244 Verification of the GPM Satellite by the Olympic Mountains Experiment (OLYMPEX)

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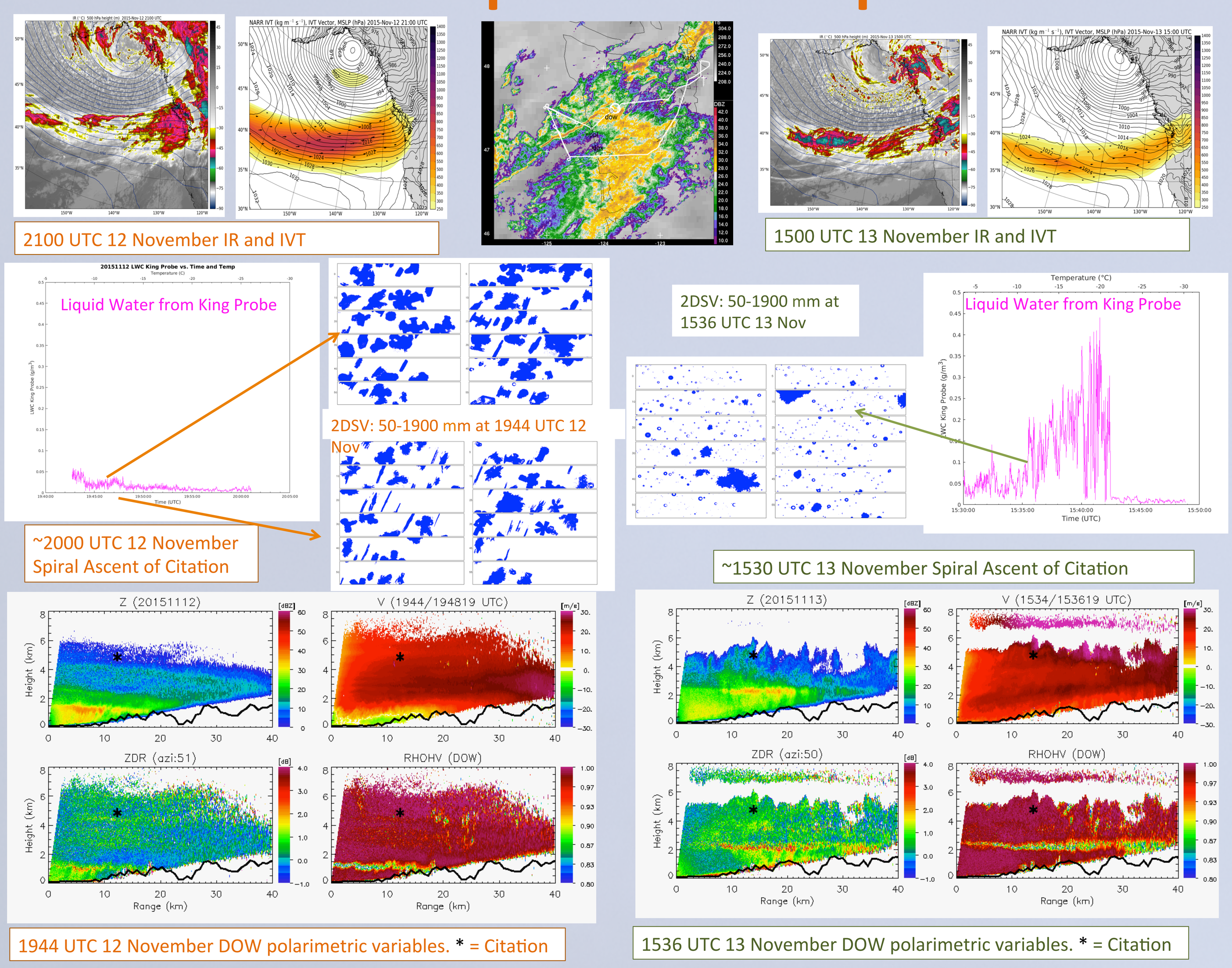
Citation microphysical measurements and DOW dual-polarization quantities

