Prepared for OLYMPEX: A GPM Ground Validation Field Campaign in the Pacific Northwest Fall 2015/Winter 2016

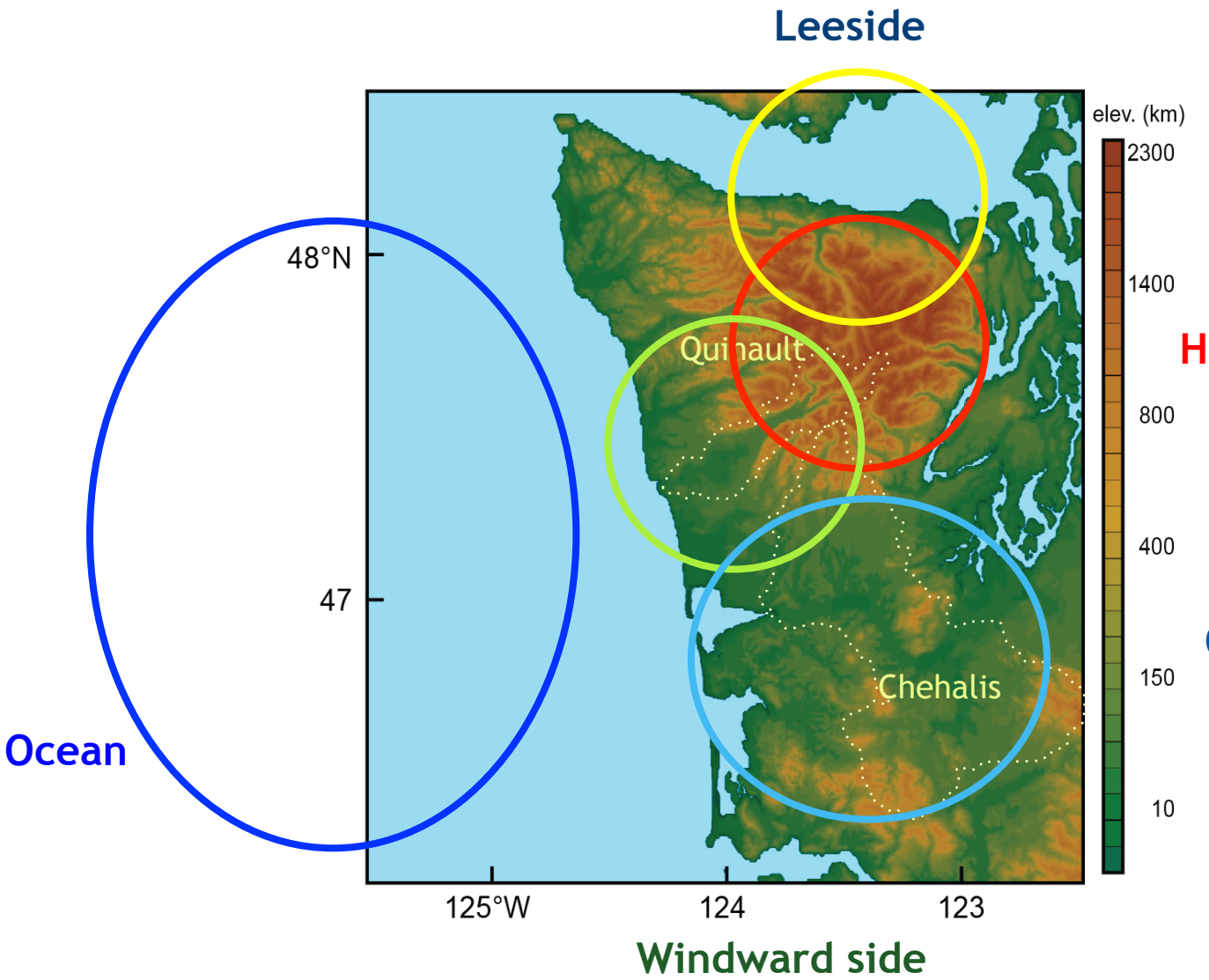
Lynn McMurdie, Robert Houze, Joe Zagrodnik, Jessica Lundquist, Cliff Mass, William Baccus, Walter Petersen, Matthew Schwaller

PMM Meeting, Baltimore, 15 July, 2015

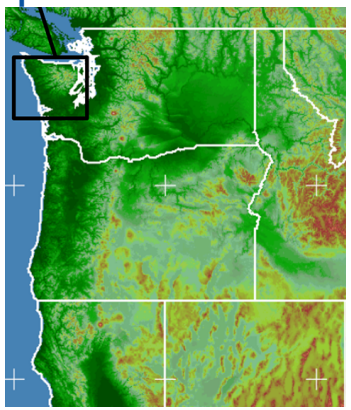
Break-out Session, Wednesday
7pm in Tuscan Room

PIZZA provided ($5-$10)
Sign up sheet

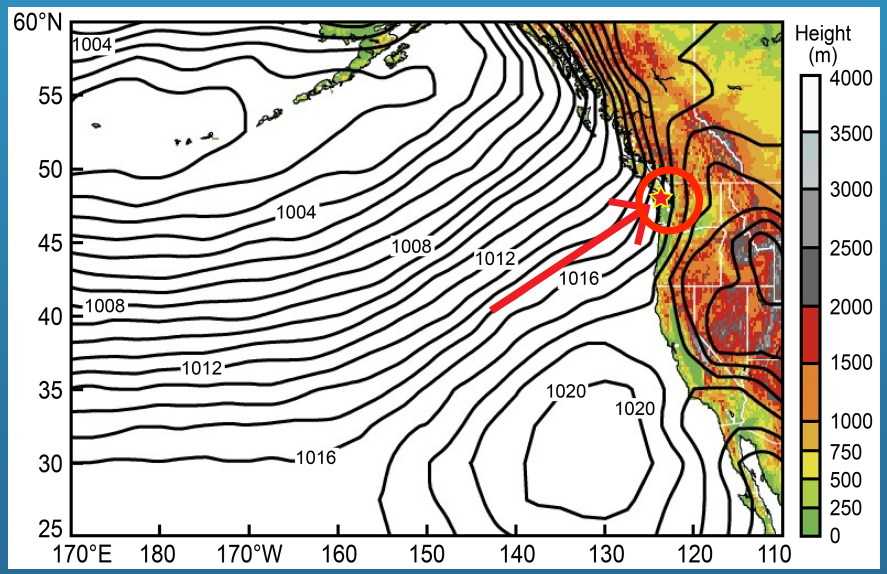
Geographical Regions



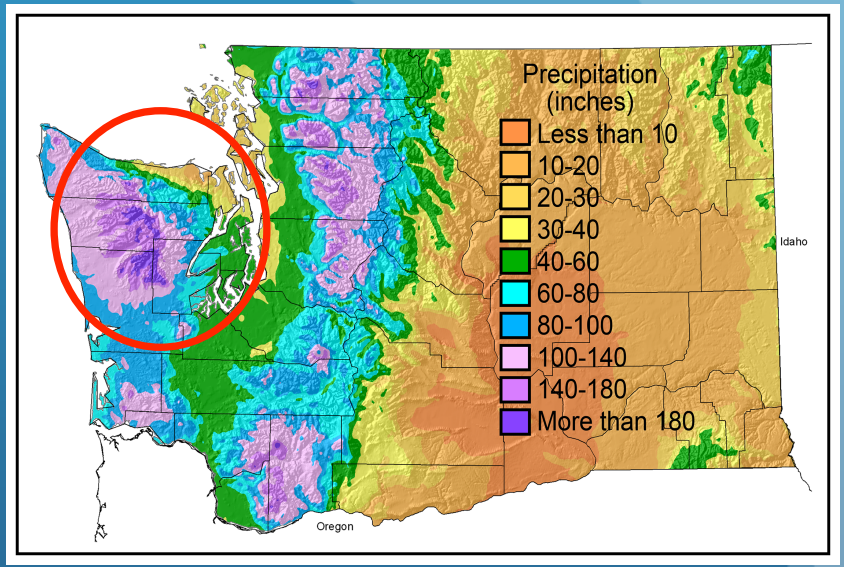
Olympic Peninsula



The Climatology of the Olympic Peninsula



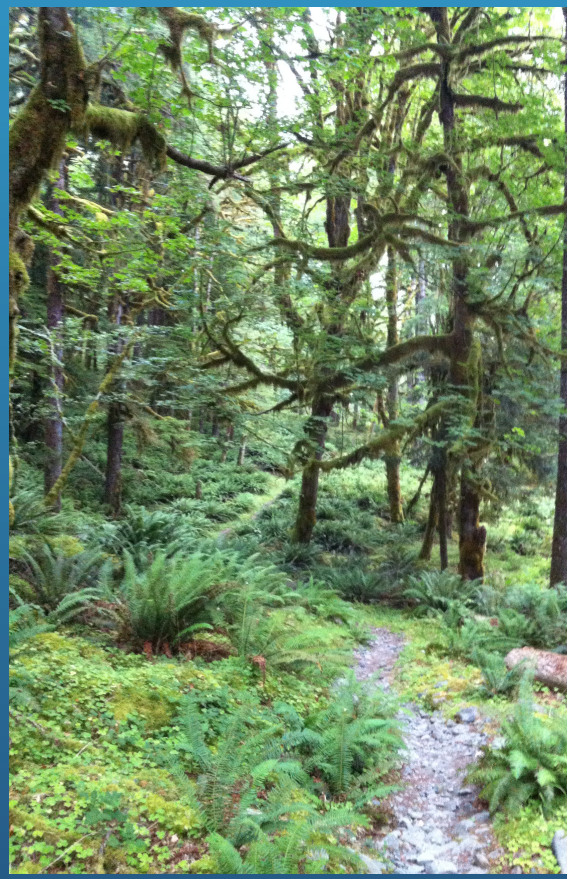
Climatology of MSLP from Nov-Feb from NCEP Reanalysis grids 1979 – 2012

