Reconstruction of glaciers extent and environment in southern Svalbard during the Holocene Climate Optimum as an analogue for modern climate warming effects

Analyzing the behavior of glaciers in the recent geological past, we can predict their evolution under the influence of accelerating Arctic warming. In recent decades the Arctic has been warming three times faster than the global average. As a consequence, we observe a rapid glacier recession, among others, in Svalbard. The source of information about the likely effects of further climate warming may be the Holocene Climate Optimum (HCO) in the first half of the Holocene. At that time (around 10,000–5,000 years ago), the Arctic climate was warmer than it is today due to astronomical factors related to the Milankovic cycles. During the HCO, the Svalbard glaciers reached minimum extents, and smaller probably disappeared entirely. Despite the development of Svalbard's paleogeography, research on the HCO has still many gaps and in the southern part of the archipelago is very scarce. So far, the minimum extent of the Svalbard glaciers has not been defined and the spatial characterization of the environmental conditions in this period has not been carried out. This project aims to reconstruct glacier's extent and fluctuations together with related components of the environment in southern Svalbard during the Holocene as a possible reference for predicting effects of the present climate warming. Our specific aims are:

[1] reconstruction of the environmental characteristics of the terrestrial and marine neighborhoods of glaciers in the HCO (e.g. shoreline configuration, approximate air and sea surface temperature),

[2] reconstruction of the fluctuations of glaciers, including their characteristics in the HCO,

[3] identification of spatial contrasts in the environment and glacier state in Svalbard during the HCO,

[4] prediction of the future evolution of glaciers under different climate warming scenarios: when they will retreat to the minimal extent from the HCO and/or decay.

The study area includes the forefields of glaciers in southern Spitsbergen (Hansbreen, Werenskioldbreen, Nannbreen, Austre Torellbreen and glaciers of the Brepollen area). To achieve the specific aims, we will use various modern research methods. Radar soundings on the tributary glaciers to Hansbreen will identify old frontal moraines now covered with ice. These forms will provide information on the extent of glaciers in the past when they covered a smaller area. Geomorphological analyzes, UAV studies and high-resolution satellite images and orthophotomaps will provide data on the presence of overpassed moraines in the glacier foreland. Radiocarbon dating of molluscs shells and peat in glacigenic sediments will indicate the periods of climate warming and glacier recession. The ^{10}Be dating of the moraine boulders will enable the determination of glacier advances. Determining the species composition of shells and plant macrofossils will provide information about their requirements and thus environmental conditions in the past. The final step will be numerical modelling of glacier's minimal extent and fluctuations in response to climate forcing.

Data compilation will provide a comprehensive picture of environmental conditions and state of glaciers during the Holocene Climate Optimum. The results, including the minimum extent of glaciers, will be an analogue for future changes due to the progressive climate warming and deglaciation of the Arctic.