P1: Status on the most recent QPE-products provided for RealPEP and outlook

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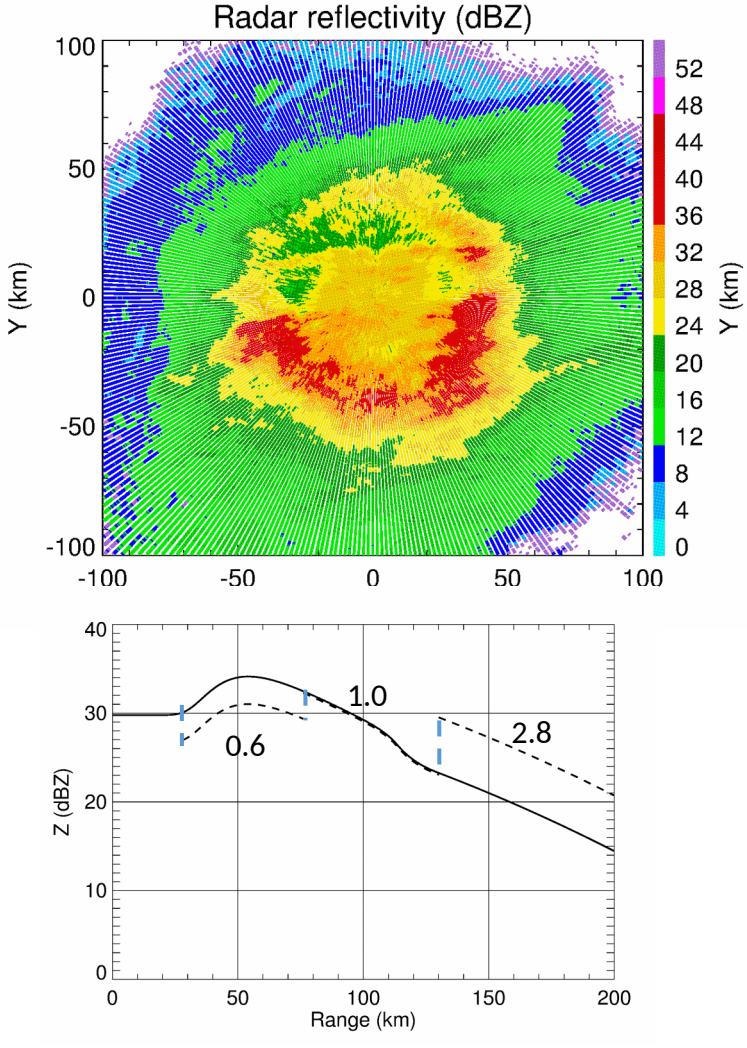
Work packages

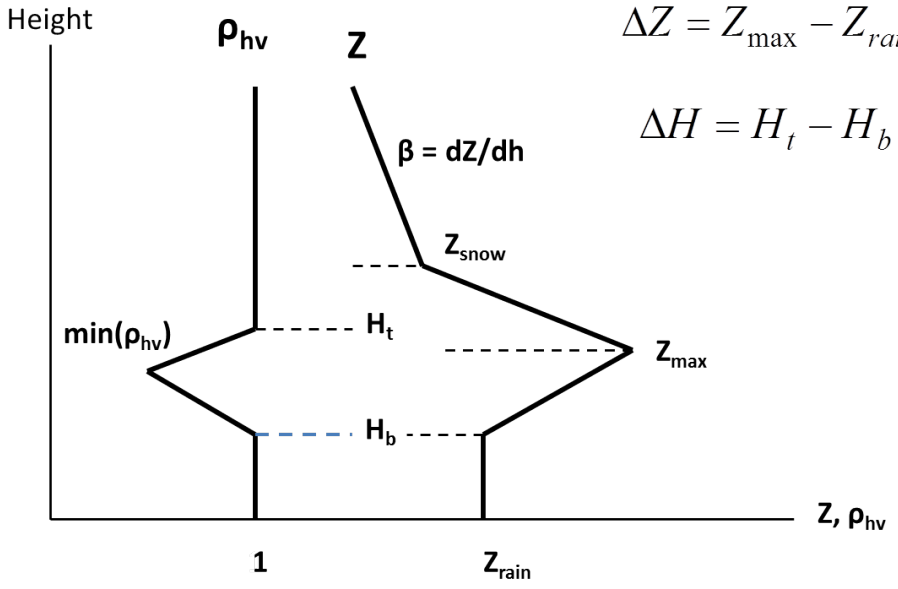
- **WP-P1-1: Joint evaluation, data provision and operationalization**
  - ✓ Evaluate methods and estimators on a large dataset
  - ✓ Synchronise evaluation with other projects
  - ✓ Identify remaining deficiencies
  - ✓ Perform evaluation with a semi-operational system in POLARA
- **WP-P1-2: Polarimetric QPE refinement by α segmentation**
  - ✓ Identify hail cores and segments with PHIDP bumps
  - ✓ Apply the ZPHI method to rainy segments
  - ✓ Derive segment-wise α estimates
  - ✓ Estimate uncertainties
- **WP-P1-3: Polarimetric QPE in snow and mixed-phase regions**
  - ✓ Apply polarimetric VPR (PVPR) in heterogeneous rain
  - ✓ Improve retrievals for snowfall intensity
- **WP-P1-4: Probabilistic merging at increasing resolutions**
  - ✓ Error estimation and bias correction between QPE products
  - ✓ Formulate a Bayesian merging framework
  - ✓ Use estimated uncertainty to derive ensemble QPE

Polarimetric Vertical Profile of Reflectivity - PVPR



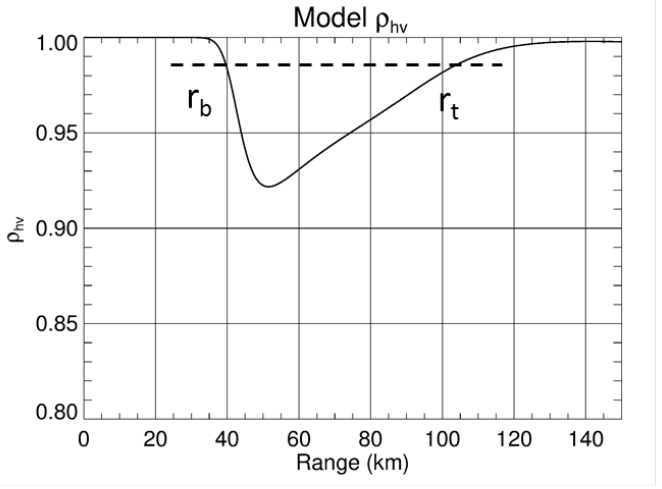
- Freezing level at low levels may produce a bright band even at low elevations
- QPE products are affected by high reflectivity from wet snow (bright band contamination)
- If the beam penetrates into the snow region QPE is underestimated as snow has a smaller refractivity index than rain
- Standard methods consist in applying a coefficient to the retrieved QPE depending on the location relative to the ML.
- These introduce discontinuities in the final product.

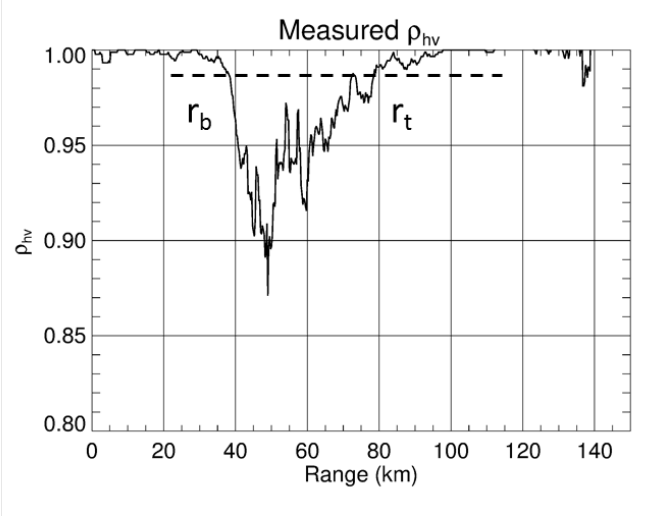
Polarimetric Vertical Profile of Reflectivity - PVPR



