RPG-DP-RR series

The **RPG DP-RR** instrument is a stand-alone system for automated weather-station use under nearly all environmental conditions. The modular design of the RPG-DP-RR series observes at 2, 3 or 4 frequencies with 2 orthogonal polarisations (V/H). Later frequency extensions are possible. Typical configurations are:

- 4 channels at 21.0 (or 18.7) and 36.5 GHz
- 6 channels at 10.7, 21.0 (or 18.7) and 36.5 GHz
- 8 channels at 6.9, 10.7, 21.0 (or 18.7) and 36.5 GHz

A key features of RPG's rain radiometer is the measurement of Polarisation Difference ($PD = TB_V - TB_H$) during rain events under e.g. 30° elevation angle. Falling droplets are flattened due to the air resistance from below and nearly form an ellipsoid with long axis along the horizontal direction. Therefore the emission of falling droplets is more pronounced in the horizontal polarisation compared to the vertical. This allows for the separation of cloud liquid (perfectly round droplets, approx. 20 µm in diameter) and rain liquid.

Applications

The RPG-DP-RR series providing brightness temperature measurements with polarisation information is dedicated to the observation of raining clouds. Polarisation effects on non-spherical hydrometeors can be observed with this kind of instrument.

Discrimination between **Cloud Liquid** and **Rain Liquid**

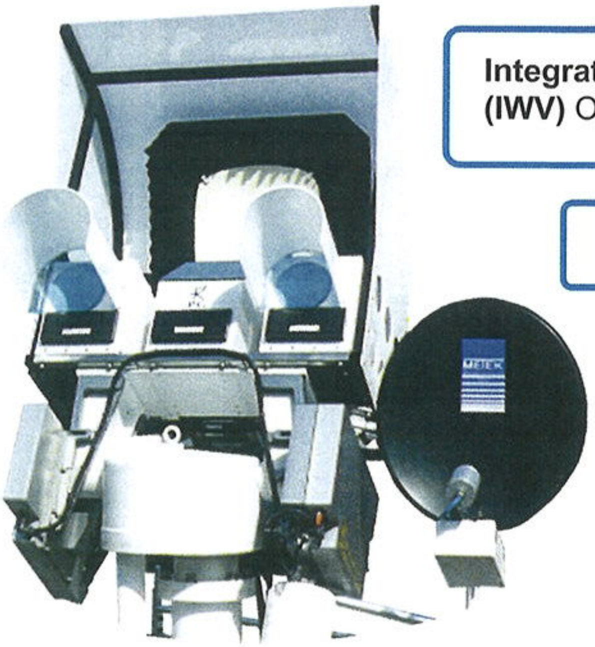
Accurate LWP during Rain < 2 mm/h up to 50 mm/h

Cloud Coverage

Integrated Water Vapour (IWV) Observations

3D Humidity Field

2D Sky Mapping



RPG Radiometer Physics GmbH
Werner-von-Siemens-Str. 4
53340 Meckenheim, Germany

09/2015
+49 (0) 2225 99981 – 0
www.radiometer-physics.de
remotesensing-sales@radiometer-physics.de

Features

Parallel Detection
at all channels

Purely Passive Operation
no internal oscillators or other RF sources

Immune to RF interference below reception bands e.g. radio transmitters or mobile phones