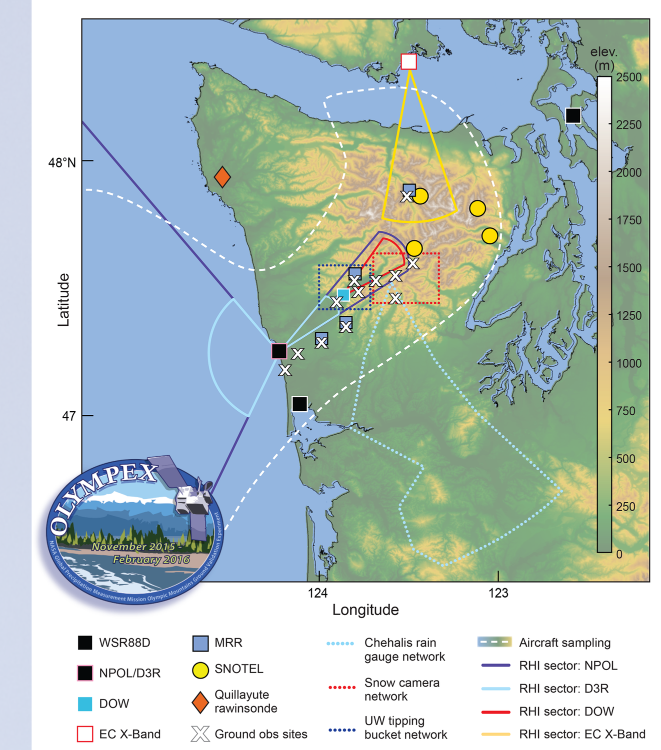


- Very warm, moist atmospheric river event 12—13 November 2015
- These data were taken during spiral ascents by the Citation on the 12th (left) and 13th (right)
- On the 12th, there was very little liquid water and the ice crystals were predominantly plates and dendrites. The DOW observed a ZDR secondary maximum during the Citation ascent.
- On the 13th, there was high liquid water content that increased with decreasing temperature and higher elevation with super-cooled liquid drops and rimed particles sampled by the Citation. The DOW observed generating cells during the Citation ascent.

Rowe, A., R. A. Houze, Jr., L. A. McMurdie, 2017: Microphysical mechanisms in stratiform precipitation as observed in OLYMPEX, in prep.

OLYMPEX - Goals

- Physical validation and verification of precipitation measurements by the GPM satellite
- Measure precipitation processes and their modulation by synoptic conditions and complex terrain

