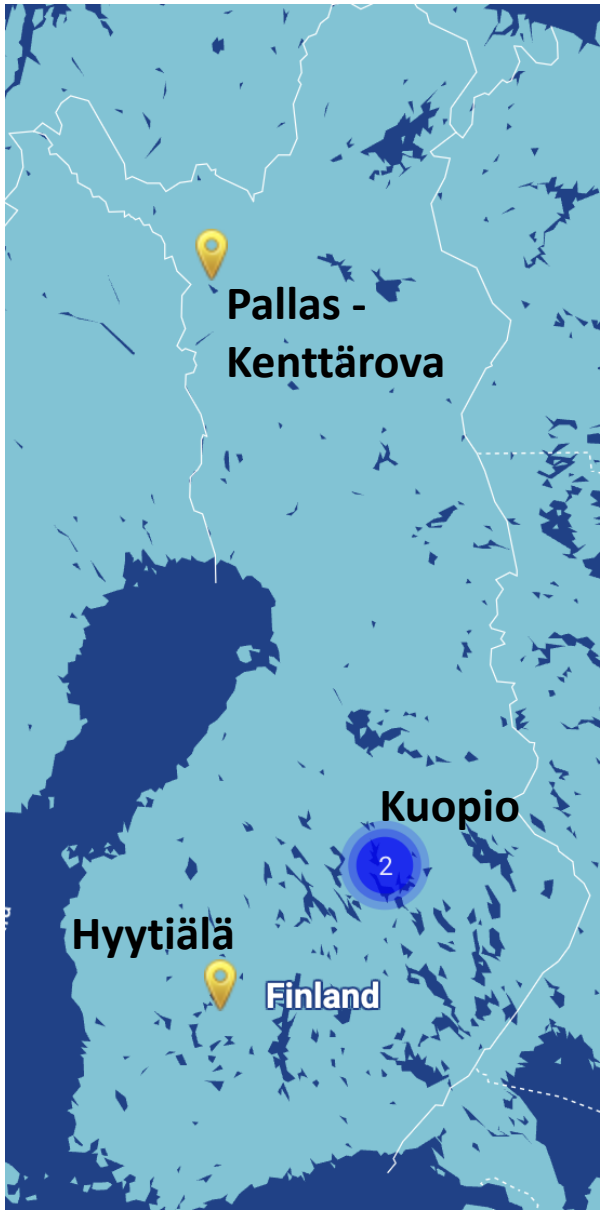
ESA-JAXA Pre-Launch EarthCARE Science and Validation Workshop

13 – 17 November 2023 | ESA-ESRIN, Frascati (Rome), Italy

EarthCARE validation activities in Finland

Dmitri Moisseev[1,2], Bernd Mom[1], Matti Leskinen[1]
Ewan O'Connor[2], Annakaisa von Lerber[2], Jani Tyynelä[2]
[1]University of Helsinki, [2]Finnish Meteorological Institute

