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Impact of warm air mass intrusions on atmospheric chemistry and microphysics – Observations during MOSAiC

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The Arctic aerosol and trace gas regime features strong seasonal differences. The haze season in winter is dominated by long-range transported mid-latitude anthropogenic emissions, while the cleaner summer season is characterized by more local and natural trace gas and aerosol sources. Aerosols and trace gases have been shown to be important for the Arctic radiative balance, inducing an overall net positive radiative forcing through direct radiation interactions.

Aerosols and trace gases are fundamentally different between seasons in terms of chemical composition and microphysical properties. In winter, accumulation mode particles - with a concentration between 100 and 300 cm^{-3}- composed mainly of sulfate, sodium and organics occur, and trace gases relevant for aerosol formation have very low concentrations. In summer, the aerosol number concentration is highly variable reaching from a few to thousands per cubic centimeter, in case of new particle formation. Their size distribution contains nucleation, Aitken and accumulation modes. Trace gases become more abundant, particularly in the marginal ice zone where marine microbial activity emits dimethylsulfide, which leads to the formation of the trace gases sulfuric acid and methanesulfonic acid, which in turn form secondary aerosol mass.

The transition seasons, i.e. spring and autumn, have been studied much less in terms of aerosol and trace gas chemical and microphysical properties in the past , except for ozone depletion events in spring where halogenated trace gases are predominantly involved. The transition between the two aerosol regimes is relatively short. Focusing on spring, the season is characterized by the arrival of warmer and moister air masses from the south, which transport different aerosols and trace gases up north. Cloud formation and precipitation en route have a strong impact on the aerosol number concentrations and size distribution, as well as on the chemical composition due to heterogeneous chemistry in cloud droplets.

Here, we present first results from observations of warm air mass intrusions reaching the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition in mid-April 2020. The period before arrival was characterized by persistent northerly winds, hence aged and dry Arctic air masses, where a very stable accumulation mode composed of sulfate and organics with traces of halogens was measured. With the arrival of southerly air masses, the size distribution started featuring several modes, which increased and decreased in diameter and

concentration. Moreover, the chemical composition was significantly changed, featuring methanesulfonic acid from algal blooms in the north Atlantic.