Supplement of Atmos. Chem. Phys., 23, 7955–7973, 2023
https://doi.org/10.5194/acp-23-7955-2023-supplement

Supplement of

Airborne investigation of black carbon interaction with low-level, persistent, mixed-phase clouds in the Arctic summer

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CLOUD DESCRIPTION

The boundary layer was well defined by a marked inversion, similar to Brooks et al. (2017), located at 400 - 500 m asl, where potential temperature (T_P) increased by approximately 269-273 K to approximately 277-282 K (Figure S1a). The cumulative mean of T_P from the cloud base to the lowest sub-cloud measurement was compared with T_P calculated for each layer below-cloud. In general, the T_P difference never exceeded 0.5 K, suggesting the presence of surface-coupled clouds (Gierens et al., 2020) and the establishment of a well-mixed boundary layer (Shupe et al., 2013). A moist atmospheric layer (RH > 80%) was confined by the inversion with values up to 98-100% between approximately 200 m asl and 500 m asl, while drier air (20% < RH < 50%) was observed above 500 m asl (Figure S1b). Within this moist boundary layer, liquid droplets were observed from a maximum altitude of 500 m asl to a minimum altitude of 50-60 m asl (Figure S1c). Following the work of Sedlar et al. (2011), these cloud cases can be classified as cloud inside inversion, since the cloud top height extended above inversion-base height but below inversion-top height. Ice crystals with diameter larger than 75 μm measured with the CIP probe were observed across the cloud layer to the lowermost altitude below cloud base, indicating the presence of mixed phase clouds and, ice precipitation below cloud base during all selected flights (Figure S1d). Overall, the vertical atmospheric structure remained quite similar from 02 to 08 June, confirming the establishment of stable atmospheric conditions maintaining mixed-phase clouds in the boundary layer, as expected in Arctic summer conditions (Morrison et al., 2012). Valid measurements of cloud residuals ranged from a maximum altitude of 544 m asl on 05 June to a minimum altitude of 60 m asl on 04 June. Overall, the vertical thickness of residual measurements varied from 310 m to 435 m, accounting for a total of 197 minutes. Above-cloud observations of aerosol particles were performed above the cloud top and inversion layer in the 400-750 m altitude range. The vertical range covering the below-cloud bottom was very thin (100 - 150 m) and is considered to be representative of Arctic boundary layer impacted by mixed-phase clouds.

