

Stratiform Precipitation Processes in Cyclones Passing over the Olympic Mountains



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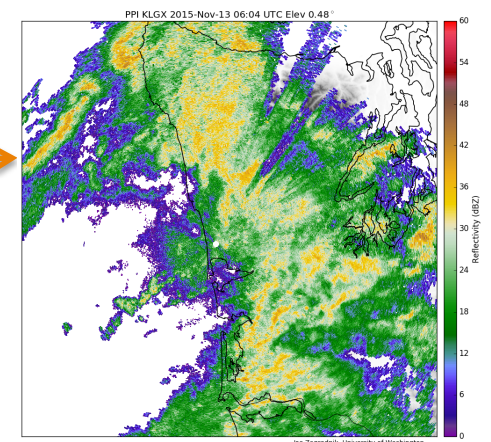
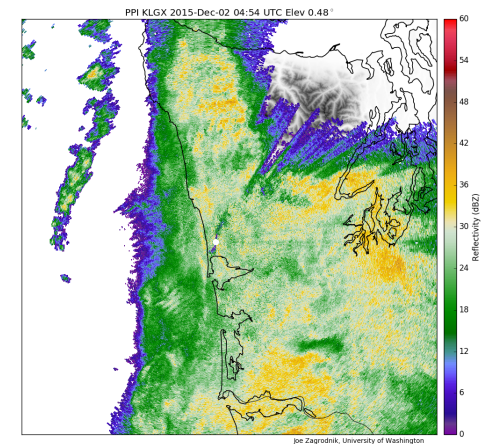
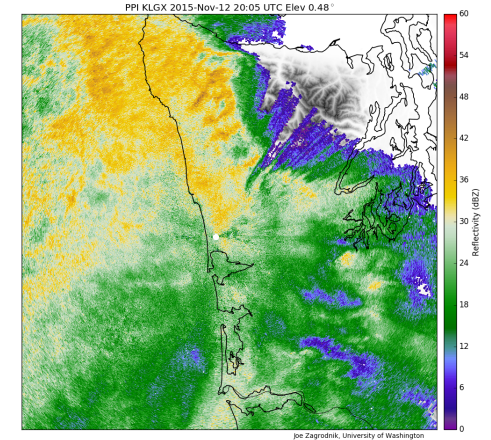
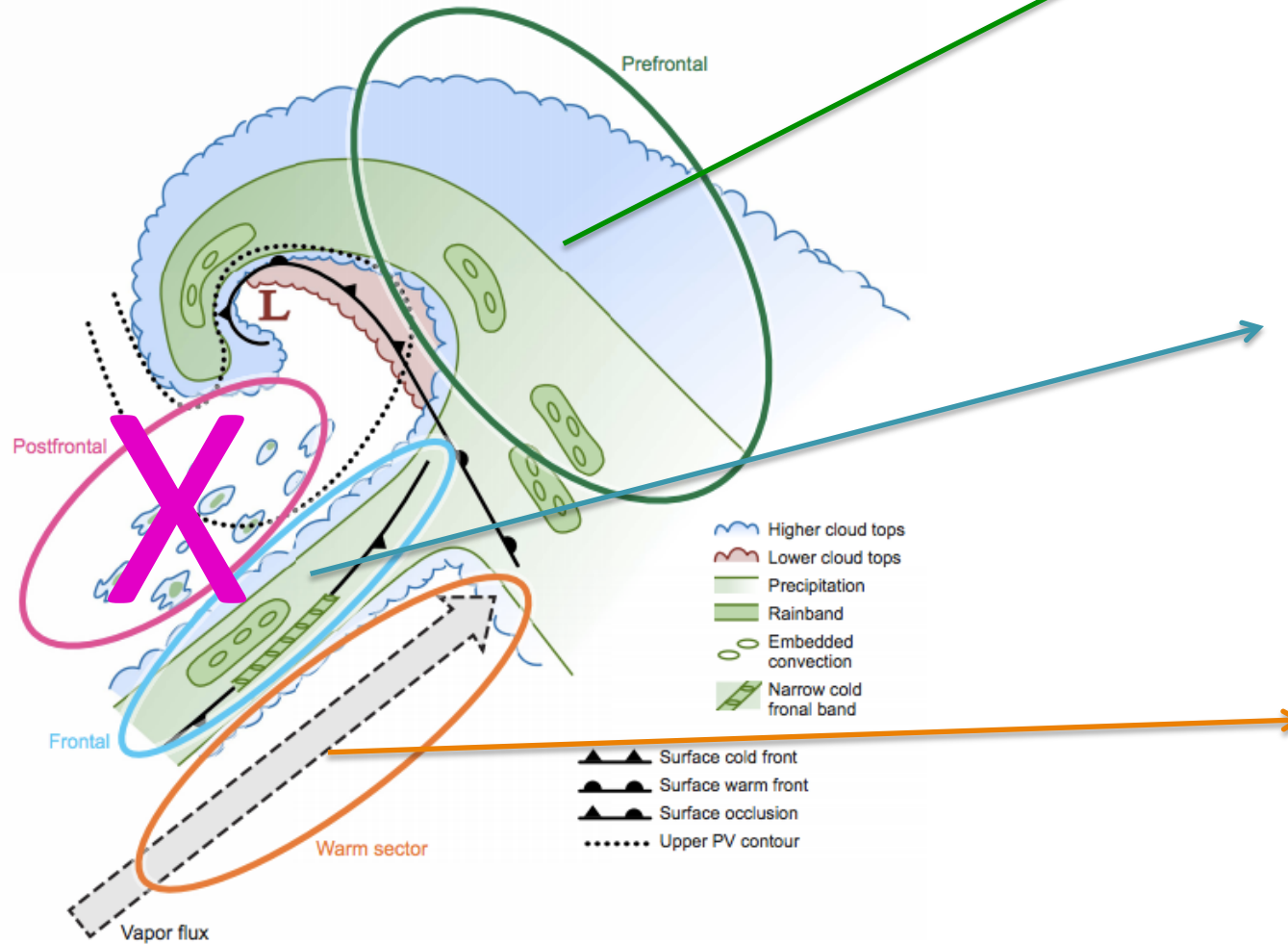


