



Improving Sub-Seasonal and Seasonal Precipitation Forecasting for Drought Preparedness

*Forecasting Needs and Water Agency Perspectives –
Drought Preparedness and Response*



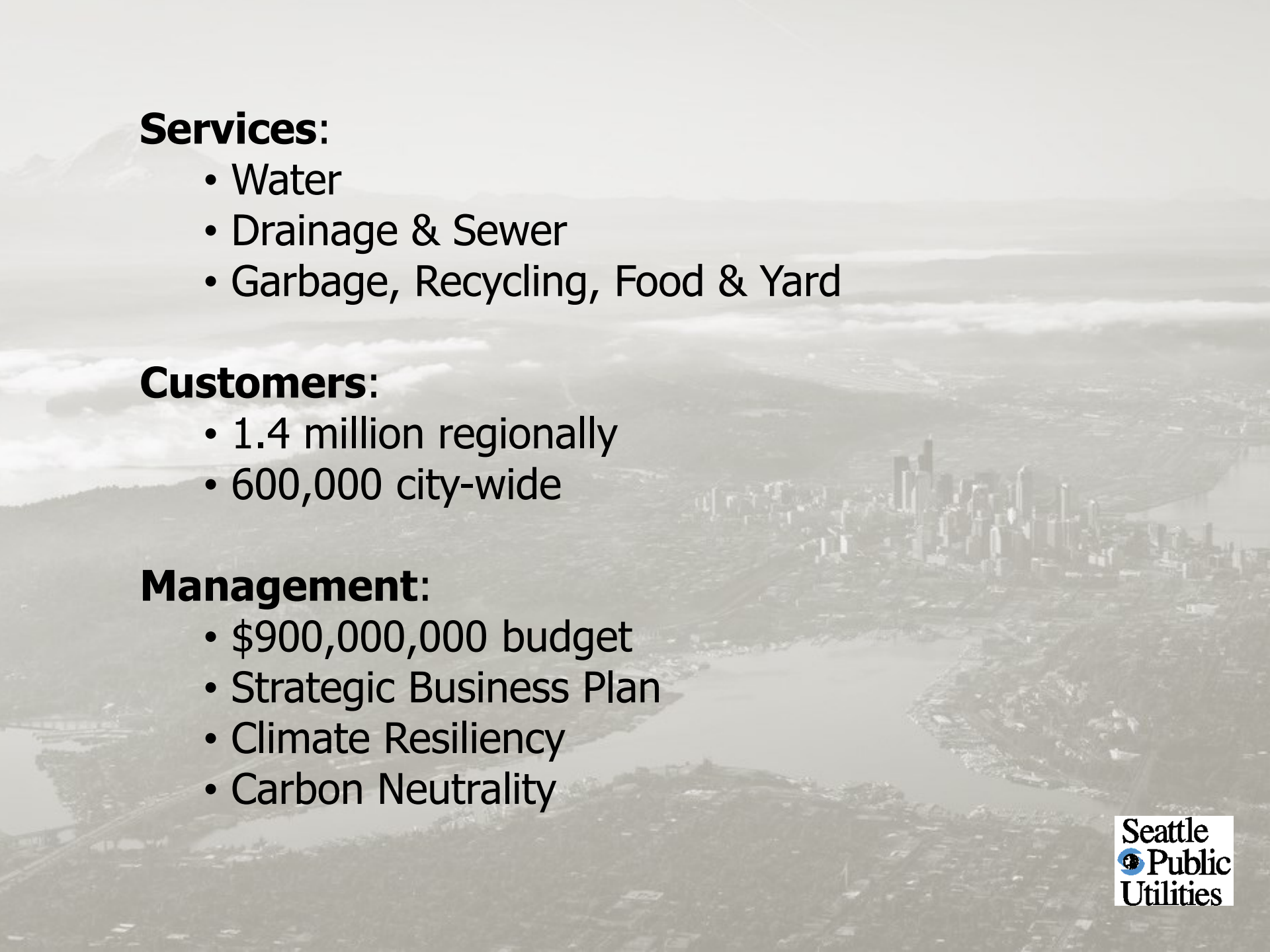
Double-edged Swords



James Rufo Hill
Climate Resiliency Group
Seattle Public Utilities
climatechange.seattle.gov

Seattle
Public
Utilities



An aerial, grayscale photograph of Seattle, Washington, showing the city skyline, the waterfront, and surrounding hills and mountains. The image is used as a background for the text.

Services:

- Water
- Drainage & Sewer
- Garbage, Recycling, Food & Yard

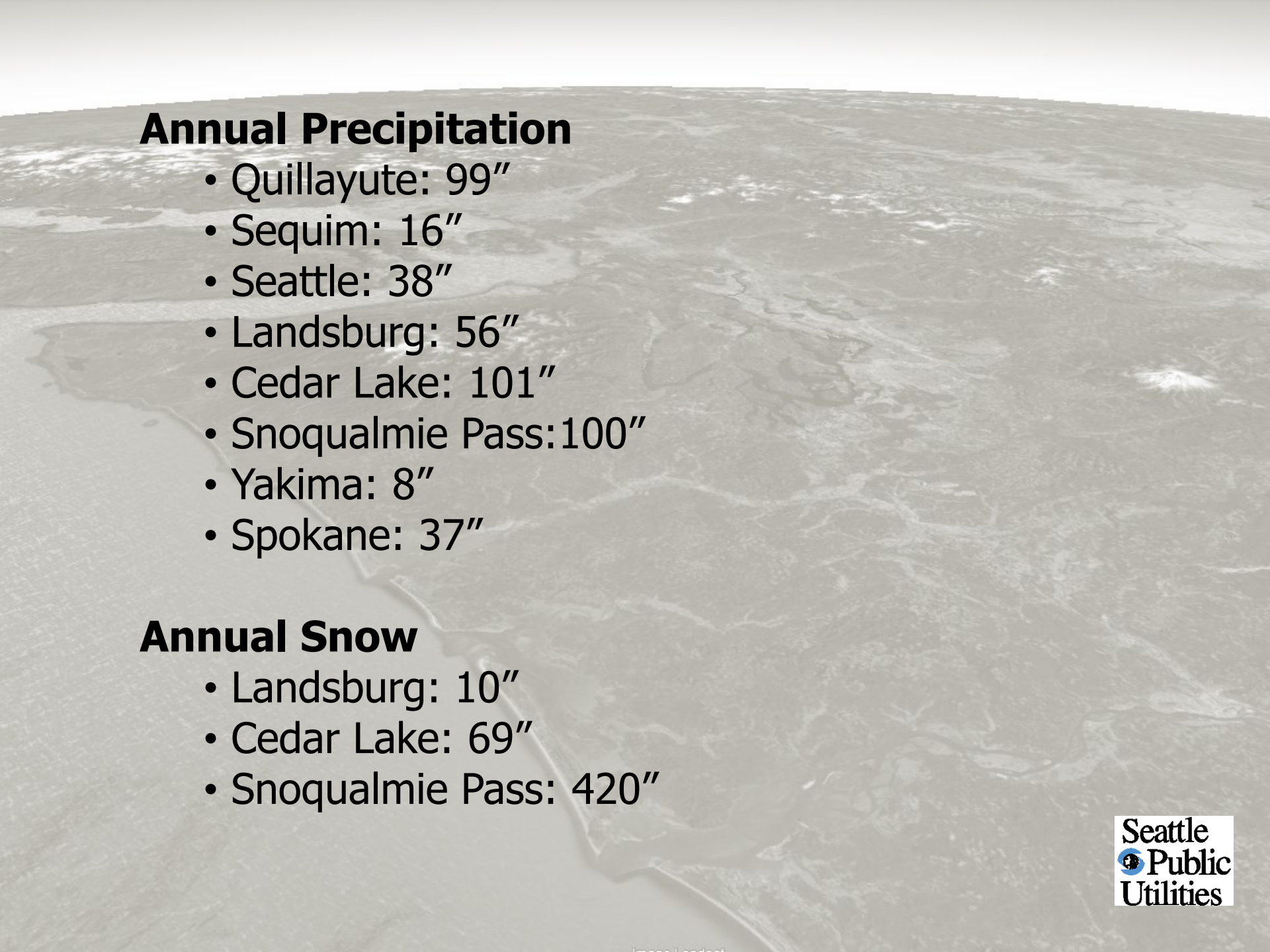
Customers:

- 1.4 million regionally
- 600,000 city-wide

Management:

- \$900,000,000 budget
- Strategic Business Plan
- Climate Resiliency
- Carbon Neutrality