High Temporal Resolution
1 second

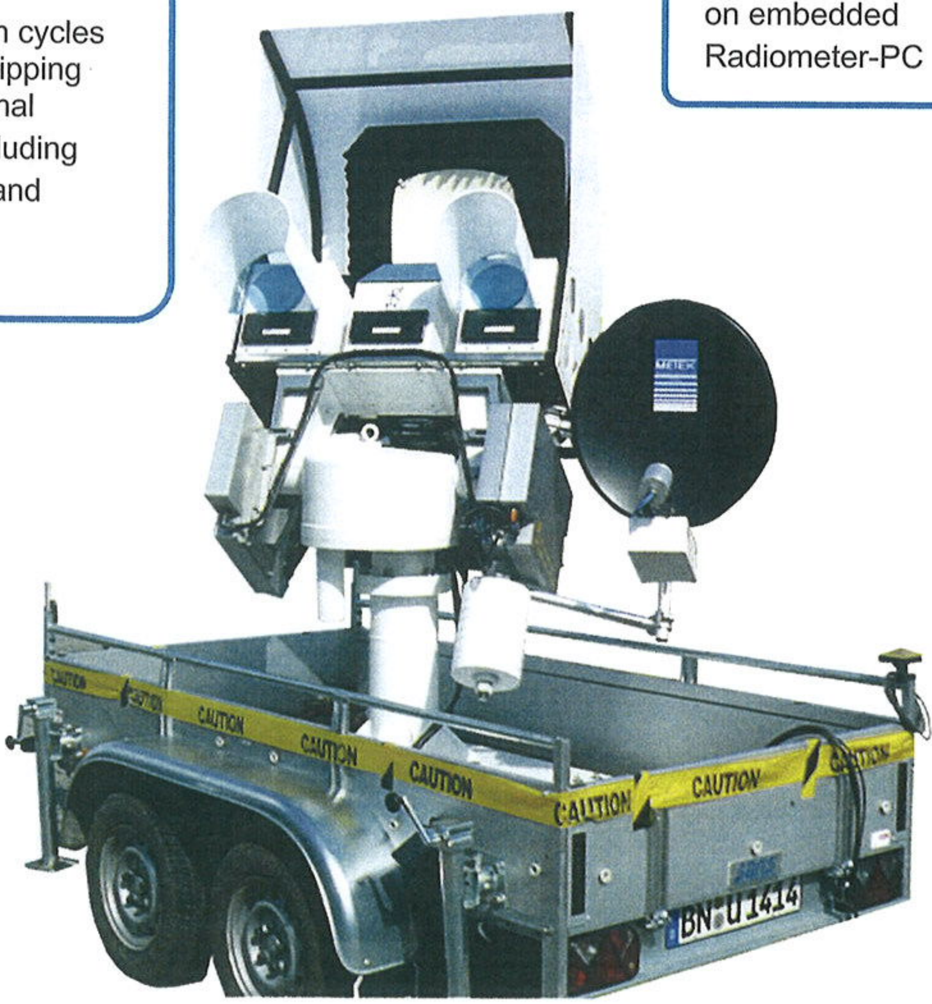
High Spatial Resolution
6° HPBW

Rapid Full Sky Mapping
350 data points in 10 minutes

Automatic Calibration

- short calibration cycles
- automatic sky-tipping
- automatic internal calibrations including noise sources and Dicke switches

Data Backup
on embedded Radiometer-PC



RPG Radiometer Physics GmbH
Werner-von-Siemens-Str. 4
53340 Meckenheim, Germany

09/2015
+49 (0) 2225 99981 – 0
www.radiometer-physics.de
remotesensing-sales@radiometer-physics.de

Highlights

Zenith Sky Observations

When observing the sky in zenith direction, polarisation splitting should be zero, even if clouds are passing the field of view. Falling rain droplets are vertically flattened, but this cannot be seen in zenith direction. Therefore, by directing the radiometer to zenith, the polarisation difference between V and H should vanish. Figure 1 shows the brightness temperatures (TB) observed for a cloudy atmosphere. Figure 2 gives the polarisation difference.