Thanks to:

Olympic National Park (Bill Baccus and C.J. Urnes)

NASA (Matt Wingo, Ali Tokay, many others)

Most precip on the Olympic Peninsula is nearly-continuous stratiform rain

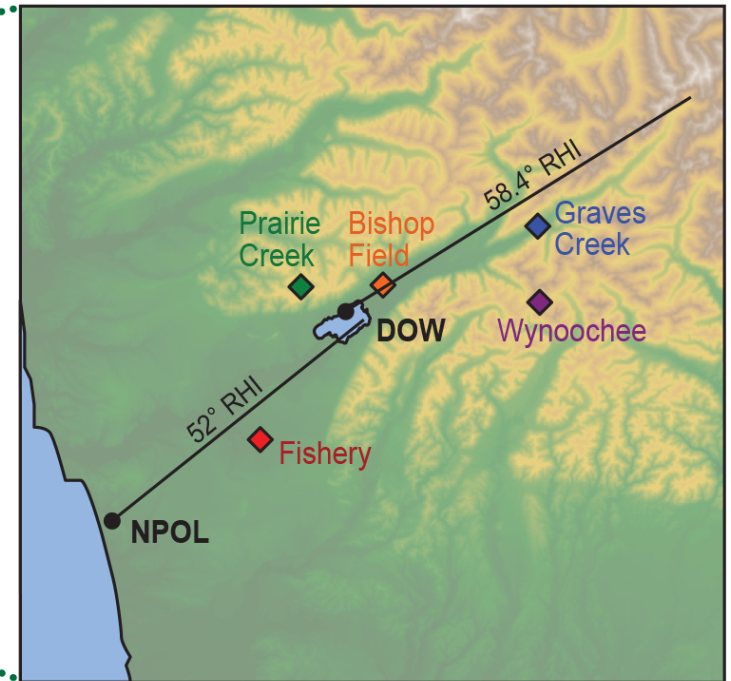
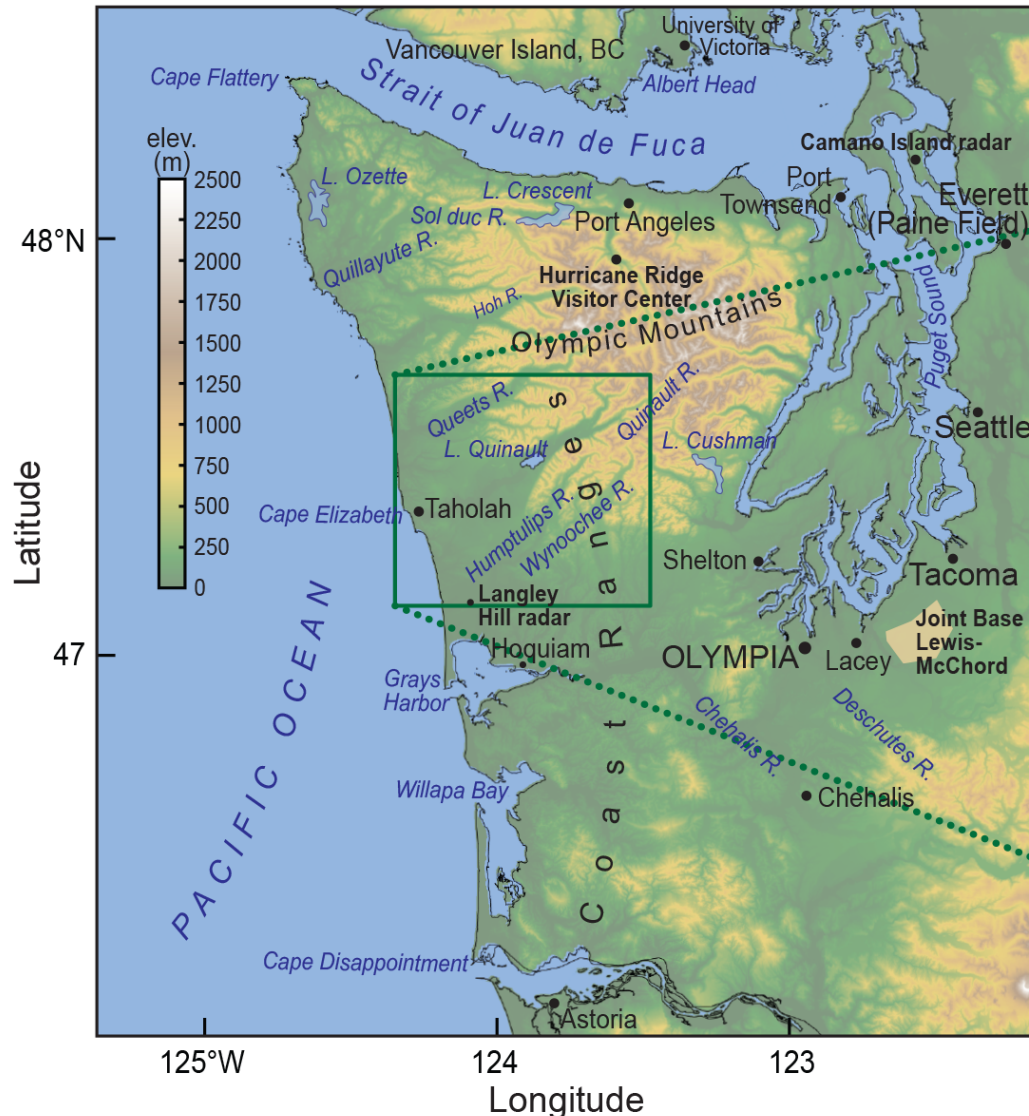


