"RAW – Retreat And Wither" – What is an influence of glaciers recession from tidewater to land-based on the marine biological production and biogeochemistry in Arctic?

Productivity of marine ecosystems is an important factor conditioning element and organic matter cycling on Earth. It also has the potential to influence the composition of the atmosphere and thus to shape our climate. The world's oceans are a great source of O_2 and sink for atmospheric CO_2 because they absorb about 22% of anthropogenic CO_2 emissions and therefore limit global warming and all its consequences. The CO_2 uptake and O_2 emission by the oceans are to large degree propelled by the so-called "biological pump". This typically causes surface seawater to be oversaturated with O_2 and undersaturated with CO_2 during productive periods, which in turn drives the gas exchange through the air-sea interface.

The Arctic Ocean, due to its relatively high productivity and low water temperatures enhances CO_2 solubility, and is responsible for as much as 5-14% of the global CO_2 uptake by marine regions. This makes the Arctic marine ecosystems important components in the global carbon cycle. Recent findings show that Arctic fjords are especially effective in absorbing atmospheric CO_2. The biogeochemistry of the fjord systems is, however, very complex and not yet fully understood. The great unknowns that remain include the effect of glacial retreat on the CO_2 budget of coastal waters.

Climate change is disproportionately strong in the Arctic, which is the most rapidly warming region on Earth. One of the observable consequences of the transformation of the Arctic environment is the rapidly receding glaciers, which are leaving behind new bays. Due to glaciers calving, submarine melting and drainage of meltwater through glacial outflows, glaciers are recognised as the main source not only of freshwater supply into the fjord, but also mineral, organic matter and nutrients. It is worth mentioning that the exchange of this with the fjord main basin and open sea can be restricted by bay geometry and bottom morphology. In such situations, transport of nutrients to the open sea is limited. All nutrients have in the past been argued to affect marine primary productivity in the areas where there are tidewater glaciers. However, there is a growing body of evidence suggesting that deep water upwelling at the terminus of tidewater glaciers causes the most important increases in primary production. These deep waters are usually rich in nutrients, including nitrogen, the most common productivity-limiting nutrient in the Arctic. As a result, marine primary (algal blooms) and secondary production (high fish catch) increase in front of tidewater glaciers. The increased primary productivity in coastal waters may also create an important and underappreciated negative feedback following CO_2 drawdown via photosyntesis. However, the opposite effect has been observed near the land-based glacier inputs, where low nitrogen availability in meltwater limits the productivity. Futhermore, sustained glacier recession will change the glacial regime from predominately tidewater to land-based. The current oceanographical, sedimentological, and biogeochemical conditions will, therefore, adopt more characteristics of land-based glaciers and non-glacial inputs. This, in turn, may alter the total nutrient flux supplied to euphotic zone (either directly via runoff or indirectly via reduced circulation driven by buoyant upwellings in front of tidewater glaciers). Therefore, it remains uncertain how the marine ecosystem productivity will respond to future changes in the Arctic and so this project aims to test the following hypothesis:

The warming-driven glacier recession cause the reduction in marine biological production in polar coastal regions and seas due to:
unfavourable nutrient balance caused by a reduction in nutrient-rich deep water upwelling from buoyant meltwaters plumes;
shallowing the euphotic zone caused by increased surface suspended sediments concentration;
reduction of water mass exchanges and sediment-bound nutrients transfer between the fjord/open sea and newly formed bay due to hydrography and formation of natural sediment traps.

The proposed project directly addresses the problem of changing productivity in the Arctic fjords due to glacial retreat. As such it is of great importance for understanding the role of high latitude coastal regions for the global carbon cycling in the future warm, CO_2-rich world. As the pelagic productivity shapes the structure and condition of the entire ecosystems, the project results will also provide important knowledge to assess ecological consequences of the changing climate in the delicate Arctic ecosystems.

The knowledge gained in the project will be disseminated to society during public events, like scientific festivals or picnics. Additionally, a dedicated project web page will be updated regularly with recent scientific findings and publications, whilst popular social media platforms will be used to communicate the project results.