Managing Seattle's Water Supply in Context: Weather and Climate

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Seattle Public Utilities supplies more than 1.3 million people with about 50 billion gallons of high quality water each year.

A Conservative Basis for Management

In the course of water management operations and planning
seek to never:

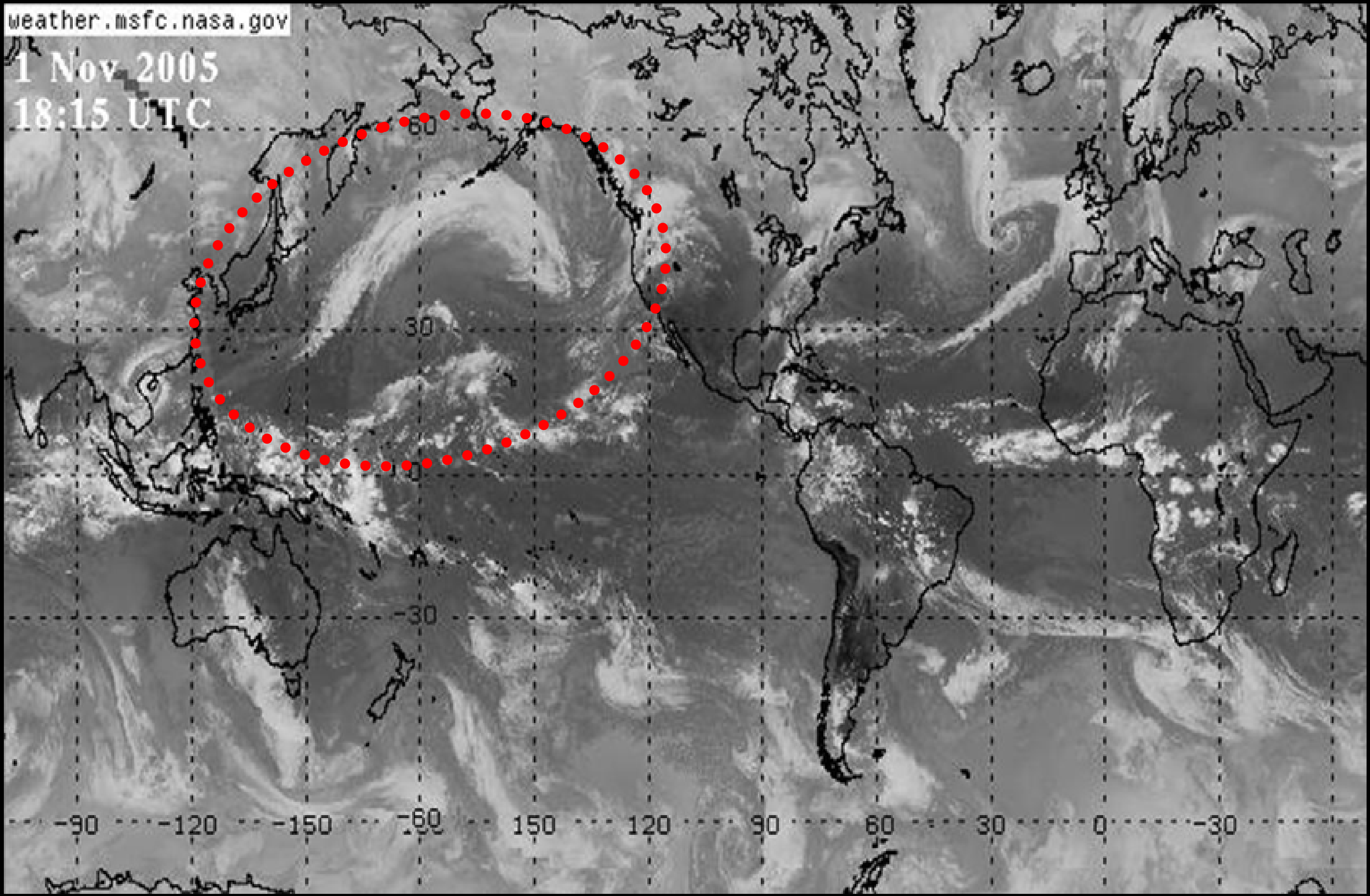
- Incur the loss of life or property
- Interrupt the supply of water
- Deliver poor quality water
- Damage or destroy instream resources

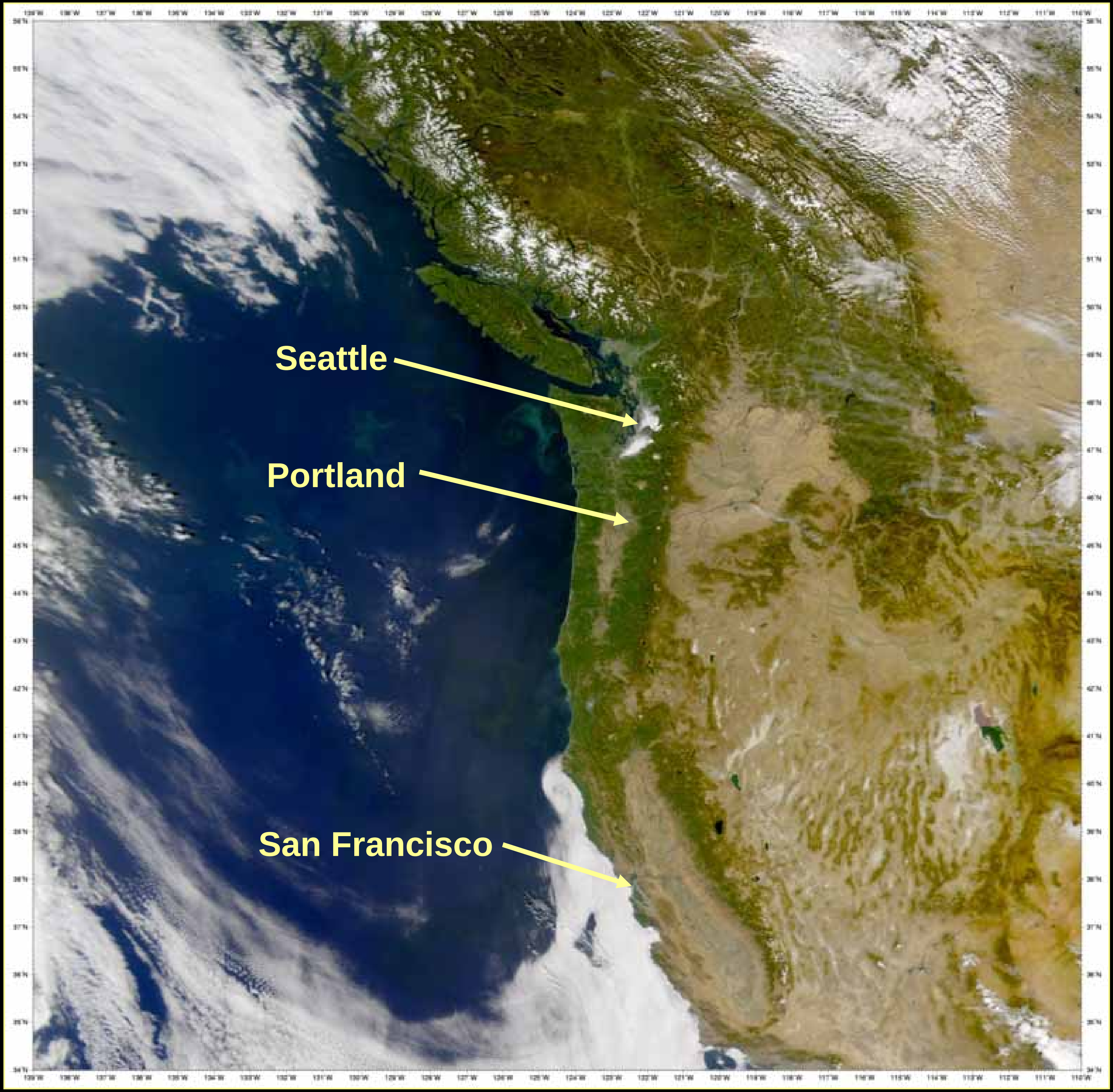
Topics To Consider Here:

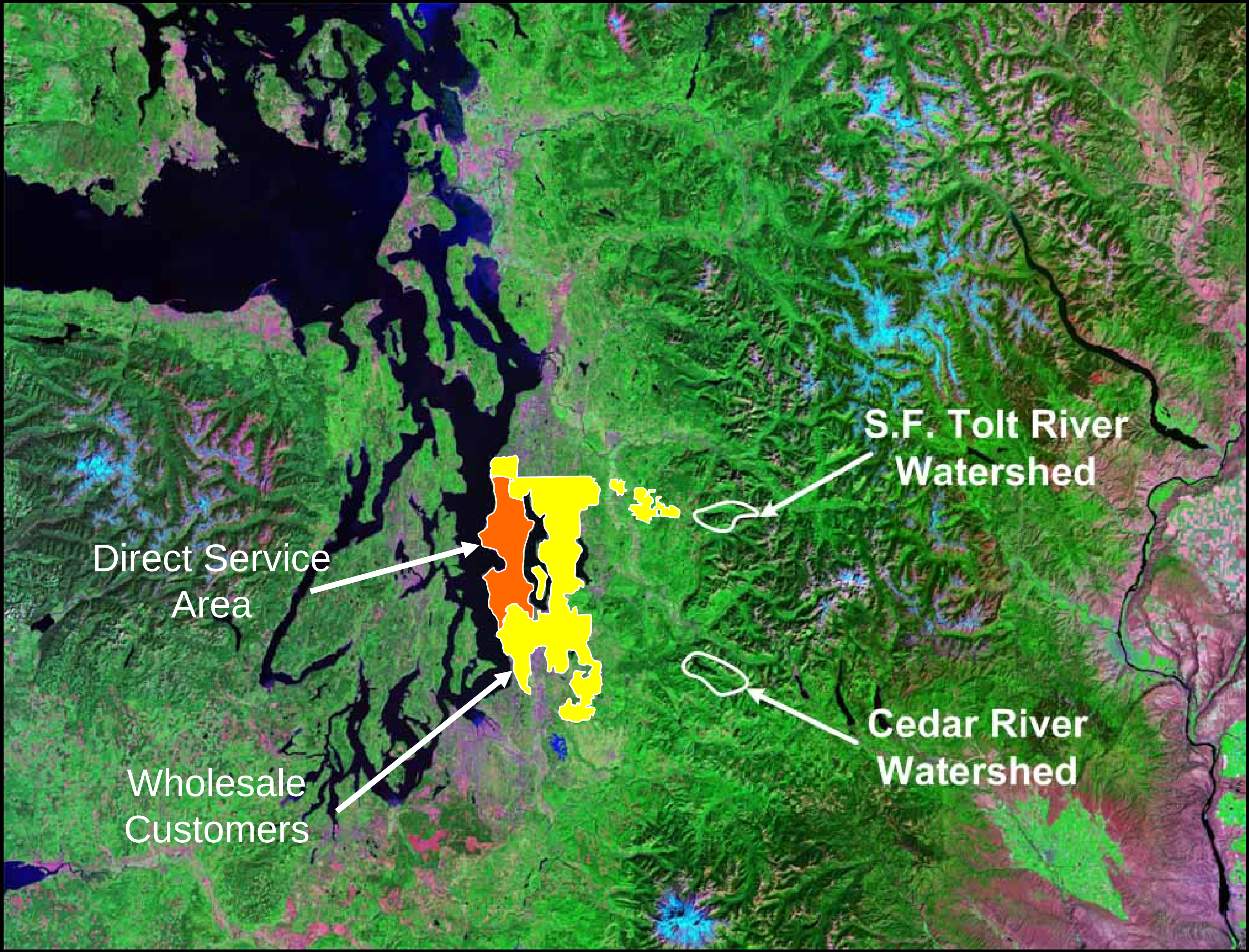
- Physical setting of Seattle within the Pacific Northwest
- Weather and climate forecasting tools we employ
- Water management limitations imposed by outcome versus uncertainty
- Some observations

