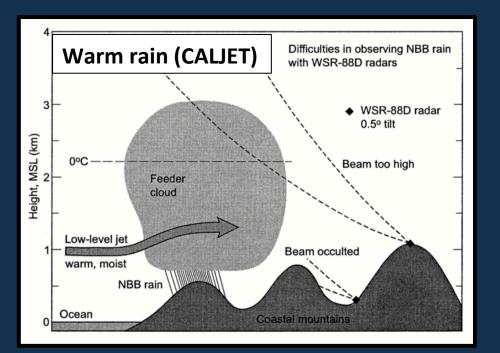
Terrain-influenced Microphysical Processes Observed by Dualpolarization Radar during OLYMPEX

> Angela Rowe Robert A. Houze, Jr. University of Washington, Seattle, WA

AMS 17th Conference on Mountain Meteorolog Burlington, VT

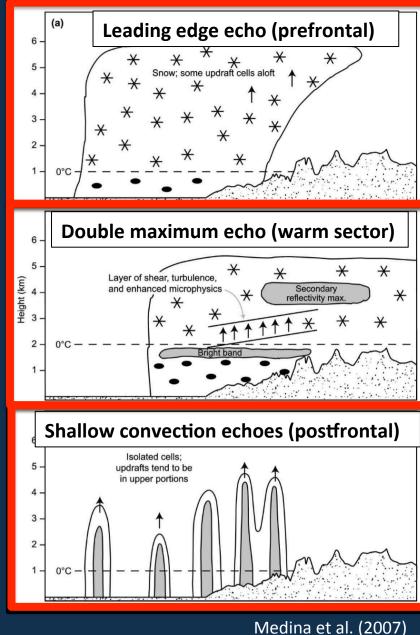
28 June 2016

Orographic Precipitation Processes

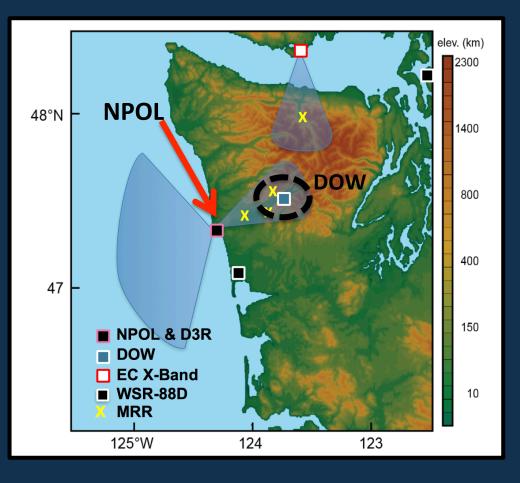


White et al. (2003)

Hybrid*, bright band, non-bright band NBB: 28% total rain (inferred small drops)

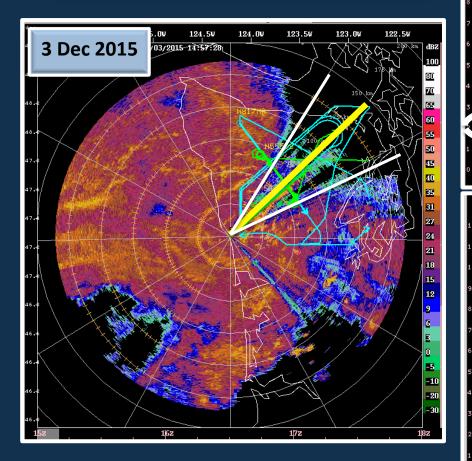


OLYMPEX radar network



- How do microphysical and dynamical processes change as storms move from ocean to coast to windward to leeside?
- How do these processes vary between storm sectors?
- Under what circumstances does orographic enhancement of precipitation occur? Which processes are responsible?
- Relative roles of warm-rain and ice-based processes

Orographic Enhancement



dBZ 100 80705 60550440 3312724 21815 12 NPOL -10-20 30 90 100 110km 50 NPOL VEL45 RHI: 45.9998 deg - 12/03/2015 15:14:51 m/s 45 35 25 20 15 10 6 3 -3 -6 -10 -25 -35 -45 70 60 80 90 100110a