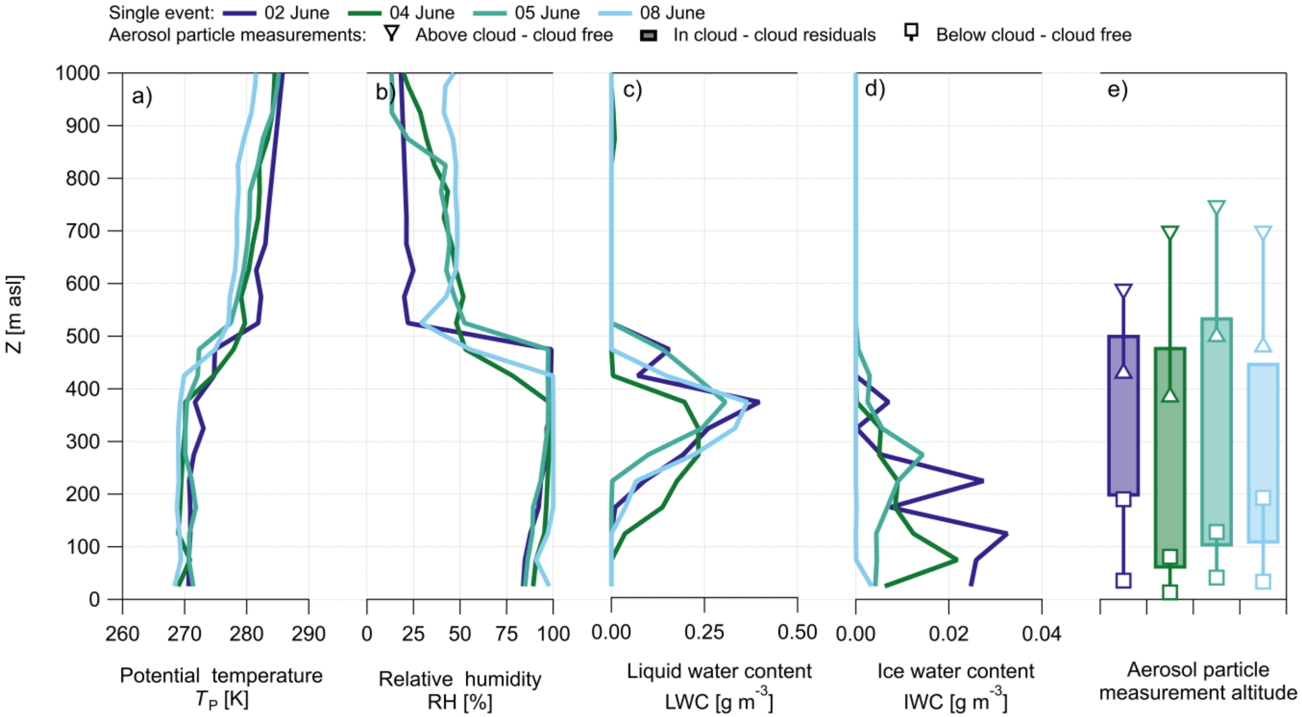

Figure S1 Atmospheric and cloud characterisation of four flights occurred on 2, 4, 5 and 8 June 2017 (ACLOUD warm period) northwest of Svalbard. Median vertical profile of: a) potential temperature, TP; b) relative humidity, *RH*; c) number concentration of droplets, N_{Dro}; d) number concentration of ice crystals, N_{Ice}; e) altitude range of aerosol particle measurement in different conditions. Liquid droplets measured with the SID-3 probe in the 5-45 µm diameter range. Ice crystals measured with the CIP probe in the 75-1550 µm diameter range. Statistics calculated for equidistant altitude steps starting at the surface (0m asl) and 50 m thick.

