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## Remote Sensing

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### Microwave radiometry

#### Motivation

Microwave radiometers measure the thermal radiation of the atmosphere, which provides information about the water-vapor and liquid-water content. Also temperature profiles of the lower troposphere can be inferred. Typically, microwave radiometers are not sensitive to the thermal radiation of ice. Thus, only information about the water-vapor and liquid-water content are retrieved, which can be used for the investigation of mixed-phase clouds.

Microwave radiometers are key devices of LACROS and Cloudnet to identify liquid water clouds. Therefore they are also central instruments for the investigation of aerosol-cloud interaction.

#### Measurement principle

Microwave radiometers measure the thermal radiation of the atmosphere. When appropriate detection frequencies are used, the emission of microwave radiation of atmospheric trace gases, of liquid water, and of ice crystals can be measured.

The emissivity of these substances, and thus their radiative temperature, depends on the concentration, the air pressure and air temperature. When the radiative temperatures are measured in frequency bands which in particular depend on these parameters, they can be estimated.

Between frequencies of 20 and 30 GHz an absorption band of water vapour is located. Measurements of the radiative temperature on the flanks of this absorption band allow to estimate the integrated water vapour (IWV) content and a profile of absolute humidity.

Between frequencies of 50 and 60 GHz an absorption band of oxygen is located. Because the relative concentration of oxygen is constant and depends only on pressure and temperature, measurements of the radiative temperature at the flanks of the oxygen-band allow to estimate profiles of the air temperature.

The total emissivity of the atmosphere in the range from 20 to 60 GHz depends in addition to the total amount of liquid water in the atmospheric column. This property is used to estimate the liquid water content.

#### The microwave radiometer HATPRO



Fig. 1: Microwave radiometer HATPRO operated at TROPOS:

TROPOS operates two microwave radiometers of the type 'Humidity and Temperature Profile' (HATPRO) (see Fig. 1). One instrument is part of the ground-based surface station LACROS, whereas the second one is operated in the framework of the OCEANET-Station. Both instruments run continuously and provide important information about the amount of water vapour and liquid water in the atmosphere.

HATPRO detects the atmospheric radiation temperatures at the following frequencies:

- 22-31 GHz: 7 channels in the absorption band of water vapour
- 51-58 GHz: 7 channels in the absorption band of oxygen
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The following parameters are measured:

- Vertical profile of atmospheric air temperature
- Vertical profile of absolute humidity
- Liquid water path (LWP)
- Integrated water vapour content (IWV)

#### Further information

- Webpage of the manufacturer of HATPRO
- Data archive of measurements of HATPRO at the LACROS supersite

## Contact

Dr. Patric Seifert  
Scientific staff

+49 341 2717-7080  
patric.seifert[at]tropos.de

**Leibniz-Institut für  
Troposphärenforschung e.V. (TROPOS)**  
Permoserstraße 15  
04318 Leipzig

Phone: ++49 (341) 2717 7060  
Fax: ++49 (341) 2717 99 7060

**Follow us on Twitter:**  
@TROPOS\_de



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