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Weak signals of dense shelf water cascading in 2020 during a persisting phase of sporadic Atlantic water intrusions into the deep layer of the SW-Svalbard slope

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The intensifying influence of warmer Atlantic Ocean waters in the Arctic, known as Arctic Atlantification, amplifies climate change effects by accelerating sea ice melting and altering ecosystems. Long-term data series are indispensable for discerning nuances in climate changes, especially when occurring in the deep ocean. They also provide a crucial temporal foundation for accurate modeling, useful to predict future scenarios and formulate effective strategies to address the challenges of climate change.

Here, we present oceanographic data collected from June 2014 to June 2023 at mooring site S1 (76°N, 14°E, 1040 m water depth), above the continental slope on the southwestern margin of Svalbard Archipelago (Fram Strait). There, the main branch of the West Spitsbergen Current transports Atlantic Water (in the upper layer) and Norwegian Sea Deep Water (below 900 m depth) poleward into the Arctic Ocean. Site S1 strategically lies at the convergence of Atlantic waters, the Arctic Ocean heat source, with waters from Storfjorden (Spitsbergen largest fjord) and shelf waters from the West Spitsbergen continental shelf. The oceanographic mooring S1 is part of the SIOS marine infrastructure network (Svalbard Integrated Arctic Earth Observing System, https://sios-svalbard.org/), and has undergone progressive instrument improvement over time, adding data collection at the intermediate layer since the summer 2022.

We focus on exploring short-term and seasonal variations in thermohaline properties, ocean currents, and particulate fluxes recorded in the deep layer over the last nine years. This analysis is undertaken in conjunction with meteorological conditions and trends in sea ice concentration. Oceanographic mooring data together with repeated Conductivity-Temperature-Depth (CTD) casts during summer surveys, show that the period 2014-2021 was characterized by the absence of dense shelf water exported at the near bottom on the slope, probably due to a limited production of dense water in the fjords, while the wind-induced vertical mixing and the resulting internal oscillations were probably favoured. During this period, a gradual decline in sea ice cover in winter is observed in the S1 area and adjacent fjords. The only exception is the winter 2020, when the sea ice extent returned apparently to pre-2013 levels, and at 1000m depth there were weak signals of cascading of dense shelf water, probably originated in the Storfjorden polynya.

Contrary to what is clearly evident in the literature regarding the increasing propagation of Atlantic waters northwards, temperature and salinity at mooring S1 showed no, or very little, positive trends over the investigated period. However, sporadic intrusions of relatively warm and saline water into the deep layer were observed. These occur most frequently in winter and are associated with the passage of internal waves that promote turbulent mixing of intermediate Atlantic waters with deep waters, facilitating the heat diffusion into the ocean depths.