Ny-Ålesund
Research Station
Norway

Atmosphere | Terrestrial Ecosystems | Glaciology | Kongsfjorden System

DATE: 31.10.2021

EVENT: Workshop - Nutrients in the Arctic

DRAFT Agenda

The project *Nutrient cycle - linking the Atmosphere, Terrestrial, Marine and Glaciological flagship programs in Ny-Ålesund* will bring together all Ny-Ålesund flagships to evaluate nutrient fluxes between Kongsfjorden and its surrounding environment - terrestrial, glacier, atmospheric and ocean realms - and how some of these fluxes are expected to change with the ongoing warming trends.

To bridge the keynote seminars on this topic from October 2020 to the planned three-day workshop in Orvieto in spring 2022, we will take advantage of the Svalbard Science Conference to arrange a one-day workshop. The workshop will focus on the following two topics:

- Kongsfjorden net ecosystem metabolism (nitrogen budget)
- Nutrients, carbon and nitrogen in atmosphere, biosphere and soil continuum

Details about the topics and structure of the workshop below

Program summary

Time	Title	Responsible
09:00-09:15	Welcome	Christina A. Pedersen, NPI
09:15-09:30	Introduction and program for topic 1	Pedro Duarte, NPI
09:30-10:45	Parallel sessions with group discussions Group 1: Atmosphere – fjord exchanges Group 2: Cryosphere – fjord exchanges Group 3: Land-fjord exchanges Group 4: Biological "fluxes" between the fjord and surrounding environments Group 5: Ocean-fjord exchanges	All participants
10:45-11:00	*Coffee break*	

11:00-11:30	Parallel sessions with group discussions (cont.)	
11:30-12:20	Summaries from each group (10 min each)	
12:20-12:50	Discussion and planning	Pedro Duarte, NPI
13:00-14:00	*Lunch break*	
14:00-14:15	Introduction and program for topic 2	Angela Augusti, CNR
14:15-15:30	Separate group discussions Group 1: Carbon and the nutrient cycles with changing climate in Ny-Ålesund ecosystem Group 2: Changes in soil nutrient characteristics and effects on microbial communities Group 3: Nutrient cycle variations in freshwater ecosystems Group 4: Relationships among nutrients and biodiversity, phenology and physiology	All participants
15:30-15:45	*Coffee break*	
15:45-16:30	Separate group discussions (cont.)	
16:30-17:15	Presentation of the result discussion from each group	
17:15-17:45	Discussion and planning	Angela Augusti, CNR
17.45-17:55	Conclusions and wrap-up	Angela Augusti, CNR
19:00	*Workshop dinner at Pier31 at Lysaker Brygge 31*	

Topic 1: Kongsfjorden Net Ecosystem Metabolism

Net Ecosystem Metabolism is one of the holistic ecosystem properties that informs about ecosystem functioning. Its calculation involves the calculation of the water budget, the salt budget and the nitrogen budget of an entire ecosystem. Moreover, nitrogen NEM links stoichiometrically to the phosphorus, oxygen and carbon budgets, allowing us to get insight into the carbon sink/source role of a given ecosystem. Changes in NEM leads to changes in the interactions with neighbouring ecosystems and may be indicators of changes in ecosystem health. Considering the theory of ecological succession, one may assume as a starting point, that changes corresponding to an ecosystem shift from a higher succession stage to a lower one, will be followed by a deviation of NEM further away from zero and this may be seen as a decrease in ecosystem health, since it corresponds to a decrease in ecosystem "self-sustainability".

Figure 1 shows a synthesis of fluxes obtained from the literature, data and simulations with the K160 coupled physical-biogeochemical model. Model data was used only to compute flows between the fjord and the ocean. Question marks indicate data gaps. In most cases it may be anticipated that these data gaps will not be very influential on ecosystem metabolism, especially considering the dominant role of the fjord-ocean fluxes. However, understanding their variability over time (seasonally and interannually) may be relevant to anticipating possible ongoing trends.
Available evidence suggests that residual nutrient loads are towards the fjord, since published data shows decreasing surface concentrations from the ocean to the fjord. All things considered; it looks like Kongsfjorden is a net sink for nitrogen with a predominantly autotrophic metabolism (P/R > 1). Therefore, it should also be a carbon sink.