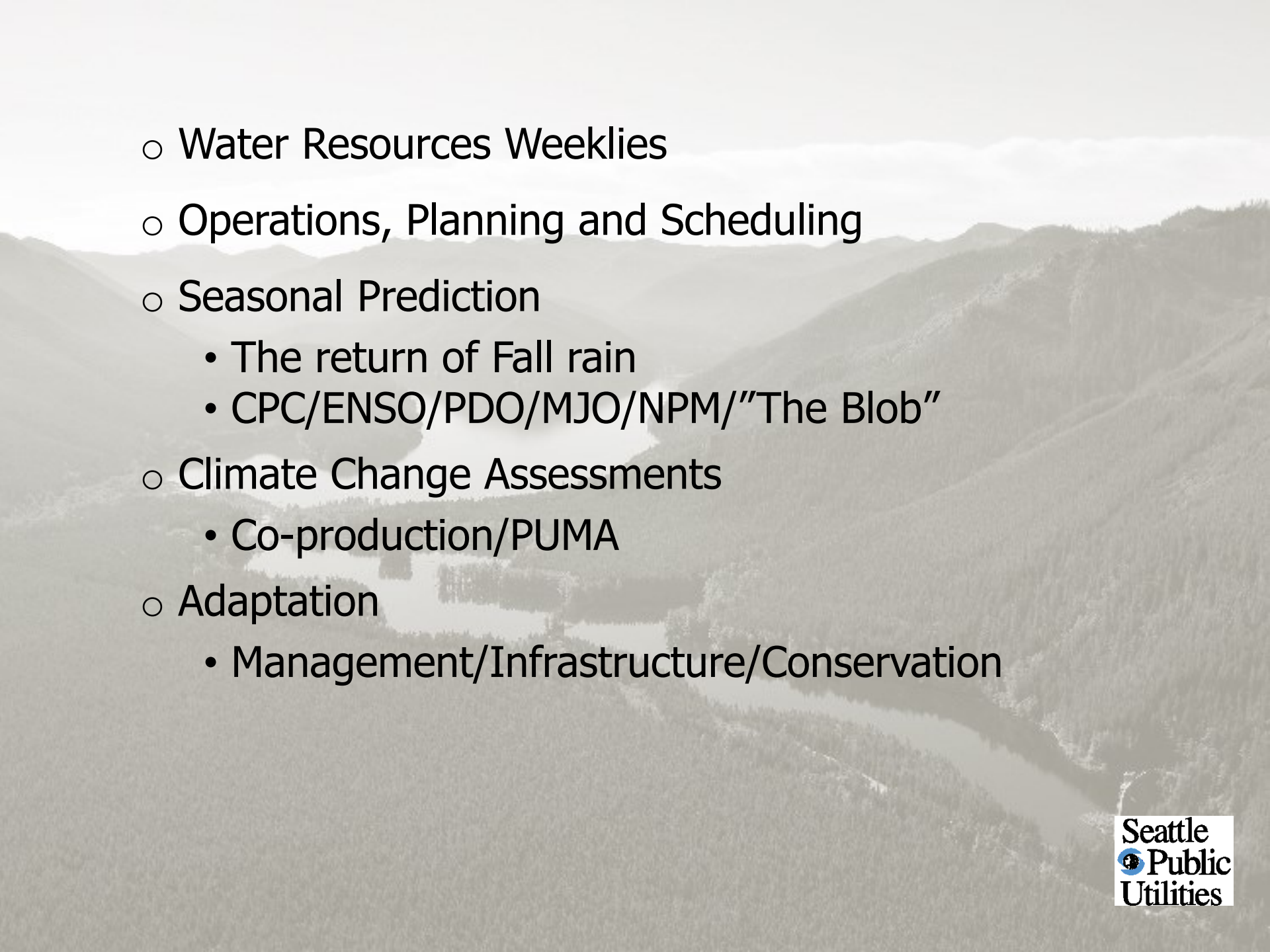
Annual Precipitation

- Quillayute: 99"
- Sequim: 16"
- Seattle: 38"
- Landsburg: 56"
- Cedar Lake: 101"
- Snoqualmie Pass: 100"
- Yakima: 8"
- Spokane: 37"

Annual Snow

- Landsburg: 10"
- Cedar Lake: 69"
- Snoqualmie Pass: 420"



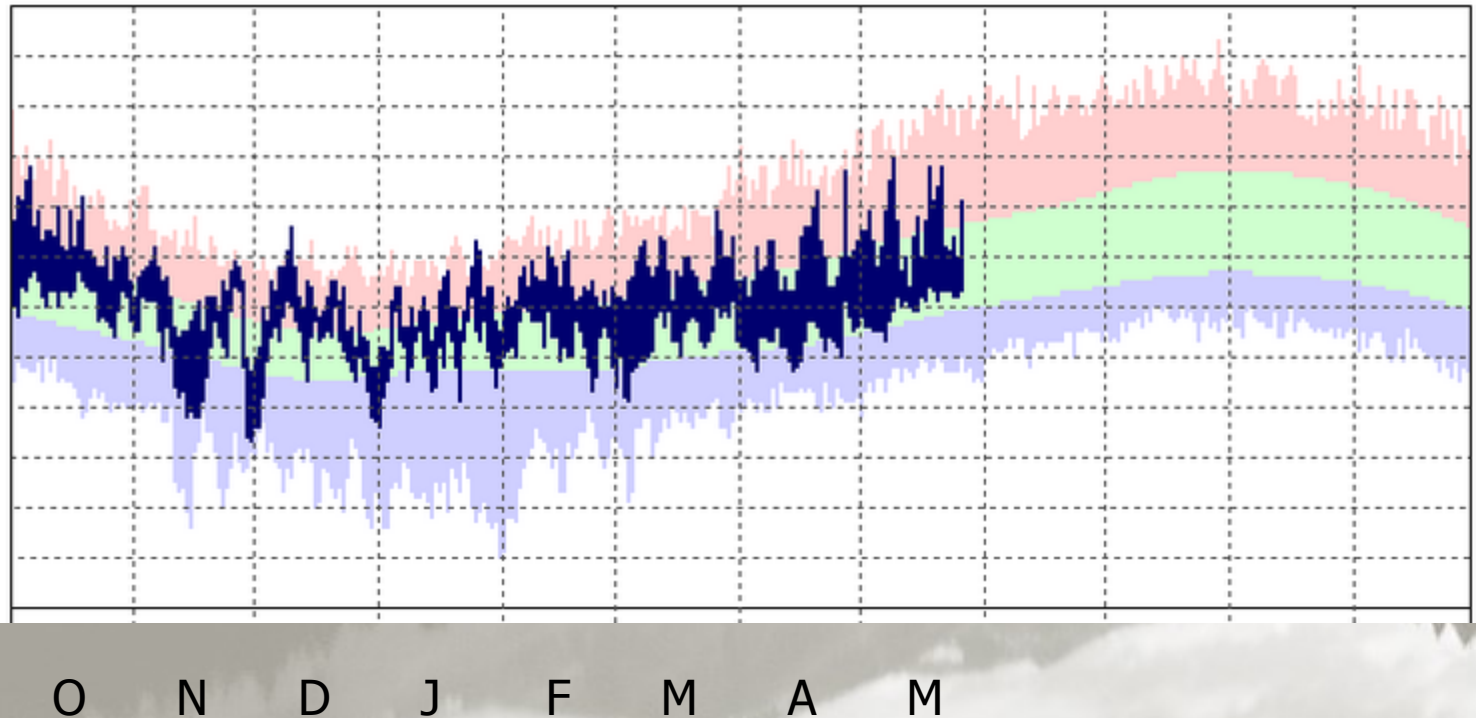
- 
- Water Resources Weeklies
 - Operations, Planning and Scheduling
 - Seasonal Prediction
 - The return of Fall rain
 - CPC/ENSO/PDO/MJO/NPM/"The Blob"
 - Climate Change Assessments
 - Co-production/PUMA
 - Adaptation
 - Management/Infrastructure/Conservation

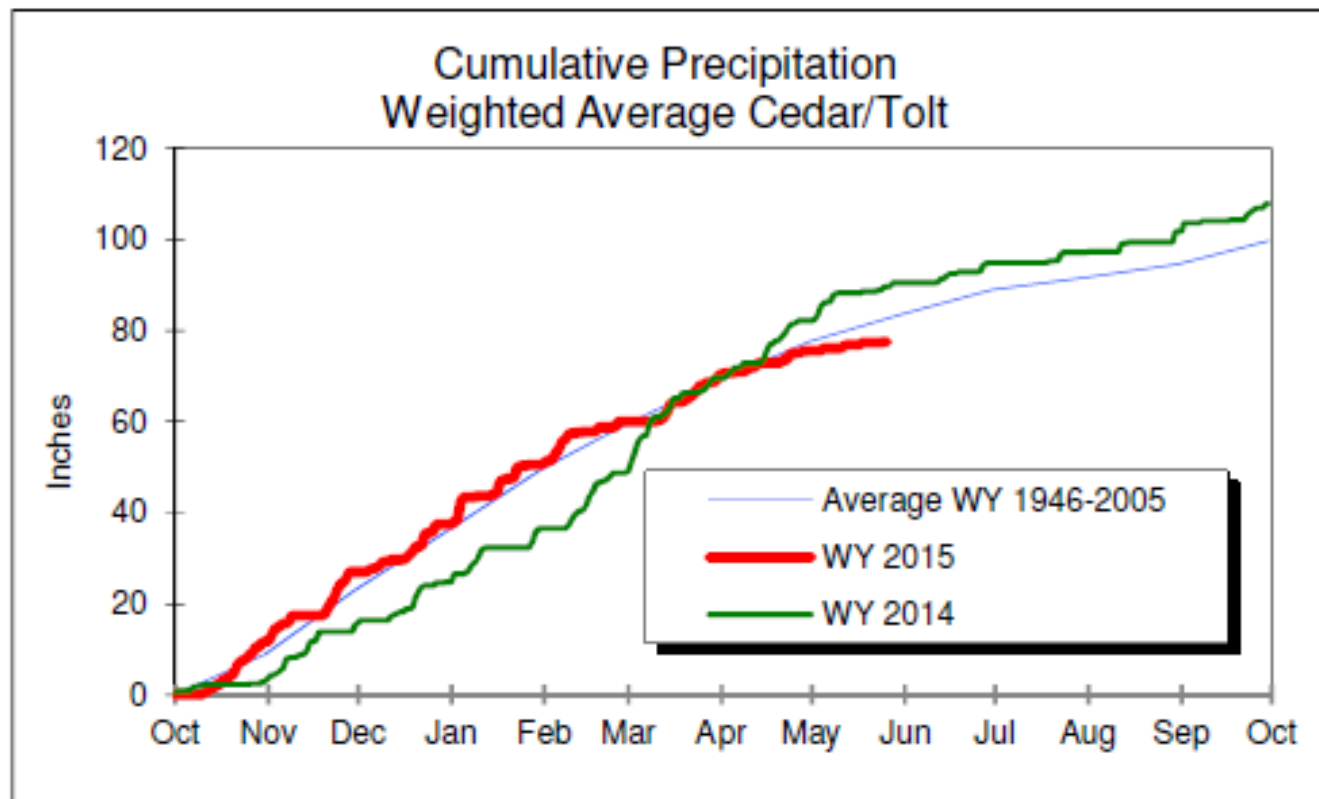


- Storm Characterization
 - Extreme events of 2006, 2007
- Meteorological Database
- Tools
 - Nowcasting/RainWatch
 - UW WRF-GFS
 - ECMWF/HRRR
- Communications
 - email/listservs/social media
- Adaptation
 - Scaling Factor
 - Assessment Storms
 - Real-time Control
 - Modeling/Water Supply Lessons, like 2015...

