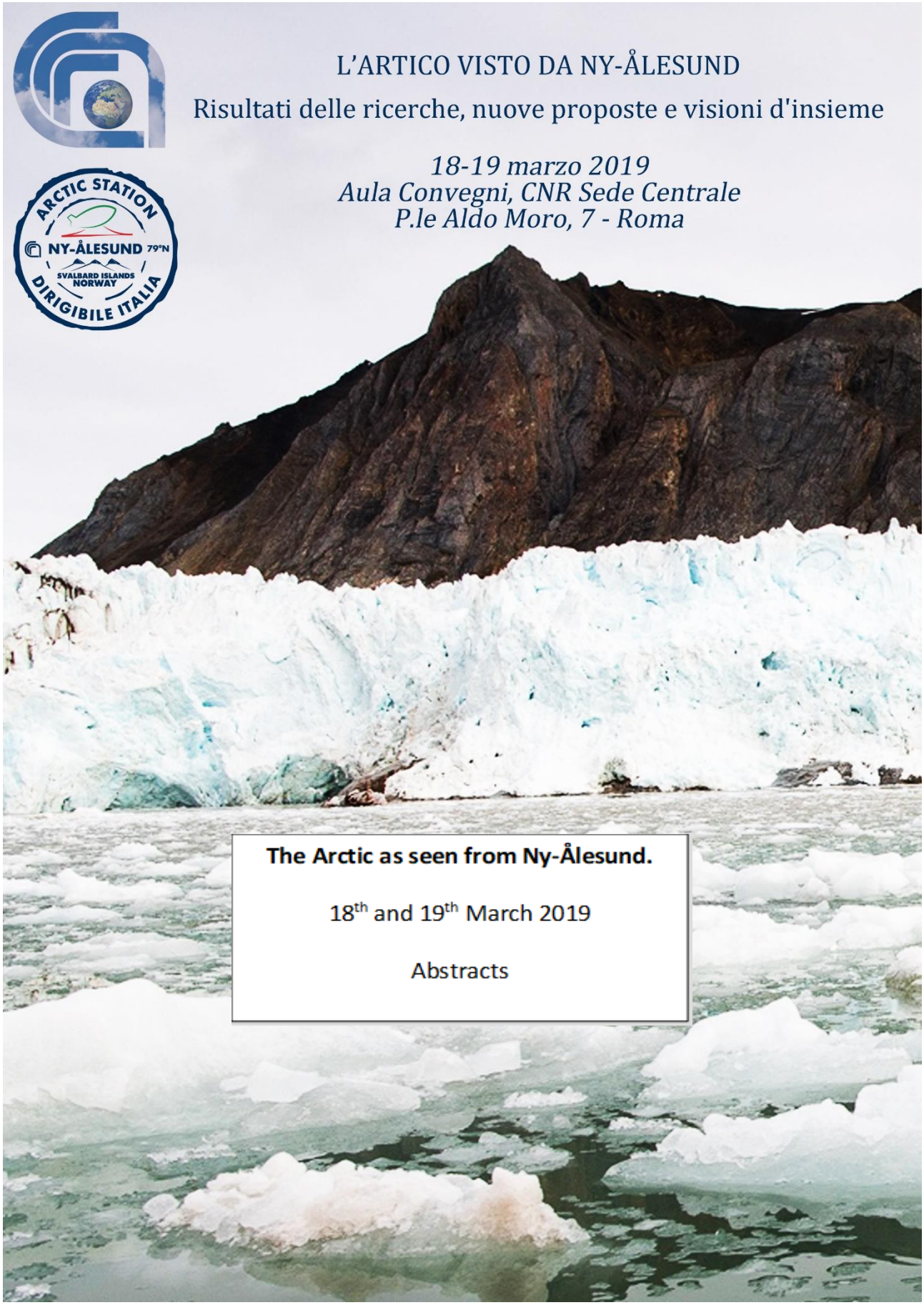


ISSN: 2239-5172 n. DTA/29-2019 November

The workshop aims to highlight the state of the art of italian research activities at the Arctic Station "Dirigibile Italia" Ny-Ålesund – Svalbard and to define common strategies to strengthen the synergy between the different groups in relation to the new scientific emerging challenges.
With a focusing on the climate change, the workshop program has been organized in five sessions such as:

1. Atmosphere

2. Ocean

3. Cryosphere

4. Terrestrial ecosystems

5. Technology and innovation

Scientific programme committee
Antonello Provenzale, Angelo Pietro Viola, Tommaso Tesi, Andrea Spolar, Angela Augusti, Annalisa Iadanza

Organizing committee
Working Group of Research Activity in the Arctic in collaboration with the Department of Science of the Earth System and Technology for the Environment of the National Council of Research

Executive Editor
Daniela Beatrici
Pamela Cialli

The seminar is financially supported by the CNR-National Research Council of Italy

Index

Observations Atmospheric processes

Atmospheric Observations at the Amundsen-Nobile Climate Change Tower: climatology and processes

M. Mazzola (1), A. Viola (1), F. Tampieri (1), M. Schiavon (1), O. Drofa (1), A. Lupi (1), C. Elefante (1)(2), T. Choi (3,) S. Park (3), A. Pelliccioni (1)(4), V. Vitale (1)

1 – Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
2 – Università del Salento, Lecce, Italy
3 - Korean Polar Research Institute (KOPRI), Incheon, Republic of Korea
4 – INAIL - Dipartimento di Medicina, Epidemiologia, Igiene del Lavoro e Ambientale (*DiMEILA*), Roma, Italy

Abstract

At high latitudes, the Atmospheric Boundary Layer (ABL) is often characterized by extremely stable vertical stratification since the surface radiative cooling determines inversions in temperature profiles, especially during the polar night over land, ice and snow covered surfaces. Improvements are required in the theoretical understanding of the turbulent behaviour of the high-latitude ABL. Understanding the processes occurring in the ABL is very important in order to link them to those occurring within the different components of the climate system. The Amundsen-Nobile Climate Change Tower (CCT), is one of the important scientific platforms operating in Ny-Ålesund, Svalbard, that has been set up to provide continuous recording of the atmospheric parameters along the vertical and at the surface. The configuration allows to measure at the same site wind and temperature profile, radiation balance, turbulent fluxes of mass and energy, heat fluxes at surface and study exchange processes occurring between the surface and the lower layer of the atmosphere. At the same time, provides integration of environmental data with other scientific installation located in the vicinity of CCT that observe the state of soil, permafrost, vegetation and snow (CALM-grid, Borehole, SnowIceCrem) or high range wind profiles and thermal structure of the ABL (WINDLIDAR, SODAR). The CCT is continuously operational since 2009 and this time frame can be considered a first slot for a climatological approach to analyse the small scale processes in relation with large scale changes. Specific studies have been done and other research are still ongoing, such as on the parameterizations of surface-atmosphere exchanges to improve numerical weather prediction and climate models; on the vertical profiles for the different stability conditions, on the influence of the boundary layer structure and dynamics to the vertical distribution of aerosol, on the issue related to the height of the ABL, on the decoupling between the surface layer and the atmosphere aloft, on the critical conditions, for which the classical similarity approach is not satisfactory, for example at low wind and profiles. Numerical experiments with the atmospheric model Bolam have also been performed on a domain covering the area of the observations, in order to assess the capability of an atmospheric numerical model to reproduce the observed vertical profiles in the ABL. The CCT data have contributed in the years also to numerous works in other related fields, such as oceanography, geology, biology etc.

Fiber OPTic thermOhygrometers for AdmundseN-Nobile Climate Change Tower (CCT)

M. Giordano, A. Martone, C. Leone

Istituto per I Polimeri Compositi e Biomateriali (CNR-IPCB), Napoli, Italy

Abstract

Sensors for the monitoring of the atmospheric parameters in polar climate conditions are the relevant technology for the operation of the Amundsen-Nobile Climate Change Tower (CCT). That is the key infrastructure needing continuous acquisition of the atmospheric parameters at different heights. Here a technology for the sensing of the temperature and the relative humidity is proposed that is based on the fiber optic technique. The fiber optic sensor system provides the easy multiplexing of many sensors over a single fiber and it overcomes the problem of the transmission of data being simultaneously the transductor and the data transmission support. In addition, the fiber optic systems are proven to function at extremely severe environmental conditions such as those are in high energy physic experiment (near zero Kelvin temperature, huge electromagnetic and nuclear particles fluxes and near zero pressure), i.e. the Compact Muons Solenoid experiment at CERN. The research proposal aims to deploy a fiber optic sensor system able to monitor the thermo-hygrometric profile along the height of the Amundsen-Nobile Climate Change Tower (CCT). Such sensory system will be connected by a fiber optic cable to the Station Dirigibile Italia where the optoelectronic demodulation device will provide the continuous monitoring of the said atmospheric parameters.

Expected advantages deriving by the adoption of the fiber optic technology are:

+the multiplexability (a large number of sensors can be interrogated along a single cable),
+the multiparametric nature of optical transduction (same technology can support strain static and dynamic, temperature, relative humidity, magnetic field and chemicals measurements),
+the ease of installation and retrofitting of existing structures,
+the low energy consumption (the sensors do not need a dedicated power source),
+the high distance between the sensors and the demodulation optoelectronic device.

The proposal also aims to demonstrate that the fiber optic sensor technology is robust and reliable to be employed in polar regions. Further implementation of other relevant measurands such as radiation and chemicals would be left to the validation of the said subset (temperature and relative humidity) of measures.

Spatial distribution of aerosol properties in the lower troposphere upon Ny-Ålesund

D. Cappelletti (1)(2), M. Mazzola (2), B. Moroni (1), L. Ferrero (3), J. Lisok (4), K. Markowicz (4), S. Crocchianti (1), M. Maturilli (5), A. Lupi (2), C. Petroselli (1), A. Spolaor (6), E. Barbaro (6), C. Ritter (5), C. Boeckmann (7), J.C. Gallet (8), R. Traversi (9), S.J. Park (10), A. Dekhtyareva (10), A. Viola (2), V. Vitale (2)

1 – Università di Perugia, Italy
2 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
3 – Università Bicocca, Milano, Italy
4 - University of Warsaw, Institute of Geophysics, Warsaw, Poland
5 - Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, AWI - Potsdam, Germany
6 - Istituto per la dinamica dei processi ambientali (CNR-IDPA), Venezia, Italy
7 - University of Potsdam, Potsdam, Germany
8 - Norwegian Polar Institute, Tromso, Norway
9 – Università di Firenze, Italy
10 - Korean Polar Research Institute (KOPRI), Incheon, Republic of Korea
11 - UiT, University of TromsØ, Norway

Abstract

The primary objective of this long-term research activity is to build a climatology of vertical aerosol profiles in and above the Arctic Boundary Layer. To this aim since 2011, an international research team has performed yearly field campaigns at the Ny-Ålesund super-site thanks the support of the Italian CNR Arctic Station Dirigibile Italia and the German-French AWIPEV station. We employed various aerosol payloads and tethered balloons systems (TBS) and recorded, up to date, about 500 aerosol profiles in the first 2 km, providing detailed information on black carbon (BC) concentration, aerosol size distribution, aerosol scattering coefficients, and chemical composition. These pieces of information are necessary for the understanding of the aerosol formation, long-range transport, and fate in the Arctic troposphere. Case studies will be highlighted describing the influence of ship emissions, Arctic haze and new particle formation events on the vertical aerosol structure. In situ TBS activities have been often accompanied by simultaneous lidar profiling and a closure study of aerosol microphysical property retrieval is in progress based on this data and also on a full chemical aerosol characterization both at a bulk level on filter samples and on single particles by scanning electron microscopy. Complementary information has also been obtained from extensive computational studies of air mass transport utilizing Eulerian and Gaussian models. Since 2016 the study of the horizontal distribution of BC and nanoparticles has been initiated and performed along transects of the main glaciers around Ny-Ålesund exploiting portable instrumentation with the primary goal of studying the processes at the atmosphere/snow boundary. More recently in summer 2018 a TBS campaign has been performed in Longyearbyen for investigating pollution due to ship emission, and during the winter 2018/2019, for the first time, vertical aerosol profiles have been measured during the polar night. These scientific activities have been accompanied by constant development of the instrumentation and payload performances as well as by regular intercomparison campaigns with ground-based measurements performed at the Gruvebadet laboratory and the CCT. The next generation of aerosol payloads, currently under development and test, will include the possibility of characterizing the Arctic thin clouds, with dedicated measurements of cloud droplet size distribution, cloud chemistry, and cloud microbiology, within the framework of collaborations with the Korean polar research Institute (KOPRI) institute and other national research teams.

References

This activity featured 15 publications in ISI journals in the 2014-2018 period. Some relevant examples are listed below.

C. Ritter, et al.; Microphysical Properties and Radiative Impact of an intense Biomass Burning aerosol event measured over Ny-Alesund, Spitsbergen in July 2015, Tellus B: Chemical and Physical Meteorology, 70, 1-24 (2018).

B. Moroni et al.; Mineralogical and Chemical Records of Icelandic Dust Sources Upon Ny-Alesund (Svalbard Islands), Frontiers in Earth Science, 6, 187 (2018).

A. Spolaor, et al.; Determination of black carbon and nanoparticles along glaciers in the Spitsbergen (Svalbard) region exploiting a mobile platform, Atmospheric Environment, 170, 184--196 (2017).

K.M. Markowicz et al.; Vertical variability of aerosol single-scattering albedo and equivalent black carbon concentration based on in-situ and remote sensing techniques during the iAREA campaigns in Ny-Alesund, Atmospheric Environment, 164, 431--447 (2017)

B. Moroni et al.; Morphochemical characteristics and mixing state of long range transported wildfire particles at Ny-Alesund (Svalbard Islands), Atmospheric Environment, 156, 135--145 (2017)

K. M. Markowicz et al.; Impact of North American intense fires on aerosol optical properties measured over the European Arctic in July 2015, Journal of Geophysical Research: Atmospheres, 121, 14487--14512 (2016)

L. Ferrero et al.; Vertical profiles of aerosol and black carbon in the Arctic: a seasonal phenomenology along 2 years (2011-2012) of field campaigns, Atmospheric Chemistry and Physics, 16, 12601--12629 (2016) .

Chemical composition of Arctic aerosol: Water soluble organic compounds, trace and rare earth elements

E. Barbaro (1), A. Spolaor (1), M. Feltracco (2), C. Turetta (1), R. Zangrando (1), C. Barbante (1)(2) , A. Gambaro (1)(2)

1 – Istituto Dinamica dei Processi Ambientali (CNR-IDPA), Venezia, Italy
2 - Dipartimento di Scienze Ambientali, Informatica e Statistica - Ca' Foscari, Università di Venezia, Italy

Abstract

The atmospheric aerosol is an important pathway by which chemical compounds are transported both locally and on a global scale. It is extremely important to know the origin, geochemical composition and effects that the aerosol composition could have on a very sensitive environment such as the Arctic. Due to their distance from the principal emission sources, polar regions represent an important natural laboratory to study the atmospheric aerosol. Ten aerosol sampling campaigns were performed at Gruvebadet observatory close to Ny-Alesund in the Svalbard Islands (78°55'07''N, 11°53'30''E) from spring 2010 to spring 2019.

Aerosol samples were collected with a high-volume cascade impactor. This sampler allows the collection of airborne particles in five size classes with aerodynamic diameter ranges of 10-7.2 µm, 7.2-3.0 µm, 3.0-1.5 µm, 1.5-0.95 µm, 0.95-0.49 µm and <0.49 µm. The aerosol samples were analyzed to determine trace elements, rare earth elements and water-soluble-organic compounds (WSOC), such as ionic species, carboxylic acids, sugars (monosaccharides, disaccharides, alcohol sugars and anhydrosugars), free and combined amino acids and phenolic compounds.

