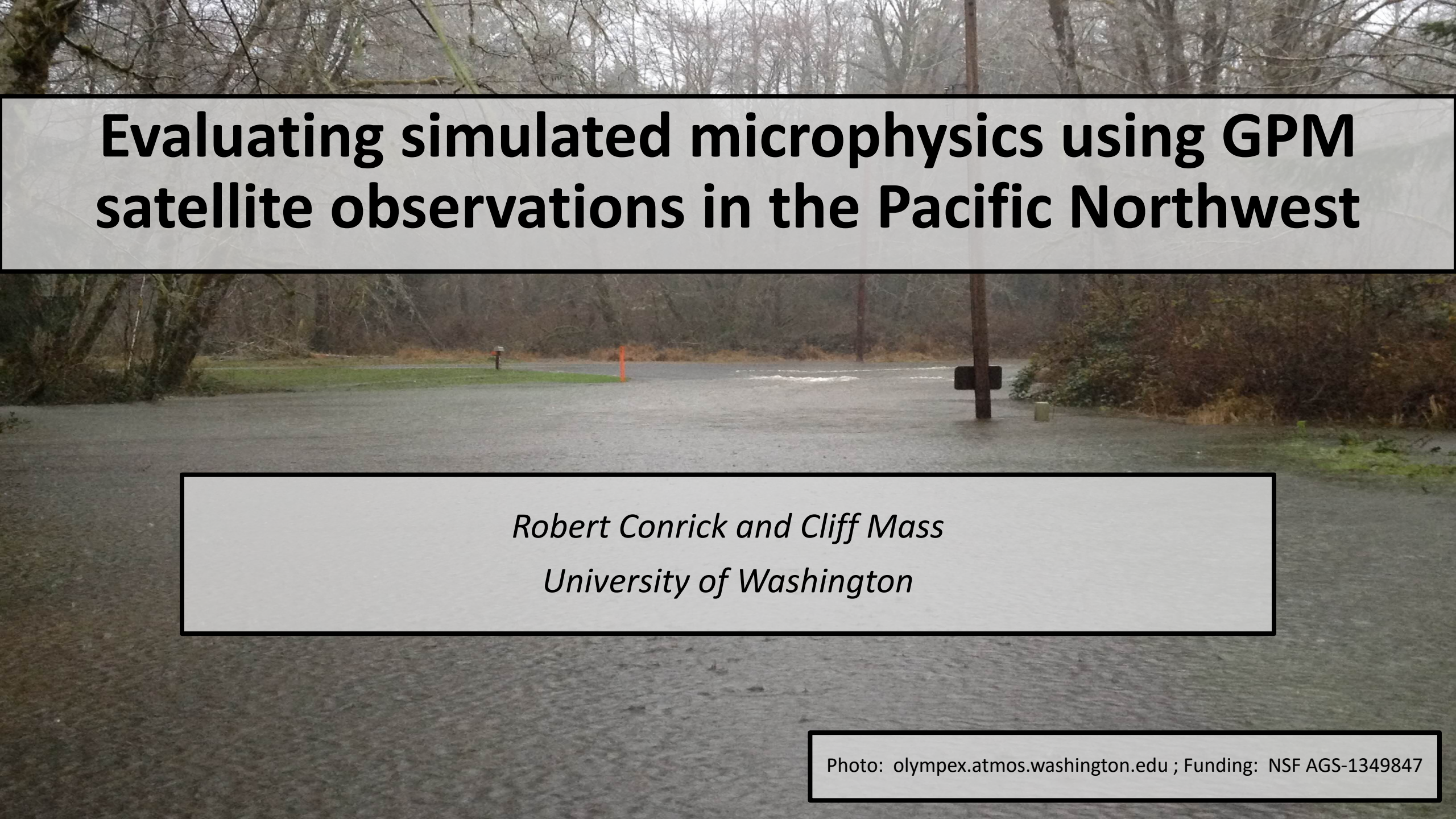


Evaluating simulated microphysics using GPM satellite observations in the Pacific Northwest

