Evaluation of the cycling and re-cycling of persistent contaminants between the atmosphere, cryosphere, and ground water with their seasonal fluxes

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WP2 - In-situ component for organic contaminants, mercury and other heavy metals

Deliverable 2.4.2: Evaluation of the cycling and re-cycling of persistent contaminants between the atmosphere, cryosphere, and ground water with their seasonal fluxes

Final version

The Evaluation of the cycle of persistent organic contaminants between the atmosphere, cryosphere and ground water with their seasonal fluxes has been completed although it was not possible to fully address contaminant release into the ground water during the snow melting periods due to the COVID-19 restriction and the drastic reduction of the field activities. The results obtained from the study of organic contaminants in the surface snow pack clearly shows a seasonal deposition pattern for these compounds and a direct interconnection between the atmosphere and the surface snow pack. Cumulative PAH concentrations range between 0.76 and 37 ng/L where the seasonal trend determined (Figure 1A) can be explained by different air mass transport and by the meteorological conditions during the sampling period. The contribution of local sources prevails in the deposition of PAHs at the beginning and towards the end of the snow-sampling season. These two periods correspond to the highest concentrations of Retene (RET) registered, 97 ng/L at the beginning of the sampling season and 82 ng/L at the end of it (Figure 1C). Retene is an organic compound used to trace the presence of coal and, considering that Ny-Alesund was a coal mining town, in a first approximation we could assume that high values of RET indicate that the concentrations of PAHs could be mainly linked to local sources, vice versa lower concentrations of RET could identify predominantly long-range transport sources. Based on this evidence we can infer that the PAHs

detected in the surface snow in Gruvebadet can come from both local and long-range transport sources. The concentrations of PAHs in Winter and Spring coincide with the lowest values of RET. Therefore, during this period, the deposition of PAHs can be explained by long-range transport. PAHs concentrations start to increase in the second half of December reaching the maximum cumulative value of 37 ng/L on December 31st. This peak coincides with an increase of about 35 cm in the snowpack thickness after heavy snowfalls during the previous days (Figure 1B). According to the HYSPLIT frequency data of the back-trajectories, the air masses passed above Northern Europe and Siberia during the first half of December (Figure 2). These areas are densely populated and during winter they are sources of particulates and contamination. Moreover, every year these sources areas could be responsible for the Arctic haze phenomena occurring in Winter and Spring. During the first weeks of December, the particles coming from Eurasia and the polluted air masses probably remain in the atmosphere due to the absence of wet deposition that scavenges the impurities. During the second half of December heavy snow precipitation occurred and scavenged the impurities suspended in the atmosphere (including PAHs). The concentration of ∑PAHs increased from 10 ngL^{-1} to approximatively 30 ngL^{-1} between the 16th and the 24th of December. In January the ∑PAHs concentration decreased to 10 ngL^{-1} likely due to the effect of wind drift and erosion of the ∑PAHs enriched upper snow pack layer and the absence of snow fall associated to polluted air masses. The following period between 26th of February and 26th of April, is characterised by the increase of the mean snowpack thickness. The maximum value registered during the season was 86 cm. ∑PAHs concentrations remain in a range of 0.81 and 16.55 ng/L. The peak of the ∑ PAHs is mainly related to the high concentration of Naphthalene (9.97 ng/L) registered the 1st of April. According to HYSPLIT frequency data of the back trajectories, the air masses came mainly from the Arctic Ocean and Greenland transporting clean air and contributing to the deposition of relatively clean snow (Figure 3). The last period of sampling, between the 1st and the 13th of May, is characterized by PAHs transported from local sources as suggested by the increase in RET concentrations. Our results seem to suggest a seasonality in PAHs deposition where higher concentration of PAHs are determined during the polar night (December and January) while during autumn and spring the concentration seems to be lower but characterized by more rapid fluctuations (also connect to local meteorological conditions). Dry deposition seems to play a minor role in controlling the PAHs presence (except for Retene) in the

surface snow layer, instead, wet deposition seems to remove the organic compounds from the atmosphere and transfers them to the snow pack very efficiently.

FIGURES

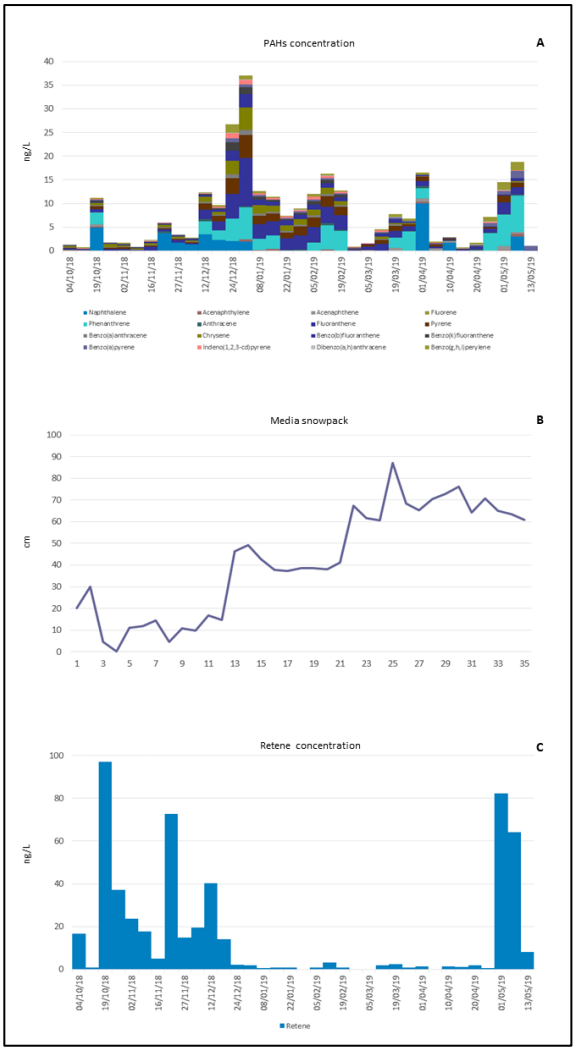

Figure 1. Cumulative PAHs concentration (ng L-1) (A), the (mean o average) snowpack height measured at the sampling site (B), and the Retene concentration (C).

