Publications of the Institute of Geophysics, Polish Academy of Sciences
Geophysical Data Bases, Processing and Instrumentation
vol. 455 (P-5), 2025, pp. 281–283
DOI: 10.25171/InstGeoph_PAS_Publs-2025-152
40th International Polar Symposium – Arctic and Antarctic at the Tipping Point, 4–7 November 2025, Puławy, Poland

Variability of Organic Carbon and Nitrogen Concentrations in the Snow Cover of a Non-glaciated Catchment in Svalbard

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1. INTRODUCTION

Arctic catchments are particularly sensitive to ongoing climate change. On Svalbard, a clear upward trend in average air temperature has been observed – reaching up to six times the global average (Migała et al. 2023). Climate warming leads to changes in the carbon and nitrogen cycles, which, as a result of cryosphere melting, may be released into surface waters (Francis et al. 2023; Gao et al. 2024; Lehmann-Konera et al. 2018).

The primary objective of this study was to examine the spatial variability of total organic carbon (TOC) and total nitrogen (TN) concentrations within the non-glaciated Fuglebekken catchment, located in close proximity to the Polish Polar Station in Hornsund (Svalbard). The study provided insight into the less well-known aspects of the cycling of TOC and TN in the environment.

2. MATERIALS AND METODHS

Snow samples were collected from the small Fuglebekken catchment, covering an area of 1.27 km^2. Samples of the surface snow cover and the entire snow profile were analyzed for TOC and TN and collected in a manner that allowed for the illustration of spatial variability in relation to snow cover depth, altitude above sea level, anthropogenic influence and the colony of the little auk (Alle alle), that nests in the spring on the mountain slopes in the northern part of the catchment (Fig. 1).

Concentrations of TOC and TN were determined using a Shimadzu TOC-L analyzer, equipped with a TNM-L module. TOC analyses were carried out based on high-temperature (680 °C) combustion with catalytic oxidation to CO_2 using a platinum catalyst and non-disper-