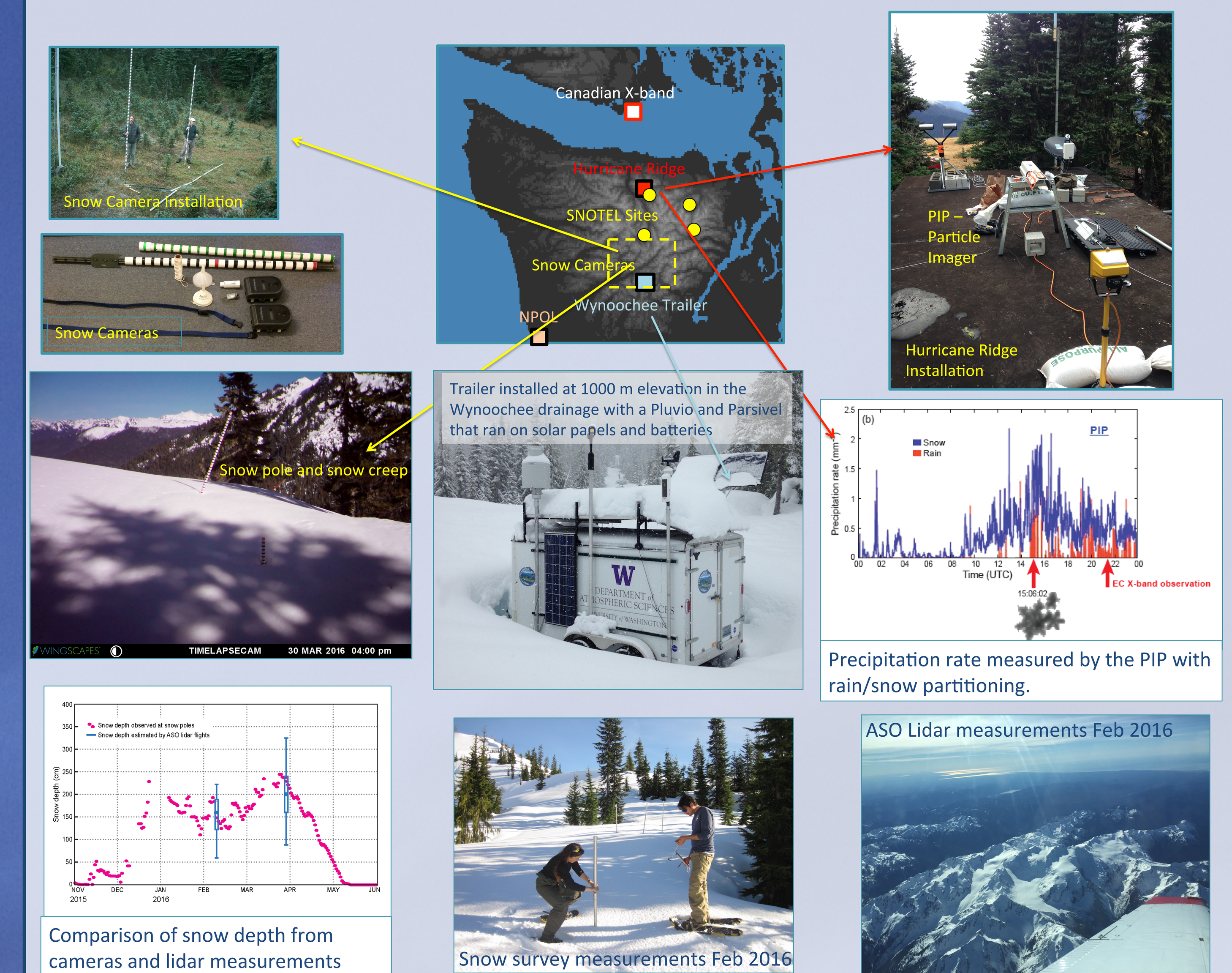


Field Campaign Overview

- OLYMPEX regions included ocean, windward and leeward side of the Olympic Mountains and the Quinault and Chehalis river basins
- **Radars:** S-Band (NPOL) and Ka- Ku-Band (D3R) on coast sampled RHI- sectors over ocean and mountains, X-bands on Vancouver Island and Quinault Valley
- **Ground Network:** Parsivels, dual-tipping buckets, Pluvios, MRRs, Soundings
- **Aircraft:** DC-8 , ER-2 with radars (Ka- Ku- and W-band) and passive microwave instruments, Citation with microphysics instrumentation
- **Snow Measurement:** Seasonal accumulation of the snowpack from SNOTEL and snow cameras, 2 lidar Airborne Snow Observatory (ASO) flights and snow surveys and Particle Imager (PIP) disdrometer at Hurricane Ridge.

Houze, R. A., Jr., L. McMurdie, W. Peterson, M. Schwaller, W. Baccus, J. Lundquist, C. Mass, B. Nijssen , S. Rutledge, D. Hudak, S. Tanelli, J. Mace, M. Poellot, D. Lettenmaier, J. Zagrodnik, A. Rowe, J. DeHart, L. Madaus, H. Barnes, 2017: The Olympic Mountains Experiment (OLYMPEX), *Bull. Amer. Soc.*, DOI: 10.1175/BAMS-D-16-0182.1.