$$\Delta Z = Z_{\max} - Z_{rain}$$

$$\Delta H = H_t - H_b$$

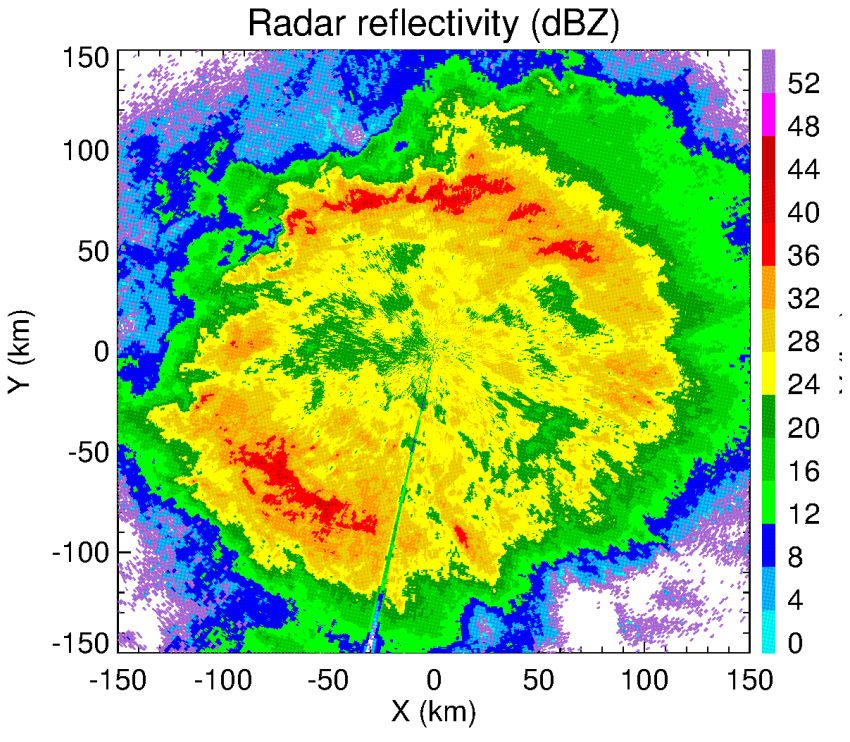




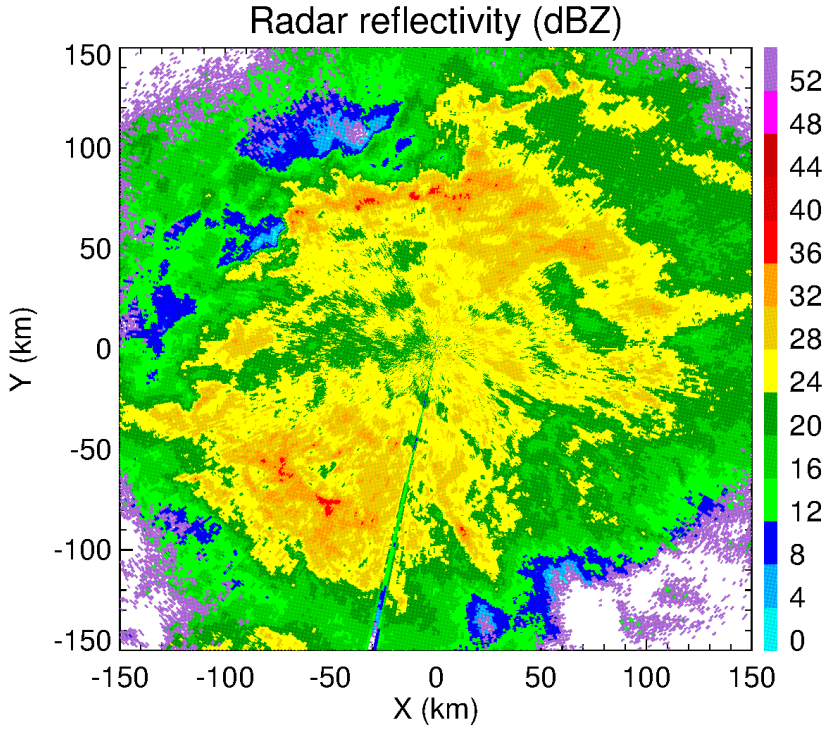
- For each radial profile the ML is characterized by two parameters (or indexes): (1) range of the ML bottom H_b and (2) strength of the ML
- These are estimated from ρHV and ZH
- The two parameters vary with the elevation
- Lookup tables are generated for a set of elevations, Hb and ML strength
- Locate Hb and ML strength that best represents the observations for each radial and correct Zh

