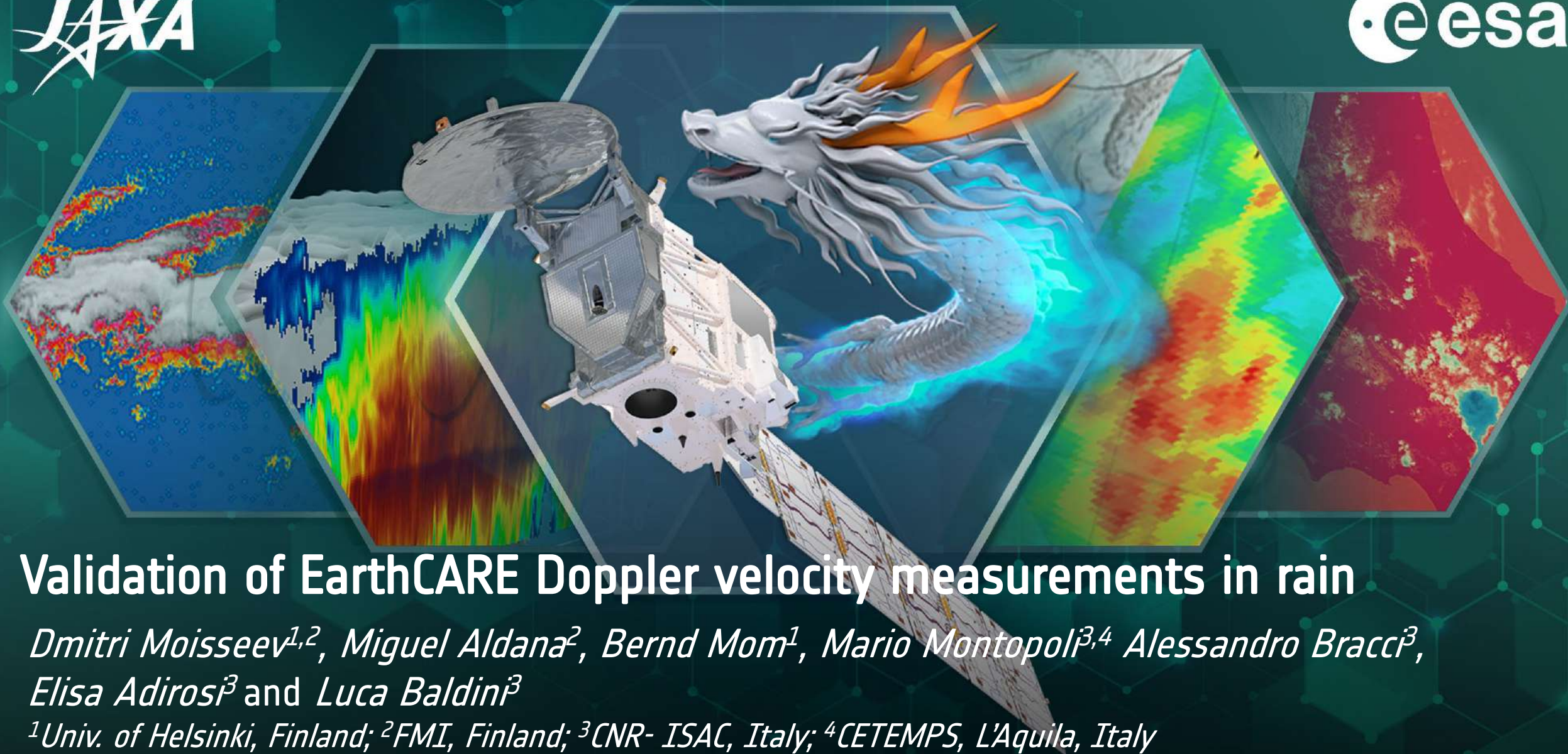
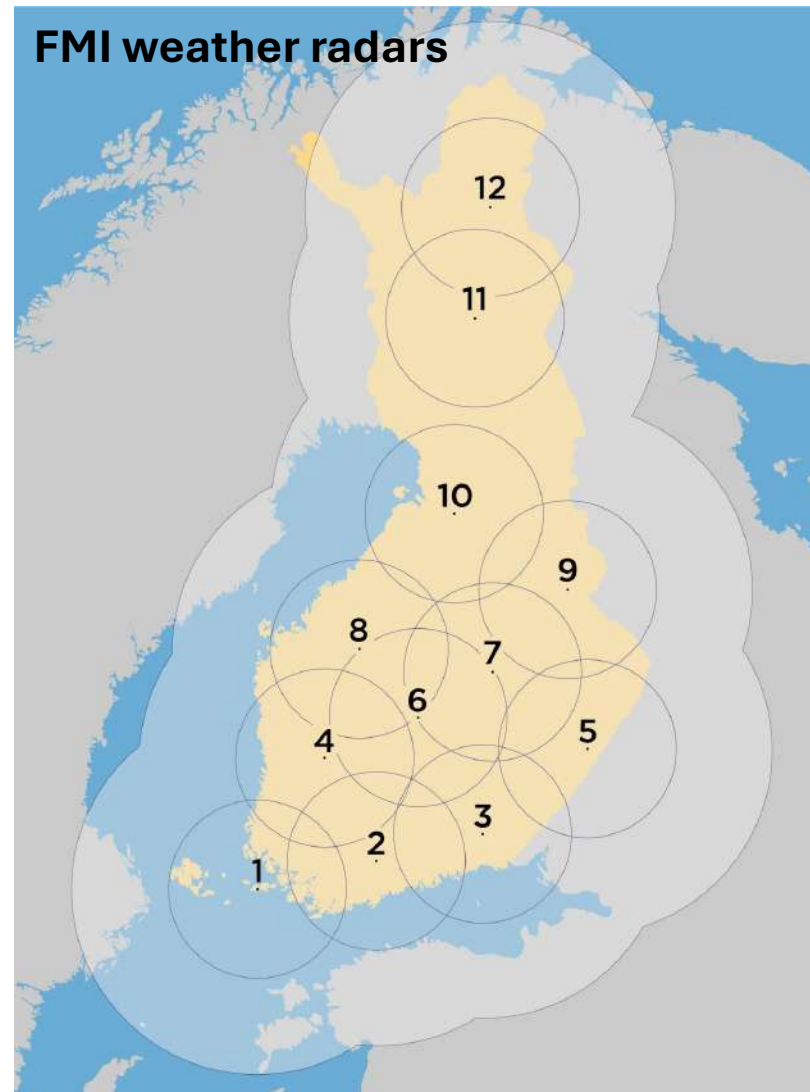