Physical Setting

A Maritime Focus




Seattle
Portland
San Francisco


S.F. Tolt River Watershed
Direct Service Area
Cedar River Watershed
Wholesale Customers

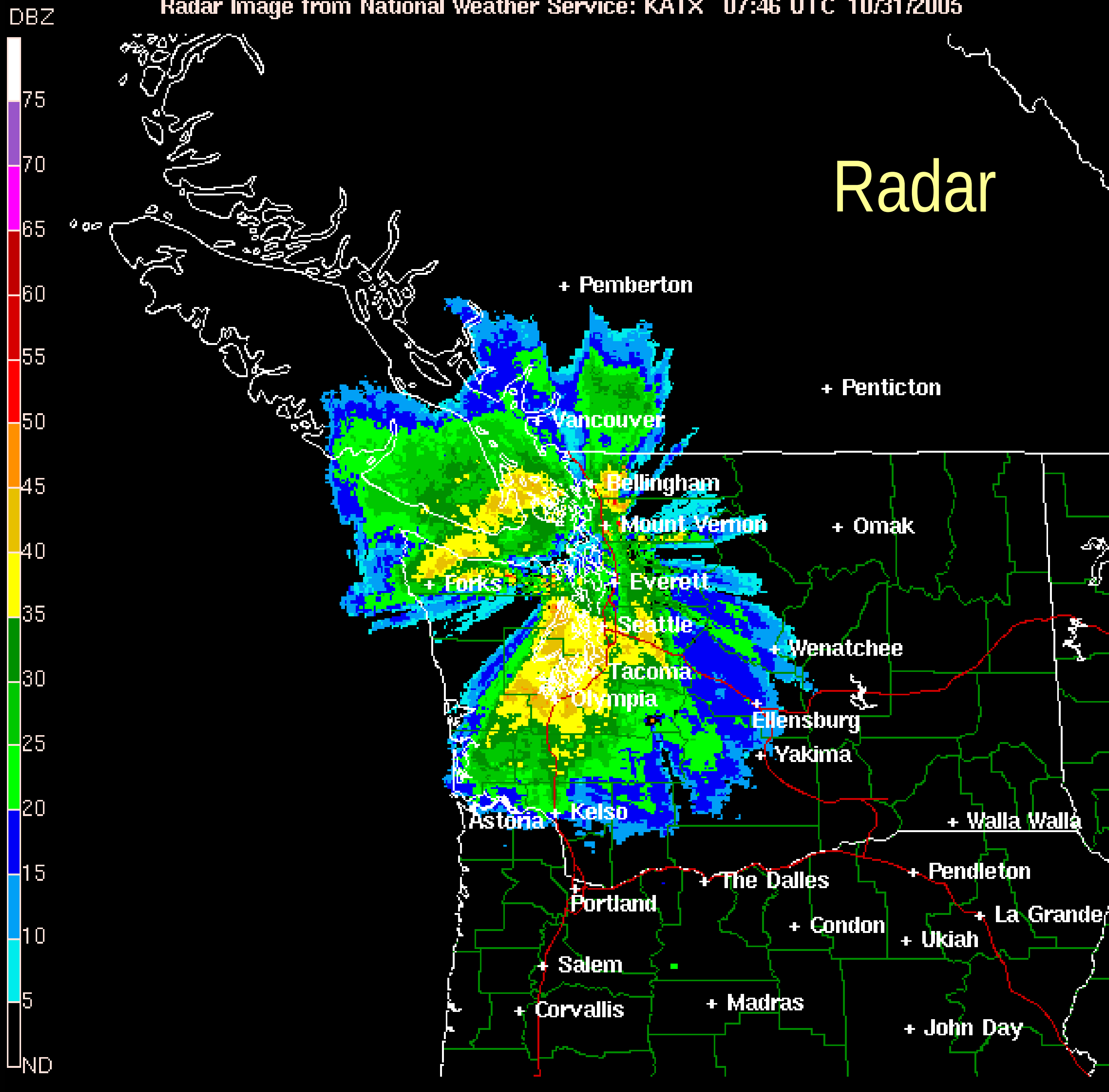
Our Mountain Storage Reservoir Management Objectives

- Water Supply
- Hydropower
- River Flood Management
- Instream Flow Resources

Management Tools:

From Weather to Climate

Remote Sensing


Radar Image from National Weather Service: KATX 07:46 UTC 10/31/2005
Radar
DBZ
75
70
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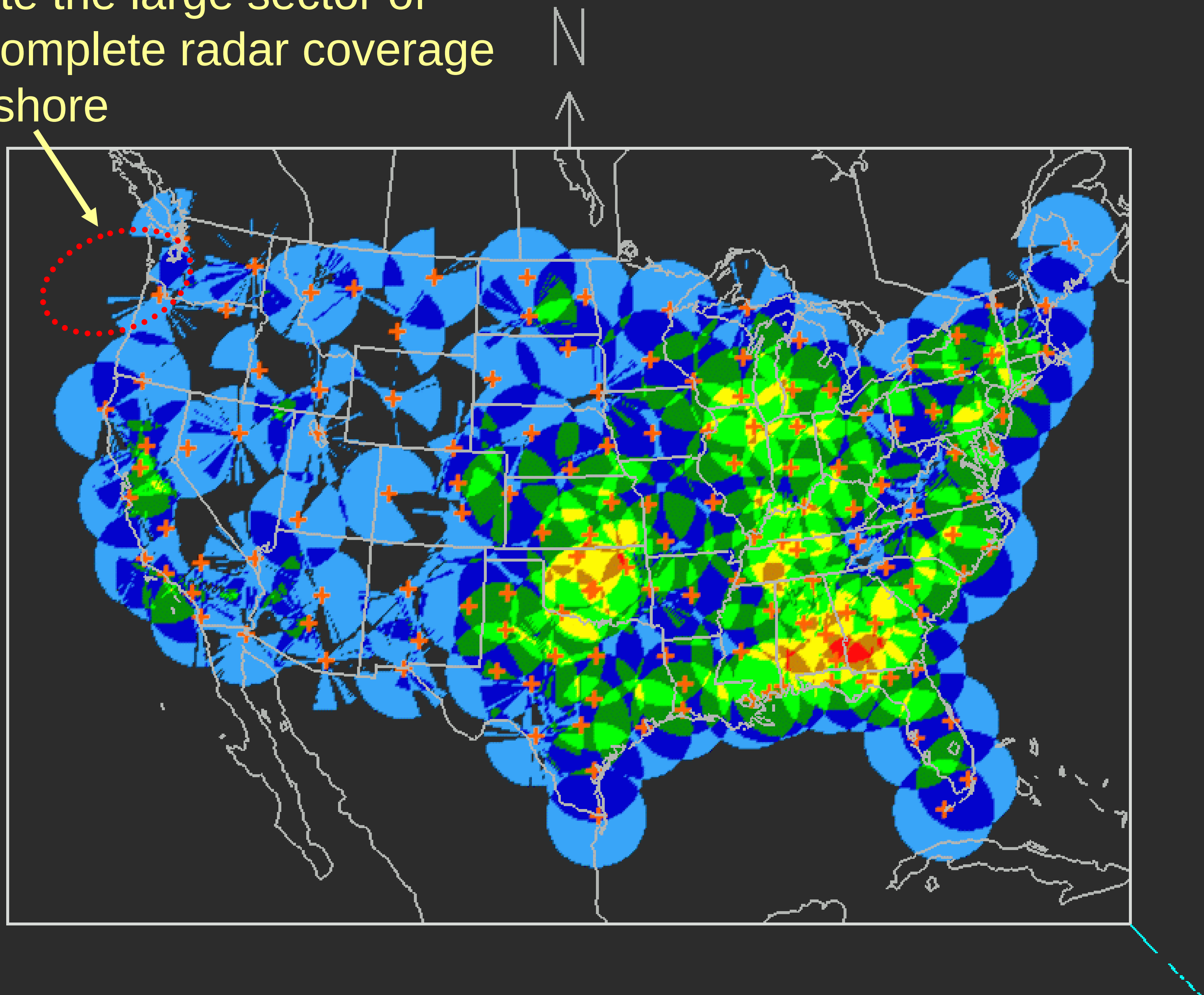
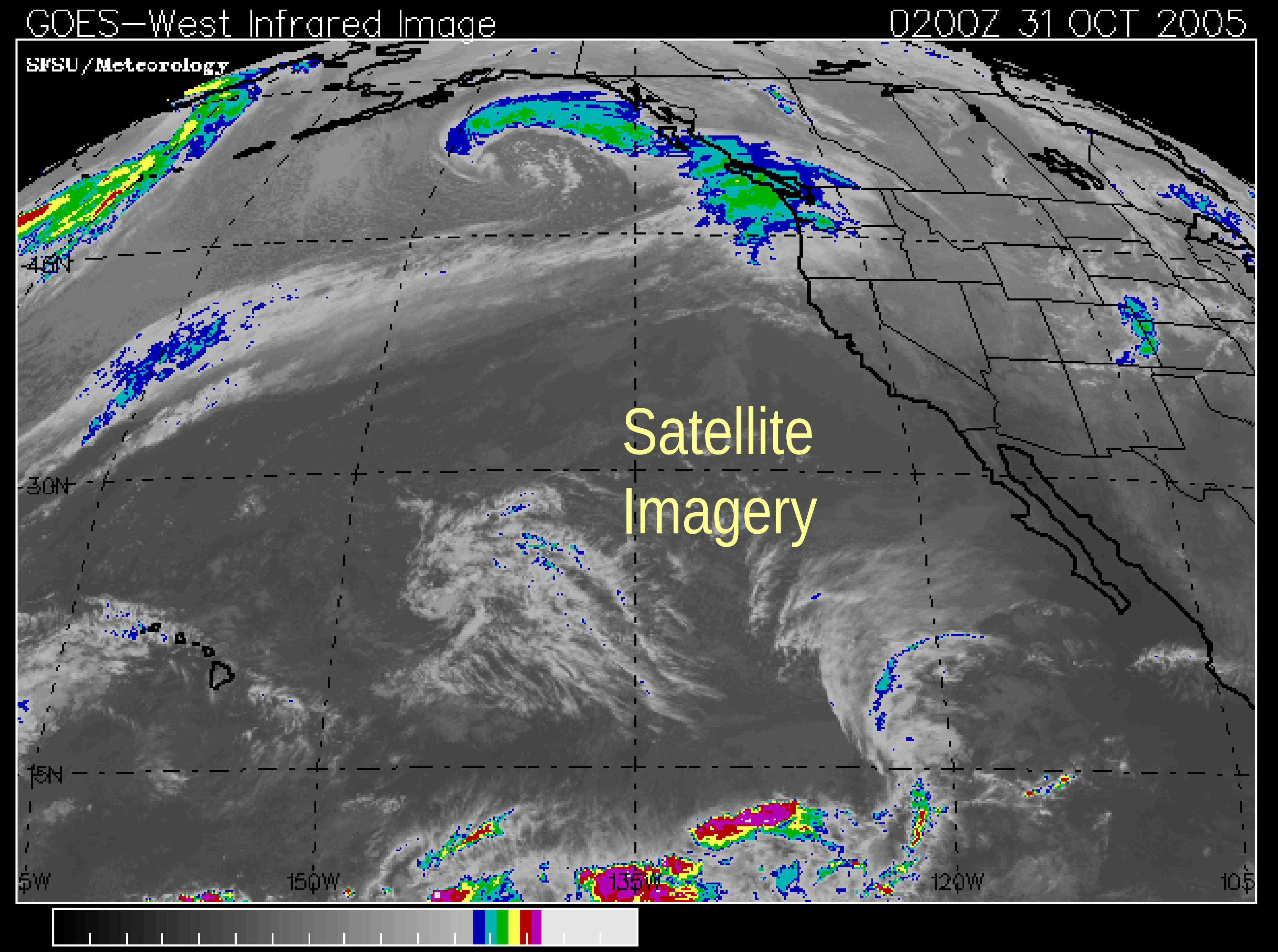
ND
Pemberton
Penticton
Vancouver
Bellingham
Mount Vernon
Omak
Forks
Everett
Seattle
Wenatchee
Tacoma
Olympia
Ellensburg
Yakima
Walla Walla
Astoria
Kelso
Pendleton
The Dalles
Portland
Condon
La Grande
Ukiah
Salem
Madras
Corvallis
John Day