ACTRIS cloud profiling stations

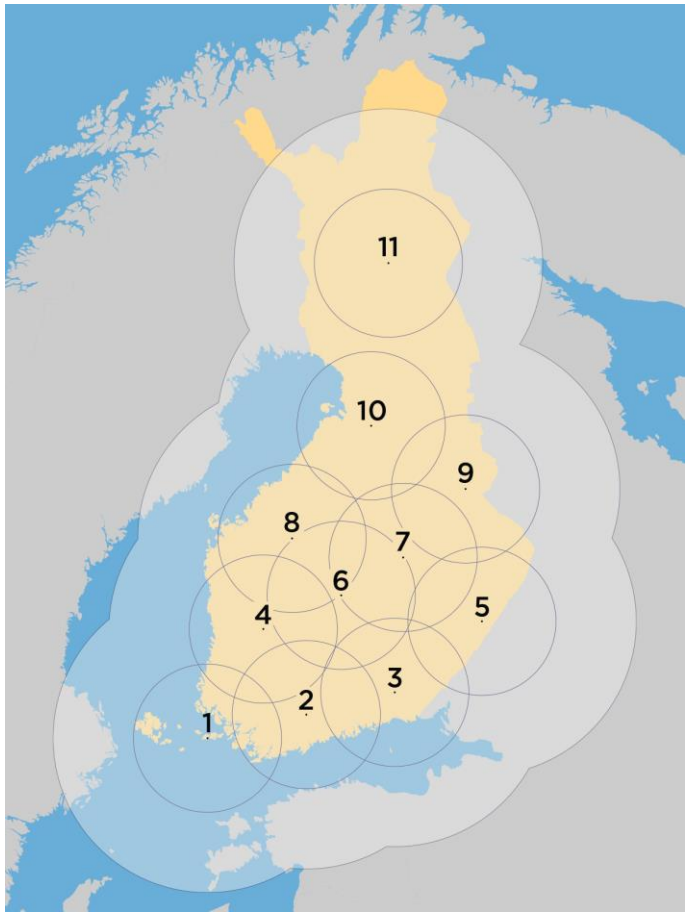


Hyytiälä:
CL61 ceilometer
HALO 46 Doppler lidar
HATPRO-G5
RPG-FMCW-94
+ precip. instruments

Pallas-Kenttärova:
CL61 ceilometer
HALO 146 Doppler lidar
RPG-FMCW-94-DP

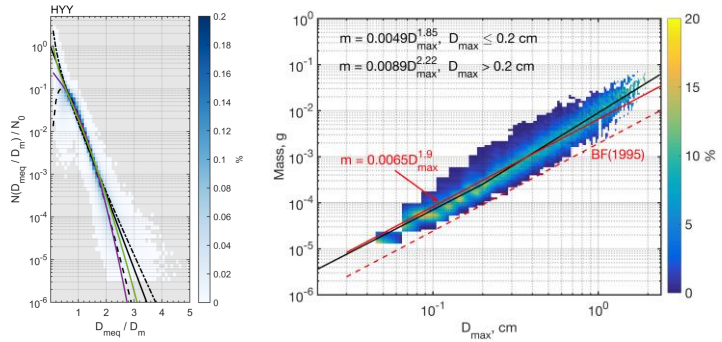
Hyytiälä (62 N) and Pallas (68 N): EarthCARE overpasses every 2-3 days (<100 km)

FMI weather radar network



11 (+1) C-band Dual-polarization weather radars

Physical validation: ice microphysics

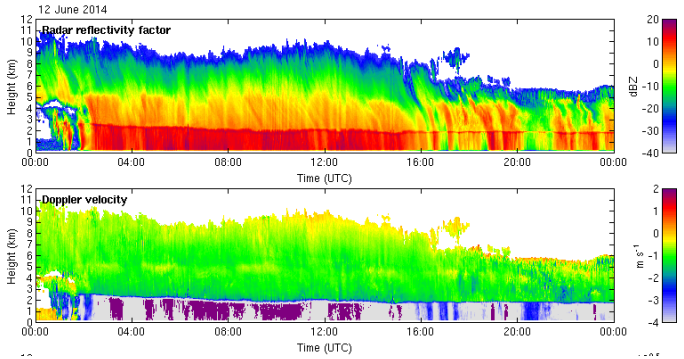


Observations: PSD, v(D), particle shape, precip rate

Retrieved: m(D) and validation of particle scattering tables

Measurements since 2014. Started as a part of NASA GPM GV, and BAECC experiment (AMF2)

Ground-based RS of clouds



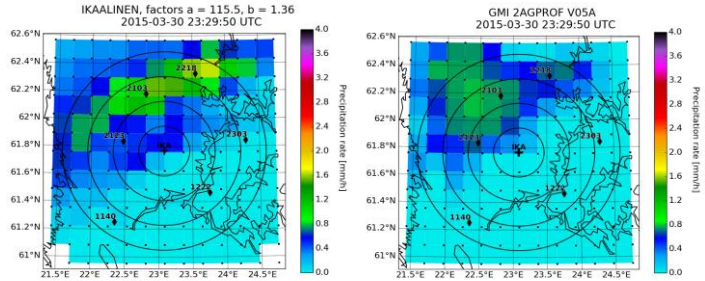
Correlative data for validation of LVL2 cloud and precipitation products