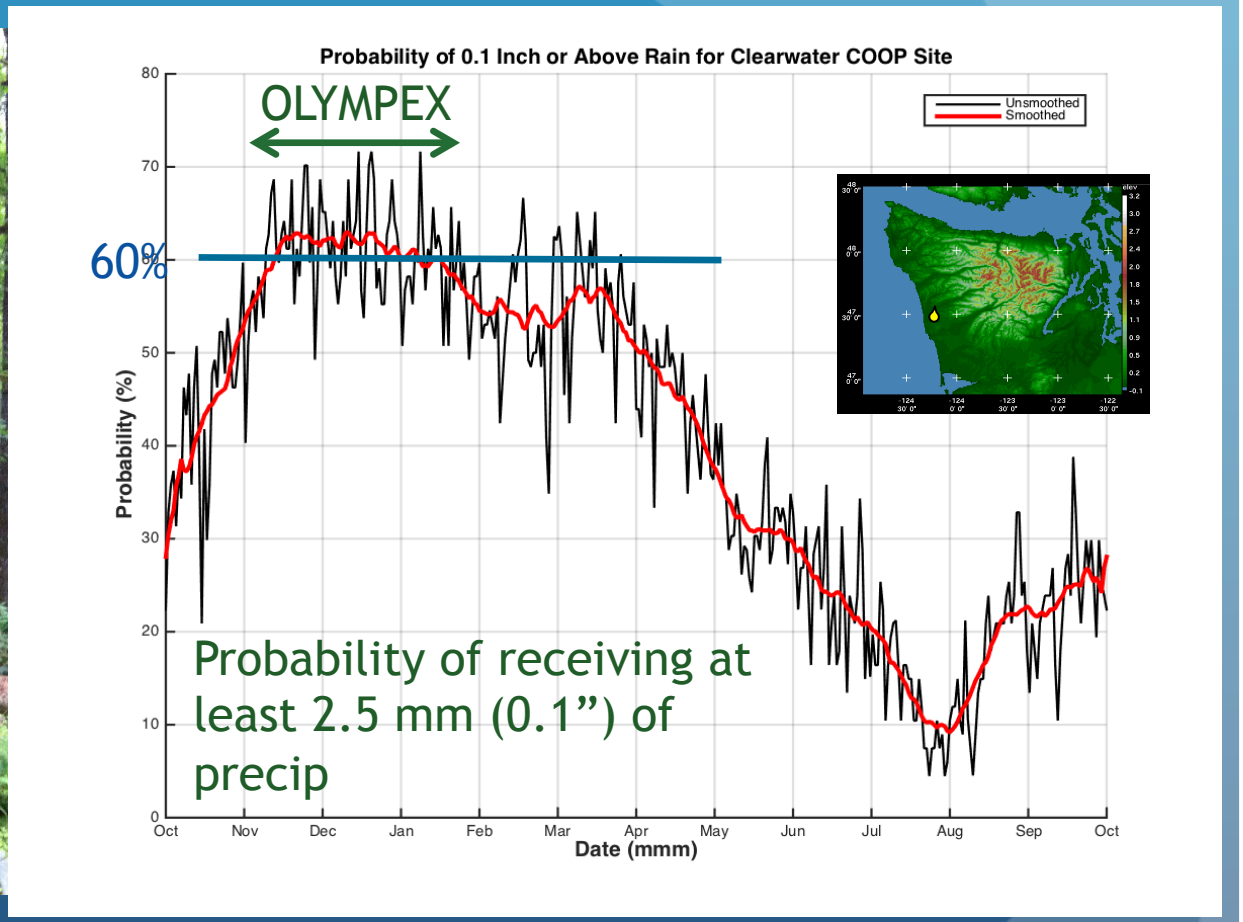


Annual average precipitation in inches from PRISM (Parameter-elevation Regressions Independent Slopes Model)

- Persistent moist onshore flow produces extraordinary annual precipitation totals
- 2500 mm (100”) on the coast and more than 4570 mm (180”) in the interior

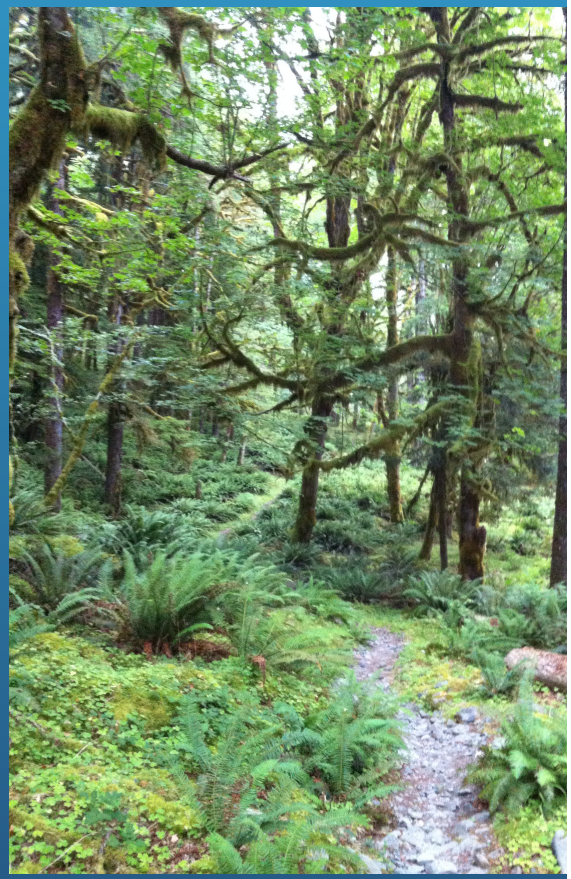
Rain Forest Climate

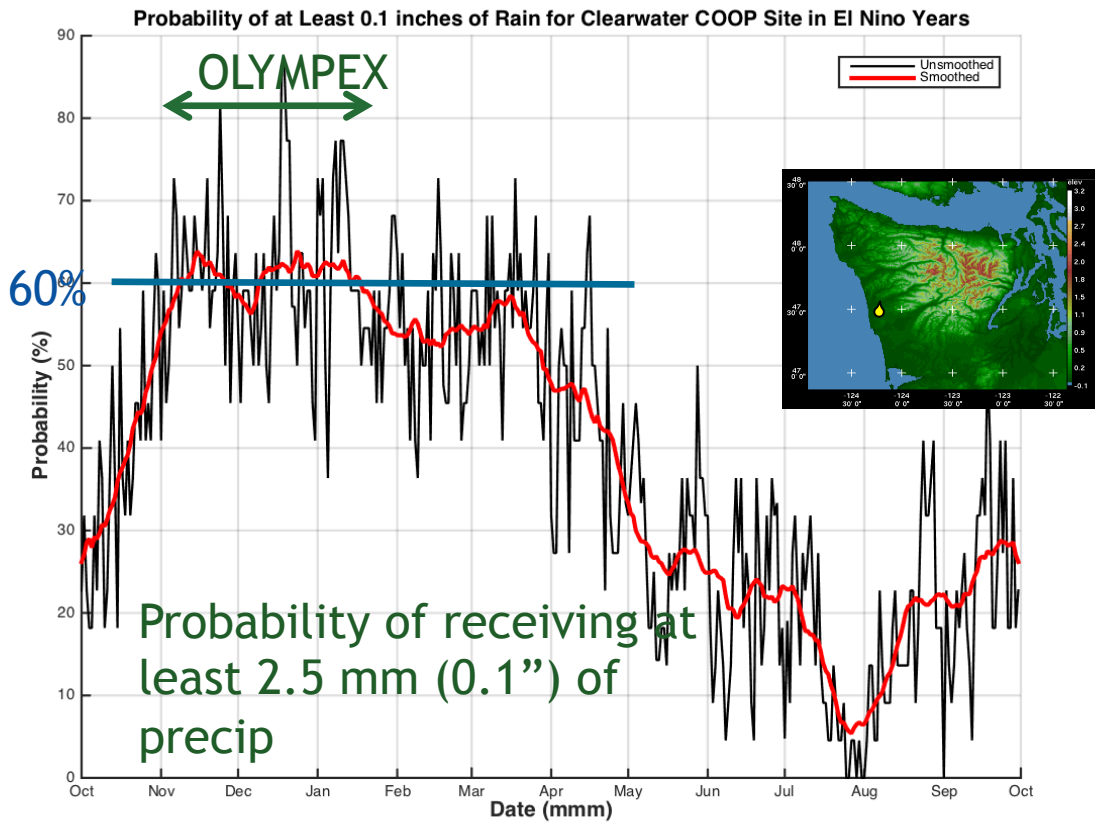




Average rainfall during Nov, Dec and Jan is 400 mm (16”) each month. Range is 75 – 750 mm (3 – 30”) from 98 years of data.

