

Wave energy delivery to the shores of Hornsund fjord, Svalbard

Water levels at the shore depend on sea level rise, tides, atmospheric pressure and waves. Elevated shoreline water levels cause coastal erosion, overtopping and flooding, threatening communities and infrastructure. Elevated shoreline water levels due to wind wave action are particularly visible in the Arctic, which is due to two factors. Firstly, over the last few decades there has been an increase in storminess over North Atlantic, including Greenland, Northern Scandinavia and Svalbard. Storm events happen more often, the waves are larger (higher and longer), and the duration of single extreme events is longer. Secondly, the sea ice extent has been shrinking and the duration of the annual sea ice cover has been declining. Sea ice attenuates wave energy, and, consequently, protects the shore. Less ice means that the shores are exposed to wave action over longer time or perennially. Moreover, decreasing sea ice extent increases potential fetch, that is a distance over which waves can build up height, length and velocity. Consequently, more energetic waves reach Arctic shores over longer time.

The goal of the project is to understand the role of sea ice in attenuating wave energy reaching Hornsund, a Svalbard fjord where Polish Polar Station is located. A team of scientists from Poland, Norway and the United Kingdom will apply a range of novel research methods to complete three parts of the project. The first part aims to characterize sea ice conditions in Hornsund area over the last 10 years by using daily satellite data. The second part is focused on modelling wind wave climate in the fjord considering the impact of sea ice on wave transformation. The third part of the project consists of field observations of the wave runup on Hornsund beaches. Field data will allow the formulation of an empirical model that links wave parameters in the fjord with the specific shoreline water levels.

We will describe typical sea ice and wind wave conditions at the fjord scale, as well as wave runup at individual beaches. We will constrain daily, seasonal and inter-annual variability, and identify frequency, duration and intensity of storm events. We will analyze the role of sea ice in wave transformation by looking at how sea ice extent and concentration impact wave height, length and velocity. We will reconstruct shoreline water levels over the last 10 years and use existing scenarios of climate change, namely changes in sea ice extent and storminess pattern, to predict possible wave runup in 21st century. Accurate modelling of shoreline water levels at present and in future is crucial for assessing the hazard of coastal erosion and flooding, and risk of damage of the Polish Polar Station infrastructure.