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Supplement of

Effects of mixing state on optical and radiative properties of black carbon in the European Arctic

Marco Zanatta et al.

Correspondence to: Marco Zanatta (marco.zanatta@awi.de)

Supplementary Material

Origin of air masses

Back-trajectories were computed using the NOAA HYSPLIT model with a 1° x 1° resolution. The model was based on the GDAS meteorological data and run for Zeppelin altitude using twice daily 3-days back-trajectories at 00:00 and 12:00 UTC. Our Sampling period was mainly affected by air masses originating from high latitudes, with periodic influence from northern Siberia.

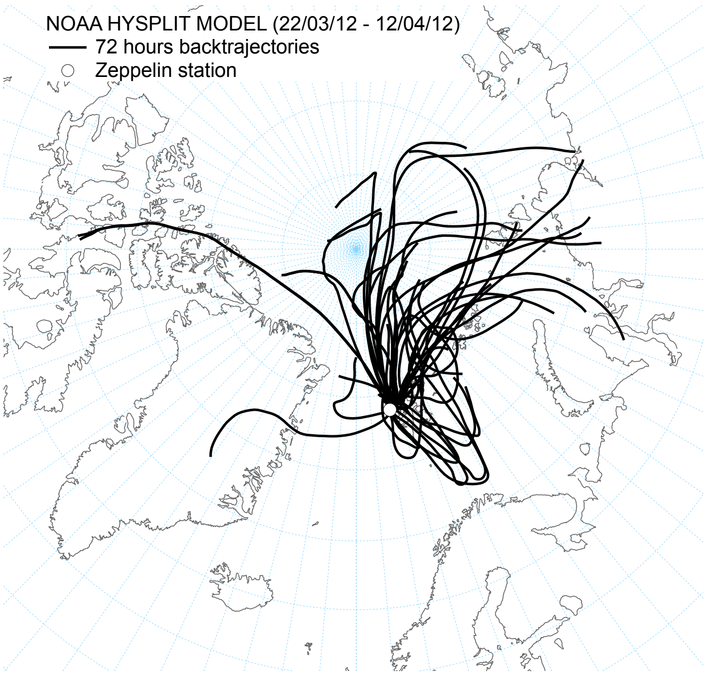

Figure S1 HYSPLIT back-trajectory analysis for Zeppelins station (78.91N 11.88E ; 475 m asl). 72 hours back-trajectories calculated two times a day (00:00 and 12:00 UTC) between the 22/03/2012 and the 12/04/12.

Aerosol absorption exponent

The aerosol absorption dependence on light wavelength was parametrized trough the Ångström absorption exponent (AAE). The latter was calculated by fitting with power function the campaign averaged absorption coefficient at the three wavelengths 370, 590 and 880 nm and quantified as 0.82.

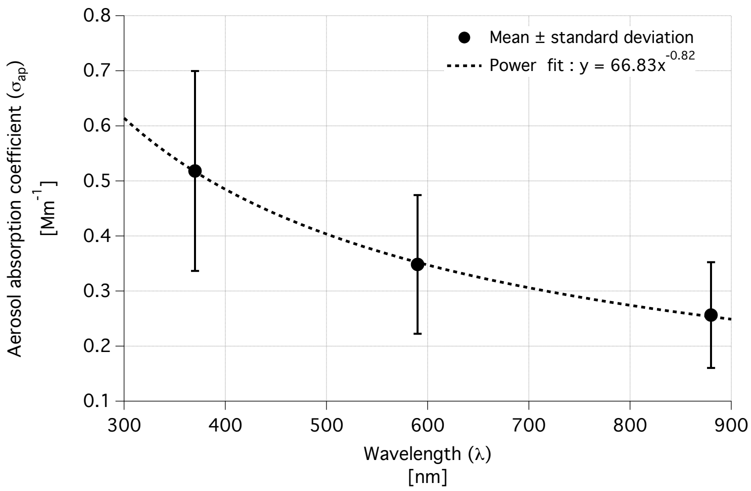

Figure S2 Campaign averaged aerosol absorption coefficient measured at three different wavelengths (370, 590, 880 nm) by the aethalometer instrument. Error bars display the standard deviation.

ARI sensitivity to aerosol and environmental characteristics

The dependency of the aerosol radiative forcing difference (ΔRF_{ARI}) on aerosol characteristics (BC load and vertical position) and environmental conditions (solar zenith angle and surface albedo) is investigated here. For each scenario only one variable is changed at a time. Standard conditions involve an aerosol load as described in Section 3.4.1, an aerosol layer located between 0 and 1 km agl, a solar zenith angle of 77°, a highly reflective surface representative of snow, and a constant asymmetry parameter representative of the dry aerosol.