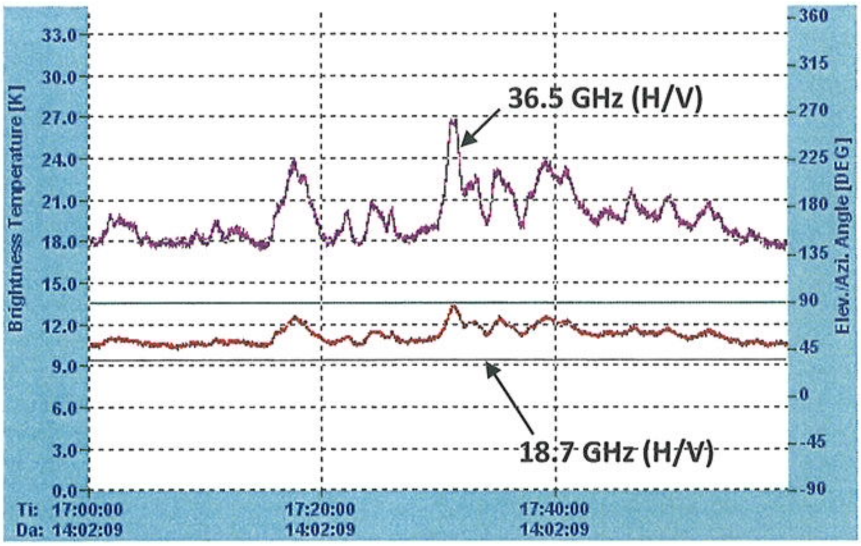


Figure 1: Time series of brightness temperatures for two frequencies

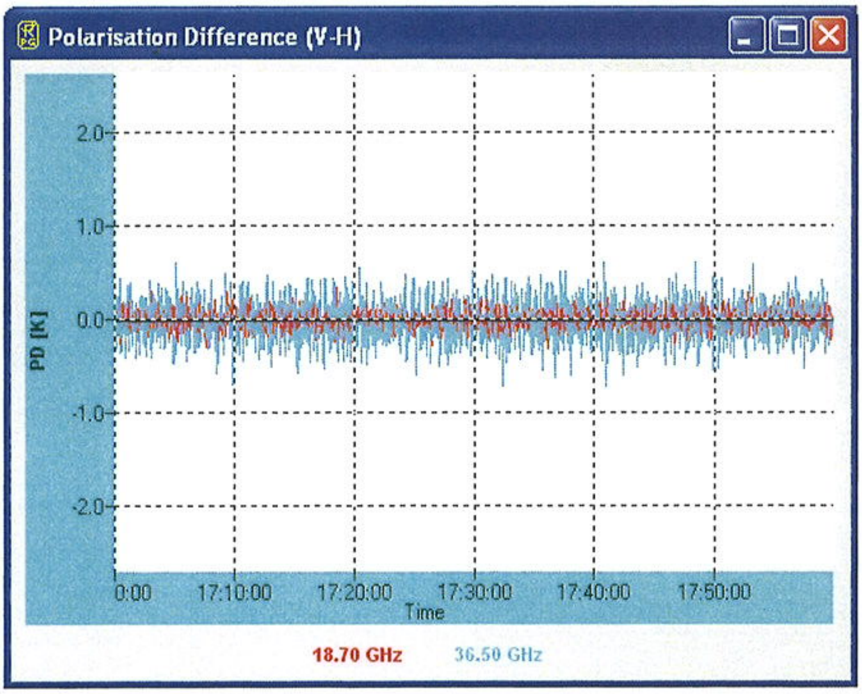


Figure 2: Time series of Polarisation Difference (PD) for a cloudy sky

RPG Radiometer Physics GmbH
Werner-von-Siemens-Str. 4
53340 Meckenheim, Germany
+49 (0) 2225 99981 – 0
www.radiometer-physics.de
remotesensing-sales@radiometer-physics.de

Observations under Low Elevation Angles

Polarisation effects due to falling rain droplets have to be observed under lower elevation angles. The following measurements (Figure 3-6) were performed at 30° elevation angle, observing a raining atmosphere (rain rate 5 mm/h). The polarisation splitting is very obvious but immediately drops down to zero, when the rain pauses. As expected, the 36.5 GHz channels respond much more sensitively to the liquid water and the Polarisation Difference (PD) is more exaggerated. The 36.5 GHz channels are used for light rain detection while the 18.7 GHz channels cover the strong rain events with rain rates above 20-30 mm/h when the 36.5 GHz channels are starting to saturate. Figure 5 shows the retrieval outputs for the TB time series above. LWR is the liquid water content of the rain droplets, LWC denotes the cloud liquid, and LWP is the total liquid water amount. The three time series are consistent even though the three quantities have been derived by three independent retrieval algorithms, one for each product.