Observing snow in remote locations



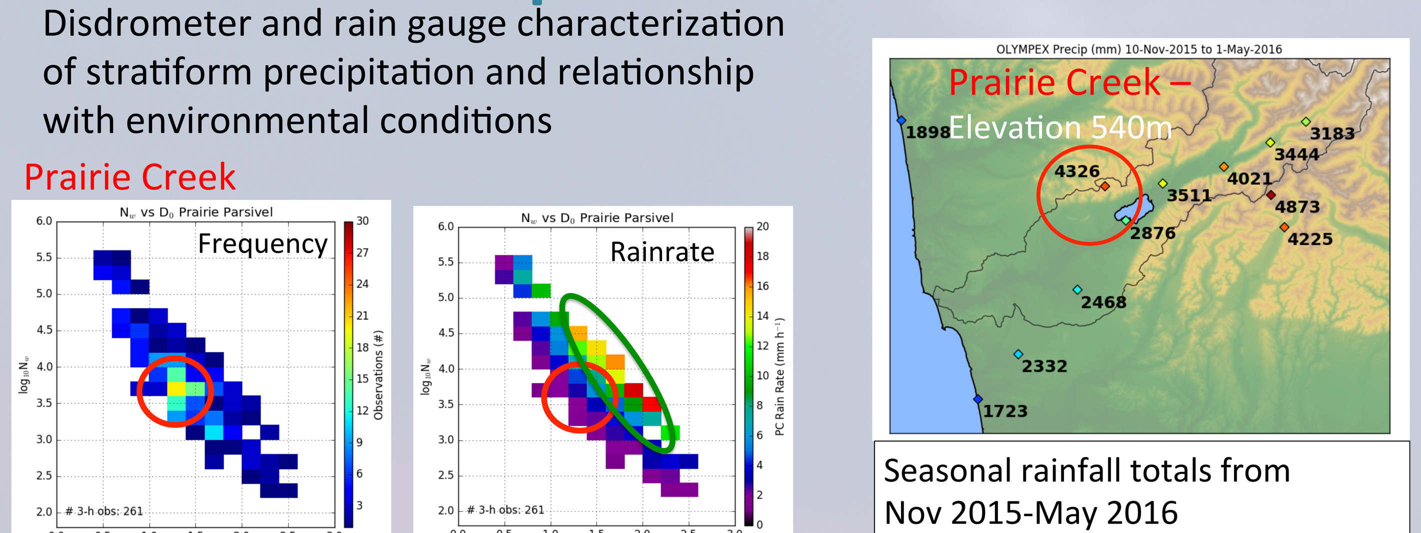
- Snowpack measurements were made throughout the 2015—2016 snow season.
- Cameras measured daily snow depth at 18 locations throughout the windward slopes at 1000—1500 m elevation. Four SNOTEL sites are installed above 1500 m.
- Two Airborne Snow Observatory Lidar flights were made of the snowpack in February and April 2016. Snow surveys were conducted on the same days at locations near the snow poles to measure snow depth and density.
- PIP was installed at Hurricane Ridge (elevation ~1700 m) and made high-speed camera measurements of falling particles that can be used to distinguish between rain and snow.

Currier, W. R., T. Thorson, J. D. Lundquist, 2017: Independent evaluation of frozen precipitation from WRF and PRISM in the Olympic Mountains, Washington, USA. *J. Hydrometeor*, doi:10.1175/JHM-D-17-0026.1, in press