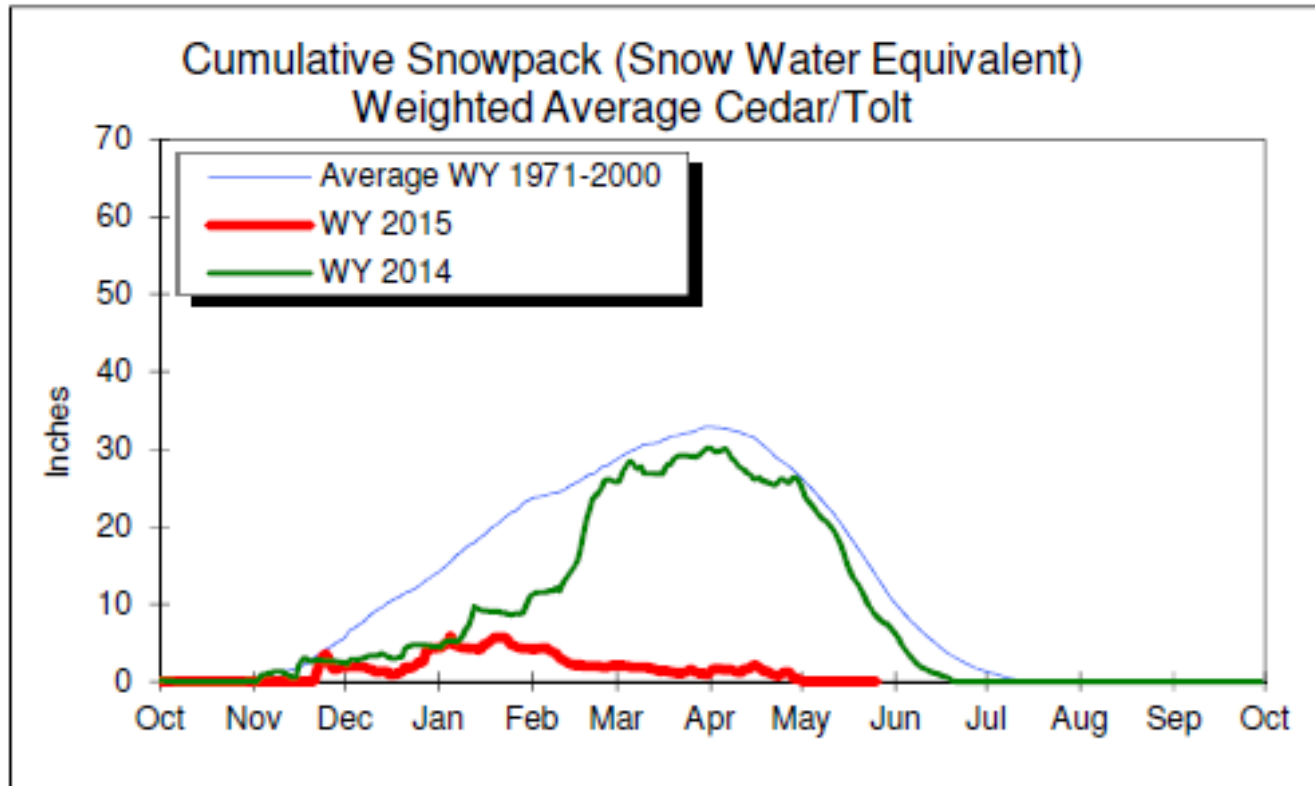


WY2015 Temps (Seatac)

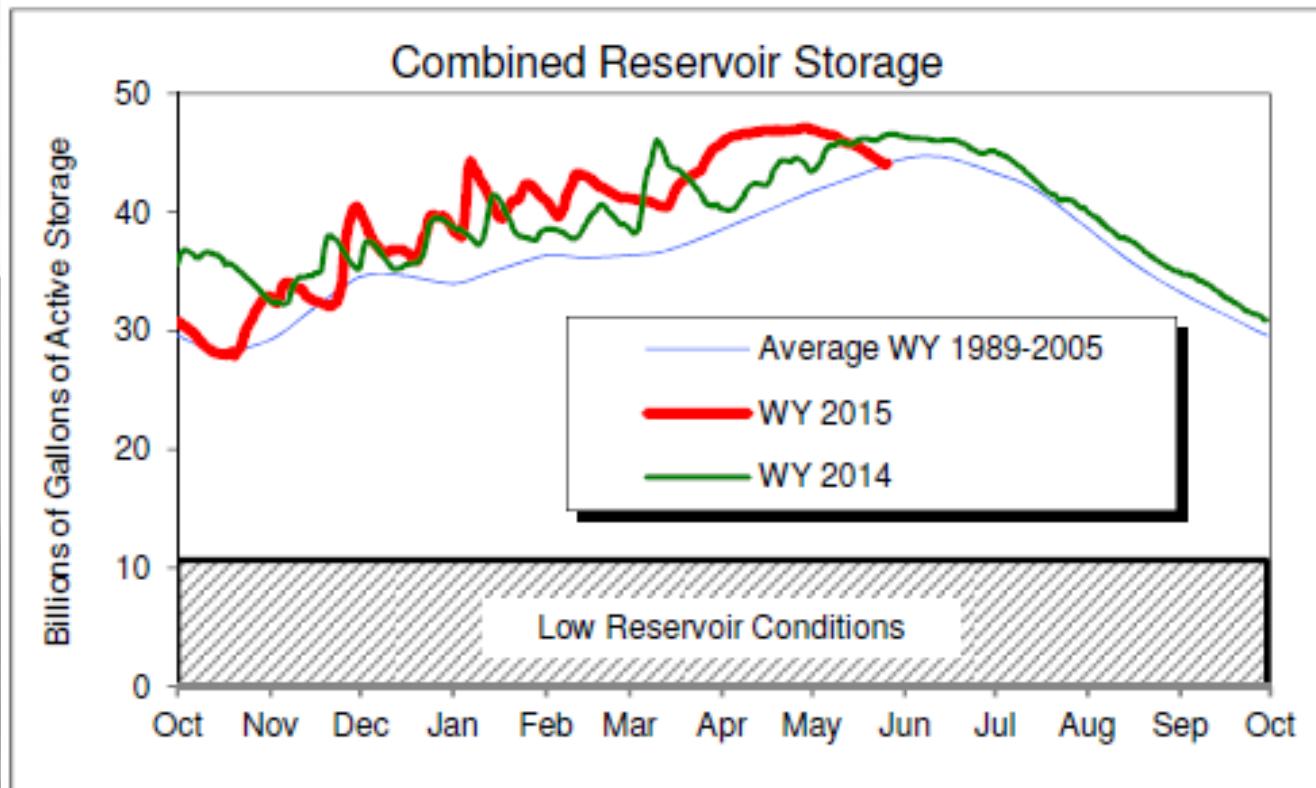




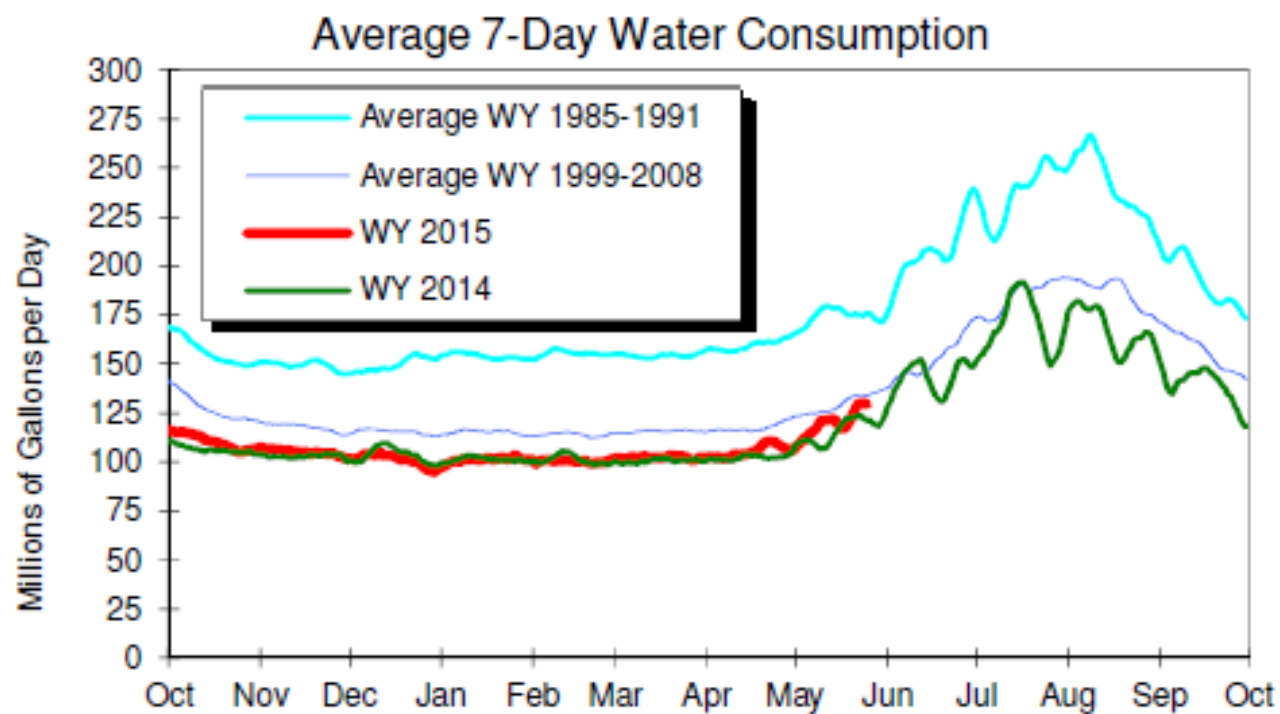
Precipitation was recorded in the Cedar River and South Fork Tolt River Watersheds over the past week.



The average snow accumulation across the sites that we monitor is estimated to be about 0.0 inches snow water equivalent which is below the long term average for this time of the year.



The combined reservoir storage of Chester Morse Lake, Masonry Pool, Lake Youngs and South Fork Tolt Reservoir is at the long term average for this time of the year.



Water use over the past week averaged about 129 million gallons per day (mgd), which is less than the 134 mgd used during the same period over the years 1999-2008.



Hydrology:

- Phenohydrology – Timing of Fall Rains
- Snow Drought – Spring Rains?
- Objective Drought Declaration

Meteorology:

- ARs
- Teleconnections
- NAM?