Polarimetric Vertical Profile of Reflectivity - PVPR

Before correction

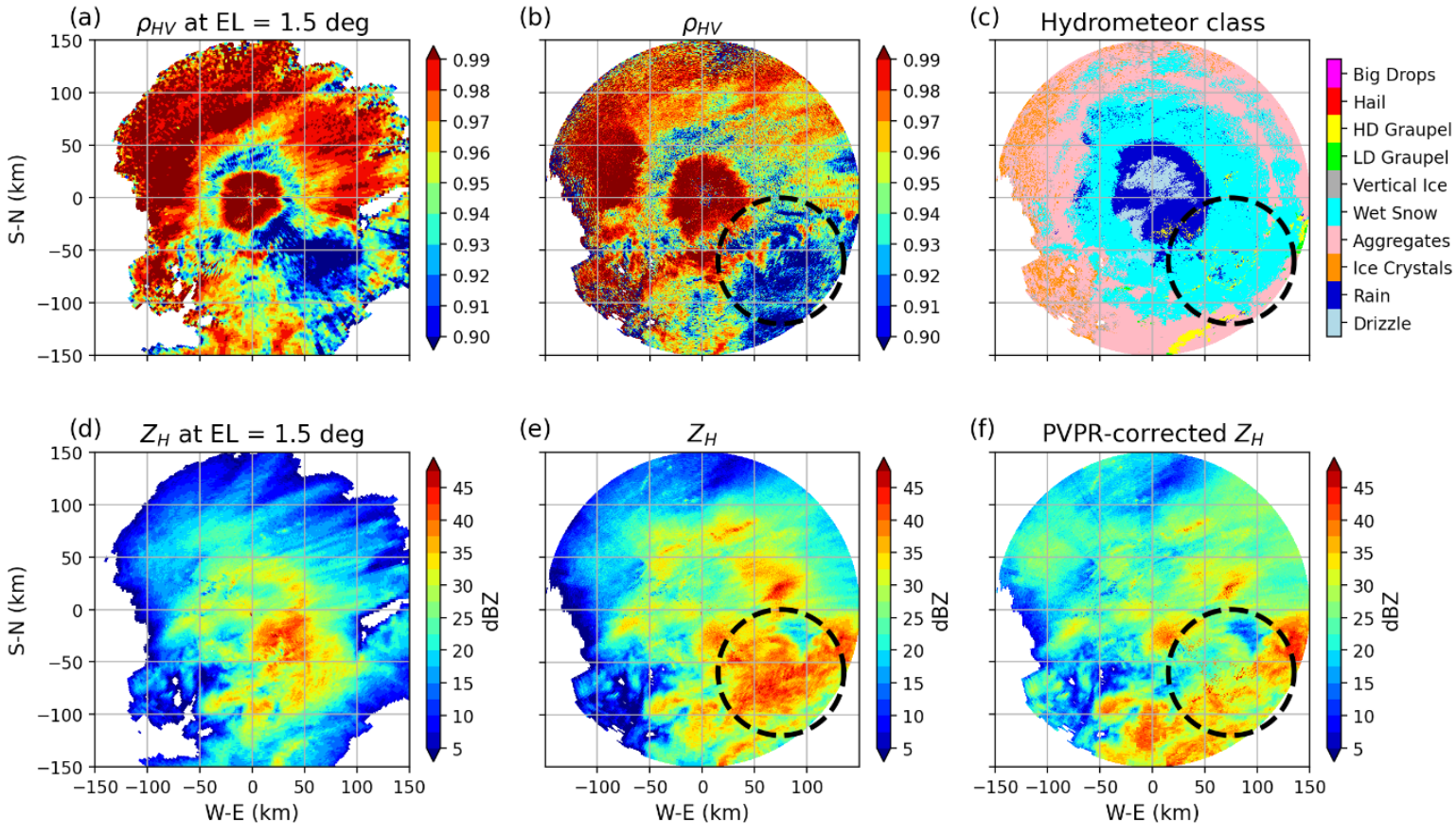


After correction



KINX WSR-88D radar, 2020/01/17, El = 1.3°

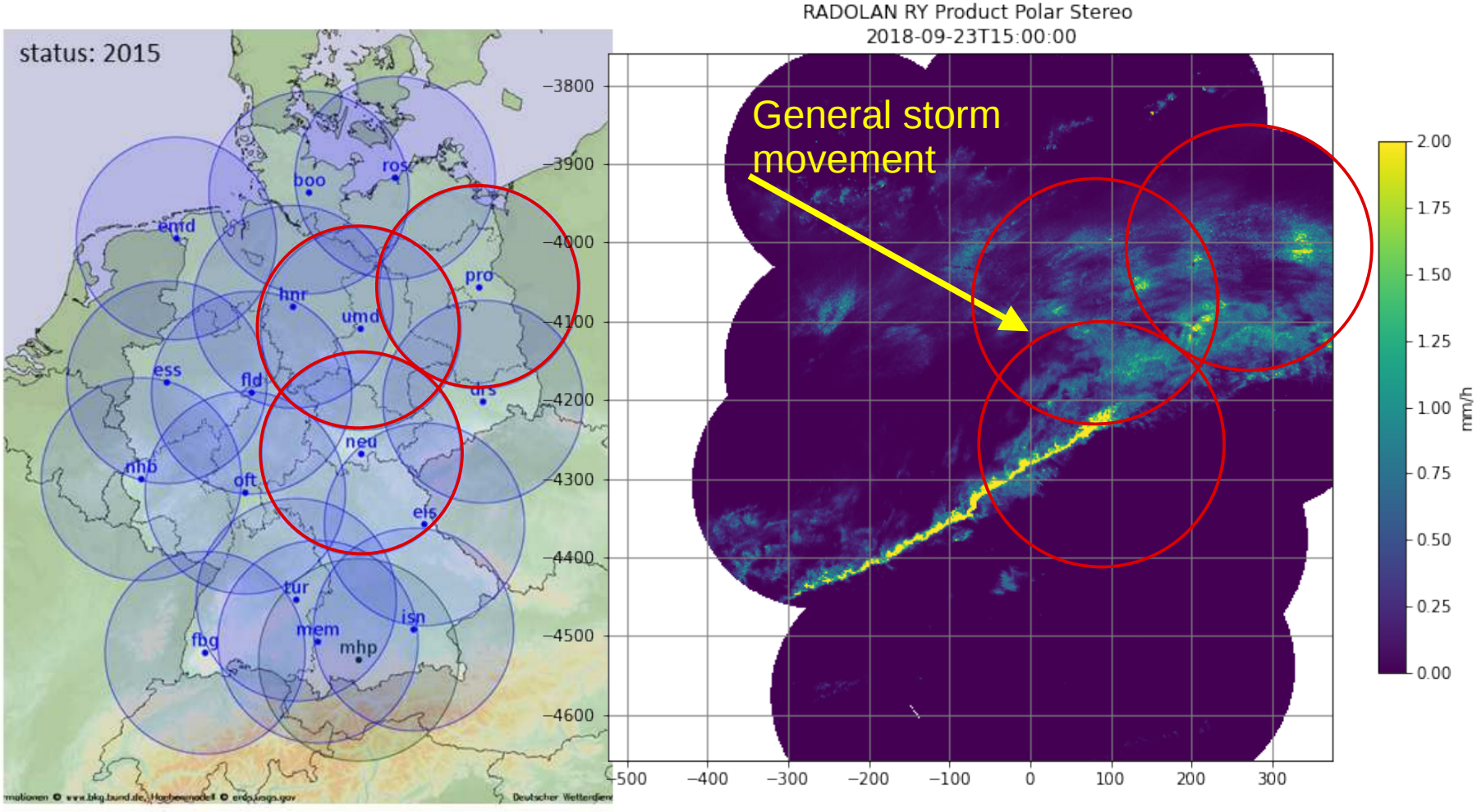
Apply polarimetric VPR (PVPR) in heterogeneous rain



UMD radar 20180923 1515 UTC.

WP-P1-3: Polarimetric QPE in snow and mixed-phase regions

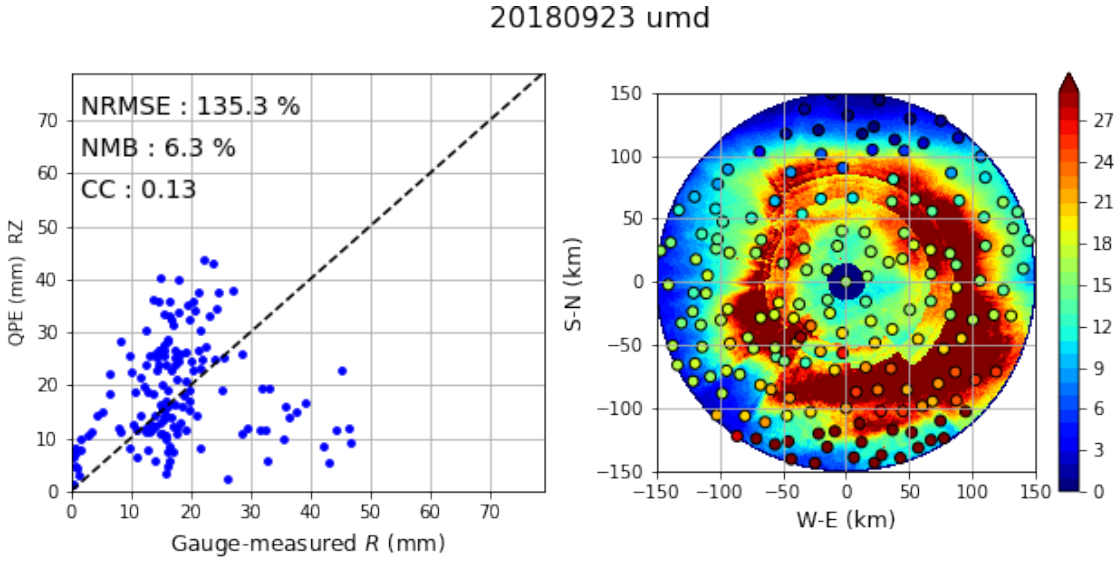
Convective event 20180923



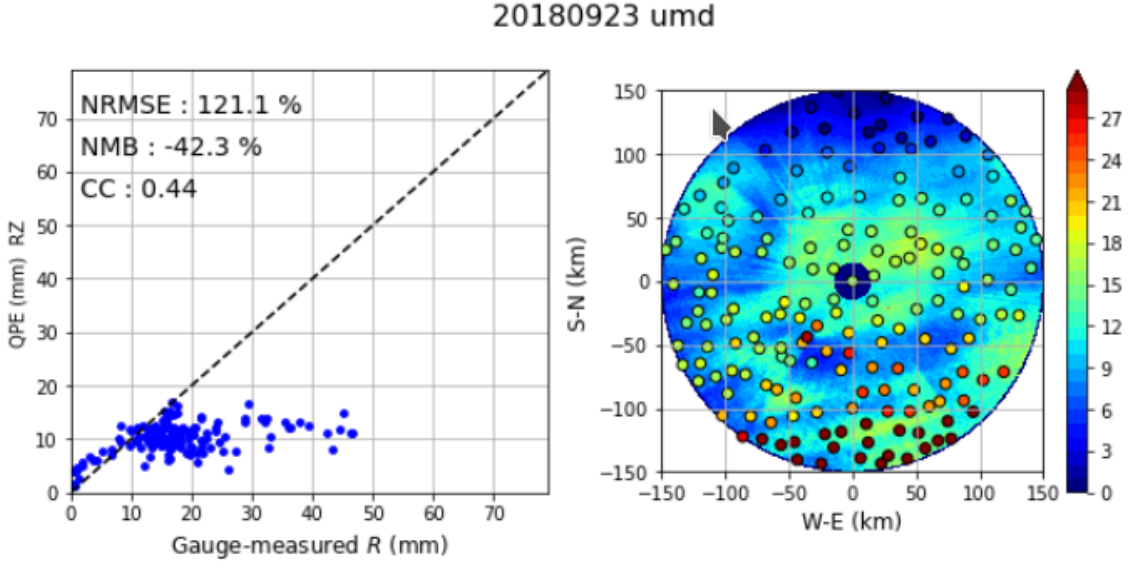
Apply polarimetric VPR (PVPR) in heterogeneous rain

UMD

Standard QPE



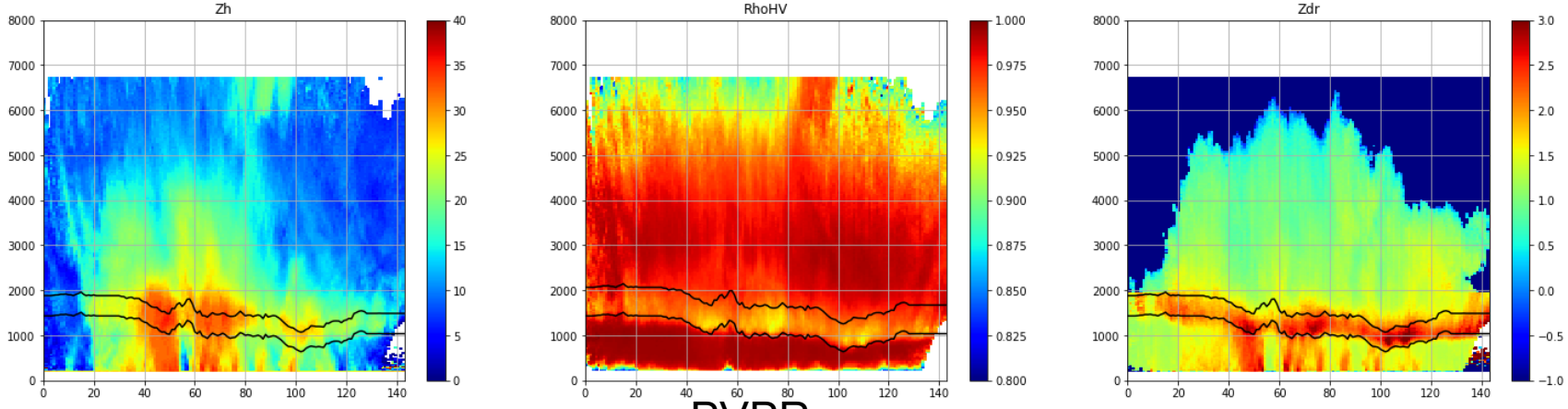
PVPR QPE



Actual beam elevation (right)