Rain Forest Climate



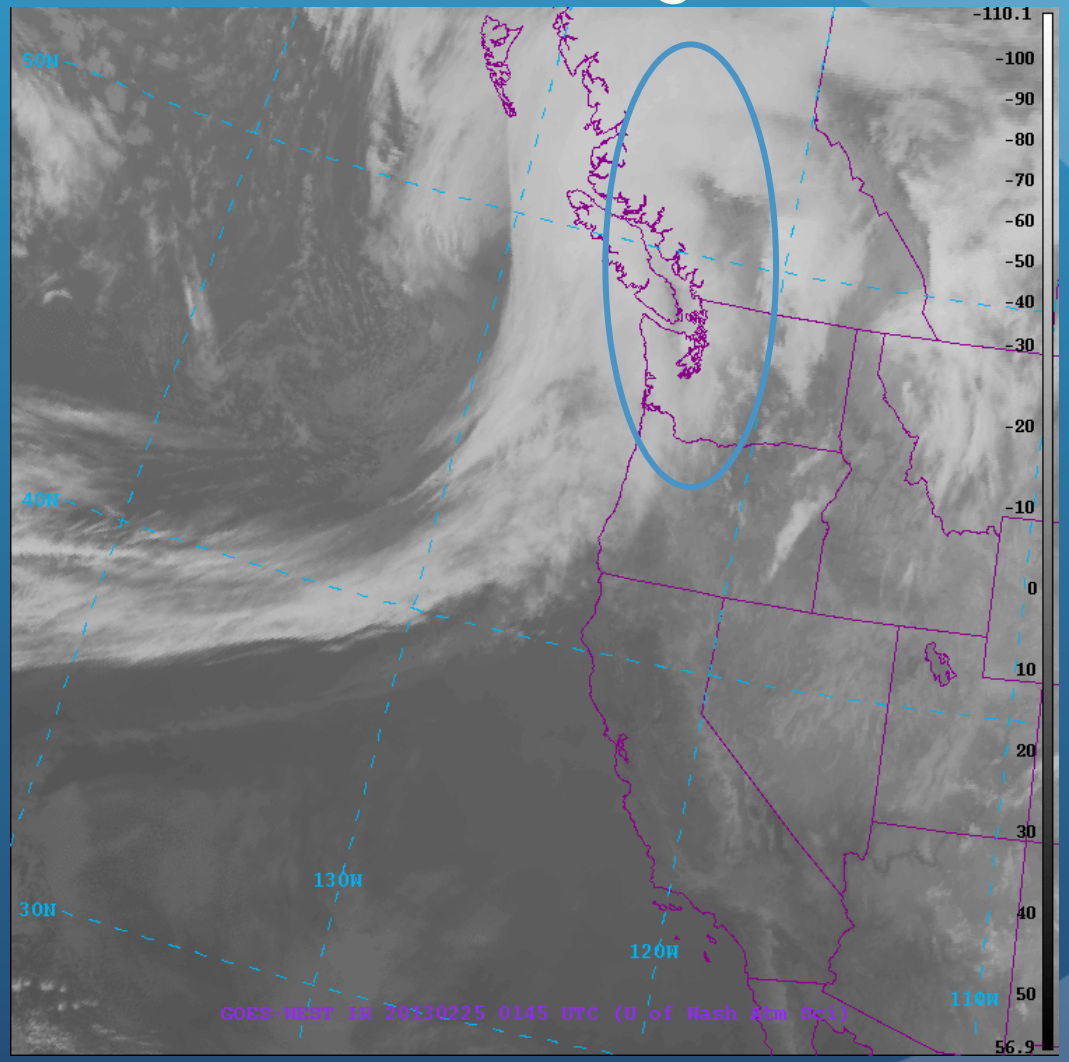


El Nino years only

Typical Frontal Passage

Three different regimes!

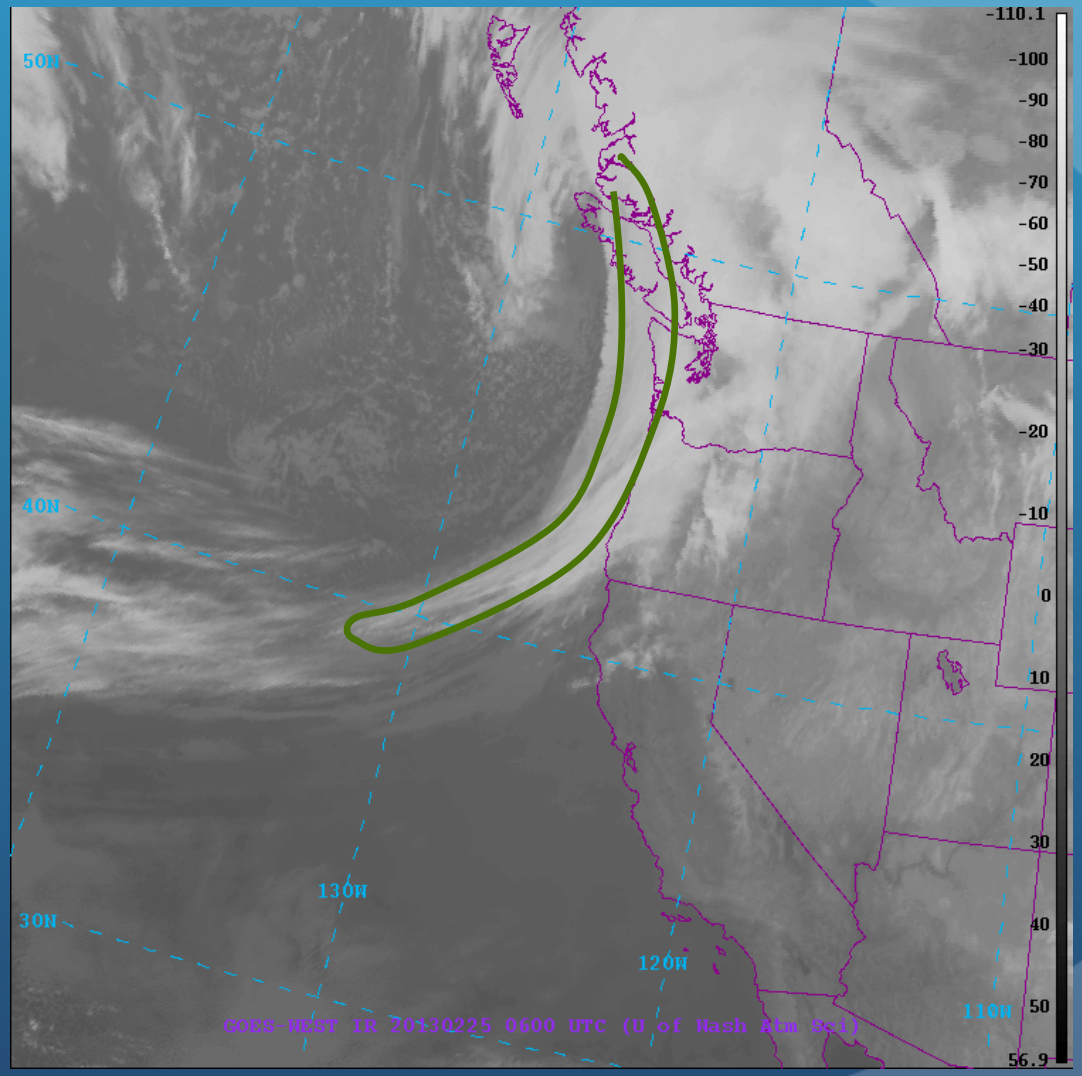
Prefrontal



Typical Frontal Passage

Three different regimes!

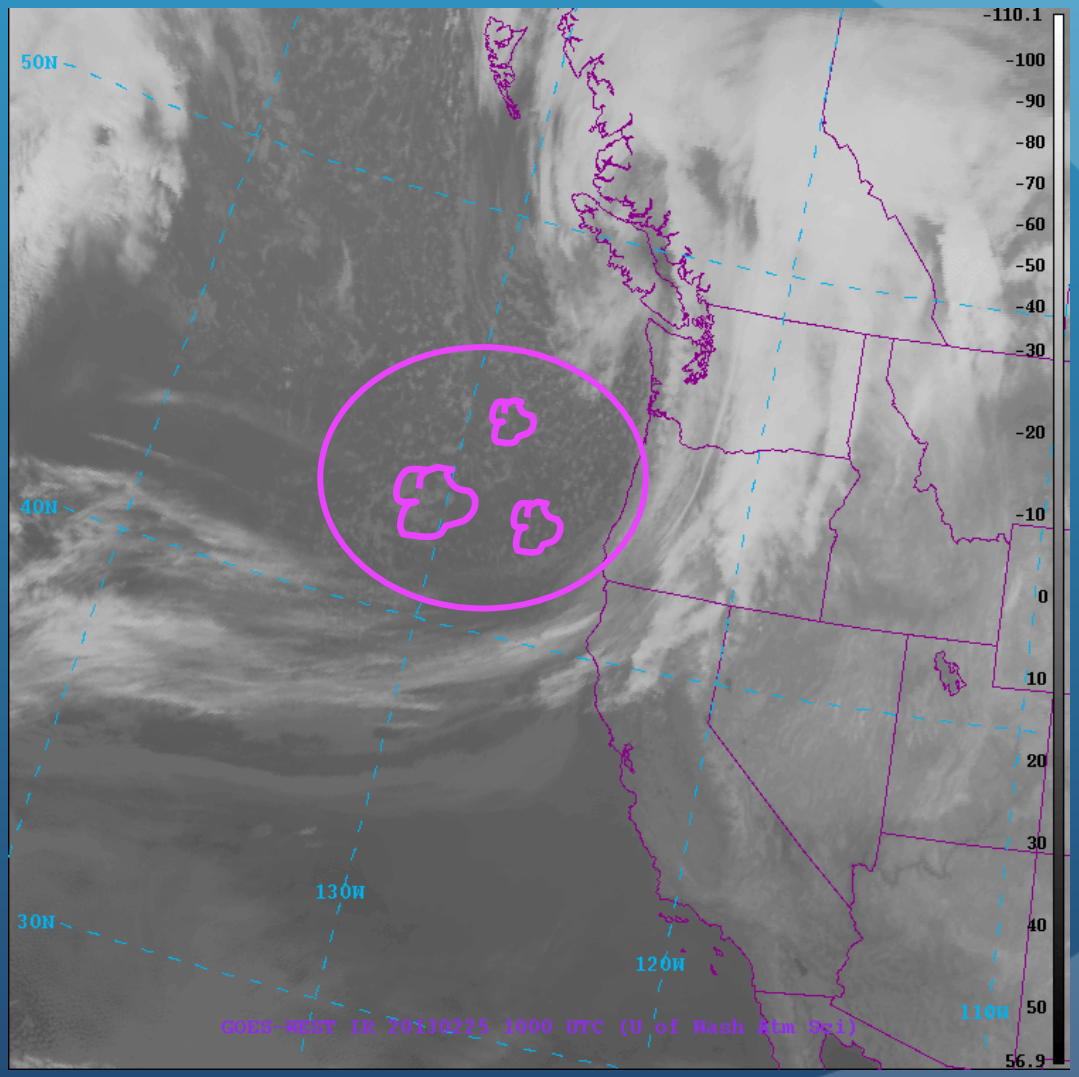
Frontal



Typical Frontal Passage

Three different regimes!