Management:

- “co-production ... actionable science”
- Embracing Uncertainty
- Info mgmt & viz
- Double-edged sword – real-time Control



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*Forecasting Needs and Water Agency Perspectives –
Drought Preparedness and Response*



Double-edged Swords

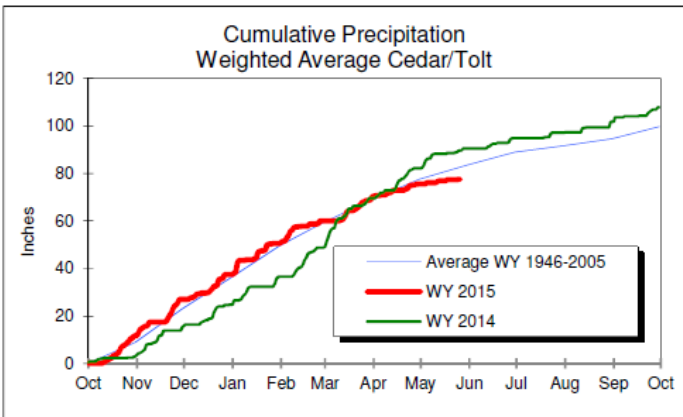


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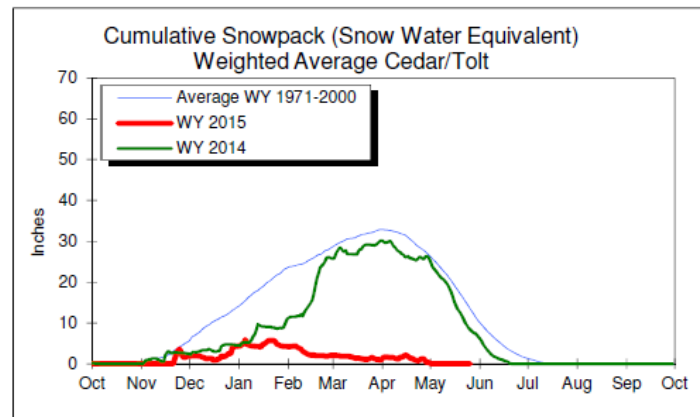
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APPENDIX

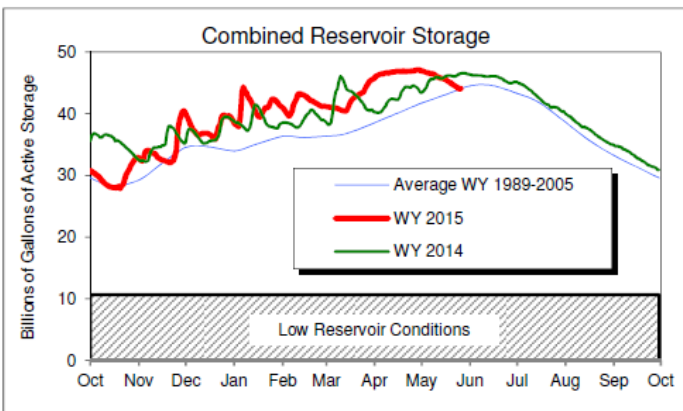
Seattle Public Utilities Water System Synopsis as of May 26, 2015



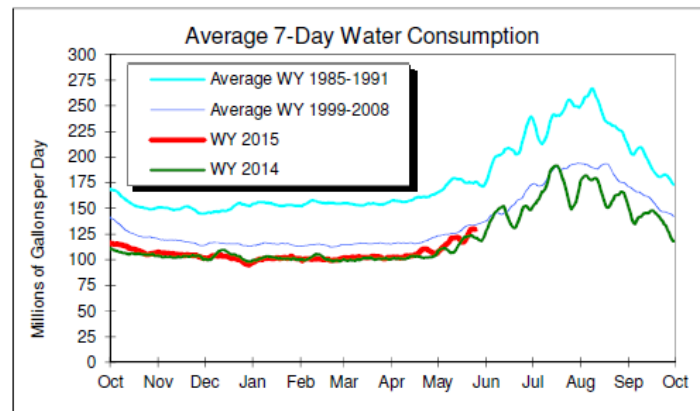
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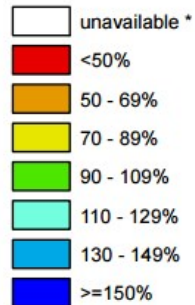
Water use over the past week averaged about 129 million gallons per day (mgd), which is less than the 134 mgd used during the same period over the years 1999-2008.

All data is provisional and subject to revision.

Washington SNOTEL Current Snow Water E

Apr 01, 2015

**Current Snow Water
Equivalent (SWE)
Basin-wide Percent
of 1981-2010 Median**

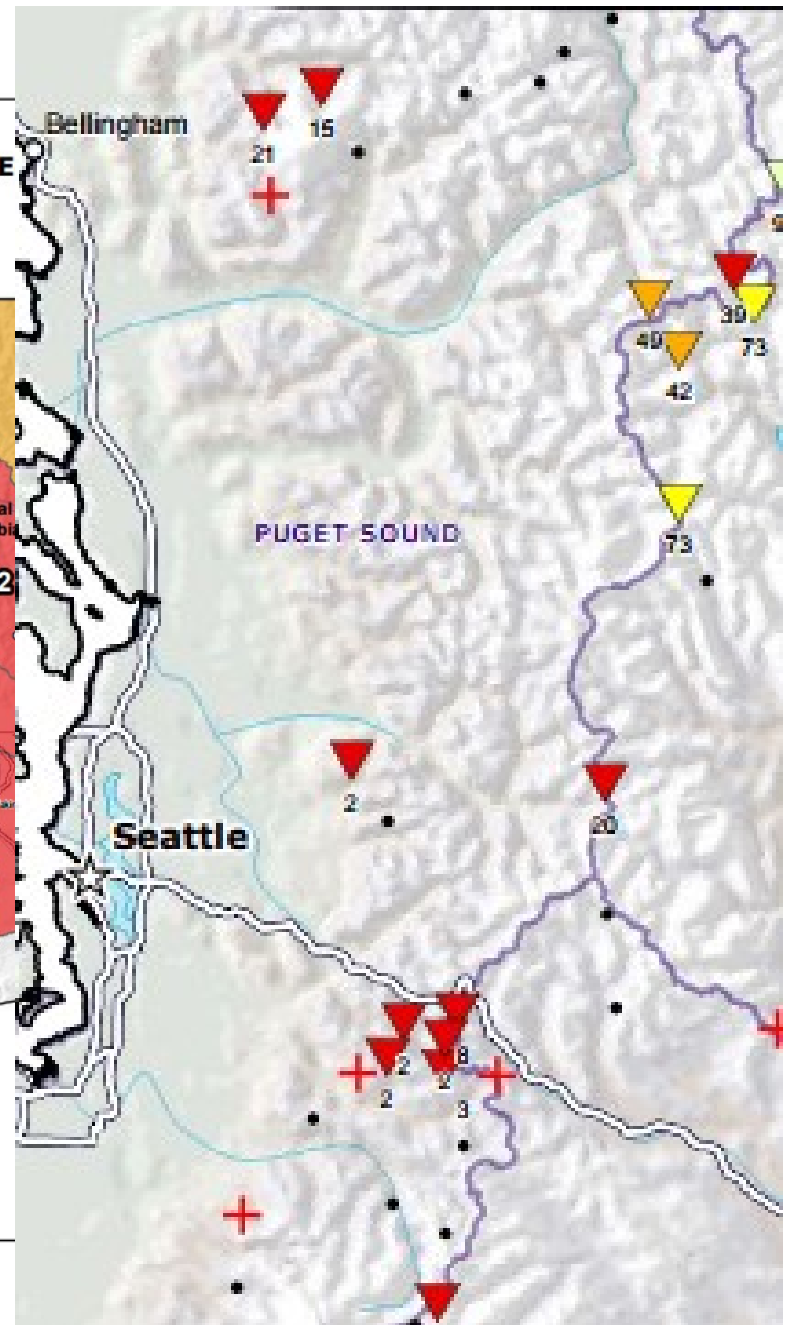
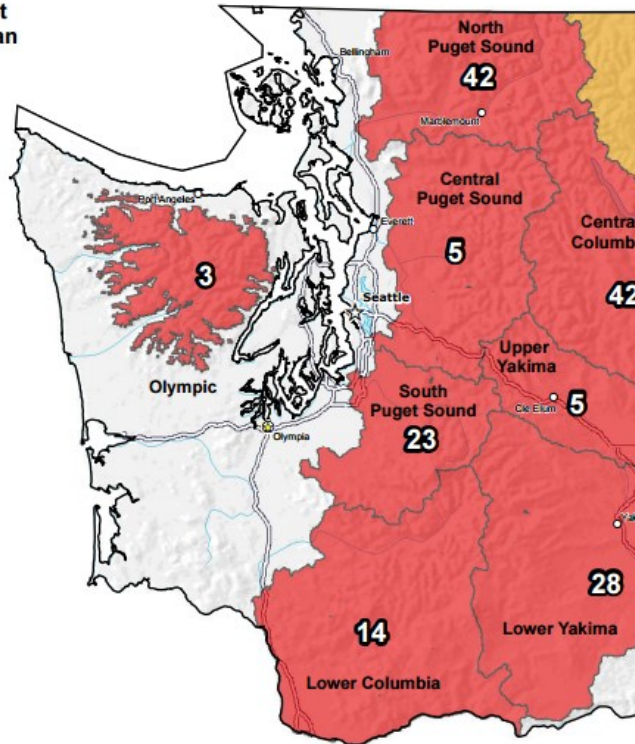


* Data unavailable at time
of posting or measurement
is not representative at this
time of year

*Provisional Data
Subject to Revision*



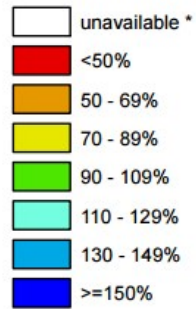
The snow water equivalent percent of normal represents the current snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).



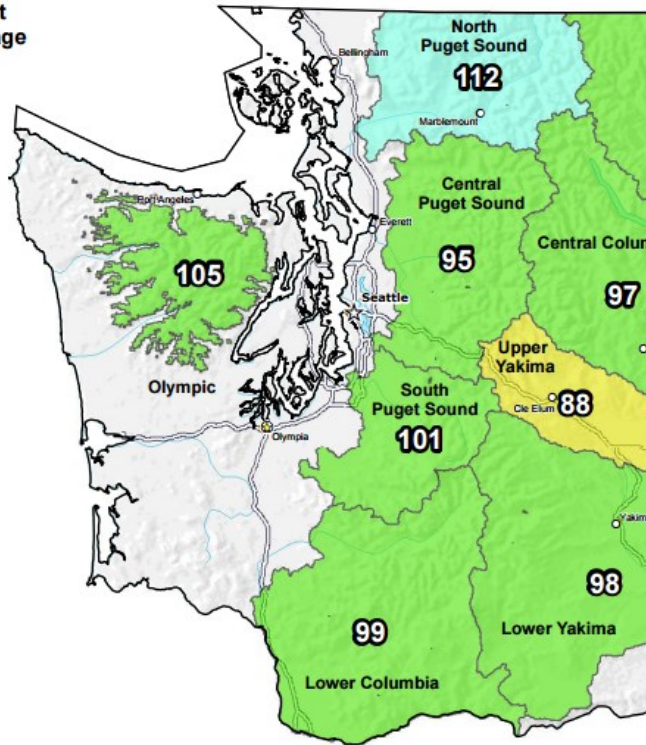
Washington SNOTEL Water Year (Oct 1) to Date