Note the large sector of incomplete radar coverage offshore

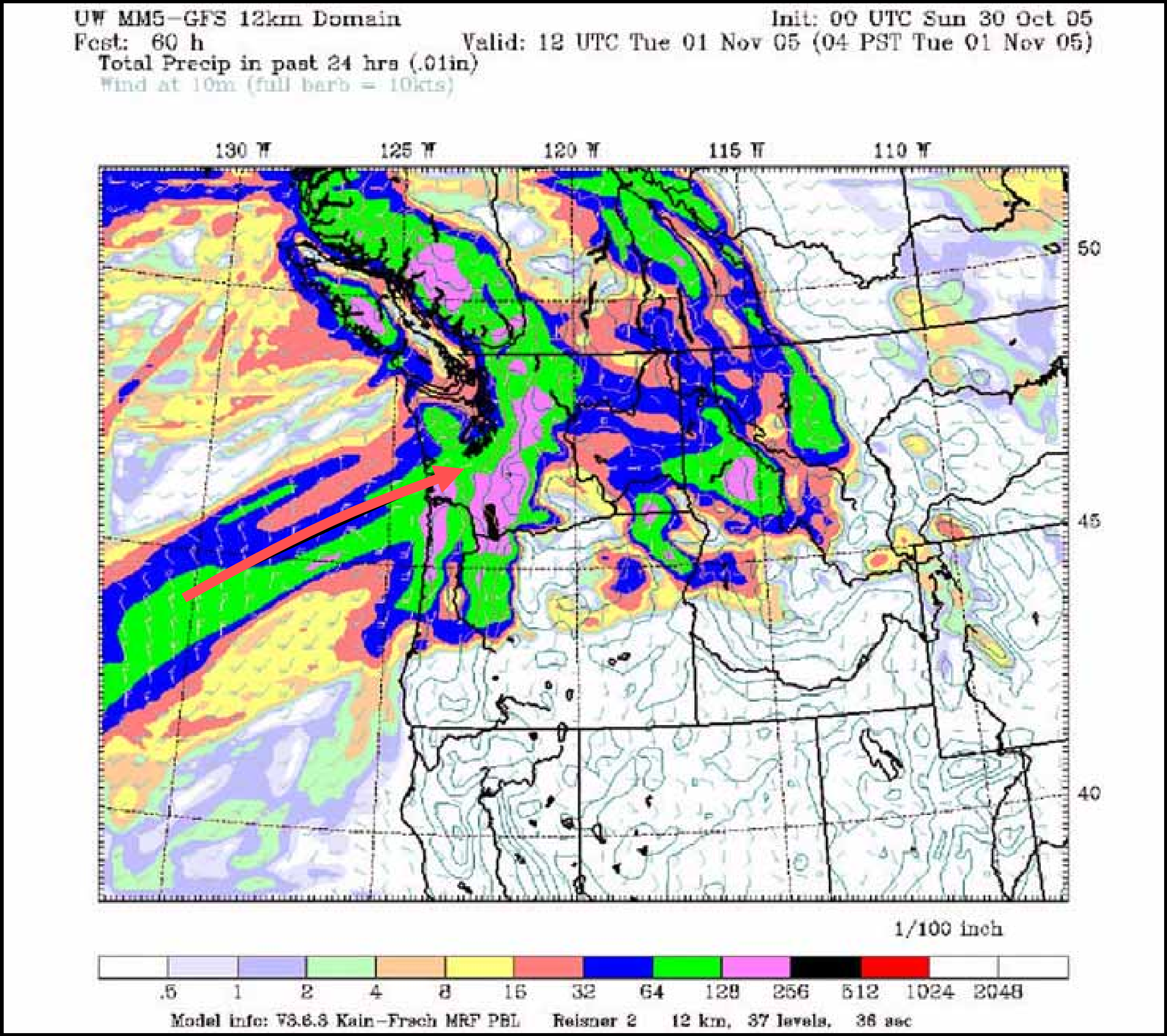


Satellite Imagery

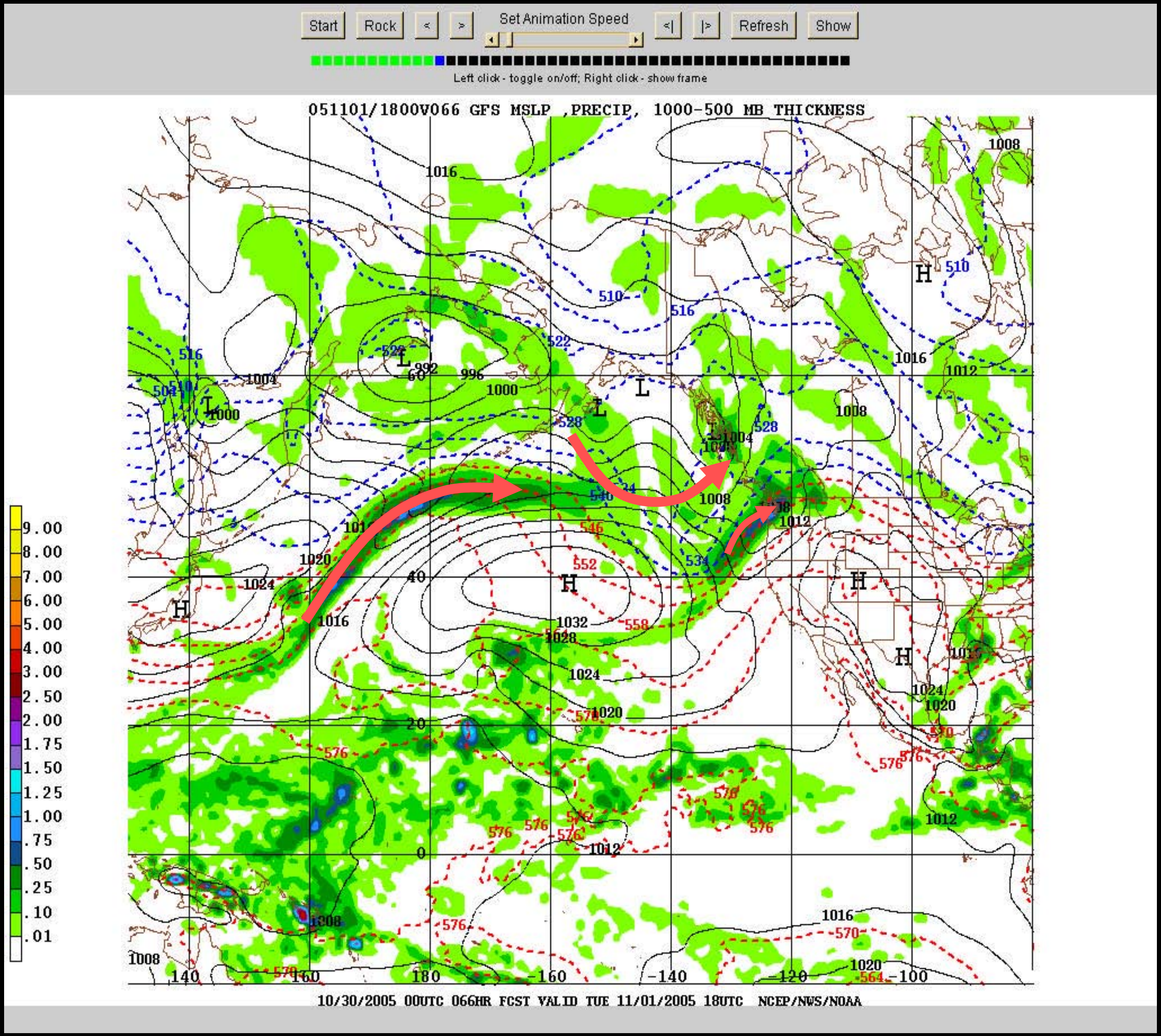


Numeric Weather Prediction

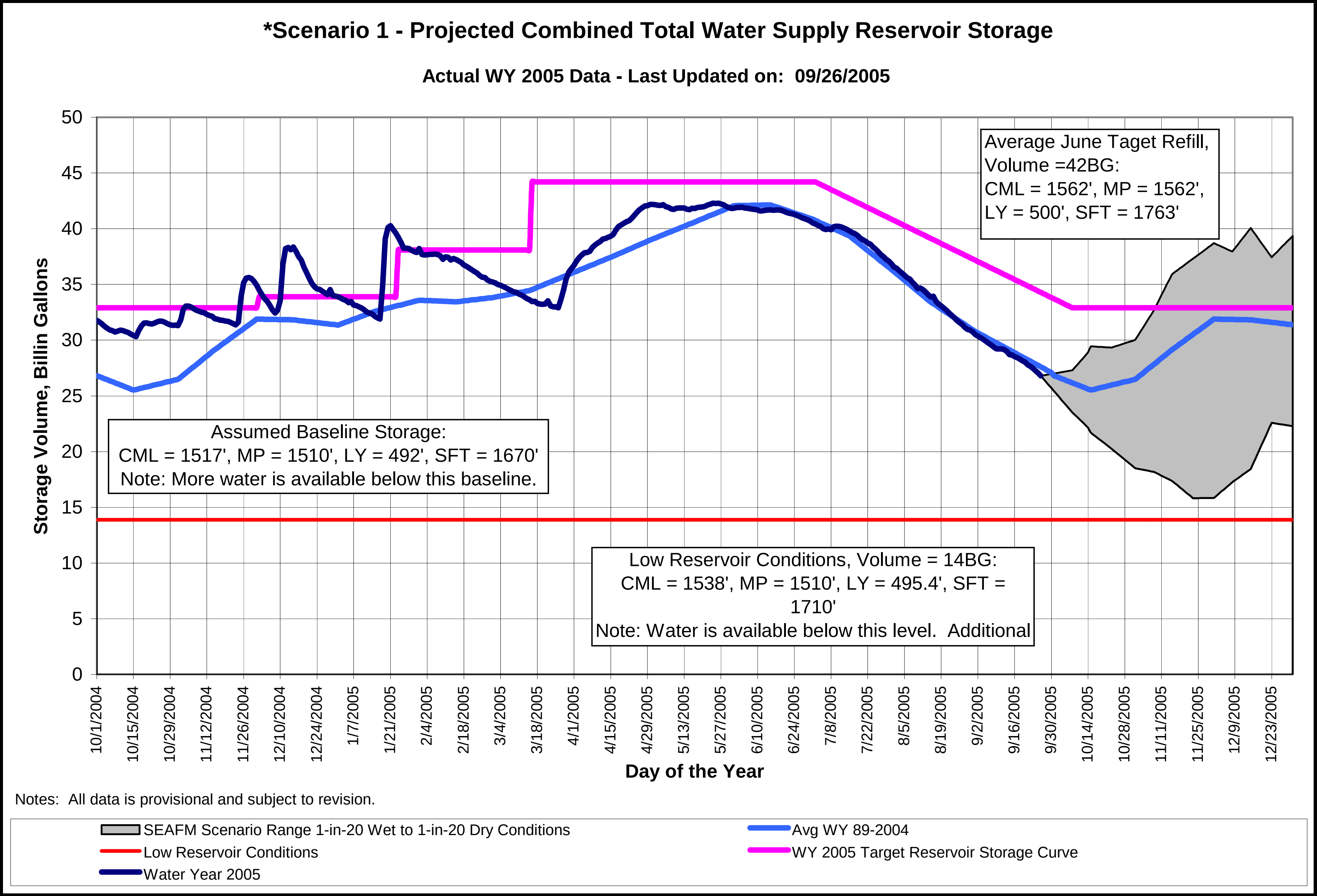