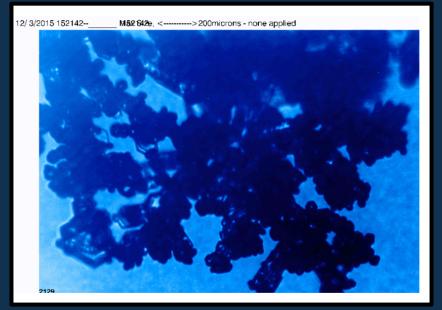
NPOL DBZ RHI: 45.9998 deg -

12/03/2015 15:14:51

RHI (valley) sector DC-8 Citation

Orographic Enhancement

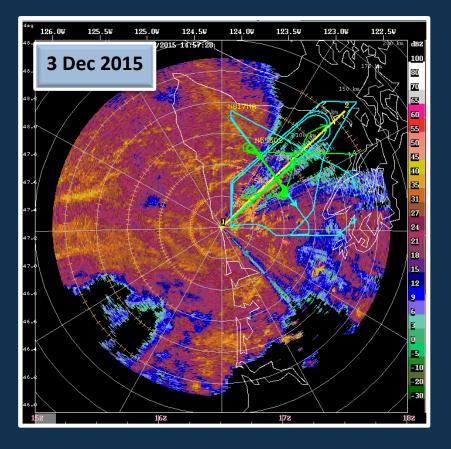
UND Citation cloud particle imager (4 km): Rimed, branched, and aggregated snow

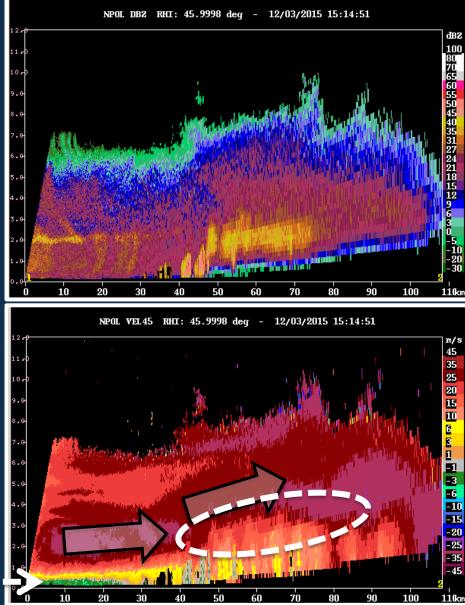


Snow melting to rain

RHI: 45.9998 deg -12/03/2015 15:14:51 NPOL DBZ Reflectivity 100 80 70 3 Dec 2015 6055045403531272421815 100 90 $110 \ k$ NPOL ZDR RHI: 45.9998 deg -12/03/2015 15:14:51 95 50 20 15 10 **Differential Reflectivity** Dendritic growth Aggregation/ riming 2.5 50 20 30 40 70 90 100 60 80 110a

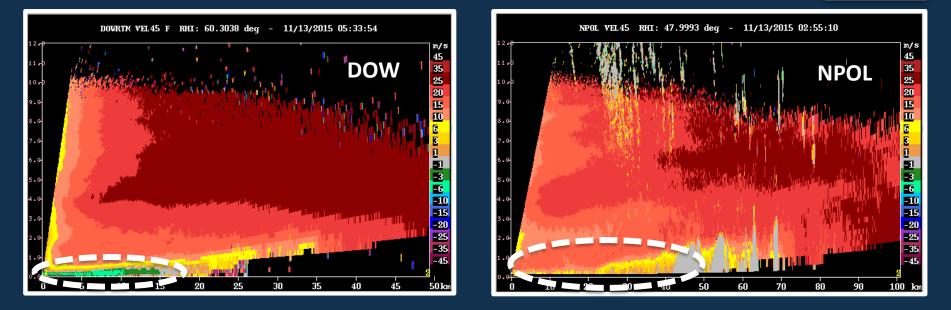
Orographic Enhancement





Down-valley low-level flow

13 Nov

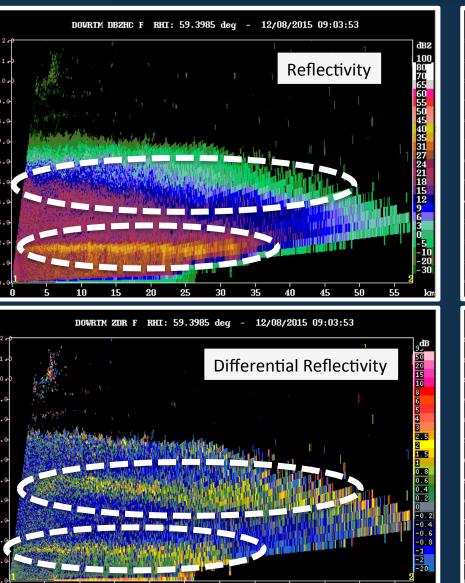


- Also observed during MAP, SNOW-V10
- Diabatic cooling from evaporation and melting snow, formation of down-valley flow (Thériault et al. 2012)

- How does this flow pattern vary?
- What is the effect on microphysics?