Increasing the total BC burden leads to an increase of absorption enhancement and thus ΔRF_{ARI} (Figure S3a). The impact of absorption enhancement showed a positive correlation with the total BC column load (Figure S3a). The latter was calculated from the absorption component of the AOD (AAOD) by means of the MAC_{rBC} estimated in Section 3.3.1. The vertical position of the aerosol layer did not influence significantly the ΔRF_{ARI} (Figure S3Figure S3b). Considering the environmental variables, the absorption enhancement was shown to be attenuated at high zenith angles; this is due to a shorter light path reducing the aerosol radiation interaction (Figure S3Figure S3c). The surface albedo also affects ΔRF_{ARI} (Figure S3Figure S3d): at low reflective surfaces, such as the open ocean, the impact of absorption enhancement due to lensing effect on the radiative forcing might be negligible, while being enhanced over ice and snow-covered grounds. No significant change in the ΔRF_{ARI} was observed considering higher asymmetry parameters potentially induced by high relative humidity (Figure S3, Figure S3e).

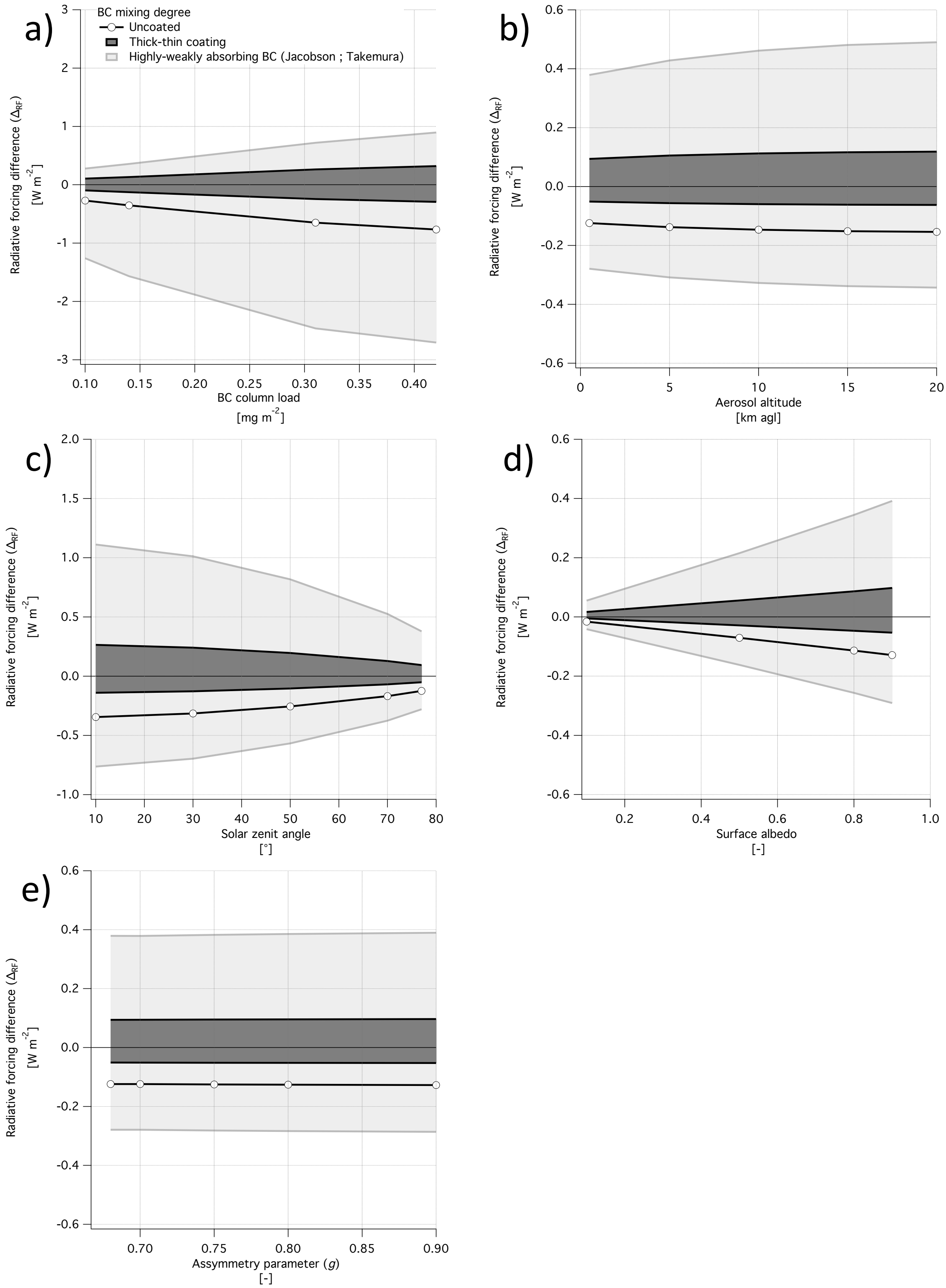

Figure S3. Sensitivity of the simulated radiative forcing difference to when a single aerosol property or other model parameters is varied while keeping all other parameters fixed at the values of the base case scenario: a) total aerosol and BC burden at fixed SSA; b) altitude of the aerosol layer; c) solar zenith angle; d) surface albedo; e) aerosol asymmetry parameter. The simulations for the base case MAC_{rBC} corresponding to the observed "medium" coating thickness fall by definition on $\Delta RF_{ARI} = 0$ W m^{-2}.