Forecast Model: MM5/GFS



Forecast Model: NCEP/GFS

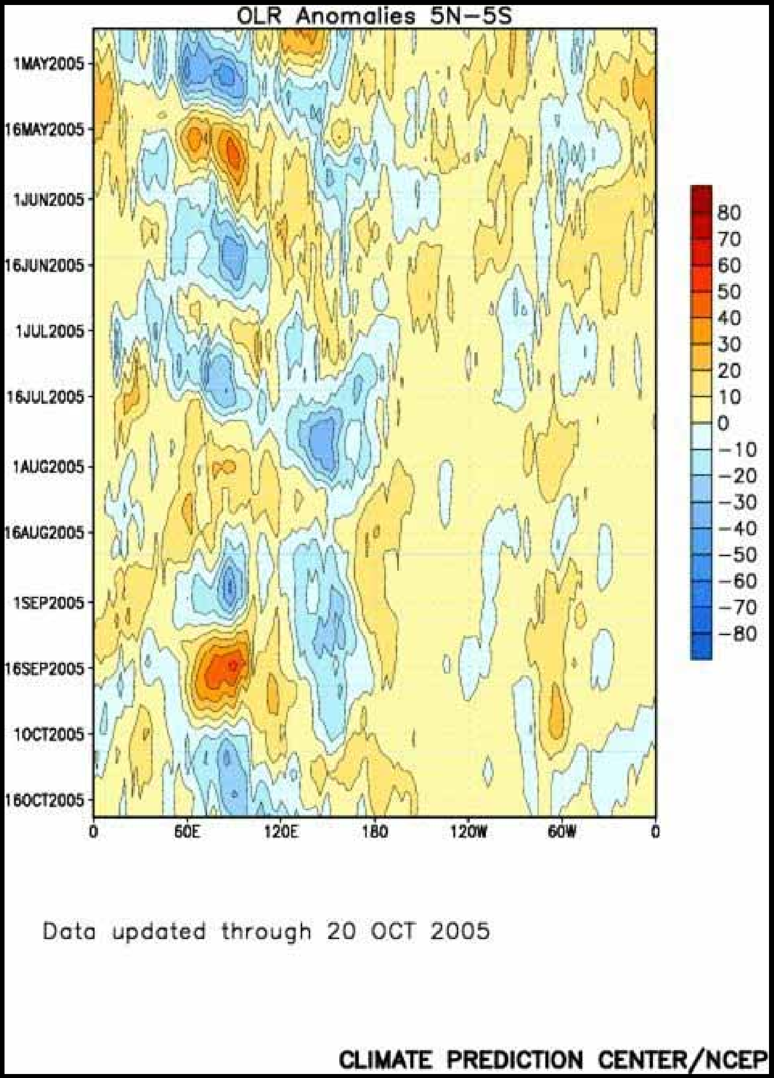


Seattle Forecast Model (SEAFM)



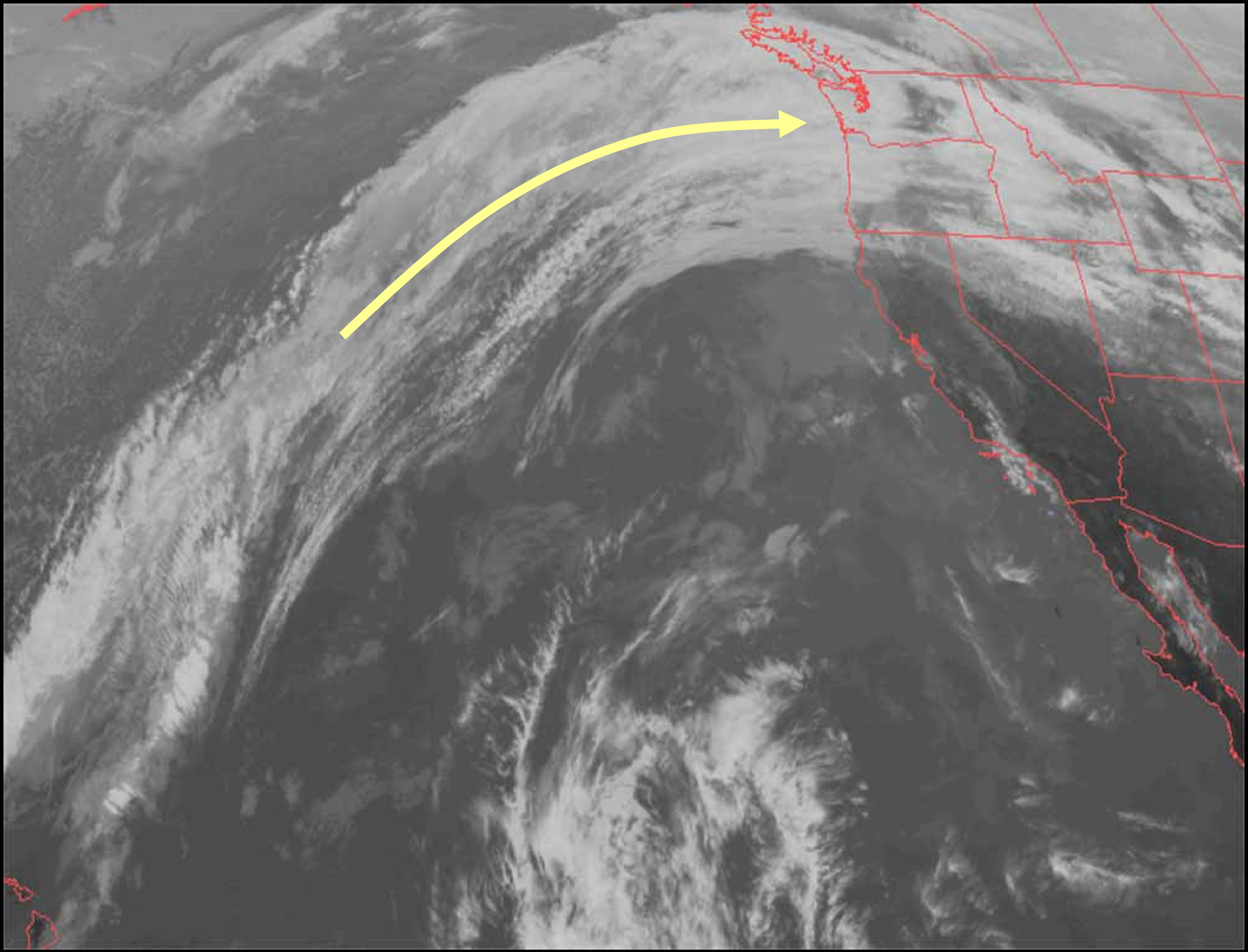
Climatic Tools & Resources

Madden-Julian Oscillation (MJO)