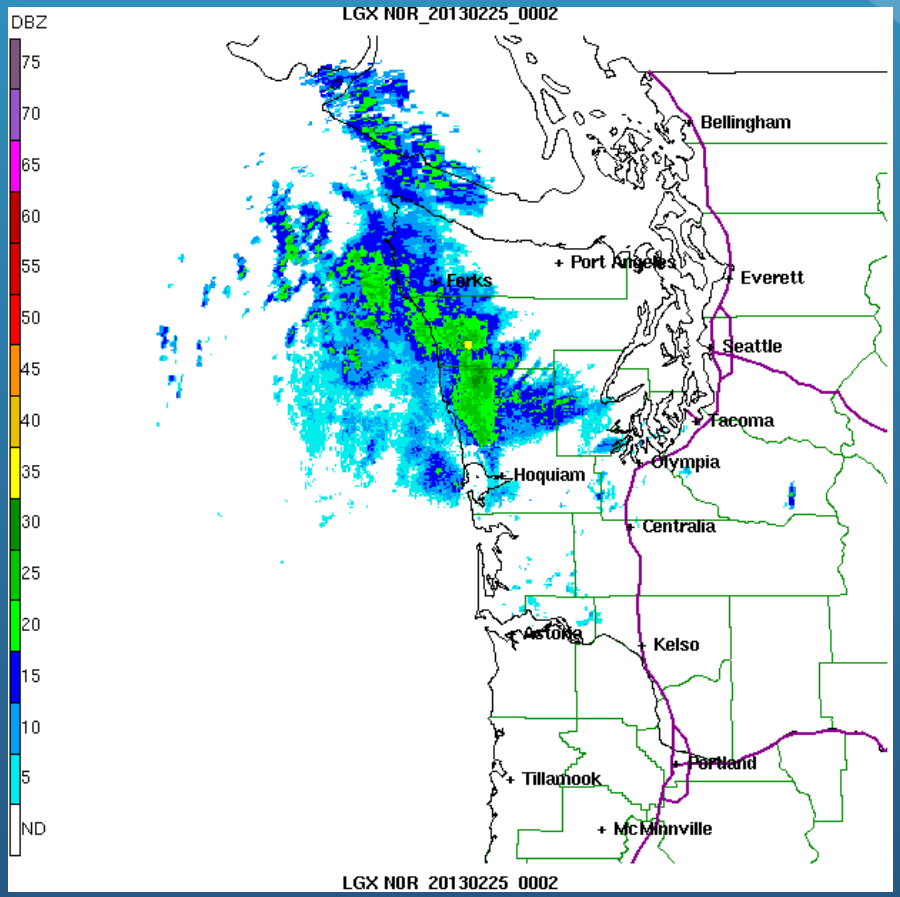
Postfrontal



Typical Frontal Passage

Three different regimes!

Prefrontal
Frontal
Postfrontal

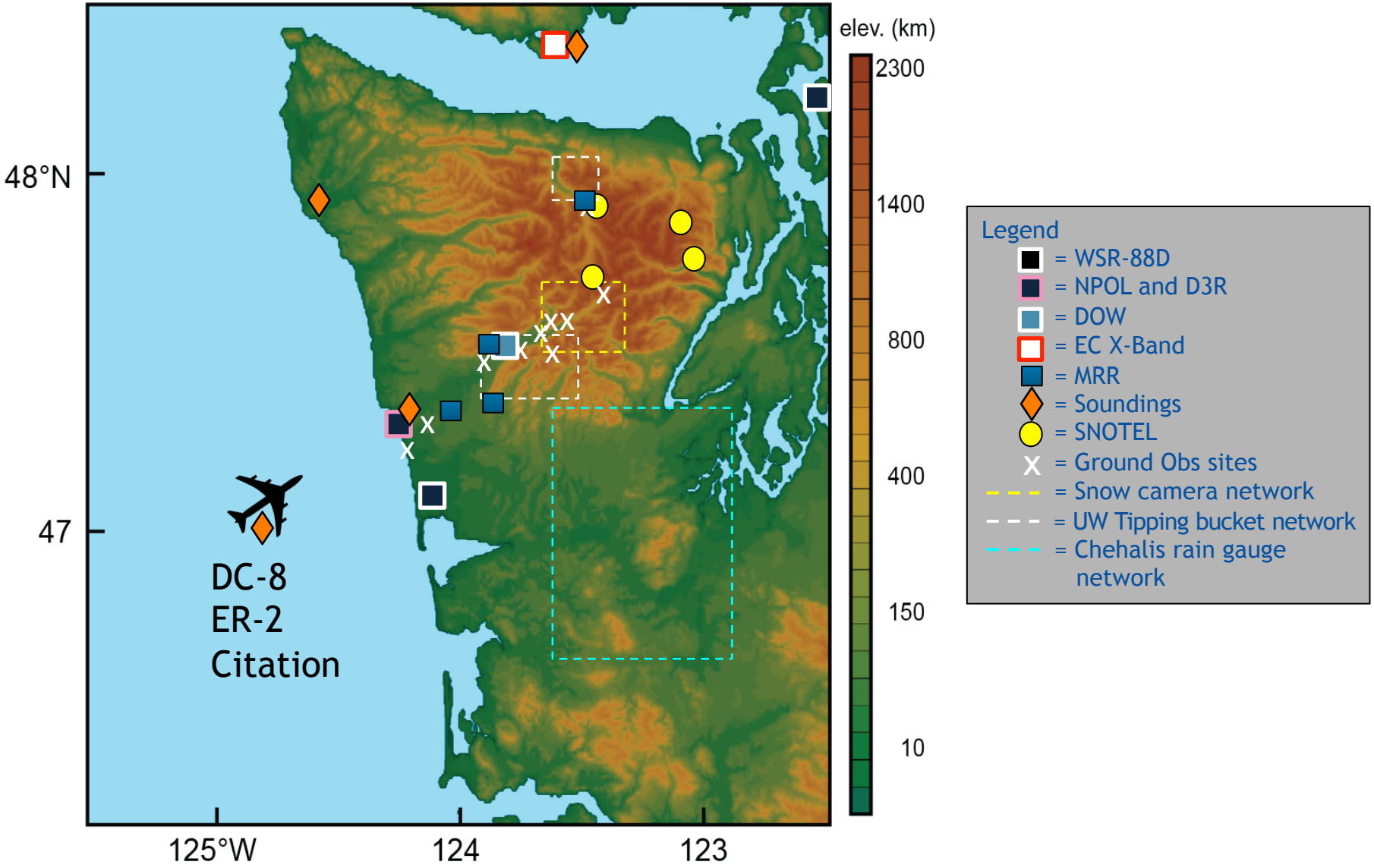


- SW side of Olympics gets rain well ahead of front
- SW side gets rain during front
- SW side gets post-frontal showers

OLYMPEX objectives

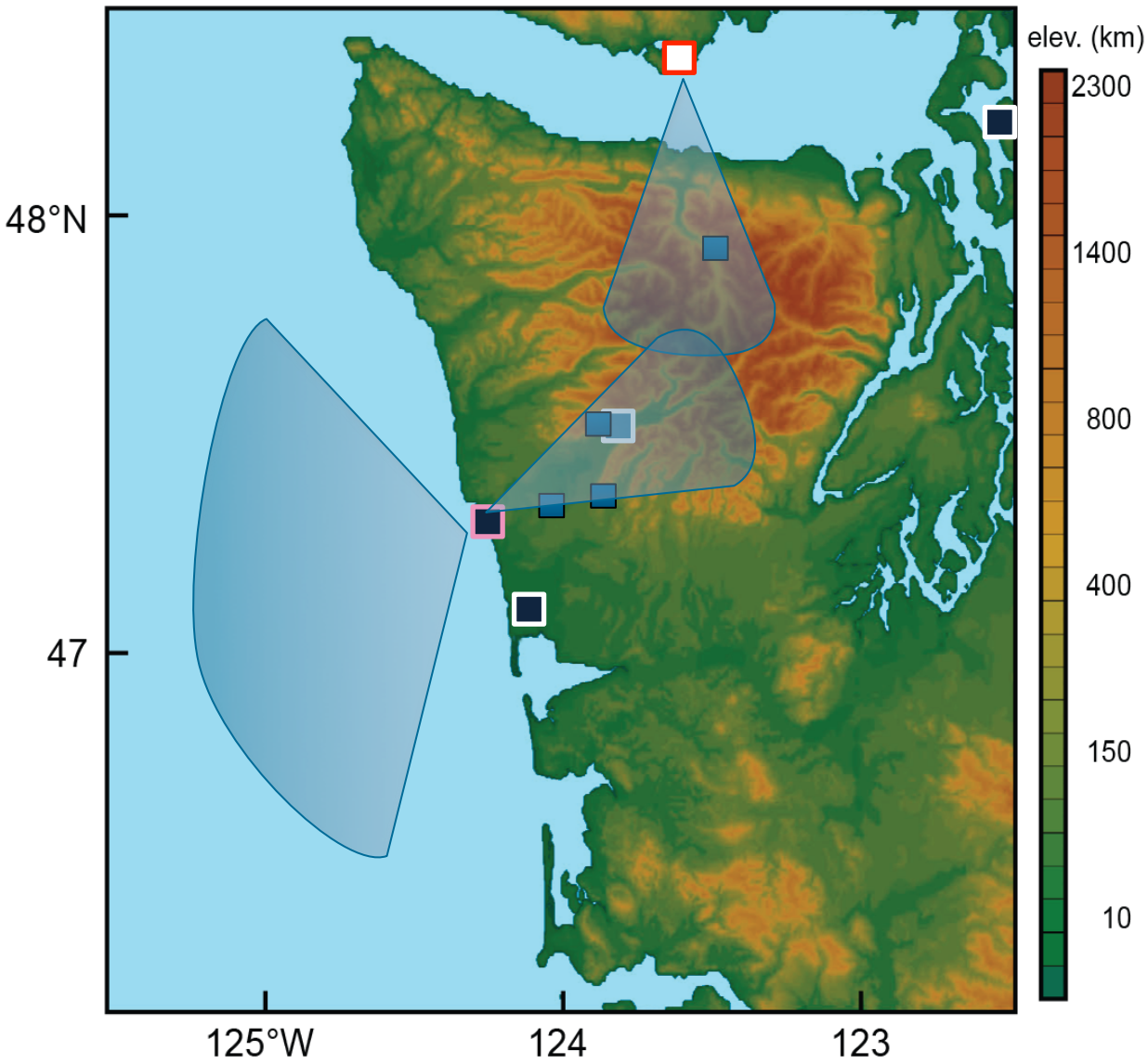
- Observe all 3 sectors of frontal systems
- Observe storm passage from ocean to coast to upslope to leeside
- Determine how precipitation processes vary between sectors
- Modification of processes by terrain
- Hydrology
- Model experiments