Stratiform Precipitation Processes

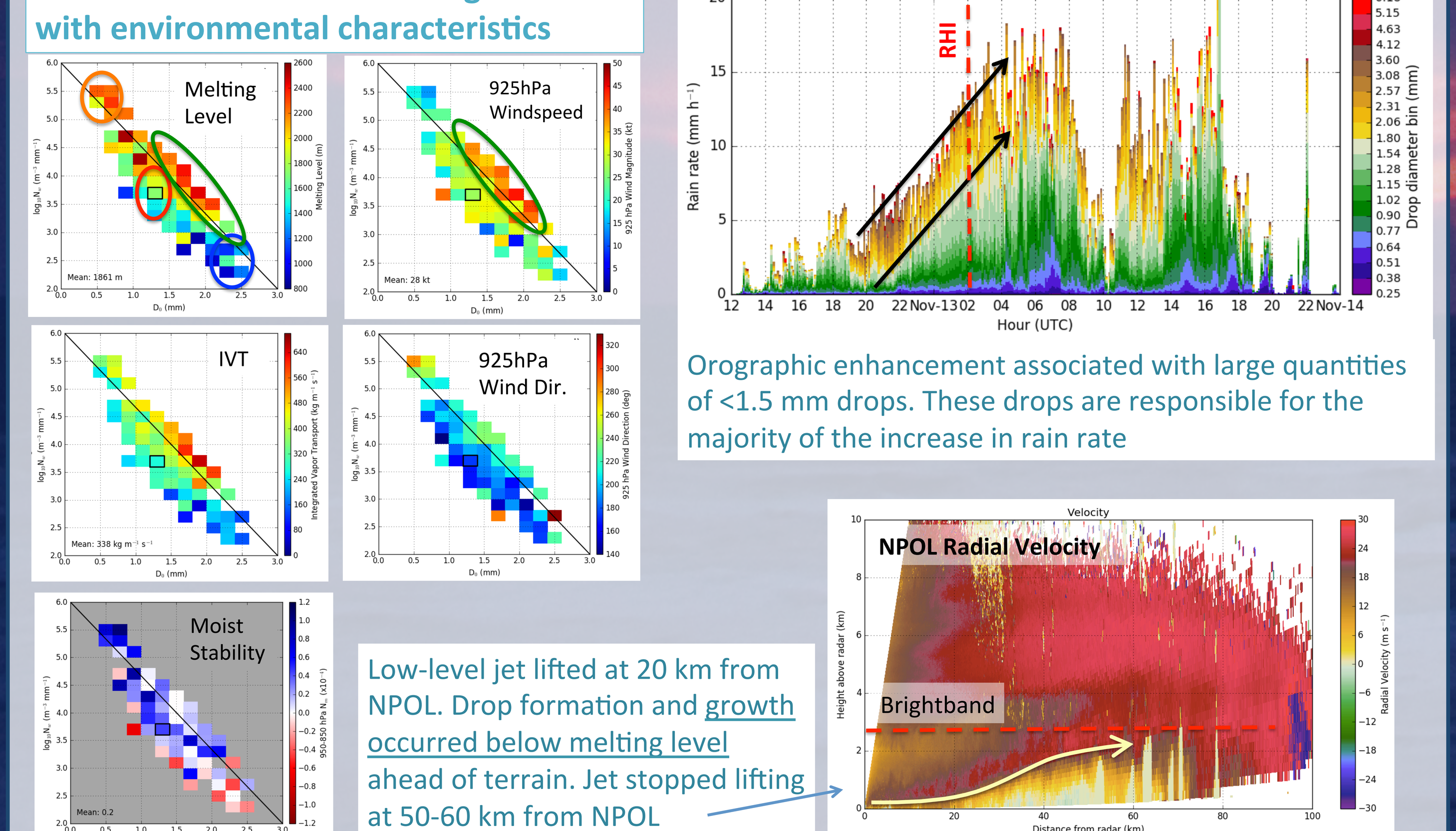
Disdrometer and rain gauge characterization of stratiform precipitation and relationship with environmental conditions