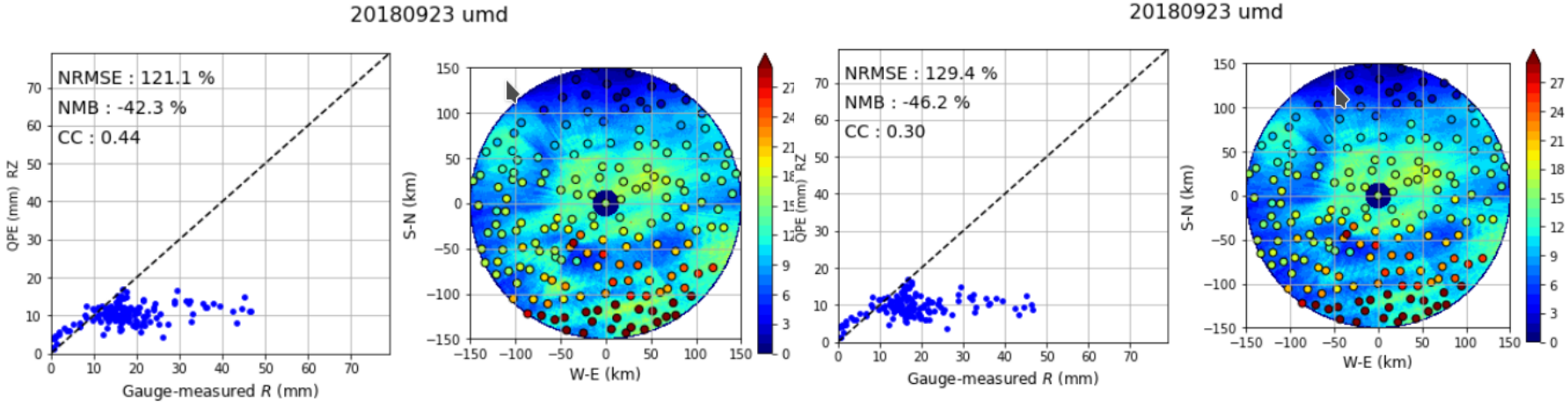
Cumulative rainfall 12h

WP-P1-3: Polarimetric QPE in snow and mixed-phase regions



ML fg fixed

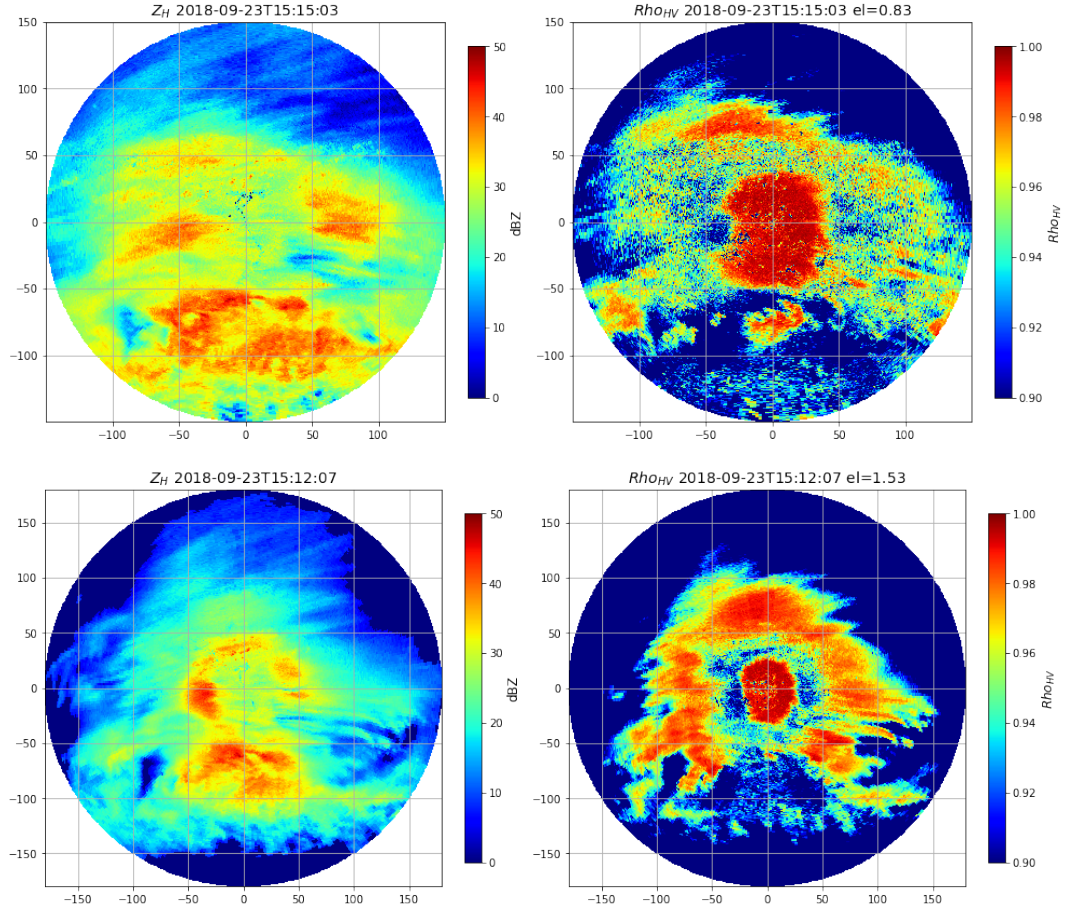
ML fg variable in time



Apply polarimetric VPR (PVPR) in heterogeneous rain

El=0.8

El=1.5

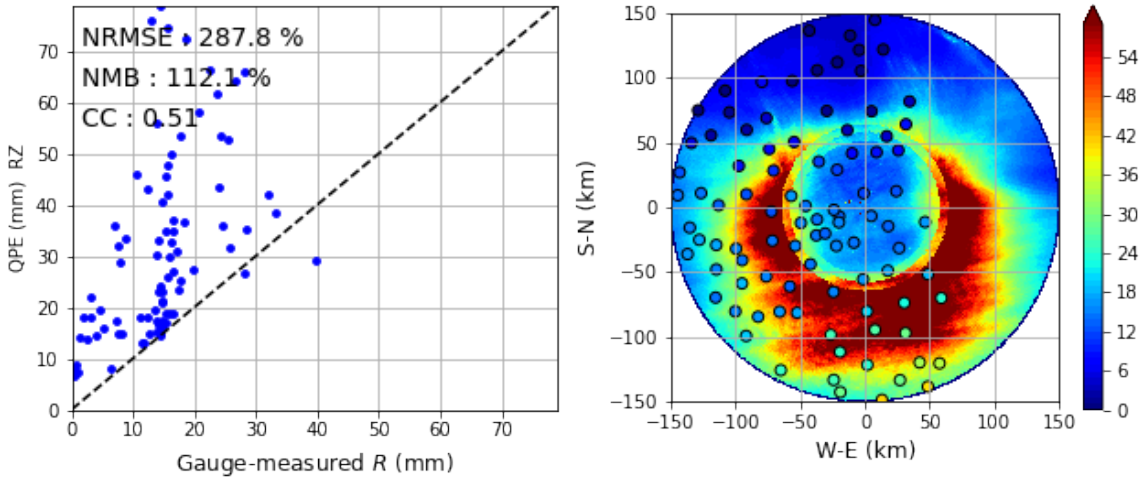


20180923 1515 Prötzel

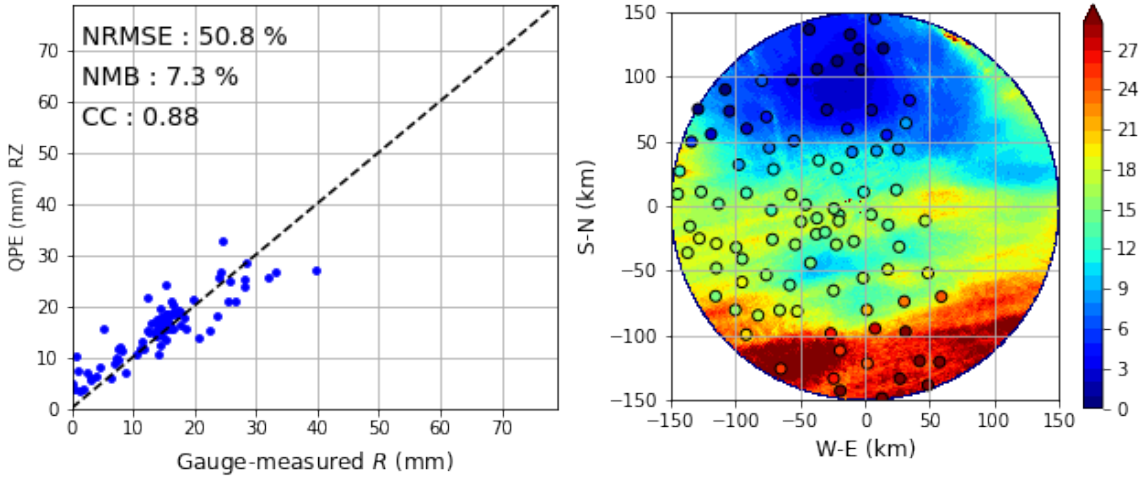
Apply polarimetric VPR (PVPR) in heterogeneous rain

20180923 pro

R(Z)



