Isotopic and physical-chemical monitoring of glacial drainages and sea water in the Ny-Ålesund area, Svalbard

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Abstract

The monitoring of glacial meltwaters, which are transferred to the ocean, can represent a valid tool to understand the climate conditions and their change and effects. In this framework, ISMOGLAC project is aimed at investigating the dynamic processes of the glacial melting and evaluating the consequent transfers of fresh water towards the Arctic Ocean. The activities that are carried out to accomplish these goals consist of an isotopic and physical-chemical monitoring of inland glacier drainages and ocean water into Kongsfjorden. The project activities started in June 2015 and will be performed for 5 years, thus providing to achieve information both on the seasonal and medium periods evolution of glacial melting.

Introduction

Some studies (e.g.: Bingham et al., 2005; Bartholomew et al., 2011; Chandler et al., 2013), carried out on meltwater in Arctic regions using hydrological observations and tracer tests, suggest that the hydrological system of the glacial bodies can evolve significantly as the melt season advances. This may increase the velocity of ice masses, allowing them to respond much more rapidly to climatic warming. The penetration of supraglacial meltwater within the glacier bodies seems to play a key role in the evolution of subglacial drainage systems, nevertheless in the outflow volumes other components such as water from basal melting and water stored during the winter in "subglacial reservoirs" are involved (Bingham et al., 2005; Bartholomew et al., 2011).

Studying the mass balance, the Norsk-Polar Institutt outlines that the glaciers near Ny-Ålesund mainly have lost mass over the last 40 years (http://mosj.npolar.no/en/climate/land/). The superficial drainage system of these glaciers consists of numerous meltwater channels, short-lived lakes and few open moulins and crevasses, all leading the water into the englacial and/or subglacial system (Hagen et al., 2003). The freshwater that generates throughout such drainage systems is then transferred to the fjord by surface runoff (glaciers ending on land) or directly (calving glaciers).

In the Arctic region the isotopic parameters have been successfully tested as a powerful tool to trace the glacial meltwater dynamics and to distinguish water sources in mixing processes (e.g. Ostlund & Hut, 1984; Azetsu-Scott & Tan, 1997; Bauch et al., 2005). At the Svalbard Islands, few data were published on meltwater and their relationship with ocean water. A first salinity-$\delta^{18}O$ mixing line within Kongsfjorden was proposed by MacLachlan et al. (2007).

In this framework, the ISMOGLAC project aims at producing knowledges on the dynamic processes of the glacial melting in the Ny-Ålesund area (Fig. 1) and the transfers of fresh water towards the Arctic Ocean, by means of an isotopic and physical-chemical monitoring of inland glacier drainages and ocean water into the Kongsfjorden.

Methods and preliminary results

The inland field-work regards glacial streams that originate in supraglacial, englacial and subglacial zones of different glaciers neighbouring the Kongsfjorden. The distribution of the sampling points on the glacier systems and the fjord is showed in Fig. 1.

The collection of various aliquots of water and in-situ measurements of the physical-chemical parameters (temperature, electrical conductivity, pH, alkalinity, flow rate), trough portable devices, are performed starting from the higher sector of the glaciers, where the first meltwater is encountered, continuing towards the glaciers terminus, both laterally and centrally, and downstream, on the proglacial rivers, up to the sea.

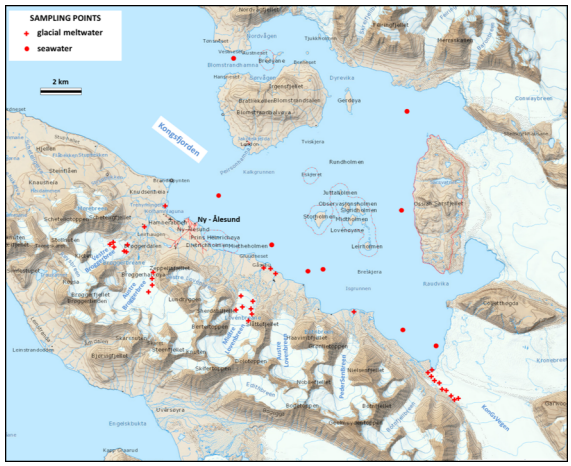

Figure 1 *Location of the water sampling points for the glacier systems and the Kongsfiorden.*

Seawater sampling is performed in several points, moving from the Ny-Ålesund coast line towards the inner part of the fjord. At the sampling points, a multi-parametric probe is used in order to perform vertical profiles of temperature, pH, salinity, redox potential and dissolved oxygen. According to the profiles data the collection of various aliquots of water are planned and performed at specific depths along the investigated verticals, by using Niskin bottles.
The sampled waters are analysed in the IGG-Pisa (Italy) laboratories to define: i) water isotopes signature ($\delta^{18}O‰$, $\delta^{2}H‰$ and ^{3}H); ii) TDIC isotopes ($\delta^{13}C$ e $\delta^{18}O$ of the Total Dissolved Inorganic Carbon); 3) concentration of the main, minor and trace chemical components (with particular attention towards those inserted within the priority list of the European Community). Instruments used in laboratories are the ICP-OES, Ion Chromatograph, Spectrophotometer UV-VIS, Potenziometer (using Ion selective Electrode) and Mass Spectrometers.
All the produced data are elaborated and interpreted also in comparison with climate data and isotope signatures of the meteoric precipitation (IAEA/WMO, 2016) and ice cores (e.g. Divine et al., 2011), in order to evaluate the relative importance of the several sources (supraglacial, englacial-subglacial) that contribute to the total glacial streams (i.e. dynamic processes of the glacial melting) and to verify the transfer paths and quantity of fresh water within the fjord.
The project activities started in June 2015 and will be performed for 5 years, thus providing to achieve information both on the seasonal and medium periods evolution of glacial melting.
The project is in a preliminary stage, nevertheless, both chemical and isotopic data hitherto achieved are promising for the purposes of the project.
First results point out a significant differentiation of values both among various glacier systems and within the same system, in relation to the sectors of the drainage network and the relative importance in term of flow rate. Also, the data referred to the fjord water allow to verify the mixing of fresh water coming from glacial drainages and seawater.

Perpectives

Furthermore, field activities are planned at least for the next five years to study the evolution over time of both the glacial melting process and the transfer of fresh water within the Arctic Ocean. Next activities will also include sampling of soils and particulate matter suspended in the water for isotopic analyses of carbon and nitrogen. Cooperation with other groups that are studying meltwater and/or seawater for other purposes will continue. The comparison of tools, data and approaches among the various research groups could improve the effectiveness of the several water-proxy indicators of the climate change and related effects.

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