

Investigation of precipitation events with vertically pointing UHOH X-band radar at Hornisgrinde during COPS



Sandip Pal¹, Andreas Behrendt¹, Marcus Radlach¹, Andrea Riede¹, Volker Wulfmeyer¹, Martin Hagen², Jan Handwerker³ and Donat Högl⁴

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

²German Aerospace Center, Oberpfaffenhofen, Weßling, Germany

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

⁴Eidgenössische Technische Hochschule, Zürich, Switzerland

Introduction

A vertically pointing X-band Doppler radar [1] was deployed from June to August 2007 COPS on top of Hornisgrinde. The COPS Supersite H lay along one line with the two Supersites R (Rehental) and M (Murgtal). This line was covered with one scan of the DLR polarization radar POLDIRAD. Measurement examples of 20 July 2007 (IOP 9c) and 13 August 2007 (IOP 15b) are presented here.

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.

[1] B. Baschek, Dissertation, No. 15793, ETH Zurich, 2005.

Technical details of the mobile X-Band Radar



Fig. 1: Mobile platform on which the X-Band radar is mounted

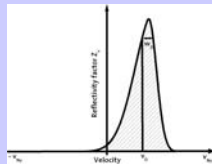


Fig. 2: Sketch of a Doppler spectrum and its moments. The reflectivity corresponds to the shaded area. The Doppler velocity v_D is given by the normalized first, and the spectrum width w_D by the normalized second moment.

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

Disdrometer



Fig. 3: Joss-Waldvogel - Disdrometer which is mounted on the roof of the radar van.

Diameter classes

class #	mean diameter \bar{r} [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	2.209	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	3.1685	3.05 – 3.35
5	0.9135	0.83 – 1.01	15	3.541	3.35 – 3.75
6	1.1135	1.01 – 1.21	16	3.944	3.75 – 4.15
7	1.3315	1.21 – 1.42	17	4.388	4.15 – 4.65
8	1.5710	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:

$$R = \frac{\pi}{6} \frac{3.6}{10^3} \frac{1}{F \cdot E} \sum_{i=1}^{20} (N_i \cdot D_i^3)$$

F: Size of the sensitive surface of the disdrometer.
 E: Size of the sensitive surface of the disdrometer.
 D: Vertical diameter of the drops in class i.
 N: Number of drops measured in class i during time interval Δt .
 V: D: Fall velocity of a drop with diameter D.

Measurements during COPS 2007: Example 20 July 2007, IOP 9c

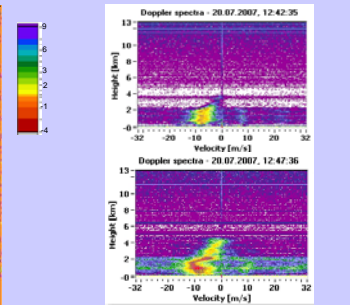
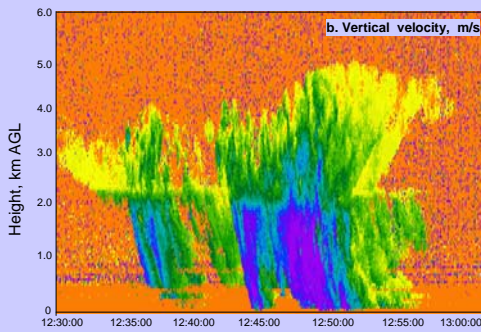
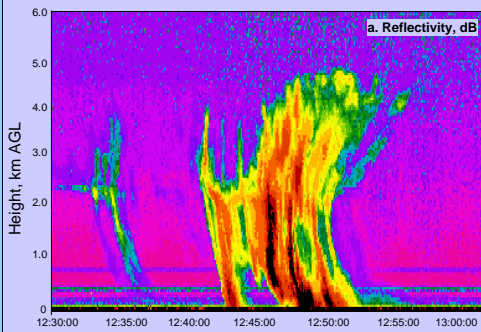


Fig. 5: Doppler spectra of 12:42 (upper panel) and 12:47 UTC (lower panel). The spectra are averaged over 10 s.

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

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 00:21 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.

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)

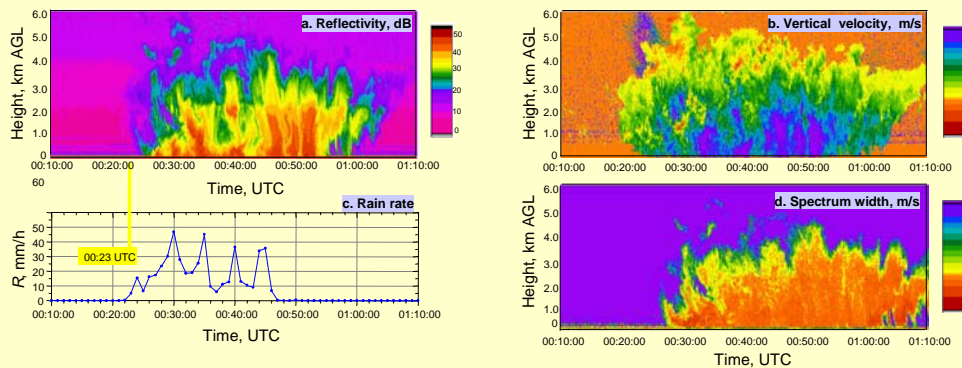


Fig. 6: Time-height cross-section of reflectivity (a), velocity (b), rain rate (c), and spectrum width (d) measured between 00:10 and 01:00 UTC on 13 August 2007 (IOP 15b).

