



Intercontinental transport of black carbon to the Arctic free troposphere

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Black carbon has a large radiative forcing potential in the Arctic, through altering the atmosphere's radiative balance and also initiating ice melt after deposition. Here we present an analysis of aerosol data collected aboard the UK Facility for Airborne Atmospheric Measurements (FAAM) BAe-146 research aircraft during five flights in the free troposphere in the region of Svalbard in March 2013 as part of the Natural Environment Research Council (NERC) Aerosol-Cloud Coupling and Climate Interaction in the Arctic (ACCACIA) project. A number of discrete layers of pollution typical of continental emissions were detected, evidenced by black carbon (measured using a single particle soot photometer), carbon monoxide, organic matter and sulphate (measured using an aerosol mass spectrometer). These were detected at all altitudes within the free troposphere (up to 8 km) and potential source regions were investigated on a plume-by-plume basis using FLEXPART and HYSPLIT. Continental areas were identified as separate potential sources for the different plumes, with transit times of up to 12 days. East Asia showed the strongest influence, being responsible for high concentration plumes at all layers and Europe was found to be responsible for plumes in the lower to mid troposphere. North America had a somewhat weaker influence and no significant influence from Northern Russia was found. Emissions inventory data was used in conjunction with the FLEXPART potential source footprints to try to estimate the relative significance of different sources and it was found that direct emissions from human activities (e.g. transport, industry) were more prevalent than open biomass burning. Significant loadings were detected (of the order of 100 ng sm⁻³ black carbon relative to CO concentrations of around 50 ppbv) even when instrumental data and model outputs suggest that significant precipitation occurred during uplift, indicating that inefficient scavenging is taking place.