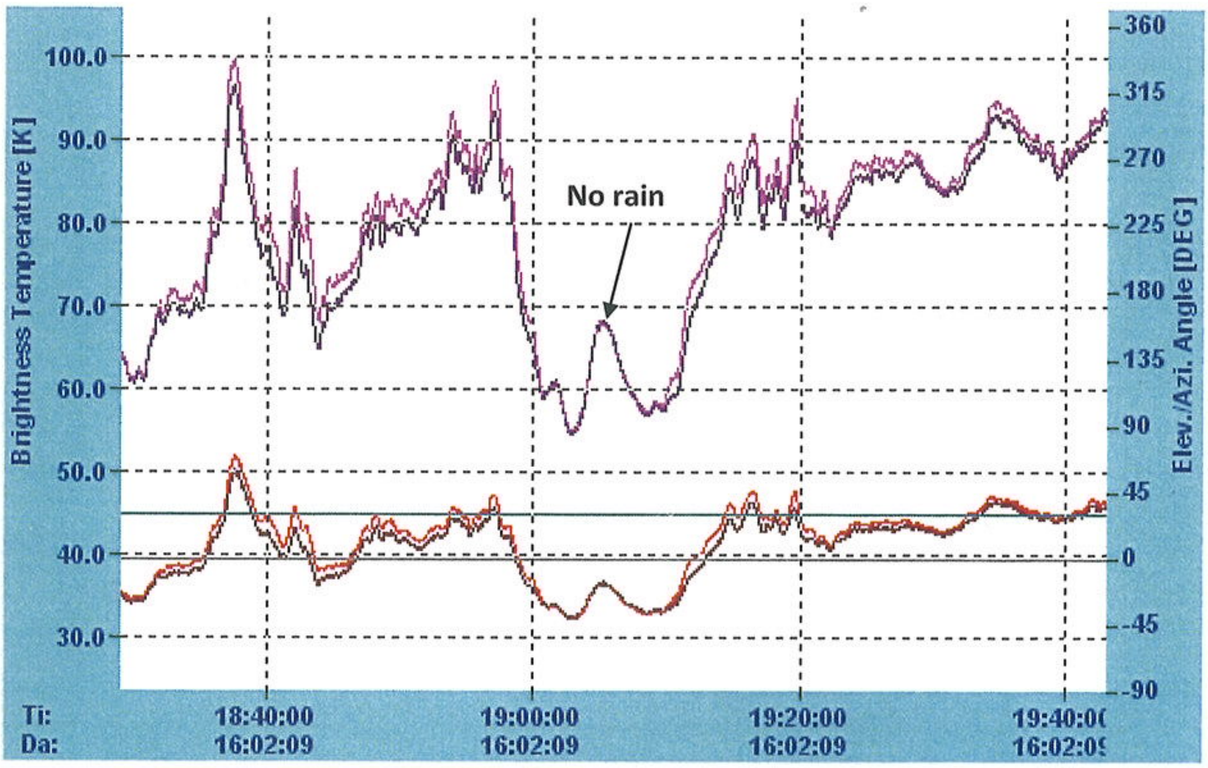


Figure 3: Time series of brightness temperatures at 18.7 (red/black) and 36.5 GHz (purple/blue)

RPG Radiometer Physics GmbH
Werner-von-Siemens-Str. 4
53340 Meckenheim, Germany

09/2015

+49 (0) 2225 99981 – 0
www.radiometer-physics.de
remotesensing-sales@radiometer-physics.de