Network Overview



Radars

Radar coverage



Scan Strategies:

NPOL: RHI scans up Quinault Valley and over Ocean with PPIs interspersed

D3R: TBD

DOW: Scan up and down Quinault valley to document precipitation growth 'under' NPOL beam

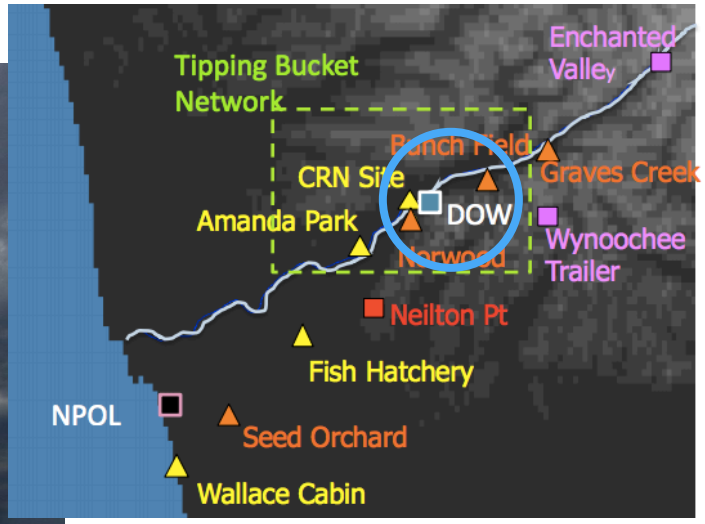
X-Band: RHI scans over Hurricane Ridge on leeside

MRR's: 3 placed in Quinault to document precip growth in lowest levels, 1 at Hurricane Ridge

NPOL/D3R Radar Site

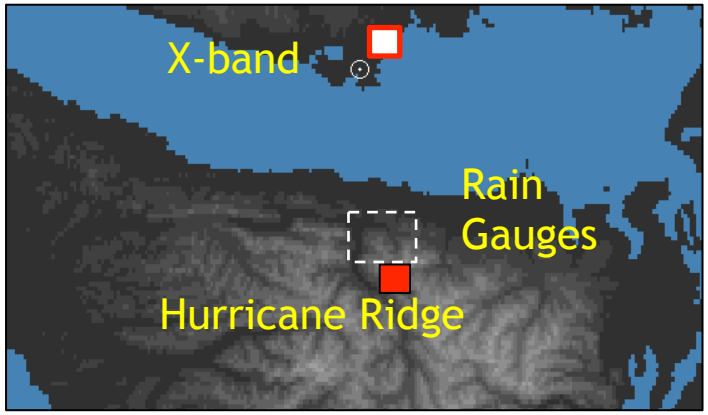
On Quinault Indian Nation land near the coast where the radar has clear views towards the Ocean and towards the Olympic Mountains and up the Quinault River

Doppler on Wheels (DOW)



Will be installed at Lake Quinault so it can make measurements where it will sample ‘under’ the lowest NPOL radar beam. It will have a range of ~40 km (can ‘see’ to NPOL and can ‘see’ to Upper Quinault Valley installation.

Canadian X-band



Will be installed at southern tip of Vancouver Island at Albert Head. It will have a range of ~50 km (can 'see' to Hurricane Ridge and rain gauge and CoCoRaHS network).

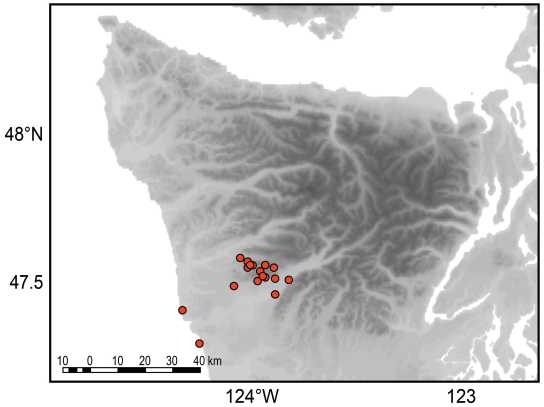
Samples leeside transition of incoming frontal systems

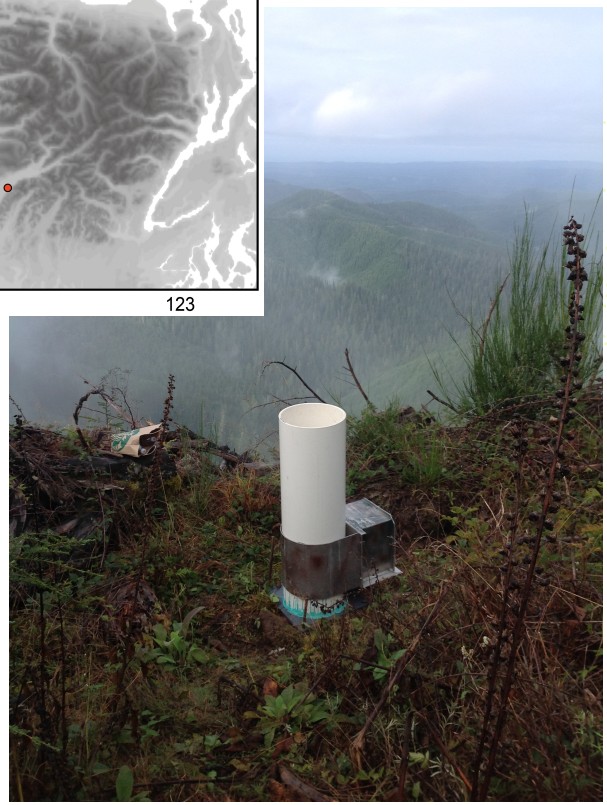
Ground instruments

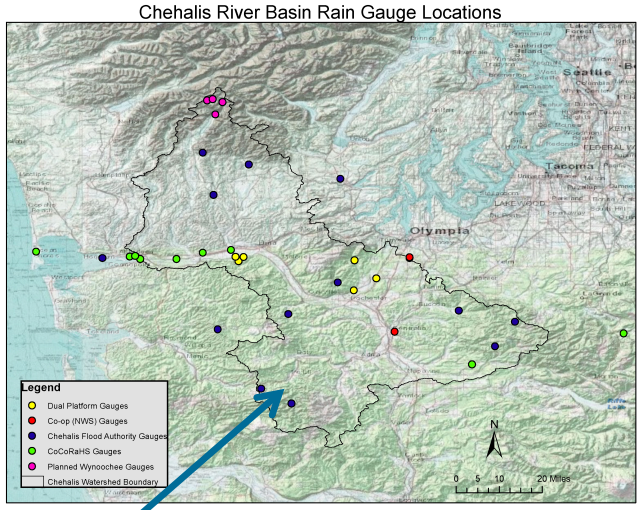
Two Rain Gauge Networks

Quinault Valley

Single bucket gauges across ridge between the Queets and Quinault. 10 dual gauges co-located with other ground instruments