Goal of this Presentation:

- Relate environmental factors affecting orographic enhancement to precipitation processes:
 - Flow:
 - Low-level moisture flux (IVT—Integrated Vapor Transport)
 - Thermodynamics:
 - Melting level height
 - Static Stability
 - Cloud/Precipitation Microphysics:
 - Drop size distribution (DSD) and rainfall distribution at a variety of locations/elevations

Site Locations

Ground Site	Elevation (m)
Fishery	52
Bishop Field	85
Prairie Creek	543
Graves Creek	180
Wynoochee	1020

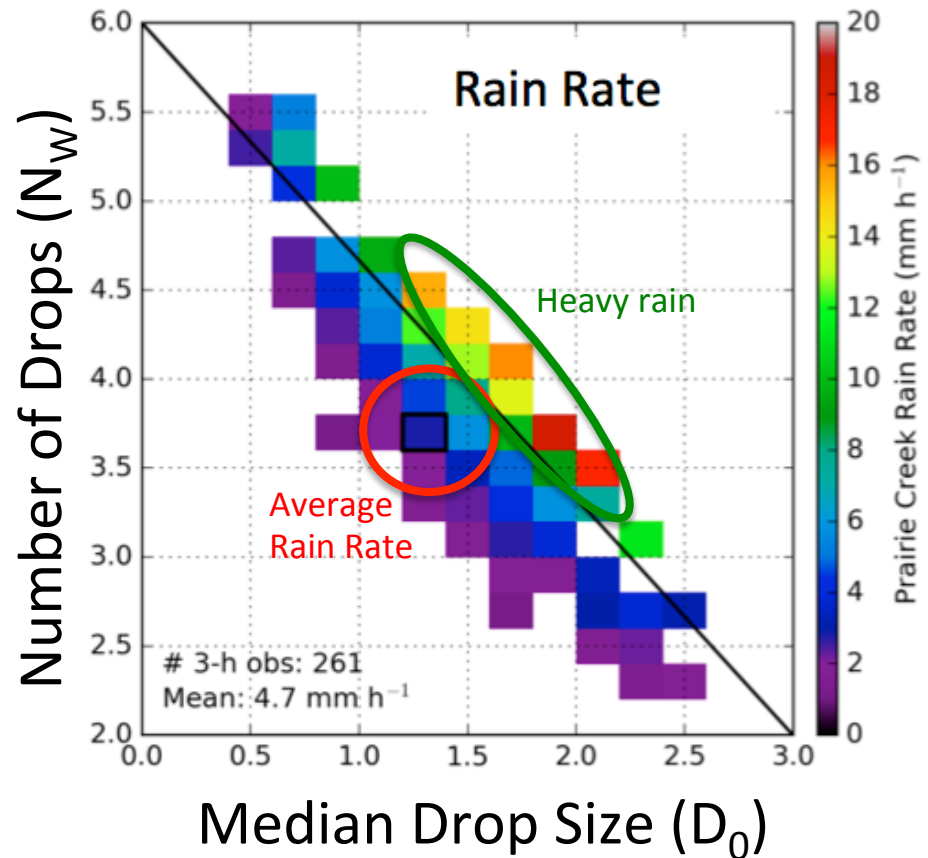
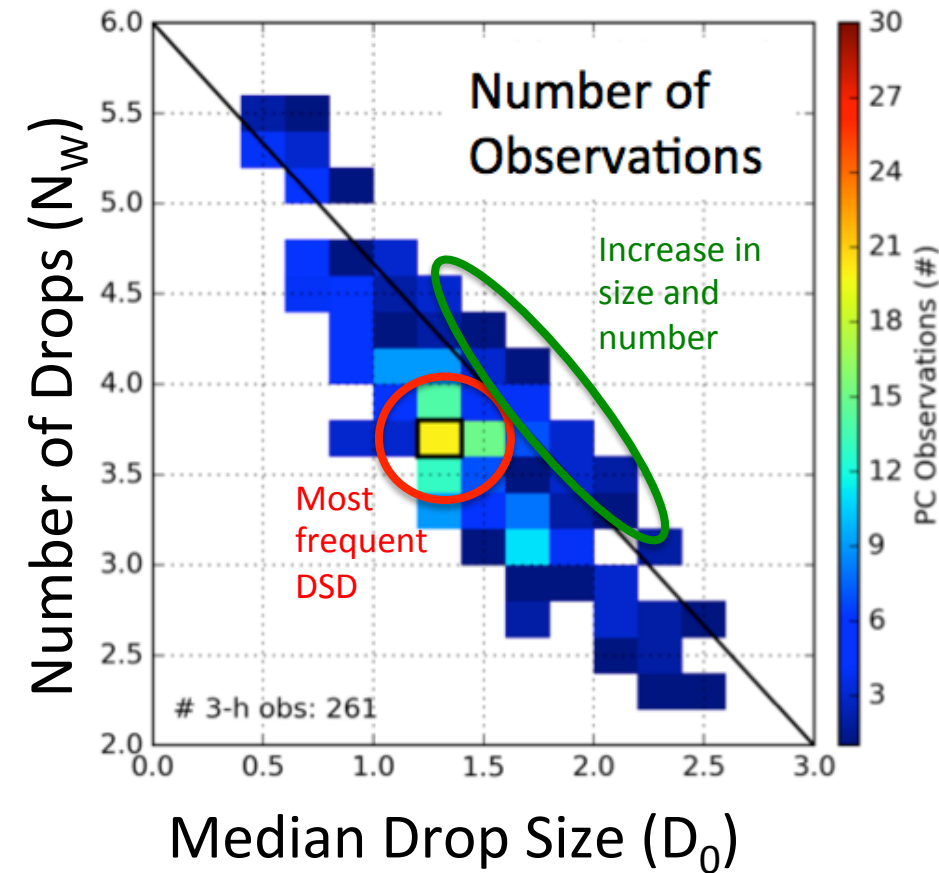