R(Z)
PVPR
correction

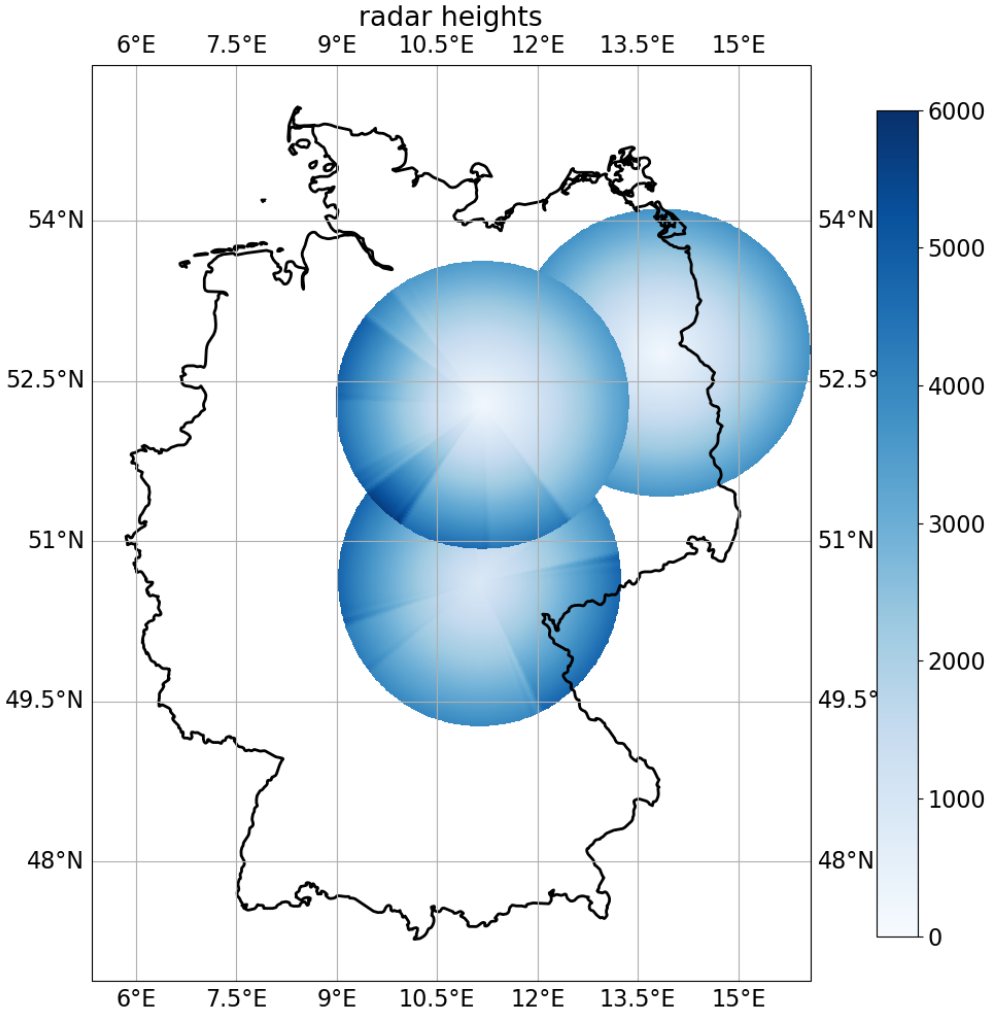


20180923 09-21UTC Prötzel QPE

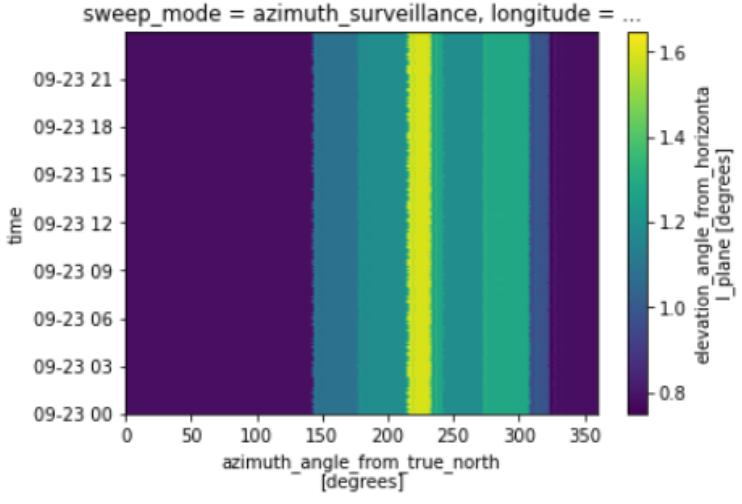
Cumulative rainfall 12h

WP-P1-3: Polarimetric QPE in snow and mixed-phase regions

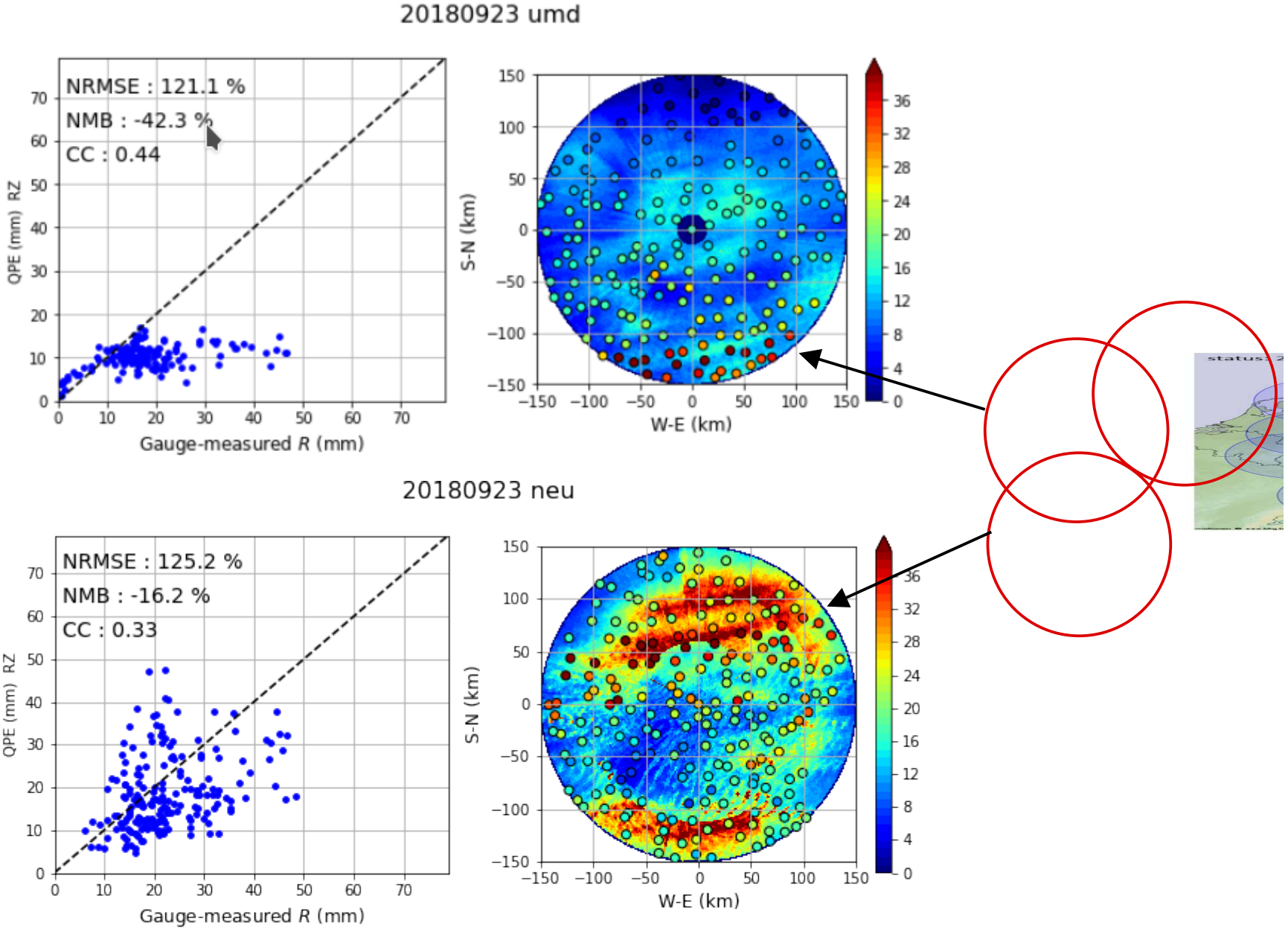
Beam heights for the precipitation scan:



Elevation for UMD precip scan

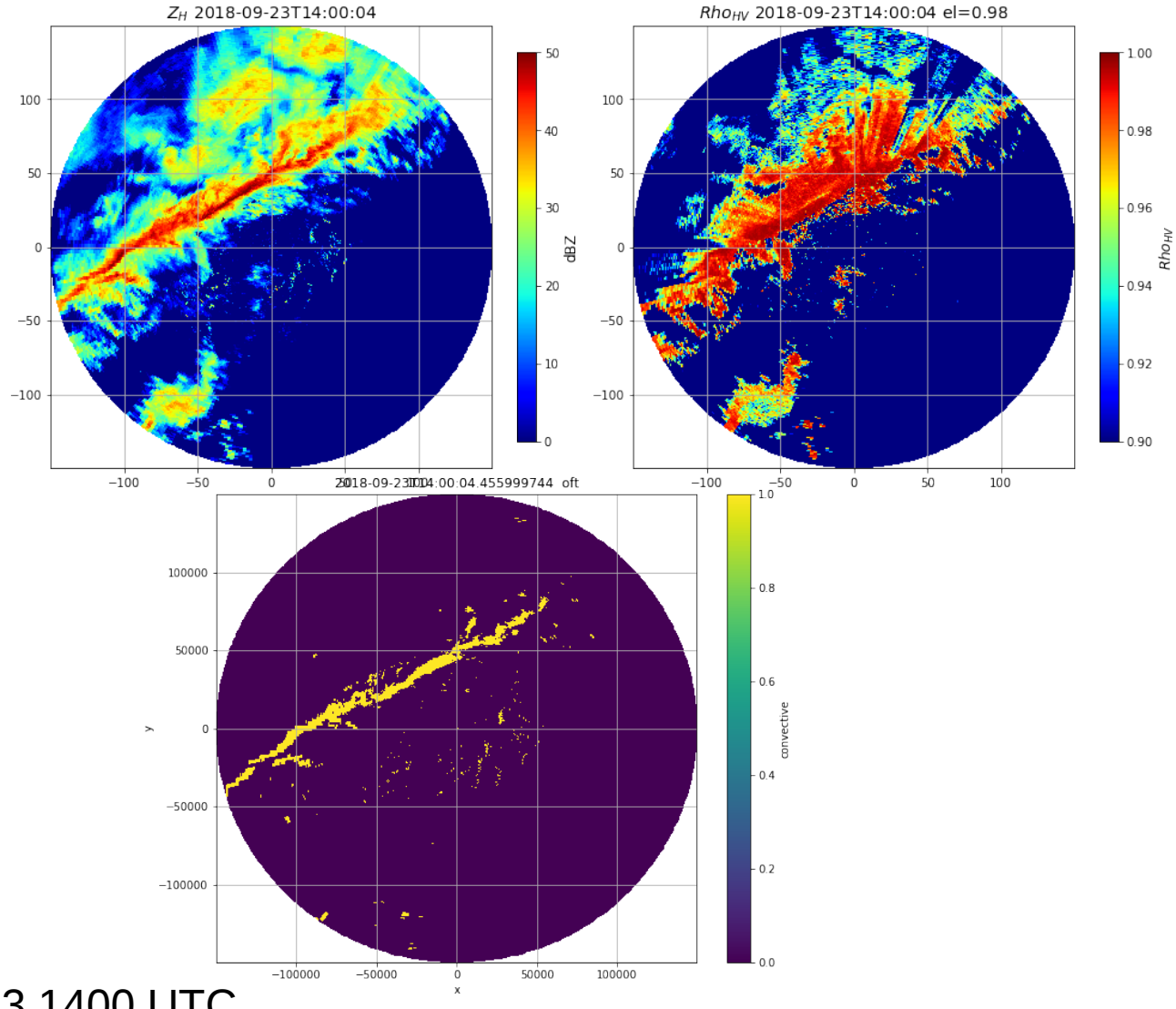


WP-P1-3: Polarimetric QPE in snow and mixed-phase regions



WP-P1-3: Polarimetric QPE in snow and mixed-phase regions

Methodology from Powell *et al.* 2016 to identify and distinguish stratiform/convective zones



Oft 20180923 1400 UTC

WP-P1-3: Polarimetric QPE in snow and mixed-phase regions

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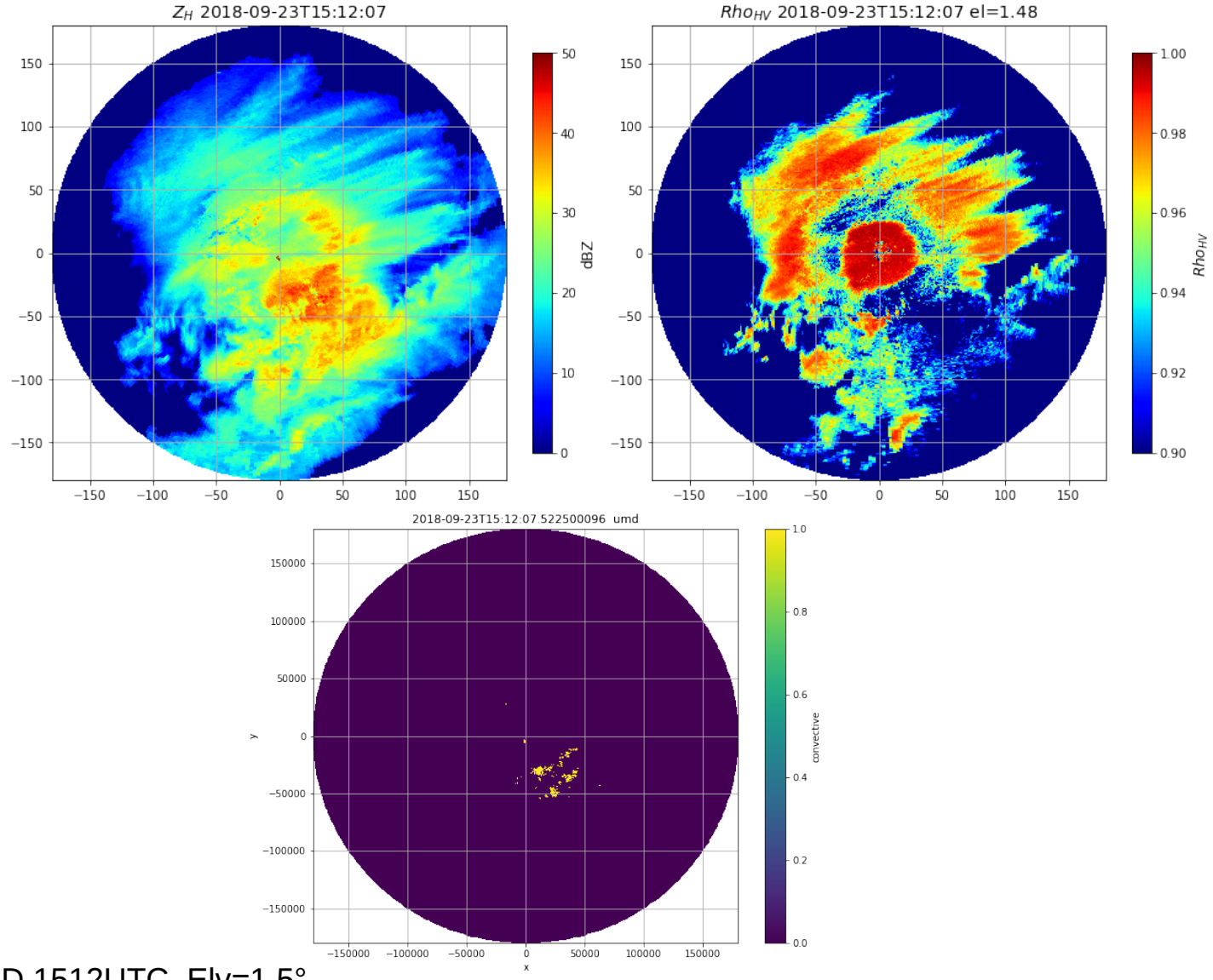
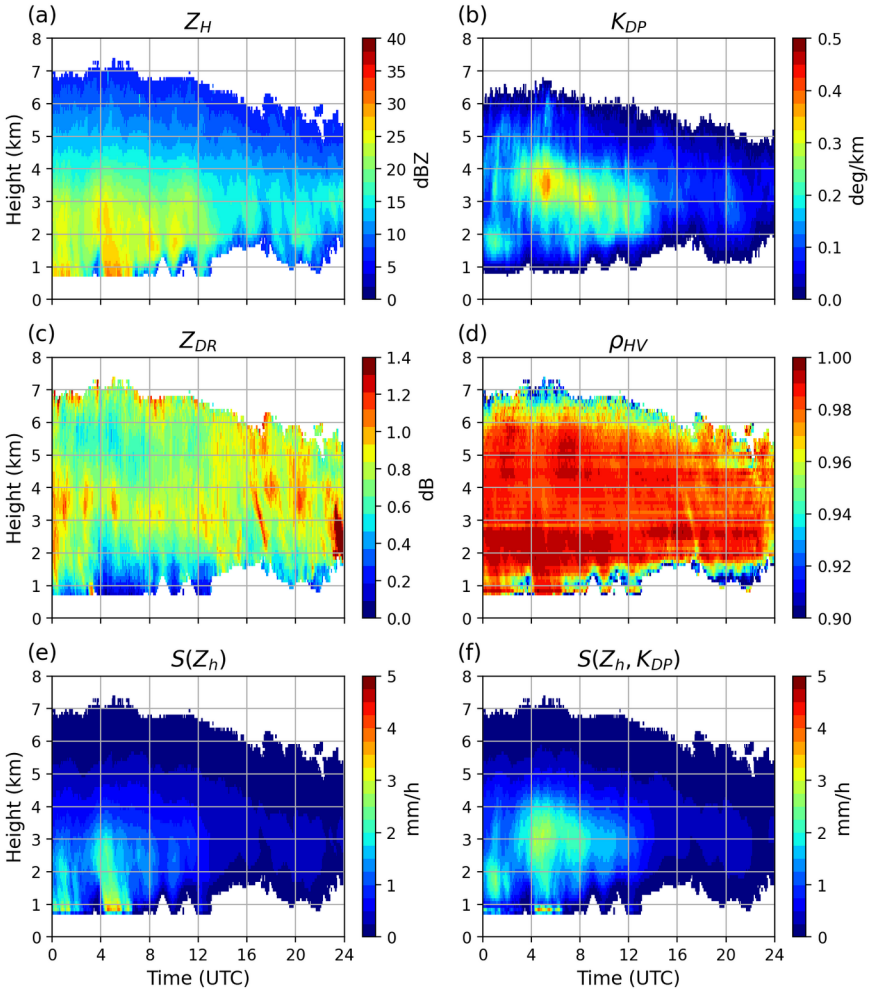


