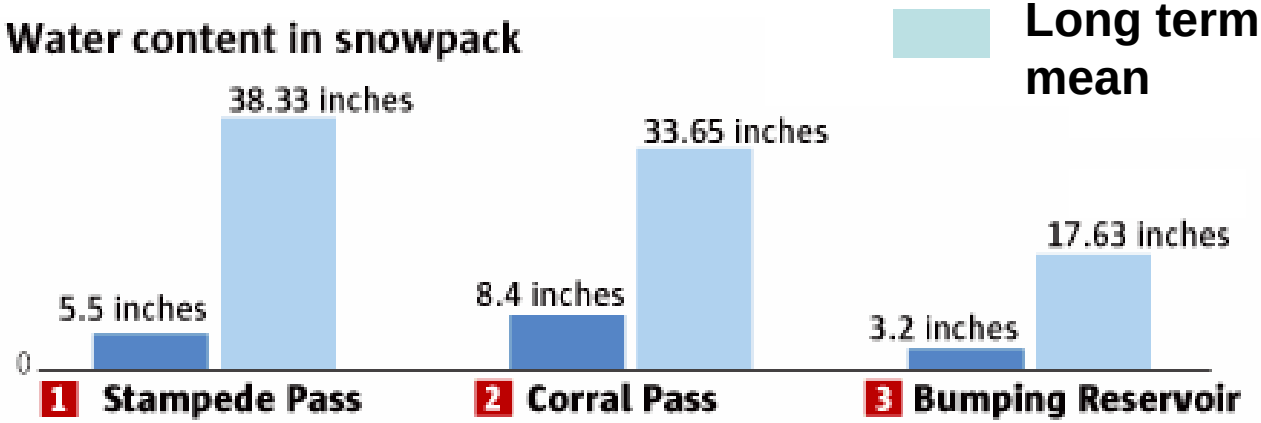






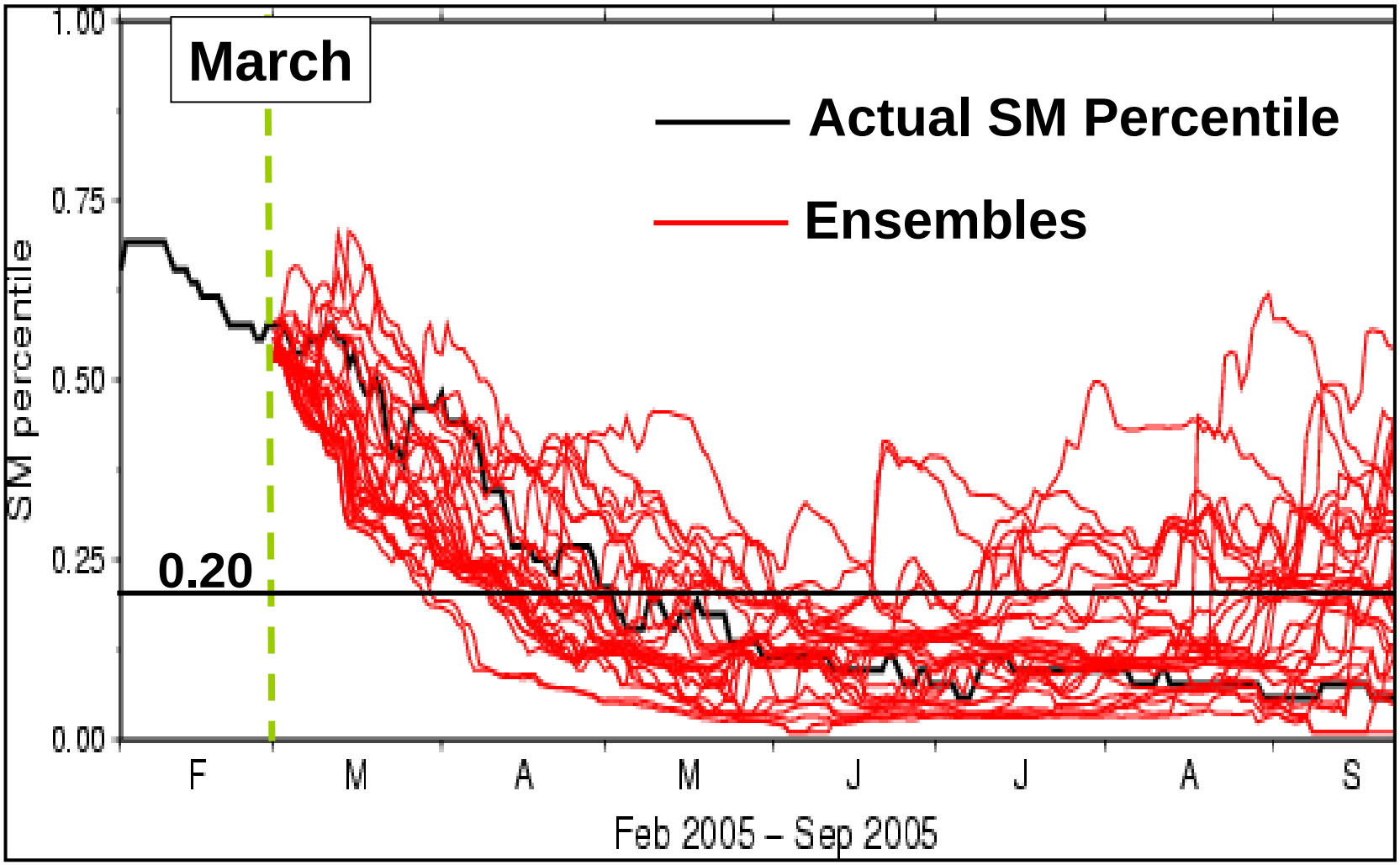
Yakima River Basin

A snow-depth gauge that would normally measure several feet of snow this time of year has no snow to measure at the USBR data collection site