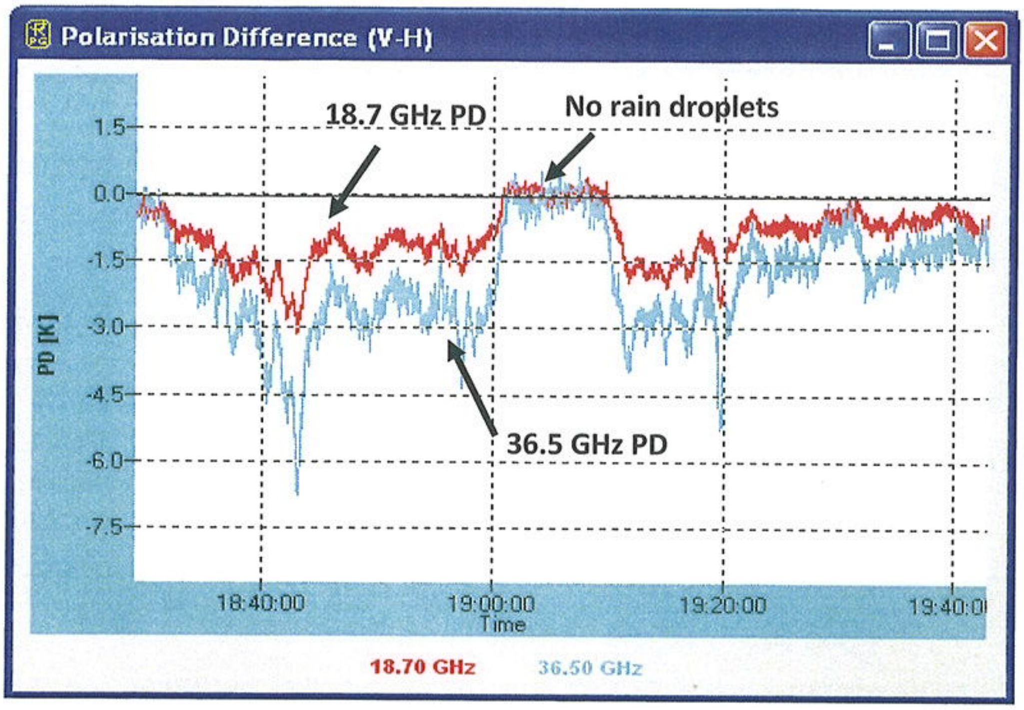


Figure 4: Polarisation Difference (PD) for rain and cloud mixtures

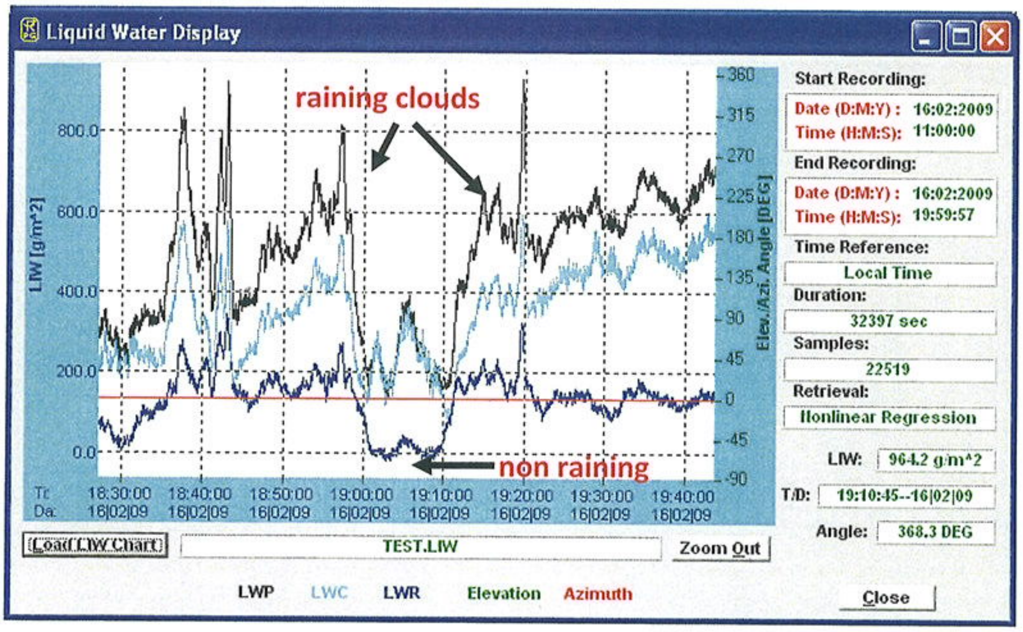


Figure 5: Simple regression retrieval for rain and cloud fraction of LWP