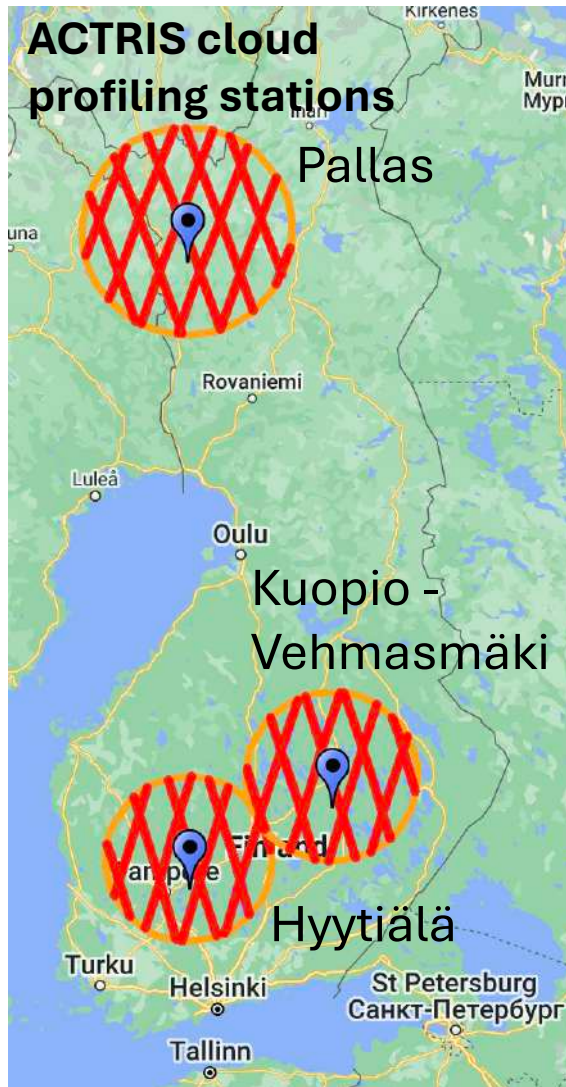