Atmospheric River Event

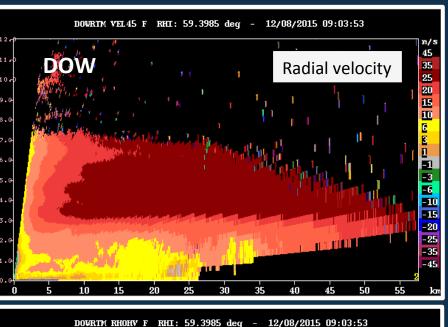
55



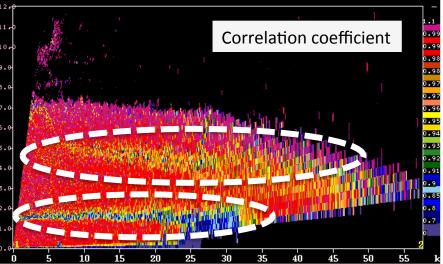
35

20

4N



8 Dec



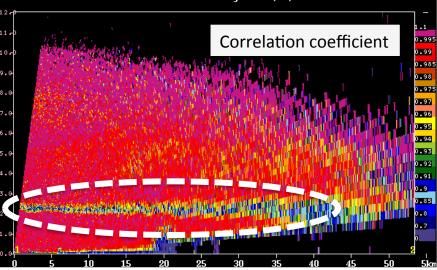
Atmospheric River Event

-0.: -1

DOWRTM DBZHC F RHI: 63.3031 deg - 11/13/2015 05:43:54 dBZ 100 80 70 65 60 55 50 45 40 35 31 DOW Reflectivity 24 21 18 15 12 -5 -10 -20 -30 10 50 5km DOWRTM ZDR F RHI: 63.3031 deg - 11/13/2015 05:43:54 950 20 15 10 **Differential Reflectivity**).6).4).2

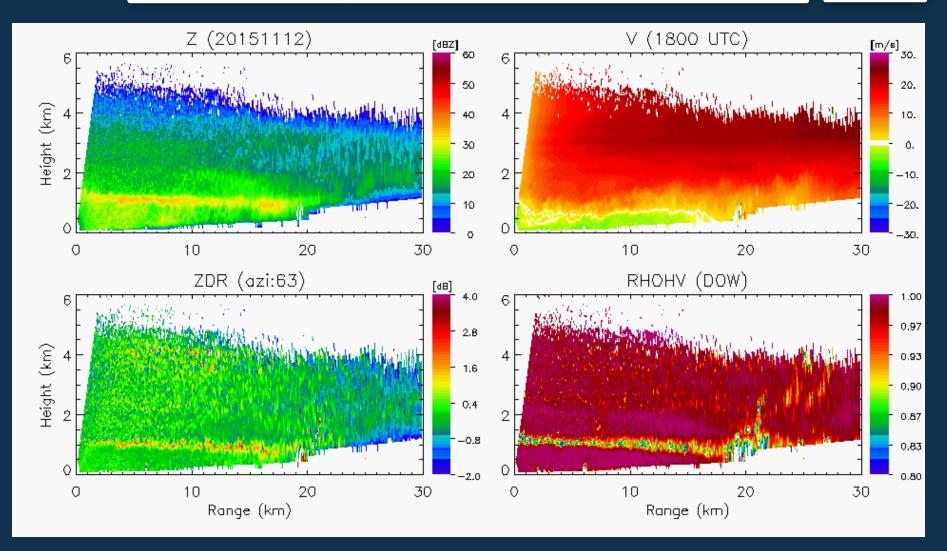
DOWRTM VEL45 F RHI: 63.3031 deg - 11/13/2015 05:43:54 m/s 45 Radial velocity 35 25 20 15 10 6 -1 -3 -6 -10 15 -20 -25 -35 -45 5km 50 11/13/2015 05:43:54 DOWRTM RHOHV F RHI: 63.3031 deq

13 Nov



Atmospheric River Event

12-13 Nov



Large-scale easterly flow

14 Nov

11/14/2015 20:43:54 DOWRTM DBZHC F RHI: 57.299 deg RHI: 57.299 deg -11/14/2015 20:43:54 VEL45 F dBZ m/s 45 100 80 70 65 60 55 50 45 40 35 31 DOW Reflectivity 35 25 20 15 10 **Radial velocity** 1.0 -6 -10 Citation (2045 UTC): -15 -20 -25 Aggregates of needles at -35 45 ~2.3 km, little water observed, shallow cloud DOWRTM ZDR F RHI: 57.299 deg -11/14/2015 I: 57.299 deg - 11/14/2015 20:43:54 50 20 15 10 **Differential Reflectivity Correlation Coefficient** 0.995 0.99 0.985 0.98 0.975 0.97 0.96 0.95 0.94 . 9 . 91).85).8 50