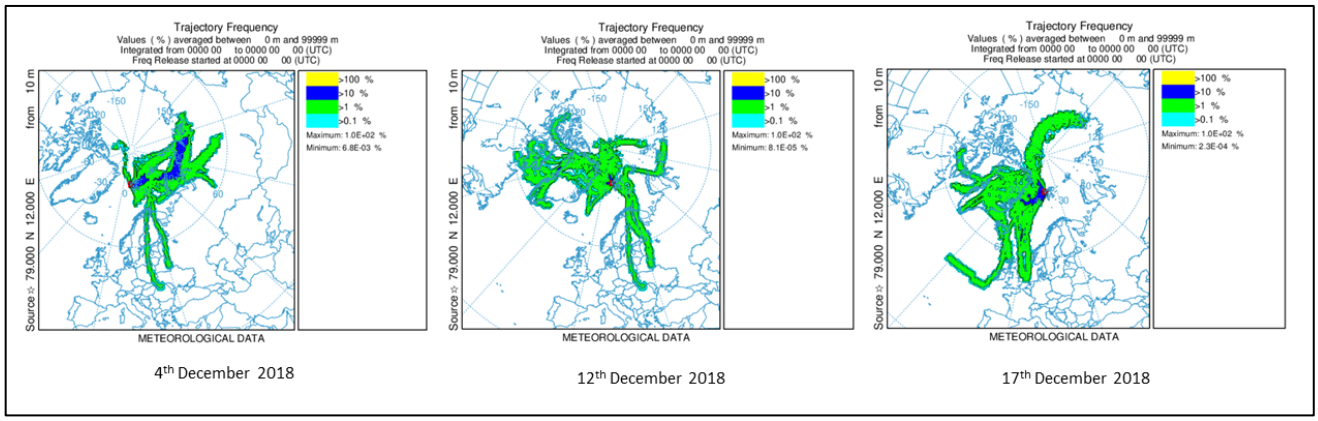

Figure 2. Hysplit frequency data of the back trajectories on the first half of December 2018

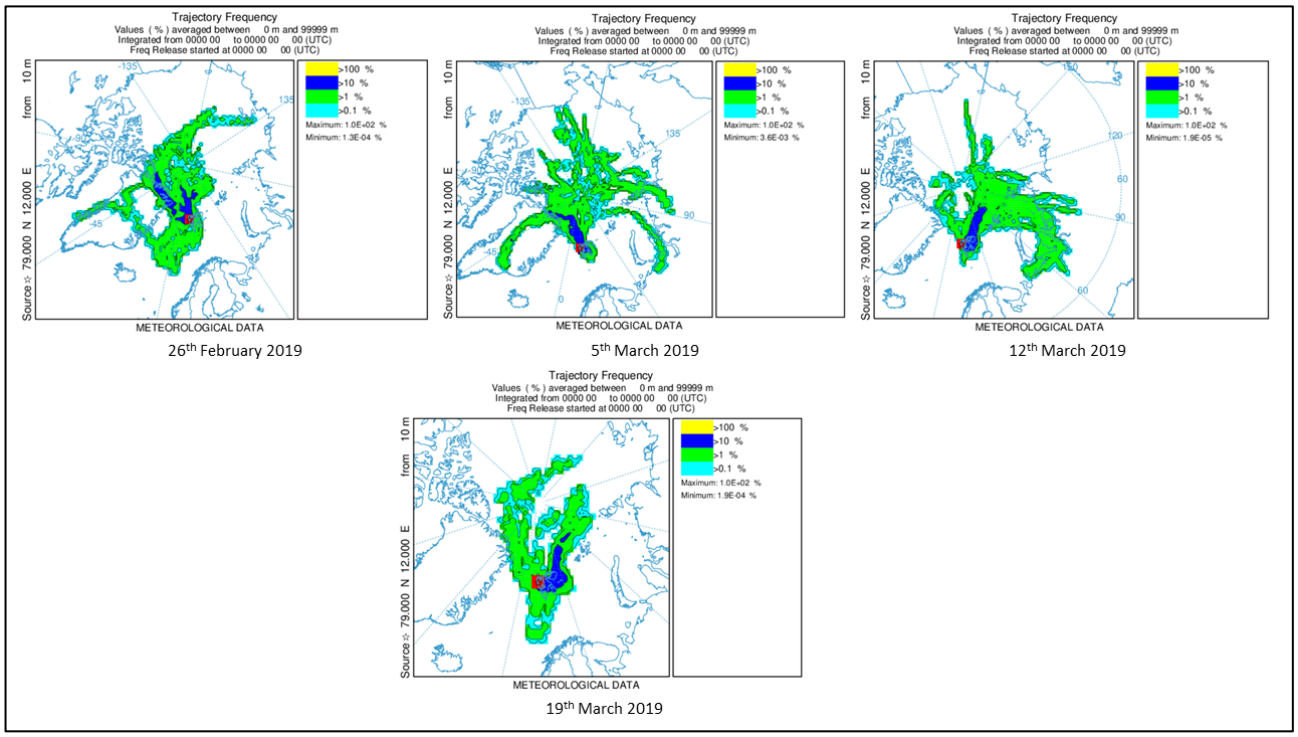

Figure 3. Hysplit frequency data of the back trajectories on the period between the 26th February and 19th March 2019