Apr 01, 2015

**Water Year (Oct 1)
to Date Precipitation
Basin-wide Percent
of 1981-2010 Average**



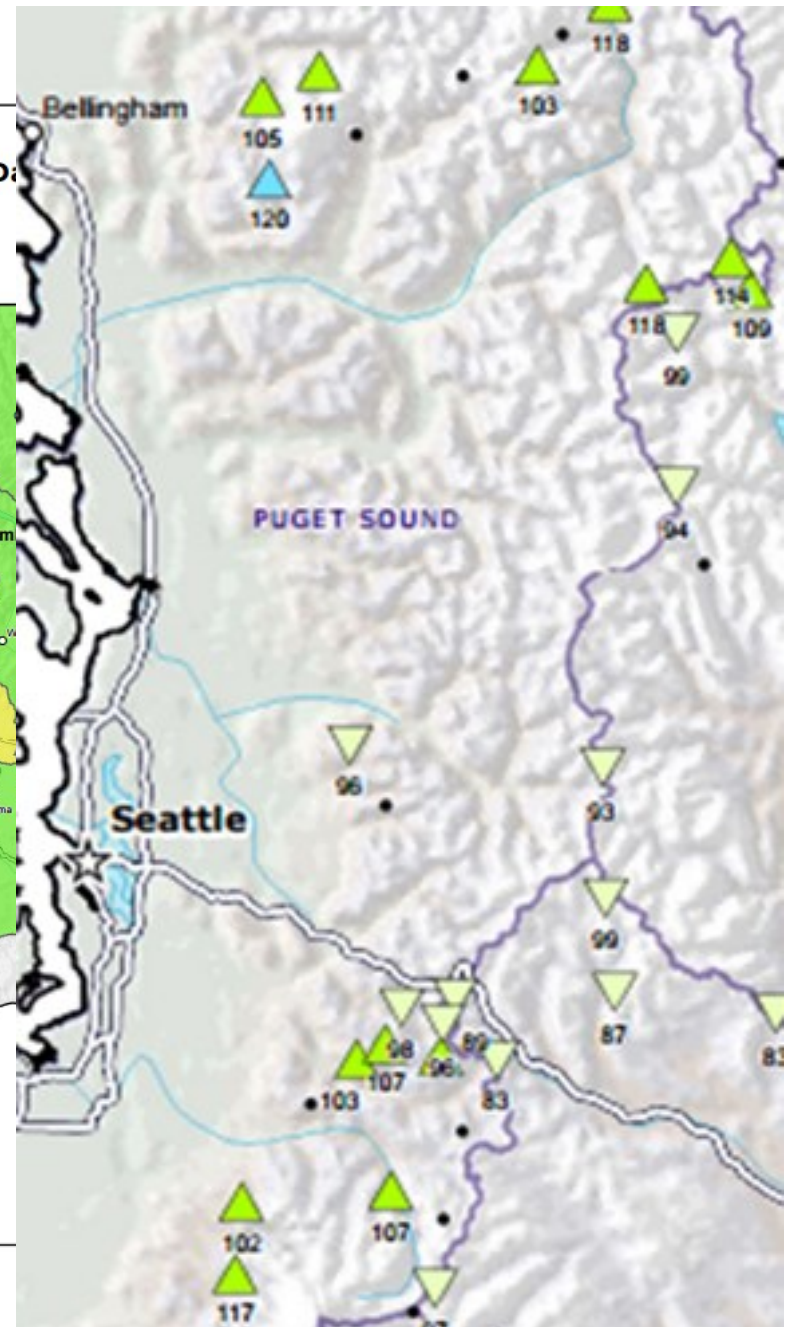
* Data unavailable at time of posting or measurement is not representative at this time of year



*Provisional Data
Subject to Revision*



The water year to date precipitation percent of normal represents the accumulated precipitation found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).





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FXUS66 KSEW 182340
AFDSEW

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE SEATTLE WA
300 PM PST TUE NOV 18 2014

.SYNOPSIS...AS AN UPPER RIDGE MOVES EAST TONIGHT AND WEDNESDAY...THE COLD AND DRY WEATHER WILL COME TO AN END. A WEAK FRONTAL SYSTEM WILL MOVE THROUGH THE AREA WEDNESDAY NIGHT AND ANOTHER STRONGER SYSTEM WILL MOVE THROUGH ON FRIDAY. CONDITIONS TO WESTERN WA. WEATHER AREA THROUGH EARLY NEXT WEEK.

&&

.SHORT TERM...A SHARP UPPER LOW MOVE EAST THIS EVENING AND IN SHORTWAVE TROUGH AND ITS ASSOCIATED WEDNESDAY NIGHT AND BRING ANOTHER BEING HAVING. TEMPERATURES WILL ACROSS THE AREA WITH THIS FRONT SWITCH FROM SOUTHEASTERLY TO THE COLD FRONTAL PASSAGE AND INTERIOR AS WELL.

THURSDAY AND THURSDAY NIGHT A SHORTWAVE TROUGH MOVES TO THE TROUGH MOVES INTO NORTHERN CA MOSTLY CLOUDY.

ON FRIDAY...ANOTHER SLIGHTLY MOVE INTO WESTERN WASHINGTON. LOWER...POSSIBLY IN THE 4000 PRECIPITATION IN THE MOUNTAINS HOWEVER...UNCERTAINTY IN THE LOCALLY WINDY CONDITIONS WILL LOWER PRESSURE IN THE NORTH

&&

LONG TERM...A SERIES OF WEAK SATURDAY THROUGH MONDAY NIGHT AREA. TUESDAY...THE ECMWF HAS STREAM HITTING THE NORTHWEST LOW DEVELOPING OFF THE COAST SYSTEM MOVING INTO THE NORTH WE WILL SEE IF EITHER OF THESE

&&

.HYDROLOGY...RIVER FLOODING

&&

.AVIATION...A STRONG UPPER LOW WASHINGTON THROUGH TONIGHT. WILL MAINTAIN DRY EASTERLY LOW MASS WILL REMAIN DRY AND STABLE WITH UNRESTRICTED VFR CONDITIONS. HIGH CLOUDS WILL CONTINUE OVER THE AREA THIS EVENING...IN ADVANCE OF AN APPROACHING COLD FRONT. CLOUD LAYERS WILL GRADUALLY LOWER TO AROUND 10000 FEET LATE TONIGHT THROUGH WEDNESDAY. THE COLD FRONT WILL MOVE ACROSS W WA WEDNESDAY NIGHT WITH CIGS LOWERING TO MVFR TO IFR LEVELS.

KSEA...HIGH CLOUDS WILL CONTINUE OVER THE AREA THOUGH 08Z WITH UNRESTRICTED VISIBILITY. MID LEVEL CLOUDS AROUND 10000 FEET WILL INCREASE AFTER 08Z...AHEAD OF A DEVELOPING FRONT OFFSHORE. SURFACE WINDS WILL BE 6 KT OR LESS FAVORING E TO SE. KAM



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For warnings and/or advisories in effect for adjacent areas to this point,
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Forecast For Lat/Lon: 47.2960/-121.4680 (Elev. 4303 ft)
9 Miles SSW Snoqualmie Pass WA
Forecast Created at: 9am PST Nov 19, 2014

Custom Weather Forecast Table																												
Weather	Wed Nov 19				Thu Nov 20				Fri Nov 21				Sat Nov 22				Sun Nov 23				Mon Nov 24				Tue Nov 25			
	Chance Snow		Snow		Chance Rain Showers				Rain and Snow	Rain Showers	Likely Snow	Chance Snow			Likely Snow				Chance Snow	Chance Rain and Snow								
Daily-Temp	High 39 Low 32				High 39 Low 30				High 40 Low 33				High 36 Low 30				High 35 Low 30				High 38 Low 31				High 40 Low 32			
Chance of Precip	5%	10%	45%	75%	50%	40%	15%	10%	75%	90%	85%	85%	65%	65%	50%	50%	45%	45%	30%	30%	65%	65%	65%	65%	30%	30%	30%	30%
Precip	0.00"	0.00"	0.01"	0.26"	0.02"	0.01"	0.00"	0.00"	0.06"	0.13"	0.26"	0.28"	0.26"	0.26"	0.19"	0.12"	0.23"	0.10"	0.03"	0.13"	0.12"	0.35"	0.33"	0.18"	0.21"	0.23"	0.18"	0.1
12-hr Snow Total	0"		2"		0"		0"	0"	0"		0"	0"	4"		2"		2"		1"		3"		4"		3"		0"	
6-Hour Temp	4am 36	10am 35	4pm 36	10pm 41	4am 36	10am 35	4pm 36	10pm 34	4am 37	10am 35	4pm 37	10pm 35	4am 38	10am 33	4pm 33	10pm 33	4am 37	10am 33	4pm 32	10pm 33	4am 35	10am 35	4pm 36	10pm 33	4am 37	10am 37	4pm 37	10pm 34
Cloudiness	81%	85%	95%	97%	80%	81%	71%	54%	93%	95%	99%	99%	78%	78%	85%	85%	87%	87%	85%	85%	90%	90%	86%	86%	83%	83%	91%	91%
Dewpoint	12	11	24	15	29	29	31	29	31	32	30	30	31	30	29	29	30	30	29	29	30	30	30	31	31	33	33	32
Relative Humidity	41%	35%	65%	51%	88%	78%	81%	82%	88%	82%	80%	97%	97%	87%	88%	100%	94%	86%	85%	93%	90%	82%	81%	92%	89%	85%	86%	94%
Wind	E 20	E 21	E 21	E 21	SW 2	W 12	W 5	E 9	E 13	E 16	W 14	W 15	NW 12	W 12	W 9	W 15	W 10	W 10	W 14	W 14	SW 18	SW 18	SW 22	W 16	W 15	W 8	S 8	S 8
Snow Level (ft)	3124	5067	3450	1919	5081	4936	4793	4608	4374	4559	4428	4428	3929	3929	3415	3415	3320	3320	3550	3550	3971	3971	4253	4253	3259	3259	4705	4705

Forecast Weather Table Interface

Select Weather Format

- ☒ Custom Weather Table
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☐ Point Forecast Page
☐ Point Forecast Matrix
☐ Hourly Tabular Forecast
☐ Hourly Weather Graph

