Validation of Precipitation in the Complex Terrain of OLYMPEX

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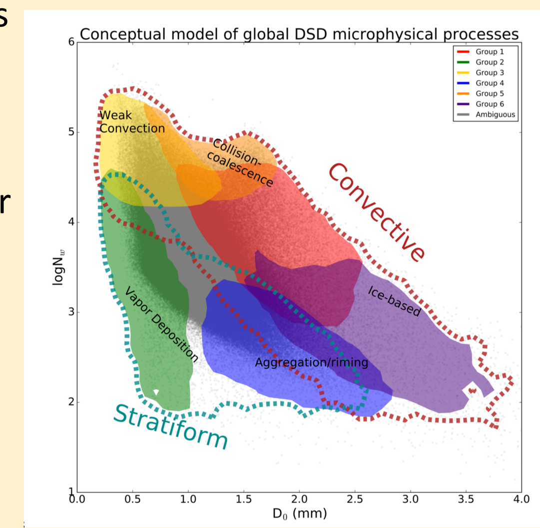
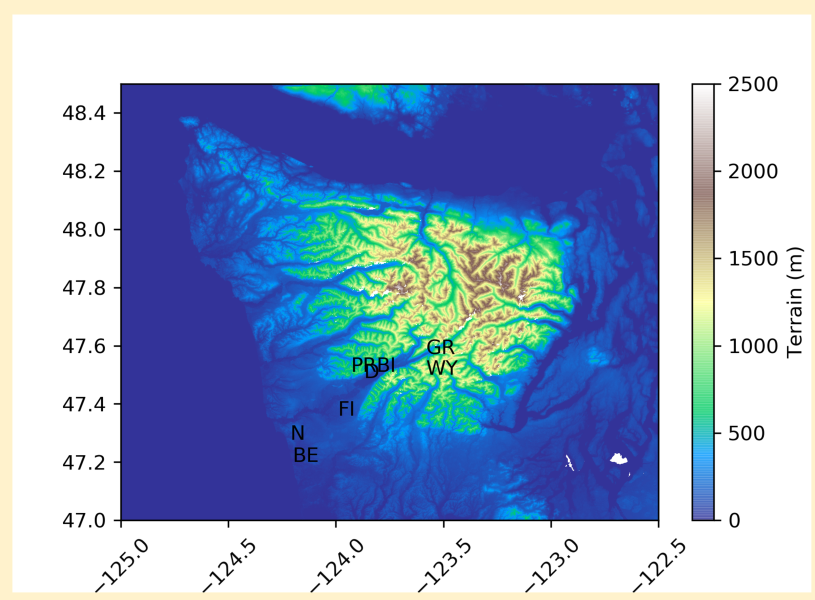
Motivational Questions

In previous studies we have shown that surface rain can be objectively sorted into six groups based on covariability of drop size distribution and integral rain parameters. Radar observations showed these six groups may give clues about microphysical processes aloft and perhaps be linked to environmental influences (such as warm cloud depth and CCN concentrations). However, the complex orographic and synoptically driven precipitation over the Olympic peninsula give rise to new questions about the relationship between environment, microphysics, and precipitation. **Do snow particle size distributions show the same objective modes of variability seen in rain? What microphysical processes or synoptic regimes contribute to surface precipitation variability, both rain and snow? Are these critical processes and variability adequately captured in GPM algorithms?** Additionally, analysis of GPM DPR overpasses in OLYMPEX and NPOL precipitation rates showed a tendency for over or under estimation of rain depending on the extratropical regime. **Are these differences linked to microphysical processes or synoptic regimes?**



Methodology

Use APU rain observations at Prairie Creek (542 m) to look at surface rain rates and size distributions as a function of melting layer height, as well as synoptic and mesoscale environmental features. Compare with polarimetric-derived hydrometeor distributions using the Thompson et al. (2014) cold-season classification algorithm from NPOL for ice crystals, plates, dendrites, aggregates, and wet snow. Time-height series are calculated from means of gridded RHI data, and Hovmöllers are calculated using means in height over the raining layer in 0.01º longitude bands. APU data were processed from raw matrix data with the effects of splashing and shattering removed. Synoptic regimes identified following Zagrodnik et al. (2018).



Precipitation Processes in Extratropical Cyclones

Determine cyclone-centered composites of Extratropical Cyclones (ETCs) → Quantify precipitation vertical structure across different types of frontal structures → Estimate and evaluate vertical latent heating profiles in different ETC components