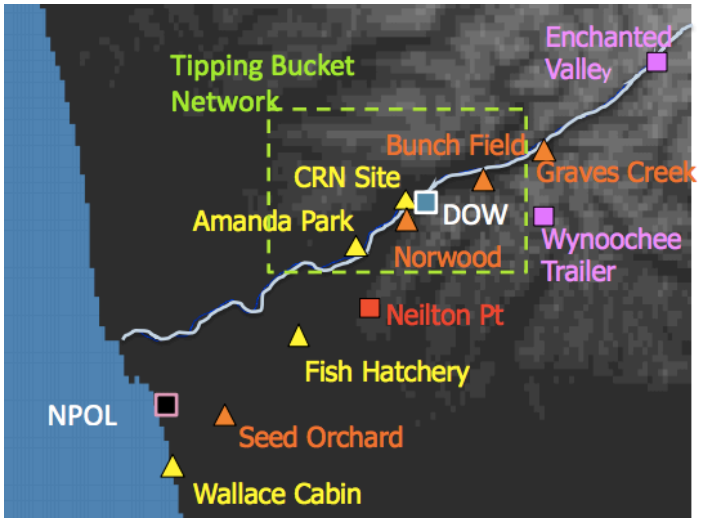
Chehalis

10 dual gauges
21 CoCoRahs sites
Coop observers

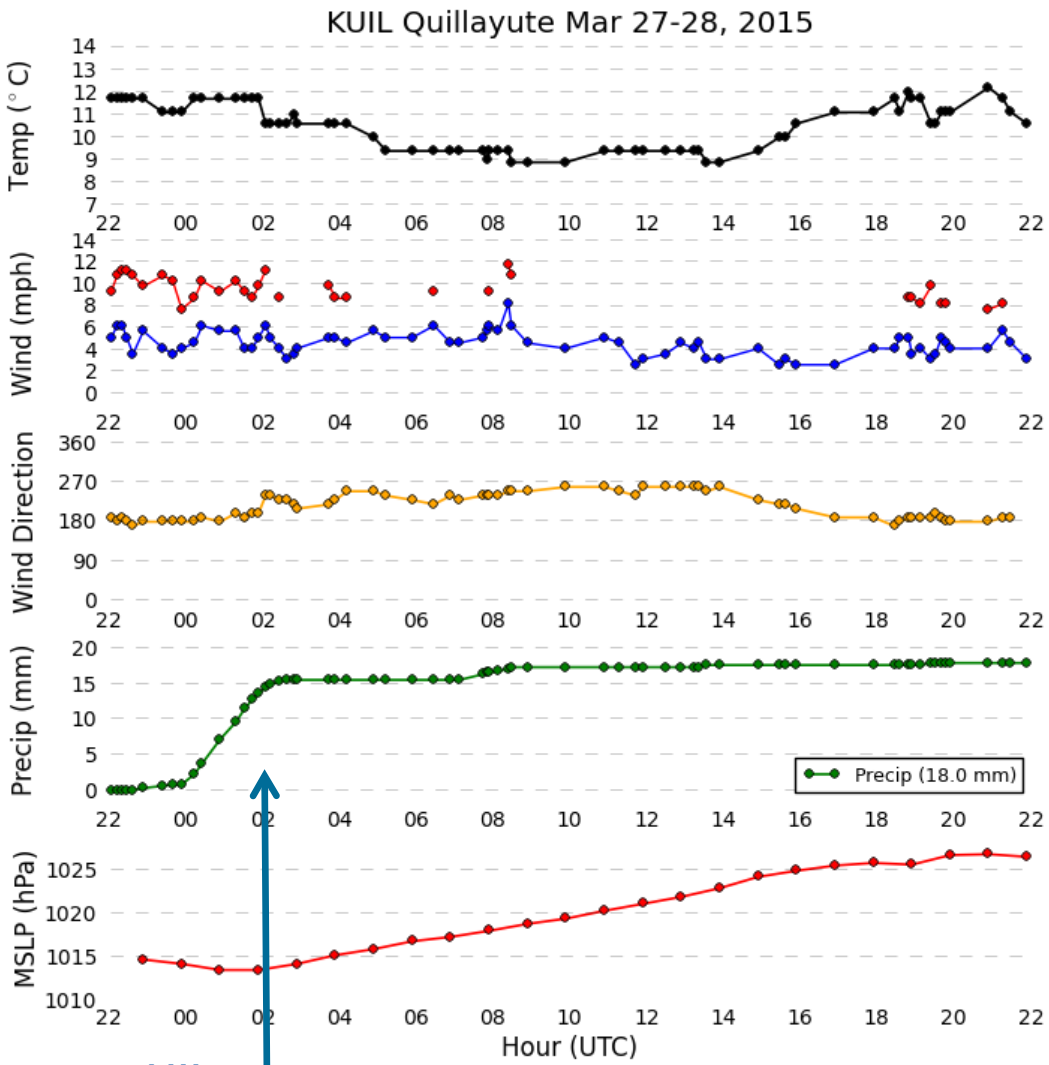
Ground Instrument Sites For Rain

Low Elevations Sites <u>with Power</u>
- Micro Rain Radar (MRR)
- Parsivel (disdrometer)
- 2DVD
- Rain gauge (dual bucket)

Low Elevation Sites <u>without Power</u>
- Parsivel (powered by solar panel/battery)
- Rain Gauge (dual bucket)

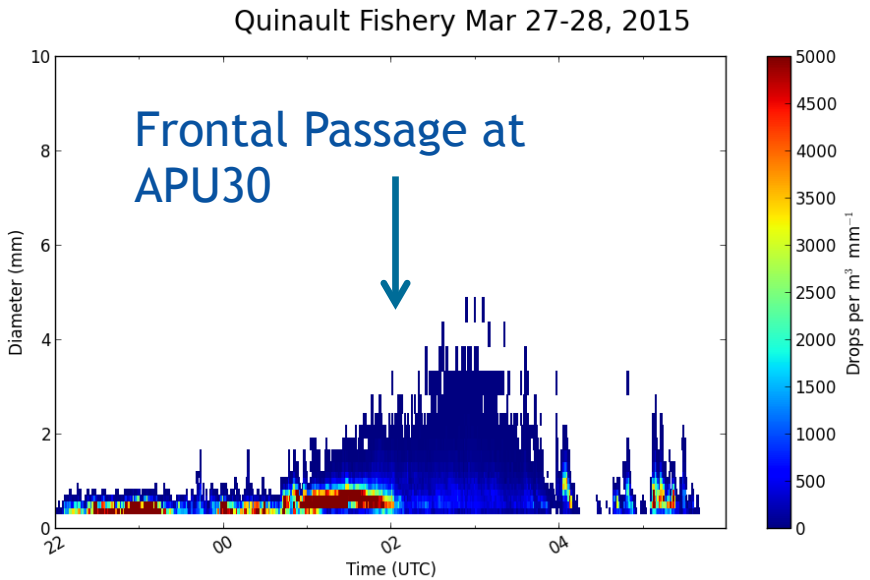


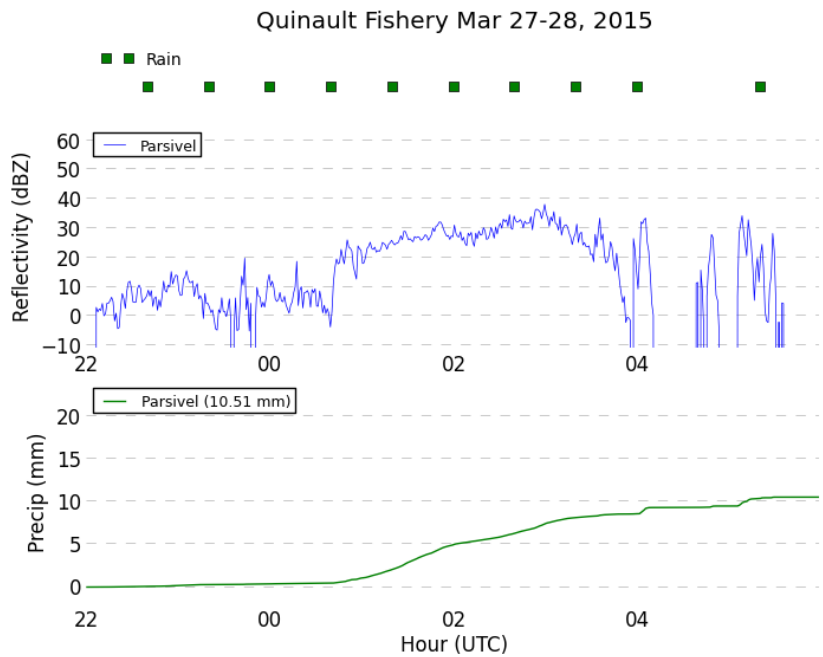
Event Sampled at Quinault Fisheries 27 – 28 March, 2015



Frontal Passage at UIL

Event Sampled at Quinault Fisheries 27 – 28 March, 2015

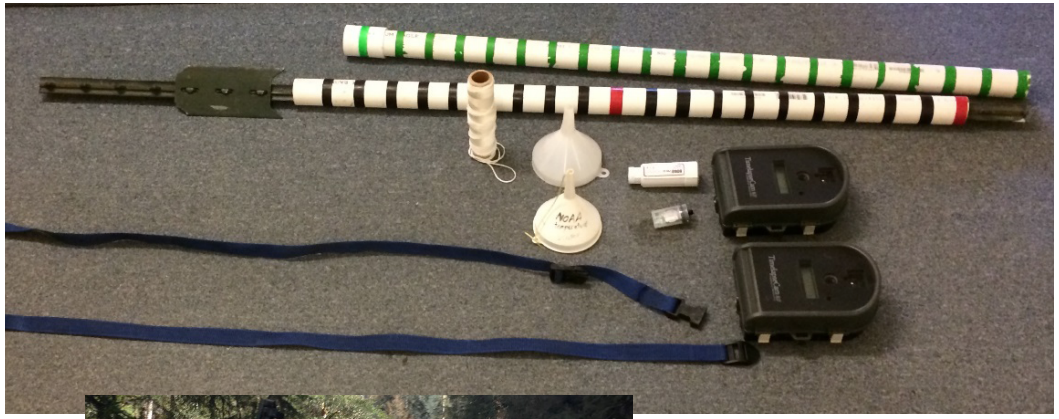




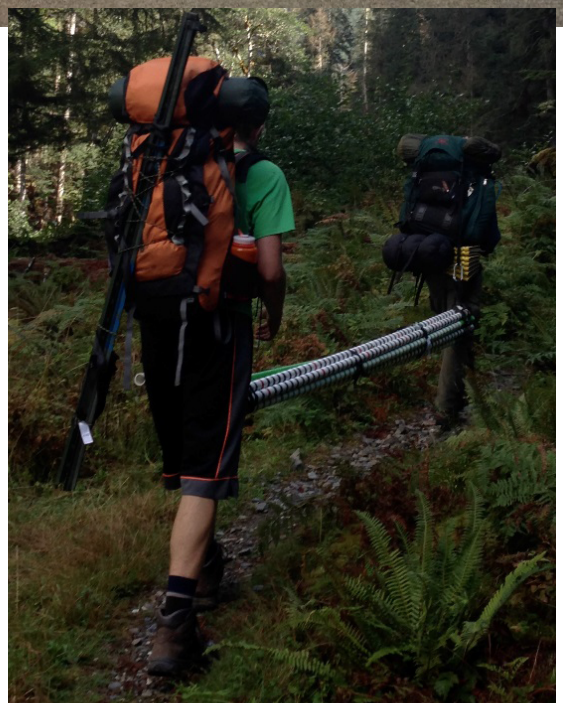
- Lots of small drops before frontal passage – Reminiscent of White et al. (2003) of non-brightband warm rain processes and like Waldvogel 1974
- Sounding at UIL shows lowest 1.5km layer of saturated air above 0°C
- Droplet size growth at time of frontal passage
- Reflectivity similar for prefrontal and frontal regimes
- 24hr total precip = 20 mm
- Post-frontal showers after 0400 UTC