Frontal passage

-1

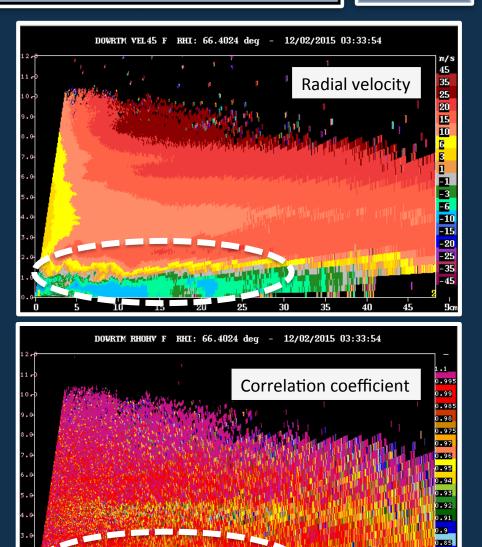
Skar

40

45

21

DOWRTM DBZHC F RHI: 66.4024 deg -12/02/2015 03:33:54 dBZ 100 870 55 50 40 55 317 24 218 15 29 DOW 11 Reflectivity -10 -20 -30 45 12/02/2015 03:33:54 RHI: 66.4024 deg DOWRTM ZDR F dB 95 20 15 10 **Differential Reflectivity** 2.5 2 1.5 1 0.8 0.6 0.4 0.2 0.4 0.6 -0.:



15

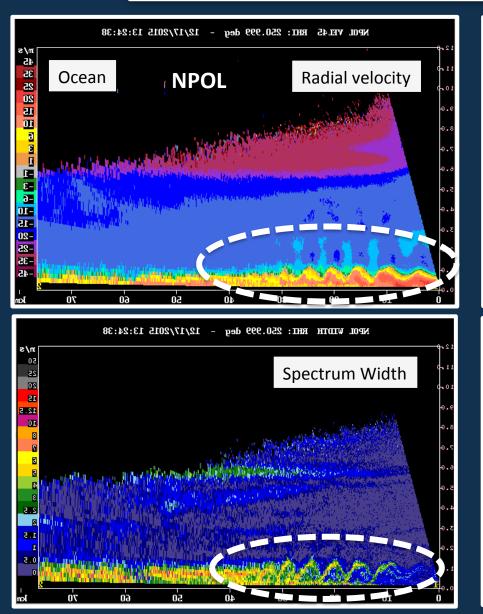
1-2 Dec

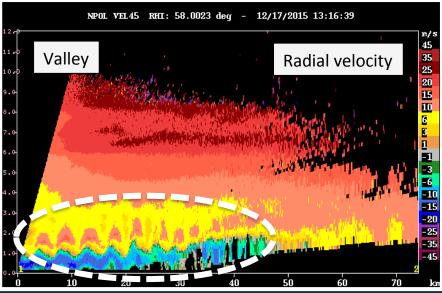
0.7

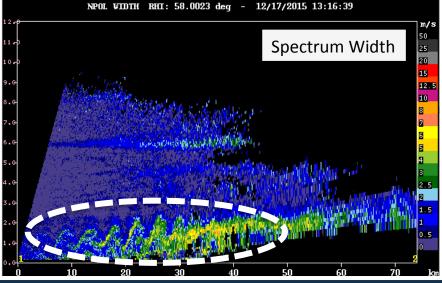
40

Kelvin-Helmholtz waves

17 Dec

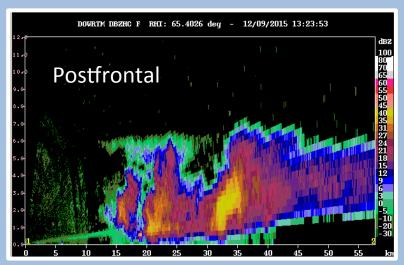


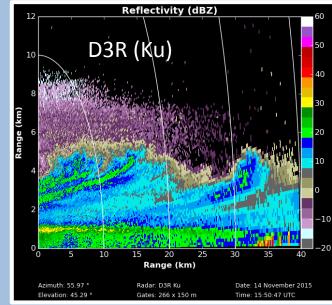




Looking forward

- Continue quality control of data
- Determining relative roles of warm-rain vs. icebased processes (combinations)
 - Analysis of polarimetric variables relative to terrain and storm sector/type
 ¹² Reflectivity (dBZ)





Looking forward

- Continue quality control of data
- Determining relative roles of warm-rain vs. icebased processes (combinations)
 - Analysis of polarimetric variables relative to terrain and storm sector/type
 - Use of aircraft data (transects, spirals)
 - Orographic enhancement
- Mechanisms (context of previous studies)
 - Brightband, shear, K-H instability



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