Prairie Creek



12—13 Nov 2015 Atmospheric River Event

DSDs at Prairie Creek showing variance with environmental characteristics

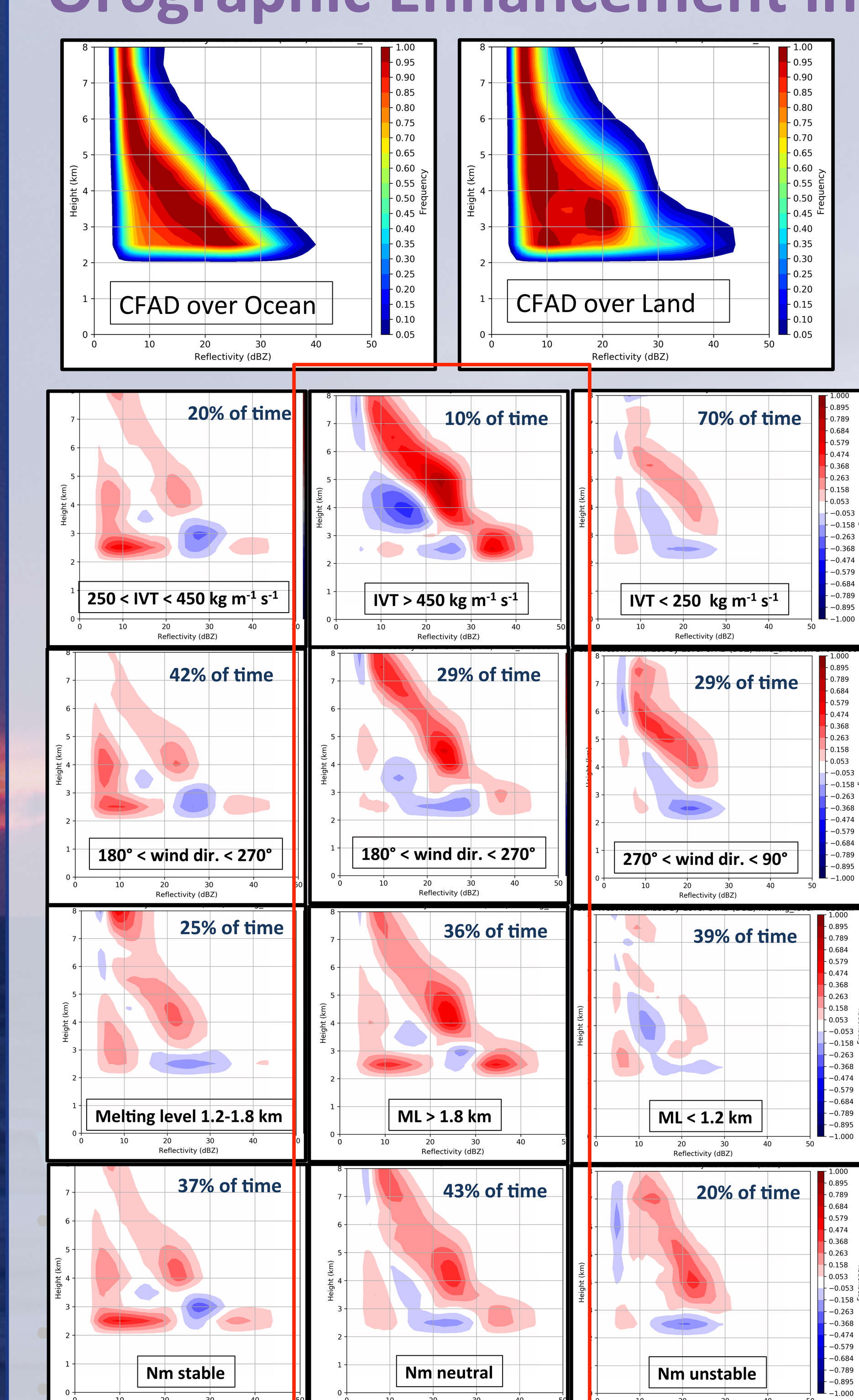


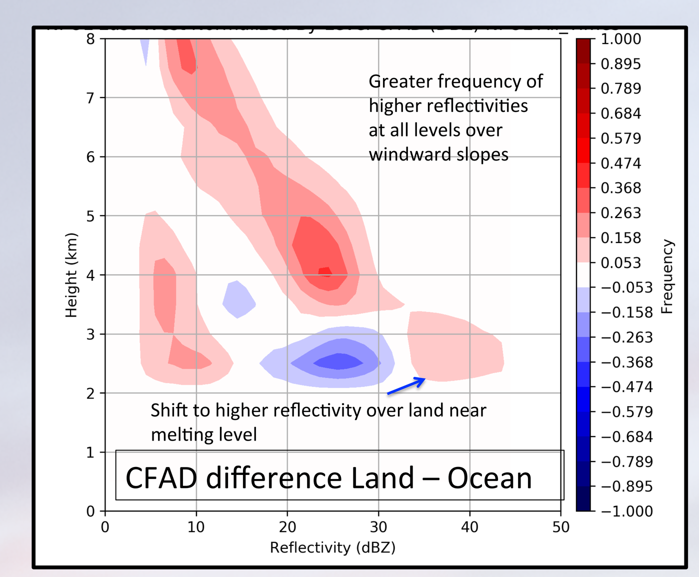
Orographic enhancement associated with large quantities of <1.5 mm drops. These drops are responsible for the majority of the increase in rain rate