20180923 UMD 1512UTC, Elv=1.5°

Outlook

Improve retrievals for snowfall intensity



A single relationship $S(Z_h, K_{DP})$ cannot capture the high diversity of snowflakes and ice crystals

- Define classes and accordingly apply different S relationships
- Signatures to consider for the classes
  - Dendritic growth layer (DGL) detected with Z_{DR} and K_{DP}
  - Downward gradients below the DGL
  - High Z_{DR} at cloud top, indicating pristine ice with high habit diversity
  - Secondary ice production manifested in K_{DP} enhancements

Outlook

- **Improve retrievals for snowfall intensity:**
  - **Bukovcic** new algorithm presented recently at the 40th AMS Conference on Radar Meteorology with very promising results

$$S(K_{DP}, Z) = f(f_{rim}, F_o, F_s, \mu, p, \lambda, K_{DP}, Z)$$

f_{rim} – riming degree, F_o & F_s – particle orientation & shape parameters, μ – PSD shape parameter, N_t – number concentration, p – atmospheric pressure, λ – radar wavelength

f_{rim}, F_oF_s, and N_t can be retrieved at ASOS stations – snowfall rate + extinction coefficient σ_e needed!

S, σ_e – ASOS

$$f_{rimA}(S_{ASOS}, \sigma_{eASOS}, Z, \mu) = const \times f_1(\mu) \frac{S_{ASOS}^{\ a}}{\sigma_{eASOS}^{\ b} Z^c}$$

Z, Kdp – radar

$$F_oF_s = F_{osA}(K_{DP}, Z, \sigma_{eASOS}, f_{rimA}, \mu) = const \times f_2(\mu) \frac{Z^g (K_{DP}\lambda)^h}{f_{rimA}^{\ i} \sigma_{eASOS}^{\ j}}$$

https://ams.confex.com/ams/40RADAR/meetingapp.cgi/Paper/426118

Outlook

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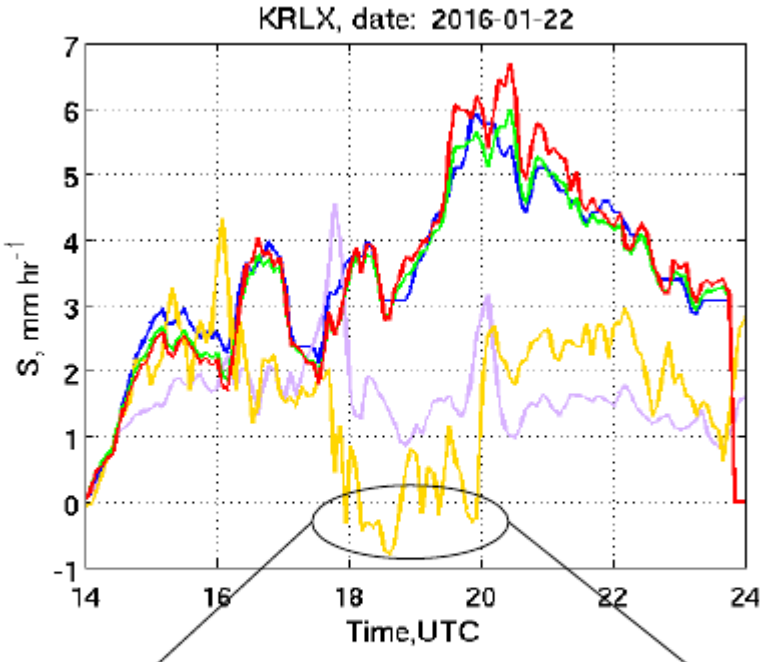
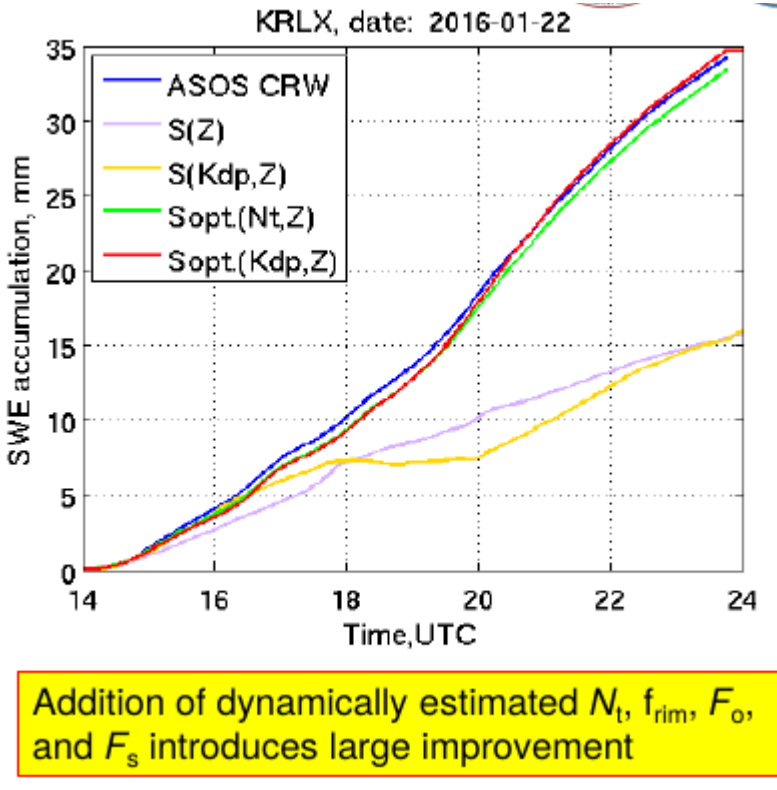


