Black carbon as a strong light absorber in the Arctic during springtime

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Keywords: Arctic, black carbon, optical properties, radiative forcing
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The Arctic atmosphere is each year affected by the so-called Arctic haze occurring in spring. One of its particulate components is black carbon (BC), which is considered to be an important contributor to climate change in the Arctic region. The radiative forcing due to BC in the Arctic depends on two mechanisms: aerosol radiation interaction in the atmosphere and in the snow. On the global scale these two effects correspond to around +0.60 W m^{-2} and +0.04 W m^{-2}, respectively. The long-term variability of equivalent BC (eBC) concentration was monitored with filter-based instruments at the Zeppelin research station. Maximum monthly concentration of 80 ng m^{-3} was found in spring (Eleftheriadis *et al.*, 2009). Although the radiative forcing depends on the optical properties of the BC particles, no related full investigation has so far been conducted in the Arctic. The optical properties depend on size, shape, geometry, and mixing state with other non-absorbing species. In fact, BC internal mixing might lead to an absorption amplification of a factor 1.5 (Bond et *al.*, 2006) while radiative forcing by ~60% (Adachi *et al.*, 2010) compared to bare BC particulate. The goal of this work was to investigate the optical properties of aerosol during the Arctic haze period and to focus on the BC mixing state in order to assess its impact on Arctic radiative forcing.

A single particle soot photometer (SP2) was used to determine the mixing state of individual refractory BC (rBC) particles. The measurements took place in Svalbard at the Zeppelin station (474 m asl) during March and April 2012. By default, the Aethalometer uses an internal conversion factor of 16.6 m^2g^{-1} (at λ=880 nm) to infer the eBC mass concentration from the measured attenuation signal. This conversion factor accounts for the mass absorption cross section (MAC) of the BC particles and the effects of multiple scattering in the filter matrix. Despite it is widely used, high degree of uncertainty is still present nowadays. By comparison with the SP2 reference measurement, we investigated a site specific conversion factor of for the Svalbard aerosol The Ångstrom exponent (average of 1.4) and the aerosol optical depth (average of 0.1) depicted an aerosol haze dominated by relatively small particles and moderate opacity, which is in contrast to the smoke event observed in 2006 by Tunved *et al.* (2007). A negative Ångstrom exponent difference parameter and a small asymmetry parameter confirmed that the majority of particles were in the fine mode. The single scattering albedo ranged between 0.85 and 1 underlining a dominant scattering behaviour of the aerosol. The SP2 measurements showed that the rBC mass concentration oscillated around an average of 33 ng m^{-3} with the mass size distribution centred around 240 nm. The analysis of the single particle mixing state revealed that 65 % of the rBC cores, with a diameter of 140-280 nm, presented a non-absorbing coating with a median coating thickness of 45 nm (Figure 1).

Microphysical BC properties are used to assess the change in optical properties of uncoated and coated cores and the relative impact of the mixing state on the radiative forcing in the Arctic.

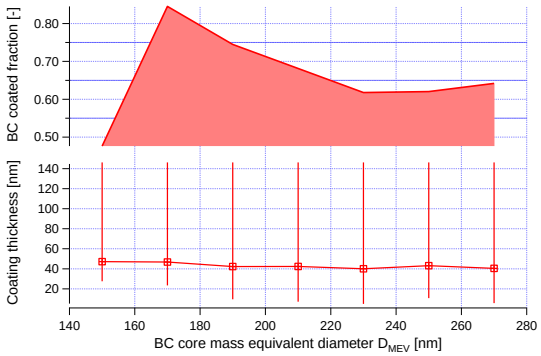

Figure 1 Mixing state of the rBC particles as a function of rBC core size. Top panel: fraction of internally mixed rBC cores with core-shell geometry. Bottom panel: median of coating thickness

This work was supported by the "Agence Nationale de la Recherche" under the contract ANR 2011 Blanc SIMI 5-6 021 04 and a grant from Labex OSUG@2020 (Investissements d'avenir – ANR10 LABX56).
Financial support was provided by ERC (grant 615922-BLACARAT).

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