Ny-Ålesund
Research Station
Norway

WHAT: Nutrients in the Arctic – workshop to increase the links between the Atmosphere, Terrestrial, Marine and Glaciological flagship programs in Ny-Ålesund

WHEN: Tuesday-Thursday 20.-22. Sept 2022

WHERE: Orvieto, Italy

Program Orvieto workshop

Program overview

Time/ date	Tuesday	Wednesday	Thursday
09-12	Introduction & keynote	Session 2: Cryosphere-marine interaction Session 3: Closure experiments	Parallel writing sessions
13-17	Session 1: Data and methods	Various topics	Parallel writing sessions
17-21	Mingle time and dinner	Mingle time and dinner	

Detailed program

Time	Title	Responsible
Tuesday 20th Sept		
08:30	*Meeting at piazza Cahen at 8.30 to be transferred to the venue at Porano*	
09:15-10:30	**Introductory session** 09:15-09:35 Welcome to the workshop & practical information 09:35-09:45	 Carlo Calfapietra, Angela Augusti, CNR Christina A. Pedersen, NPI

	Joint flagship collaboration- aim and goal 09:45-10:45 Round the table 2-min introduction by everyone	All
10:45-11:15	*Coffee break*	
11:15-12:15	**Keynote: "**Nutrient dynamics and related future challenges in Kongsfjorden"	Carlos Jiménez, Uni Malaga
12:30-13:30	*Lunch*	
13:30-14:30	**Session 1** Nutrients across disciplines: Comparing concepts, methods, and key processes **Homework:** We will be comparing how different disciplines consider, collect, and measure nutrients, as a step to better collaboration between fields. Before Orvieto, please refresh yourself on how your team collects nutrient samples, which methods are used for preservation and analysis, what units are used, and exactly which nutrients are quantified, and at what time and space scales.	Allison Bailey, NPI, and Melissa Chierici, IMR
14:30-15:00	*Coffee break*	
15:00-17:00	Session 1 cont.	
17:00-18:00	Scientific mingle-time	
19:30	*Dinner*	
Wednesday 21th Sept 2022		
08:30	*Meeting at piazza Cahen at 8.30 to be transferred to the venue at Porano*	
09:00-10:30	**Session 2**: Cryosphere-marine interaction: fresh-water inputs to the marine system.	Jack Kohler, NPI et al.

	09:00-09:15 Jack Kohler: Introduction 09:00-09:45 Ward van Pelt: Runoff modelling 09:45-10:30 TBA	
10:30-11:00	*Coffee break*	
11:00-12:30	**Session 3:** Creating brave experiments from the outcomes of this workshop **Homework:** The Research Council of Norway will announce the priority for their 2023 polar research call: *Svalbard in a Pan-Arctic Context* in February 2023. The aim of the call is to increase our knowledge about the environment on Svalbard and in the surrounding sea areas. It will support research on or about Svalbard. The use of already established infrastructure in Longyearbyen, Ny-Ålesund, Bjørnøya and Hopen and available research vessels or autonomous vehicles will be prioritized. The research projects should contribute to international coordination of regional and global observation systems, for example through the use of SIOS. The call will specify that international research cooperation is necessary. Can the outcome of this workshop kindle thinking towards creating interdisciplinary projects that would fit for this forthcoming call. Closure experiments were burdens and fluxes are overdetermined by data and measurements on both sides of boundaries could be a pathway to pursue. Bring ideas for bold projects!	Kim Holmen, NPI
12:30-13:30	*Lunch*	

13:30-14:30	**Session 4**: Intensive school for students on long-term trends at Svalbard Homework: What observational time series you can provide for the course. Participants will analyse them together and look for connections and interpretations of various, preferable cross flagship long term trends.	Radovan Krejci, SU
14:30-15:00	*Coffee break*	
15:00-16:30	Introduction to Thursdays two writing sessions Kongsfjorden Net Ecosystem Metabolism "Round table" to discuss the reason why we want to write a paper about Nutrients and isotopes in Arctic (Topic 2), the aims and where the paper can bring us as community.	Pedro Duarte, NPI, and Angela Augusti, CNR.
17:00-19:00	Excursion Visit to a close by vineyard	
19:30	*Dinner*	
Thursday 22th Sept 2022		
09:00-17:00	Writing group sessions Topic 1: Kongsfjorden Net Ecosystem Metabolism (lead: Pedro Duarte, NPI), see appendix Topic 2: Nutrients, carbon and nitrogen in atmosphere, biosphere and soil continuum (lead: Angela Augusti, CNR), see appendix.	Pedro Duarte, NPI, and Angela Augusti, CNR.

Appendix

Writing session - topic 1: Kongsfjorden Net Ecosystem Metabolism

Responsible, Pedro Duarte, NPI

In line with the work presented and discussed in the previous workshop, we aim at producing a paper about Kongsfjorden Net Ecosystem Metabolism. The main goals of the paper and methods employed are briefly described in the accompanying paper draft/outline. The writing session will last for the whole day, and we should have a brief introduction of ~15 minutes and then split into four groups, preferably covering the main topics listed below. Ideally, each of you should decide before hand the group you want to be involved in, but it will be possible to move between groups during the writing session. We work in groups for most of the time, but will set aside time to present main achievements per group.
Each group should have data to work with in its writing session. Therefore, once you identified the group(s) you may contribute to, please, try to prepare and bring to the workshop the relevant data. We should be able to organize ideas, data, and some preliminary text about the evolution of nitrogen exchanges associated with the scopes covered by the four groups. However, the extent to which we may accomplish this will depend on your contributions. Please note that, whenever possible, we should use the largest possible timeseries to make sure we have a clear picture of the evolution of nitrogen exchanges over time and may detect relevant trends.
Groups

1) Inputs from glaciers (freshwater inputs and associated nitrogen inputs)
2) Atmospheric deposition
3) Inputs/Outputs associated with bird excretion/feeding
4) Inputs/outputs associated with fjord-ocean exchanges (dissolved and particulates, including plankton and nekton)

See also the accompanying draft paper.