The main aims are to better understand: (1) the distribution of each species among different particulate sizes, (2) the transport processes of aerosol towards the Arctic zone and 3) the inter-annual patterns of each species, using these compounds as specific markers for sources or processes. Free amino acids are determined for the first time in Arctic aerosol collected from 19 April to 14 September 2010 (Scalabrin et al., 2012). The ultrafine aerosol fraction (<0.49 µm) accounted for the majority of the total amino acid content in most samples. Cluster analysis and factor analysis for the ultrafine aerosol samples suggest the contribution of two sources of amino acids in Arctic aerosols: (1) regional and long-range transport from marine areas and (2) the influence of local sources such as marine primary production. Biomass burning markers were investigated in the aerosol samples collected during the 2010 campaign.

Levoglucosan concentrations, an unambiguous cellulose combustion tracer, derived from 2010 Russian fires. Phenolic compounds levels in the Ny-Ålesund atmosphere in different size fractions reflected both long-range transport linked to biomass burning and a terrigenous local source (Zangrando et al., 2013). Turetta et al. (2016) reported the results about the analysis of 39 elements and rare earth elements, and enrichment factors were used to distinguish between natural and anthropogenic sources.

The chemometric method was used to discriminate the sources of trace elements, rare earth elements and water soluble organic compounds in the aerosol samples with the aim to recognize anthropogenic input and inputs deriving from extreme and/or natural peculiar events (Turetta et al., 2016).

The first investigation of free and combined L- and D-amino acids in Arctic atmospheric particulate matter was performed using the aerosol samples collected from 4th April to 13th June 2015. Free and combined amino acids were mainly found in the fine aerosol fraction (<0.49 mm) and their concentrations could be affect by several sources, the most important of which were biological primary production and biomass burning (Feltracco et al., 2019). Finally, monosaccharides (arabinose, fructose, galactose, glucose, mannose, ribose, xylose), disaccharides (sucrose, lactose,

maltose, lactulose), alcohol-sugars (erythritol, mannitol, ribitol, sorbitol, xylitol, maltitol, galactitol) and anhydrosugars (levoglucosan, mannosan and galactosan) were measured in the Arctic aerosol collected during 2013, 2014 and 2015 sampling campaigns. This study presents the first results of sugar composition and concentration in the Arctic aerosol.

References

Feltracco, M., Barbaro, E., Kirchgeorg, T., Spolaor, A., Turetta, C., Zangrando, R., Barbante, C. and Gambaro, A.: Free and combined L- and D-amino acids in Arctic aerosol, Chemosphere, 220, 412–421, doi:10.1016/j.chemosphere.2018.12.147, 2019.

Scalabrin, E., Zangrando, R., Barbaro, E., Kehrwald, N. M., Gabrieli, J., Barbante, C. and Gambaro, A.: Amino acids in Arctic aerosols, Atmos. Chem. Phys., 12(21), 10453–10463, doi:10.5194/acp-12-10453-2012, 2012.

Turetta, C., Zangrando, R., Barbaro, E., Gabrieli, J., Scalabrin, E., Zennaro, P., Gambaro, A., Toscano, G. and Barbante, C.: Water-soluble trace, rare earth elements and organic compounds in Arctic aerosol, Rend. Lincei, 27, 95–103, doi:10.1007/s12210-016-0518-6, 2016.

Zangrando, R., Barbaro, E., Zennaro, P., Rossi, S., Kehrwald, N. M., Gabrieli, J., Barbante, C. and Gambaro, A.: Molecular markers of biomass burning in Arctic aerosols, Environ. Sci. Technol., 47(15), doi:10.1021/es400125r, 2013.

Aerosol Biogeochemical cycles, Sources and TRansport processes in the climate-sensitive ArCTic (ABSTRACT) – RIS 3693 - Gruvebadet Atmospheric Laboratory Project

R. Traversi (1), S. Becagli (1), M. Severi (1), L. Caiazzo (1), A. Amore (1), F. Lucarelli (2), S. Nava (2), G. Calzolai (3), M. Chiari (3), M. Malandrino (4), M. Grotti (5), F. Ardini (5), R. Salzano (6), A. Ianniello (6), G. Esposito (6), D. Cappelletti (7), B. Moroni (7), S. Crocchianti (7), L. Ferrero (8), E. Barbaro (9), C. Turetta (9), A. Viola (10), M. Mazzola (10), A. Lupi (10), M. Rinaldi (10), F. Belosi (10), V. Vitale (10)

1 – Dipartimento di Chimica "Ugo Schiff", Università di Firenze, Italy
2 – Dipartimento di Fisica e Astronomia, Università di Firenze, Italy
3 – Istituto Nazionale di Fisica Nucleare (INFN), Italy
4 - Dipartimento di Chimica, Università di Torino, Italy
5 - Dipartimento di Chimica e Chimica Industriale, Università di Genova, Italy
6 – Istituto sull'Inquinamento Atmosferico (CNR-IIA), Italy
7 - Università of Perugia, Italy
8 - Università of Milano-Bicocca, Italy
9 – Istituto Dinamica dei Processi Ambientali (CNR-IDPA), Venezia, Italy
10 – Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy

Abstract

The general aim of the project is to obtain a better knowledge of the complex processes characterizing the atmospheric BL and the sea-atmosphere exchanges in the Arctic region and new information about the feedback processes of the polar climate system to ultimately improve the model settings and to reduce the uncertainty on future scenarios. To this purpose, thanks to the funding granted by two MIUR-PRIN Projects (PRIN 2007"Dirigibile Italia" and PRIN 2009 "Arctica" – Scientific Responsible Prof. Udisti, University of Florence), a well equipped observatory for the study of the chemical and physical properties of the aerosol was set up at Gruvebadet (about 1 km south of Ny Ålesund village). Such an observatory has become the reference facility for the research on atmospheric aerosol carried out at Ny Ålesund by Italian and foreign research groups. An ensemble of samplings and direct measurements of particulate matter has been active since 2010 and it is still ongoing, all through the opening period of the CNR Base "Dirigibile Italia" (typically Feb – Sep) and for the first time also during winter, in 2018/19. The main tasks of the activities run at Gruvebadet within the present project are to highlight and apportion as reliably as possible the natural and anthropic sources and transport processes affecting aerosol by the determination of chemical proxies (ion and elemental composition, including trace metals; carbonaceous fractions as Elemental and Organic Carbon – EC/OC) on the collected samples and by continuous size distribution measurements. As concerning aerosol samplings devoted to chemical characterization, a number of sampling devices have been used, to collect bulk (PM10) and size-segregated (4-stage, 12-stage) aerosol with different time resolution (1-7 days) and on a different sampling material (Teflon, quartz, polycarbonate) as function of the targeted chemical species. The analytical methods used to measure the selected chemical species (IC, ICP-AES, ICP-MS, PIXE, Thermo-Optical Analyzer) were carefully optimized for sensitivity and reproducibility in order to achieve reliable data. During specific periods, natural radioactivity of Rn progeny was also measured by means of a PBL mixing monitor, to study the relation between radioactivity and the mixing state of the lower atmosphere. Besides the continuous sampling activities, spot sampling campaigns were carried out for specific purposes, such as the mineralogical characterization by single particle analysis (SEM), to be compared with measurements performed during vertical profiles by tethered balloons. Moreover, the collected samples have been used also for the study of ice nucleating particles, in relation with their chemical composition. As concerning direct measurements of aerosol optical and physical properties, a nephelometer, a PSAP and two particle counters covering different

size ranges (namely, SMPS 10-487 nm – and APS 500-20 um) have been run since 2010 as well, yielding data of scattering and absorption coefficients and particle size distribution, allowing spotting in real time sudden or long-term episodes of higher atmospheric load, due to specific advection processes, often of anthropic origin. Joining this data set with the chemical composition has shown the occurrence of recurring transport processes (Arctic Haze) or short and intense events (i.e. biomass burning or, more rarely, pollution from the nearby village). A large chemical and size distribution data set was produced by this project, covering the spring-summer season since 2010 up to nowadays and so far various valuable results were provided in terms of publications and scientific contributions. Nonetheless, a substantial work of chemical analysis and data processing is needed to merge the different data sets and the cooperation among all the groups within the projects working at Gruvebadet will represent a pivotal asset to achieve the best possible results from the present and future activities.

Elemental composition and isotopes of lead in atmospheric particulate matter collected in Ny-Ålesund

M. Malandrino (1), M. Grotti (2), O. Abollino (1), A. Giacomino (3), S. Buoso (1), E. Conca (1), F. Ardini (2), A. Bazzano (2), S. Bertinetti (2), M. Severi (4), S. Becagli (4), R. Traversi (4)

1 - Dipartimento di Chimica, Università di Torino, Italy
2 - Dipartimento di Chimica e Chimica Industriale, Università di Genova, Italy
3 - Dipartimento di Scienza e Tecnologia del Farmaco, Università di Torino, Italy
4 - Dipartimento di Chimica, Università di Firenze, Italy

Abstract

Chemical composition of airborne particulate matter can influence climatic changes, altering the mechanisms of cloud formation and the radiative balance of the atmosphere. This mainly happens in polar regions, because they play a key role in the regulation of the global climate system. For this reason, the identification of local and global sources and the understanding of transport and deposition processes of polar particulate matter is very important. In this study, we have determined major, minor, trace elements and lead isotopes in PM10 collected at Ny-Ålesund (Arctic), to identify the emissive sources and to understand the short and long-range transport processes, as well as their possible future evolution. Concerning the inorganic composition, the results obtained for PM10 Arctic samples collected during four sampling campaigns show a remarkable seasonal trend for most of the elements investigated. For all the samples, the enrichment factors were calculated with respect to the average values of the earth's crust reported by Turekian and Wedepohl, to be able to distinguish between elements having crustal, anthropic or mixed origin. The concentrations of typically geogenic or anthropogenic elements were generally higher in March and April months, when the soil is still almost completely covered by snow and ice; consequently, these elements are probably affected by long-range transport processes. As for the characteristic elements of marine aerosol (for example Mg and Na) and some elements often considered markers for ship emission (i.e. Co, Ni and V), a peak concentration was detected in late spring and summer, coinciding with the period of maximum ship traffic. From the analysis of variance (Kruskal-Wallis test) it emerged that, for most analytes, the four campaigns considered are not significantly different; therefore, during the period considered, the composition of the atmospheric particulate matter at Ny-Ålesund did not change significantly. The Principal Component Analysis (PCA) and the Hierarchical Clustering Analysis (HCA) have allowed us to make hypotheses on the main sources of the different groups of identified elements. Concerning the determination of atmospheric lead, during the 2010-2014 campaigns most of the atmospheric lead was found to be of anthropic origin, with no significant inter-annual difference ($p > 0.1$) in terms of concentration or isotopic composition. Instead, a strong seasonality was found, with higher concentrations in spring than in summer ($p < 0.001$). In particular, the isotopic analysis of the atmospheric particulate matter, combined with the study of back trajectories of air masses, allowed to associate the spring contribution to mining activities in the Russian region of Altai, and the summer contribution to industrial emissions from the north-eastern regions of Canada and United States. In 2013, however, the concentration of lead was similar in the two seasons, as well as its origin from the Eurasian regions. The presence of these annual anomalies underlines the need to monitor the area for prolonged periods of time, in order to study the causes and possible trends of these variations.

Monitoring of surface solar UV irradiance and ozone column at Svalbard

B.H. Petkov (1), V. Vitale (1), M. Mazzola (1), A. Lupi (1), A. Viola (1), F. Zardi (1), C. Rafanelli (2)

1 – Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
2 – Associated Researcher (CNR-ISAC), Italy

Abstract

Solar ultraviolet (UV) radiation reaching the ground is an important environmental parameter able to influence the biota and photochemical reactions. The intensity of this spectral band closely depends on the ozone column (OC) and these two parameters are usually jointly observed. The OC measurements at Ny Ålesund by Italian team started in 1990 using Brewer 050 spectrophotometer that, before the opening of Dirigibile Italian station was hosted on the roof of the French station. Latter, in 2008 the observations of UV irradiance and OC were intensified by involving the narrow band filter radiometer UV-RAD developed at ISAC-CNR, Bologna, in cooperation with ENEA, which provided the optical elements and the monitoring activity started through the RiS 3305 U-VIVA project. UV-RAD was installed on the terrace of Sverdrup station and has operated regularly until now, with a gap in 2013.

It also participated to a couple of intercomparison campaigns, while Brewer spectrophotometer worked with some discontinuity and holes for lack of resources. Recently, also Brewer measurements re-started on a more regular base: a calibration of the spectrophotometer were performed in the summer 2018, UV flux measurements were added to OC observations and for better maintenance the instrument was moved near UV-RAD on the Norwegian station terrace.

Considering this large and long activity carried out by Italian researchers, and other similar activities carried out by different national along Svalbard, in 2013 a working group devoted to UV and ozone issues, leaded by CNR, was created in the frame of the Atmospheric Flagship Programme(AFP, http://nysmac.npolar.no/research/flagships/atmosphere.html). Discussions and work developed by this AFP working group, leaded to the decision in 2016 to promote an action to integrate the efforts of all researcher teams performing similar studies at Svalbard and create a regional network with the aim to provide a more complete picture about the level of UV radiation, spectral features, seasonal and interannual variability so that to from scientific products useful to different users.

Thanks the support of a Strategic Grands founded by the Svalbard Science Forum, a first step of this initiative, an intercomparison campaign performed at Ny-Ålesund in April 2018 (RiS 10871), where the instruments working at Longyearbyen and Hornsund were compared with the local devices, was performed.

Results showed an acceptable consistence among the radiometers and then the possibility to establish a network. Currently, the inter-institutional team is working on organisation issues like data flow and format, quality check, storing, developing of software for initial processing of the data from different station in order to achieve integrated data products for potential users.

In addition to the work for establishing a network, with the aim to present the status and trends of UV and OC at Svalbard Archipelago, another task for this team was the analysis of available data sets that outlined specific features of variations in these two parameters.

Such an analysis, presented through a chapter of the first SIOS Svalbard Environmental Science Status (SESS) report revealed on the other hand variety of scientific problems that could be resolved jointly with scientific groups working in other fields, like cloud properties, snow cover, aerosol features and so on. In the talk, a brief overview of all above indicated activities and achieved results will be provided together with future perspective for the network, the cooperation with other stations and other countries, as well as possibilities to develop cross-cutting activities.

Study of the High-Latitude auroral activity, Space Weather and Sun-Earth relationship

S. Massetti

Istituto Nazionale di Astrofisica (INAF), Italy

Abstract

Since 1999, ITACA (*ITalian Allsky Camera for Aurora observations*) is monitoring the high-latitude aural activity from Ny-Ålesund (Svalbard) during the wintertime, at three reference wavelengths (427.8 nm, 557.7nm, 630.0 nm). It participates to the MIRACLE (*Magnetometers - Ionospheric Radars - Allsky Cameras Large Experiment*) international network, devoted to mesoscale studies of the auroral activity. Thanks to its geographical position, ITACA is perfectly located for monitoring the dayside auroral activity associated to the geomagnetic cusp, and produced by the direct precipitation of the Solar Wind plasma. For about 4 years, from 2002 to 2006, ITACA had a twin instrument located on the northeast coast of Greenland, at about the same magnetic latitude. The two instrument allowed joint observations of the high-latitude auroral events over a wide region: FOV = 20° Lat x 130° Long, at about 400 km of altitude.