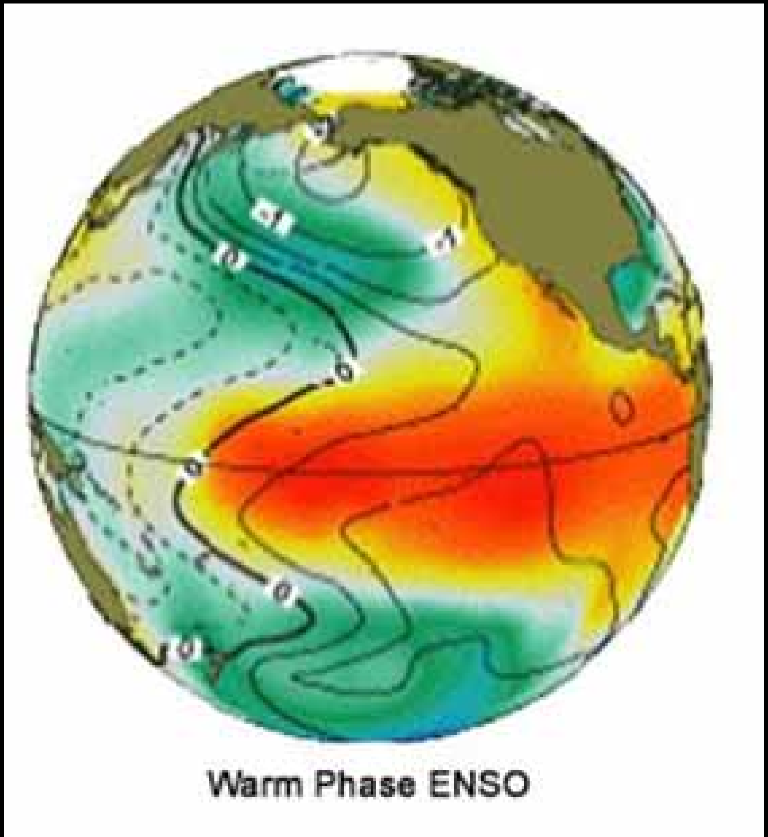


- A major intraseasonal fluctuation in tropical wind, outgoing radiation, and rainfall
- Exerts impacts in the mid-latitudes
- Average period of 45 days assists in 2 to 3 week forecasts

The “Pineapple Express”



El Niño Southern Oscillation (ENSO)



- El Niño winters tend to be warmer and drier than average with below normal snowpack and streamflow
- La Niña winters tend to be cooler and wetter than average with above normal snowpack and streamflow
- ENSO forecasts a few months to one year in advance of maturation provide SPU an opportunity to consider how a particular ENSO forecast may affect our water supply

Adapted From: Climate Impacts Group/JISAO/UW

EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

issued by

CLIMATE PREDICTION CENTER/NCEP

October 6, 2005

Spanish Version (Español -- Courtesy of INFOCLIMA, Peru)

Synopsis: ENSO-neutral conditions are expected during the next 3-6 months.

By the end of September, equatorial SST anomalies greater than +0.5ºC were found between 160ºE and 170ºE, while negative anomalies less than –0.5ºC were observed at most locations between 130ºW and the South American coast (Fig. 1). The SST departures in the Niño 3,and Niño 1+2 regions were negative, while weak positive departures were observed in the Niño 4 and Niño 3.4 regions (Fig. 2). During the last three months surface and subsurface temperature anomalies decreased, especially in the eastern equatorial Pacific, while. atmospheric conditions (low-level winds, convection and sea level pressure) remained near average over most of the tropical Pacific.

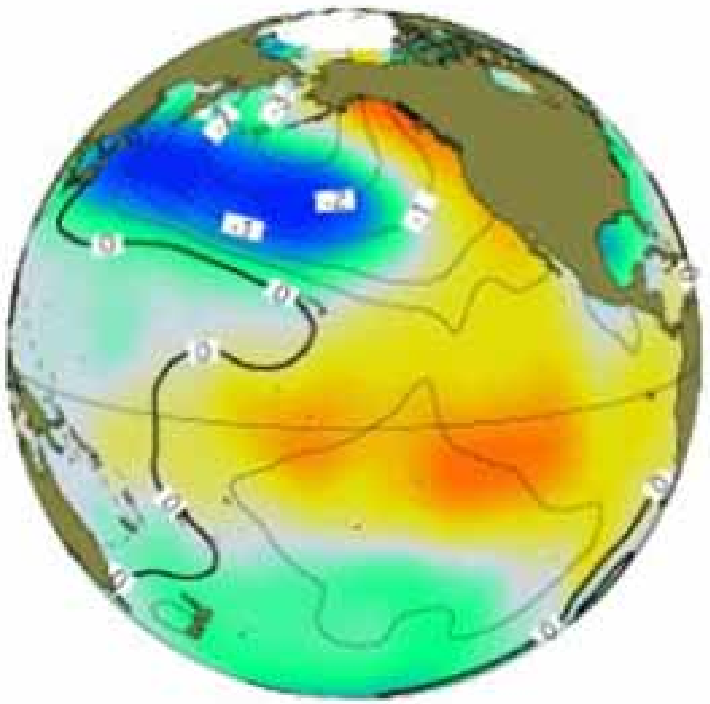
The large spread of the most recent statistical and coupled model forecasts (weak La Niña to weak El Niño) indicates considerable uncertainty (Fig. 3). However, current conditions and recent observed trends support a continuation of ENSO-neutral conditions for the next 3-6 months.

Bulletin.

Climate Prediction Center
National Centers for Environmental Prediction
NOAA/National Weather Service
Camp Springs, MD 20746-4304

Adapted From: CPC/NCEP

Pacific Decadal Oscillation (PDO)

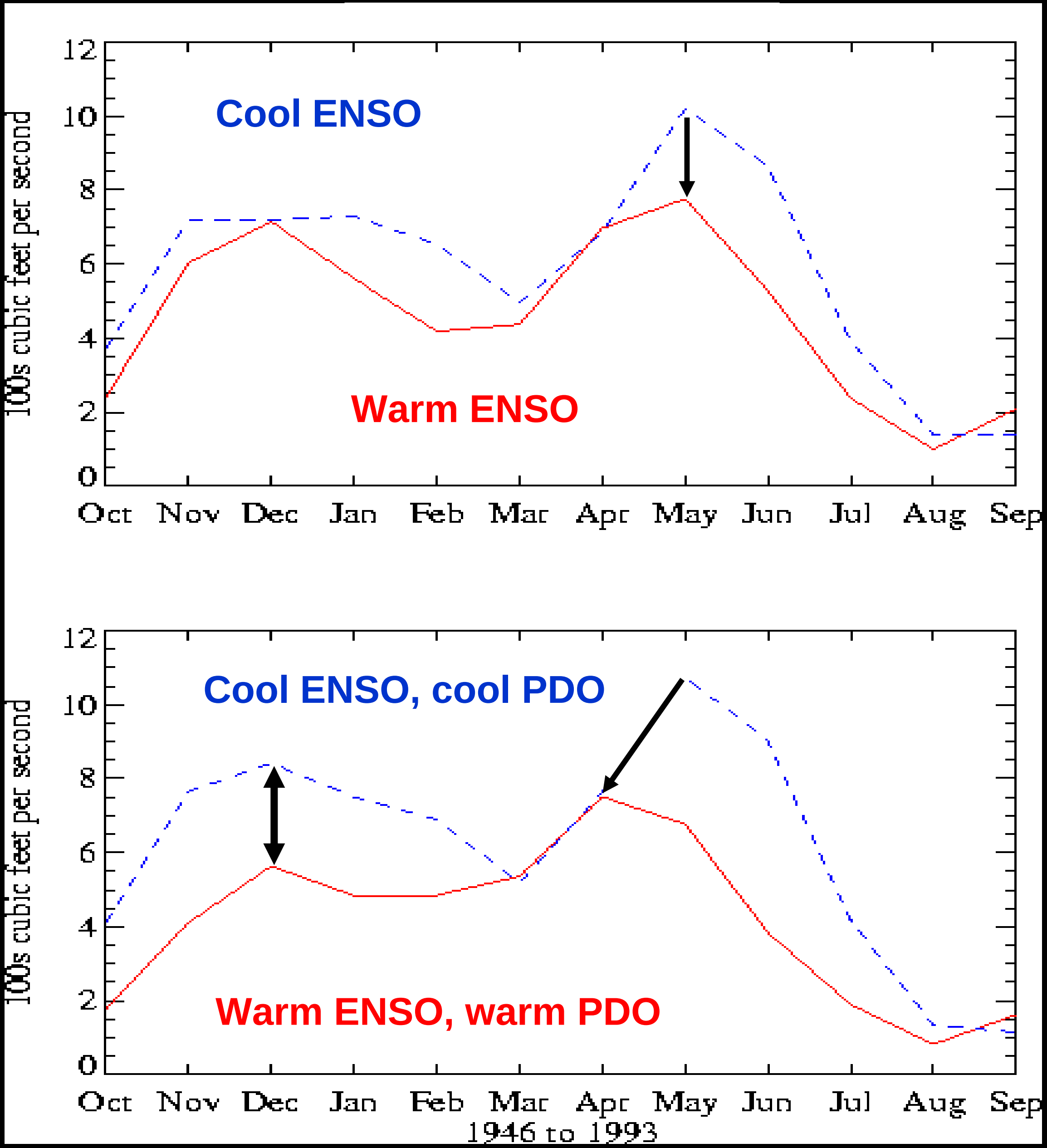


Warm Phase PDO

- The predominant source of inter-decadal climate variability in the Pacific Northwest
- Characterized by changes in sea surface temperature, sea level pressure, and wind patterns
- Warm phase PDO winters tend to be warmer and drier than average
- Cool phase PDO winters tend to be cooler and wetter than average
- Water year (October 1-Sept. 30) precipitation is ~10% less during warm phase vs. cool phase PDO