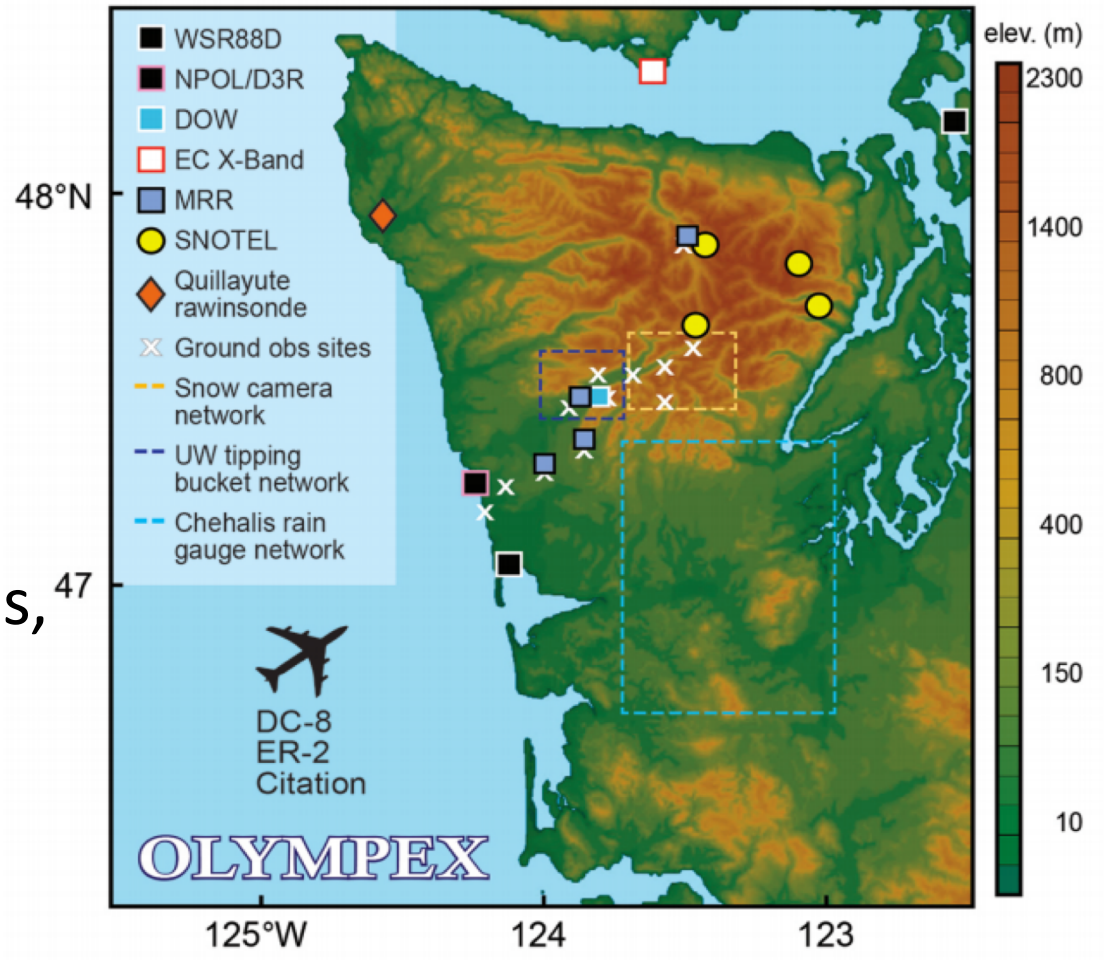
Robert Conrick and Cliff Mass

University of Washington

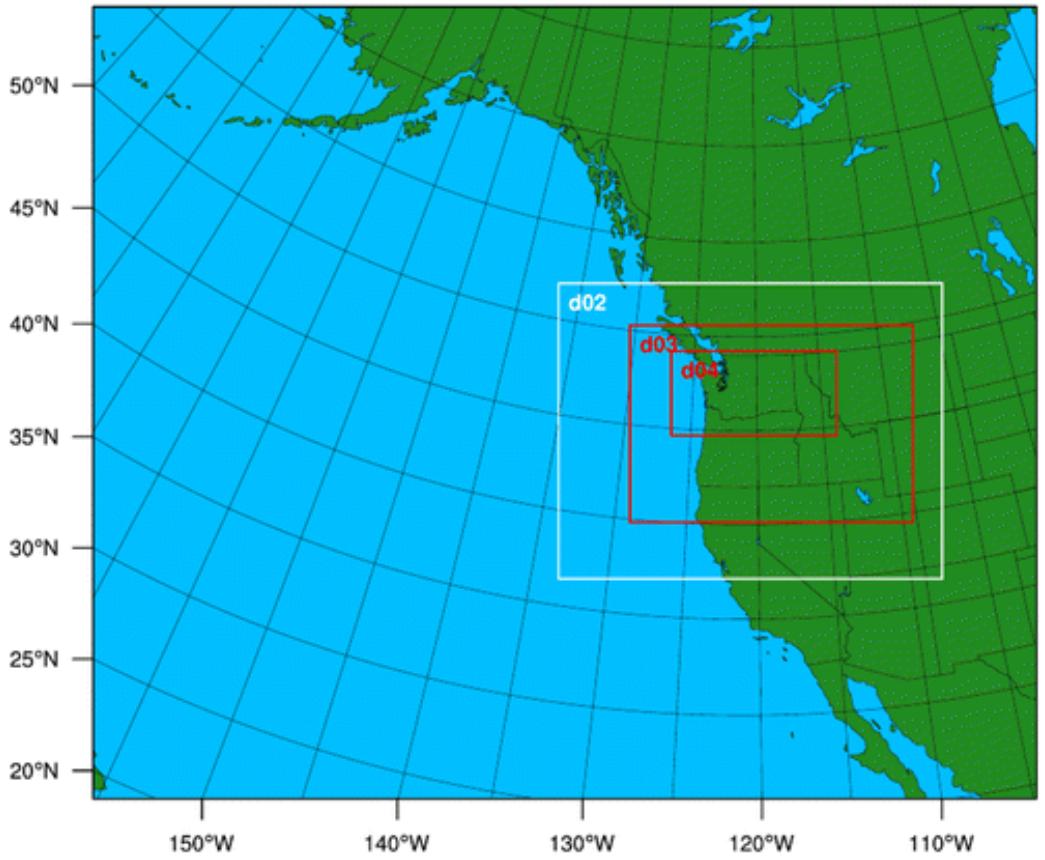
Photo: olympex.atmos.washington.edu ; Funding: NSF AGS-1349847

OLYMPEX Campaign

- Winter 2015-2016, Olympic Peninsula of WA
- Assets included 3 aircraft, several radars, satellite (GPM), additional radiosondes, dropsondes, rain gauges, and parsivels.
- Observations on windward and leeward slopes, including radar coverage.