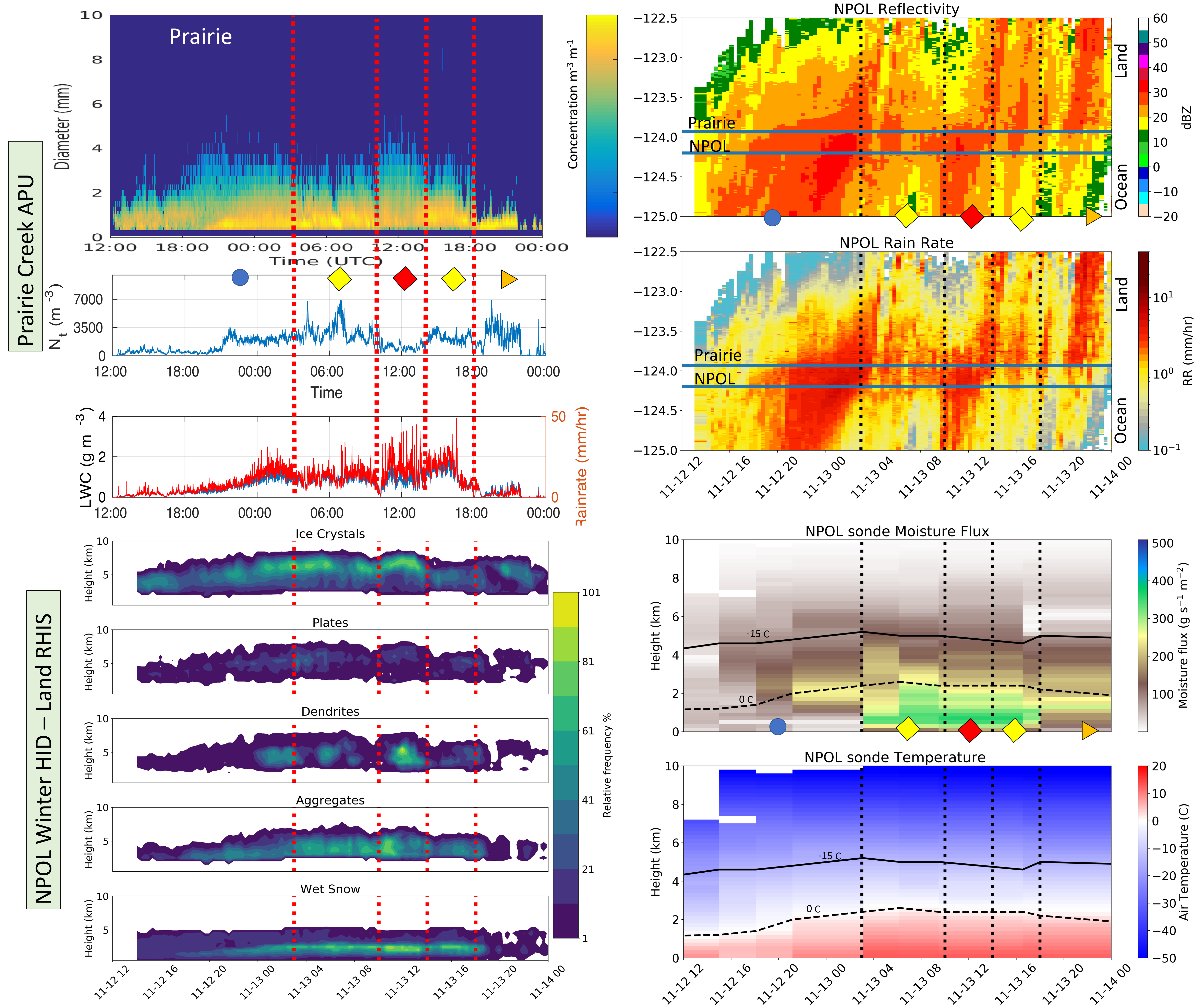
- **Detect ETCs** using the NASA Modeling, Analysis and Prediction (MAP) Climatology of Midlatitude Storminess (MCMS; Bauer and DelGenio 2006)
- Examine collocated horizontal precipitation structures, frequency, and intensity using **GPM DPR observations**

- **Compute composite vertical profiles of ETCS** over oceans, making landfall, and storms classified as atmospheric rivers
- Further separate into frontal types across above categories **→ Examine environmental conditions as a function of type**

- **Evaluate the latent heating algorithm in different ETC categories** described in previous objective
- Variability of latent heating profiles in various ETC components → **Goal of communicating such characteristics to PMM CSH algorithm team**

Future Work

Continue to examine the link between environment, microphysics, and surface precipitation. Examine other cases where different ice habits are more frequent, such as plates, relative to the moisture flux and the surface precipitation. Look at DSDs from APUs as a function of regime and microphysics at different locations in the terrain. Extend the APU observations to snow periods to look at snowfall rates, snow PSDs in the principal component analysis framework, and the bulk microphysical insights provided with polarimetric data. We also plan to look at the correlation between environmental parameters such as moisture flux, stability, and warm cloud depth and DSD and PSD variability derived from principal component analysis. We plan to expand our analysis of precipitation variability to more extratropical cyclones (ETCs) by applying a detection algorithm to GPM data, and then examining the environment as a function of ETC type with the goal of evaluating the latent heating algorithm in different ETC types. This work is funded by NASA PMM 18-PMMST18-0017.



Pre-Frontal

- Shallow warm depth (1.2 km)
- Offshore maximum in rain rates
- Mostly characterized by ice crystals
- Some larger drops

Warm Sector 1

- Deeper warm layer (2.0 km)
- Maximum rain rates over terrain
- Increased moisture flux below 3.0 km
- Generally high concentrations of small drops (1-2 mm)
- Low rain rates, few large particles
- Frequent ice crystals, dendrites, and aggregates in the ice region

Warm Sector 2

- Deep warm layer continues
- Still significant moisture flux in low levels
- Second peak in ocean rain rates and enhanced rain rates over terrain
- Echo tops increase slightly
- Significant dendritic growth zone between -10 and -15 C with increased aggregation below
- Large rain rates, but larger drops and fewer total number of drops

Warm Sector 3

- Deeper warm layer (2.0 km)
- Maximum rain rates over terrain
- Decreasing moisture flux
- Lower echo top heights
- Moderate rain rates, smaller drop sizes
- Some aggregates and ice crystals

Frontal

- Rain rates peak in and beyond highest terrain
- Less moisture flux
- High number concentrations of small drops (< 1 mm)
- Low rain rates at Prairie Creek site
- Very little diversity in HCA; mostly ice crystals