# Events of increased particle number concentrations around trade wind cumuli near Barbados

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Beside numerous measurements at ground-based stations, new particle formation has been occasionally observed in higher altitudes of the troposphere. However, such measurements are rare and thus the relevant processes and meteorological conditions under which particle formation and growth occur are still not completely understood.

In November 2010 and April 2011 the CARRIBA (**C**loud, **A**erosol, **R**adiation, and Tu**R**bulence in the trade w**I**nd regime over **BA**rbados) campaign (Siebert et al., 2012) has been performed to observe the role of aerosol particles within the life cycle of trade wind cumuli. During these campaigns more than 30 research flights using the helicopter-borne platform ACTOS (Airborne Cloud and Turbulence Observation System) have been done. For measuring aerosol particles a new FastCPC (Wehner et al., 2011) has been implemented on ACTOS to measure the total particle number concentration *N* with a time resolution of 10 Hz. The aerosol particle number size distribution from 6 nm to 2.5 µm was measured using an SMPS (designed by TROPOS) and an OPC (Model 1.129, Grimm Aerosol Technik, Ainring, Germany). Furthermore, ACTOS contains various instruments to measure cloud properties and thermodynamic parameters, such as temperature, humidity and wind vector.

**Results & Discussion**

The flight pattern of the individual flights started usually with a vertical profile over the sea east of the island of Barbados. After that ACTOS was usually carried to a field of shallow cumuli with typical cloud cover of 10 to 30%.

During individual flights, *N* was nearly constant around clouds about a few hundred $cm^{-3}$. During approximately 70 % of all flights one or more events with significantly increased (more than a factor of 5) values of *N* have been observed. These events were often connected to clouds, i.e. the number concentration increased close to cloud edges. However, in a few cases there was no cloud influence visible.

Figure 1 shows an example for increased particle number concentrations near cumulus clouds. The liquid water content (LWC) is used as cloud indicator. Here, the background value of *N* is around 300 $cm^{-3}$, while some peaks reach values above 4000 $cm^{-3}$ near a cloud. Anthropogenic pollution as particle source can be excluded because the concentration of $CO_2$ did not show any increase in these regions.

Figure 1 shows no obvious correlation between specific humidity *r* or vertical wind speed *w* and observed increased particle number concentration. This is similar to most other cases and a more detailed analysis needs to be done.

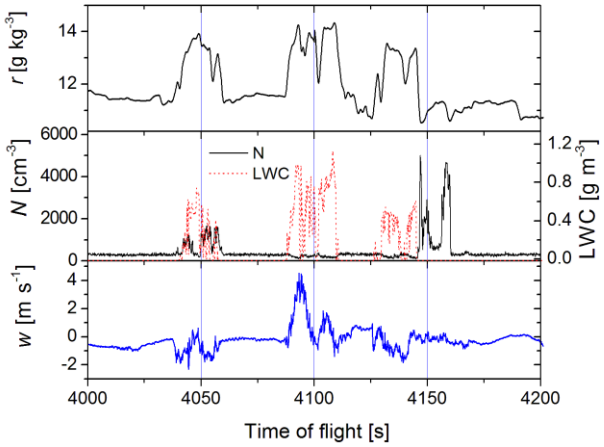


Figure 1. Time series of specific humidity *r*, total particle number concentration *N*, liquid water content LWC, and vertical wind speed *w*.

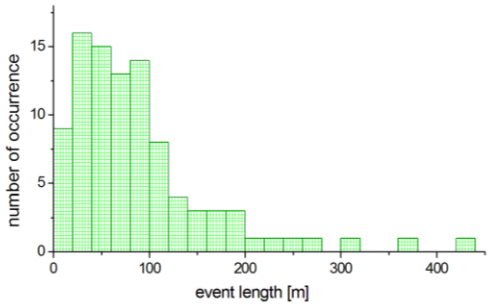


Figure 2. Length of events of increased *N*.

After a quality check, 95 events of increased particle number concentrations have been detected. Most of them occur close to cloud edges (~95%) others without any cloud nearby. More than 50% of them lasted between 1 and 5 s corresponding to a horizontal extension between 20 and 100 m. The detection of such small regions was possible due to the combination of the low true airspeed of 20 m/s and the fast measuring instrumentation. The implication of such particle bursts for further cloud development is not yet fully understood. In conclusion, the cloud system does not only act as a particle sink for CCN but also as a particle source. The relevance of new particle formation for the particle balance in general will be part of an on-going discussion.

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Siebert, H., et al. (2012), The fine-scale structure of the trade wind regime over Barbados - An introduction to the CARRIBA project -, *Atmos. Chem. Phys. Discuss.*, *12*, 28609 - 28660.

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