Influence of vertical transport on the mixing state of black carbon at the high-alpine Jungfraujoch site

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Atmospheric black carbon (BC) aerosol particles are mostly emitted by anthropogenic combustion processes. They are a concern due to their adverse effects on human health and their contribution to climate warming (Shindell *et al.*, 2012). Climate-relevant BC properties such as the mass absorption cross-section, cloud condensation nuclei activity and ice nuclei activity depend on the mixing state of BC. BC particles are often emitted with almost no coating and atmospheric aging processes such as condensation and coagulation result in acquisition of coatings with other aerosol components.

In this study we investigated the mixing state of BC particles observed at the high-alpine research station Jungfraujoch (3580 m asl) in the Swiss Alps. A single particle soot photometer (SP2; Schwarz *et al.*, 2006) was applied for quantitative detection of BC mass in individual particles using laser-induced incandescence. The coating thickness of BC particles is determined by comparison of the optical particle diameter (derived from the light scattering signal) with the BC core diameter (derived from the incandescence signal).

An example of the BC properties observed at the Jungfraujoch is shown in Fig. 1 for two days in summer 2010. The green shading indicates times when the Jungfraujoch was exposed to free tropospheric (FT) air, the pink shading indicates times with distinct influence from injections of the planetary boundary layer (PBL), and the grey shadings indicate local pollution from a snowcat. The arrival of PBL influence results in an increase of both BC particle number concentration (Fig. 1A) and BC mass concentration (Fig. 1B) by about one order of magnitude, while the number fraction of BC-containing particles (mass equiv. BC core diameter D_{MEV} > 70 nm) to purely scattering particles (optical diameter > 125 nm) remains unchanged (Fig. 1A). Fresh snowcat exhaust can be identified by a massive increase of BC-containing particles, while the concentration of purely scattering particles remains almost unaffected. Fig. 1C shows the median coating thickness ($\Delta_{coating}$) of BC cores with $D_{MEV} \approx 200$ nm. BC from the snowcat exhaust is uncoated within experimental uncertainty. A substantial coating thickness of $\Delta_{coating} \approx 60$ nm is observed for FT air and PBL influence results in a slight decrease of the coating thickness to $\Delta_{coating} \approx 40$ nm. The latter value is substantially larger than that of fresh pollutions in urban areas (e.g. Laborde *et al.*, 2012), thus indicating that the time scale for the acquisition of a substantial coating is shorter than the typical transport time from the BC source to the Jungfraujoch.

The whole data set covering 1.5 months will be used to investigate whether the coating thickness difference between FT air and PBL influenced air reported in Fig. 1 is generally representative. The influence of coating thickness variations on the mass absorption cross-section of the BC particles will also be addressed.

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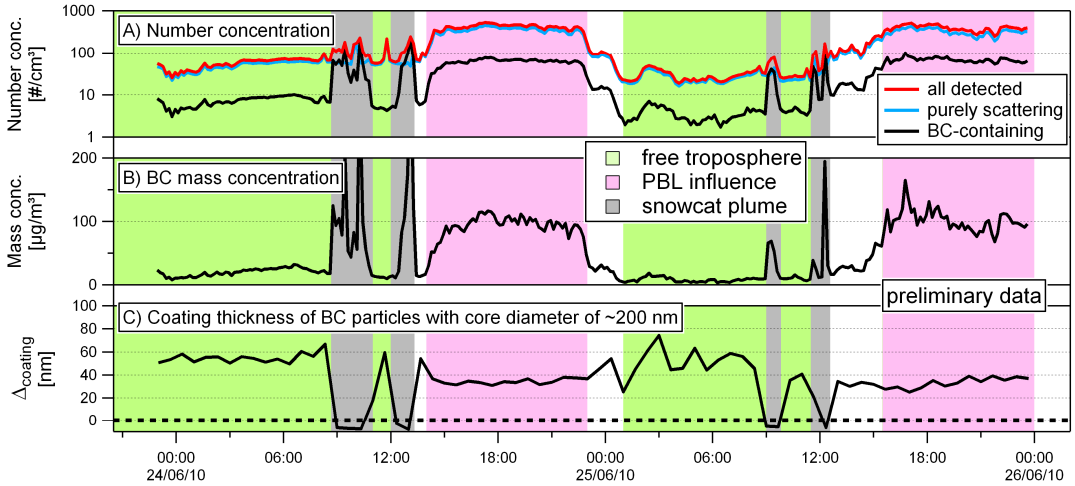

Figure 1: A) Number concentration of BC-containing, purely scattering and all detected particles, shown on a logarithmic scale. B) BC mass concentration. C) Coating thickness of the BC particles with non-BC aerosol components.