Universität Bremen

Radiometric Measurements of Tropospheric Water Properties in the Tropics

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Introduction

To understand the processes leading to climate change observations of tropical water vapor are of primal importance due to its dominant abundance as a greenhouse gas and its high variability. This applies particularly to the tropospheric region near the equator where only few measurements exist. The portable TRARA radiometer (developed by the IAP Bern) is operated at the Anton de Kom University of Suriname in Paramaribo and measures continuously since mid of December 2006. The sensor consists of two channels at frequencies of 21 and 35 GHz to observe the integrated water vapour content and the liquid water path. The results of two years of microwave data using statistical retrieval algorithms based on local sonde profiles which are available every other week at Paramaribo are shown.

Project

Aim of the radiometric measurements is to obtain tropospheric parameters: **Integrated Water Vapor** (IWV) and **Integrated Liquid Water** (ILW) which are observed since Dec. 2006 at the tropical site Paramaribo (6N/55W) in **Suriname**, South-America, using two microwave channels at **20.9 GHz** and at **35.0 GHz**. This site is ideally suited for the study of the dynamics of atmospheric processes as the ITCZ passes twice a year.

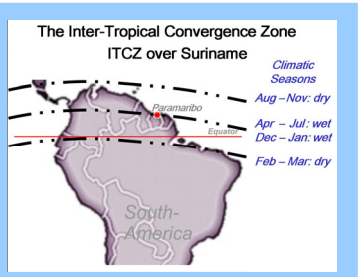


*Fig.1: The site of the **TRARA** observations*

Linear retrieval

The TRARA instrument is a Dicke radiometer at which calibrated brightness temperatures T_b are obtained by hot/cold measurements. **Zenith opacities** are calculated for each frequency channel (21/35 GHz) using

$$\tau = \cos\Theta \cdot \ln\left(\frac{T_c - T_m}{T_b - T_m}\right) \quad (1)$$

where Θ is the zenith angle, Tc the cosmic background, and T_m the effective mean temperature of the atmosphere [1].

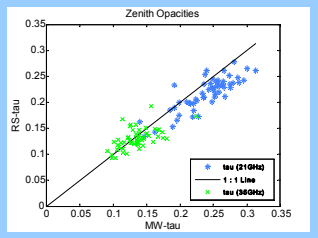
The linear dependence between τ and water vapor (IWV) or liquid water (ILW) leads to the best-fit models

$$IWV = B_0 + B_1 \cdot \tau_{21} + B_2 \cdot \tau_{35} + B_3 \cdot T_S + B_4 \cdot D_S + B_5 \cdot V_S$$

$$ILW = C_0 + C_1 \cdot \tau_{21} + C_2 \cdot \tau_{35} \quad (2)$$

where T_S is the air temperature, D_S the dry-air density, and V_S the water-vapor density at the surface.

Comparison with forward model based on sonde profiles



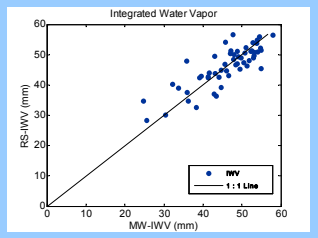


Fig.2: Opacity simulations based on radiosondes (RS) and measured by the microwave sensor (MW) and integrated water vapor using the fit model (eq. 2).

Analysis of TRARA IWV is done by a **linear statistical retrieval** with coefficients derived from **forward calculations** using the model of Rosenkranz [2].
56 sonde humidity profiles of the on-site station measured in 2007/08 between 12 and 16 UT are used as the model input. Comparison is with correlated TRARA data (12-18 UT) using median values (see also Fig. 3).

Seasonal variability

Continuous two-year observations of integrated water vapor near the equator are performed by microwave radiometry.

Results:

- high day-to-day variability of the water vapor columns
- both years show similar long-term behavior
- correlation with ITCZ (wet and dry seasons) are observable
- retrieved IWV median agrees well with IWV derived from humidity profiles of sonde data
- Frequent outliers of the mean values (not observed in the median) are due to occasions when rain hits the window.

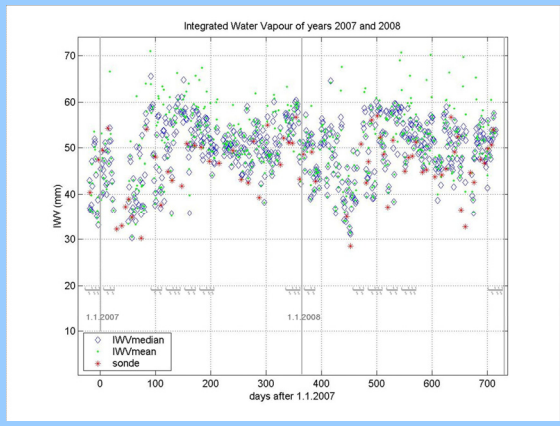


Fig.3: Columns of water vapor (IWV) measured by TRARA and derived from ozone sonde data using relative humidity profiles.

Conclusion

Tropical columnar water vapor (IWV) measured by the 2-channel radiometer TRARA is derived from comparison with simulated data based on sonde humidity profiles above Suriname. First results are promising to continue monitoring tropical water vapor and other parameters characterizing the ITCZ.

References

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Acknowledgement

We gratefully appreciate Ge Verver (KNMI / Netherlands) and Cor Becker (MDS / Suriname) for providing sonde profiles [3] and meteorological data.