Development of new products as part ACTRIS and CERTAINTY

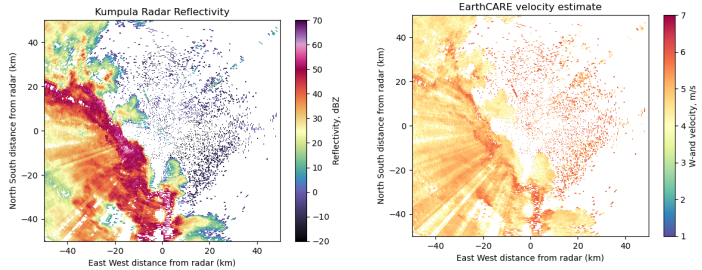
CERTAINTY: van Zadelhoff (Mon)

Application of weather radar observations for calval

Validation of precipitation products



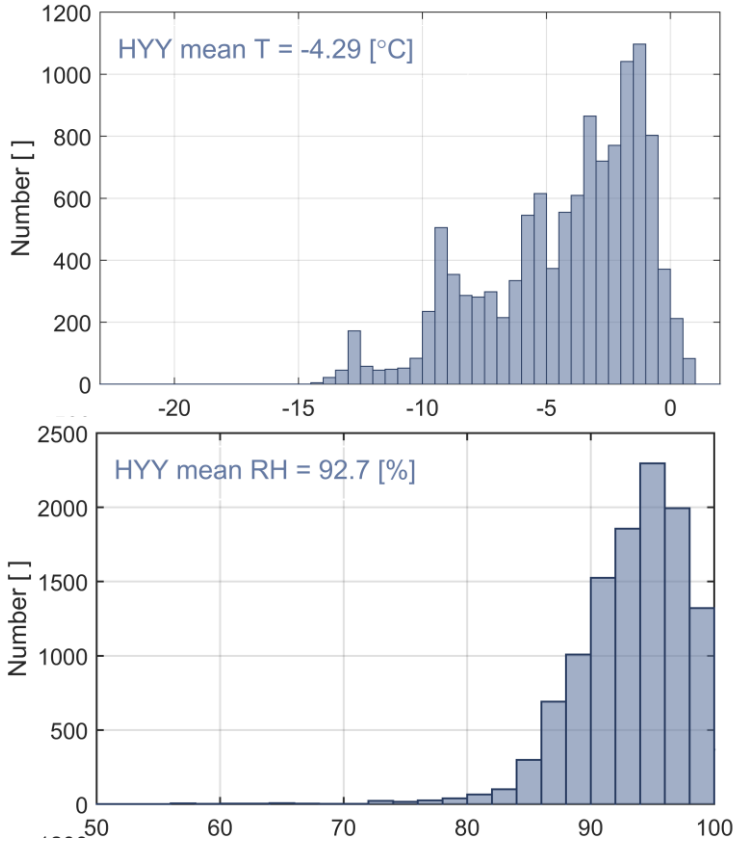
Validation of snowfall rate (similar to what we have done for NASA GPM)



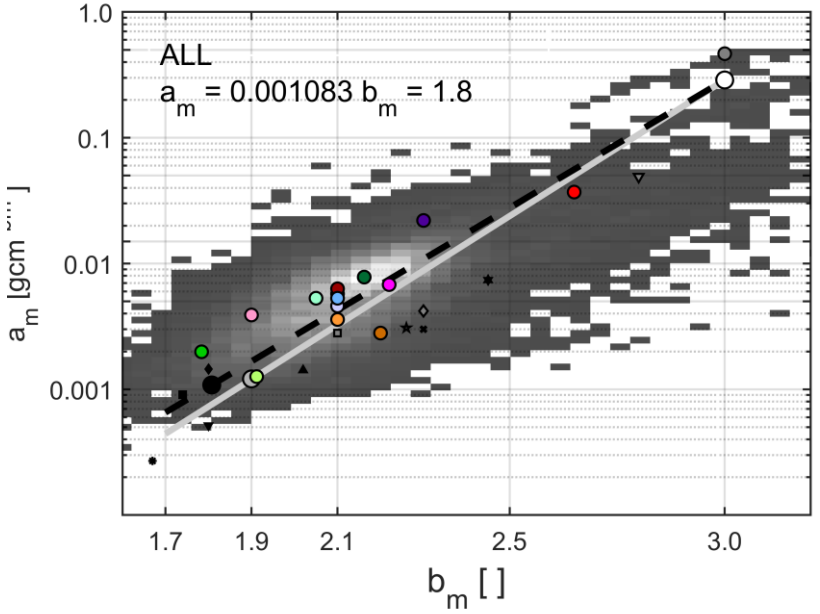
Validation of EarthCARE Doppler observations (L. Baldini and M. Montopoli)