COATING THICKNES DISTRIBTUION

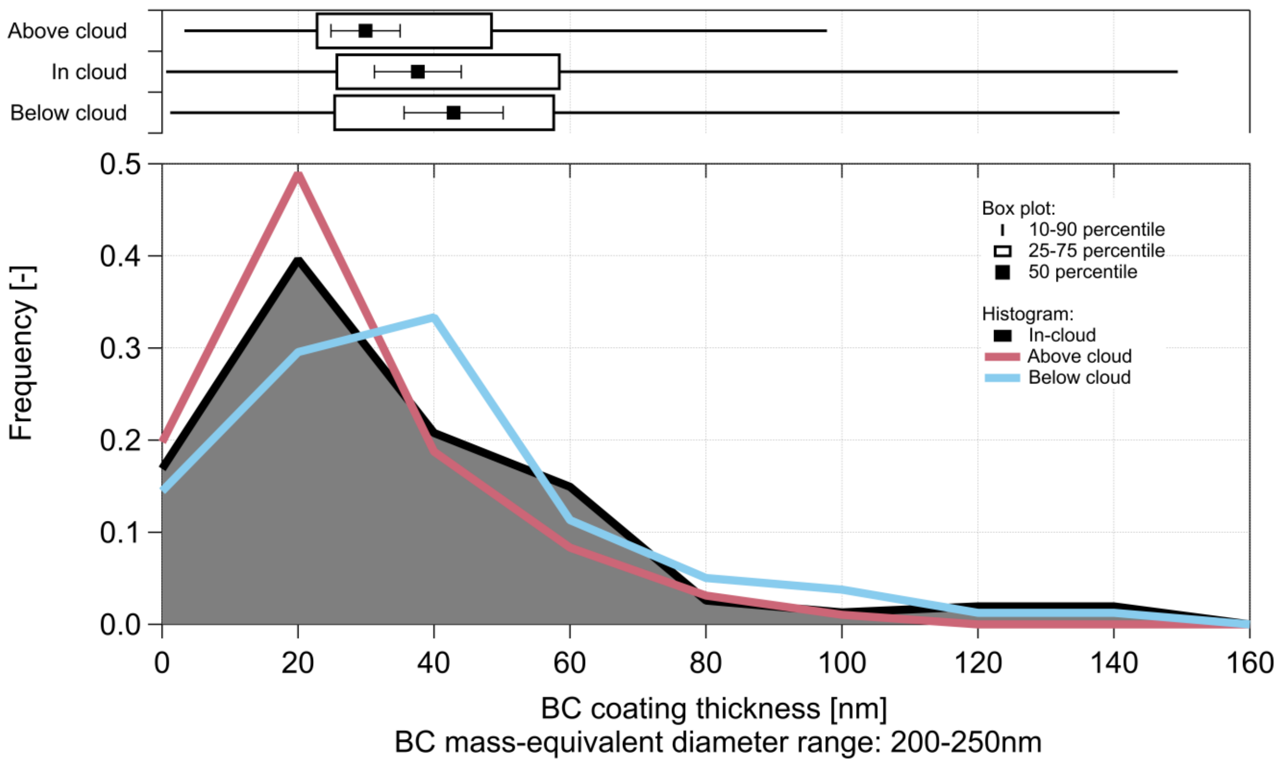

Figure S2 Coating thickness distribution calculated for BC particles with a mass-equivalent diameter in the 200-250 nm range. Coating thickness data available only for the flight occurred on 02 June 2017.

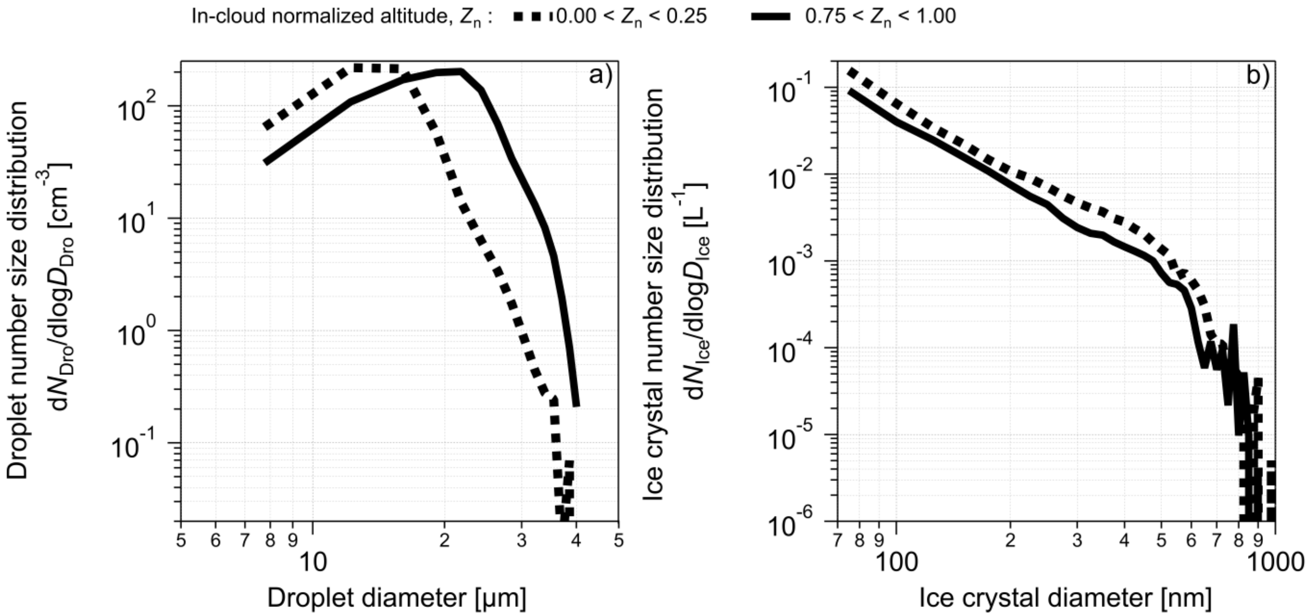

Figure S3 Size distribution of: a) liquid droplets measured with the SID-3 in the 10-45 μm diameter range; b) ice crystals measured with the CIP in the 75-1550 μm diameter range

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