Interval in Hours: ☐ 1 ☐ 3 ☐ 6

Duration in Days: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

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UW WRF-GFS 36km Domain

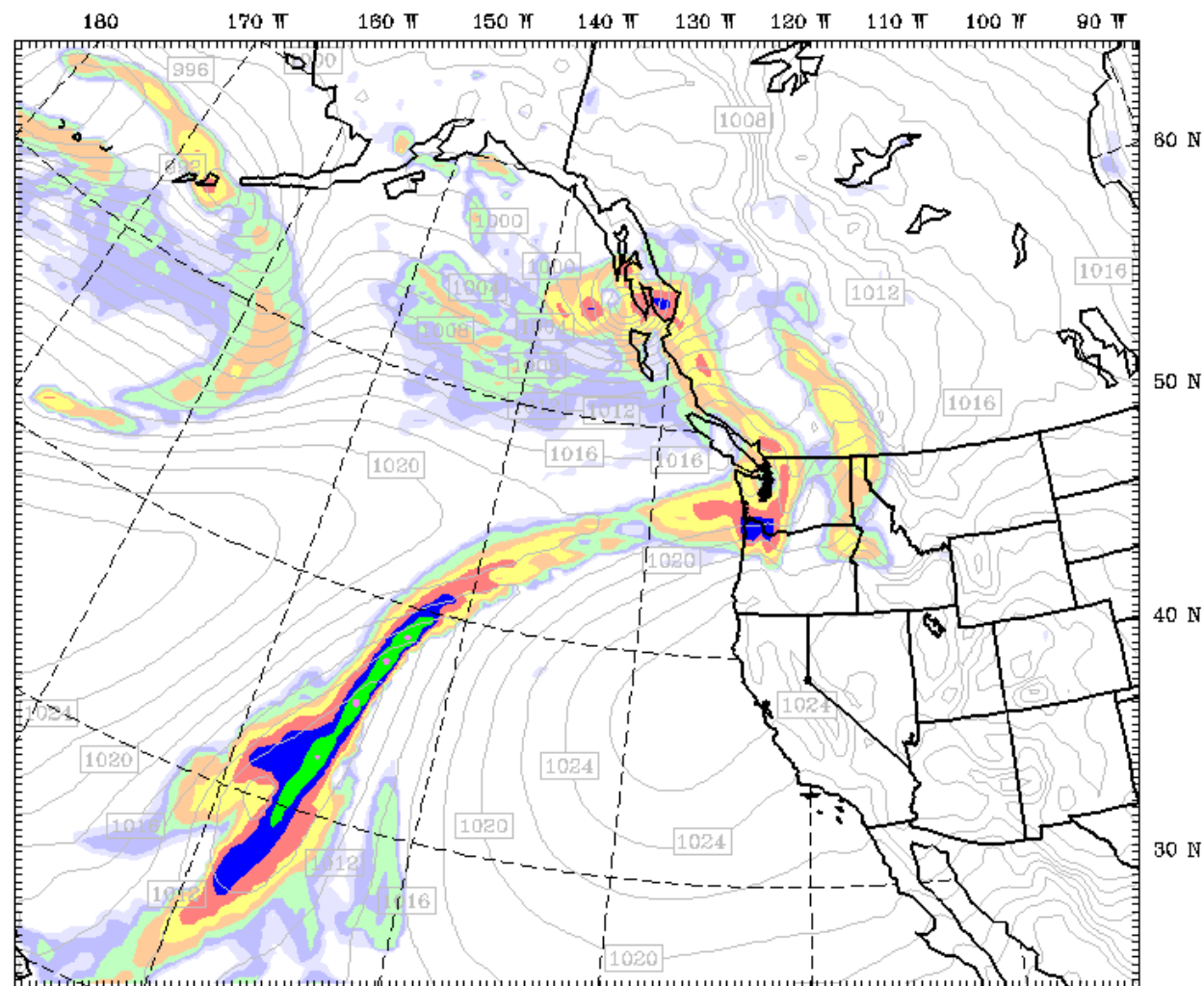
Init: 12 UTC Wed 19 Nov 14

Fcst: 144 h

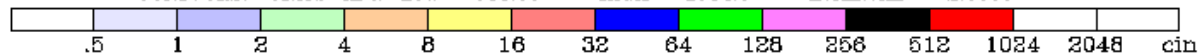
Valid: 12 UTC Tue 25 Nov 14 (04 PST Tue 25 Nov 14)

Total Precip in past 3 hrs (.01in)

Sea Level Pressure (hPa)



CONTOURS: UNITS=hPa LOW= 988.00 HIGH= 1034.0 INTERVAL= 2.0000



Model Info: V3.5

SAS Sch YSU PBL Thompson Noah LSM 36 km, 37 levels, 216 sec

LW: RRTM SW: RRTMG DIFF: simple KM: 2D Smagor

UW WRF-GFS 36km Domain

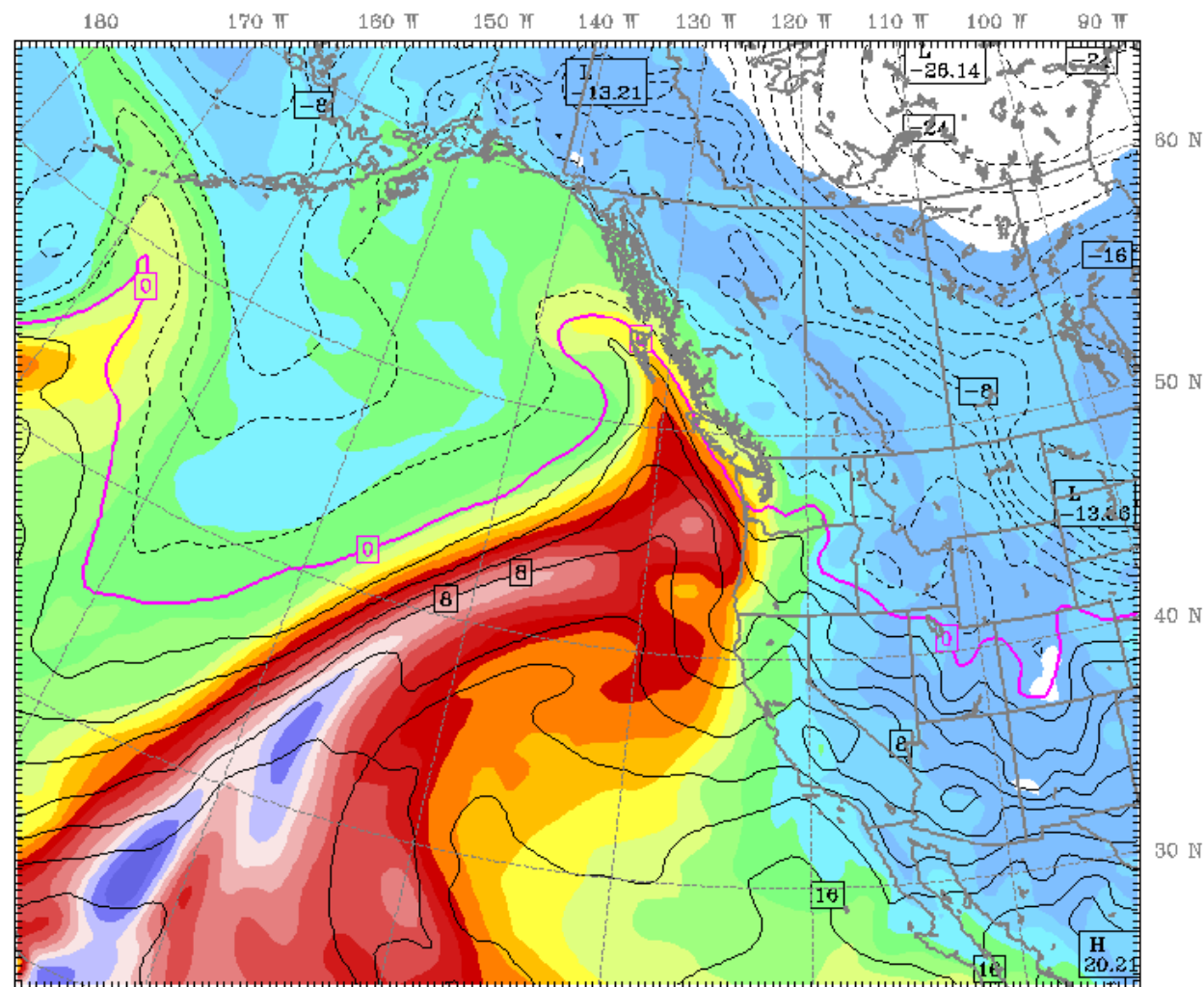
Init: 12 UTC Wed 19 Nov 14

Fcst: 132 h

Valid: 00 UTC Tue 25 Nov 14 (16 PST Mon 24 Nov 14)

Column-integrated water vapor (mm)

850 mb Temperature (C)



CONTOURS: UNITS=°C LOW= -26.000 HIGH= 20.000 INTERVAL= 2.0000

0	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75	82.5	90	mm
---	-----	----	------	----	------	----	------	----	------	----	------	----	----

Model Info: V3.5 SAS Sch YSU PBL Thompson Noah LSM 36 km, 37 levels, 216 sec
LW: RRTM SW: RRTMG DIFF: simple KM: 2D Smagor

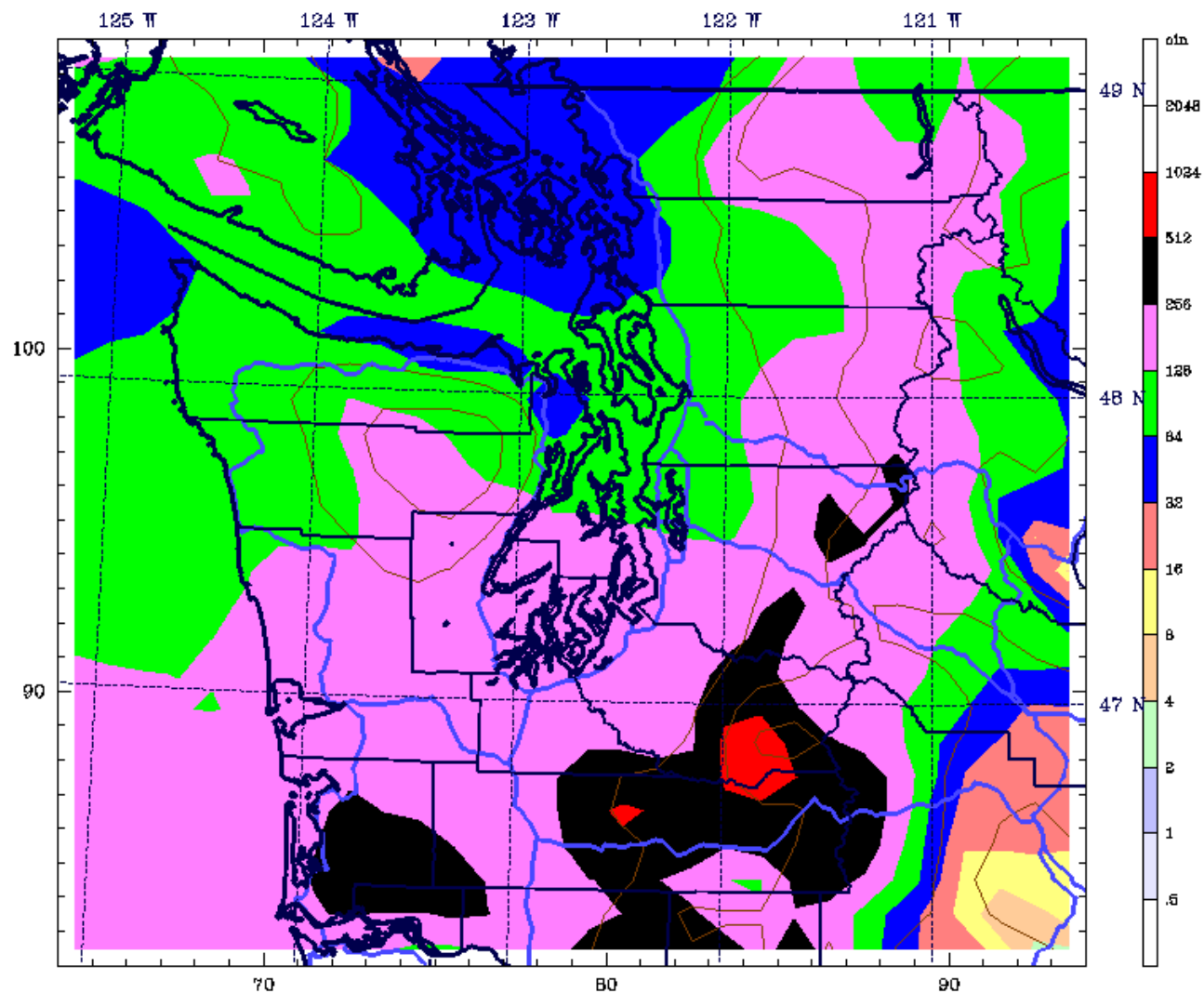
UW WRF-GFS 12km Domain

Init: 12 UTC Wed 19 Nov 14

Fcst: 156 h

Valid: 00 UTC Wed 26 Nov 14 (16 PST Tue 25 Nov 14)