Validation of EarthCARE Doppler velocity measurements in rain

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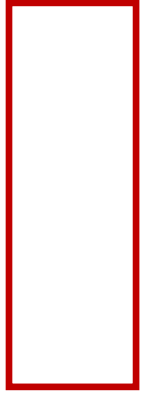


- ACTRIS cloud profiling stations in Finland and simulated overpasses within 100 km from the stations
 - Stations are equipped with W-band or Ka-band cloud radars + other sensors
 - Well-suited for EarthCARE cal/val (see EVID05 presentations, O'Connor, Pfitzenmaier, and Feuillard)
- FMI weather radar network
 - Consists of 12 C-band radars
 - Circles around radars indicate distances at which radar beams are expected to go above cloud tops (in winter and summer)

University of Helsinki Hyytiälä station



- Detailed characterization of precip microphysics in combination with weather radar observations, can be used to create spatial datasets suited for satellite cal/val (e.g. von Lerber et al 2018)
- Use dual-polarization radar observations to estimate W-band reflectivity weighted mean fall (sedimentation) velocity of raindrops
- The relations are computed from disdrometer observations
- The uncertainty of the $V_w - (Z, Z_{dr}, K_d/Z)$ relations increases for larger V_w , because of Mie scattering effects in W-band



Stratiform rain



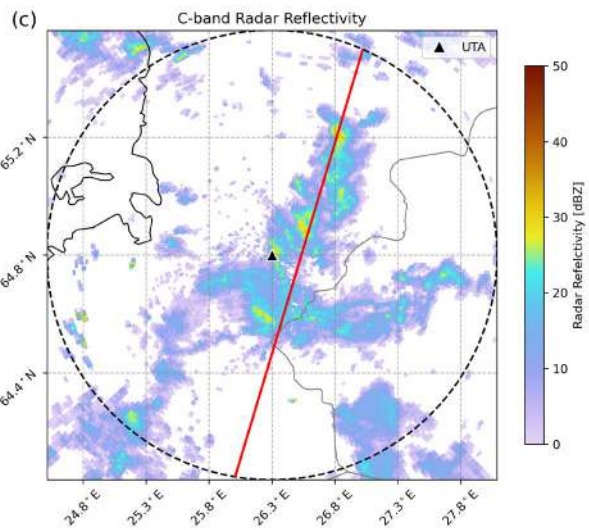
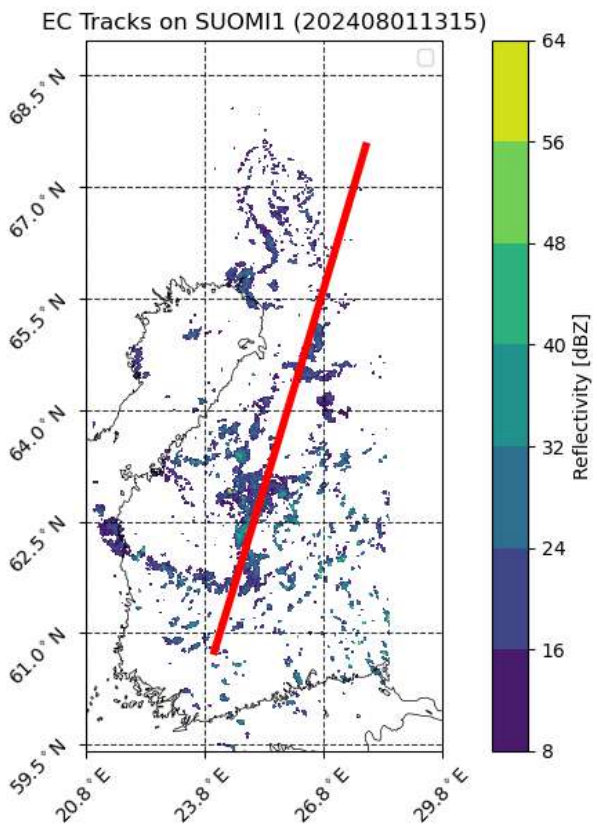
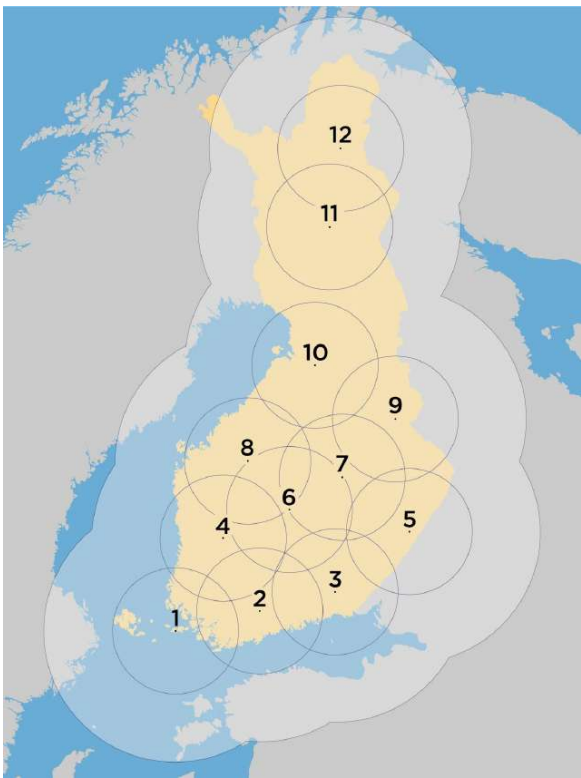
Convective rain

