# Boundary layer observations in West Africa using a ground-based 14-channel microwave radiometer

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In the frame of the AMMA project (African Monsoon Multidisciplinary Analyses), the Universities of Bonn, Munich and Cologne deployed a 14-channel microwave radiometer (HATPRO) in Nangatchori (Benin, 9.7°N, 1.7°E).

The HATPRO (Humidity And Temperature PROfiler) microwave radiometer continuously measures thermal emission by atmospheric components (water vapour, oxygen, cloud water). The thermal emission is expressed as brightness temperatures.
The radiometer comprises 14 channels in 2 frequency bands. 7 frequencies are located along the high-frequency wing of the water vapour absorption line at 22.235 GHz, and 7 channels are located along the low-frequency wing of the oxygen absorption complex around 60 GHz.
Profiles of water vapour and temperature as well as integrated water vapour and liquid water path can be derived from the measurements. High receiver stability and low noise level of HATPRO allow - under assumption of horizontal homogeneity – the exploitation of brightness temperatures for temperature retrieval at relatively opaque frequencies under several elevation angles from 90 to 5 degrees. This angular information is added to the spectral information around 60 GHz and improves retrieval performance in the lowest 1500 m significantly (error <0.5 K). Therefore, the evolution of night-time temperature inversions and other boundary layer phenomena can be observed with high vertical as well as high temporal resolution.

Besides HATPRO, a lidar ceilometer CT25K and a low-power vertically observing Doppler radar (Micro Rain Radar MRR) were operated from January 2006 to January 2007. The overall data availability over this period is about 80 % for HATPRO and 90 % for the ceilometer and the MRR. In combination with additional surface meteorological data, co-located wind profilers and precipitation radars, these instruments proved to be very suited to describe the lower troposphere over Nangatchori in detail.
The one-year deployment of these instruments also provides a good overview of the annual cycle of various atmospheric parameters. In addition, the high temporal resolution of these measurements compared to radiosondes allows the analysis of diurnal boundary layer development and the passage of fronts. With this unique dataset it is possible to obtain a completely new insight into processes in the lower atmosphere over West Africa.

One special feature which could be observed by HATPRO was the diurnal cycle of the ITD (Inter-tropical discontinuity) during the monsoon onset phase.
The annual cycle of the ITD is a crucial process for the West African climate system. The ITD marks the border at the surface between dry harmattan air to the north and the moist monsoon air to the south. The northward move of the ITD preceding the monsoon onset causes the advection of moist air in the lower troposphere into still very dry areas. It is assumed that this low-level moisture transport is a key factor for the monsoon system in West Africa.
As a result of these temporally highly resolved measurements, it was possible to observe a distinct diurnal cycle of the ITD position. During night-time a sharp low-level front which divides moist and relatively cool air masses to the south and dry and hot air masses to the north, moves northward with a speed of about 12 $ms^{-1}$. This flow is rather shallow (< 1 km deep), but completely changes the atmospheric conditions of this layer. E.g. HATPRO measurements show a temperature drop in 200 m above ground of up to 7 K within 10 minutes, associated by an increase in IWV of > 5 $kgm^{-2}$.

This presentation will consist of statistical analyses of these events, comparisons with regional model simulations as well as case studies combining different instruments. Additionally, the statistical analysis of boundary layer parameters, such as temperature and humidity profiles, integrated water vapour, and cloud liquid water content for the whole year 2006 will be discussed.