Statistical Analysis

- All storms Oct 2015 – Apr 2016
- Postfrontal and $< 1 \text{ mm h}^{-1}$ rain rates removed
- Divide everything into 3-hour periods centered on North American Regional Reanalysis (NARR) times (00, 03, 06 UTC etc)
 - Drop size distribution (DSD) at Prairie Creek
 - Precipitation gauges at 5 ground sites with varying elevation/distance from coast

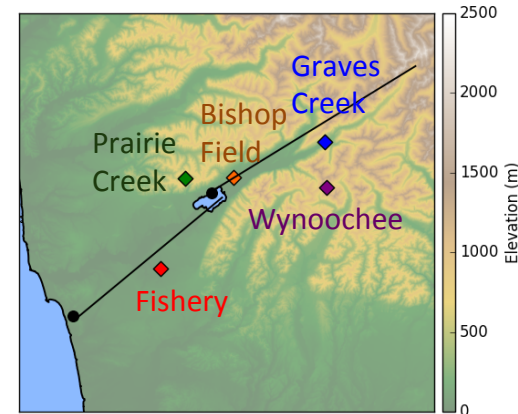
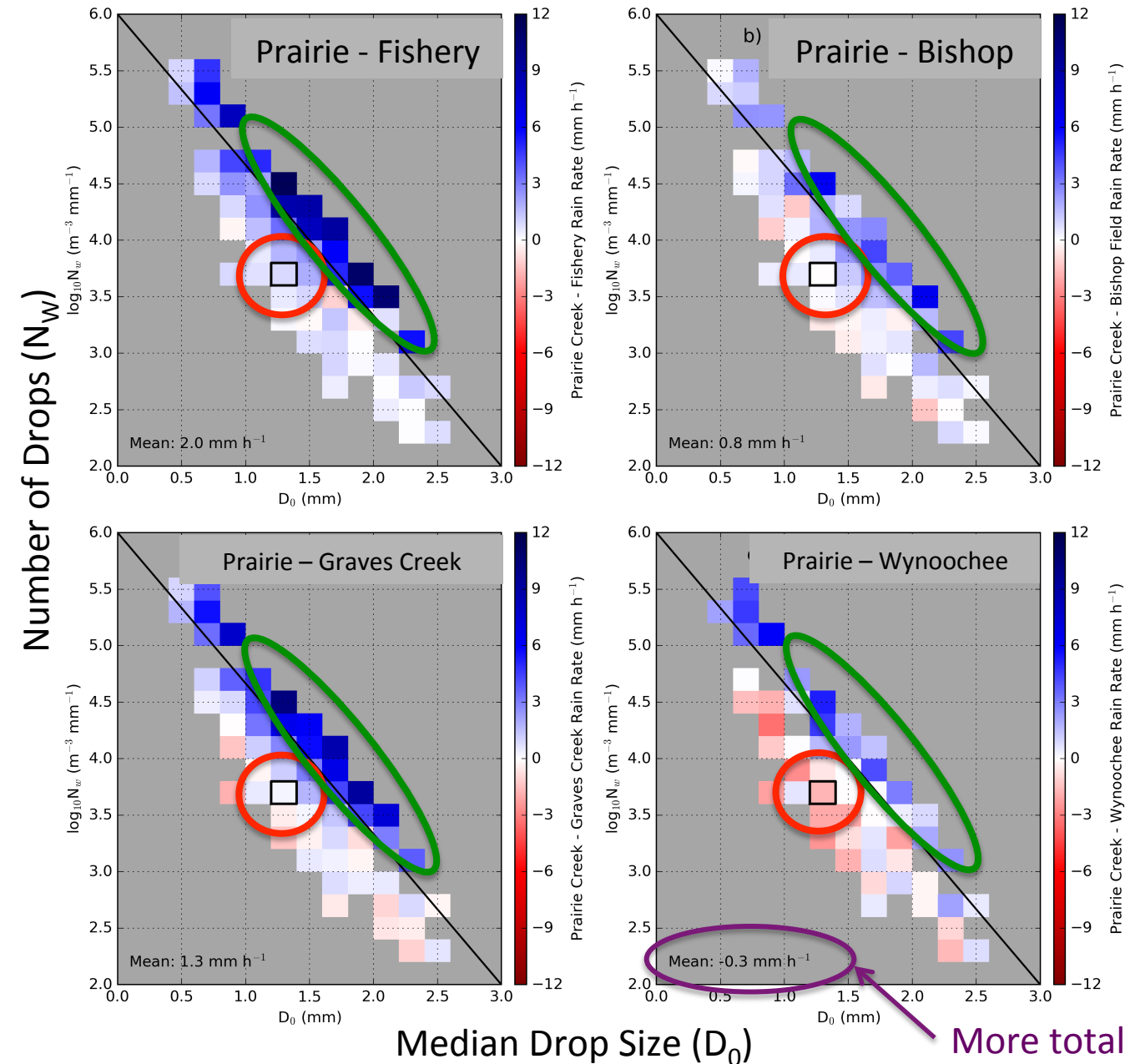
Drop Size Distribution at Prairie Creek

Histograms of Drop Diameter vs. Drop Number:



Similar DSD at near-coastal site (Fishery) but less outliers

Prairie Creek DSD vs. Orographic Enhancement



For a given Prairie Creek DSD:

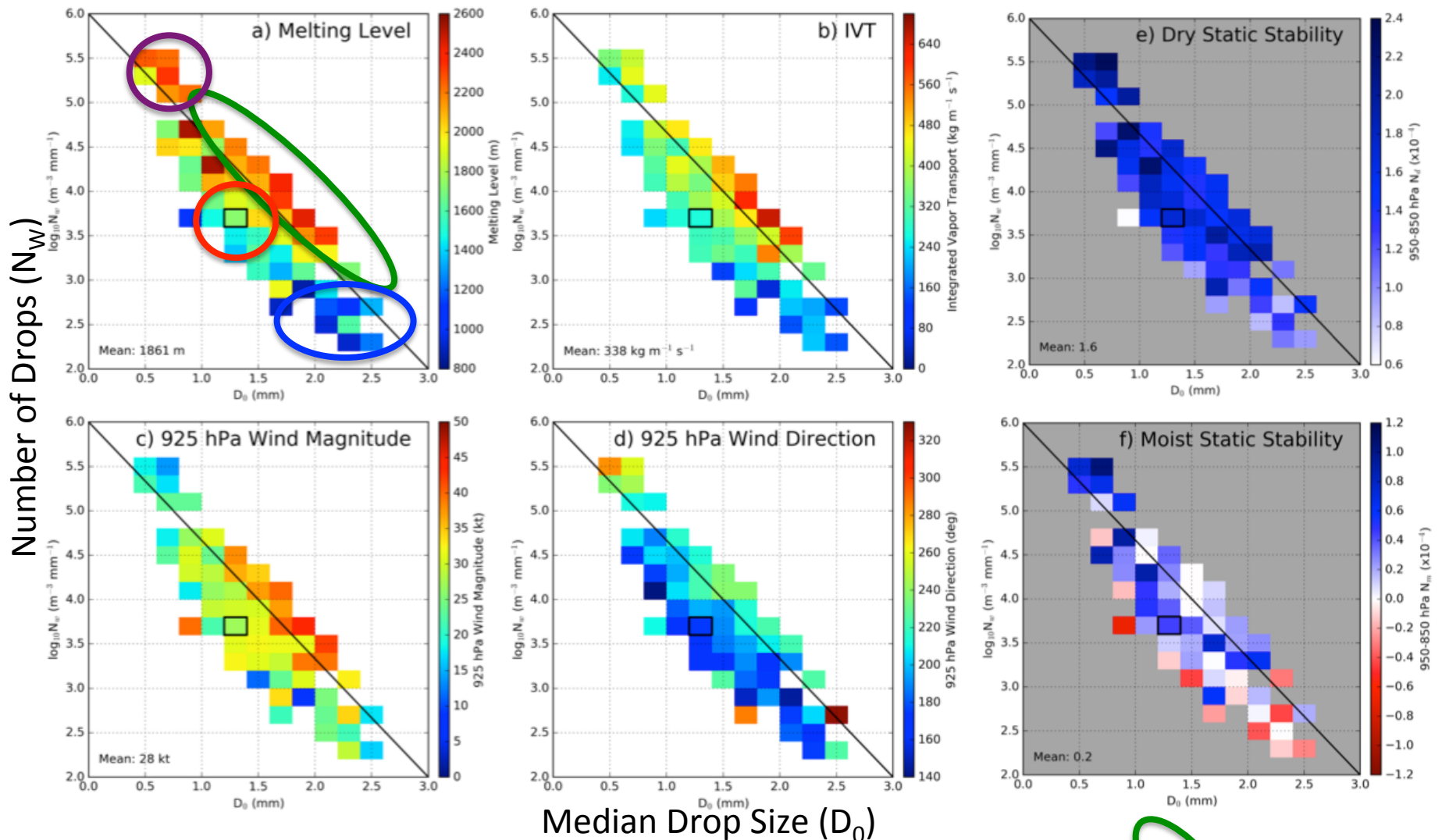
Blue = more precip at Prairie Creek

Red = less precip at Prairie Creek

White = same at both sites

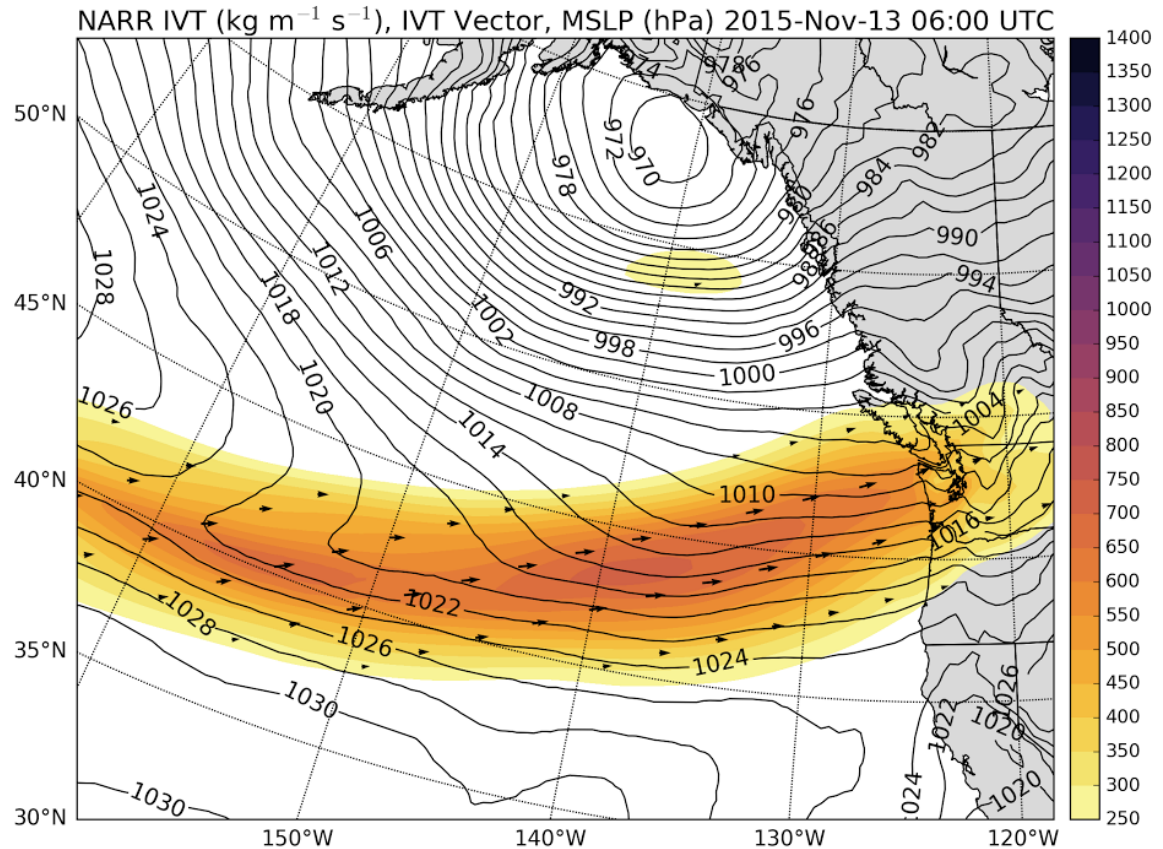
More total precip at Wynoochee

Prairie Creek DSD vs. Synoptic Environment



