

A 94-GHz RADAR NETWORK IN EUROPE FOR THE CALIBRATION AND VALIDATION OF SPACEBORNE CLOUD PROFILING DATA PRODUCTS

L. Pfitzenmaier¹, P. Kollias^{1,2}, U. Löhnert¹, D. Nicolae³, A. Nemuc³, B. Antonescu³,
A. Thoss⁴, D. Dufton⁴, E. O'Connor⁵, J. v. Bismarck⁶

¹ Institute of Geophysics and Meteorology, University of Cologne, Germany;
² School of Marine and Atmospheric Sciences, Stony Brook University, USA;
³ National Institute for Research and Development in Optoelectronics (INOE), Bucharest, Romania;
⁴ Swedish Metrological and Hydrological Institute (SMHI), Norrköping, Sweden
⁵ Finnish Meteorological Institute (FMI), Helsinki, Finland
⁶ European Space Agency (ESA-ESRIN), Frascati, Italy

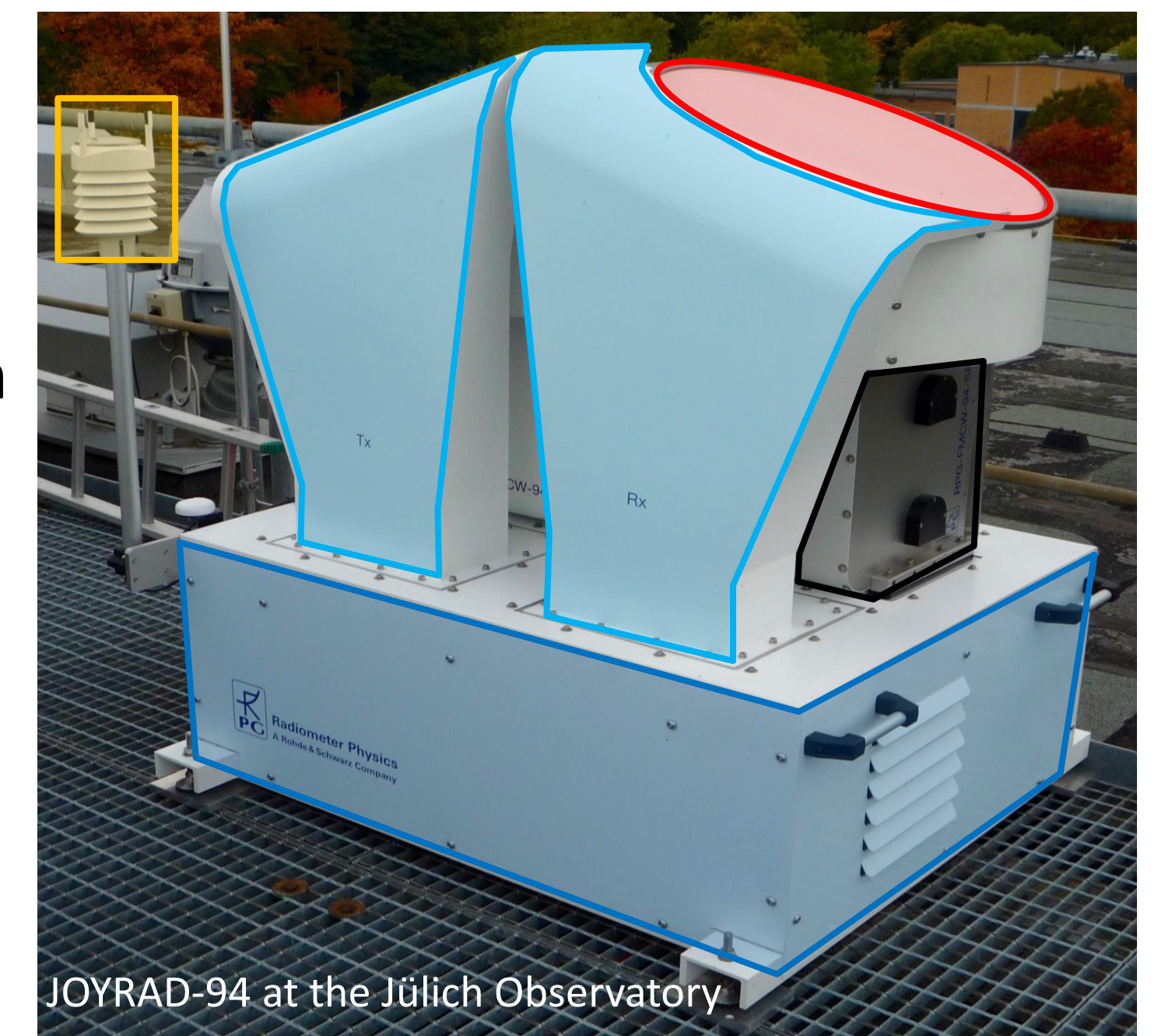


Objectives of the project

- Improve availability and quality of cloud profile reference data for satellite vertical cloud profile product validation
 - Identified need to tailor calibration, operation and product generation of ground based cloud radars towards specific needs of satellite Cal/Val ("FRM")
 - Foster the development of new Cal/Val products
 - Quality check the L2 EarthCARE data (C-CT, C-CLD, C-PRO)
 - Mimic the satellite sensor - W-band is the same wavelength as EarthCARE-Cloud Profiling Radar (CPR)
 - Close geographical gaps in the existing European ground based radar network (northern and southeastern Europe)
 - Long term monitoring of the data
 - Statistical analysis and co-located measurements
- Improve the scientific understanding of clouds