Physical validation: ice microphysics

Snowfall microphysical properties observed in Hyytiälä



Environmental conditions

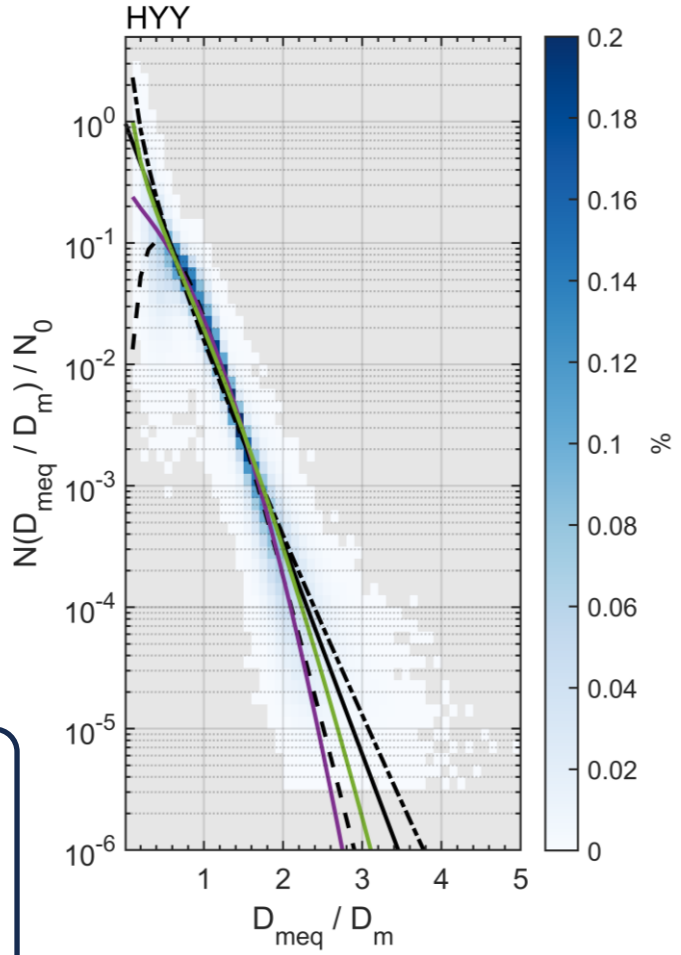


Relationship between a and b ($m = aD^b$)

PIP observations of

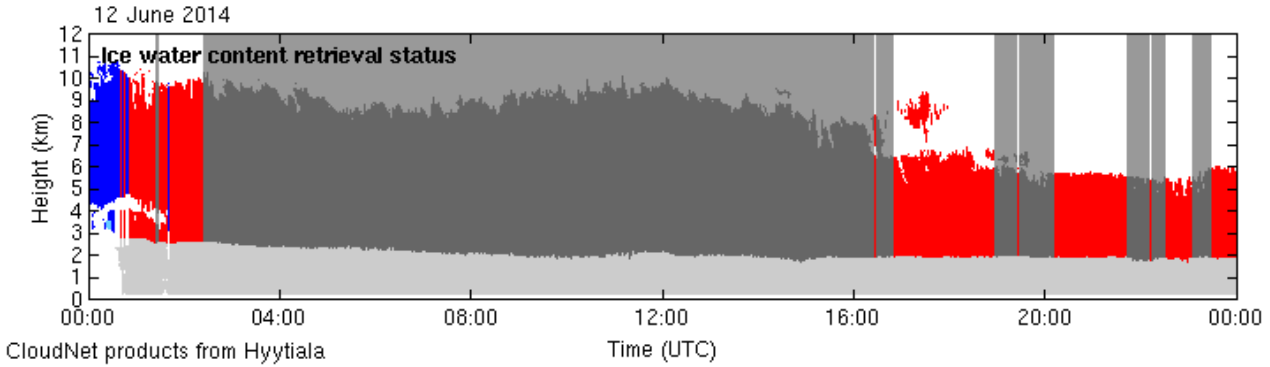
- particle size distribution (PSD)
- particle fall velocity
- particle dimension characteristics