WRF Configuration

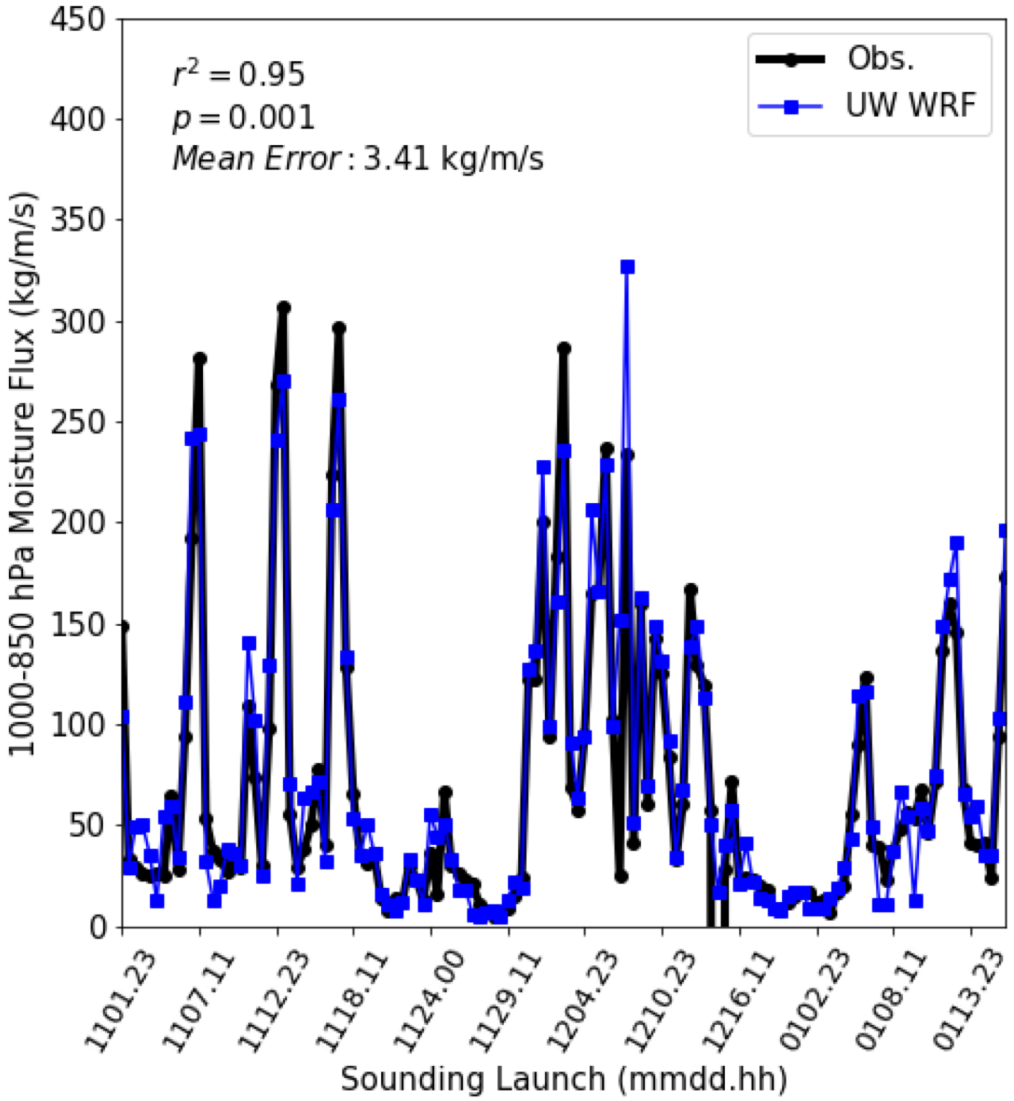


- The University of Washington WRF used WRF v.3.7.1 during OLYMPEX

- 38 vertical levels
- 36-12-4-1.33 km configuration
- Thompson MP, YSU PBL, RRTMG radiation,
- Grell-Freitas Cu scheme (on 36-12-4 km domains)
- GFS IC/BC, 36-km grid nudging.

- Using 0000 UTC daily runs between 01 November 2015 and 01 February 2016

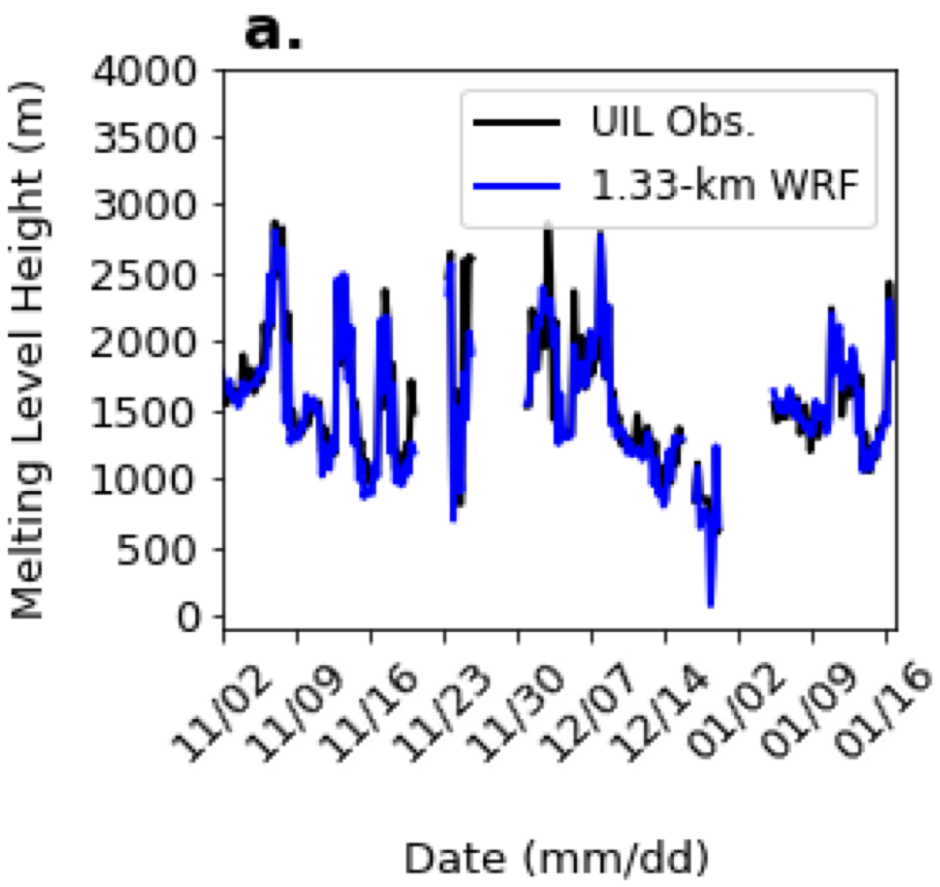
How were *synoptic* forecasts during OLYMPEX?

