Development of under-ice survey capabilities for autonomous underwater vehicles around the Illulisat Fjord, western Greenland

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Over the last decade Autonomous Underwater Vehicles (AUVs), including underwater gliders, have seen a significant increase in usage with applications ranging from seafloor mapping and imaging to mine detection and environmental monitoring. The success of these applications was based on the improvements in data quality and data collection cost. With this proven track-record, AUVs are ready to be applied into new areas that have previously been inaccessible, such as the deep sea and the Polar Regions. AUVs hold the promise to provide us with new insights into those regions. Around the world several research groups are mobilizing over the coming years to launch campaigns to further explore the Antarctic ice shelves, map parts of the Arctic Basin and eventually traverse the Arctic Basin using AUVs. For these potentially long missions, underwater navigation, communication, endurance, and reliability are the most significant hurdles to overcome.

After having successfully proven the viability of underwater gliders to operate in the harsh environment around Newfoundland, we participated in a scientific expedition to investigate the dynamic behavior of the Illulisat Glacier in Western Greenland. This particular glacier is a significant source for icebergs in the Northwest Atlantic. It is also one of the fastest flowing glaciers worldwide, with a significant acceleration over the last decade. The reasons for this increased flow rate are thought to be influenced by climate change and have sparked a debate about the importance of atmospheric and oceanographic factors on this system. In order to provide data about the oceanographic conditions the water inside the fijord has to be sampled. But since the glacier is flowing into the Illulisat Fjord and its debris keeps the fijord year around ice covered, the waters of the fjord are inaccessible by conventional sampling methods. As part of our expedition we used a glider to profile the water at the partially ice-free area at the mouth of the fjord. We also used a helicopter to dip a depth sounder and a man-handled CTD into small leads inside the fjord to obtain the first data points of this system. As part of a general exploratory phase we deployed a glider to profile an iceberg from underneath. The lessons learned from the sampling, the glider deployments, visual observations, and local knowledge are now used to design a cost-effective next step to bring an autonomous underwater vehicle into the fjord to provide better and denser oceanographic and bathymetric data of this fjord.

We plan to take advantage of two ice-free side arms, one on each side of the fjord, for launch and recovery. In order to recover the vehicle and the data, the glider has to autonomously navigate its way across the fjord in the presence of a number of unknowns, such as currents, bathymetry and icebergs, and find the ice-free side-arm. The initial concept is to use a modified 1000 m depth-capable glider that is assisted by an acoustic navigation system, to provide conductivity, temperature, depth and current information of a cross-section of the fjord. In the case of a successful mission this survey will be repeated and eventually expanded away from a purely cross-sectional survey to a mission penetrating further into the fjord, potentially using other types of AUVs with complementary capabilities.

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