Advantage of 94-GHz (W-band) ground based radars

- FMCW technology using high duty cycle solid state transmitters
 - Low power consumption
 - Low maintenance and acquisition costs
- Full Doppler capability
 - Records Doppler spectra
- Passive 89-GHz receiver
 - Estimate the Liquid Water Path at the radar column resolution
- Calibration of the receiver can be performed regularly using liquid N₂



Receiving antenna with radome, Radar hardware, Blower outlets, Blower and stand, Weather station

Initial Radar network

- Fill the gaps in the existing network of Cloudnet stations
 - INOE – Romania
 - SMHI – Sweden
 - Planning to extend the network of 94-GHz radars - Barbados (MPI), Antarctica (EPFL),...
- Good representation of several cloud types
- Long term observations



● Existing Cloudnet station (35 GHz)
✗ Planned Cloudnet station (94 GHz)
● Existing Cloudnet station running a 94-GHz

Fiducial Reference Measurements – FRM

- FRM provide independent, high quality ground-based measurements referring to definition of Fiducial reference measurements <https://earth.esa.int/web/sppa/activities/frm>
 - Fully characterized, including uncertainty estimations and traceability to community standards with best practice
- FRM4RADAR in particular serve EarthCARE and other missions cloud profile product validation

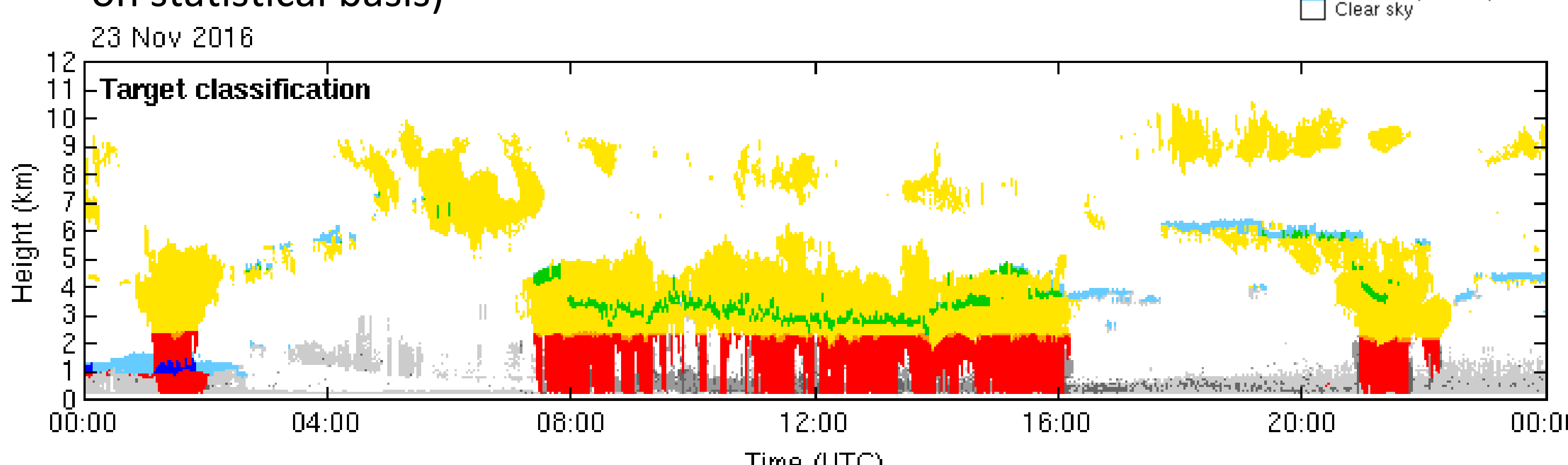
Project time-line

- RM4RADAR is a 27 months project, supported by ESA
- Project kicked off early June, 2018
- Instrument installation and network setup in the first phase
- Product processing and quality assessment
- Cal/Val product readiness before EarthCARE launch in 2020

Approach

- Establish 94-GHz radar systems in Europe
- Instrumental synergy of the ground based radars with a Ceilometer and a microwave radiometer
 - implement the Cloudnet algorithm for the validation of cloud profiling data products
- Validation of CPR retrievals
 - Produce cloud and precipitation type classification
 - Compare to the CPR C-TC product with the ones provided by the Cloudnet algorithm
- long term observation and co-located observations (validation on statistical basis)

■ Aerosol & insects
■ Insects
■ Aerosol
■ Melting ice & cloud droplets
■ Melting ice
■ Ice & supercooled droplets
■ Ice
■ Drizzle/rain & cloud droplets
■ Drizzle or rain
■ Cloud droplets only
■ Clear sky



Outlook and discussion

- Tailored calibration, operation and products of mini-network towards needs of Sat. Cal/Val
- Extend the FMR4RADAR framework to increase the number of EarthCARE overpasses that can be used for Cal/Val activities
 - Extend the 94-GHz radar network in Europe
 - Explore the use of 35-GHz profiling radar systems to derive similar ground-based L2 CPR data products (e.g., C-FMR, C-CD).
 - Multi-frequency radar observations are key to microphysical data evaluation
- Paving the way towards long-term availability of cloud and precipitation FRM for satellite-based cloud profile product validation over Europe

CONTACTS:

Lukas Pfitzenmaier
lpfitzenmaier@uni-koln.de

Pavlos Kollias
pkollias@uni-koeln.de

Web page
www.geomet.uni-koeln.de/index.php?id=2771