High Terrain Measurements

Snow Camera Installations 2014 - 2015



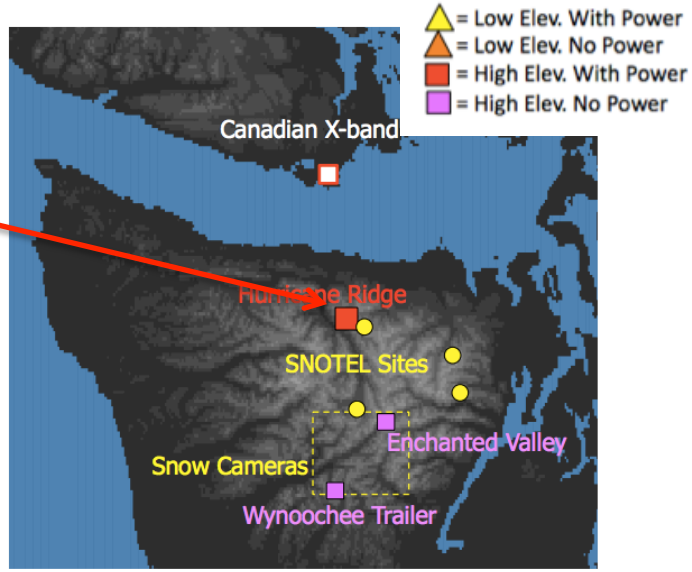
Jessica Lundquist's crew installed 18 Cameras and Snow Poles at various locations near historical snow course locations and along the Quinault River and tributaries.



Leeside Station

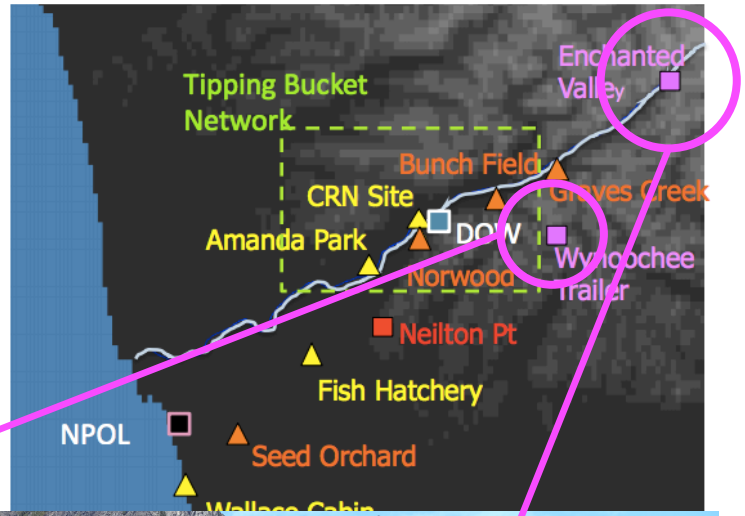
Hurricane Ridge

- Coordinated with Env. Canada radar
- Has power
- Testing during past winter
  - MRR, Parsivel, PIP and Hot Plate
  - Collecting data, but have not analyzed it
- Potential problems:
  - Snow/rime removal
  - PIP alignment/bulb replacement
  - Wind



High Elevation Ground Sites with no Power

Want to put instruments to measure precipitation at 2 very remote sites with no power: North Wynoochee (3000+ ft), Upper Quinault Valley (2200+ ft)



Requires mountain biking and snowshoe to access site.

Trailer for high elevation installation at Wynoochee

- 15 ft trailer anchored to ground with 8 deep-cycle batteries, electronics, computer inside
- Solar panel to recharge batteries
- Pluvio and Parsivel mounted to be 'above' snowpack
- Testing
  - how long batteries can last
  - How long instruments can operate in snowy environment
  - how often is maintenance needed

Aircraft

DC – 8

- Will fly satellite simulator instruments
- Flight patterns over ocean and land, including over NPOL and ground network
- Dropsondes over the ocean
- Dates of operation: Nov 10 – Dec 22, 2015

ER – 2

- Will fly satellite simulator instruments
- Flight patterns over ocean and land, including over NPOL and ground network
- Dates of operation: Nov 17 – Dec 15, 2015