- To verify validity of the derived relations combination of C-band observations and W-band cloud radar measurements were used
- C- and W-band radars are collocated and are vertically pointing
- In the stratiform rain there is a good agreement between estimated and measured V_w
- Some differences due to air motion

**Retrieved W-band
velocity**

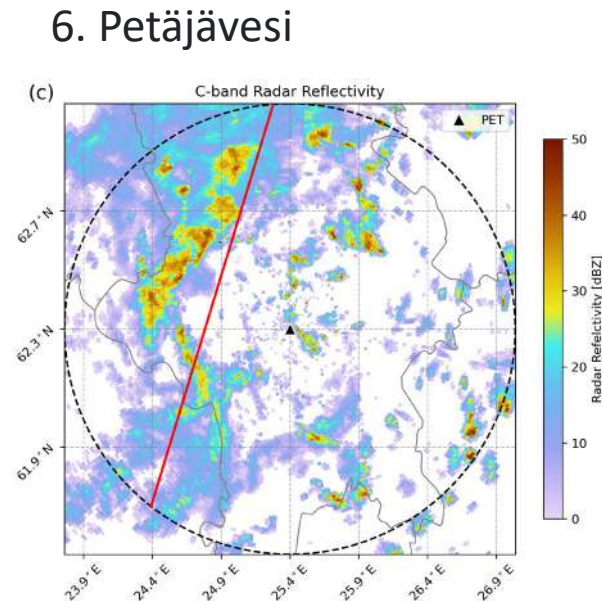
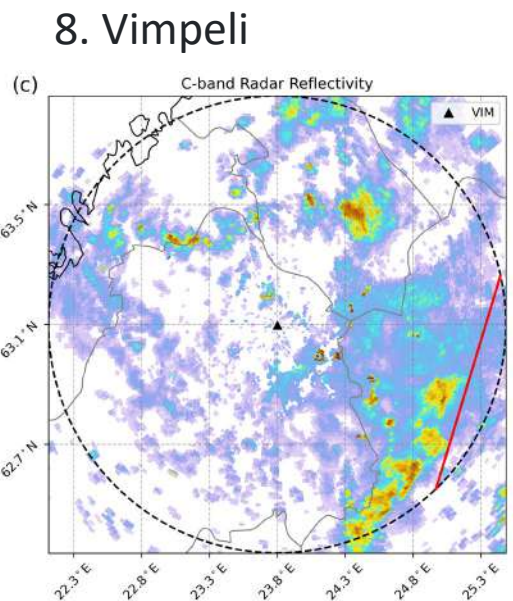
**Observed W-band
velocity**

