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ORIGINAL RESEARCH ARTICLE

Modelling of the Svalbard Fjord Hornsund

Jaromir Jakacki [a,*], **Anna Przyborska** [a], **Szymon Kosecki** [a], **Arild Sundfjord** [b], **Jon Albretsen** [c]

[a] *Institute of Oceanology, Polish Academy of Sciences, Sopot, Poland*
[b] *Norwegian Polar Institute, Tromsø, Norway*
[c] *Institute of Marine Research, Bergen, Norway*

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Summary The Arctic Ocean is currently in transition towards a new, warmer state. Understanding the regional variability of oceanographic conditions is important, since they have a direct impact on local ecosystems. This work discusses the implementation of a hydrodynamic model for Hornsund, the southernmost fjord of western Svalbard. Despite its location, Hornsund has a stronger Arctic signature than other Svalbard fjords. The model was validated against available data, and the seasonal mean circulation was obtained from numerical simulations. Two main general circulation regimes have been detected in the fjord. The winter circulation represents a typical closed fjord system, while in summer the fresh water discharge from the catchment area generates a surface layer with a net flow out of Hornsund. Also described are the local hydrographic front and its seasonal variability, as well as the heat and salt content in Hornsund. The integration of salt and heat anomalies provides additional information about the

Abbreviations: A4, 4-km resolution Pan-Arctic model (based on ROMS); ADCP, Acoustic Doppler current profiler; AO, Arctic Ocean; AW, Atlantic Water; AWAKE, Projects (including the AWAKE-2 – Arctic Climate System Study of Ocean, Sea Ice and Glaciers Interactions in Svalbard Area); GAME, Growing of the Arctic Marine Ecosystem project; GLAERE, Glaciers as Arctic Ecosystem Refugia project; ERAi, ERA-Interim – a global atmospheric reanalysis; HOBO, temperature and pressure sensor; HRM, high resolution numerical model of the Hornsund; HYCOM, Hybrid Coordinate Ocean Model; SCA, Salt Content Anomaly; KNOW, The Leading National Research Centre; MIKE, MIKE by DHI – software from the Danish Hydrological Institute; MIKE HD, Mike Flow Model, Hydrodynamic module; NavSim, NavSim Polska sp. z o.o. – Polish Dealer of the Canadian branch of this marine software company; ModOIE, Mesoscale modelling of Ice, Ocean and Ecology of the Arctic Ocean; NPI, Norway Polar Institute; ROMS, Regional Ocean Modelling System; S800, 800 m Svalbard area model (based on ROMS); SC, Sorkapp Current; TOPEX/POSEIDON, Ocean Surface Topography from Space – NASA; TOPAZ4, an ocean-sea ice data assimilation system for the North Atlantic and Arctic global TPXO model of ocean tides; WSC, West Spitsbergen Current.

* Corresponding author at: Institute of Oceanology, Polish Academy of Sciences, Physical Oceanography Department, Powstancow Warszawy 55, Sopot, Poland. Tel.: +48 587311903.
E-mail address: jjakacki@iopan.gda.pl (J. Jakacki).

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salt flux into the innermost basin of the fjord - Brepollen during the summer. Extensive *in situ* observations have been collected in Hornsund for the last two decades but our hydrodynamic model is the first ever implemented for this area. While at the moment *in situ* observations better represent the state of this fjord's environment and the location of measurements, a numerical model, despite its flaws, can provide a more comprehensive image of the entire fjord's physical state. *In situ* observations and numerical simulations should therefore be regarded as complementary tools, with models enabling a better interpretation and understanding of experimental data.
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1. Introduction

Hornsund is a fjord in the south-west of the Svalbard archipelago. Its position and wide opening to Greenland Sea shelf waters (Fig. 1), as well as the large area of contact between the coastal waters and tidewater glacier fronts, expose it to the strong influence of the shelf waters. The fjord's 12 km wide mouth faces west towards the Greenland Sea. Hornsund is 30 km long with a maximum depth of about 260 m (average *ca* 90 m) (Frankowski and Zioła-Frankowska, 2014), an estimated surface area of 275 km^2 and a volume of 23 km^3. The fjord's coastline is very diverse, with a number of small bays, which are the mouths of valleys with glaciers flowing into the sea. Some of these small bays appeared as late as the beginning of the 20th century as a result of glacier recession. The area and coastline of Hornsund have been expanding gradually since the retreat of glaciers. The total area of glacier cover in Hornsund diminished from 1899 to 2010 by

Figure 1 Location of the study area — the Hornsund fjord.
Source: https://en.wikipedia.org/wiki/Svalbard (Oona Räisänen).

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