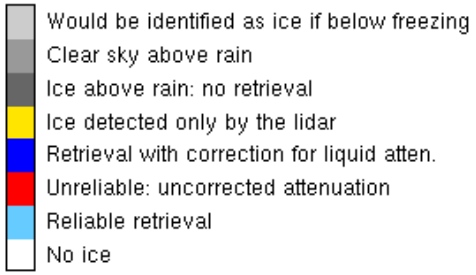
Snowflake mass retrieval of the falling particles (von Lerber et al., 2017)



Normalized PSD

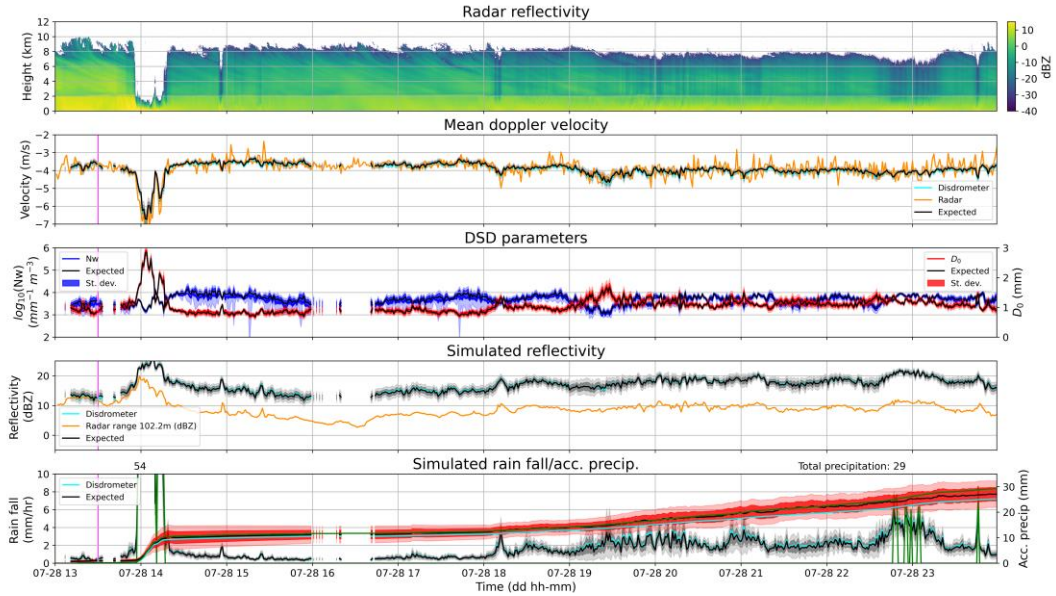
Ice cloud above rain





Currently there is no IWC estimation above rain, because of unknown attenuation (radome, rain, and ML)

Estimation of radome and rain attenuation (from disdrometer observations)