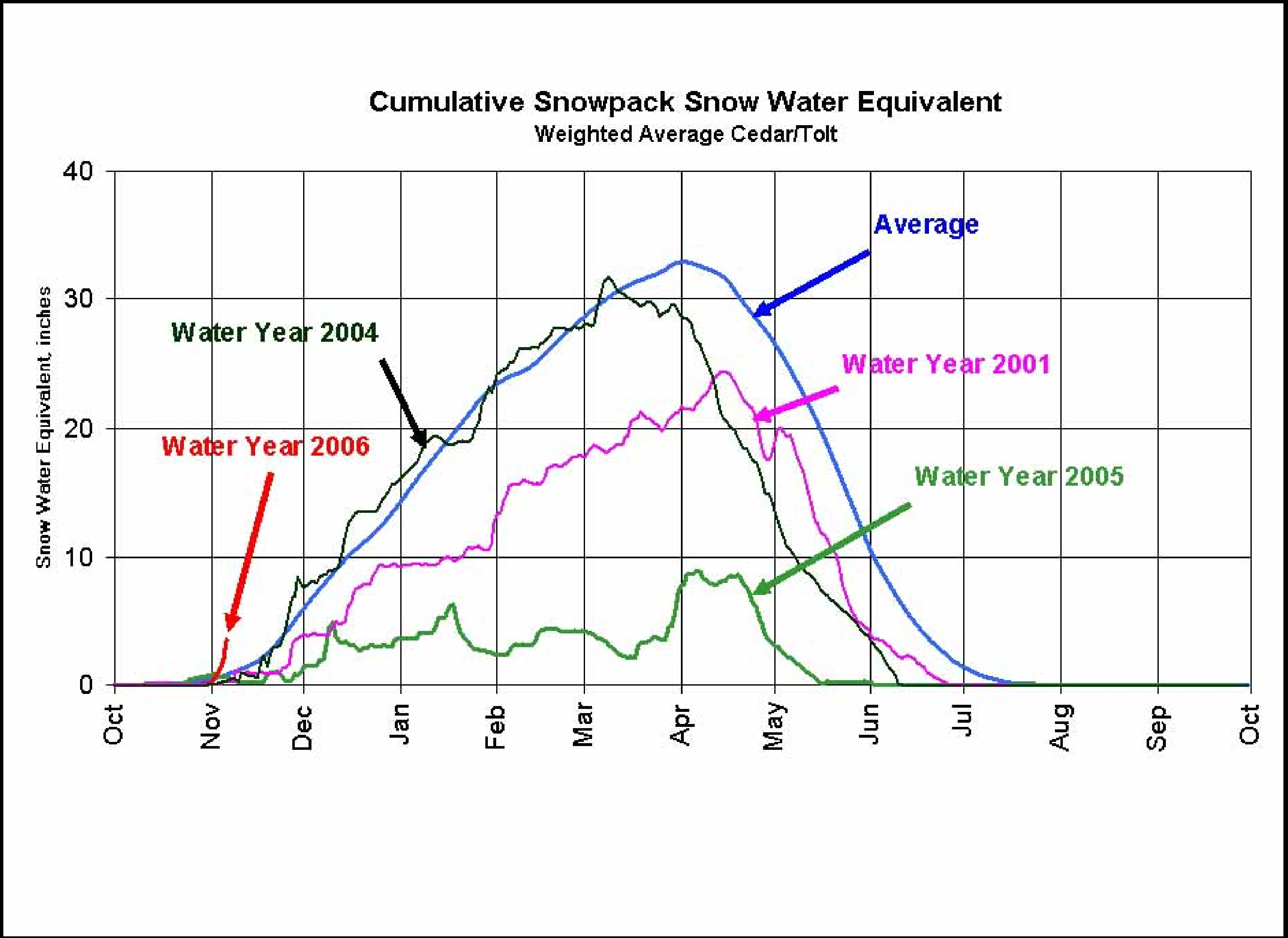
Adapted From: Climate Impacts Group/JISAO/UW