Oceanography and Marine research

Italian Marine Arctic Experimental Infrastucture in Ny-Ålesund, Svalbard - IMEI

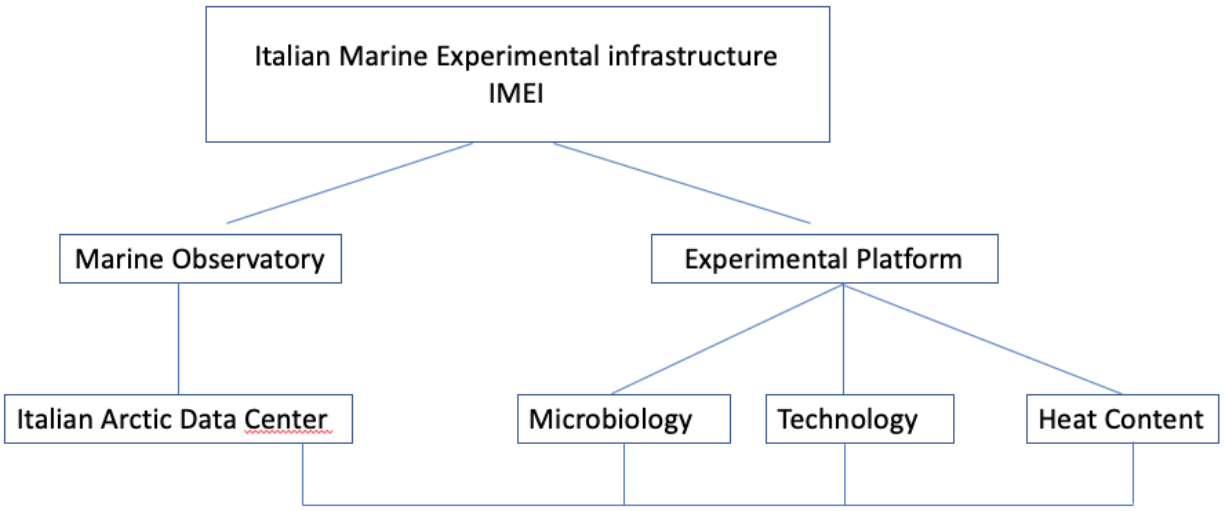
S. Aliani (1), R. Sciascia (1), F. Giglio (1), S. Miserocchi (1), P. Giordano (1), T. Tesi (1), A. Viola (2), M. Mazzola (2), V. Vitale (2), I. Conese (1), M. Azzaro (3), G. Zappalà (3), G. Bruzzone (4), L. Langone (1)

1 – Istituto di Scienze Marine (CNR-ISMAR), Italy
2 – Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
3 - Istituto per le Risorse Biologiche e le Biotecnologie Marine (CNR-IRBIM), Italy
4 - Istituto sui Sistemi Intelligenti per l'Automazione (CNR-ISSIA), Italy

Abstract

Observing systems are the tool to study climate change when they provide the basic information to assess changes: time-series of good quality data. Marine observatories historically involved the collection of physical data as seawater temperature and salinity, but, in relative recent time, timeseries have been improved with relevant data about C fluxes and other climate related variables., e.g. nutrients, DMS or dissolved CO_2, also thanks to improved technology of measurements. Parallel to data collection by moored instruments, time-series are also derived from regular hydrological survey and CTD casts. Although these CTD surveys do not have the robust time coverage of moorings, they are often replicated on a regular basis, resulting in a time-series. The marine observing system in Ny-Ålesund provides a full coverage of the major ocean variables relevant to monitor climate-related changes in Arctic sea water properties. It has been built around the permanent mooring Dirigibile Italia and has been improved with other measurements and observations. Italian moorings were first deployed at sea in September 2000 and 2001 in a site that was in the innermost part of the fjord at that time (Aliani et al., 2004). Melting of tidewater glaciers' ice tongues produced in big changes in Ny-Ålesund and the mooring Dirigibile Italia, which is the core of the present-day observing system, has been positioned close to the inner moraine. Sediment traps and new sensors were added to the traditional CT recorders and regular CTD surveys were performed within FIKO project during moorings maintenance, resulting in a large data set every year since September 2010 when the mooring was first deployed. These data after Quality Control will be delivered to the CNR Arctic Data Center and available for modelling. Taking advantage of the presence of Dirigibile Italia marine observatory, experiments have been performed in Ny-Ålesund about the microbial communities in seawater and about the technological exploitation of autonomous vehicles for measuring in extreme and very dangerous environments as the glacier's front, which successfully brought an instrumented AUV to touch Kronebreen glacier (Zappalà et al., 2016, 2017). Time-series of thermohaline properties from the mooring Dirigibile Italia (MDI) revealed a large seasonal variability (θ = -1.82 / 6.26°C, S = 34 / 35) and from the beginning of the time-series an increasing trend in temperature (0.07 °C y^{-1}) was measured showing constant minima, and progressively higher warm peaks. An average total mass flux (TMF) of about 20 g m^{-2} d^{-1}, with the highest peaks recorded in summer-fall months (avg. flux, ~100 g m^{-2} d^{-1}) and reduced fluxes in autumn-winters (avg. flux, ~7 g m^{-2} day-^{1}). The terrestrial input due to the melting of glacier terminations generated an increase of the detritus, and the surface runoff introduced debris into the sea from the permafrost surface layer erosion (D'Angelo et al., 2018). All this variability may affect prokaryotic and phytoplanktonic biomass and microbial remineralization rates over short time scales (Azzaro et al., 2017; Caroppo et al., 2017). Nowadays, the Italian marine experimental platform has two pillars. The first is the marine observatory centered on the mooring(s) MDI which will deliver oceanographic data to IADC. The second pillar is the experimental platform that derives from the presence of the marine observatory, which is used for dedicated experiments. Together with Climate Change Tower atmospheric measurements, they are a solid and multidisciplinary approach to monitoring climate change in the Arctic.

Table 1. Schematic diagram of Italian marine infrastructure in Ny-Ålesund, with examples of some experiments



Passive acoustic monitoring of Kongsfjorden

G. Buscaino (1), M. Ceraulo (1), R. Grammauta (1), E. Papale (1)(2), S. Mazzola (1)

1 - Istituto per lo studio degli impatti Antropici e Sostenibilità in ambiente marino (CNR-IAS), Italy
2 - Dipartimento di Scienze della Vita e Biologia dei Sistemi, Università di Torino, Italy

Abstract

The Bioacoustics Lab of CNR-Capo Granitola since 2014 is monitoring the Kongsfjorden. This activity was funded by two projects of the Norwegian Research Council (AFG 2015 - KUAM - Underwater Acoustic Monitoring in Kongsfjorden, Svalbard for bio-glacio-seismo-logical studies; KLIMAFORSK - CALVINGSESIS - Glacier dynamic ice loss quantified through seismic eyes). Data were collected since February 2014 through three autonomous passive acoustic recorders deployed at three sites: the first is located in the inner Kongsfjorden (coordinates 78°54.74' N - 12°24.31' E) at a distance of approximately 4 km from the Kronebreen glacier front, one of the larger fast-flowing and actively calving marine-terminating glacier streams in the Svalbard Islands; the second is at the mouth of the fjord (79°03.22' N - 11°32.83'E), about 27 km away from the Kronebreen glacier and the third is located near the Ny-Alesund harbour, in the middle of the fjord. Acoustic recordings contain information about biological activities of species producing sound (i.e. sound from *Gadidae* fish, marine mammals, crustaceans) and ice dynamics, both as icecalving events from tidewater glacier and sea ice presence and melting. The analysis of these data already allowed the study of bearded seal vocalizations and their spatio-temporal distribution in relation to environmental conditions such as light and ice presence (Parisi et al, 2017; de Vincenzi et al, under review), and a calving quantification from seismic and hydro-acoustic observations calibrated with lidar volume measurements (Köhler et al, in prep). Other analyses are in progress and some results will be shown during this Workshop (see the poster Buscaino G et al: Seasonal distribution of vocalizations and analysis of some acoustic parameters of haddock fish Melanogrammus aeglefinus in Kongsfjorden; Papale et al: Detection of the acoustic presence of beluga whale (Delphinapterus leucas) in Kongsfjorden; Alonge et al: A new methodology to study the ice calving event using underwater acoustic data; Giacalone G et al: Acoustic pattern recognition of water column structures in front of marine-terminating glacier Kronebreen using multibeam data). Long term passive acoustic monitoring is allowing the study of the abundance and spatial distribution of many species of animals producing sounds but also an high resolution study of the dynamics of Kronebreen ice loss. This information together with data available from other monitoring systems will support the understanding of the effects of climate change on the Arctic marine ecosystems.

References

Parisi I., De Vincenzi G., Torri M., Papale E., Mazzola S., Bonanno A., Buscaino G. Underwater vocal complexity of Arctic seal Erignathus barbatus in Kongsfjorden (Svalbard) (2017) Journal of the Acoustical Society of America, 142 (5), pp. 3104-3115.

Köhler A., Petlicki M., Lefeuvre PM., Buscaino G., Nuth C., Weidle C. Calving quantification from seismic and hydro-acoustic observations calibrated with lidar volume measurements. To be submitted to "The Cryosphere".

Multi-year particle fluxes in Kongsfjorden, Svalbard

L. Langone (1), F. Giglio (1), S. Miserocchi (1), P. Giordano (1), A. Sanchez-Vidal (2), S. Aliani (1), T. Tesi (1), A. Viola (3), M. Mazzola (3), I. Conese (1), A. D'Angelo (1)

1 – Istituto di Scienze Marine (CNR-ISMAR), Italy
2 - Universitat de Barcelona, Spain
3 – Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy

Abstract

Over the last decades, the Arctic area has experienced faster environmental changes than any other regions on Earth in response to global warming. The Arctic amplification may be due to feedback mechanisms from loss of sea ice and changes in atmospheric and oceanic circulation. Kongsfjorden is a small Svalbard fjord whose glaciers are rapidly retreating. However, how the land-to-ocean fluxes of particulate matter are changing in the fjord remains elusive. Here, we show results from a mooring deployed in the inner fjord since 2010 that collected multiannual time-series, monitoring the interaction between the entering Atlantic water (AW), melting glacier water and local winter water. Thermo-haline properties reveal a large seasonal and interannual variability (θ = -1.91/6.87°C, S = 34.10/35.28) with greater AW intrusion in November. Middle and bottom water temperatures generally follow the same pattern, although periods of water stratification occur. Bottom temperatures show a consistent increasing trend of 0.16 °C y^{-1} during the period investigated. Currents are generally <10 cm/s. The average total mass flux (TMF) is 20 g m^{-2} d^{-1}, with relatively higher peaks in summer (~100 g m^{-2} d^{-1}) and reduced fluxes in autumn-winters (~7 g m^{-2} d^{-1}). Notably, in summer 2013, TMF reached ~330 g m^{-2} d^{-1}. Lithics and clastic carbonates released by glacier and iceberg melting are the most abundant components. During May-June, higher contents of $bSiO_2$ and OC with heavier $\delta^{13}C$ show a higher fraction of marine organic matter by diatom production. The complex interplay of processes driving the particle supply of autochthonous (marine) and allochthonous (terrestrial) origin in Kongsfjorden will be elucidated, and some inferences on possible future changes in particle fluxes for arctic fjords are suggested in a climate warming scenario.

Ocean Heat content in Kongsfjorden, Svalbard

S. Aliani (1), R. Sciascia (1), F. Giglio (1), S. Miserocchi (1), P. Giordano (1), T. Tesi (1), A. Viola (2), M. Mazzola (2), I. Conese (1), A. D'Angelo (1), L. Langone (1)

1 – Istituto di Scienze Marine (CNR-ISMAR), Italy
2 – Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy

Abstract
The warming trend of seawater experienced in the Arctic region results in changes in water properties with complx interactions with surrounding environment. Increased water temperature is expected to enhance tidewater glacier melting. This process had been widely reported in Greenland and Svalbard, and one possible reason has been addressed in the inter-action of warming ocean water with the portion of the ice terminus in contact with the sea. Five major tidewater glaciers are in n Kongsfjorden, positioned in the innermost part of the fjord. The innermost part of the fiord records a periodic intrusion of warm water of Atlantic origin. These warm veins provide a large part of the heat for melting of tidewater glaciers. Temperature itself is not a good descriptor of the process as Ocean Heat Content (OHC). Of course the two variables are related but the second also consider the total amount of heat and depends also on the volume of warm water. In fact, OHC estimates were based on calculations of the volume of water in the major basins of Kongsfjorden as inferred by a dedicate and accurate bathymetric survey and by CTD casts. Ocean water temperature after interaction with freshwater of glacial origin drops up to 2 ‰. We calculated OHC over a profile ranging from the lower limit of surface fresh water exiting the fjord (-7.5m) to 30 m depth m, assuming deeper heat was not relevant to regularly interact with glaciers because of the depth of the submerged moraine. OHC in outer area was 4.66 10^{16} J, whereas in the southern part was $1.47 \cdot 10^{16}$ J and was $1.17 \cdot 10^{16}$ J in the northern part of tidewater glaciers fronts. Changes in the thickness of warm water results in impressive changes in OHC at glaciers' intefaces.

Disentangle local and remote contamination in fjord ecosystem of the high Arctic: The Kongsfjorden (Svalbard, Norway) as model system

N. Ademollo, J. Rauseo, T. Pescatore, F. Spataro, L. Patrolecco

Istituto di Ricerca sulle Acque (CNR-IRSA), Italy

Abstract

The polar oceans are the final sink for many semi-volatile organic contaminants, which, thanks to the atmospheric transport and to the cold condensation, concentrate in these areas. The decrease of sea ice, as well as the presence of snow and the mechanism of ice formation/melting, can have a big impact on the carbon cycle, on the mobility of contaminants and on the biodiversity loss (VandenBrink, 2011). Indeed, the list of chemicals found in Arctic ecosystems are continuously growing and for some current-use chemicals increasing temporal trends have been reported (NCP, 2013). The study of the composition of Dissolved Organic Carbon (DOC) and the occurrence of organic contaminants is of strategic importance to describe the circulation of nutrients and the impact of allochthonous sources on the marine ecosystem. Anthropogenic impacts can change the quality of the natural DOC, with repercussions on the spread, persistence and bioavailability of allochthonous organic matter, including the fate of some persistent organic pollutants and their possible toxic effects. In the present work the results obtained within the sampling campaigns carried out in the Arctic Station "Dirigibile Italia" (Ny-Ålesund, Svalbard, 79° N 12° E) in two different seasons (June 2016 and March 2017) are shown. The Kongsfjorden Bay ecosystem is a high–latitude (sub)-Arctic fjord, influenced by both the Atlantic water masses of the WSC (West Spitsbergen Current) and the Arctic-type coastal waters as well as a glacial input of melt water (Svendsen et al., 2002). The experimental design included surface water sampling along a transect of the fjord in order to assess presence, distribution and contamination levels of some persistent and emerging organic contaminants like PFAAs, PCBs; PAHs; nonylphenols (NPs) and bisphenol A (BPA). At the same time, by using a tangential-flow ultrafiltration system, dissolved organic matter (DOM) was characterized according to its main molecular size fractions (colloidal and truly dissolved). Statistical analyses were conducted following the information-theoretic approach (Burnham & Anderson, 2002). The model on PCB concentrations supported the additive effect of season and distance from the glacier, but not their interaction: PCBs were higher in June than in March and decreased with increasing distance from the glacier in both sampling seasons. PAHs, NPs and BPA levels were affected by the additive effect of distance from both the glacier and the harbour, but not by the season: PAHs, NPs and BPA decreased with increasing distances from the glacier and the harbour, independently from the month. PFAA concentrations were not influenced by the distance from the glacier or the harbour. DOC decreased with increasing distance to glacier in both seasons, but this trend was stronger in late winter. Overall, DOC was higher in late winter and it was also influenced by the distance from the harbour: it decreased with increasing distance from this latter in both seasons. This trend highlights the release of POPs from melting glaciers acting as secondary sources of legacy pollutants. Unexpectedly, POP values found at the end of the polar winter were not significantly lower than the summer ones: the absence of solar irradiation and the lower temperature of seawater probably inhibited the degradation of these xenobiotics, competing with the greater anthropogenic pressure and the ice melting inputs occurring in the spring-summer period.The ongoing research concerns the determination of "old" and "new" emerging contaminants (pharmaceuticals compounds including antibiotics) in the water column and in surface sediments, in order to better understand their dynamics in the fjord and to disentangle the role of point-sources and seasonality in the fate of the material released into the water column after ice melt. The studies on sediments are in collaboration with the project "Fiko-Freshwater Input in the KOngsfjorden" (P.I. Dr. Federico Giglio).

