

Impact of Climate Warming on Glaciers in Central Spitsbergen, Svalbard – a 25-year Perspective

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1. INTRODUCTION

In conditions of the Arctic amplification of climate warming the most impressive landscape effect is observed in Svalbard in connection with glaciers retreat. Since the beginning of the 21st century, when GPS measurements with satisfactory precision became widely available, the number of publications appeared following the first paper on glaciers margins positions (Rachlewicz et al. 2007). The aim of the paper is to compare the results of retreat rates of glaciers and show the landscape dynamics of their marginal zones in the central part of Spitsbergen collected during the last 25 years of observations on the background of verified archive sources going back to the Little Ice Age termination.

2. RESULTS

In the cited paper the retreat of twelve glaciers near northern Billefjorden, Spitsbergen, between 2000 and 2005 was examined. Using various measurement methods, including GPS, aerial photographs, satellite imagery, and geomorphological indicators, glacier deglaciation since the Little Ice Age (LIA) climax at the end of the 19th century was presented. All glaciers have been retreating, with tidewater Nordenskiöldbreen the fastest, at an average of 35 my^{-1} , while land-terminating glaciers rates were 5 to 15 my^{-1} . The retreat rates have increased significantly in last decades of 20th century, largely due to climate warming. Factors influencing retreat include water depth at grounding line of the glacier terminating at sea, surging history, and glaciers morphology. The study generally categorized Svalbard glaciers into four types based on retreat velocities: very dynamic surging tidewater glaciers retreating $100\text{--}220 \text{ my}^{-1}$, other tidewater glaciers $15\text{--}70 \text{ my}^{-1}$, polythermal valley glaciers $10\text{--}20 \text{ my}^{-1}$, and small, cold based glaciers

less than 10 m y^{-1} . Overall, the findings highlight patterns of glacier change in response to climate and local conditions across Svalbard.

The following 20 years is exhibiting even more intensive air temperature rise and in consequence more dynamic environmental change. The inner-fiord area of central Spitsbergen is the driest part of the island and despite the rise of precipitation in warming conditions of dramatic scale, there is less of snow deposition (practically no long-term accumulation on glaciers), higher evaporation, more intensive melting, shorter period of sea-ice cover implicating higher level of heat storage, all together leading to ablation almost an order of magnitude higher than in the previously described circumstances. Some glaciers areas distinctively diminished, while some vanished completely. To complete the picture of changes in the area of glaciers coverage, in reference to Geyman et al. (2022), a larger number of archival sources in the form of rectified aerial pictures and satellite images were analyzed and earlier results were also recalculated, although major differences were found in more recent periods.

3. CONCLUSION

Retreat rates of glaciers in central Spitsbergen, possible to be traced with help of remote sources, is progressing at the scale not seen since the maximum extent during the Little Ice Age. Negative trend of glaciers mass balance and resulting decrease of their area, in some cases to total disappearance, for the first time in historical period shows a complete change of the glacial land-system.

References

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- Rachlewicz, G., W. Szczuciński, and M. Ewertowski (2007), Post-“Little Ice Age” retreat rates of glaciers around Billefjorden in central Spitsbergen, Svalbard, *Pol. Polar Res.* **28**, 3, 159–186.

Received 15 September 2025

Accepted 20 October 2025