Writing session - topic 2: Nutrients, carbon and nitrogen in atmosphere, biosphere and soil continuum

Responsible: Angela Augusti, CNR

Where we started and where we are now

At the previous meetings of the project “Nutrient in the Arctic” several aspects of the nutrient cycles in Arctic ecosystems have been discussed. Among these, the variation of carbon and nutrient cycles with changing climate (with emphasis on the atmospheric

concentration and deposition), the changes in soil physical and nutrient characteristics and effects on soil microbial communities, in particular in relationship to grazing, faeces fertilization, microbial decomposition, water availability, but also with respect to biodiversity, phenology and physiology of plants and animals and the variations in nutrients in freshwater ecosystems.
Several of these aspects, mainly concerning the terrestrial and freshwater parts have been already taken in consideration in the review paper “Five decades of terrestrial and freshwater research at Ny-Ålesund, Svalbard” (Pedersen at al., Polar Research, 2022).
At last workshop we had in Oslo in November 2022, we discussed about results available the topics above mentioned, the scientific gaps still existing, this with the aim to consider a comprehensive approach to the study of Nutrients in Arctic ecosystem putting together atmospheric expertise, looking for example at deposition, terrestrial expertise, both animal, plant and microbiologists, looking at biodiversity, phenology, physiology, biochemical processes and soil expertise, looking at soil characteristic and nutrient changes also under the lens of permafrost thawing.
Among the different aspects of Nutrients in Arctic ecosystems the need of a common experimental approach to be able to compare the results among the different studies was discussed.
This, was emphasised, is needed to be able to compare studies about the same topic (i.e. Nutrients uptake in plants), and in particular, to try to put together the different aspects of the research on Nutrients (compare or link together terrestrial aspects with atmospheric, for ex.).
The **stable isotope analysis** was mentioned as possible tool to study such different aspects of the Nutrient cycle. At the same time, although the use of stable isotopes is known and several of the workshop participants has used or use currently, it was also clear that an overview of what has been achieved in Arctic ecosystem studies is missing. There was a consensus in proposing to work to a paper to put together the past studies about Nutrients in Arctic/Polar ecosystems in which the stable isotope approach has been used.

What next?

Taken into consideration this decision I started to think of a very first draft of the possible review. (some abstract in the pdf attached).

From this very preliminary literature search (some abstract in the pdf attached), the keywords defined overlap with most of the topics we have discussed previously, although some ones are not depicted, namely atmospheric deposition and marine topics (I guess because my literature search has been biased by my terrestrial interests. Anyway, here are some group of keywords:

- *Polar regions and types of terrestrial ecosystems*: Alaska, Svalbard, moist acidic tundra, subarctic tundra ecosystem
- *Nutrient and isotopes*: Isotope 15N, Nitrogen fertilization; Carbon and nitrogen cycling, carbon, nitrogen, stable isotope labelling 15N, topographical N transport
- *Vegetation and soil*: plant species-specific N uptake, tundra shrubification; mycorrhizae, roots, shrub expansion Plant-soil-microbial interactions Microbial structure and function; Bacterial and fungal growth; microbial N-mining; decomposition; biogeochemistry

- *Animals*: Arctic food webs, Arctic fox, Barnacle Goose, Fecal dietary analysis, Svalbard reindeer
- *Criosphere*: Glacier foreland, Soil-forming factors, Soil biogeochemical property, chronosequence, Glacio-fluvial runoff,
- *Environmental and climate drivers*: active layer, climate change, permafrost thaw, Arctic hillslope

Considering our previous discussions and the very partial literature found we can think of a very preliminary structure of the paper.
The title should be decided, but based on the keywords defined, should contain at least: Nutrients, Stable Isotopes, Arctic/Polar
The keywords can be decided on the base of input coming from the "writing session"
The *structure* of the paper could be arranged as follows:

- a general part on stable isotope theory with included fractionation mechanisms that explain the results are obtained and help in designing new studies.
- which are the questions generally answered by stable isotope approach
- studies and examples in the different "spheres" of the ecosystems, namely:
    - atmospheric
    - terrestrial,
    - freshwater
    - soil
    - marine
    - ???
    - ???
    - ???
- studies that eventually use stable isotopes to link the different spheres
- scientific gaps to improve knowledge of the Arctic ecosystem (Ny-Alesund and Svalbard) in particular in relationship to future climate change.

Homework before the workshop

Even if in the agenda of the workshop we have considered a writing session of this paper, and considering the very early stage of the process, I guess the time will be spent more on planning the paper than really writing.
Although there is not too much time, I would like to ask you:

- to think of your interest in being part of this process.
- in case you are interested, to start to look for past studies about Nutrients, isotopes and Arctic/Polar regions. In this way we can start to build the basis of the paper
- Be prepared to engage your self for the future activities
- To think about input to give at the structure of the paper

In brief, at the end of the workshop I hope and aim to have reached some of the following milestones:

- To define the structure of the paper
- To form the group of people that will contribute to the collection of past studies and to the writing parts.
- To assign tasks to the participants and eventually to contact people (not present) that can be interested in being part of the process.

Attached is also a literature list for this topic.