EarthCARE overpass on 01 August 2024

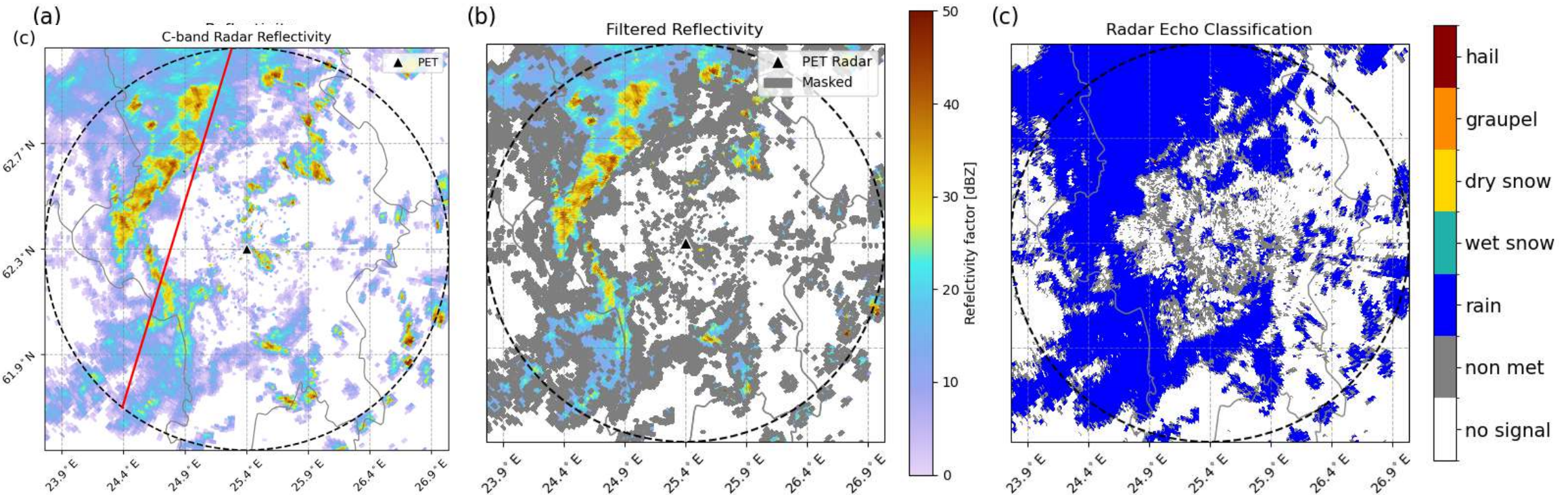


10. Utajärvi

Radars within 80 km from the track are selected



Radar: PET, task: A, timestamp: 2024-08-01 13:15:00

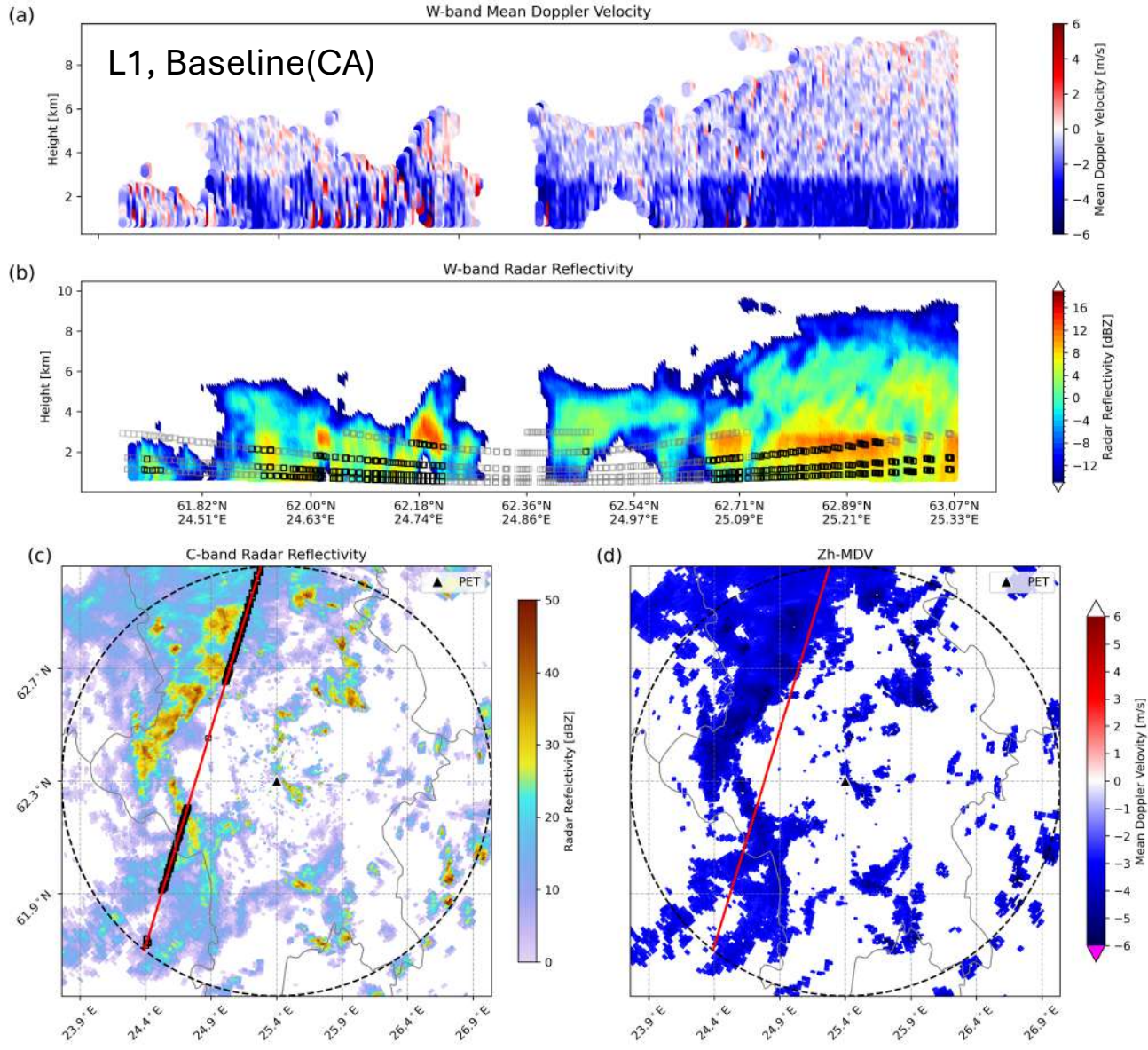


- For $R < 80$ km, the radar beam should be below melting layer
- This is verified by the hydrometeor classification
- $Z < 10$ dBZ are filtered out
- There is no good estimate of W-band MDV for $Z < 10$ dBZ
- Hydrometeor classification is used to remove non rain echoes

