# Microwave radiometer TOPHAT

Instrument name: TOPHAT
Instrument type: HATPRO G5 (updated from G2)
Manufacturer: Radiometer Physics GmbH (RPG)
Location: Forschungzentrum Jülich (JuCol)
Coordinates: Latitude 50.908547°N, Longitude 6.413536°E, Altitude 111 m asl

**TOPHAT** is a HATPRO (Humidity) passive microwave radiometer installed at Forschungszentrum Jülich as part of JuCol. It measures brightness temperatures at 7 channels along the slope of the water vapor absorption line at 22 GHz and at 7 channels along the slope of the oxygen absorption complex at 60 GHz with allow the retrieval of integrated water vapor (IWV), cloud liquid water path (LWP) as well as tropospheric temperature and humidity profiles. Zenith measurements alternate with scan patterns. Regular elevation scans provide high-quality temperature profiles in the boundary layer. Attached to the side, it also includes two broadband infrared pyrometers, sensitive to water vapor, low-LWP (< 50 gm$^{-2}$) liquid clouds as well as ice clouds.

## Instrument specifications

| Parameter | Specification |
|---|---|
| Receiver 1 (R1) | water vapor and liquid water absorption |
| Frequencies (R1) [GHz] | 22.24, 23.04, 23.84, 25.44, 26.24, 27.84, 31.40 |
| Channel band-widths (R1) [MHz] | 230, 230, 230, 230, 230, 230, 230 |
| Optical Resolution (R1) (HPBW) | 3.3°-3.7° |
| Receiver 2 (R2) | oxygen absorption |
| Frequencies (R2) [GHz] | 51.26, 52.28, 53.86, 54.94, 56.66, 57.30, 58.00 |
| Channel band-widths (R2) [MHz] | 230, 230, 230, 230, 600, 1000, 2000 |
| Optical Resolution (R2) (HPBW) | 2.2°- 2.5° |
| Pointing Resolution | 0.6° (elevation), 0.1° (azimuth) |
| Side-lobe level | < -30 dBc |
| Broadband infrared pyrometers | 11.1 µm, 12.0 µm |
| Size | 630 mm x 360 mm x 900 mm |
| Power Consumption | <120 W (350 W peak) + dew blower 130 W |
| Weight | 60 kg |
| Temporal Resolution of observations (minimum) | 1 second |

# Instrument time-line

07/08/2009 - 24/10/2009     ARM AMF site , Cerro Toco, Chile, RHUBC-II campaign
22/07/2010 - today     Forschungzentrum Jülich (JOYCE-JuCol)
2016     Upgrade to HATPRO-G5 receivers

# Available measurement modes

- Vertically pointing observations with integration times up to 1 seconds.
- Elevation scans for boundary-layer temperature profiles.
- Full azimuth/elevation scanning capability for horizontal variability of water vapor and clouds

# JOYCE-CF Standard Operation Procedures

- Standard measurement mode is vertically pointing, 1 second integration time
- Every 15 minutes one elevation scan with following angles: 42°, 30°, 19°, 10.2°, 5.4° (duration ~100 seconds)
- Every 30 minutes one azimuth scan at 30° elevation angle with 5° azimuth resolution (duration ~3 minutes)

- Automatic relative calibrations are routinely performed
    - automatic noise-switching for gain calibration with 50 Hz
    - System noise is calibrated every 5 minutes with view on ambient target
- Absolute calibrations using LN2 are performed every 6 months

# Data quality assurance procedures

- Automatic rain detection (data are flagged in case of rain detected by rain sensor)
- Offset corrections for liquid water path
- O-B statistics from atmospheric models for brightness temperature offset correction available
- Spectral consistency checks
- Thresholds for Level 2 data products
- Housekeeping data analysis
- Visual data inspection

# Available datasets

The following data products are provided via the SAMD database. If you would like to have additional data or recent data that have not been uploaded to SAMD yet, please fill a data request sheet available at JOYCE-CF website.

## Level 1

- Brightness temperatures (14 channels microwave)
  - Temporal resolution 1 second
  - 1 file per day (11-13 MB)
  - Filename: *sups_joy_mwr00_l1_tb_v00_YYYYMMDDHHMMSS.nc*

- Brightness temperatures (14 channels MW, 6 elevation angles)
  - Temporal resolution 15 minutes
  - 1 file per day (0.07 MB)
  - Filename: *sups_joy_mwr00BL_l1_tb_v00_YYYYMMDDHHMMSS.nc*

- Brightness temperature (2 channels infrared)
  - Temporal resolution 1 second
  - Filename:

## Level 2

- Integrated water vapor (IWV)
  - Temporal resolution 1 second
  - 1 file per day (3-4 MB)
  - Multivariate linear retrieval based on radiosoundings from De Bilt
  - Filename: *sups_joy_mwr00_l2_prw_v00_YYYYMMDDHHMMSS.nc*

- Integrated cloud liquid water (LWP)
  - Temporal resolution 1 second
  - 1 file per day (3-4 MB)
  - Multivariate linear retrieval based on radiosoundings from De Bilt
  - Filename: *sups_joy_mwr00_l2_clwvi_v00_YYYYMMDDHHMMSS.nc*

- Temperature profiles (from zenith pointing)
  - Temporal resolution: 1 second
  - 1 file per day (25-30 MB)
  - Multivariate linear retrieval based on radiosoundings from De Bilt
  - Filename: *sups_joy_mwr00_l2_ta_v00_YYYYMMDDHHMMSS.nc*

- Temperature profiles (from elevation scans for improved resolution in lowest 1000 m above ground)
  - Temporal resolution: 15 minutes
  - 1 file per day (0.04 MB)
  - Multivariate linear retrieval based on radiosoundings from De Bilt
  - Filename: *sups_joy_mwrBL00_l2_ta_v00_YYYYMMDDHHMMSS.nc*

- Humidity profiles
  - Temporal resolution 1 second
  - 1 file per day (25-30 MB)
  - Multivariate linear retrieval based on radiosoundings from De Bilt
  - Filename: *sups_joy_mwr00_l2_hua_v00_YYYYMMDDHHMMSS.nc*

## Composite products using data from TOPHAT

- Cloudnet target classification uses LWP data from TOPHAT. Combined with cloud radar and ceilometer observation, clouds are characterized by their geometrical extent as well as their microphysical properties.
- Data are available via ACTRIS cloudnet database http://cloudnet.fmi.fi

## Contact

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