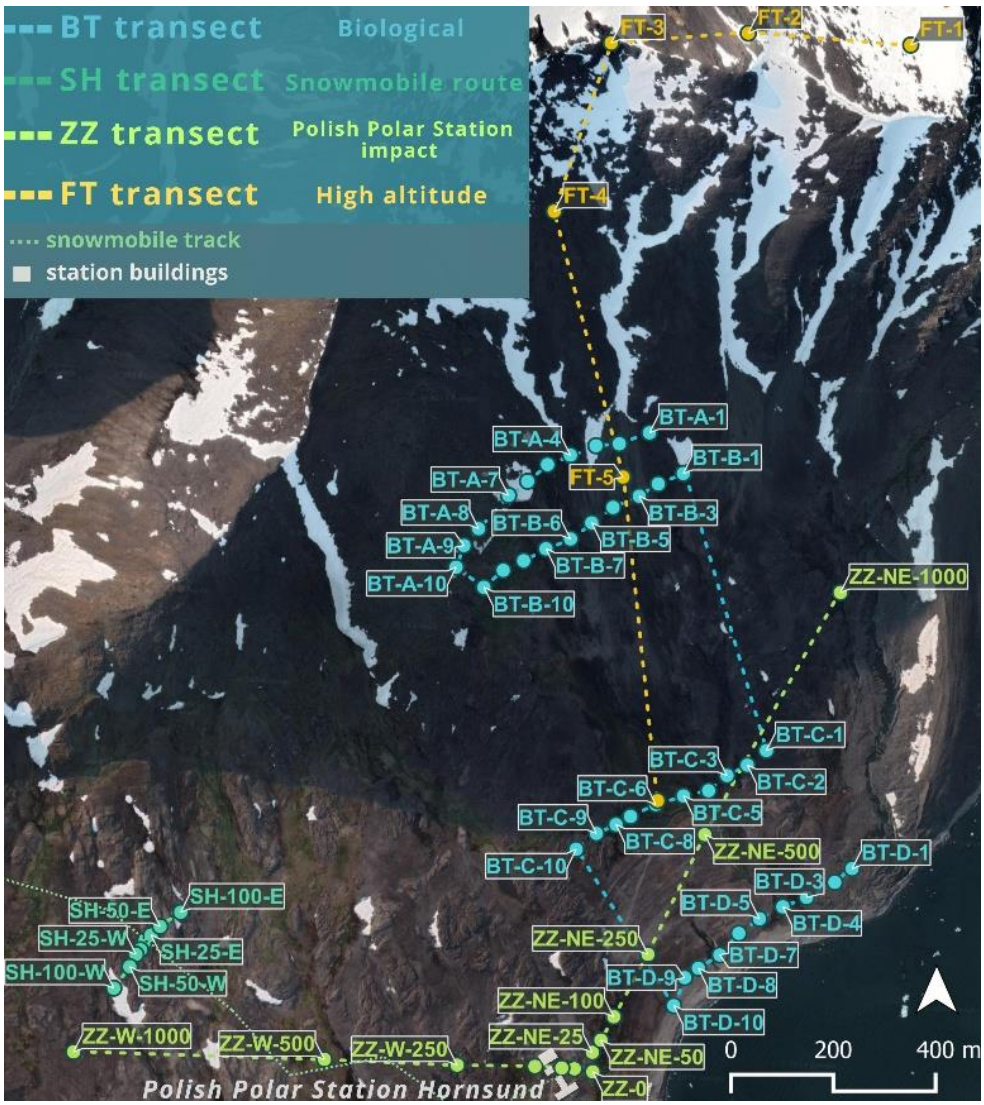

Fig. 1. Geographical distribution of sampling points within the Fuglebekken catchment area.

sive infrared detection, while TN analyses were performed by catalytic thermal decomposition (720 °C), with chemiluminescence detection. The results were analyzed in terms of spatial variability using QGIS software. Statistical significance of linear trends was tested in TIBCO Statistica^{TM} software.

3. RESULTS

The highest concentrations of TOC and TN were recorded in the nesting area of the little auk colony, with maximum values of 12.1 mg/L (TOC) and 13.0 mg/L (TN). In contrast, concentrations in areas more distant from the colony did not exceed 0.3 mg/L (TOC) and 0.25 mg/L (TN). A statistically significant ($p < 0.05$) correlation was observed between concentration levels and the distance to the bird colony (TOC: Spearman rho = –0.40, TN: Spearman rho = –0.48). For the top 5 cm of snow on 8 May, and elevation above sea level, the correlation was particularly strong for TOC (Pearson $r = 0.97$, $p = 0.001$).

A spatial analysis of inorganic nitrogen (IN), ammonium nitrogen ($N–NH_4^+$) and nitrate nitrogen ($N–NO_3^-$) concentrations was also conducted, considering the influence of biological activity and elevation. They revealed similar patterns, with the highest concentrations observed in the area influenced by the bird colony.

4. SUMMARY

The most prominent feature of the spatial variation was the high concentrations of total organic carbon and nitrogen observed in the samples collected from the nesting area of the little auk colony, which exerted the most pronounced impact on the concentration of these elements in the snow cover. An increase in concentrations with altitude (in the case of fresh snow) was also observed.

5. CONCLUSIONS

The study demonstrates that the presence and activity of biological factors can have significant impact on the snow chemistry and represent an important source of chemical compounds potentially released into surface waters, an important issue in the context of ongoing climate change and changing nutrient cycles.

Acknowledgments. We express our gratitude to the participants of the 46th IG PAS Polar Expedition and other participants of the HarSval project for their assistance during fieldwork and for creating an excellent atmosphere of cooperation. Funding was guaranteed from the EEA and Norway grants 2014–2021, predefined bilateral initiative no. 2023/43/7/ST10/00001 (project HarSval).

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Received 15 September 2025
Accepted 20 October 2025