Trace elements in Kongsfjorden: Occurrence, Sources and Bioavailability

F. Ardini, P. Rivaro, A. Bazzano, M. Grotti

Dipartimento di Chimica e Chimica Industriale, Università di Genova, Italy

Abstract

The main goal of the research project is to obtain a better knowledge of the occurrence, bioavailability, sources and transport pathways of trace elements in the marine environment of Kongsfjorden. In order to achieve this task, oceanographic activities in the fjord and extensive analytical work have been carried out to measure hydrological (e.g. temperature, salinity), biological (chlorophyll a) and chemical (nutrients, major and trace elements associated to suspended particulate matter) parameters for the sea surface and water column. The sources of trace elements have been evaluated by computing the enrichment factors and measuring lead isotope ratios ($^{208}Pb/^{207}Pb$ and $^{206}Pb/^{207}Pb$), compared with the isotopic signature of the atmospheric particulate and marine sediments collected in the same area. During the 2012 and 2014-2015 campaigns, it was found that natural input from the glacial runoff was the main source for Al, Co, Fe, K, Ti and V, whereas the intrusion of Atlantic waters is a major pathway to introduce Ba, Cr, Cu, Mn, Mo, Ni, Pb and Zn of anthropogenic origin from low and middle latitudes to this Arctic fjord. The relevance of these sources depended on both the sampling site and period. In particular, the influence of the natural source decreased by moving far from the front of the glaciers, while the effect of the Atlantic waters was more relevant at the mouth of the fjord compared to the inner basin. Finally, the effect of both sources was higher at the end of the summer season than in late spring. The actual bioavailability of trace elements for the marine ecosystem have been assessed by analysing the solid speciation patterns of heavy metals in surface sediments. The total concentration of 18 elements has been determined in two granulometric fractions (<63-µm and <2000-µm) and their bioavailability evaluated by both applying a sequential-selective extraction procedure and using a biomimetic approach based on proteolytic enzymes. Total concentration values and solid speciation patterns indicated overall that the anthropogenic impact of trace elements in the investigated area is negligible, although a minor enrichment with respect to crustal values was found for As, Cd, Cr, Ni, and V. Enrichment of trace elements in the <63-µm fraction compared to the coarser one was evident for As, Cd, Cr, and Ni. The evaluation of the bioavailable fractions showed that a large part of the total content of trace elements cannot enter the aquatic food chain and emphasised the risk of overestimating the environmental impact of heavy metals if the assessment is only based on total concentrations.

Microbiological research in the Kongsfjorden

F. Azzaro, M. Azzaro, G. Caruso, A. Cosenza, F. Crisafi, F. Decembrini, R. Denaro, R. La Ferla, M. Leonardi, A. Lo Giudice, G. Maimone, M. Papale, A.C. Rappazzo, R. Zaccone, G. Zappalà, E. Crisafi

Istituto per le Risorse Biologiche e le Biotecnologie Marine (CNR-IRBIM), Italy

Abstract

Since 1988, researchers at the CNR in Messina are investigating on the roles and diversity of prokaryotes in polar areas, with a focus on Antarctic and peri-Antartcic sites. In the framework of three distinct research projects (i.e. PolyArc, MYKA and ARCA), in the last ten years research efforts have been also devoted to the Arctic marine environment, including the Kongsfjorden in the Svalbard Islands. The microbial community plays a pivotal role within the Arctic trophic web, driving several processes such as the primary production, the turnover of biogenic elements, the organic matter degradation and the mineralization of xenobiotics and contaminants. In this context, a number of methodological approaches and sampling strategies have been adopted during field activities, taking into account logistic constrains and available resources. Our multi- and interdisciplinary studies have been mainly addressed to 1) the prokaryotic community structure and composition in sediments and seawater (*in collaboration with the University of Messina, University of Jyvaskyla and Amalfitano S., IRSA-CNR in Rome*), 2) the short-term evaluation of microbial and biogeochemical trends along the water column (*in collaboration with the University of Rio de Janeiro and Miserocchi S., ISMAR-CNR in Bologna*), 3) the isolation and characterization of bacteria able to potentially degrade persistent contaminants, such as PCBs and PAHs (*in collaboration with Giannarelli S., University of Pisa*), 4) the occurrence of fitoplanktonic blooms and potentially toxic algae (*in collaboration with Caroppo C., IRSA-CNR in Taranto*), and 5) the microbial community activities, roles and diversity in seawater just beneath glaciers by the utilization of a multi-sampler apparatus, which was designed in collaboration with colleagues at INM-CNR in Genoa (*Caccia M. And Bruzzone G. who have conceived several Autonomous Underwater Vehicles, AUVs*). This latter research topic certainly represents a challenge for future investigation in the Arctic. In fact, AUVs allow gaining the acquisition of environmental and biological data from sites that are inapproachable for man due to logistic problems, thus ensuring safe sampling activities.

The Arctic fish fauna: focus on the Kongsfjorden

L. Ghigliotti, E. Carlig, D. Di Blasi, M. Vacchi, E. Pisano

Istituto per lo studio degli impatti Antropici e Sostenibilità in ambiente marino (CNR-IAS), Italy

Abstract

The fish fauna is an essential component of Arctic marine ecosystems, accounting for about 60% of the upper-trophic level consumption. In the Arctic, fishes are also important living resources for human populations. Despite their key ecological role, and the need to support sustainable fishery with robust knowledge on species and ecosystems, current information on the Arctic ichthyofauna is still poor. This is even more paradoxical considering that, as a consequence of the ongoing climate change, the marine Arctic is changing at an unprecedented rate. In the past few decades, Arctic fishes are being faced significant changes in environmental factors, such as increased seawater temperature and reduced sea-ice cover, resulting in habitats modifications, or even loss. Spatial distributions are being shifted and zoogeographical patterns are varying, but the lack of reliable baselines from the Arctic region makes footprints of climate change in the area hardly discernible. The collection of adequate baseline data on marine arctic fish species and assemblages is therefore urgent to interpret current changing scenarios, and to infer future consequences. In this frame, the project Aristotle (RIS 10987 - Arctic fIsh diversity: snapshots from Svalbard area) is aimed at improving current information on the Arctic fish by focusing on the Kongsfjorden, a glacial fjord influenced from both Atlantic and Arctic water masses. Its peculiar hydrography makes this Kongsfjorden a good example of transition zone, and an ideal natural laboratory to study the potential influence of hydrographic regime shifts on the local fish fauna and ecosystems. Current knowledge on the fish fauna of Kongsfjorden is incomplete and patchy, suffering from limitations on spatial and temporal scales, as well as from biases linked to fishing gear selectivity. Information on the deep water fish fauna dates back to over twenty years ago. A vessel based trawl survey highlighted the dominance of the polar cod (*Boreogadus saida*), a typical Arctic species, in the pelagic and benthic realms; Arctic species, such as the Greenland halibut (*Reinhardtius hippoglossoides*) and the European sculpin (*Artediellus europeus*), as well as Boreal species, such as the Atlantic cod (*Gadus morhua*), were found to co-occurr in the fjord. The Boreal gadid haddock (*Melanogrammus aeglefinus*) was abundant in the outer fjord. The shallow waters fish community of the Kongsfjorden was investigated in more recent times by a combination of direct visual census and biological sampling.

The distinct dominance of the shorthorn sculpin (*Myoxocephalus scorpius*) was reported. The project Aristotle aims at contributing to fill knowledge gaps on the fish fauna of the Kongsfjorden by studying: i) the fish diversity at chromosomal level; ii) the local fish community through non-invasive video technologies. In July 2018, owing to the logistic support of CNR, a first field activity was held in Kongsfjorden. A total of 22 sampling stations were performed in the outer and middle zone of the fjord, and the efficacy of selected scientific fishing gears was tested. The survey allowed to detect the presence, in large quantities, of two boreal gadid species, *M. aeglefinus* (abundant in the outermost part of the fjord), and *G. morhua* (small size specimens in shallow waters, in close vicinity of Ny-Ålesund). *B. saida*, once dominant in the fjord, was not collected. These observations are coherent with the described poleward range shift, general to the Arctic, with migration northward of boreal species and retraction of Arctic fish. However, a throughout assessment of current distribution and abundance of *B. saida* in the Kongsfjorden would require further investigations also taking in consideration the biological and ecological features of the species, and its relation with the sea-ice.

Biological sampling resulted in the preparation of 36 chromosome suspensions from three species, *G. mohua*, *M. aeglefinus* and *M. scorpius.* Preliminary analyses of chromosomes from *M. scorpius*, allowed to describe, for the first time, the chromosomal set for the species in the area, and revealed an interesting intra-specific variability entailing a degree of genome plasticity for the species, with possible positive implications on adaptive capability. The chromosomal suspensions obtained in the frame of the Aristotle project will be part of the Polar Fish Chromosome Archive, a chromosome preparation repository that is being established as a biological resource for the polar community, making available the cytogenetic samples for a wide range of applications, from species characterization and identification to genome adaptation.

Cryosphere

Isotopic signatures, physical-chemical features and flow rates of glacial drainages in the Ny-Ålesund area, Svalbard

M. Doveri, I. Baneschi, E. Calvi, M. Lelli, A. Provenzale, B. Raco, S. Trifirò

Istituto di Geoscienze e Georisorse (CNR-IGG), Italy

Abstract

The monitoring of glacial meltwaters, which are transferred to the ocean, can represent a valid tool for tracing changes on climate conditions and their effects. Most of the Svalbard fjords are affected by freshwater and sedimentation from glaciers and riverine inflow, as well as sea-ice dynamics from seasonal ice formation and melt (e.g. Svendsen et al., 2002). Moreover, many glaciers on Svalbard are retreating and have shown decreasing glacier volume (e.g. Nuth et al., 2007). Several studies (Boike et al., 2018) focused on Bayelva catchment (near Ny-Alesund), which includes Austre and Vestre Brøggerbreen glaciers, highlight changes in the weathering environments and drainage network. In this framework, the main goals of ISMOGLAC project are: (1) gain more knowledge about the dynamics of glaciers melting and the complexity of the distributed drainage systems; (2) recognize and quantify the meltwater contributions to the total stream water of glacial systems, and (3) estimate the total input of freshwater and suspended solids in the Kongsfjorden.

The project started in 2015 and the activities consist of a periodical monitoring of isotopic and physical-chemical parameters (water isotopes: $\delta^{18}O‰$, $\delta^{2}H‰$; temperature, electrical conductivity, pH, alkalinity, concentration of the major, minor and trace elements; Total Suspended Solids; carbon-stables isotopes of suspended solids), which are related to inland glacier drainages, snow and ocean water into Kongsfjorden. Furthermore, we carry out flow rate measurements by ultrasound flowmeter and/or the dilution method in order to quantify the contribution of each glacial drainage to the total stream water of glacial systems and to the ocean.

The inland field-work regards glacial streams that originate in supraglacial, englacial and subglacial zones of Austre and Vestre Brøggerbreen glaciers, Midtre LovenBreen and KonGsVegen. Seawater sampling is performed in several points, moving from the Ny-Ålesund coastline towards the inner part of the fjord. Moreover, since 2016, a system for continuous monitoring of temperature and electrical conductivity has been installed on the Bayelva River, which drains the meltwaters of the Vestre and Austre Broggerbreen glaciers.

The preliminary results of the ISMOGLAC project (Doveri et al., 2017) point out chemical and isotopic differentiation 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. Moreover, a very significant variation is observed at each monitoring points at several time scales. The evolution of flow rates, isotopes signatures and physical-chemical parameters seems to suggest different rates of mixing among different components of meltwater (e.g. supraglacial, englacial -subglacial), which contribute to the total glacial streams.

For the seawater, the results highlight the interaction between freshwater coming from main glacier drainages on the southern coastline of the fjord and sea water collected at different sites inside the fjord. The relation depth-$\delta^{18}O$ (also δD) shows that upper layer water in Kongsfjorden is significantly affected by glacial melt. Indeed, the $\delta^{18}O$ and δD represent a suitable tracer to identify high-latitude freshwater sources and, more in general, to study the relationship between ocean water and glacier meltwater. Summarizing, this work points out the complexity of the processes of the glacial melting and sensitivity to climate. Hence, a multidisciplinary study, which ensures the integration of different approaches and methods, is therefore mandatory in order to address these issues.

References

Boike J. et al. 2018. Earth Syst. Sci. Data, 10: 355
Doveri M. et al. 2017. Book of Abstracts-The Svalbard Science Conference 2017, 62.
Nowak A. and Hodson A. 2014. Polar Res., 33: 22779.Nuth C. et al. 2007. Annals of Glaciology, 46: 106.Svendsen, H. et al. 2002. Polar Res., 21: 133.

Permafrost, active layer thickness and related morphology changes monitoring

M. Guglielmin (1), S. Ponti (1), N. Cannone (2), A. Viola (3), M. Mazzola (3), V. Vitale (3)

1 - Dipartimento Scienze Teoriche ed Applicate, Università degli Studi dell'Insubria, Varese, Italy
2 - Dipartimento Scienze ed Alta Tecnologia, Università degli Studi dell'Insubria, Como, Italy
3 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy

Abstract

Permafrost plays an important role in the Earth System underlying 25 % of the terrestrial parts of Planet Earth. The monitoring of essential climate variables (ECVs) for permafrost is delegated by the World Meteorological Organization to the Global Terrestrial Network on Permafrost, GTN-P, established in 1999. Among these ECVs two are related to the permafrost: active layer thickness (ALT), that reacts annually to the climate input, and permafrost temperature, that reacts to annual up to multi century climate input depending from the depths. Svalbard has the warmest permafrost this far north. However, permafrost observations in Svalbard has a much shorter history than in most other Arctic areas, particularly compared to the large permafrost areas in Russia or Canada, where permafrost thermal observations started in the 1970's. With the aim of contributing to these observations, since July 2013 on a relatively flat area close to Climate Change Tower (CCT) a 50 x 50 m grid included in the CALM (circumpolar active layer monitoring network) was established. The grid is equipped according to the CALM protocol. The grid accounted 36 nodes with a span of 10 m and, at each node, a plastic snow stake was anchored into the soil with its height fixed at 1.2 m from the surface. The same year, in the frame of a SSF Project in cooperation with Oslo University started also the snow cover monitoring within the CALM grid. For the snow cover monitoring a reflex camera was installed on the CCT (at a height of 9 m) and equipped with a time-lapse system able to take photos of the whole grid every hour, allowing to calculate the snow thickness at any time (except for the completely dark conditions during the boreal night) by measuring the length of the stakes remaining outside of the snow. Finally, in the summer 2016 a deep borehole that reached the depth of ca 50 m was finalized and equipped with a thermistors string down to 48.5 m.The data recorded in these years showed that despite of an apparent morphological and vegetational homogeneity the spatial variability is very high and the system is much more complex both in terms of ecosystem responses and energy budgets. Following the recommendations of the first SIOS SESS report, in which a chapter devoted to the status permafrost measurements in Svalbard was included also with the contribution of some of the authors, future activities will be focused on the maintaining the ongoing monitoring program but also starting with the monitoring of the ground-ice content that is a key parameter for assessing the response of permafrost landscape to changes in climate. Indeed where permafrost contains an abundance of ice, warming and thawing will lead to marked geomorphic change with thermokarst on flat areas and landslides or debris flows on slopes. Talk will illustrate the experimental setup and main achievements obtained up to now, illustrating specificity and relevance of Italian observations in the context of Svalbard and SIOS activities.