Total Precip in past 24 hrs (.01in)



Model Info: V3.5 SAS Sch YSU PBL Thompson Noah LSM 12 km, 37 levels, 72 sec
LW: RRTM SW: RRTMG DIFF: simple KM: 2D Smagor

UW WRF-GFS 1.33km Domain

Init: 12 UTC Mon 27 Oct 14

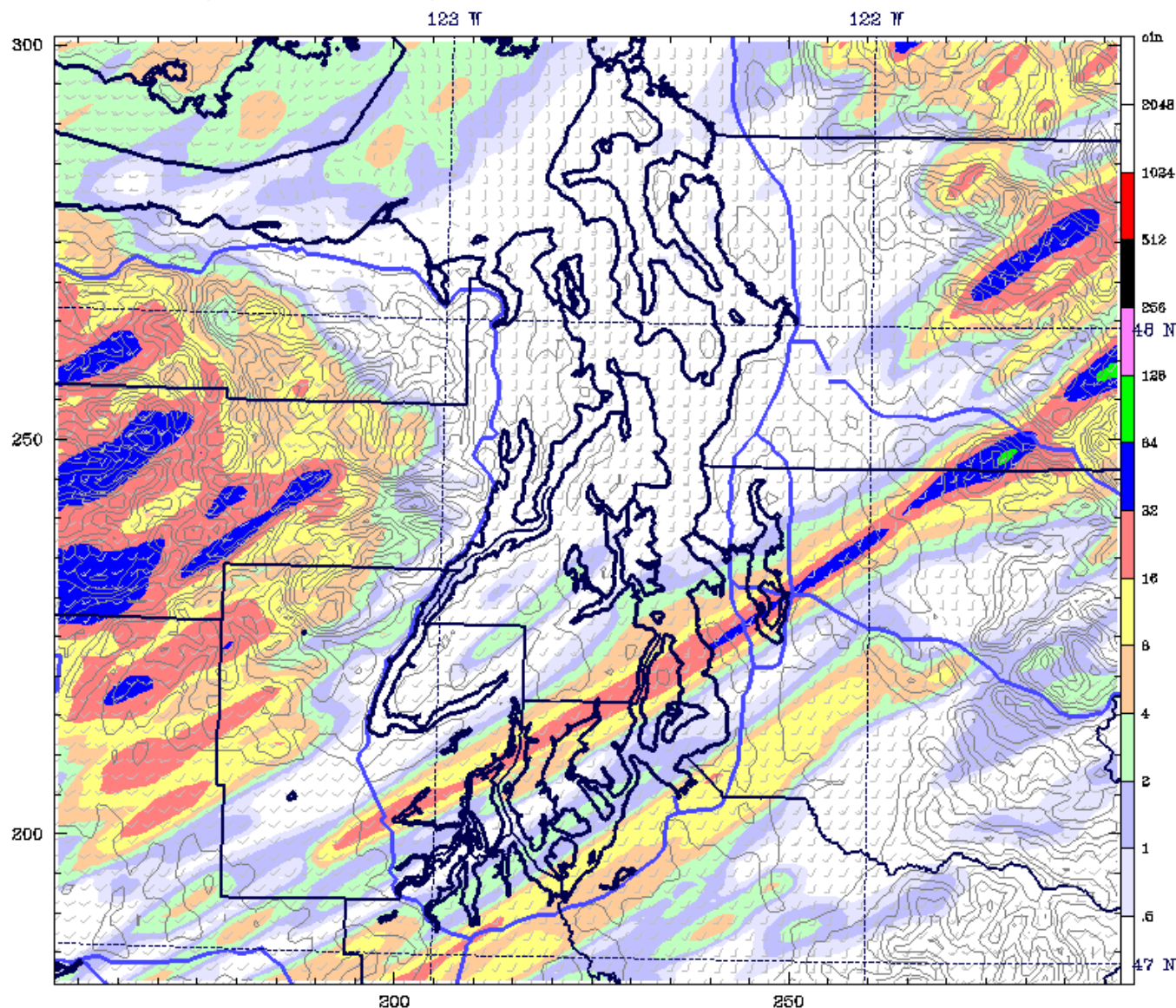
Fcst: 42.00 h

Valid: 06 UTC Wed 29 Oct 14

(23 PDT Tue 28 Oct 14)

Total Precip in past 3 hrs (.01in)

Wind at 10m (full barb = 10kts)



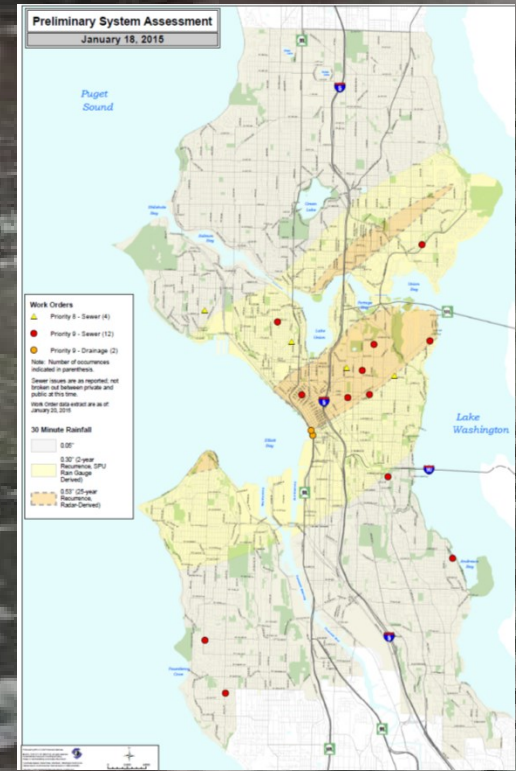
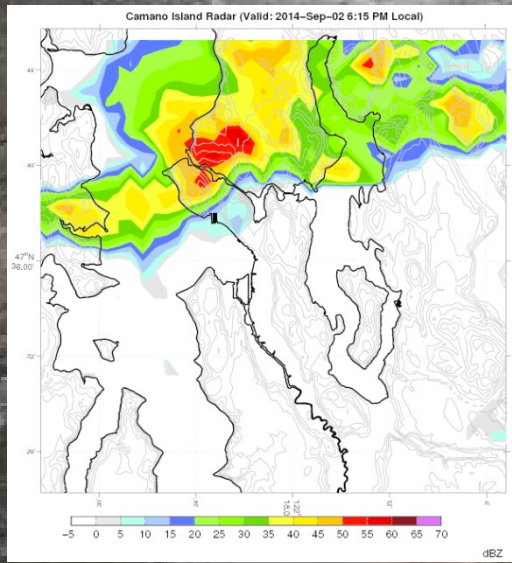
Model Info: V3.5

No Cu YSU PBL Thompson

Noah LSM 1.3 km, 37 levels,

8 sec

LW: RRTM SW: RRTMG DIFF: simple KM: 2D Smagor



radar reflect.

instant. precip

1hr pcpr

6hr pcpr

12hr pcpr

24hr pcpr

48hr pcpr

1hr pcpr FCST

radar reflect. FCST

Obs Table

QPF Table

zoom level: full domain | greater metro | local metro

Zoom level:

full domain | greater metro | local metro

Start animation:



Animation Speed:

☐ Faster ☒ Slower ☐ 4 fps

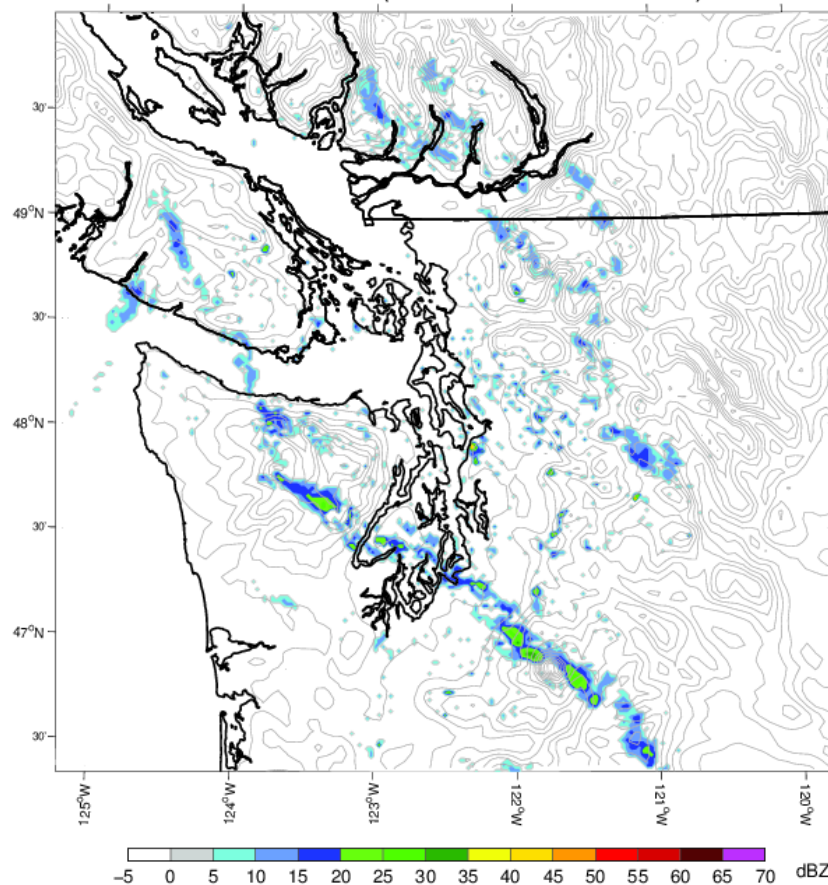
Time (UTC):