Quick look at a case study:

- Nov 12-13, 2015
“Atmospheric River”
- High melting level
- Strong 925 hPa winds and IVT
- Moist-Neutral Stability



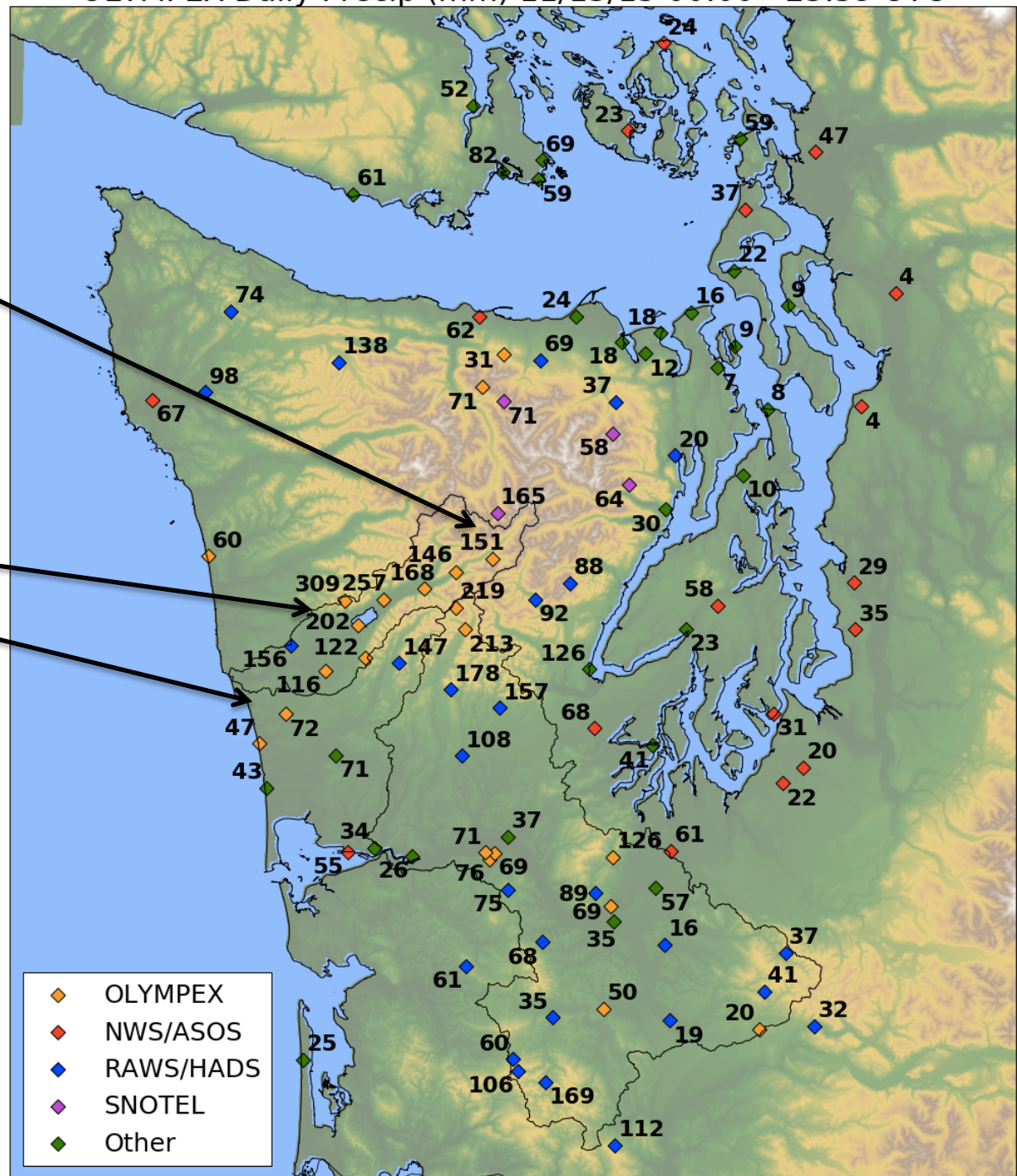
Integrated Vapor Transport (IVT)