Remote and Proximal Sensing of snow covers

R. Salvatori, R. Salzano, G. Esposito

Istituto sull'Inquinamento Atmosferico (CNR-IIA), Italy

Abstract

The snow cover behaviour varies in the Arctic regions from season to season and unexpected changes are altering the fragile equilibrium of this ecosystem more and more frequently in the last years. The snow cover can be described in terms of extent, grains size and shape, surface roughness and thickness and its monitoring is therefore mandatory for the comprehension of environmental processes and climate changes. The use of multispectral satellite data for monitoring purposes is supported by the optical behaviour of snow that is controlled, in the visible and near-infrared wavelengths, by the snow grains size and shape, by the presence of impurities and by the liquid water content. Variations in the snowpack characteristics affect its spectral response which can therefore be used both for detecting its spatial distribution and for studying its surface microphysical properties. The research activities carried out over these years at Ny-Ålesund, were focused on the integration between remotely sensed data, proximal sensing observations and ground-truth measurements. This integrated approach enhanced the possibility to investigate continuously the Arctic region, where the availability of remotely sensed images is conditioned not only by the cloud cover but also by the limited lighting period. The starting point of the developed approach is based on spectral ground measurements obtained during field surveys performed discontinuously in the Brogger peninsula for several years. This kind of activity allowed the collection of field spectral data of different snow surfaces characterized by grains with different shapes and sizes. This spectral dataset, coupled to nivological descriptions, represents the core of the spectral library (SISpec), already available online as a tool for supporting and validating the analysis of the snow cover with remotely sensed imagery. The evolution continued with studies based on systems aimed to the continuous monitoring of snow cover. The developed device, named Snow-Ice Continuous Reflectance Monitor (Snow-IceCReM), was realized in house by IIA and it is providing reflectance measurements at selected narrow bands in the visible and the near-infrared wavelength domains. These observations, coupled to NiR-GB photographs of the snow surface, provide indicators about the microphysical characteristics of the snow cover, the presence of interstitial liquid water and the specific surface area. Those indicators describe the metamorphism stage of the snow cover and they are, therefore, tracers for identifying the beginning and the duration of the melting period. Furthermore, the simultaneous acquisition and analysis of NiR-GB photographs of the surfaces allows the estimation of surface roughness, which represents an additional input for the interpretation of the snow optical behavior. The latest objective of this approach is focused on the calibration / validation of satellite data and it is based on terrestrial photography that allows to overcome the possible lack of remote sensing images caused by cloud cover. The data sources, at the moment, include a motorized camera that provides images over the entire Kongsfjord and a second camera, mounted on the CCT, that takes pictures over the entire Bayelva basin. Image processing and analysis are performed through an automatic classification algorithm that estimates the Fractional Snow Cover within the pixel grid provided by the different satellite platforms (Landsat, MODIS, Globsnow and Sentinel). The integration of satellite images with field data (photographs and spectral measurements) collected in a "natural" laboratory such as the Svalbard islands, aims to reduce the gap between remote sensing data and climate modeling. This activity is part of the H2020 ICupe Project and includes the analysis in other sites on the Svalbard islands, in synergy with other European research institutions.

Exchange processes at the air-snow interface

R. Salzano (1), R. Salvatori (1), A. Ianniello (1), G. Esposito (1), R. Traversi (2)

1 - Istituto sull'Inquinamento Atmosferico (CNR-IIA), Italy
2 - Università di Firenze, Italy

Abstract

The air-snow interface is an important component that regulates different transfer processes between the cryosphere and the lower atmosphere. The snow cover plays, in fact, an important environmental role in absorbing and emitting energy, and in impacting polar atmospheric chemistry and oxidative capacity by adsorption/desorption of reactive species. This is the reason why the snow cover characterization and its annual spatial variability represent important factors to be considered for climate modeling at a global scale. The description of processes occurring at the air-snow interface requires a multi-disciplinary approach based on the characterization of the snow cover, on the definition of the meteo-climatological conditions and on the estimation of chemical fluxes. The first component requires information about the snow extent, the snow micro-physics and the surface roughness that can be obtained combining remote sensing, proximal sensing and ground observations. While satellite products are key data sources for the estimation of the snow cover extent at a regional scale, web cameras are innovative proxy for connecting snow products at different spatial resolutions. The development of automated algorithms has produced a significant added value for estimating the fractional snow cover over long time-series and for validating satellite products. Now, we are ready to collaborate with the Norwegian Polar Institute and other players to have multi-years descriptions of the snow cover. In addition-, we developed an important asset devoted to the description of the snow cover from an optical point of view. This step is very important since the snow optical behavior, especially in the near-infrared wavelength range, is strictly related to the specific surface area available between snow grains. This parameter represents the surface available to the radiative transfer and to the chemical exchanges. We are developing a technological infrastructure, named Continuous Reflectance Monitor (Snow-Ice CReM) that, in this case, is devoted to describe continuously whole-round-year the spectral behavior of the snow cover at the CCT Tower. The combination of the spectral behavior and the spatial distribution of the snow cover define the background input for modeling radiative and chemical fluxes at the interface. Meteo-climatology is another basic input that must be investigated in terms of atmospheric stability, long-range transport of air masses and vertical intrusions of katabatic winds. From this perspective, the Italian Arctic Station represents a key infrastructure where different data sources can be integrated and new assets can be developed in order to estimate such key information. We dedicated a strong effort on using chemical tracers in order to describe the meteo-climatological framework in a complex system such as the Kongsfjord area. From this perspective, radon represents a functional tracer for these purposes and we developed a routinely system for the estimation of the atmospheric mixing and the local-to-long-range behavior of air masses. The combination between the snow radiative behavior and the micro-meteorological context offers the opportunity to describe photochemical processes occurring at the interface. The adsorption/desorption of reactive gases (ozone, nitrogen species, oxidized organic compounds) are,

in fact, controlled by the meteo-climatic conditions, the snow reflective behavior and by the thermodynamics of the involved chemical species as observed in recent observations. The contribution of air-snow exchanges on photochemistry and on the atmospheric oxidative capacity in the Arctic depends on the relation between the snowpack and the troposphere and on the temporal and spatial variabilities of major photochemically active species in snow and in air, such as NO, NO_2, HONO, HNO_3, particulate NO_3^-, volatile organic compounds (formaldehyde, acetaldehyde, acetone and carboxylic acids) and O_3.

References

R. Salzano, R. Salvatori, M. Valt, G. Giuliani, B. Chatenoux, L. Ioppi (2019). *Automated Classification of Terrestrial Images: The Contribution to the Remote Sensing of Snow Cover*. Geosciences *9*(2), 97.

R. Salzano, A. Pasini, A. Ianniello, M. Mazzola, R. Traversi, R. Udisti (2018). *High time-resolved radon progeny measurements in the Arctic region (Svalbard Islands, Norway): results and potentialities*. Atmospheric Chemistry and Physics 18, 6959-6969.

F. Spataro, A. Ianniello, R. Salvatori, M. Nardino, G. Esposito, M. Montagnoli (2017*). Sources of atmospheric nitrous acid (HONO) in the European High Arctic*. Rend. Fis. Acc. Lincei, 28, 25-33. doi:10.1007/s12210-016-0568-9.

A. Ianniello, F. Spataro, R. Salvatori, M. Valt, M. Nardino, M. P. Björkman, G. Esposito, M. Montagnoli (2016). *Air-snow exchange of reactive nitrogen species at Ny-Ålesund, Svalbard (Arctic)*. Rend. Fis. Acc. Lincei, 27, 33-45. doi:10.1007/s12210-016-0536-4.

R. Salzano, C. Lanconelli, R. Salvatori, G. Esposito, V. Vitale (2016). Continuous monitoring of spectral albedo of snowed surfaces in Ny-Ålesund. Rend. Fis. Acc. Lincei, 27 (1),

M. P. Bjorkman, C. P. Vega, R. Kuhnel, F. Spataro, A. Ianniello, G. Esposito, J. Kaiser, A. Marca, A. Hodson, E. Isaksson, T. J. Roberts (2014). *Nitrate postdeposition processes in Svalbard surface snow*. Journal of Geophysical Research: Atmospheres, 119, 12,953-12,976. doi:10.1002/2013JD021234.

Chemical fingerprints in Svalbard snow and ice to understand the changes occurring in Arctic

A. Spolaor (1), Carlo Barbante (1)(2), E. Barbaro (1), F. Burgay (1), P. Bjorkman (3), D. Cappelletti (4), G. Cozzi (1) , F. Dallo (1), G. Dreossi (1), J. Gabrieli (1), J.C. Gallet (5), A. Gambaro (2), J. Kohler (5), E. Isaksson (5), T. Martma (6), M. Maturilli (7), M. Vecchiato (2), M. Feltraco (2), N. Maffezzoli (1), F. Scoto(1), M. Vardè (1), R. Zangrando (1), A. Callegaro (1), C. Larousse (9), B. Luks (10), C. Zdanowich (11), B. Stenni (1)(2), C. Turetta (1)

1 - Istituto Dinamica Processi Ambientali (CNR-IDPA), Italy
2 - Dipartimento di Scienze Ambientali, Informatica e Statistica, Università Ca'Foscari, Venezia, Italy
3 - University of Gothenburg, Department of Earth Sciences, Göteborg, Sweden
4 - Dipartimento di Chimica, Biologia e Biotecnologie, Università degli Studi di Perugia, Italy
5 - Norwegian Polar Institute, Tromsø, Norway
6 - Department of Geology, Tallinn University of Technology, Tallinn, Estonia
7 - Alfred Wegener Institute, Division of Climate Sciences and Atmospheric Physics, Potsdam, Germany
8 - University of Oslo, Department of Geosciences, Oslo, Norway
9 - Environmental Microbial Genomics, Laboratoire Ampère, CNRS, University of Lyon, France
10 - Institute of Geophysics, Polish Academy of Sciences, Warsaw, Poland
11 - Department of Earth Sciences, Uppsala University, Sweden

Abstract

The annual snow layer, during the winter, covers most of the Svalbard archipelago, becoming one of the most important factors influencing the Svalbard environment. The annual snow layer is an extremely dynamic portion of the Cryosphere and can be defined as the snow accumulated and present on the ground during the year. The characteristics of the annual snow strata are strongly dependent on climate conditions and can influence the access to food, particularly for animals who rely on food sources below the snow strata. From a chemical point of view, snow depositions during the winter are a sink for an impressive number of chemical compounds (natural and anthropogenic) and elements trapped in the snow layers. Particularly, compounds and elements that can be photo-activated accumulate during the winter and can be re-emitted in the atmosphere, taking part in numerous geochemical and biological cycles during the spring. However, elements that can be photo-activated are not the only ones to be released from the annual snow strata. During the melting phase, all elements and compounds that are still present in the snow can be released in the melting water, accumulate in the ground or be discharged in the sea, affecting biological productivity or, in the case of anthropogenic compounds, causing a spotted contamination of the surrounding environment. The snow research conducted in the Svalbard is fundamental to better understand the whole natural dynamics that characterize the archipelago. Evaluate the photo-activation and re-emission processes can improve our comprehension of seasonal (and daily) atmospheric oscillation not fully understood for specific elements; Improve our knowledge about the chemical composition of annual snow layer can bring important information in which atmospheric, transport and climate processes are affecting the annual snow composition; Evaluate the effect of the specific meteorological events in the chemical and physical structure of the annual snow layer contributed (such as rain occurrences and snow melting events due to rapid temperature oscillations) to understanding the evolution of the snow proprieties; Collect ice core archives from the glacier summit help us in evaluate the recent changing occurring in the higher Arctic. The studies conducted until now and the activities plan for the close future, such as the ongoing 2018/2019 winter campaign, contributed to understanding the evolution of the snow's chemical proprieties as a consequence of the climate changes affecting the archipelago and better define the role of specific meteorological events. Snow research is relevant for the future evaluations of the interaction between snow, atmosphere and better define post-depositional processes able to re-emit and

introduce in the arctic food chain specific elements and compounds, including anthropogenic contaminants and a Snow Super Site close to Ny-Alesund is essential to achieve this goal. Svalbard snow is an unique environment to be studied giving extremely important information regarding a) the biogeochemical cycle of elements and compounds (natural and anthropogenic) b) understand the impact of the local and abroad human activities c) reconstruct the past atmospheric and climate conditions. The snow research, from a chemical and physical point of view, is crucial and complementary to the other research activities to understand the changes occurring in the Arctic Region.

Terrestrial Ecosystems and Soil

From ice to soil

L.P. Dacqui (1), S. Ventura (1), A. Agnelli (2), R. De Philippis (3), V. Raimondi (4)

1 - Istituto di Ricerca sugli Ecosistemi Terrestri (CNR-IRET), Italy
2 - Dipartimento di Scienze Agrarie, Alimentari ed Ambientali, Università degli Studi di Perugia, Italy
3 - Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI), Università degli Studi di Firenze, Italy
4 - Istituto di Fisica Applicata "Nello Carrara" (CNR-IFAC), Italy

Abstract

Research activities at the Ny-Alesund, were carried out through different projects and focused on the interactions of microbial communities and mineral substrates. Microbial communities for their adaptation capabilities are a significant component of polar land ecosystems and represent a significant part of local biodiversity. They are able to colonize areas without vegetation (for instance, retreating glaciers), acting as primary colonizers and allowing the formation of soil and the establishment of ecological successions. In fact, through their metabolic action, they deeply modify the mineral substrate, enrich it with nutrients and then start the development of new soil and the colonization by mosses, lichens, and finally of higher plants. Our research group has mainly focused the attention: a) on the photosynthetic component (cyanobacteria) of biocrust (BSC, biological soil crust), for its photoautotrophic capacity and for its ability to release exopolysaccharides. These capacities affect strongly the nature of BCS that are fundamental structures of polar terrestrial ecosystem; b) on how the development of the BSC in their primary colonization of different lithological substrates can influence the ecosystem in extreme terrestrial environments in order to specifically define the extent to which biological activity can interact with this type of environment at pedosphere level (soil nutrient cycle, sequestration C, biodiversity) and atmosphere (gas exchange - CO_2, N_2O and CH_4 - between soil and atmosphere).

Specific studies were carried out on:

- Metagenomics and transcriptomics of BSC;
- FTIR techniques coupled to a chemometric approach to obtain a "biological fingerprint", and identify BSC from different environments;
- Structure, hydrological properties, organic and mineral constituents of BSC system. Interaction at the interface level between the biological and mineral components of the crusts and the underlying soil/protosoil. Extracellular polymeric material produced by the crust biome and correlations with the hydrological properties of the crusts;
- Development of a portable prototype, able to operate in extreme environments, to perform fluorescence spectroscopy to be used for studies of terrestrial microbial communities *in situ*;
- Biodiversity, molecular phylogeny and evolution of cyanobacteria of polar terrestrial environments.