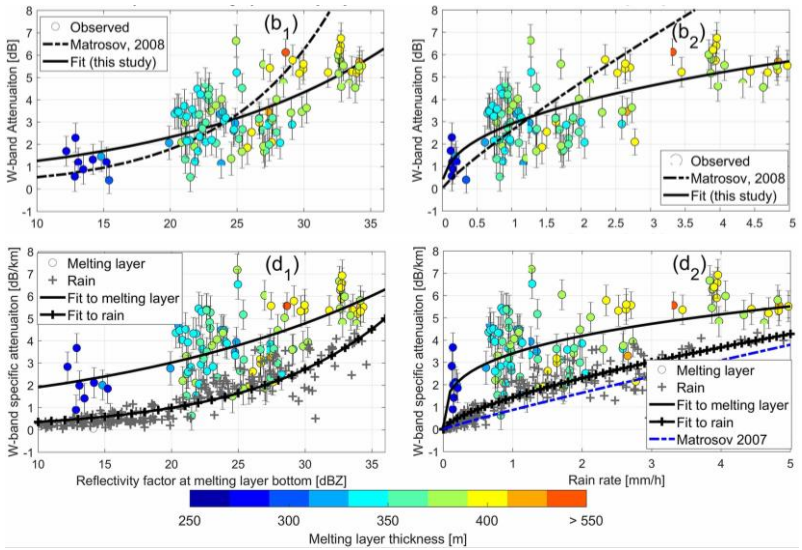


Melting layer attenuation estimation from multi-frequency Doppler spectra observations (Li and Moisseev, 2019)

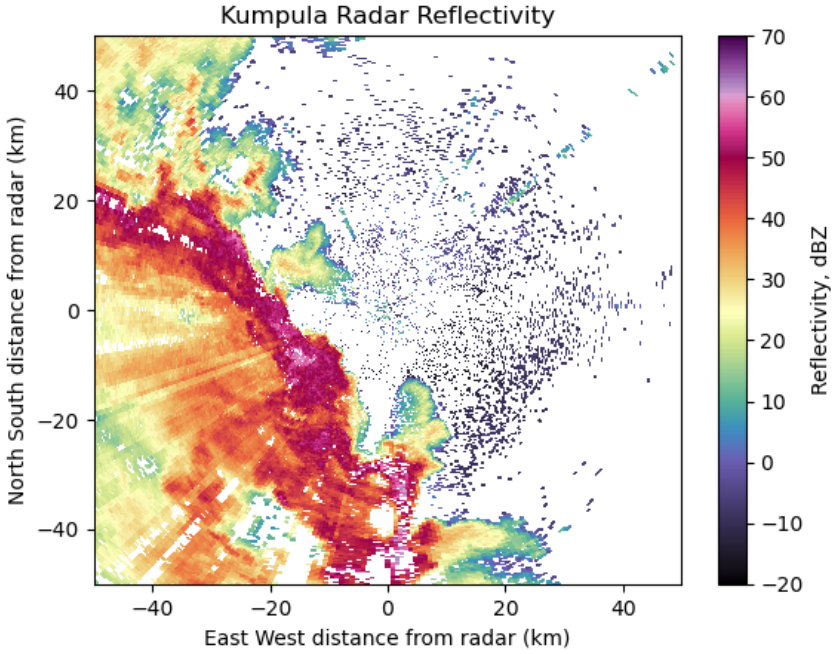
$$A_{\mathrm{Ka}} = 0.97R^{0.61} \quad \text{or} \quad A_{\mathrm{Ka}} = 0.13{Z_{\mathrm{lin}}}^{0.38}$$