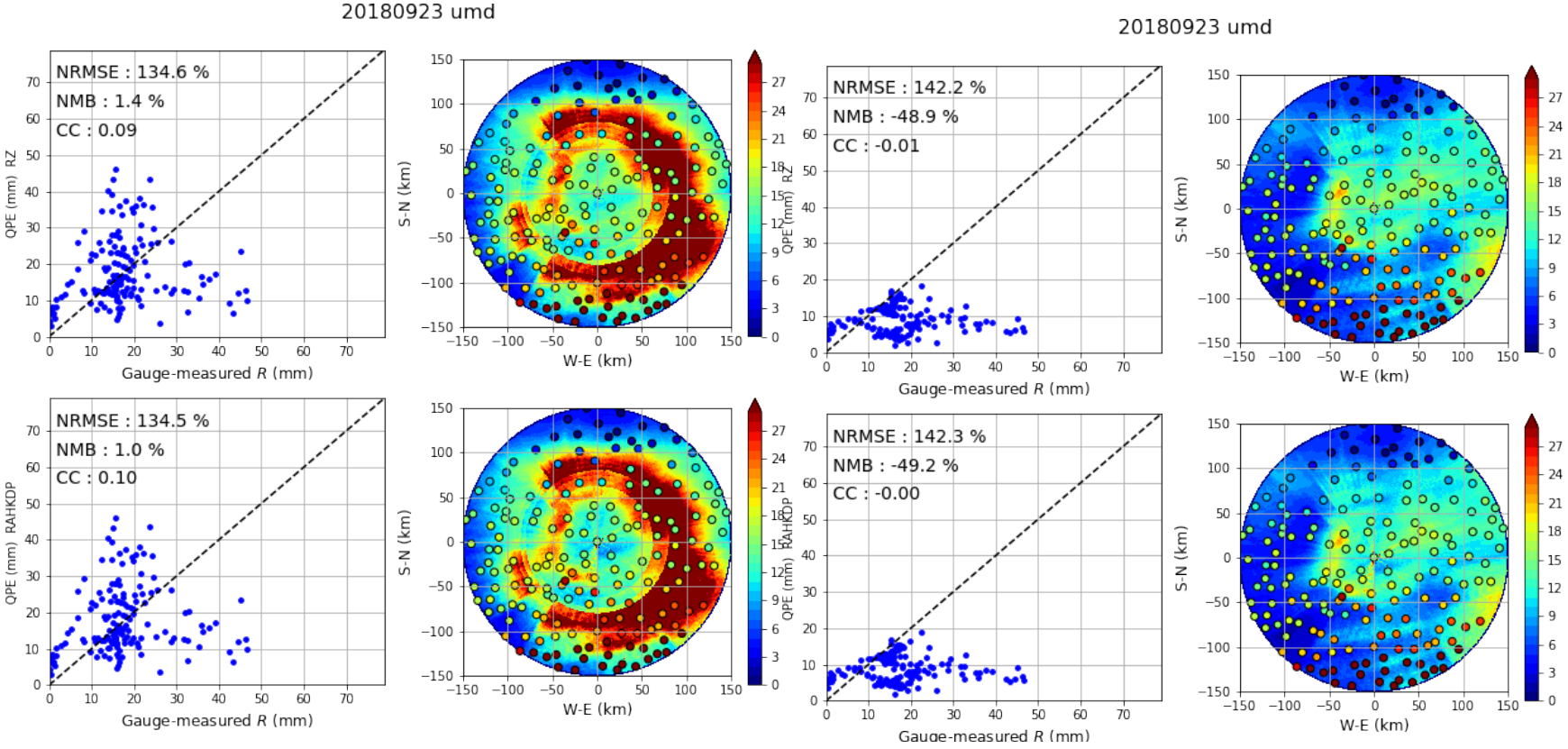


https://ams.confex.com/ams/40RADAR/meetingapp.cgi/Paper/426118

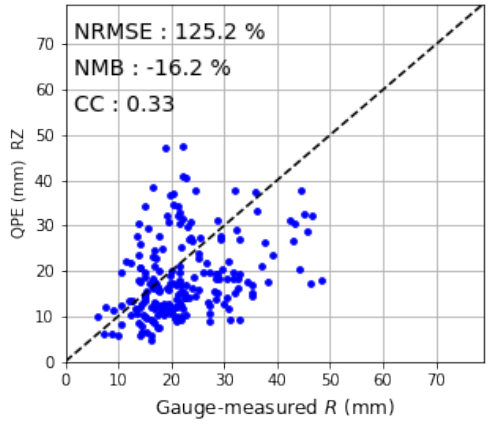
- Thanks for your attention -

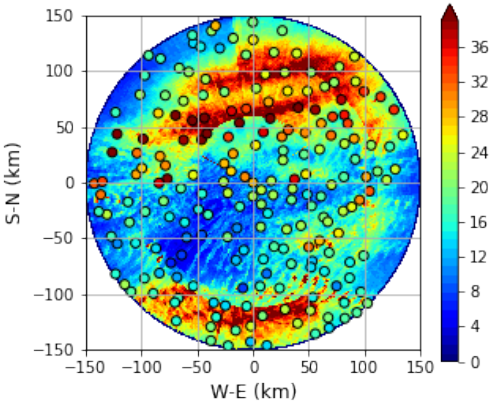
WP-P1-3: Polarimetric QPE in snow and mixed-phase regions

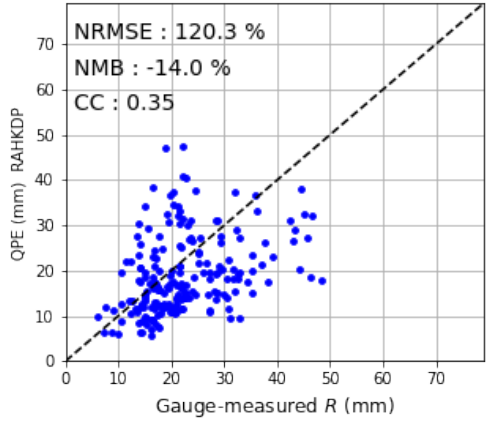
If constant elevation (wrong)

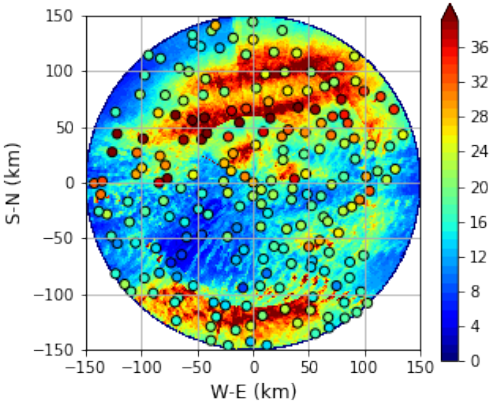


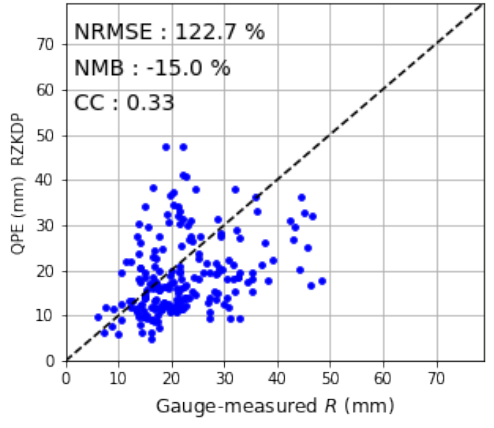
20180923 neu

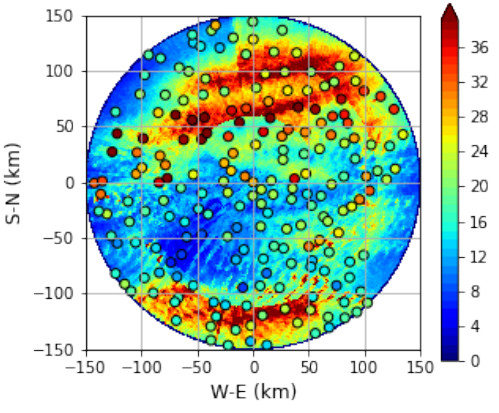




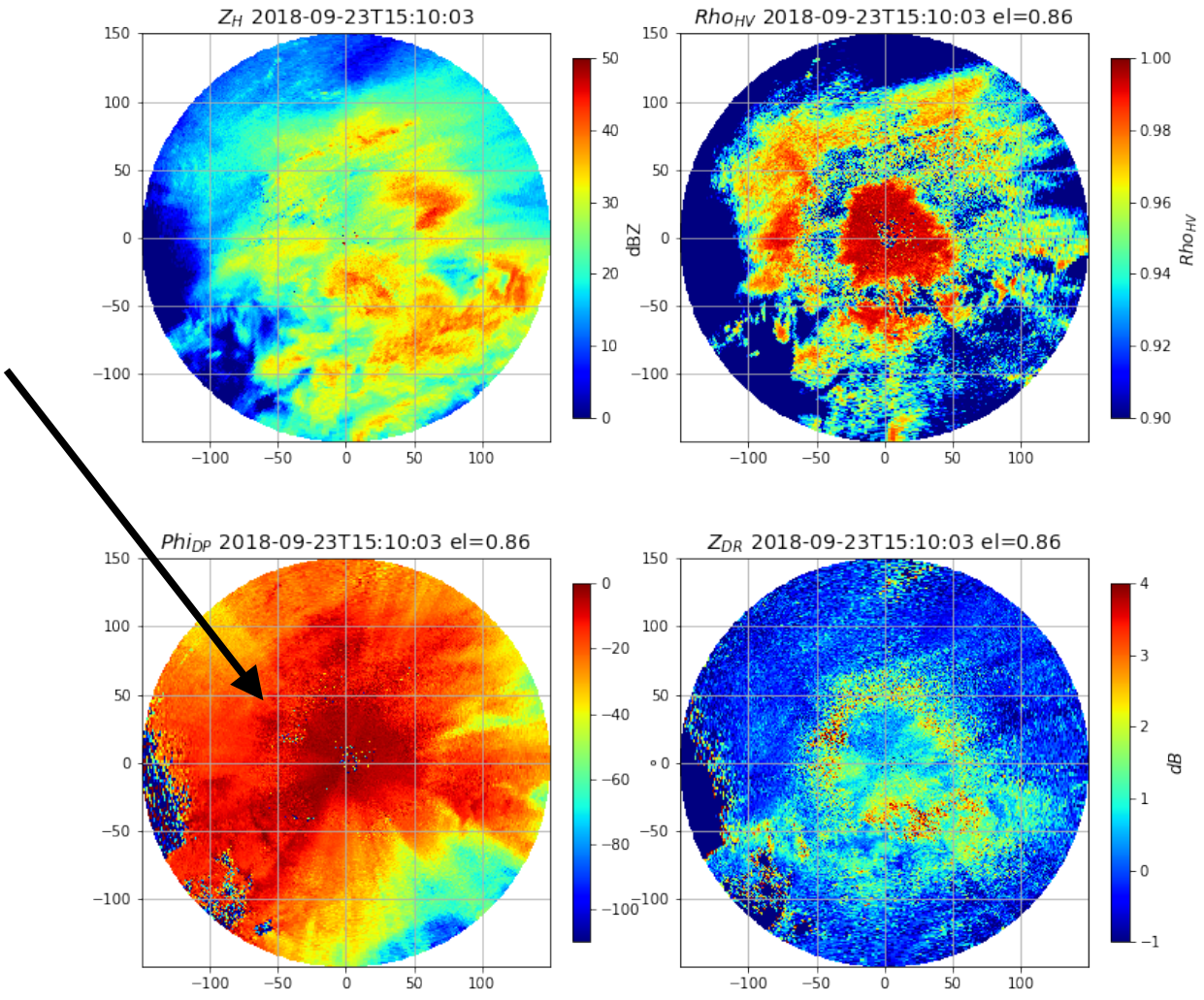








UMD PPI 20180923 1510 Precip scan



ΦDP decreasing with distance…
Reversed sign

ΦDP = 0

Original