These studies, in addition to answering questions about evolutionary mechanisms in extreme polar environments, are aimed at characterizing components with primary role of BSC and generally activators of primary colonization processes.

CZO@Bayelva: Observing Earth Critical Zone processes in the Bayelva basin

A. Provenzale (1), A. Augusti (2), I. Baneschi (1), L.P. D'Acqui (2), M. Doveri (1), O. Gavrichkova (2), S. Giamberini (1), M. Lelli (1), M. Magnani (1), E. Palazzi (3), M. Pennisi (1), B. Raco (1)

1 - Istituto di Geoscienze e Georisorse (CNR-IGG), Italy
2 - Istituto di Ricerca sugli Ecosistemi Terrestri (CNR-IRET), Italy
3 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy

Abstract

This project addresses the dynamics of the Critical Zone (CZ) in the area of the Bayelva river, close to Ny-Alesund, southward of the Kongsfjorden (W archipelago). Focus of the research activities is to monitor, understand and model soil, water cycle and ecosystem processes in the Arctic CZ. The goal is to establish a permanent CZ Observatory at Bayelva (CZO@Bayelva), devoted to understanding how climate change affects the life-support system of terrestrial ecosystems in the Arctic. In June and August 2018, we performed preliminary CO_2 flux measurements in the vicinity of the CCT tower (both Net Ecosystem Exchange and Ecosystem Respiration) using a portable accumulation chamber equipped equipped with an infrared gas analyser and an accumulation chamber able to operate both on transparent and dark modes. Starting from 2019, the research project will have two main goals that will be developed sequentially: (a) Understand the effects of small-scale environmental and topographic heterogeneity on the properties on soil and vegetation processes and on carbon fluxes between soil, vegetation and atmosphere. This activity will focus on the area between the Climate Change Tower (CCT) and the road/airport, owing to the strong small-scale heterogeneity of this site and the presence of already existing facilities. The installation of a new, permanent Eddy Covariance (EC) measurement system placed at 3.7 m above the soil at the CCT, with a footprint consistent with our goals, is planned in 2019. This, together with analysis of soil chemical-physical properties, chemical and isotopic composition of vegetation, water and soil gas (sampled at different depth) and gas flux measurements (CO_2, CH_4 and VOC) using the portable flux-chamber, will provide a detailed determination of the carbon and water exchanges between soil, vegetation and atmosphere at different spatial and time scales during the melt season. (b) Understand the effects of deglaciation on the Critical Zone, focusing on the middle portion of the Bayelva basin. We will focus on the area formerly occupied by the retreating *Vestre* and *Austre Brøggerbreen* glaciers. These CZ measurements will allow to monitor, study and characterize some of the changes taking place in the Arctic soil-vegetation-water system, and to better understand soil formation and its dynamics in areas where glaciers are retreating and the water cycle is being modified. In 2019, we shall conduct a preliminary survey to identify the potential measurement sites.

Geomorphological mapping in the Kongsfjorden area (NW Svalbard, Norway)

E. Miccadei (1), T. Piacentini (1), R. Sparapani (2), I. Berthling (3), V. Mancinelli (1)

1 – Dipartimento di Ingegneria e Geologia, Università "G. d'Annunzio" di Chieti-Pescara, Italy
2 - Consiglio Nazionale delle Ricerche (CNR), Roma, Italy
3 - NTNU Norwegian University of Science and Technology, Department of Geography, Norway

Abstract

Ice retreat since the last glaciation has triggered drastic changes in high latitude environments where periglacial processes, as well as landslides and slope and fluvial processes, are overprinting pre-existing glacial landforms in a paraglacial environment. Geomorphological mapping is a very effective tool in the comprehension of landscape changes particularly at high latitudes in poorly vegetated terrains. In this work, we present the results of geomorphologic field mapping carried out in the Kongsfjorden (NW Svalbard): Ny-Ålesund area and Blomstrandøya. The study is based on fieldwork and mapping performed with the support of CNR Polar Network and of Dirigibile Italia Station and of Norwegian Research Council (SSG 2014, RIS 6457; SSG 2016, RIS 10150). Fieldwork was supported by aerial photo interpretation on orthophoto (two datasets taken in 1998 and 2008, provided by NPI). The geomorphological analyses were integrated with detailed UAV orthoimages and terrestrial laser scanner collected specifically for the Ny-Ålesund area (RIS 10150) and allowed us to improve the geomorphological mapping and to characterize the processes affecting different types on environments (rock slopes, gentle slopes, ice-cored moraines, fluvial catchments).

These combined investigations focused on the mapping of Quaternary deposits and landforms for comprehension factors inducing rock falls, alluvial fans, slope/scarps evolution in high geomorphological sensitivity environments (i.e. glacial, periglacial or mountain). The study allowed us for the creation of geomorphological maps of the Ny-Ålesund and Blomstrandøya areas, which include the main Quaternary deposits and landform characterizing the study areas: (i) Structural landforms; (ii) Fluvial landforms (iii) Glacial and periglacial landforms; (iv) Slope landforms; (v) Coastal landforms; (vi) Anthropic landforms. Moreover, a detailed the Quaternary geological/geomorphological survey and mapping was carried out in three study areas in the Ny-Ålesund sector: Zeppelinfjellet, Scheteligfjellet and Morebreen. The detailed investigation was specifically focused mainly on slope features in order to analyze the slope evolution in the study areas. A specific analysis on the talus cones and debris flows dominated fan landforms and related catchment is in progress. Landform morphometry, deposits features and catchment morphometry were analyzed in the three study areas.

This work is part of a wider study on the analysis of geomorphological effects induced by glacier retreat in high geomorphological sensitivity glacial, paraglacial or mountain environments and it provides a contribution to the comprehension of the reciprocal relationship among the different geomorphological processes (i.e. glacial, periglacial, slope, fluvial, coastal) acting in the the paraglacial adaptation of the landscape to deglaciation.

This study is the result of different projects recorded in the Svalbard Science Forum Database:

1) 2013 - Analysis of geomorphological effects induced by climate warming and glacier retreat in high geomorphological sensitivity environments (RIS6465). Funded by Università G. D'Annunzio;

2) 2014 - HolS - Holocene environmental change on Svalbard (RIS 5842). Funded by SSF Strategic Grants Fall 2013 (UNIS team, UDA team, Bergen Univ team);

3) 2016 - Slopes - Late - glacial and present landscape evolution following deglaciation in a climate-sensitive High Arctic region (RIS 10150). Funded by SSF Strategic Grants Fall 2015 (NTNU team, UDA team, Poznan Univ team, Modena Univ Team).

References

Berti C., Hormes A., Miccadei E., Piacentini T. & Sciarra M. (2014) - The contribution of geomorphologic mapping in understanding the evolution of recently deglaciated terrain. The example of Kongsfjorden (Svalbard, Norway). GSA annual meeting, Vancouver, Canada, 19-22 October 2014.

Miccadei E., Piacentini T., Sparapani R. & Berthling I. (2019) – Geomorphologic mapping in the Kongsfjorden area (NW Svalbard, Norway). Polar Night Week – Longyearbyen, 14-18 January 2019.

Miccadei E., Piacentini T. & Berti C. (2016) - Geomorphological features of the Kongsfjorden area: Ny-Ålesund, Blomstrandøya (NW Svalbard, Norway). Special Issue on Environmental Changes in the Arctic. Rend. Fis. Acc. Lincei (2016) 27: 217.

Miccadei E., Piacentini T., Casacchia R. & Sparapani R. (2014) - Geomorphologic mapping in the Ny-Ålesund area (Svalbard Island, Norway) for the analysis of geomorphologic effects on rock slopes induced by glacier retreat in climate sensitive High Arctic regions. EGU General Assembly 2014. Geoph. Res. Abstr., 16, EGU2014-9407, 2014.

Biological rhythms in polar animals

V. Pasquali

Facoltà di Medicina e Psicologia, Università di Roma La Sapienza, Italy

Abstract

All living organisms have ‘‘biological clocks’’ that regulate physiological and behavioural functions by means of rhythms similar to the geophysical rhythms of the earth; these rhythms have an evident adaptive value to enable organisms to anticipate and, hence, to prepare for predictable changes in their environment (King & Takahashi 2000). This occurs as interaction between the clocks and exogenous time cues, the most prominent of which is the 24-h light–dark cycle. However, in polar environments, the strength of this time cues is greatly reduced around the summer and winter solstices when the sun never sets or never rises. The presence of circadian clocks is independent of the environmental conditions. There are recent evidences that, when daily transitions of dusk and dawn are not present, reindeer and ptarmigan that live in the high Arctic do not exhibit circadian rhythms in their behaviour and physiology. Free-ranging reindeer do not exhibit 24-h locomotor activity rhythms in summer and winter, under continuous light and continuous darkness photoperiod. Differently, during the equinoxes, animals express a circadian regulation of locomotor activity (van Oort et al. 2005, 2007). Seasonal absence of circadian rhythmicity has been recorded also in the daily activity of the Svalbard ptarmigan (Stokkan et al. 1986; Reierth & Stokkan 1998). In addition to the behavioural data, new hormonal and molecular evidences suggesting that reindeer living at high Arctic lack the underlying biological clock, circadian rhythms were not present neither in melatonin secretion nor in the expression of the clock genes (Stokkan et al. 2007; Lu et al. 2010). The diversity of behavioural responses, even within the limited number of species tested, is surprising and suggests that several factors may be involved in regulating circadian variability. It has been proposed that circadian clocks can be adaptively modified to enable species-specific time-keeping under polar conditions (Bloch et al. 2013; Lu et al. 2010; van Oort et al. 2007). Thereby, clocks would be ‘fitted’ to specific aspects of the ecology and behaviour of an organism. Animals everywhere are confronted by environments that demand specialized behavioural and metabolic responses; for those of us intent on understanding the adaptive significance of clocks and rhythms, arctic organisms represent an excellent model in chronobiological studies. The aim of the study was to collect behavioural and physiological data on biological rhythms of high arctic invertebrate *Lepidurus arcticus* (Branchiopoda, Nostostraca) to provide bases for further genetic investigations on the function of the biological clock on arctic invertebrate.

The *L. arcticus* is the only notostracan species found in permanent and temporary ponds in Svalbard. The sampled pond is situated in Ny-Ålesund (Svalbard) where animals and eggs were caught during summer. First results emphasize that *L. arcticus* do not show endogenous circadian rhythm in conditions of continuous light and continuous darkness.

Differently in condition light-dark 12:12 animals show a weak circadian rhythm. Respect to the melatonin concentration in natural condition during the summer, continuous light photoperiod, they do not show a circadian rhythm. These results show themselves very close to that observed on reindeer. It is too early to describe what kind of temporal organization these animals have or if their biological clock works. Further comparative studies are needed to determine the species characteristics that lead to differential dependence on circadian control in arctic animals and in *L. arcticus*. Among the other approaches, genetic studies will contribute to the comprehension of the mechanisms related to around-the-clock activity. Approaching these questions may not only shed light on the ecology and evolution of activity patterns of animals, but may also promote answers to fundamental questions in chronobiology.

Nutrient inputs and food webs in high-Arctic lakes

E. Calizza (1), L. Rossi (1), D. Rossi (2), S. Sporta Caputi (1), M. L. Costantini (1)

1 – Dipartimento di Biologia Ambienta, Univsersita di Roma La Sapienza, Italy
2 - Istituto di ricerca sulle acque (CNR-IRSA), Italy

Abstract

High-Arctic lakes represent hotspots of biodiversity and productivity in the tundra. Here, aquatic and terrestrial primary production, together with guano deposition from birds, control nutrient inputs fueling the aquatic food webs. All these factors will be significantly affected by climate change, with major effects on the structure and functioning of Arctic ecosystems. By mean of 3D-digital elevation models of lake catchments, C ($\delta^{13}C$) and N ($\delta^{15}N$) isotopic analysis in sediment, soil, aquatic and terrestrial vegetation, and aquatic macroinvertebrates, we investigated the origin and trophic transfer of nutrients in 18 high-Arctic lakes (North Spitsbergen, Svalbard), including coastal, lowland and glacier-fed lakes differing in the distance from the coast and for the presence of migratory birds (Arctic terns and Barnacle geese). We aimed at understanding the role of catchment hydro-morphology and birds presence in determining (i) the quantity and quality of food sources fueling the food web, (ii) the isotopic signatures of aquatic organisms, and (iii) the trophic niche of *Lepidurus arcticus*, a dominant invertebrate species serving as food for Arctic terns during their reproductive period. $\delta^{15}N$ in lake sediment varied among lake types, decreasing with increasing distance from the coast. $\delta^{15}N$ values were higher in sediment than in soil in coastal and some lowland lakes, but not in glacier-fed lakes. These results, in conjunction with the low $\delta^{15}N$ values in terrestrial vegetation, suggests that guano input from birds was the main driver controlling ^{15}N enrichment in lakes. This was confirmed by the high $\delta^{15}N$ values observed in guano samples. Higher $\delta^{15}N$ values were associated with higher N concentration. In parallel, the terrestrial or aquatic origin of organic matter in sediment was clearly detected by its $\delta^{13}C$ values, being mainly affected by the morphology of catchments and lake openness. Notably, landscape-scale isotopic variations observed in sediment were reflected in all the remaining food web components, including vegetation, benthic and planktonic invertebrates, thus highlighting a pervasive role of nutrient inputs from birds throughout the lake ecosystem. For *L. arcticus*, consumption of sediment was higher when this food source was of high quality, i.e. in lakes affected by birds, while more vegetation was consumed when sediment was of poor quality. This suggests a transfer of nutrients between birds and their prey, *L. arcticus*, and points to an efficient N cycling along food chains in the strongly nutrient-limited high-Arctic tundra. The presented approach proved to be an effective research pathway to understanding the link between hydro-morphology and ecology across lake types, and for the identification of nutrient inputs in lakes. The key role of guano deposition from migratory birds suggests that expected changes in density of these animals due to climate change may have profound effects on aquatic food webs. Accordingly, our approach may provide mechanistic understanding of effects of climate change on the structure and functioning of high-Arctic lake ecosystems. Lastly, the relevant amount of data produced for the present research can serve as a useful reference for other research programs, as well as a baseline for medium- and long-term monitoring of environmental changes in Svalbard.