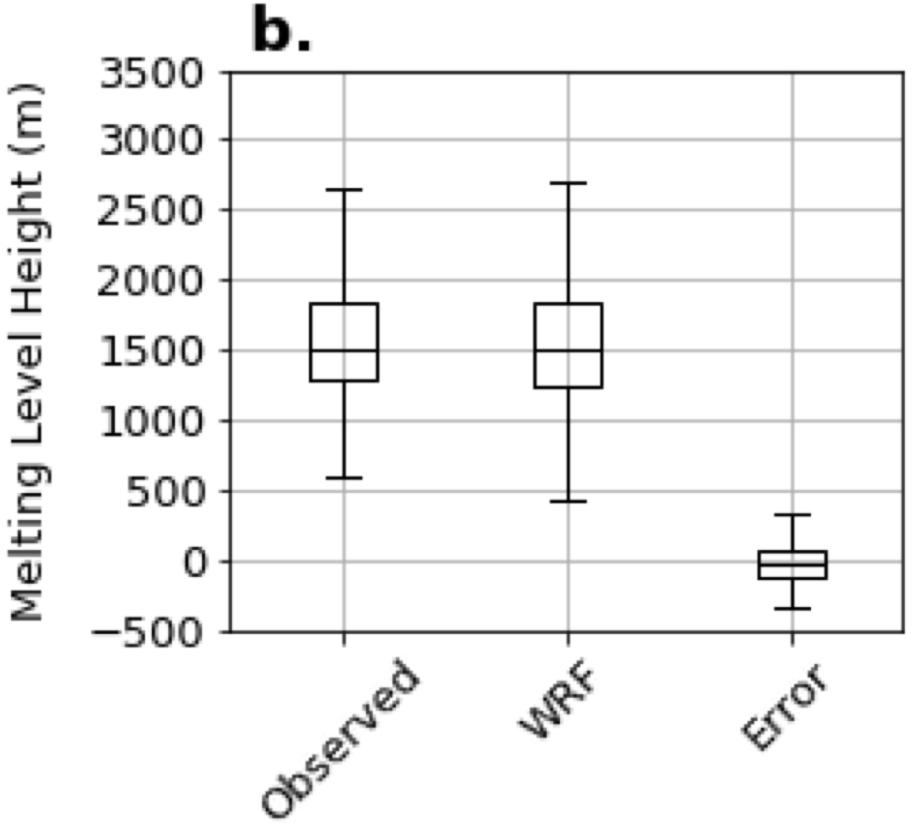


- UW WRF vs. UIL sondes
- Low-level integrated vapor transport (IVT) was well forecast during OLYMPEX.
- UW WRF: WRFv3.7.1 ; Thompson MP ; YSU PBL

How were *synoptic* forecasts during OLYMPEX?

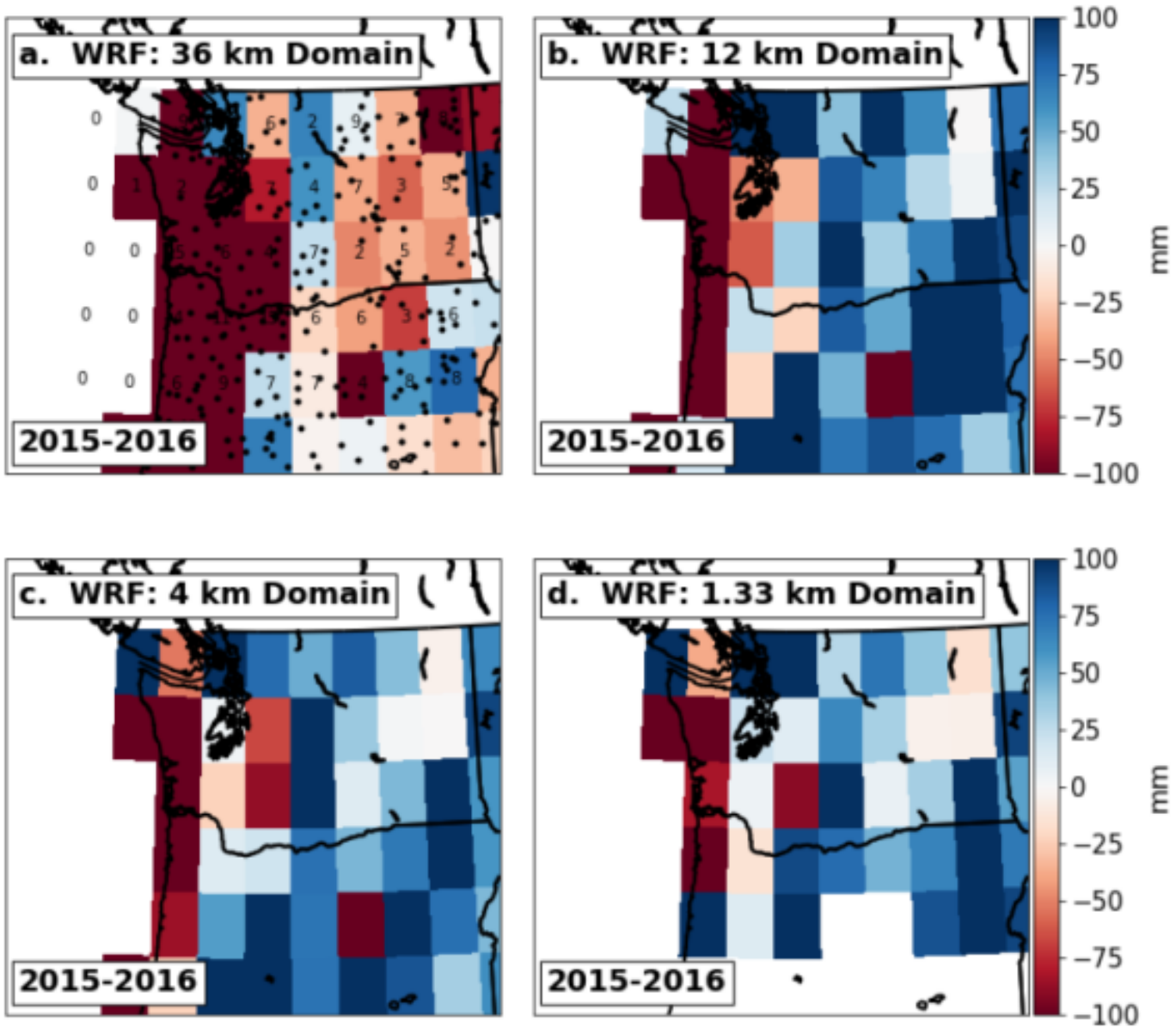
- Even the melting level height was very well forecast.





If synoptic forecasts were accurate, how good were precipitation forecasts?

Precipitation Errors during OLYMPEX



- **Nov. 2015 – Feb. 2016**
- **UW WRF (Thompson MP)**

  Error = *Forecast – Observations*

- Coastal **underprediction**.
- General **overprediction** elsewhere, including the OR Cascades.