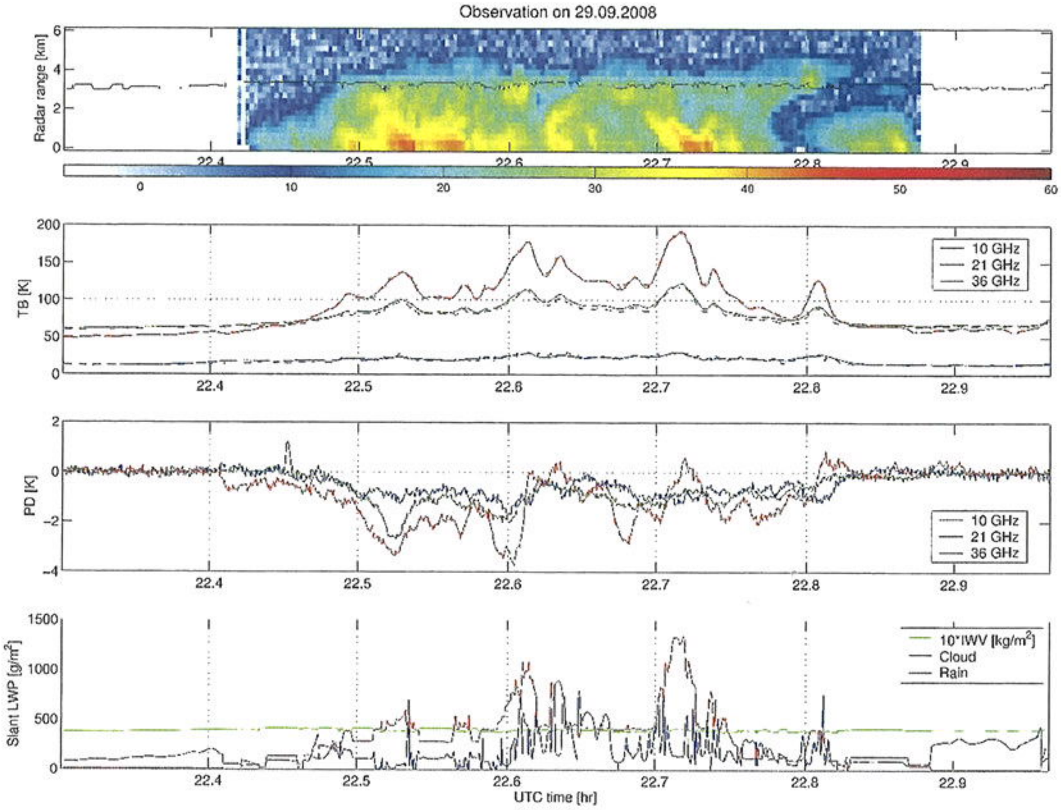


Figure 6: Time Series of TB, PD, and LWP contributions from clouds and rain

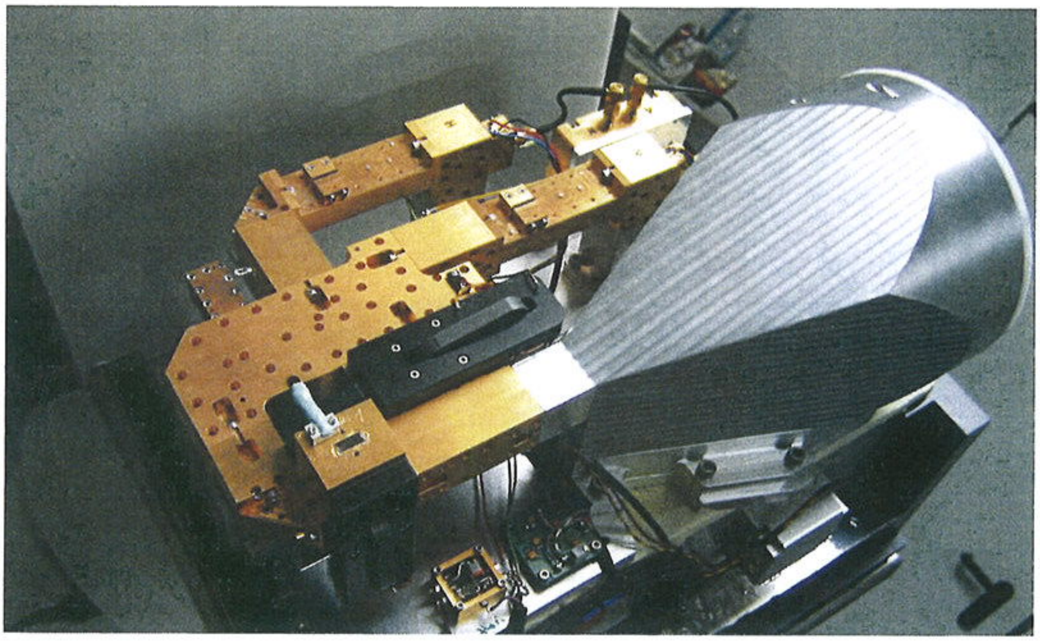


Figure 7: RPG Dual Polarisation receiver

RPG Radiometer Physics GmbH