11/19/2014 19:34 UTC

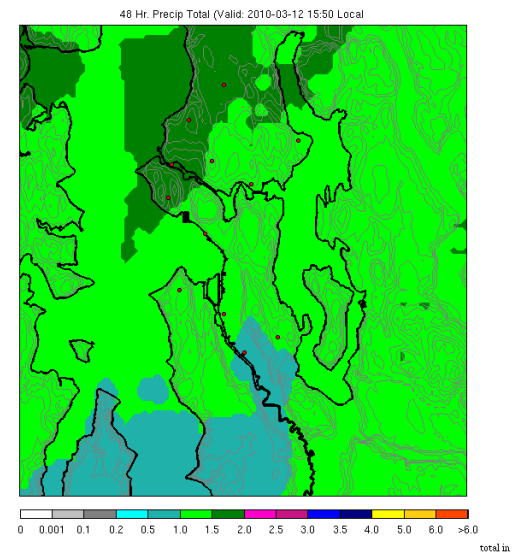
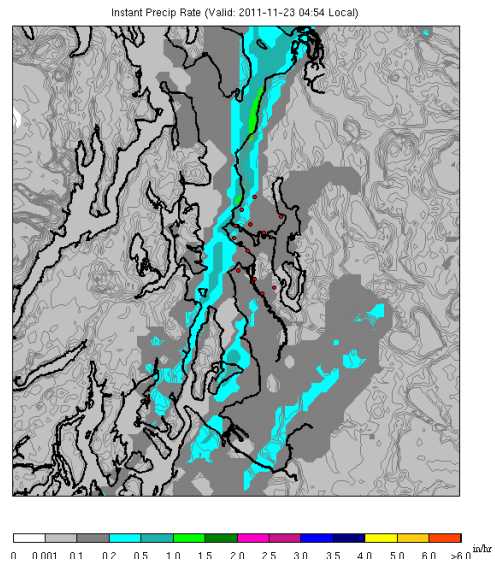
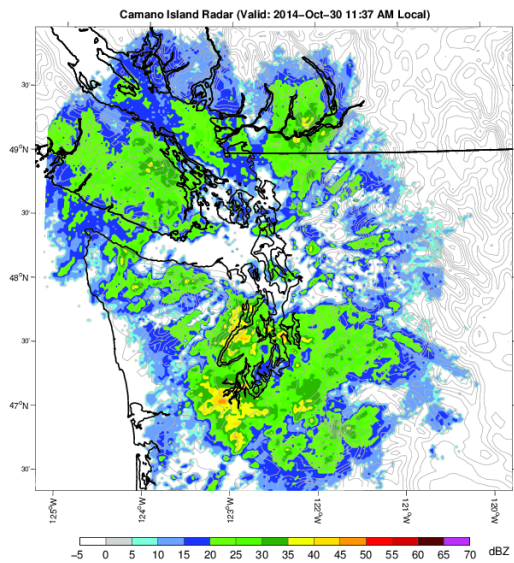
Time (local):

11/19/2014 11:34 PST

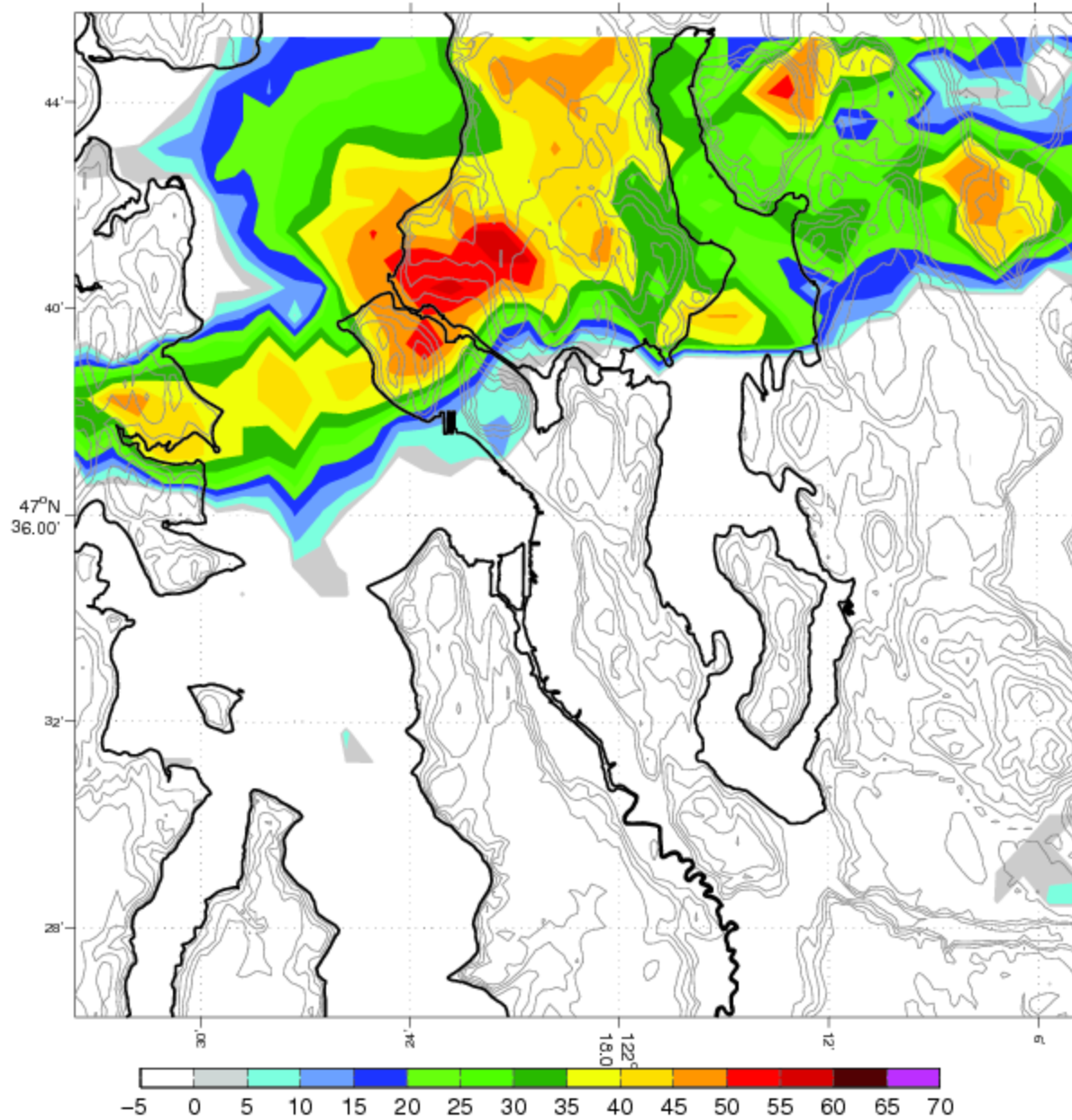
Camano Island Radar (Valid: 2014-Nov-19 11:34 AM Local)



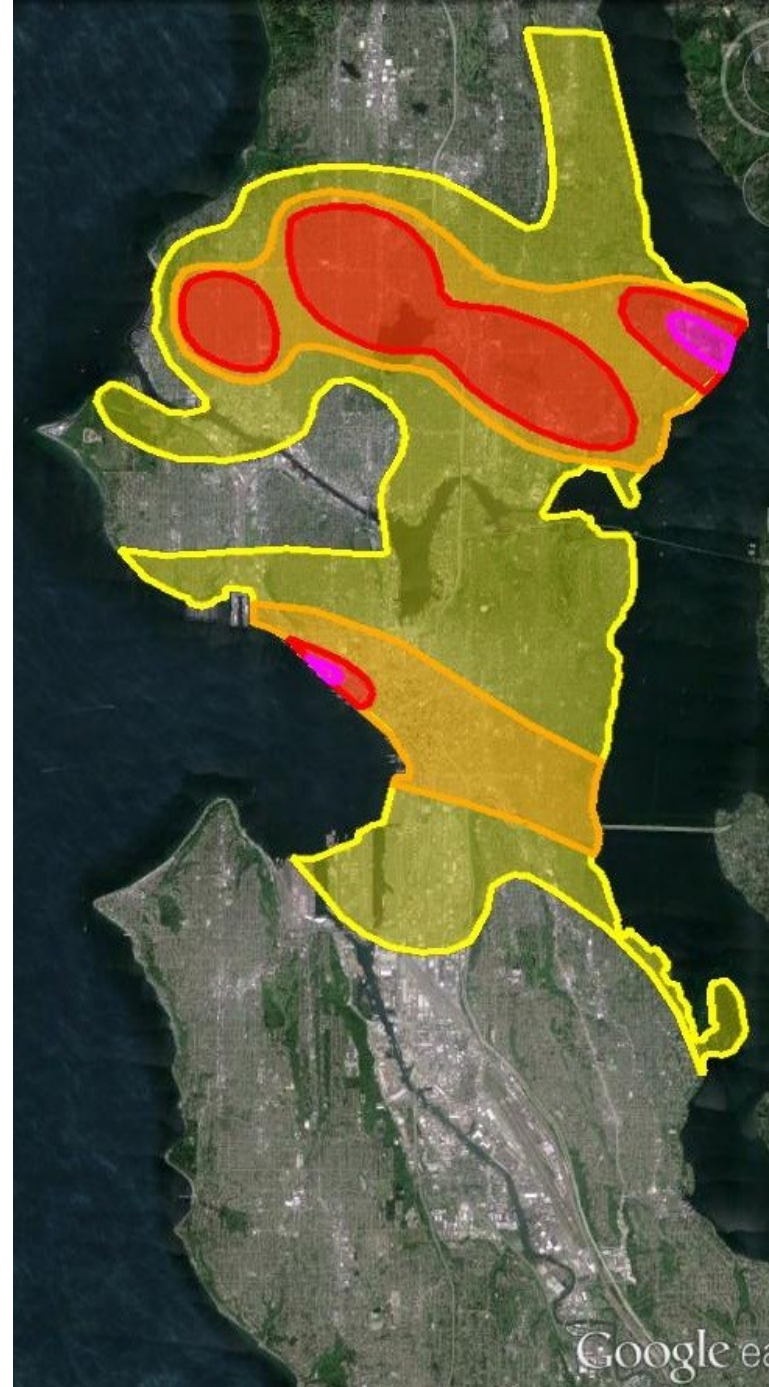
Please direct questions and comments to [Jeff Baars](#).



Camano Island Radar (Valid: 2014-Sep-02 6:15 PM Local)



dBZ











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