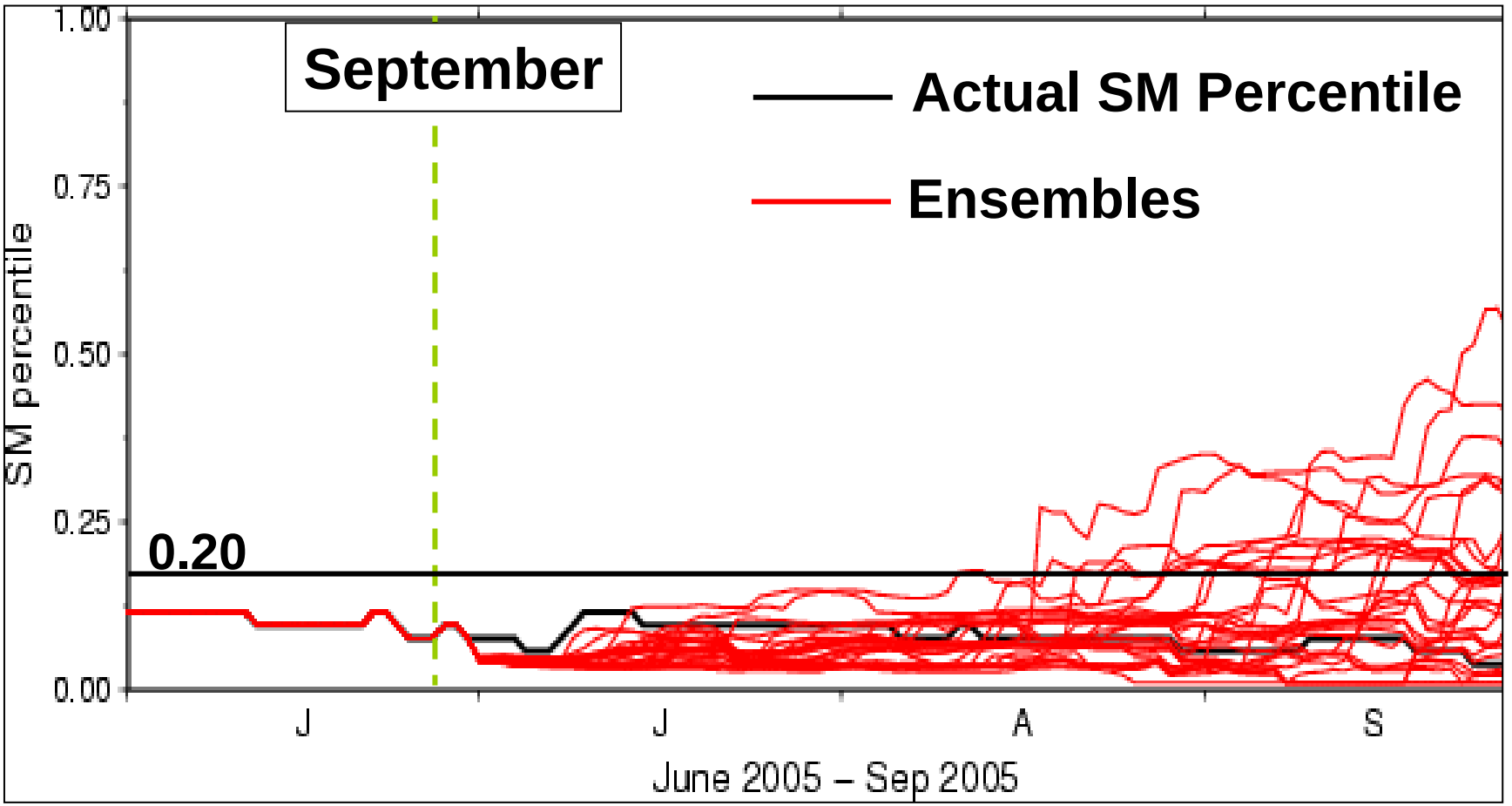
Future Directions: Model-based Outlooks

Soil moisture forecasts



Future Directions: Model-based Outlooks

Soil moisture forecasts



Summary

- The hydrologic model provides useful information for monitoring drought
- It is a potentially viable tool for state-level drought management

Future Work

- Addition of ensemble hydrologic predictions
- Focus on communication of model-based drought information

Acknowledgements

- **Prof. Anne C. Steinemann, Univ of Washington**
- **Julie A. Vano, Univ of Washington**
- **NOAA Sectoral Applications Research Program**

Thank you!

snshukla@u.washington.edu

http://www.hydro.washington.edu/forecast/sarp/index.shtml

18th Annual Review of Research

Application of A Land Surface Model For Drought Monitoring And Prediction In Washington State

Shraddhanand Shukla

Andrew W. Wood

(Department of Civil and Environmental Engineering- University of Washington, Seattle)