OLYMPEX Daily Precip (mm) 11/13/15 00:00 - 23:59 UTC

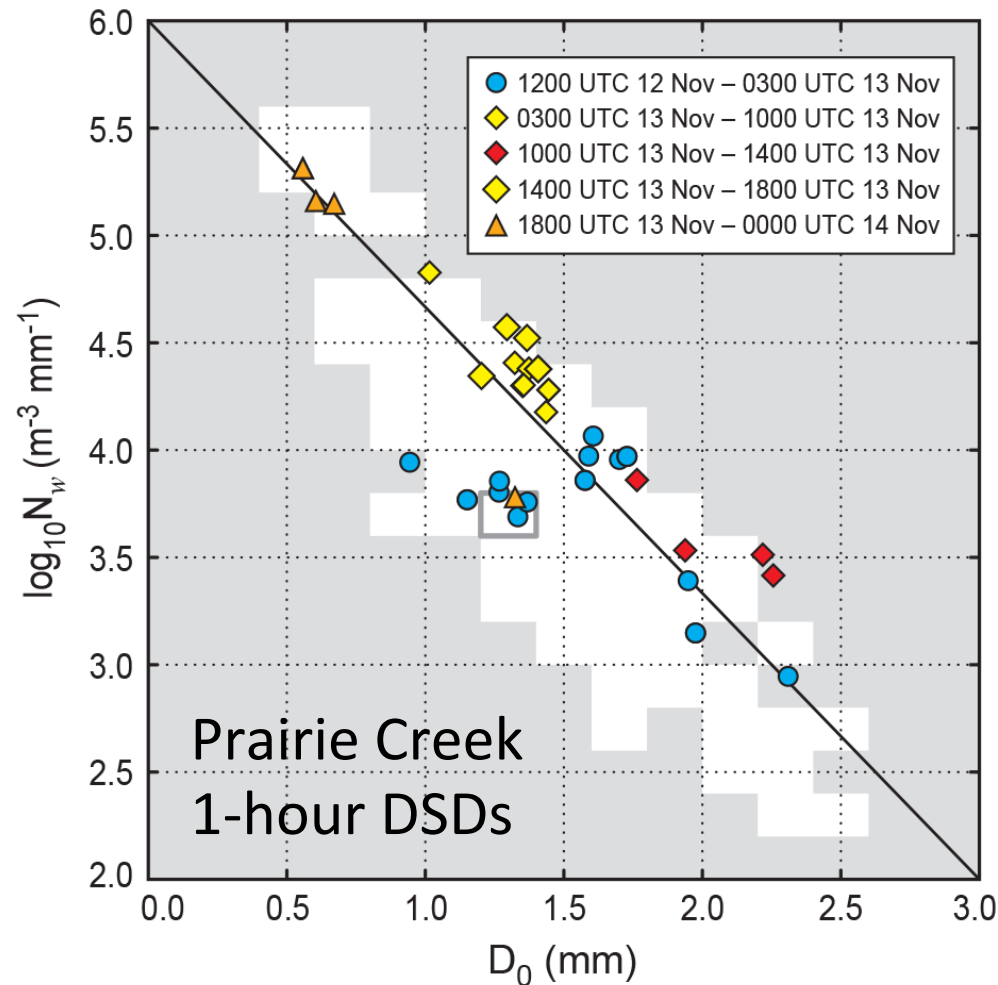
High terrain
less than
windward
slopes

Factor of 4-5
enhancement
between coast and
Lake Quinault

Different than
climatology!