ENSO, PDO & Our Reservoir Inflows

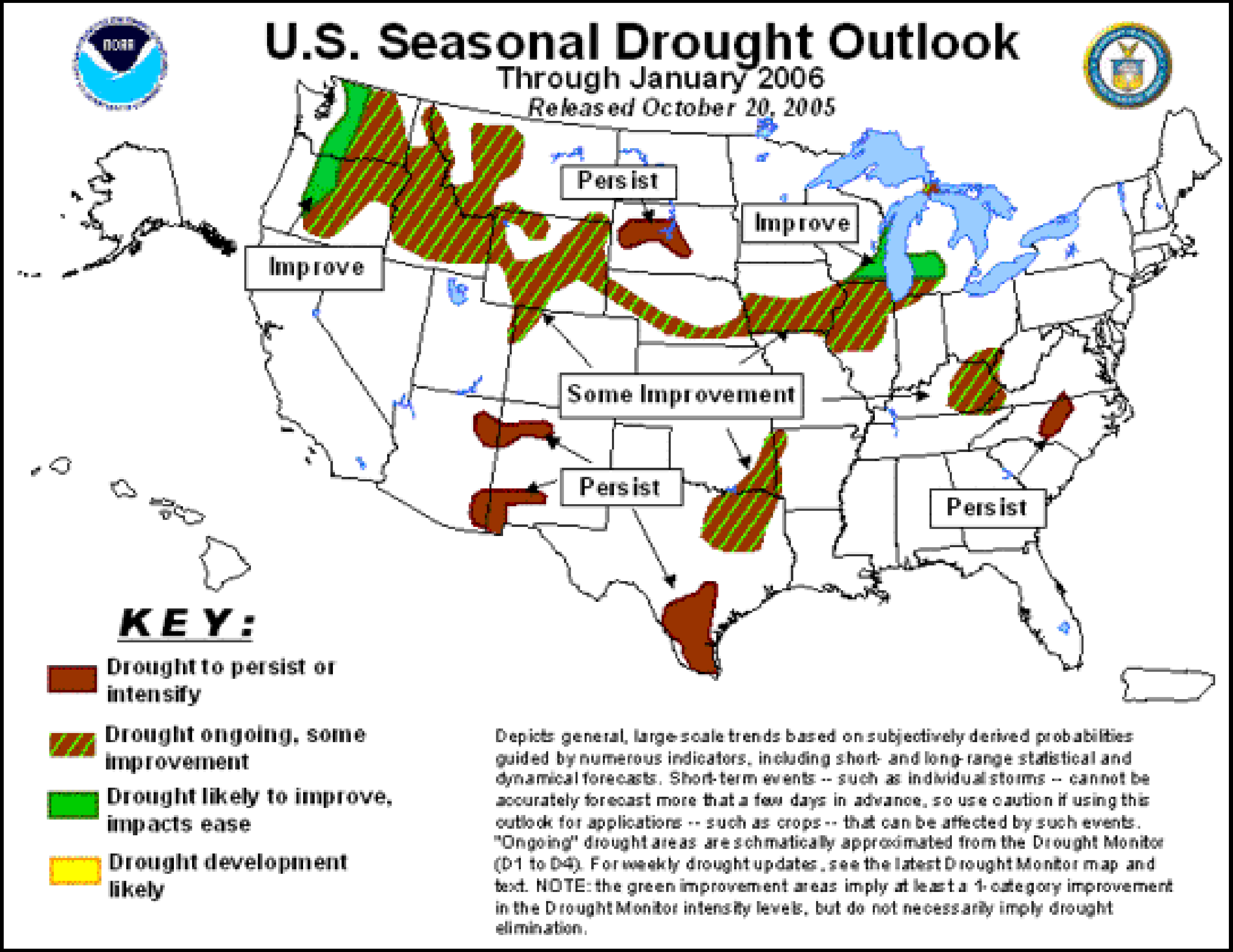


Adapted From: Climate Impacts Group/JISAO/ UW

Variability without ENSO and PDO

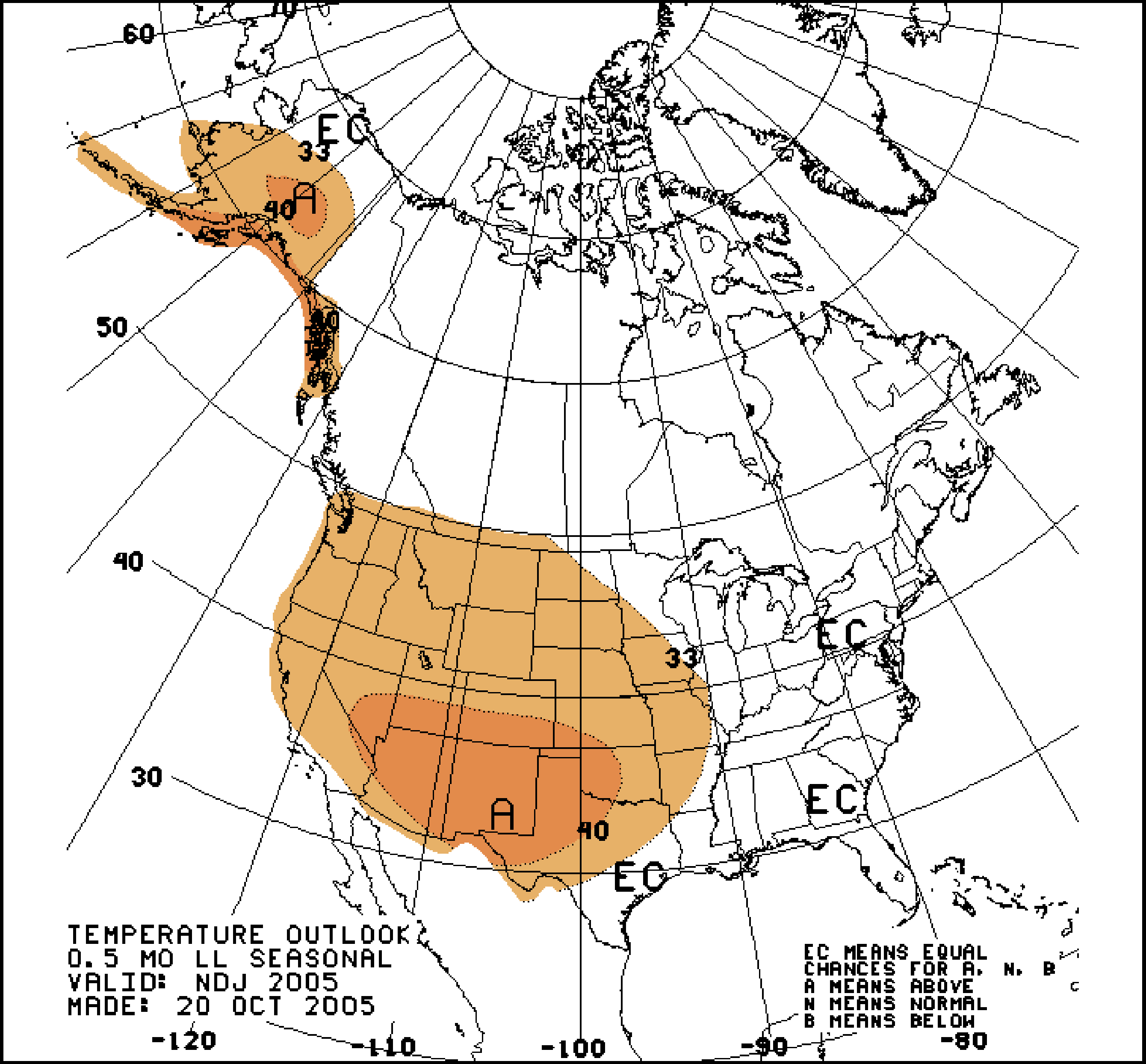


Drought



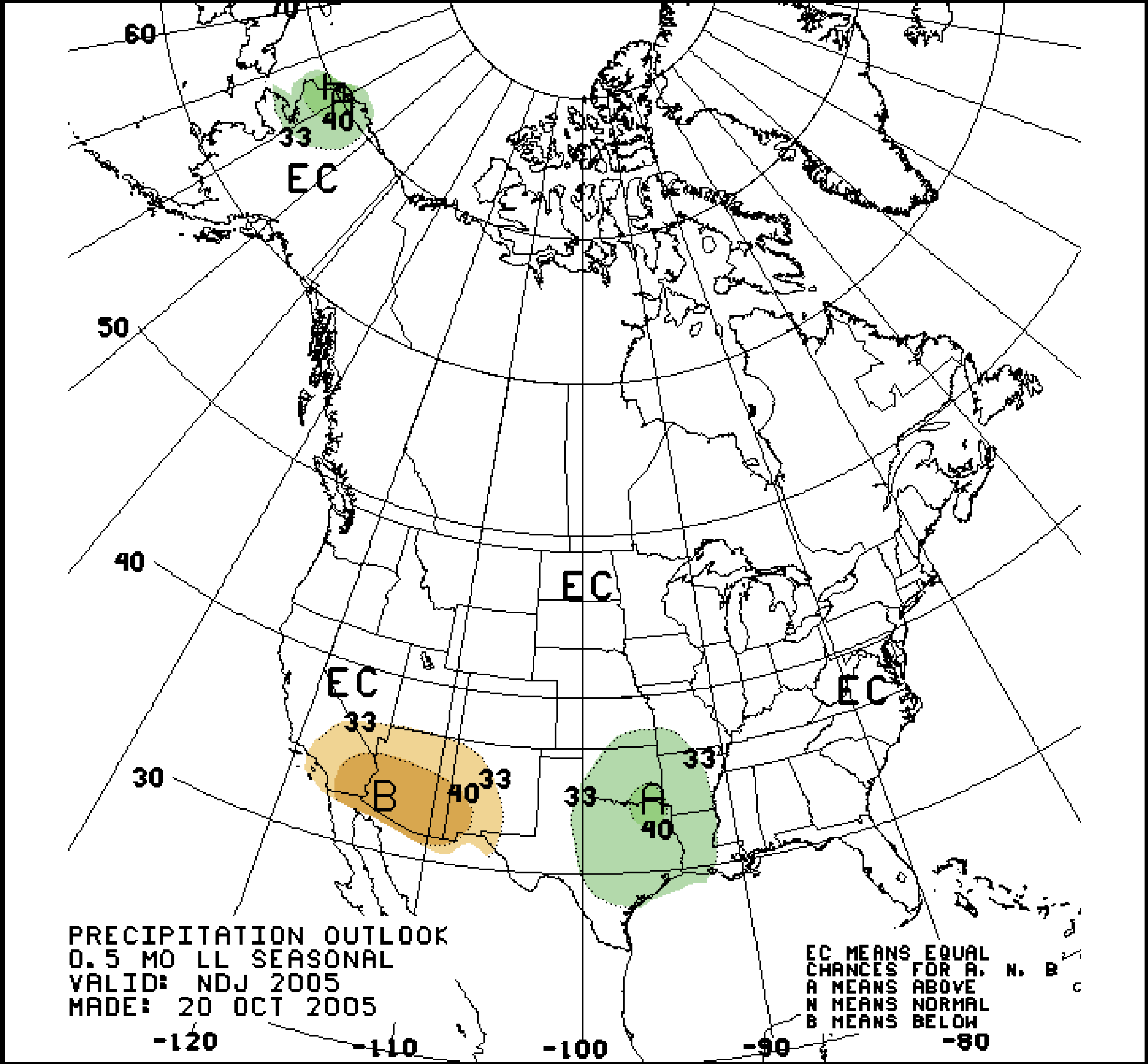
U.S. Seasonal Drought Outlook
Through January 2006
Released October 20, 2005
Persist
Improve
Improve
Some Improvement
Persist
Persist
KEY:
Drought to persist or intensify
Drought ongoing, some improvement
Drought likely to improve, impacts ease
Drought development likely
Depicts general, large-scale trends based on subjectively derived probabilities guided by numerous indicators, including short- and long-range statistical and dynamical forecasts. Short-term events -- such as individual storms -- cannot be accurately forecast more that a few days in advance, so use caution if using this outlook for applications -- such as crops -- that can be affected by such events. "Ongoing" drought areas are schematically approximated from the Drought Monitor (D1 to D4). For weekly drought updates, see the latest Drought Monitor map and text. NOTE: the green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination.