Effects of abiotic and biotic factors on CO_2 land-atmosphere fluxes in the High Arctic, Svalbard

N. Cannone (1), S. Ponti (2), F. Malfasi (2), M. Guglielmin (2), N. Pirk (3)

1 - Università degli Studi dell'Insubria, Dipartimento di Scienze e Alta Tecnologia, Como, Italy
2 - Università dell'Insubria, Dipartimento di Scienze Teoriche e Applicate, Varese, Italy
3 - Department of Physical Geography and Ecosystem Science, Lund University, Lund, Sweden

Abstract

Terrestrial Arctic ecosystems play a key role in the global carbon (C) cycle, as they store a large amount of organic matter in permafrost. Among regions with continuous permafrost, Svalbard has one of the warmest permafrost and may provide a template of the environmental responses of Arctic regions to future climate change. Moreover, climate change may turn Arctic biomes from carbon sinks into sources and vice versa, depending on the balance between gross ecosystem photosynthesis, ecosystem respiration (ER) and the resulting net ecosystem exchange (NEE). The magnitude and direction of CO_2 fluxes is dependent also on some key abiotic (thaw depth, ground surface temperature (GST), soil moisture, photosynthetic active radiation - PAR) and biotic (vebetation type, leaf area index (LAI), and plant phenology) factors able to influence both ER as well as NEE (Cannone et al., 2016). The effect of these factors may change with seasonality, with unexpected patterns especially during the transition seasons (beginning vs. end of the growing season) (Cannone et al., 2016). Moreover, it has been quantified that both NEE and ER exhibit specific patterns comparing early, peak and late season and that the main environmental drivers of CO_2 fluxes change during the season (Cannone et al., 2018). As changes of vegetation dominance, floristic composition, or species phenology in response to climate change may have great impact on the regional CO_2 balance, it is mandatory to disentangle the contribution of different vegetation types to the CO_2 fluxes comparing different spatial scales (from plot landscape). For this aim during the growing season 2016 we performed measurements of the CO_2 fluxes from the beginning of the growing season immediately after the snow melt to the end of the growing season, characterized by advanced leaf senescence, at Ny-Ålesund selecting two different study sites, the CALM grid site and the Strandvatnet site. For both sites previous measurements of CO_2 fluxes were available since 2012 (Cannone et al., 2016). During the field campaign 2016 CO_2 fluxes were measured at the plot scale at both sites using a portable automated CO_2 exchange instrument on different vegetation types representative of the dominant species and communities characterizing the arctic tundra. In addition, at Strandvatnet, the CO_2 fluxes were measured for the whole season using an Eddy Covariance system. The detailed vegetation map of the footprint area allowed to quantify the contribution of each vegetation type to the landcape NEE, hence providing quantitative data on the role of the different vegetation communities as CO_2 sinks or sources, allowing also to model potential future ecosystem responses in the frame of future climate change scenarios. In addition, it will be possible to compare the patterns of CO_2 fluxes measured at Ny-Ålesund with the results of previous studies performed in collaboration with UNIS at Adventdalen (Cannone et al., 2018), thus providing more detail on the variability of CO_2 fluxes comparing the behavior of the same vegetation type at two different and remote high Arctic sites.

Biological rhythms and decision-making in high arctic residents during summer and winter

P. Zivi, V. Pasquali, S. Sdoia, F. Ferlazzo

Dipartimento di Psicologia, Università di Roma La Sapienza, Italy

Abstract

Long term isolation and confinement may negatively affect human cognitive performance. However, decision-making is scarcely investigated in isolated, confined, and extreme environments even though it is paramount to ensure safe and successful operations in these contexts. In the present study we investigated the effects of confinement and altered photoperiod upon decision-making processes on Ny-Ålesund permanent residents through three standard decision tasks: the Iowa Gambling Task (IGT), which assesses decision making under uncertainty; the Game of Dice Task (GDT) and the Wheel of Fortune Task (WFT), which assess decision making under risk. Circadian rhythms, sleep alteration, and stress coping strategies were also investigated through biological measures (salivary cortisol, melatonin and DHEA) and subjective ratings (e.g., PSQI, Pittsburgh Sleep Quality Index; KSS, Karolinska Sleepiness Scale; DHS, Daily Hassles Stress; MEQ, Morningness-Eveningness Questionnaire). The data were collected in one of the laboratories at the Dirigibile Italia Station (CNR Italy) from the same 13 (initially) volunteers (between researchers and staff) on 6 time-points, two for each photoperiod: August 2015 and 2016 (continuous light condition, L/L), March and October 2016 (light/dark condition, L/D), January 2016 and February 2017 (continuous dark condition, D/D). Upon their arrival, participants were asked to fill in the questionnaires and then to perform the three computerized decision-making tasks (in random order). Eventually, participants were given 5 appropriately labeled salivettes they had to use to collect their saliva samples at five time-points on the successive day: immediately upon awakening, 30min and 45min after awakening, before lunch and before dinner. Saliva was centrifuged and stored at -20°C for the later deployment to the laboratory in Rome. The results on the behavioral measures suggest that light/dark cycle affects differently the cognitive processes underlying decision under risk and decision under uncertainty. Namely, the analyses on the IGT and on the WFT scores showed that Ny-Ålesund participants learned the better strategy to perform the task on the L/D time-points but were significantly less capable in L/L and D/D conditions. Instead, performance at the GDT was significantly better in the L/L condition compared to the L/D condition, and significantly worse in the D/D condition compared to the L/D condition. The results on subjective measures do not reveal any remarkable alteration: a significant increase in sleepiness in the D/D period was found in the KSS; the DHS revealed a non-significant increase in perceived stress ratings in the L/L and in the D/D conditions compared to the L/D condition; no effects were found on PSQI and MEQ questionnaires. Overall, we showed that under high stress conditions (L/L and D/D periods), decision-making processes based upon intuition (System 1, IGT and WFT) are less efficient than during low stress conditions (L/D period) compared to decision-making based upon control processes (System 2, GDT). Differently, analytical processes (System 2, GDT) are more efficient during L/L periods and less efficient during D/D periods than during low stress periods (L/D). Data on cortisol concentration showed a normal circadian rhythm and a normal cortisol awakening response during the four seasons. Differently, an unexpected increase of cortisol levels was reported throughout the whole experimental period. However, this increase was not correlated with any of the variables considered. These results can lead to significant knowledge about how people adjust their decisional strategies under chronic stress conditions, partially reflecting physiological and subjective distress.

Climate warming impacts on Arctic vegetation

N. Cannone

Università degli Studi dell'Insubria, Dipartimento di Scienze e Alta Tecnologia, Como, Italy

Abstract

Vegetation is a key component of terrestrial ecosystems showing high sensitivity to climate change impacts, especially at high latitude and high elevation regions. Air warming promoted a general Arctic greening during the last decades, with evidences of significant vegetation changes detected across the whole Arctic and involving also the poleward shift and encroachment of shrubs. Svalbard play a key role within the Arctic: indeed, biodiversity of terrestrial ecosystems is particularly rich in Svalbard and is also representative across a wider Arctic context, allowing to extend to regional scale the results of the scientific research performed at Svalbard. The long-term monitoring of flora and vegetation is mandatory as it will provide key information for the assessment of climate change impacts, considering that potential changes are already ongoing and their direction and magnitude are uncertain and still need to be understood and quantified. For these reasons, vegetation studies addressing climate change impacts were performed and are planned to prosecute at Ny-Ålesund since 1998. The first vegetation assessment carried out in 1998 allowed to provide detailed information on the vegetation characteristics and spatial variability of the Brogger Peninsula, with special reference to the relation with the periglacial features and their dynamics (Cannone et al., 2003), providing a robust baseline for a future assessment of the potential vegetation changes in response to a future climatic change. In addition, since 2013 a long-term monitoring network has been established within the Ny-Ålesund CALM grid (Circumpolar Active Layer Monitoring network) and snow grid, close to the Climate Change Tower (CCT), in order to detect within the same network the responses of different ecosystem components (active layer, snow and vegetation). The detailed vegetation survey of the 36 plots was carried out in the summer 2015, providing the baseline for future monitoring. During the summer 2018, three years after the first vegetation survey, a new survey was carried out showing that, despite the very short time period of only three years, the vegetation within the investigated plots exhibited detectable changes relating to their floristic composition and coverage, showing that these ecosystems are able to provide rapid and dynamic responses to the ongoing climate change. Moreover, within the CALM grid as well as in other sites in Ny-Ålesund area also functional measurements of CO2 fluxes, both at the plot scale as well as at landscape scale (through Eddy covariance) were carried out during different field campaigns to assess also the contribution of different vegetation types to the CO2 fluxes. Future research will involve both the prosecution of the long-term monitoring within the CALM grid as well as the revisitation of the sites surveyed in 1998 in the Brogger Peninsula to assess larger scale vegetation changes in response to more than 20 years of warming.

The Contribution of Tundra Ecosystem to Carbon Fluxes

A. Augusti, E. Pallozzi, O. Gavrichkova, E. Brugnoli

Istituto di Ricerca sugli Ecosistemi Terrestri (CNR-IRET), Italy

Abstract

To obtain more accurate future climate scenarios, the contribution of terrestrial ecosystems should be considered because of their substantial impact on Carbon (C) fluxes and, consequently, on climate warming trends. On the other hand, variation in climate drivers affects metabolic processes at plant and soil level. This is true also for Arctic regions. Indeed, climate change and, in particular, global warming impact the balance between C assimilation and respiration at the ecosystem level in several ways. Firstly, increasing air temperature stimulates permafrost thawing with increase of the soil active layer depth and consequent increase of organic C availability for microbial decomposition. Secondly, increasing temperature and atmospheric CO2 concentration may have non-univocal effects on photosynthetic activity, by modulating behaviour of tundra plant species. Moreover, the variation in photosynthetic C assimilation at plant level can affect C allocation belowground that in turn may influence the rate of soil respiration, by priming decomposition of the soil organic matter. The ultimate aim of our studies on Arctic tundra is to disentangle the contributions of terrestrial ecosystem components to C fluxes and to evaluate how these components will be affected by future climate change. In 2013, to study the ecosystem C fluxes at Ny-Ålesund experimental site, the photosynthetic characterisation of the most representative higher plant species was conducted. The CO2 assimilation rates were measured at different atmospheric CO2 concentrations, light intensities and air temperatures on 4 species: Salix Polaris, Dryas octopetala, Saxifraga oppositifolia and Carex rupestris. The assimilation rates (A) measured at increasing atmospheric CO2 concentration, showed similar behavior in the selected species. Despite all species reached remarkable values of A, none of them showed a clear saturation to elevated CO2 concentration. The CO2 assimilation rates measured at different light intensities showed significant differences among species. Independently of light intensity, S. oppositifolia exhibited the lowest A values, while D. octopetala and S. polaris were characterized by the highest A values, although only at saturating light levels. The analysis of temperature dependence of CO2 assimilation rate showed a clear decrease of A with increasing leaf temperatures for all species, although species-specific patterns were evident. From these results, it can be concluded that: the different tundra plant species contribute differently to sequester CO2 from the atmosphere; they can potentially respond positively to future increase in atmospheric CO2 concentrations, although, adaptation to low temperatures could trigger significant feedbacks in a climate change context. In 2018, to further study the contribution of vegetation species to Arctic C fluxes, we assessed the distribution of newly assimilated C between plant tissues and soil, including respiratory fluxes, as well as between different metabolic compounds. This will allow defining, for the different plant species considered, the residence time of newly assimilated C in the plant/soil continuum prior the assimilated C will return into the atmosphere. For this purpose, we used an isotope labelling approach. In brief, we allowed portions of tundra to assimilate 13C-CO2 for 40 minutes and we further “chased” the distribution of 13C for 2 weeks either in plant (bulk and structural/non-structural sugars) and soil components and in C fluxes, such as plant and soil microbial respiration. Preliminary results show differences in 13C enrichment among plant species, possibly associated with differences in assimilation rates. Moreover, a very poor enrichment was detected in root material that may be explained by root morphology and perhaps sampling design. With the aim to monitor C emissions at level of the representative species and to distinguish plant and soil microbial contribution we looked, during summer 2018, at the seasonal pattern of CO2 emission and we collected soil samples on which we are going to evaluate microbial biomass. Expected results will contribute at the main

goal of our research, namely distinguish the contribution of above- and below-ground components of terrestrial ecosystem to C fluxes. To be able to forecast the contribution of tundra to C fluxes, evaluation of the effects of future climate change on tundra physiological processes should be assessed. We aim to do that by using two kinds of approaches. Firstly, studies in which presence of different level of active layer depth are considered as a model system to study climate change effects on the C balance. Secondly, manipulative studies on the field such as warming (open chambers) and CO2 concentration enrichment (mini FACE) in which the effect of these main climate drivers can be evaluated both on C sequestration and emission. These, together with upscaling of vegetation distribution by remote sensing, will allow forecasting the function of tundra biome as a sink or source for C to be incorporated in future climate models.

Technological innovation

Reassessing air temperature profiles at the Climate change Tower by on site calibrations

C. Musacchio (1)(2), A. Merlone (1)(2), A. Viola (2), M. Mazzola (2), G. Coppa (1)

1 - Istituto Nazionale di Ricerca Metrologica (INRiM), Torino, Italy
2 – Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy

Abstract

Metrological traceability of measurements results is a fundamental aspect of data comparability in space and in time, to accurately capture trends and gradients. Improved and dedicated calibration procedures, studies on the characteristics and response of instruments and sensors, uncertainty evaluation of field measurements results are being carried out under a new born collaboration between metrologists and scientists operating in sites and research stations. Essential Climate Variables in the Arctic are measured under numerous research initiatives, stations and groups, generating an increasing amount of data, from multitudes of instruments. Full documented traceability (including corrections and associated uncertainties) is frequently missing, usually due to the logistical difficulties. At the Arctic Circle Assembly and NySMAC meetings the contribution from the metrology community in addressing such issues was identified to be of urgent importance, and an action towards the creation of a metrological infrastructure was included as a priority in the Flagship Programme on Atmospheric Research. The involvement of metrology institutes is necessary since accredited laboratories or manufacturers lack the expertise and competence to assist research teams in developing dedicated calibration procedures for such applications. An easily accessible metrology infrastructure will lead to a general improvement in the environmental data quality, through the availability of dedicated calibration systems and inclusion of measurement uncertainties, thus enabling reliable and comparable ECV measurements into the future. The availability on site is expected to increase the calibration and re-calibration frequency on instruments operated in polar environment. This will also allow to anticipate systems malfunctions or excessive ageing due to prolonged exposure to the harsh environment. Climate trends and environmental observation will be based on a more robust understanding of the measurement results and common calibration procedures will improve comparability among network stations and among networks of different nationalities. The availability of a common permanent metrology laboratory in Ny-Ålesund is expected to benefit the research and observational studies for the following reasons:

- Direct traceability to primary standards of the System of Units, arising from the involvement of National Institutes of Metrology, to reduce calibration uncertainty.
- Bespoke calibration procedures and equipment will provide more relevant values of calibration corrections and uncertainties. This will aid in assessing in-use corrections and uncertainties, and represents a unique service not available from regular accredited laboratories.
- A calibration laboratory close to the deployment sites for the sensors will greatly simplify logistical difficulties in reaching, removing, and handling instruments for the calibration campaigns. Sensors will not have to be transported to national calibration services far away. This will save time and increase the operational time of the sensors.
- A raised awareness of the importance of traceability through an active role played by arctic researchers and operators in defining common calibration procedures in cooperation with metrologists.
- The opportunity for researchers to directly take part in the calibration and test of their instruments.

- The adoption of unique calibration procedures for incrementing the comparability of the instruments response by avoiding different national approaches and unnecessary discrepancies.
- A central common infrastructure with an agreed implementation plan.

Launched within the deliverables of the MeteoMet project, in 2014, 2017 and 2018 four calibration campaigns took place in Ny-Ålesund, under a close cooperation between the Istituto Nazionale di Ricerca Metrologica (INRiM) and the Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC). The activities were performed in field and in laboratory, where a transportable calibration facility was installed at the Vaskeri lab. Having defined and adopted specific calibration procedures, the four main thermometers installed at different heights in the Climate Change Tower were calibrated against travelling standards traceable to the national standards at INRiM. The calibration allowed to correct the air temperature profiles along the CCT, improve the comparability among the sensors and add uncertainties components in the measurement process. After this first campaign other calibrations were made in this new laboratory at the Vaskeri lab, involving soil thermometers and other instruments. This contribution reports on the feasibility of the metrology laboroatory in Ny-Ålesund and the main results from the calibration campaigns.