Werner-von-Siemens-Str. 4
53340 Meckenheim, Germany
+49 (0) 2225 99981 – 0
www.radiometer-physics.de
remotesensing-sales@radiometer-physics.de

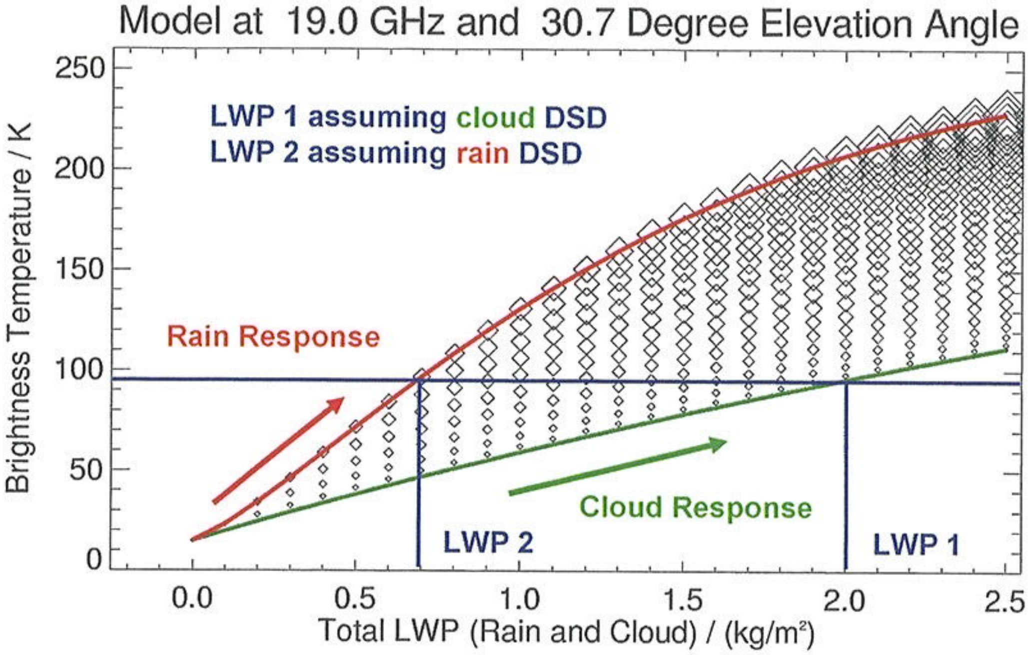
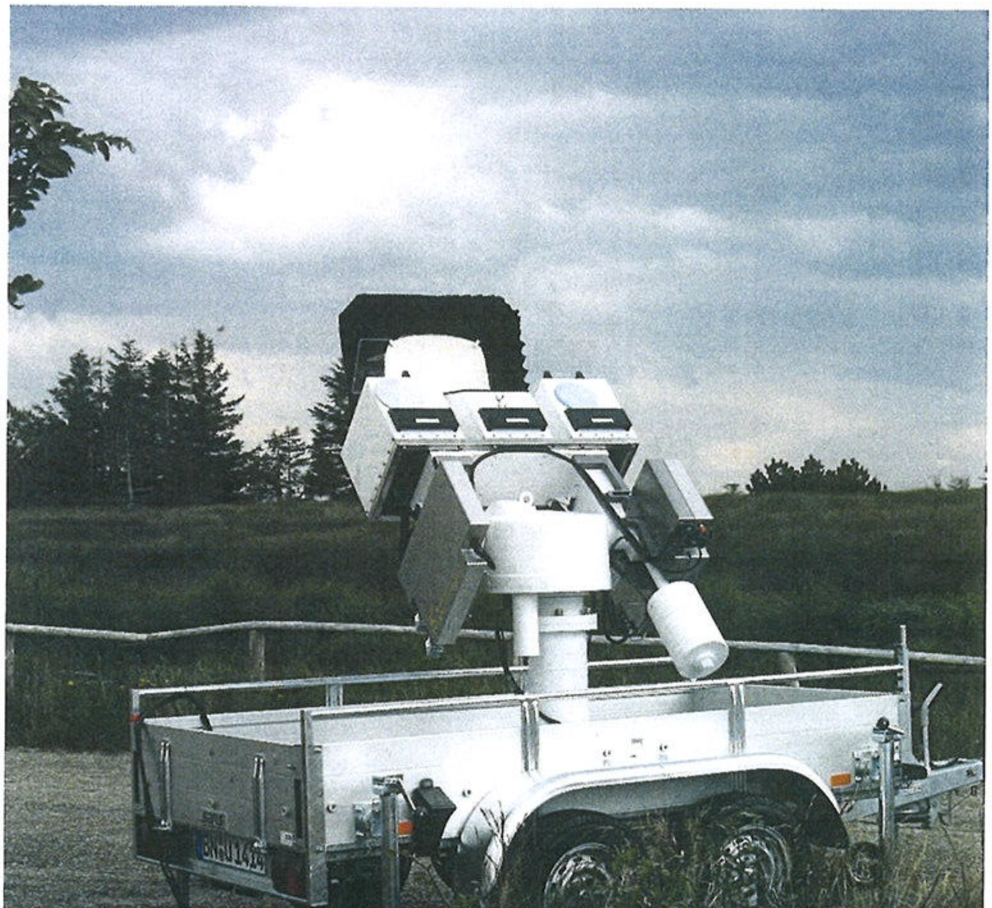