Velocity comparison



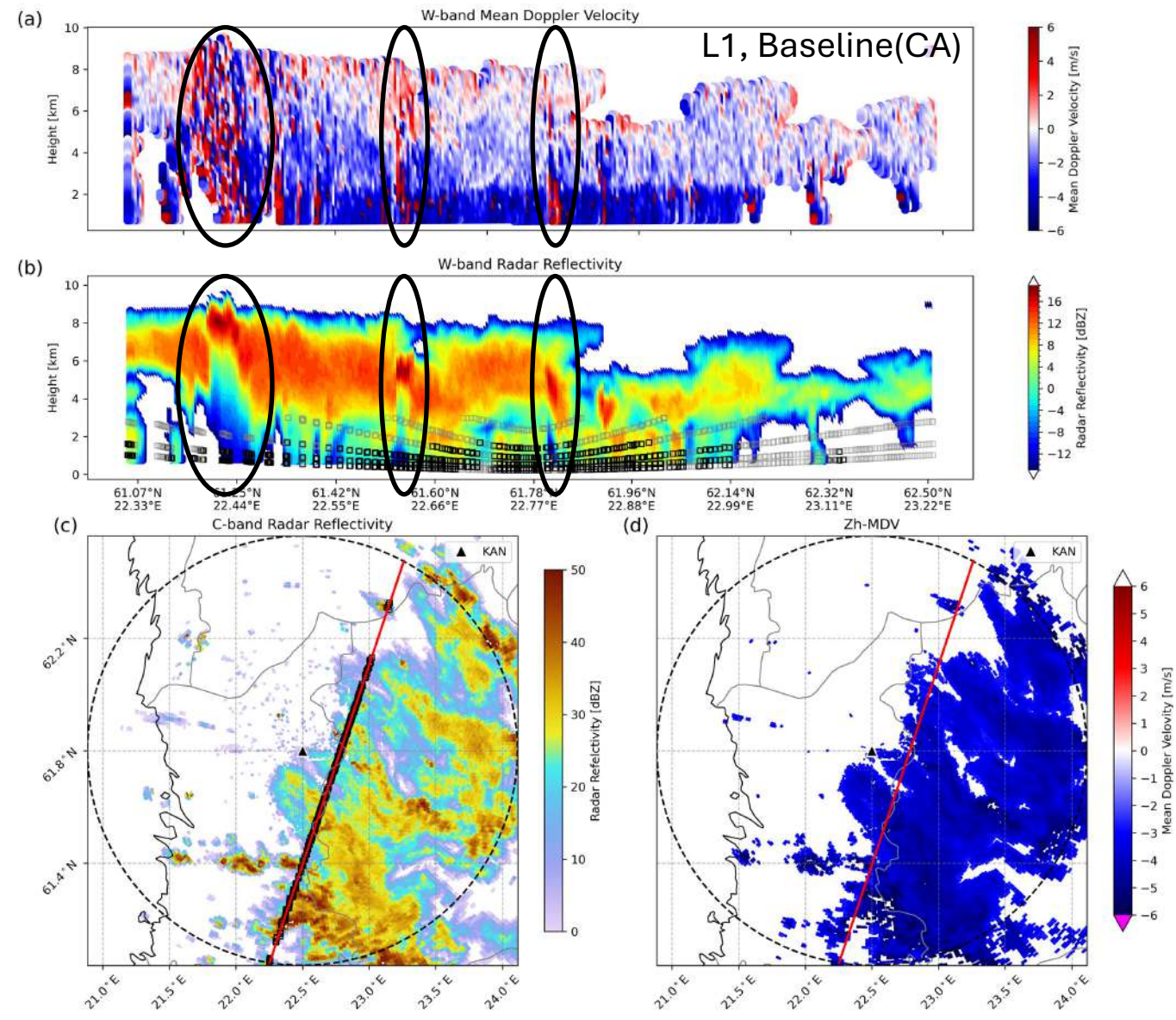
EC cross-sections & Radar PPIs: 2024-08-01 13:15:22 (UTC)



- The overall agreement is very good
- Mean difference is less than 0.25 m/s
- Note our estimate does not include air motion

Doppler velocity folding + air motion

EC cross-sections & Radar PPIs: 2024-08-10 13:21:59 (UTC)