Low-level jet lifted at 20 km from NPOL. Drop formation and growth occurred below melting level ahead of terrain. Jet stopped lifting at 50-60 km from NPOL

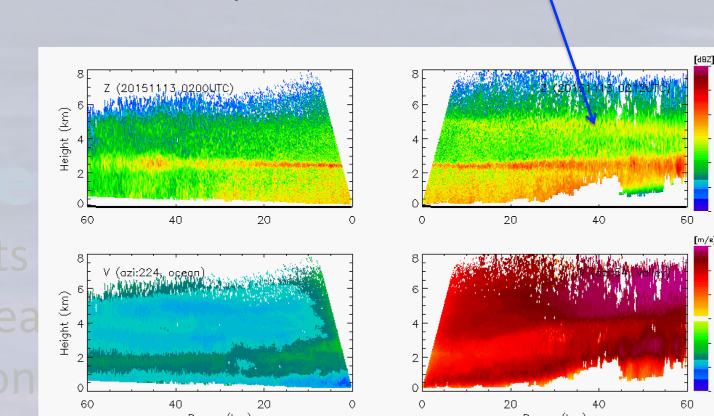
Zagrodnik, J. P., L. A. McMurdie, R. A. Houze, Jr., 2017: Stratiform Precipitation processes in cyclones passing over a coastal mountain range. *J. Atmos. Sci.*, submitted.

Orographic Enhancement in NPOL radar data





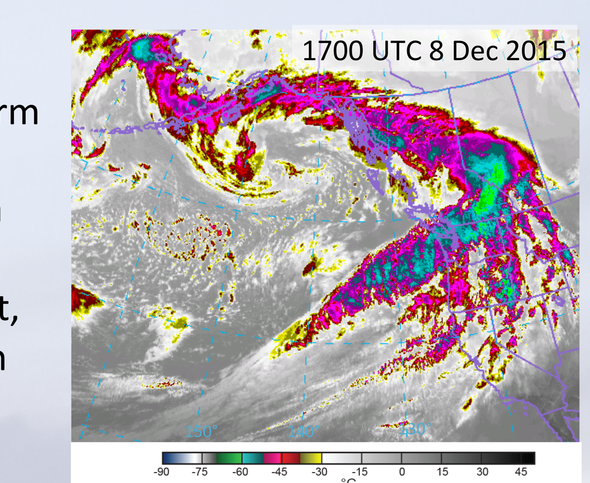
- Enhancement seen under most environmental conditions
- Largest enhancement with high IVT, high melting level, neutral stability and strong low-level winds from SW – boxed in red at left – warm sector
- Sample RHI from NPOL during high rainfall event shows enhanced reflectivity at 5 km elevation over land



