

Investigation of precipitation with a vertical pointing X-band radar at Hornisgrinde during COPS



Andreas Behrendt¹, Sandip Pal¹, Marcus Radlach, Andrea Riede¹, Volker Wulfmeyer¹
 Martin Hagen², Jan Handwerker³ and Donat Högl⁴

¹Institute of Physics and Meteorology, University of Hohenheim, Stuttgart, Germany

² German Aerospace Center, Oberpfaffenhofen, Weßling, Germany

³ Institut of Meteorology and Climate Research- Forschungszentrum Karlsruhe, Germany

⁴ Eidgenössische Technische Hochschule, Zürich, Switzerland

riede@uni-hohenheim.de

Introduction

A vertically pointing X-band Doppler radar was deployed from June to August 2007 COPS on top of Hornisgrinde, the highest peak in the Northern Black Forest with an elevation of 1161 m above sea level. The COPS Supersite H (Hornisgrinde) lay along one line with the two Supersites R (Rhine valley) and M (Murgtal). This line was covered with one scan of the DLR polarization radar POLDIRAD.

The X-Band Radar has high resolution in time (1 s), range (up to 50 m) and velocity (0.125 ms⁻¹) which makes also small scale and short lived structures in precipitation nicely visible and allows to investigate a broad range of hydrometeors from slowly falling snow over rain up to hail.

Additional a Joss-Waldvogel-Disdrometer is mounted on the roof of the radar van to measure the rain rate and the drop size distribution.

Technical details of the mobile X-Band Radar

- Wavelength:** 3.2 cm (X - Band)
- Nyquist velocity:** 32 m / s
- Height resolution:** 50 m
- Time resolution:** 1 s (adjustable)
- Velocity resolution:** 0.125 m/s (adjustable)
- Number of FFT samples:** 512 (adjustable)
- Antenna:** vertically pointing
- Beamwidth:** 2.4°
- Peak Power:** 90 kW
- Average power:** 80 W
- Maximum height:** limited by amount of data
- Pulse repetition rate:** 4.0 kHz



Mobile platform on which the X-Band radar is mounted



Interior view of the platform with the radar, steering unit, and data acquisition computer

Disdrometer



Joss-Waldvogel-Disdrometer which is mounted on the roof of the radar van.

Diameter classes

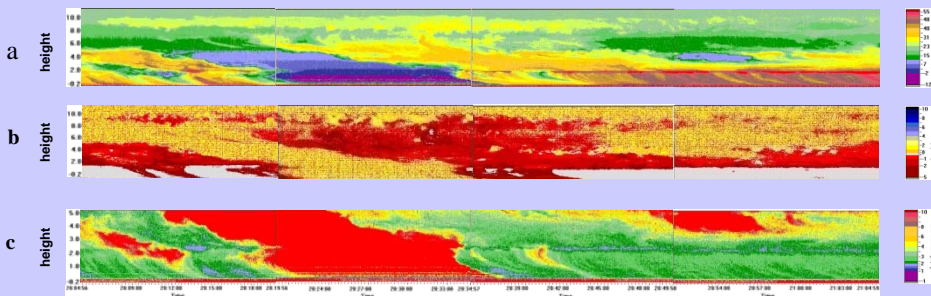
class	mean diameter [mm]	diameter range [mm]	class	mean diameter [mm]	diameter range [mm]
0	0.359	< 0.406	10	1.9115	1.80 - 2.10
1	0.455	0.40 - 0.50	11	2.269	2.10 - 2.45
2	0.5495	0.50 - 0.60	12	2.5995	2.45 - 2.75
3	0.6565	0.60 - 0.71	13	2.8915	2.75 - 3.05
4	0.774	0.71 - 0.83	14	3.1985	3.05 - 3.35
5	0.9135	0.83 - 1.01	15	3.541	3.35 - 3.75
6	1.1155	1.01 - 1.21	16	3.944	3.75 - 4.15
7	1.3215	1.21 - 1.42	17	4.395	4.15 - 4.65
8	1.5130	1.42 - 1.60	18	4.882	4.65 - 5.20
9	1.6625	1.60 - 1.80	19	5.4475	> 5.2

Rain fall rate R calculated from number distribution:

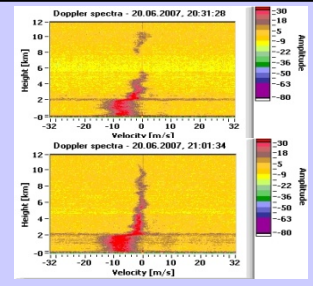
$$R = \frac{\pi}{6} \cdot 10^3 \cdot \sum_{i=1}^{20} (n_i \cdot D_i^3)$$

F: size of the sensitive surface of the disdrometer;
 D: size diameter of the measurement;
 n: average diameter of the drops in class;
 D: number of drops measured in drop size class i during t;
 D: velocity of the drop with diameter D

Measurements during COPS 2007



Time-height cross-section of (a) reflectivity (b) velocity, and (c) 2nd moment between 20:00 and 20:50 UTC on June 20, 2007.



Doppler spectra of 20:30 (upper panel) and 21:00 UTC (lower panel). The spectra are averaged over 10 s.

Comparison with POLDIRAD and IMK C-Band Radar during IOP 15b, 13 August 2007

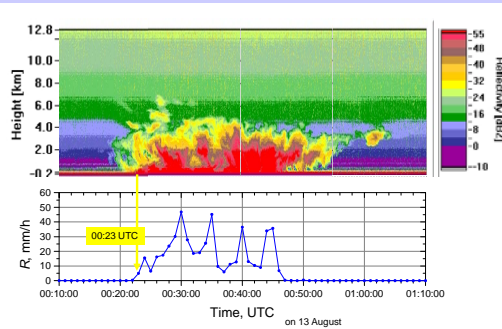
UHOH X-Band Radar

Reflectivity of a rain event on 13 August 2007 as seen by the vertical pointing X-band radar on Hornisgrinde.

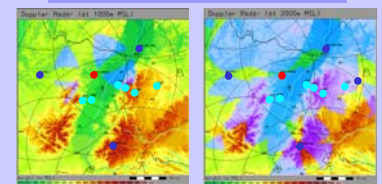
Disdrometer

Rain rate measured with the disdrometer of the X-band radar. First rain drops are detected at 00:22 UTC. As maximum rain rate 46.9 mm/h are found at 00:30 UTC.

These features are found remarkably well also in the data of POLDIRAD and the IMK C-band Radar.



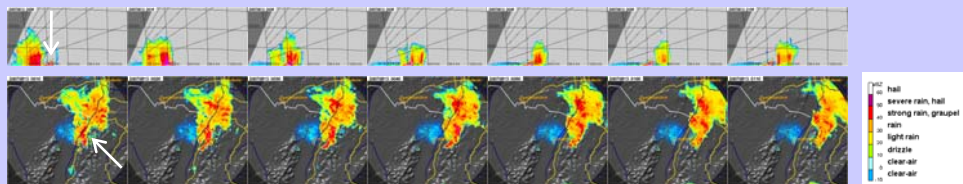
Location of the instruments



Orography in the COPS area with location of the weather radars (blue dots), POLDIRAD (red dot), and the COPS Supersites (cyan dots). Blue colors mark regions of dual-Doppler capability at heights of 1000 and 2000 m above sea level. (Courtesy of Martin Hagen, DLR.)

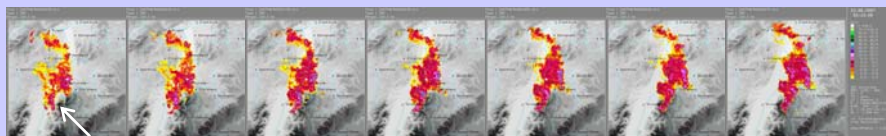
POLDIRAD

Reflectivity data of POLDIRAD. Upper panels: Range-height-indicator scans in the direction of the supersites R, H, and M. Lower panels: Plane-polar indicator scans. The location of Hornisgrinde is marked. (Plots by courtesy of Martin Hagen)



IMK C-Band Radar

Rain rates derived from reflectivity data measured with the C-band radar of Institute of Meteorology and Climate Research (IMK), Research Center Karlsruhe/University of Karlsruhe at the same time. The location of Hornisgrinde is marked. (Plots by courtesy of Jan Handwerker)



Acknowledgement: The mobile X-band radar which is now operated by University of Hohenheim was developed at Eidgenössische Technische Hochschule Zürich, CH. We are grateful for the kind donation of the radar and thank Björn Baschek for introducing the radar operation to us.