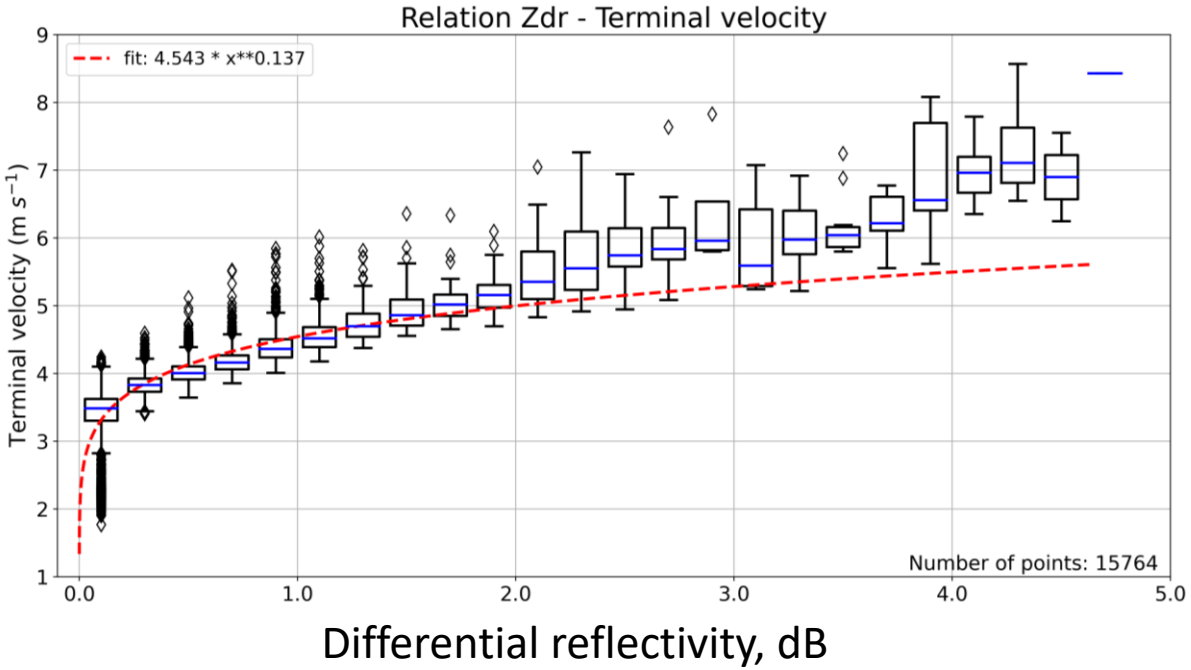
$$A_W = 2.9R^{0.42} \quad \text{or} \quad A_W = 0.67{Z_{\mathrm{lin}}}^{0.27}$$

Li & Moisseev (2019) *JGR:* https://doi.org/10.1029/2019JD030316



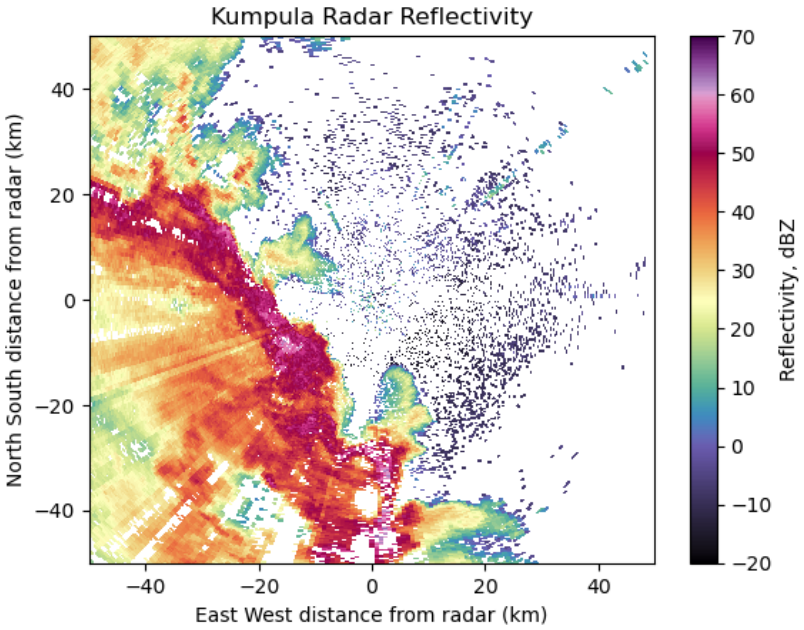
Raindrop sedimitation velocity from dual-polarization radar observations