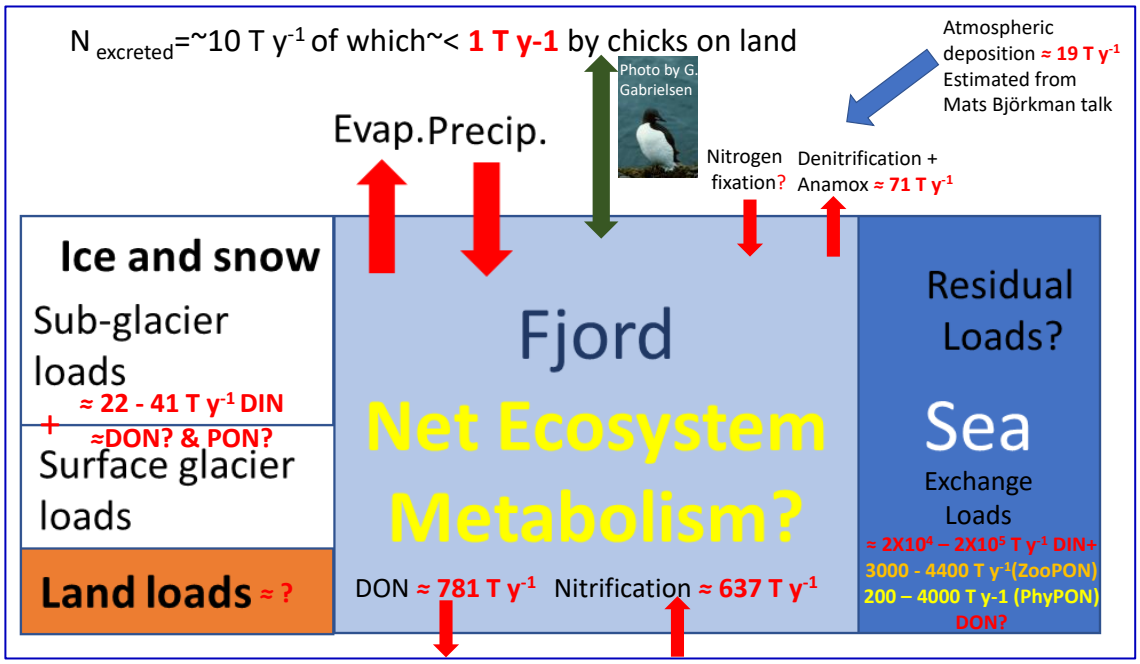

Figure 1. Synthesis of nitrogen fluxes in Kongsfjorden based on various sources (P. Duarte, NPI).

The values shown in Figure 1 are first estimates and they need to be validated to the greatest extent possible. Moreover, NEM should be computed for a typical “cold” and for a typical “warm” year, with the former being a proxy of the past, with extensive sea ice in the fjord during Winter and part of Spring, and the latter being a proxy to the present/future, with little sea ice in the fjord in the winter and a larger influence of Atlantic Water (AW). Since AW is likely the main nutrient source to the fjord, more AW will possibly lead to higher primary production and more nitrogen sinking in the fjord. Therefore, the main hypothesis of this study is that Atlantification will increase nutrient stocks in the photic zone leading to higher PP and more nitrogen and carbon sinking in Kongsfjorden.

Workshop layout topic 1

The main goal of the workshop is to bring together experts from all environmental compartments - cryosphere, atmosphere, terrestrial and marine systems – and have their contribution in estimating the various nitrogen fluxes. Glaciologists may provide time series of glacial river flows and calving ice, as well as about their chemical properties. Terrestrial and atmospheric scientists may provide comparable fluxes for the land and atmosphere derived fluxes, respectively. Physical oceanographers and marine biologists should focus on exchanges between the fjord and the sea. Moreover, biologists should contribute to quantifying inputs from birds, mammals, and other organisms. We also need input from biogeochemists studying CO_2 and oxygen fluxes between the fjord and the atmosphere. These fluxes may help understanding the sink/source role of the fjord for both carbon and stoichiometrically related elements such as nitrogen.

We do not expect all these fluxes to be quantified during the workshop but, as a minimum, to agree on the methods and the “task forces” that will focus on each of the fluxes outlined in Figure 1. We also expect to identify the main gaps. We should also agree on a timeline to develop this study and the writing and submission of a paper. This timeline should be well within the project duration.

Depending on the participants, we may have to adjust the Discussions in group 1 – 5. Possibly, some have to be merged to make sure that we have, at least 3 participants per Discussion topics. One of the participants will be responsible to conduct the discussion within his/her group and provide the respective summary in the Wrap-up session. The outcome of each discussion should be a clear assessment of the fluxes involved and of the methods/data needed to quantify them. The focus is on nitrogen fluxes, but other nutrient fluxes may also be considered, as well as carbon dioxide and oxygen.

Topic 2: Nutrients, carbon and nitrogen in atmosphere, biosphere and soil continuum

Autotrophic and non-autotrophic organisms are responsible for affecting carbon and nutrient cycles, among other things. They (directly and indirectly) both sequester and release carbon and nutrient from/to atmosphere and soil.

Atmosphere and soil carbon and nutrient concentrations are related to the biodiversity, phenology and physiology of terrestrial organisms and on how these are affected by climate change in Arctic regions (increase of temperature and CO_2 concentration, water availability, active layer depth).

Moreover, the effects of terrestrial organisms on carbon and nutrient cycles depend on the relationship between autotrophic and non-autotrophic (grazing, faeces fertilization,

microbial decomposition) and again, how these relationships are affected by climate change.

Workshop layout topic 2

The goals of the discussion are several, but all can be related to defining the general consensus on the results that are available about the topic above mentioned, and to focus on the scientific gaps.

Planning a pilot study filling the gaps will be beneficial. Ny-Ålesund offers the opportunity to set up a comprehensive study involving atmospheric scientist looking, for example, at nitrogen deposition and to carbon budget, terrestrial ecologists, both animal, plant and microbiologists, looking at biodiversity, phenology, physiology, biochemical processes and soil and permafrost scientists, looking at the thawing of permafrost and at soil characteristic and nutrient changes. Moreover, how the information already obtained can be upscaled at regional level and used for future projections should be considered.

The group discussion will be organised according to Fish bowl approach: the 4 topic discussions will run at the same time, better if in the same place (to allow participants to move from one group to the others). From 5 to 7 people will start each group with a person leading the discussion. The chair of the discussion should propose questions and guide the discussion with the aim to obtain responses. Participants can/should move from one group to the others to participate to all group discussions. The final discussion should consider the action to take to fulfill the open questions raised in the group sessions, either a pilot project or a research project to be proposed to national and international calls.