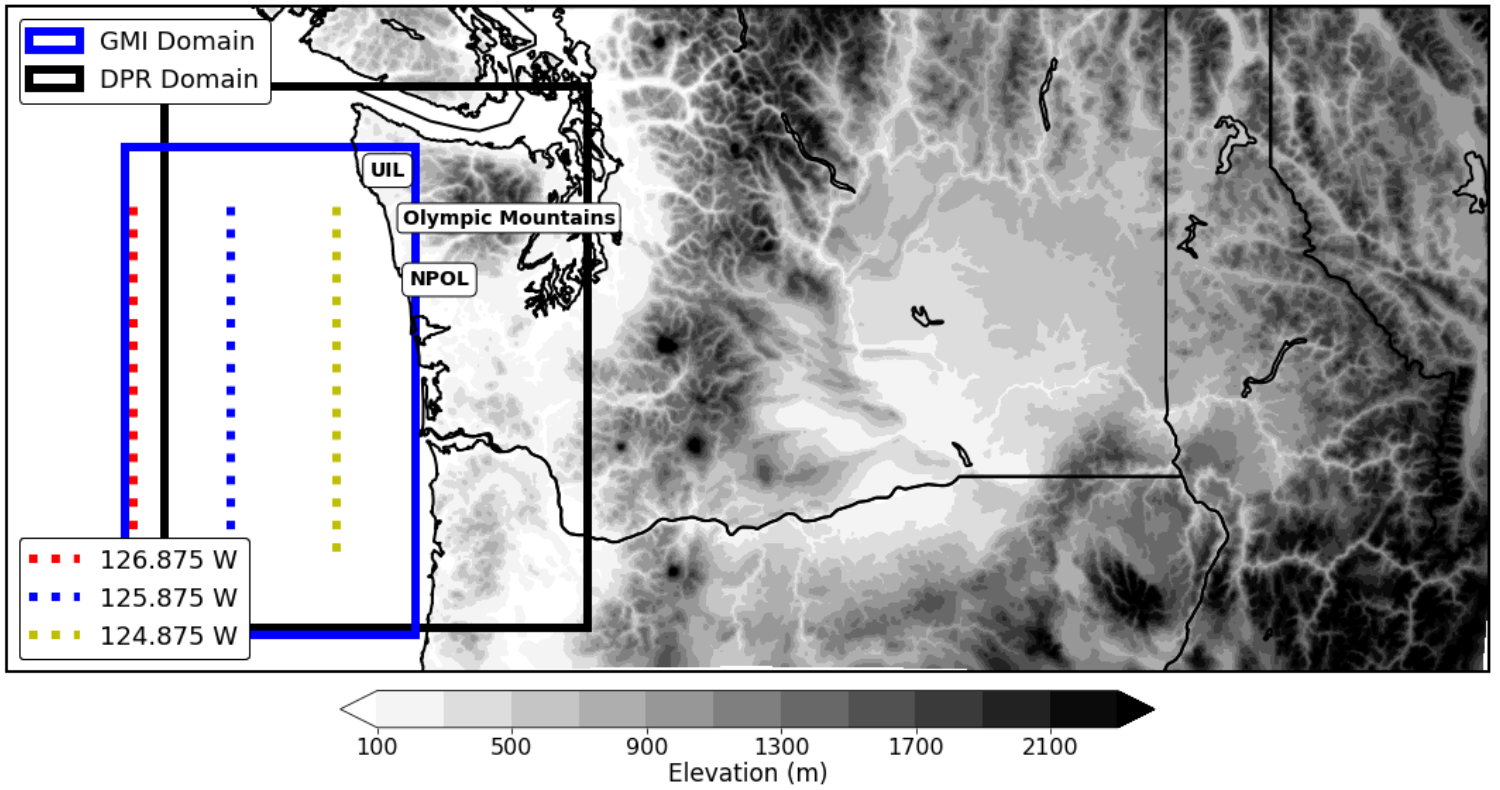
The GPM Satellite

GPM Satellite Analysis

- 12 ‘good’ overpasses during OLYMPEX
  - Precipitating over or near the Peninsula.

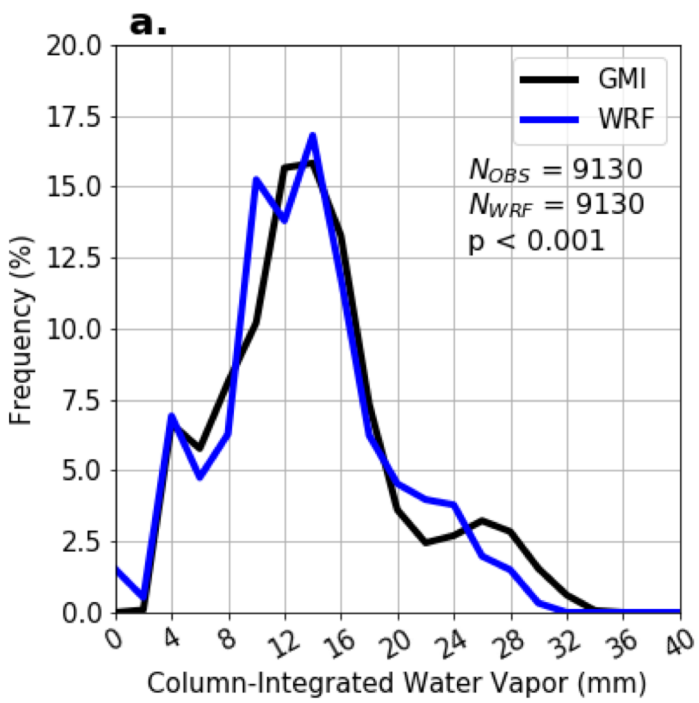
- Next slides use daily mean data.

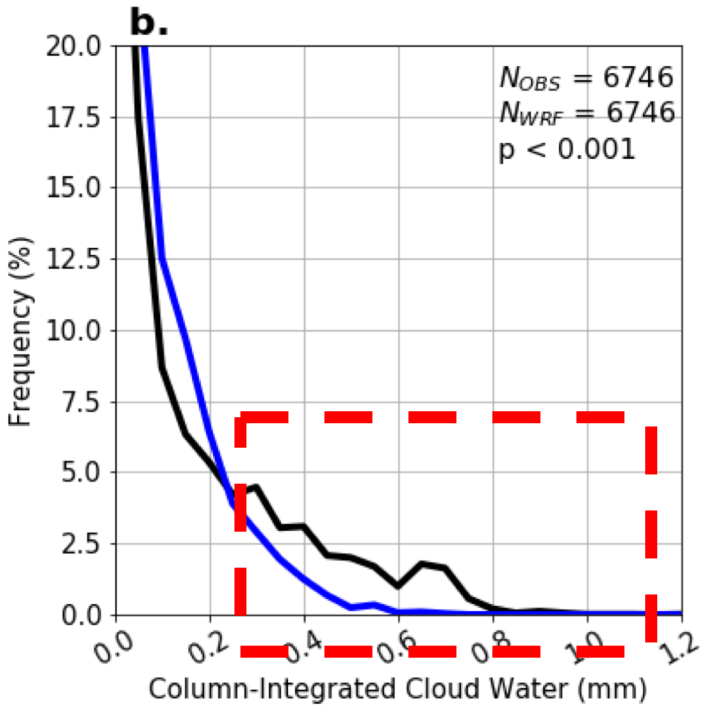
- Two instruments:
  - **GMI:** **Mixing ratios, rain rates**
  - DPR: Reflectivity, rain rates