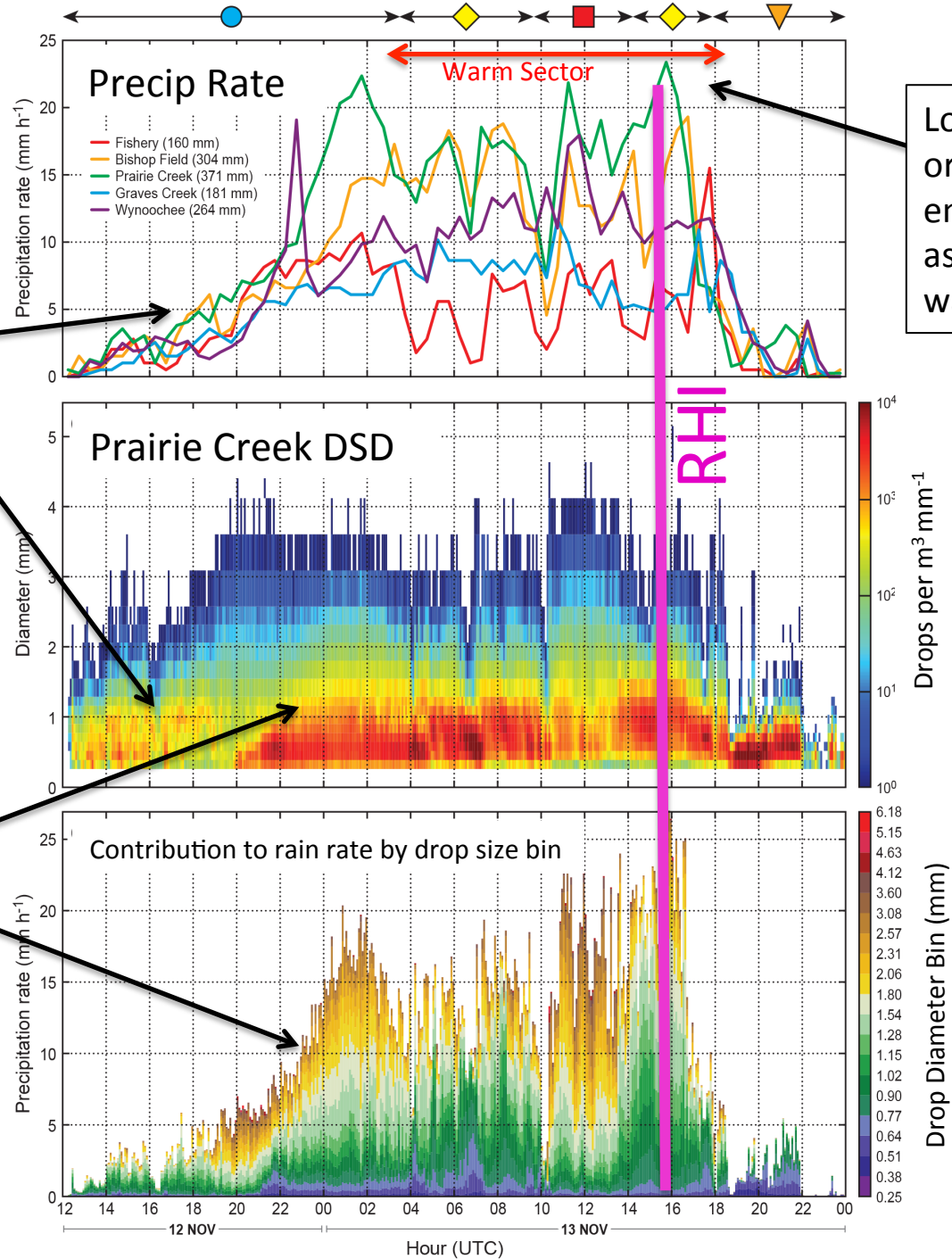


All 4 DSD Regimes were observed in this event at Prairie Creek



Transitions in DSDs matched changes in storm sector
(Prefrontal -> Warm Sector -> Frontal)

Time Series
12-13 November 2015

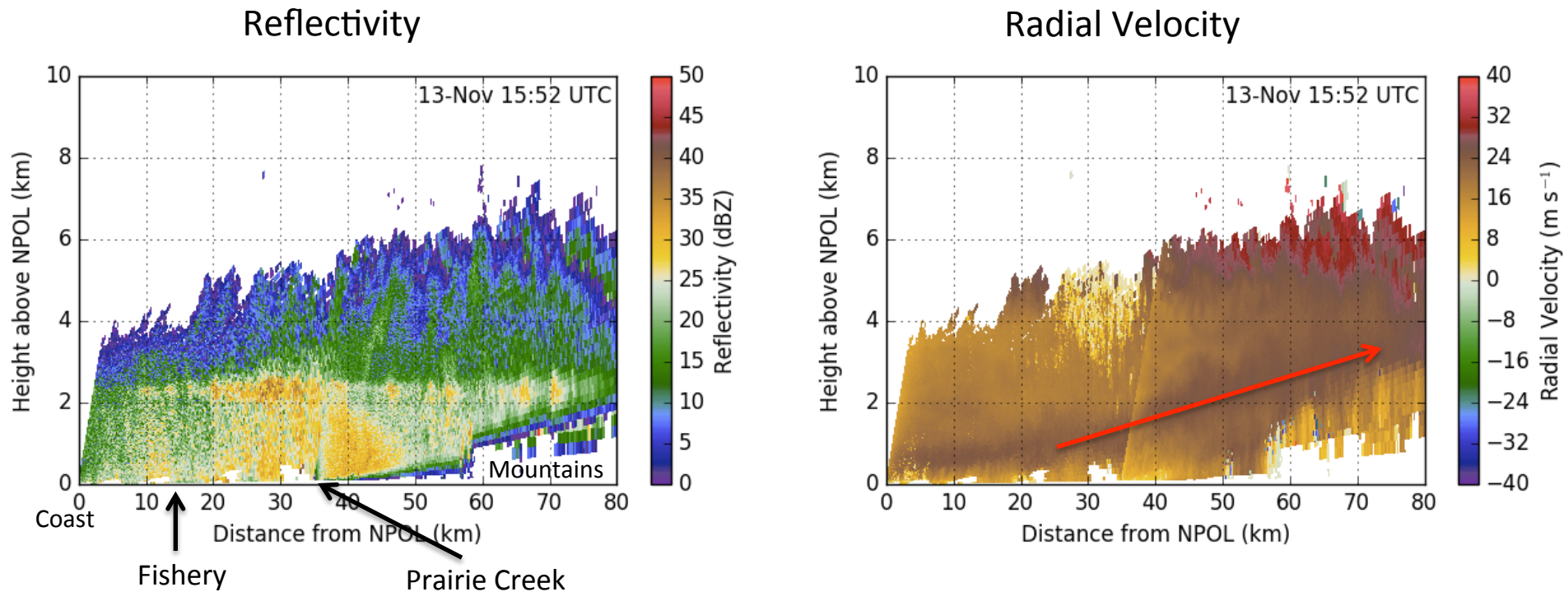


Event begins with most frequent DSD. No orographic enhancement

Small-to-medium drops become dominant during transition to warm sector

Long period of orographic enhancement associated with warm sector

NPOL+DOW RHI (Coast -> Mountains)



- Low-level jet lifting over terrain
- Enhanced reflectivity below bright band
- Echo tops relatively low (4-6 km)

Rain rate at time of RHI: 6 mm h⁻¹ at Fishery and 23 mm h⁻¹ at Prairie Creek!

Summary

- **Seasonal time scale**: most precip over higher elevations (lots of weak storms)
- **Warm, heavy rain events** (Atmospheric Rivers) have most precip at **low-to-mid elevations**
 - Rain consists of mostly small-to-medium drops
 - Formed by condensation/collision-coalescence
 - Related to moist-neutral lifting of low-level jet
- Surprising result: warm precipitation processes can generate heavy rain without significant contributions from **seeding by ice crystals** (seeder-feeder) and **shear-generated turbulence!!!**

Thanks to:

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