Figure 8: Contributions from cloud and rain liquid to slant path observations



RPG Radiometer Physics GmbH
Werner-von-Siemens-Str. 4
53340 Meckenheim, Germany

09/2015
+49 (0) 2225 99981 – 0
www.radiometer-physics.de
remotesensing-sales@radiometer-physics.de

Detailed Instrument Specifications

Parameter	Specification
System noise temperatures	< 900 K typical for all receivers < 400 K below 60 GHz (including auto-calibration frontend)
Radiometric resolution	0.15 K RMS @ 1.0 sec integration time
Channel bandwidth	400 MHz typical (can be adjusted, if required)
Absolute system stability	0.5 K
Radiometric range	0 – 400 K
Available Frequencies	6.9, 10.65, 18.7, 21.0, 23.8, 36.5, 37, 89, 90, 150*
Polarisation	2 linear polarisations (V/H), simultaneously
Absolute calibration	With internal Dicke switch, automatic sky tipping no external calibration targets needed
Internal calibration	Gain: internal Dicke Switch + noise standard
Receiver and antenna thermal stabilization	Accuracy: < ±0.015 K
Gain nonlinearity error correction	Automatic, four point method
Brightness calculation	Based on exact Planck radiation law
Integration time	≥ 0.4 second for each channel
Data interface / rate	Ethernet (TCP/IP)
Instrument control	Windows™ System with Ethernet interface
Housekeeping data	All system parameters, history documentation
Optical resolution	HPBW: 6.1° typical
Side-lobe level	< -30 dBc
Steering / positioner system	Elevation: -90° to +90°, azimuth: 0° to 360° < 1° resolution, full software control
Pointing speed	Elevation: 3°/sec, azimuth: 5°/sec
Operating temperature range	-40°C to +45°C
Operating humidity range	0 – 100 %
Power consumption	< 350 Watts average, 500 Watts peak
Input voltage	100-230 V AC, 50 to 60 Hz
Weight	Approx.105 kg for receiver modules, 300 kg for positioner
Modularity ("plug and play")	Any 4 frequencies (equals 8 channels) are supported by a positioner incl. power supplies and software control

RPG Radiometer Physics GmbH
Werner-von-Siemens-Str. 4
53340 Meckenheim, Germany

09/2015
+49 (0) 2225 99981 – 0
www.radiometer-physics.de
remotesensing-sales@radiometer-physics.de