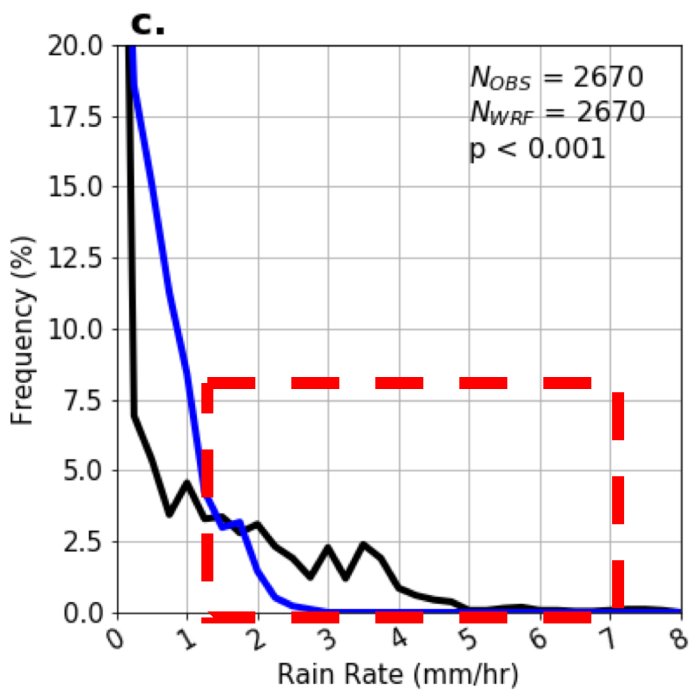


GPM Mixing Ratios

- **Blue** = WRF ; **Black** = GPM
- Good water vapor prediction.
- Underprediction of high cloud water and high rain rates.