Seasonal Temperature Outlook



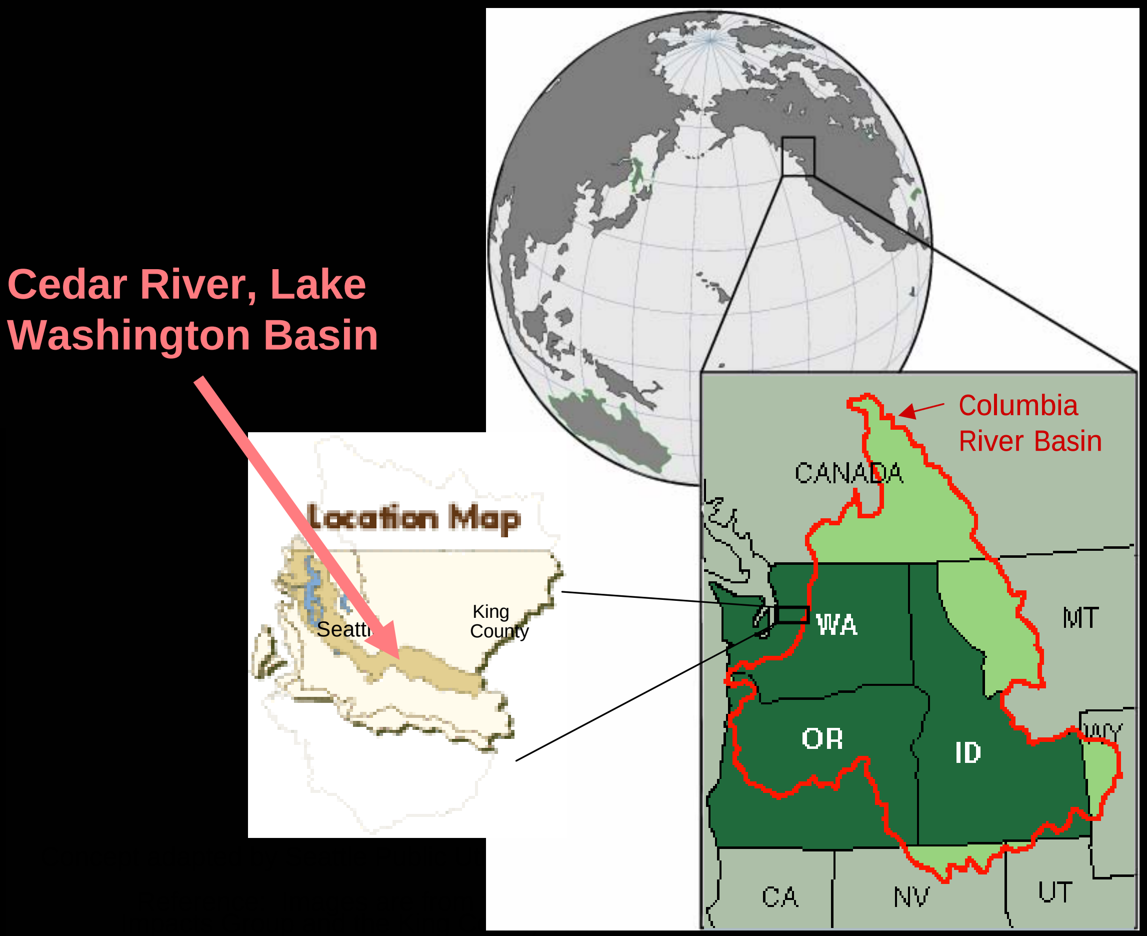
From:
CPC/NCEP

Seasonal Precipitation Outlook



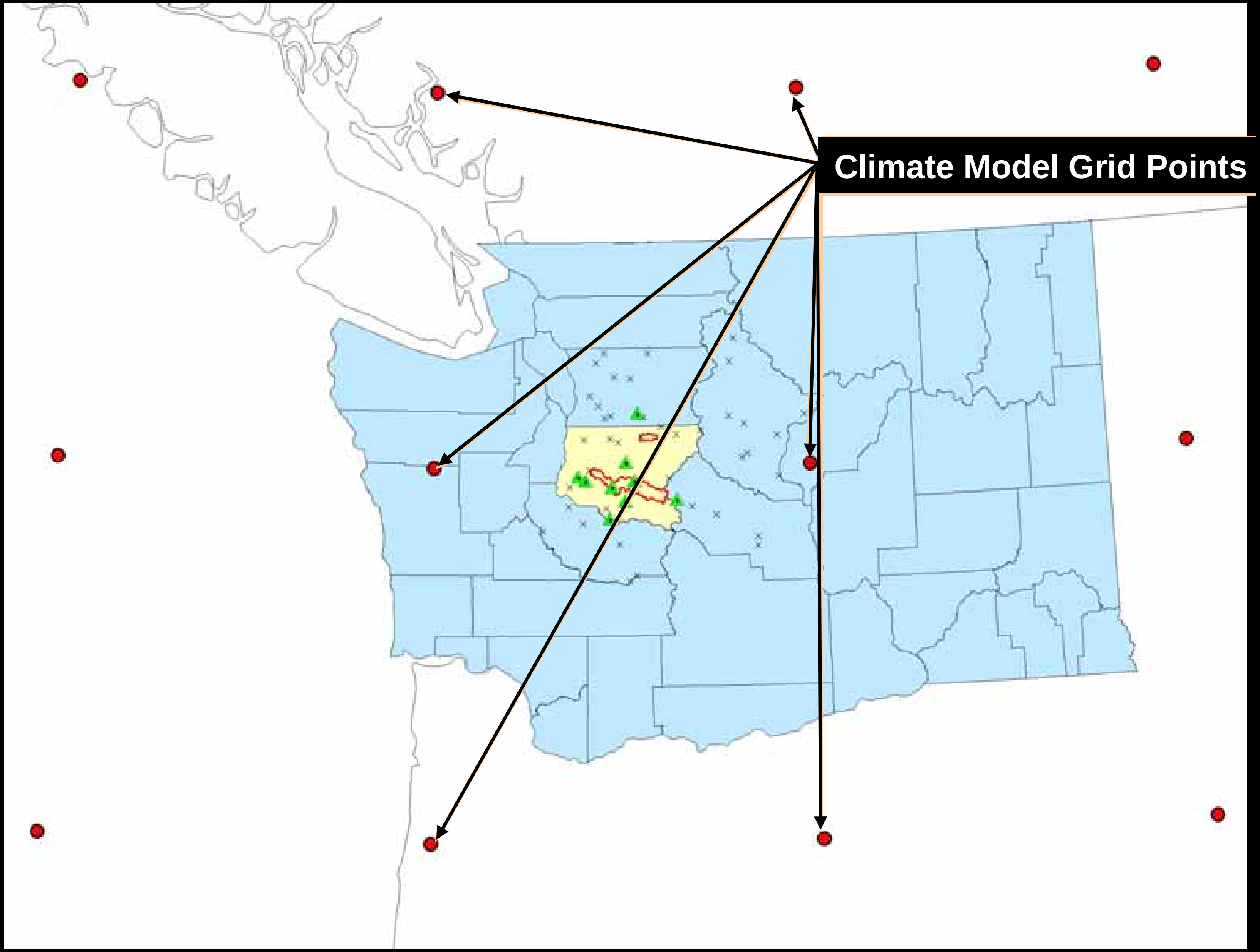
From:
CPC/NCEP

Modeling & Downscaling



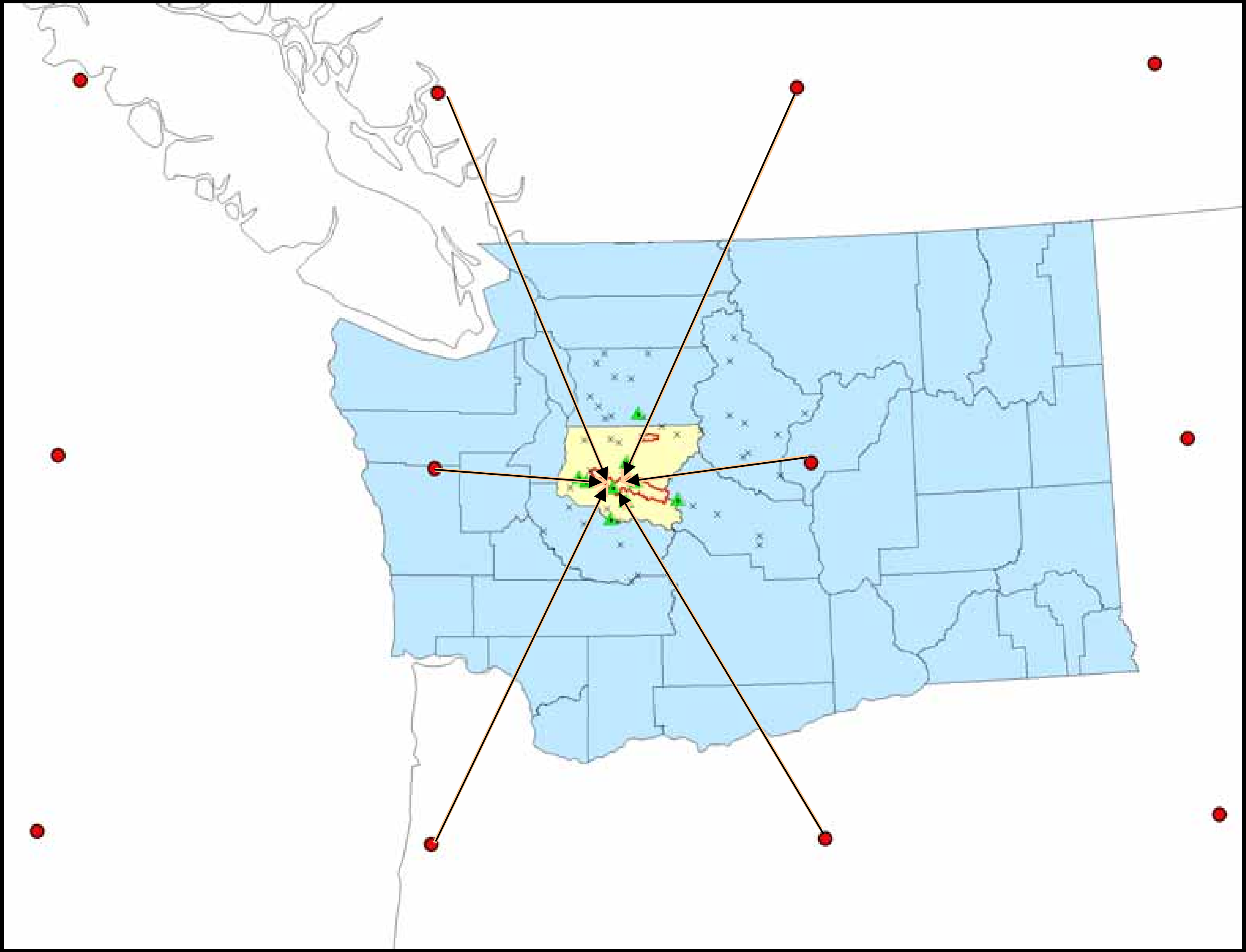
Adapted From: Climate Impacts Group/JISAO/UW

Modeling



Adapted From: Climate Impacts Group/JISAO/UW

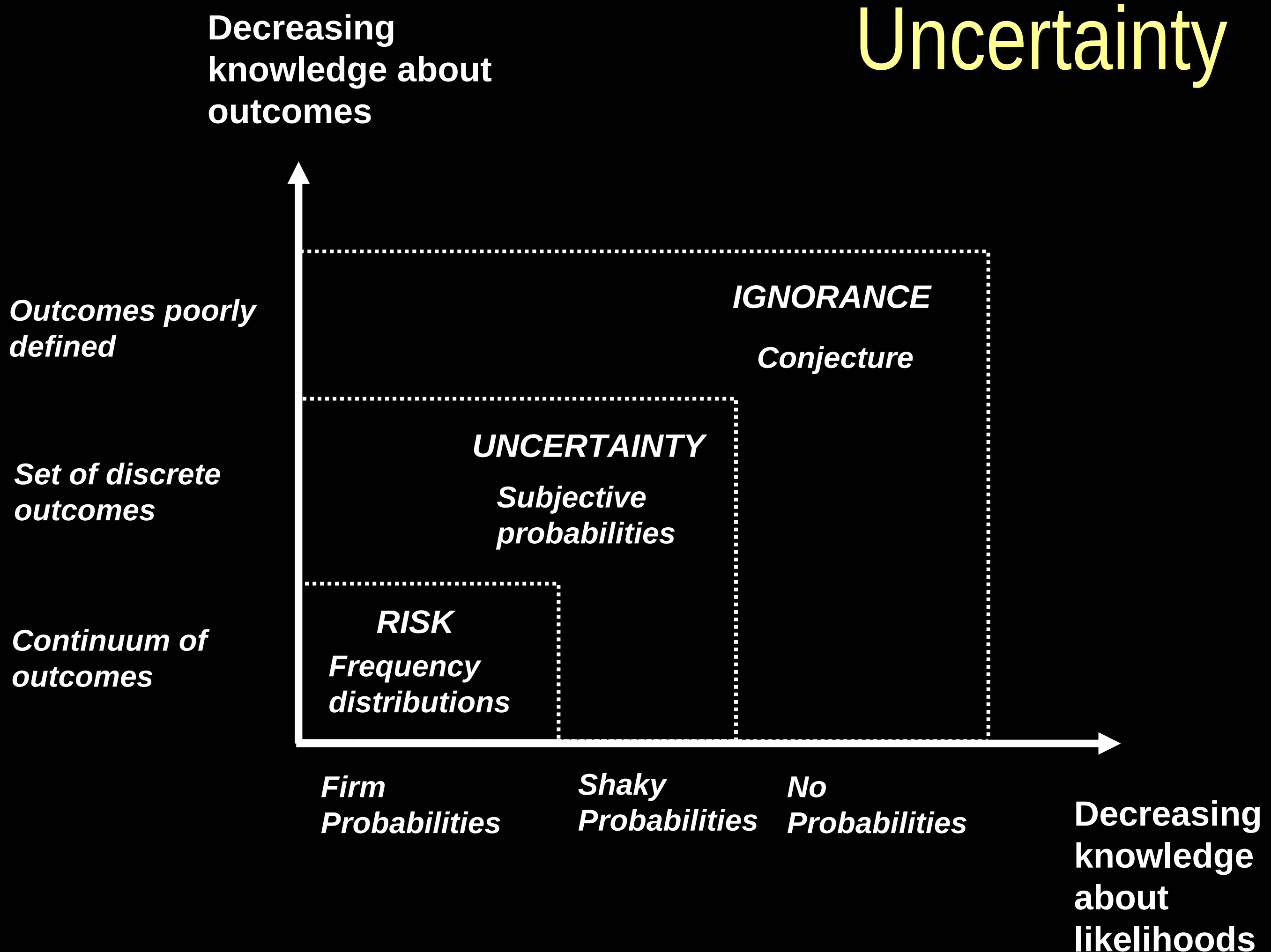
Downscaling



Adapted From: Climate Impacts Group/JISAO/UW

Water Management: Outcome versus Uncertainty

Outcome versus Uncertainty



Adapted from Dessai and Hulme (2003)

Robust Adaptive Management

the flexibility to respond to a wide range of climatic outcomes and uncertainty

- Produce positive results under a wide variety of climatic circumstances
- Cultivate populations of relevant weather and climate tools and resources that evolve over time
- Keep an array of response options open over time to minimize long-term, perhaps irreversible commitments

Robust Adaptive Management

the flexibility to respond to a wide range of climatic outcomes and uncertainty

- Science & Technology:
  - *Data Monitoring and Collection Systems*
  - *Forecasting Tools and Resources*
  - *Watershed Simulation Models*
- Dynamic Reservoir Rule Curves
- Water System Operations Optimization
- Water System Improvements
- Water Shortage (Flood) Contingency Planning
- Educational Programs and Public Outreach

Some Observations

- Water utility managers deal with weather and climatic variability daily, not in weekly, monthly, or six-month cycles
- Many climate change response models are limited by assuming static system operations, *not dynamic system management*
- Climate response planning starts with knowing individual water supply system's strengths and vulnerabilities
- Forecasts that focus on *temporal and spatial scales relevant to water manager's tactical and strategic decision making* are more relevant than highly reliable general climate forecasts

Some Observations

- *Plausible* local-scale climatic downscaling is crucial to the acceptance of forecasts by water operations and planning management
- Guidance from credible *water management professionals* on how downscaling and forecasts should and should not be used is highly desirable
- Scientific knowledge competes with local skill, political and stakeholder pressures, and internal organizational traditions, and therefore
- Assigning proper weights to climatic information are subjective decisions

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