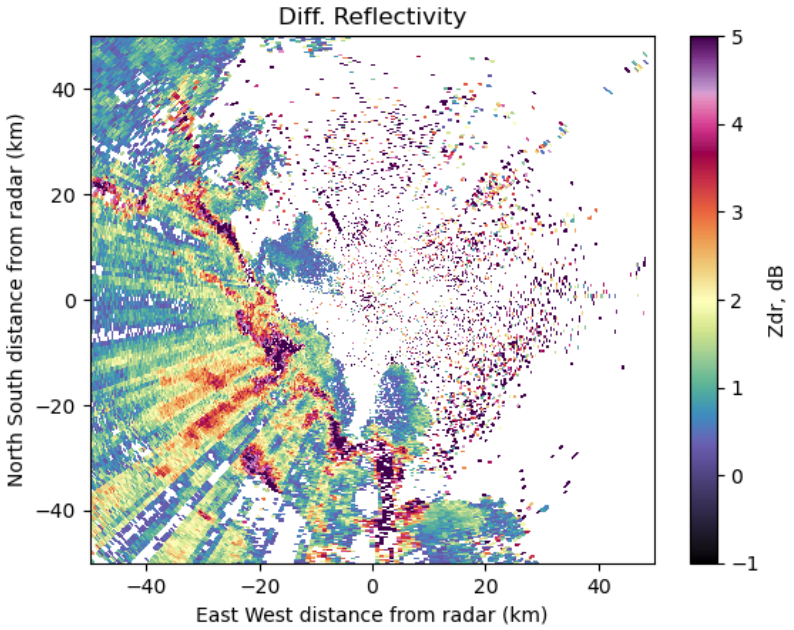


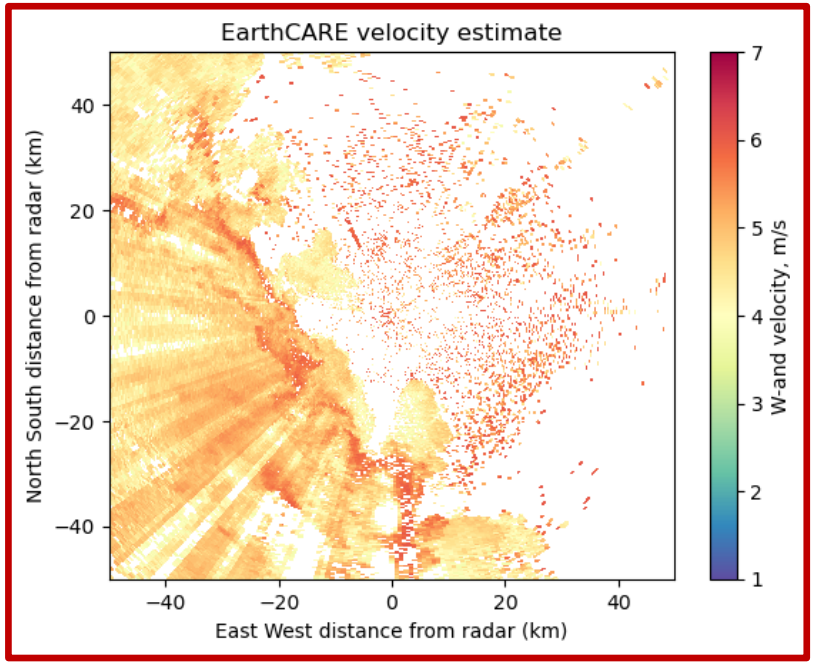


The relation is computed from 2 years of disdrometer observations

- Weather radars provide large spatial coverage => easy to match with EarthCARE observations
- Dual-polarization weather radar observations can be linked to raindrop sizes and fall velocities
- From dual-pol radar observations we can estimate EarthCARE velocity measurements in rain







- University of Helsinki Kumpula radar observations and computed EarthCARE velocity in rain
- This approach can be applied to observations collected at various locations (i.e. Italy, USA, …) providing validation of EarthCARE Doppler measurements at different latitudes

SUMMARY

Physical validation: ice microphysics

Measurments that started in 2014 as a part of NASA GPM and ARM BAECC experiment continue. More than 9 years of observations snowfall microphysics
(W-band radar Feb – Sept 2014, and after Novemebr 2017)

Correlative validation

Use of ACTRIS Cloudnet observations for EarthCARE cal/val are part of CERTAINTY project

Direct validation of Doppler observations

As a part ESA ACPV project method for validation of EarthCARE Doppler velocity observations using weather radar measurments (in collaboration with L. Baldini and M. Montopoli)