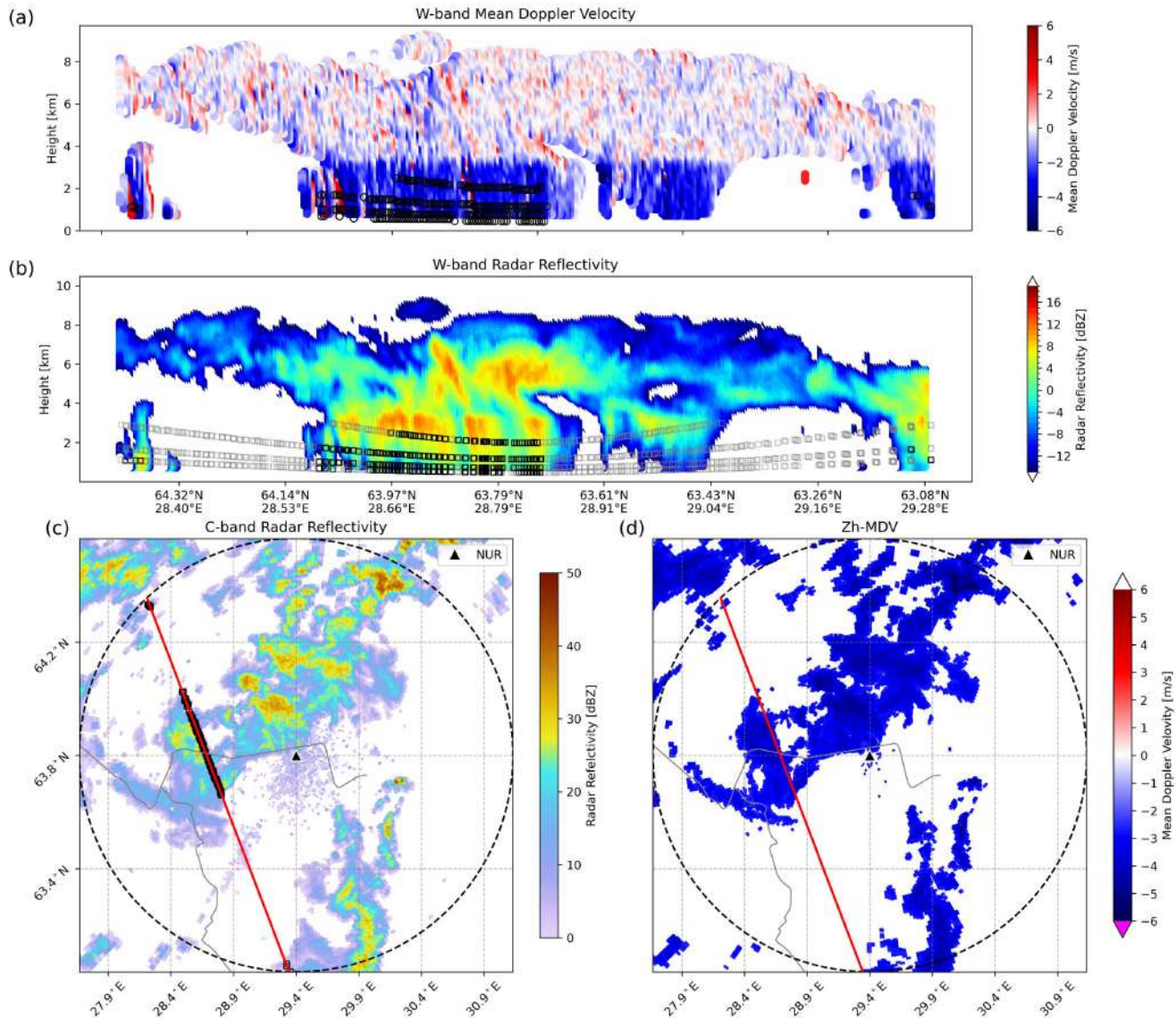
- Signatures of Doppler folding occur in heavy precipitation cores in attenuated CPR regions

+ air motion



- Weather radar observations can be used to assess CPR Doppler measurements
- Weather radar retrieved Doppler velocity is the sedimentation velocity and does not include air motion; mainly applicable to stratiform rain cases
- Our analysis shows good agreement between CPR MDV and our estimate (mean difference is about 0.21 m/s)

EC cross-sections & Radar PPIs: 2024-09-14 22:57:55 (UTC)



Bias -0.7 m/s