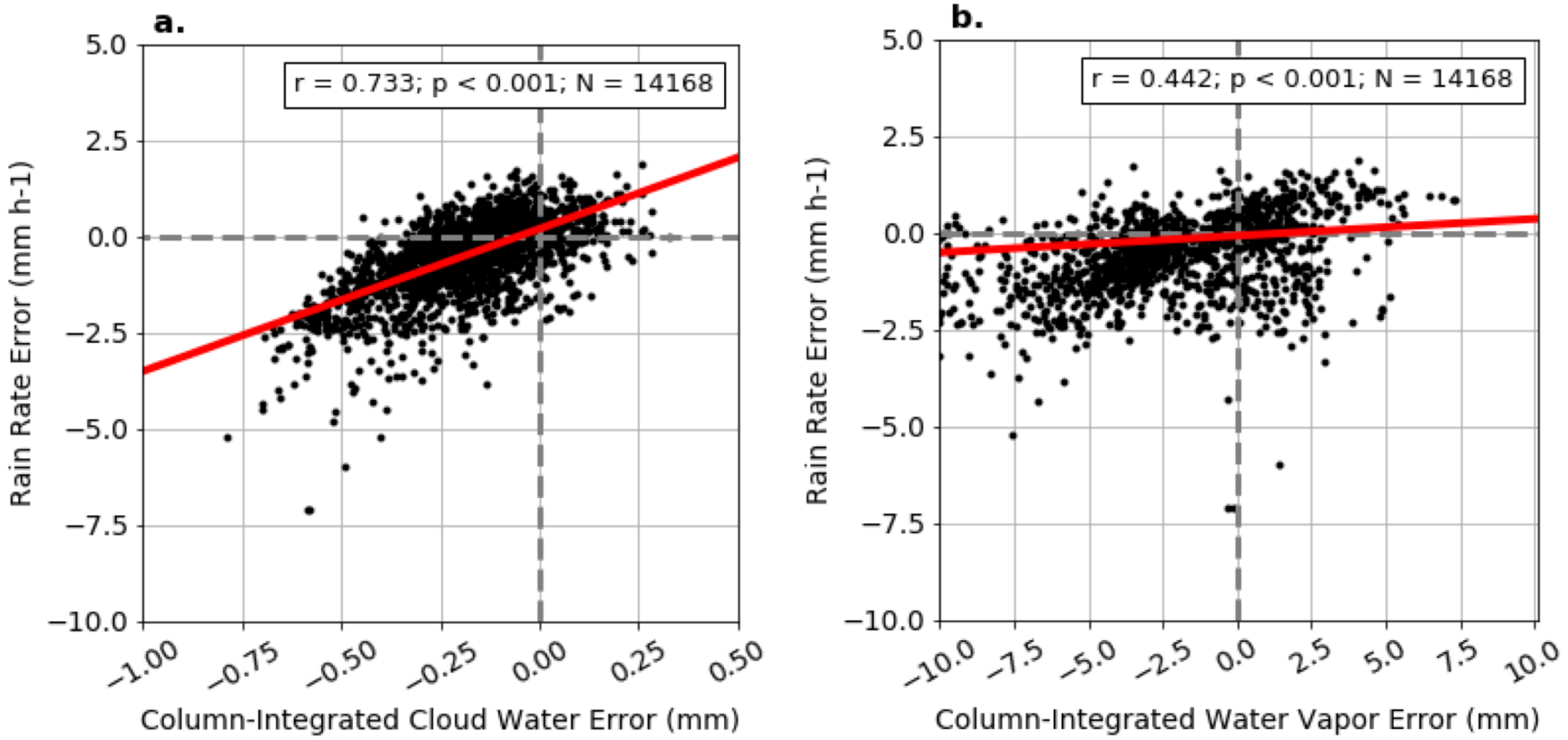






Connecting cloud and rain water errors…

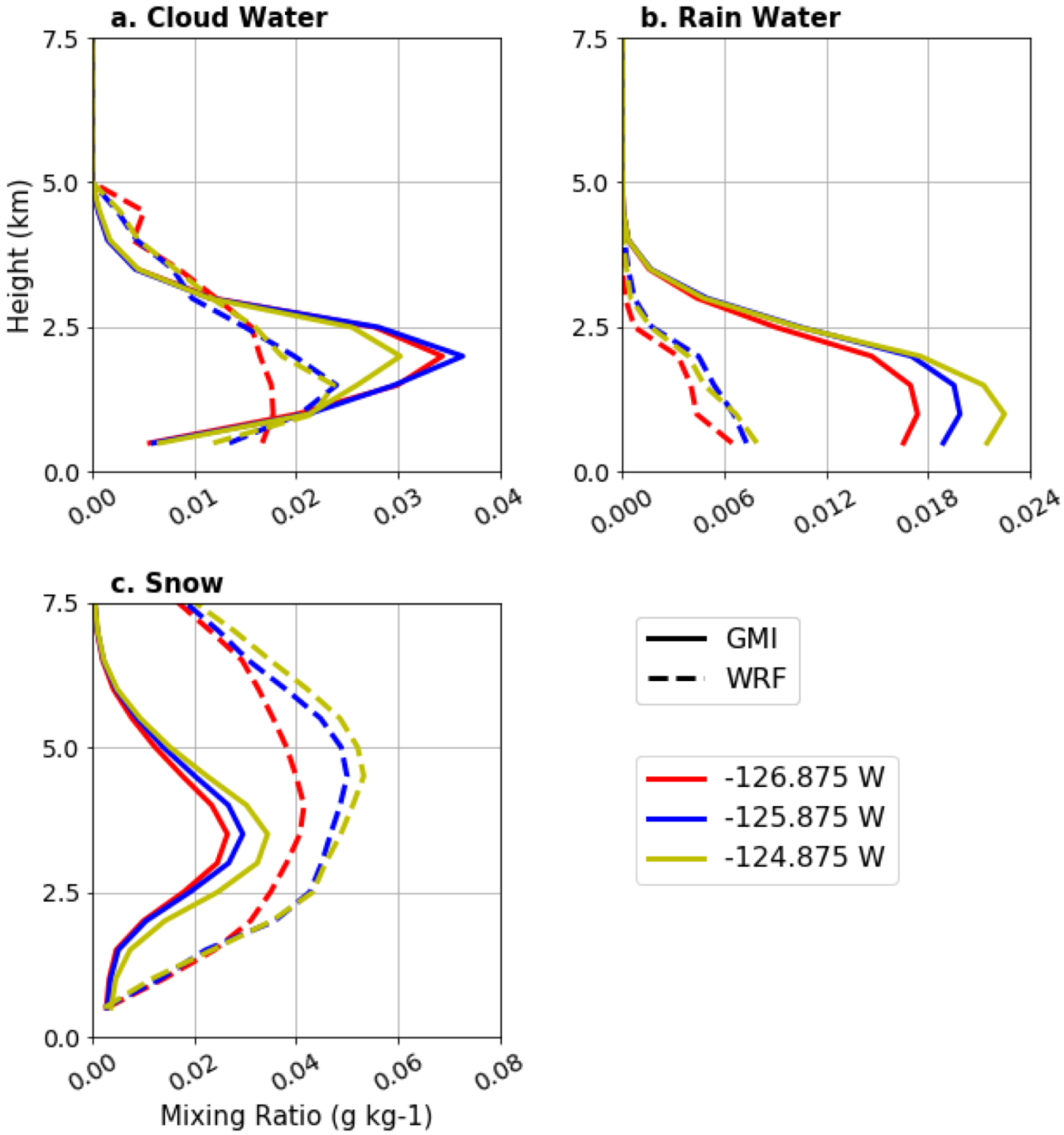
- Comparing WRF to GPM:
  - Strong relationship between underpredicted cloud water and underpredicted rainfall.



Let's look aloft…

- Underprediction of cloud water and rain water in the lower atmosphere.
  - *Similar magnitude.*

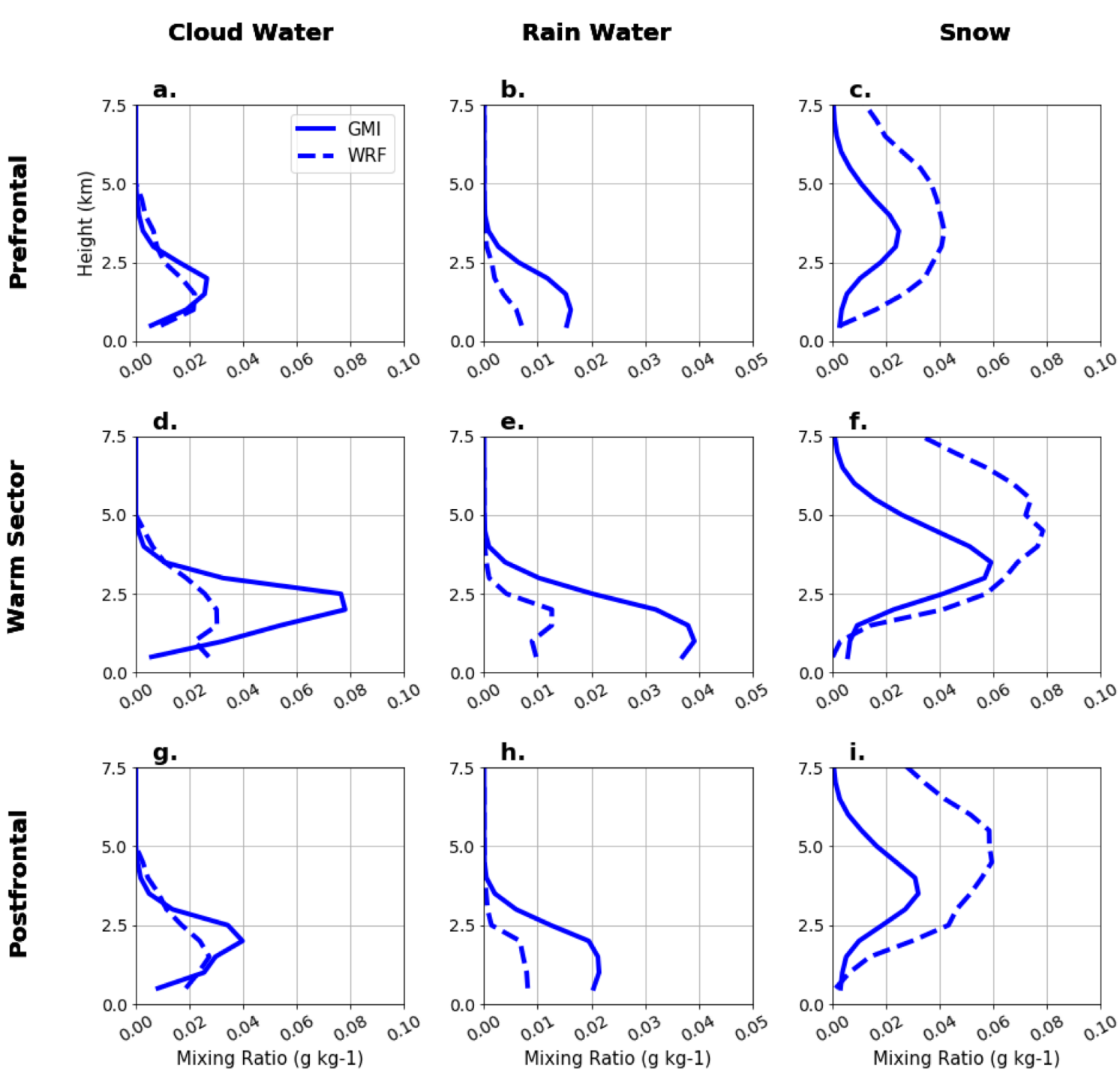
- Snow overpredicted in WRF, consistent with *years* of literature.