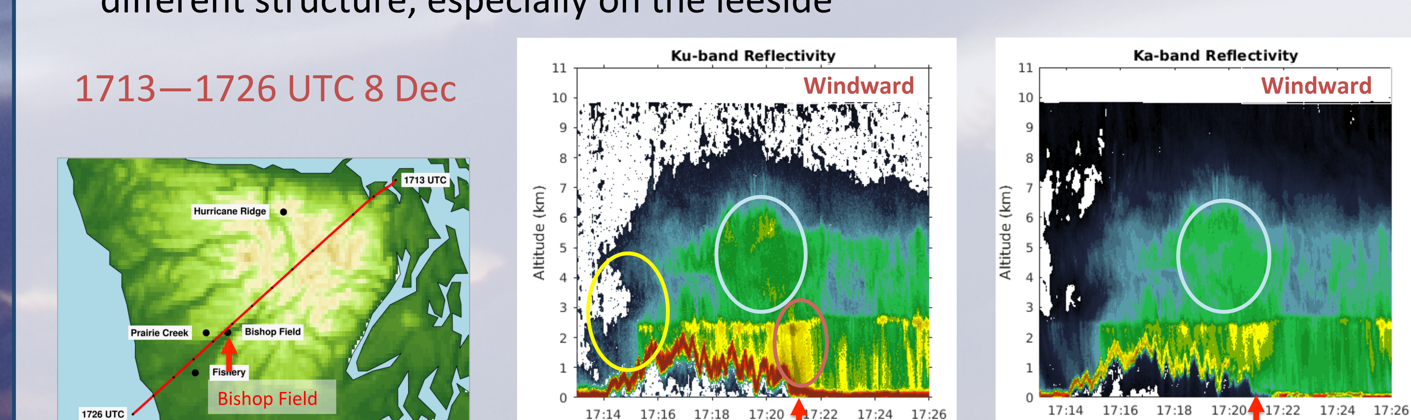
McMurdie, L. A., A. K. Rowe, T. M. Schuldt, S. Brodzik, J. P. Zagrodnik, R. A. Houze, Jr., 2017: Orographic enhancement above the melting level as observed in OLYMPEX, in prep.

Airborne radar observations over high terrain

- Observed an atmospheric river type of storm
- The DC-8 had an Airborne Precipitation Radar 3 (APR-3) with 3 wavelengths: W, Ka and Ku
- DC-8 flew legs from the ocean, to the coast, to the windward side, over the high terrain and to the leeward side
- Two legs less than 20 minutes apart show different structure, especially on the leeside

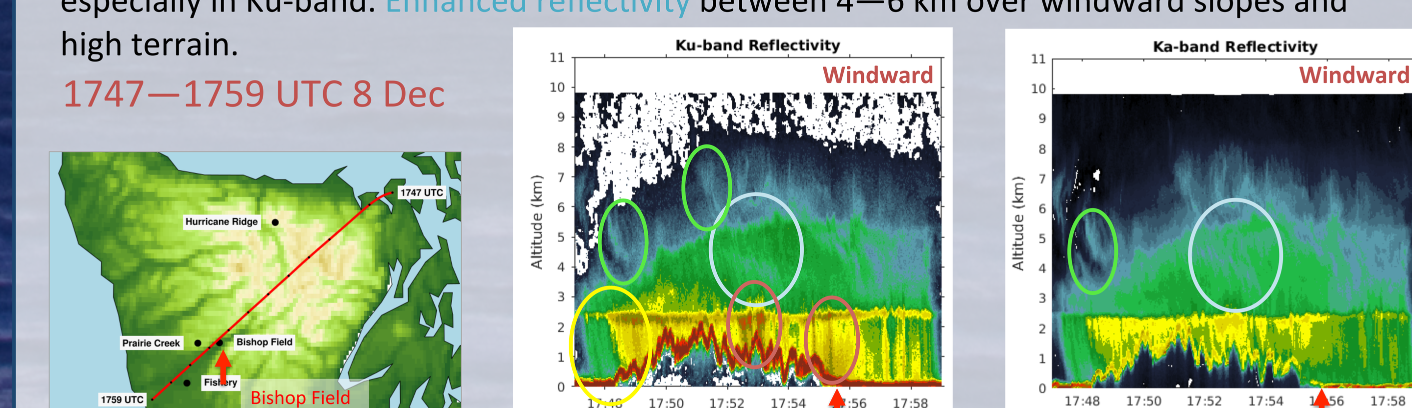


1713—1726 UTC 8 Dec



Highest reflectivity on lower windward slopes, abrupt erosion of echo on leeward side, especially in Ku-band. Enhanced reflectivity between 4—6 km over windward slopes and high terrain.

1747—1759 UTC 8 Dec



Highest reflectivity on lower windward slopes and higher terrain, less erosion of echo on leeward side. Possible signature of generating cells aloft, less enhanced reflectivity than before.

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