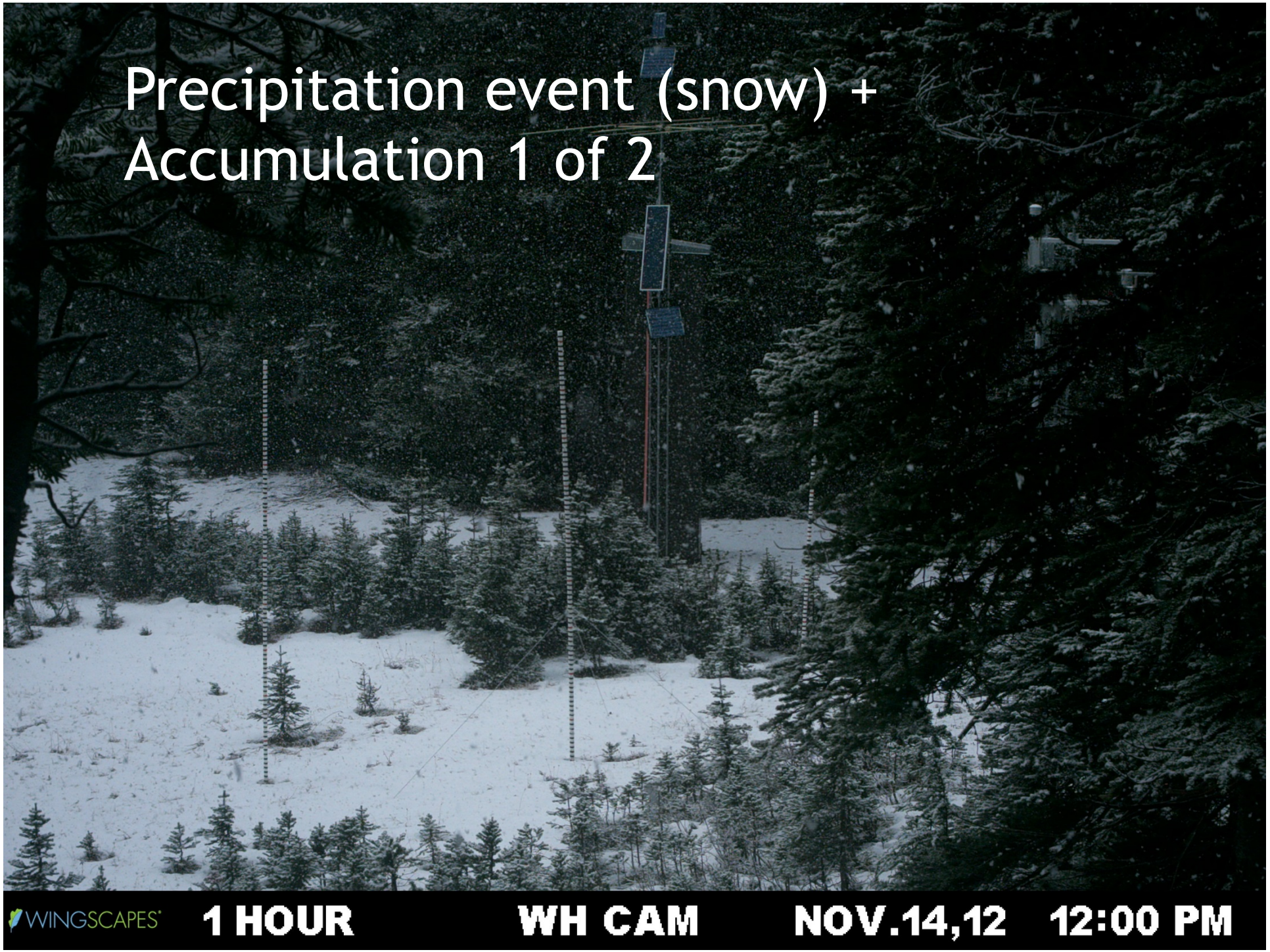
Citation

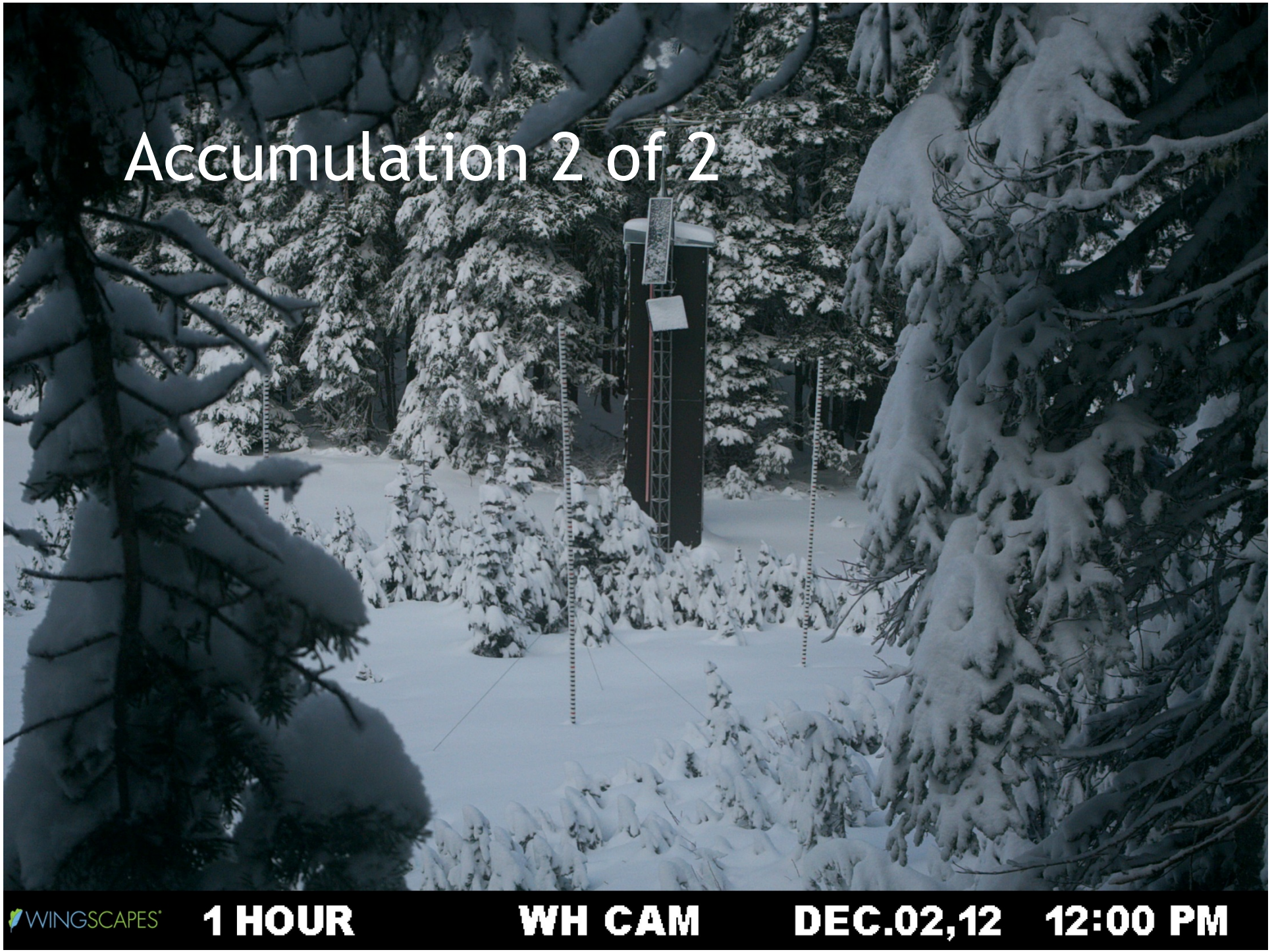
- Will fly satellite simulator instruments
- Flight patterns over ocean and land, including over NPOL and ground network
- Dates of operation: Nov 17 – Dec 15, 2015

OLYMPEX Summary

- Fall 2015 — Winter 2016
- Rain and snow over ocean, coast, mountains
- Windward side ehancement, leeside suppression
- Snowpack buildup and melt off
- Two watersheds
- Ground instruments at a variety of elevations and locations
- Ten radars including NPOL, D3R, & DOW, W-band RADEX
- 3 aircraft from 6 Nov - 21 Dec 2015

Precipitation event (snow) + Accumulation 1 of 2



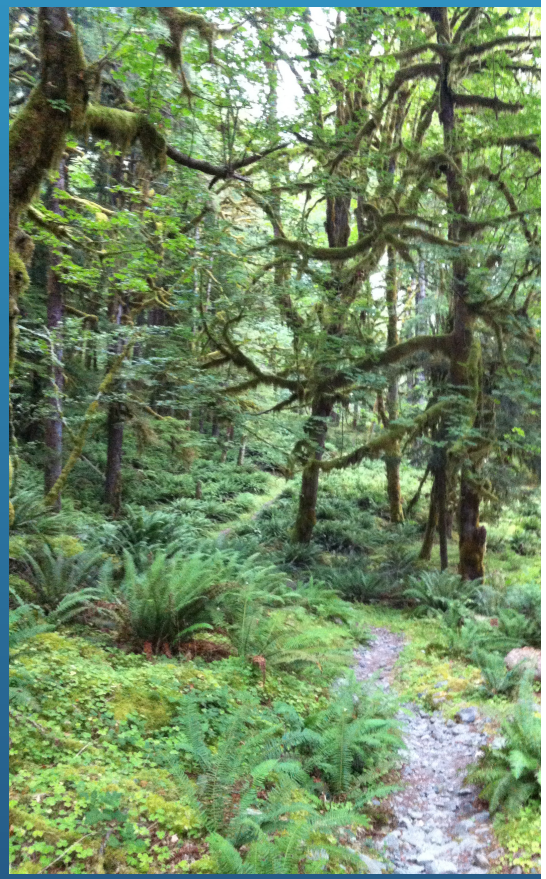

Accumulation 2 of 2
WINGSCAPES
1 HOUR
WH CAM
DEC.02,12
12:00 PM

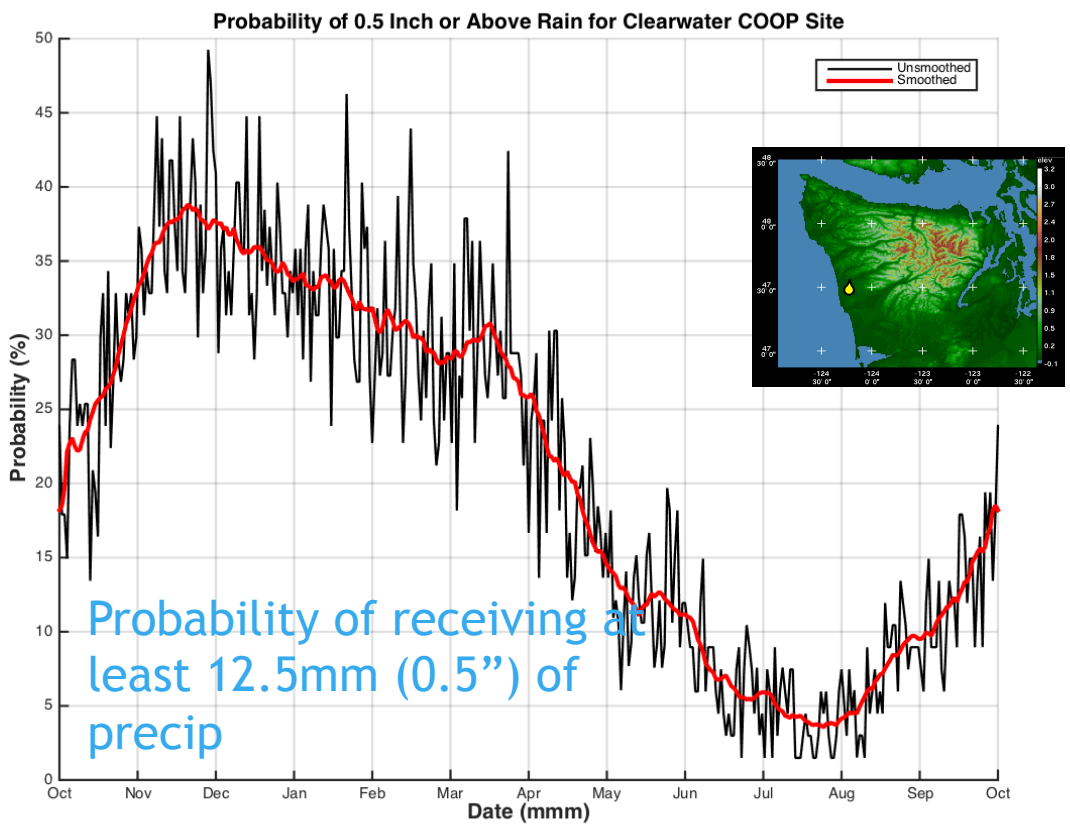
End

Acknowledgment

This work is supported by the National Aeronautics and Space Administration grants NNX13AG71G & NNX14AO64G

Climatology of Olympic Peninsula





Average rainfall during Nov, Dec and Jan is 400 mm (16”) each month. Range is 75 – 750 mm (3 – 30”) from 98 years of data.

Olympic Peninsula
UNITED STATES
CANADA
UNITED STATES
MEXICO
North Pacific Ocean
North Atlantic Ocean
Gulf of Mexico
Hudson Bay
Labrador Sea
Davis Strait
Baffin Island
Victoria Island
Banks Island
Beaufort Sea
Bering Sea
Gulf of Alaska
ALEUTIAN TRENCH
MIDDLE AMERICA TRENCH
ROCKY MOUNTAINS
CASCADES
SIERRA NEVADA
APPALACHIAN MOUNTAINS
Great Bear Lake
Great Slave Lake
Lake Athabasca
Lake Winnipeg
Lake Superior
Lake Huron
Lake Michigan
Lake Ontario
Lake Erie
Great Salt Lake
Death Valley
Mt. McKinley
Nuk (Godthåb)
Ottawa
Washington, D.C.
Mexico City
Havana
Nassau
Kingston
Guatemala City
San Salvador
Tegucigalpa
Managua
Belmopan
Scale: 1:36,000,000
Lambert Conformal Conic Projection, standard parallels 25°N and 77°N
0 300 600 Kilometers
0 300 600 Miles