

Press Release

Chasing Clouds in the Caribbean

Scientists from Leipzig examine Trade Wind Cumuli by use of a Helicopter

Barbados/ Leipzig. In April, German scientists perform a measurement campaign that aims at examining trade wind cumulus clouds in the Caribbean. Goals of the campaign are to understand details of the formation of low level cumulus clouds and to examine how these processes are influenced by atmospheric aerosol particles. These issues are of great importance for gaining understanding with respect to the interaction of clouds and climate. The German Science Foundation (Deutsche Forschungsgemeinschaft (DFG)) and German and Saxonian government are therefore funding the project with a total of 250 000 Euro.

A first measurement campaign on the Caribbean island of Barbados already took place in November 2010 as a cooperation between the Leibniz-Institute for Tropospheric Research (IfT), the Institute for Meteorology of the Leipzig University (LIM) and Météo-France/GAME and Scripps Institution of Oceanography. The measurements in April will add three more weeks of data to the already existing dataset. The measurements done in 2010 already managed to obtain the most precise examinations of single clouds worldwide, made possible by the use of newly developed and improved instrumentation as a particle counter and a cloud condensation nucleus counter in direct combination with radiation measurements. The experiment is combined with observations done by the Max-Planck-Institute for Meteorology in Hamburg, which recently has built a long-term observation station on Barbados.

Trade wind clouds are ubiquitous in the trade wind regions of the earth and play an important role for the transport of water vapor into the free atmosphere, and therewith also for the Earth' radiation budget. These clouds also influence the dynamics of the whole atmospheric boundary layer because they enhance the vertical transport of moisture and heat between the oceans' surface and the free atmosphere. Global models to date do not adequately account for these clouds, although they have a large influence on Earth' climate. In addition, the last IPCC report emphasized that "low level clouds cause the largest uncertainties in the climate models". Typically, there are many clouds in the trade wind region, which is connected to a moist and well mixed air layer above the ocean that extends from 300 to 800m in heights. Above that layer, there is a layer rich in clouds up to heights of about 2km. Due to the small vertical extent, clouds here only exist for a few hours, which prevents the development of much precipitation. However, when precipitation forms, surprisingly strong rain events can occur.

Barbados, being situated at the fringe of the Caribbean, was chosen as the measurement location because of the good conditions it offers. Starting from the 1960s, long term studies have been done on the island, by joint effort between the University of Miami and the Caribbean Institute for Meteorology and Hydrology. On Barbados, stable trade winds regularly arrive from the east. The island is the eastern most of the Caribbean islands, and as the winds come in across the Atlantic, there are (except for ships and airplanes) no sources for manmade pollution for thousands of kilometers upwind of the island. Seasalt particles have the largest potential for influencing cloud properties by acting as cloud condensation nuclei, directly followed by dust particles from the Sahara that are carried across the Atlantic all the way from Africa.

The first measurement campaign took place in November, because the risk for being hit by a hurricane or strong rain events is already reduced compared to the summer months; and

because typical trade wind cumuli are abundant during that time of the year. “And then we were hit by hurricane Tomas during our preparations for the campaign – this was the first hurricane that really hit Barbados in decades. But we were lucky and did not encounter real damage, neither the instrumentation nor the four colleagues who were already on the island, preparing the campaign”, says Holger Siebert, a scientist from IfT. Satellite images had shown previously, that approximately half of Barbados is covered by clouds during that time of the year. This reliable presence of the right clouds, together with the remoteness of the location, being free of significant sources of anthropogenic pollution, were good reasons to choose Barbados as the location for the campaign. In addition, the height of the trade wind inversion was at about 1500m. Therefore, the clouds are in easy reach for the helicopter, which carries the measurement platform underneath it, on a 150m long rope. A helicopter can fly at only a fifth of the speed of airplanes, and this increases the special resolution of the measurements that the scientists can obtain. During the experiment in November, a newly developed fast particle counter could measure properties of a cloud with a spatial resolution of less than one meter. This new measurement technique was used in airborne measurements for the first time, here.

It is exactly this kind of measurements for which ACTOS (Airbone Cloud Turbulence Observation System) has been developed in Leipzig. ACTOS is a carrier for instrumentation that has been used to do measurements with a high spatial resolution in clouds beginning in the year 2000. ACTOS carries a large number of different, sometimes even newly developed, scientific instrumentation. During the campaign in November 2010, many different important parameters were measured simultaneously and with a very high spatial resolution for the first time. Among these sensors were a miniaturized cloud condensation nucleus counter developed by Greg Roberts and SMART-Helios, a radiation sensor that had been developed by the Leipzig Institute for Meteorology (LIM). SMART-Helios was located along the rope, between the helicopter and ACTOS. “It is unique that we could get measurements from within and above the clouds simultaneously, when ACTOS was inside a cloud and SMART-Helios above it. To do this without ACTOS, one would need two airplanes that fly exactly above each other, which practically is very difficult to do”, explains Holger Siebert. Additionally to sampling data with ACTOS, also ground based measurements are a part of the Barbados measurement setup. These data will be used to characterize the atmospheric aerosol continuously during the duration of the campaign, and they will give information about the comparability of data collected on ground with that collected at greater heights.

“The local authorities were skeptical about our activities in the beginning, but then they truly supported us. Also the flight control trusted us tremendously. We managed to quickly prove that ACTOS take-offs and landings were safe, despite the strong prevailing winds on the island. Although we were situated close to the Barbados international airport, there were almost no time delays during our flights. We had two pilots with us, one being a German whom we already knew from many ACTOS campaigns in Europe, the other one having been sent from the Canadian Owner of the helicopter. They flew 17 research flights in total, in November, and all take-offs and landings were observed by many local people from just outside the fence”, says Birgit Wehner from IfT. “We are convinced that our use of the unique measurement platform ACTOS together with the examinations of the radiation properties of clouds in the trade wind region will advance our knowledge about the basic cloud processes quite a bit.”

The number of condensation nuclei – aerosol particles in the size range of about 100 nanometers – is of great importance for the formation of clouds and radiative properties, but it is unlikely that they are the main factor controlling the development of precipitation of

these tropical clouds; at least that the scientists expectation. "It is likely that turbulent processes cause large droplets to collide and to form even larger droplets. There are not many condensation nuclei in the tropical marine air around Barbados, therefore the water that condenses in the clouds is distributed among fewer but therefore larger droplets. And then collisions cause the droplets to grow even faster and to enable them to reach the size of precipitation droplets", Holger Siebert tells us. "For precipitation, there is a big discrepancy between results of models and observations that still cannot be explained. Besides the formation of precipitation, also the role of trade wind cumuli for the global water cycle has not been examined sufficiently." Evaluation of the data that are obtained during the Barbados campaigns will go on for months, even up to years. Subsequently, these data will be used in cloud models which are operated by the Max-Planck-Institute for Meteorology in Hamburg and which are highly relevant for modeling the Earth' climate.

Links:

ACTOS:

http://cloudlab.tropos.de/actos/ACTOS_ger.html

SMART-HELIOS

http://www.uni-leipzig.de/~strahlen/web/research/de_index.php?goto=helios

Barbados-Observatory of the MPI Hamburg:

<http://www.mpimet.mpg.de/en/wissenschaft/atmosphaere-im-erdsystem/initiativen/barbadosstation.html>

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<http://www.leibniz-gemeinschaft.de>