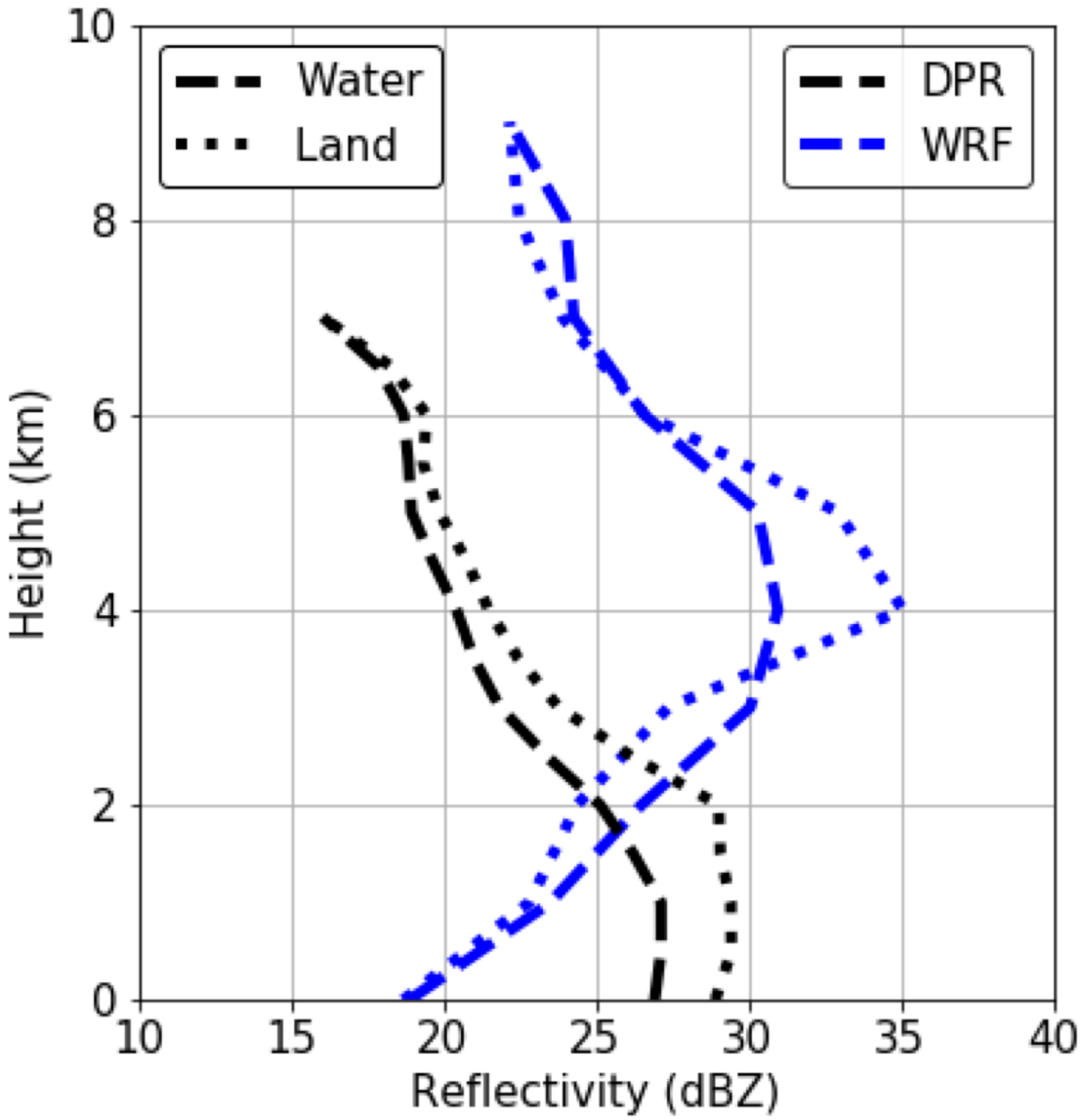
In different environments…

- Pre- and post-frontal environments generally have lowest errors in cloud/rain water.

- Largest errors during **warm sector** at lowest levels.



DPR Reflectivity: Evidence of snow overprediction?



- Reflectivity over land greater than water.
  → Terrain enhancement?

- WRF refl. Much greater than DPR above 2 km.
  → Snow
- Below 2 km, WRF refl is underpredicted.
  → Rain

Conclusions

- Synoptic forecasts are accurate over the PNW using the UW WRF.

- Precipitation is underpredicted along the Pacific Coast and has been for a long time. ***Not unique to UW WRF.***
  - *Also not unique to Thompson MP.*

- From GPM observations:
  - Related underprediction of cloud and rain water, especially in warm sector. Is the snow overprediction related?
  - Evidence of snow overprediction / rain underprediction in reflectivity profiles.

- Testing an autoconversion fix thanks to Greg Thompson.

More info: Conrick, R. and C.F. Mass, 2019: Evaluating Simulated Microphysics during OLYMPEX Using GPM Satellite Observations. *J. Atmos. Sci.*, **76**, 1093–1105,https://doi.org/10.1175/JAS-D-18-0271.1

Extra: Wind and Qvapor

- Low-level wind and water vapor content (IVT constituents) were also in good agreement with observations.