Black Carbon and aerosol absorption measurement results from global airborne campaigns

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The information on vertical and geographical distribution is a crucial requirement for our understanding the effects of aerosol absorption on radiative forcing, cloud condensation, and other phenomena which can detrimentally influence the climate. Light absorbing carbonaceous aerosols, in general, and black carbon (BC) in particular are a unique tracer for combustion emissions, and can be detected with high time resolution and great sensitivity by filter-based optical methods.

We conducted two separate flight campaigns: a circumnavigation of the world, mainly in the southern hemisphere in spring 2012 and one across the Arctic in 2013. The goal of the campaigns was a demonstration of aerial measurements of aerosolized Black Carbon (BC) and aerosol absorption with ultra-light aircraft, determination of sources of BC and the relevance of sources in the context of climate forcing. The pilot flew the aircraft around the world and to the Arctic: the flights were conducted above all seven continents and five oceans at altitudes from 3000 m ASL to 8900 m ASL. The aircraft carried a specially-developed high-sensitivity miniaturized dual-wavelength Aethalometer, measuring BC concentrations with very high temporal resolution (__, 2012; Močnik et al., 2015).

The BC concentrations and aerosol absorption measurements are the first ever over such a large area at altitude. In the regions with high concentrations, measurements of the dependence of the aerosol absorption on the wavelength yielded the aerosol absorption Angstrom exponent. Results indicate that aerosols produced during biomass burning can be transported to high altitude in high concentrations. We calculate that the models assuming a simple linear relationship between BC concentration and forcing underestimate the direct forcing by up to a quarter in comparison to observations. This is an important experimental observation adding to the attempts to reconcile the observations and models (Samset et al., 2014; Bond et al., 2013). Our observations constrain this uncertainty and provide some information on the regional extent of the effect.

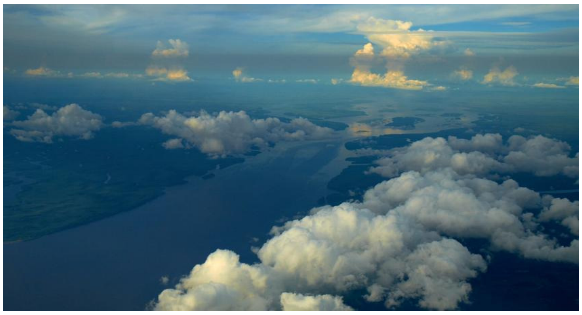

Figure 1. A layer of soot over Congo River.

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