Autonomous marine and aerial vehicles for carrying out scientific surveys near Arctic tidewater glaciers

Ga. Bruzzone, Gi. Bruzzone, M. Caccia, R. Ferretti, A. Odetti, A. Ranieri, E. Spirandelli

Istituto di iNgegneria del Mare (CNR-INM), Italy

Abstract

Acquiring scientific data in polar regions is often problematic due to harsh weather and risky operating conditions. In the last decade the use of robots for substituting human beings in performing difficult, dangerous and burdensome tasks has become more and more frequent. According to this trend, in the summers 2015, 2017 and 2018, a group of researchers of ISSIA-CNR (now INM-CNR) carried out three scientific campaigns in the Kongsfjorden, an Arctic glacial fjord located in the Svalbard Archipelago, where autonomous vehicles both marine and aerial were used for collecting environmental physical, chemical and biological data. In particular, the USSV (Unmanned Semi-Submersible Vehicle) Shark, the USV/ROV (Unmanned Surface Vehicle/Remotely Operated Vehicle) PROTEUS (Portable Robotic TEchnology for Unmanned Surveys) and the UAV (Unmanned Aerial Vehicle) Otto were used to acquire both marine and atmospheric data in the proximity of tidewater glacier fronts. These areas are extremely hazardous and hardly accessible for human beings because of the possible sudden fall of massive ice blocks. Thanks to the open and modular software and hardware architectures of the robots developed by the INM-CNR robotics group, it was possible to integrate on the vehicles numerous instruments (e.g. automatic water samplers, CTD probes, multi-parametric probes, air quality sensors, sonars, etc.) that allowed to collect measurements of multiple environmental parameters. The success of the carried out campaigns demonstrated that autonomous marine and aerial vehicle technology is now mature and can be of great help to scientists involved in the acquisition of both atmospheric and marine data in polar regions.

The Global Cryosphere Watch prescriptions and guidelines on measurement traceability and related WMO initiatives

A. Merlone (1)(2), A. Viola (2), G. Coppa (1), M. Mazzola (2), C. Musacchio (1)(2), V. Vitale (2)

1 - Istituto Nazionale di Ricerca Metrologica (INRiM), Italy
2 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy

Abstract

To promote high-quality observational data and worldwide compatibility of networks and observations, in its 2018 CIMO-17 meeting the World Meteorological Organization adopted as vision the concept of fit-for-purpose measurements and standards, and expressed the need to ensure that users and providers are committed to achieve documented measurement traceability. The cryosphere is the component of the Earth System where water is present in solid state; in polar, cold, and mountain regions. It provides useful early indicators of climate variability and change. WMO has established the Global Cryosphere Watch programme for multiple applications: climate, hydrology, disaster risk reduction. GCW encompasses the development and implementation of standardization and assessments to enhance the quality and robustness of data by improving observing standards and best practices (1). This includes research sites, under the Cryonet network, where best practices, instrument characteristics, measurement procedures and uncertainty, can be assessed and guidance be developed.

The Global Cryosphere Watch programme of the World Meteorological Organization pursues the development of best practice guidance in measuring cryosphere variables to achieve greater coordination and comparability of data provided by stations operated by diverse institutions. In this effort, the engagement of the metrology community is essential, and a mandatory step in addressing the need to evaluate the measurement uncertainty, the data quality aspects, the measurement traceability, and the definition of attributes of reference stations. To establish a co-located GSRN-GCW station in the Arctic is for sure an outstanding scientific goal, also considering the lack of *Cryonet* stations in the area and amplification of climate change in polar regions.

The implementation of co-located stations is strongly recommended in implementation plans of both GSRN and GCW networks, and highly necessary considering the status of information on instrumental performances in Arctic environment. Just as an example, comparisons of thermometers shields have been performed by WMO in desert conditions (2), while a similar study in cold environment (3) is missing and recommended. After a feasibility study (4), the CIMO 17 expressed the need for the *organization of an intercomparison of available thermometers and shields in a polar environment*, being complementary to the 2008 intercomparison, which took place in a desert area (WMO-IOM 106, TD1579).

Ny-Ålesund (Svalbard), due to the unique infrastructure and previous involvement in polar metrology campaigns within the European Metrology Research Programme (EMRP), with trained staff and top quality instrumentation, offers a high-level opportunity for these purposes.

Thanks to the ongoing cooperation between CNR and INRIM, research groups, the Italian scientific community is in a key position to take leadership of a such effort. Since 2014 in the framework of the MeteoMet project of the EMRP, metrology campaigns took place in Ny-Ålesund and regarded the calibration of atmospheric air temperature sensors at the Climate Change tower, and soil temperature sensors. Specific equipment was transported and installed at the Vaskery lab, offering a common calibration laboratory available for all researchers operating in the area.

Experience acquired, infrastructures implemented up now, and a good connection with the international community operating in Ny-Ålesund will represent the backbone on which to move towards more ambitious targets. Large knowledge and experience in implementing standards and test technologies on the Alps will also be very useful to secure achievements. Focusing on cryosphere observations of physical ECVs (Essential Climate Variables), this contribution reports on the ongoing activities within the GCW *Best Practice Group*, and the World Meteorological Organization Commission of Instruments and Methods of Observations on linking metrological approach to field measurements and installations. The opportunity to implement and register a new Cryonet-GSRN station in Ny-Ålesund is also considered including technical features of the installation and sustainability of its maintenance.

(1) - [WMO/GCW Implementation Plan, April 2016]

(2) - https://library.wmo.int/index.php?lvl=notice_display&id=15530#.XBPHQPZFzLk

(3) - https://www.wmo.int/pages/prog/www/IMOP/meetings/MG-15/CIMO_MG_15_Report%202.2(3)_ET-II-A3_Appendix%20III%20.pdf

(4) - http://www.wmo.int/pages/prog/www/IMOP/meetings/MG-15/CIMO_MG_15_Report%202.2(3)_ET-II-A3_as_published.docx

Stratospheric Balloons from Svalbard Islands

S. Masi, P. de Bernardis

Università di Roma La Sapienza, Italy

Abstract

The Svalbard islands provide a very effective site for launching long-duration circumpolar stratospheric balloons. ASI, ARR, SSC, ISTAR have launched stratospheric balloons of various sizes and with different durations, with payloads devoted to Cosmic Microwave Background radiation studies and other science targets. In this contribution we focus on the OLIMPO payload, the largest mm-wave telescope ever flown in the stratosphere, which was launched on July 14th, 2018, aimed at spectroscopic measurements of the CMB in the direction of clusters of galaxies. We also report on the development of the future night-time flights, like the forthoming Short Wavelength Instrument for the Large-scale Polarization Explorer (SWIPE/LSPE), devoted to the precision measurement of CMB polarization. Finally, we speculate on the possibility of establishing a stable facility for stratospheric balloons for wider support of stratospheric flights.

Monitoring the ionospheric irregularities through GNSS signals: the ISACCO and GENIUS projects

G. De Franceschi (1), L. Alfonsi (1), C. Cesaroni (1), I. Hunstad (1), V. Romano (1)(2), L. Spogli (1)(2)

1 - Istituto Nazionale di Geofisica e Vulcanologia (INGV), Italy
2 - SpacEarth Technology, Roma, Italy

Abstract

The high-latitude ionosphere is directly exposed to the disturbance phenomena induced by geoffective solar transients. In case of a geomagnetic storm, the ionosphere can become highly turbulent, resulting into an increased probability of formation of the so-called "ionospheric irregularities". They are significant variations of the ambient electronic density and are largely variable in space and time. These irregularities can induce refractive and diffractive phenomena on the GNSS (Global Navigation Satellite System) signals, generating random fluctuations on the phase and the amplitude of the signal received at ground. These fluctuations are known as "ionospheric scintillations". The consequence of these scintillations is the reduced accuracy, if not the complete loss, of GNSS positioning. The ISACCO project (Ionospheric Scintillations Arctic Campaign Coordinated Observation) was born at the beginning of 2003 to perform a continuous and systematic monitoring of ionospheric scintillations in the polar and auroral ionosphere through the use of a very extensive network of special GNSS receiver, of which the one installed at "Dirigibile Italia" station represents the progenitor. Recently, the ISACCO project was supported by the project GENIUS (GNSS TEC and Scintillation monitoring under the Cusp), financed by SIOS (Svalbard Integrated Arctic Earth Observing System). The aims of GENIUS are the upgrade of the receivers for scintillation studies already present at Svalbard, the consolidation of the scientific importance of monitoring ionospheric scintillations at Svalbard and the assimilation of the scintillation data with the rocket experiments launched in 2019 as part of the GCI (Grand-Challenge Initiative) Cusp initiative. In this contribution, details on the two projects and the main scientific results obtained using data covering more than one solar cycle (11 years) are presented. Its privileged position and the exceptional length of the ionospheric scintillation dataset above Ny-Ålesund make it possible to describe the arctic ionosphere along about two solar cycles, from the descending phase of cycle 23 to almost the end of cycle 24. Our work presents a detailed evaluation of the climatological behaviour of ionospheric irregularities in conditions of maximum and minimum solar activity. Finally, since November 2015, a multi-constellation GNSS receiver was installed in “Dirigibile Italia” station, providing the opportunity to perform, for the first time, the ionospheric climatology of Galileo signals. The results contribute substantially to the necessary improvements of the forecasting models, providing a wide spectrum of ionospheric responses to different space weather conditions. In addition, long-term studies on the upper atmosphere may contribute to a deeper understanding of the impact of the geospace variability on the "natural" climate change trend.

Poster Session

Observation of atmospheric processes

Laboratory calibration and field assessment of low-cost electrochemical Ozone sensors in Alpine and Arctic environments

F. Dallo (1), F. de Blasi (1), J. Gabrieli (1), C. Barbante (1), P. Bonasoni (2), P. Cristofanelli (2), F. Calzolari (2), M. Mazzola (2), D. Cappelletti (3), A.M. Fjaeraa (4), A. Bäcklund (4)

1 – Instituto di Dinamica dei Processi Ambientali (CNR-IDPA), Venezia, Italy
2 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
3 - Università degli Studi di Perugia, Perugia, Italy
4 - Norwegian Institute for Air Research (NILU), Kjeller, Norway

Abstract

The rapid development and continuous improvement of low-cost technology are demonstrating notable applications and today low-cost sensors (LCSs) are beginning to play a role in areas such as model or emissions validation and spatial variability in pollution in support the state-of-the-art instrumentation and established networks. However, data quality remains an important concern that hampers the widespread adoption of low-cost sensor technology. Recently also WMO/GAW recognized the need of assessing the performance and the correct use of such new kind of technology (*). Purpose of the study is to assess the reliability of low-cost sensors (LCSs) for environmental monitoring of near-surface Ozone mixing ratio in remote Alpine and Polar areas. Indeed, Ozone is highly relevant for the Earth's climate, ecosystems and human health. Also, the needs of reliable spatial data is ever more decisive in remote and harsh environments of the planet, known is climate sentinels. Twins sensing system (http://colmargherita.dsa.unive.it/zepp_manual/) have been located in two atmospheric observatories where comparison of data harvested by low cost sensors can be compared with state-of-art instrumentation. Part of the study are the Zeppelin Observatory (78.9062 N, 11.87911 E) of the Norwegian Polar Institute and the Col Margherita Observatory (46.36683 N, 11.79192 E) of the IDPA-CNR. At these stations, state-of-arts instrumentation based on UV-absorption are running in the framework of WMO/GAW and NextDATA National Project. Sensors evaluated are the Alphasense OX-B431. These sensors have been calibrated at the CNR-ISAC headquarter before field installation. The choice of the sensors was due to positive evaluations of recent publications (**) and reports (www.snuffle.org). For each sensing system a group of three equivalent sensors were installed to evaluate the intra-comparison between sensors. A dedicated VPN and Cloud solutions were adopted with the perspective of creating a large network of stations and to ease remote control, data management and backup.
Moreover, to offer interactive web applications for collaborators and for the general public, a dedicated web-server was set-up using R-Shiny (http://colmargherita.dsa.unive.it/o3net/). A major result of the study is the evelopment of a real-time air quality validation protocol and use guidelines for near-surface ozone measurement in remote areas with low-cost sensors. Data, software, reports and technical documentation, currently under development, will be released under free open-source license so that can be used, reproduced and improved freely (https://github.com/theRosyProject). These results will be useful for the design and use of lowcost wireless sensors network for environmental ozone monitoring usable by both the scientific community and by citizen engineers.

References

* - Lewis, A., Peltier, W.R. and von Schneidemesser, E., 2018. Low-cost sensors for the measurement of atmospheric composition: Overview of topic and future applications. ** - Hagan, D.H., Isaacman-VanWertz, G., Franklin, J.P., Wallace, L.M., Kocar, B.D., Heald, C.L. and Kroll, J.H., 2018. Calibration and assessment of electrochemical air quality sensors by co-location with regulatory-grade instruments.

Short Climatology of Brown Carbon at Ny-Ålesund

S. Gilardoni, M. Mazzola, A. Lupi, C. Lanconelli, A. Marinoni

Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy

Abstract

In the last decades, surface temperature in the Arctic region has been rising twice as fast as the global average. Most climate models are not able to capture the Arctic amplification recorded in the paleo-climate archives, nor the actual trend, showing a limited ability to predict future climate (Lambert et al., 2013). These models often include among climate forcers green house gases and changing albedo as climate forcers, but neglect the contribution of short lived climate forcers, including brown carbon (BrC). BrC is a fraction of organic aerosol able to absorb UV and visible light (Andreae and Gelencser 2006), whose contribution to the atmosphere energy budget is potentially significant in polar regions (Chen and Bond 2010). At the moment, sources, spatial distribution and optical properties of BrC-containing particles are characterized by large uncertainties. This study aims at investigating the temporal variability of BrC absorption coefficient at Ny- Ålesund. Aerosol optical properties are routinely measured by a Particle Soot Absorption Photometer operating at three wavelengths (467 nm, 530 nm, e 660 nm) since 2010. Black carbon (BC) absorption coefficient is extrapolated at 880 nm based on the absorption angstrom exponent (AAE) measured between 467 and 660 nm, while the BrC absorption coefficient is calculated at 467 nm subtracting black carbon (BC) contribution from total absorption. The AAE median value is 0.8, typical of black carbon coated or aggregated particles (Liu et al., 2018). The statistical variability of AAE shows that aerosol optical properties are controlled by BC, whose particles are subject to ageing and mixing processes. Nevertheless, BrC contribution is not negligible as, on average, it accounts for 11% of total absorption at 467 nm. BC absorption coefficient is the highest in spring, during the Arctic haze period, while BrC does not show a specific seasonality. It follows that the relative contribution of BrC to total absorption is larger in summer and spring, when occasionally it can be as high as 20%. Using Kolmogorv-Zurbenko filter we removed the seasonal variability of BC and BrC absorption coefficients, to isolate the long trend variability. BC long term trend shows similar concentrations till 2016, when a sudden decrease occured, while BrC reaches the highest values in 2013 and 2015.Longer data trend is necessary to understand and verify the consistency of such trends. In summary, BrC contributes together with BC, to aerosol light absorption and short wavelengths. The intensification of anthropogenic activities that will increase BrC emission in the Arctic region in the near future (such as wood combustion ship traffic) requires further investigation of BrC sources, optical properties, and its potential impacts on climate and air quality.

References

Andreae M.O and Gelencser A., Black carbon or brown carbon? The nature of light-absorbing carbonaceous aerosols, Aerosol Chemistry and Physics, 6, 3131–3148, 2006.

Chen Y. and Bond T.C., Light absorption by organic carbon from wood combustion, Aerosol Chemistry and Physics, 10, 1773–1787, 2010.

Lambert F. et al., The role of mineral-dust aerosols in polar temperature amplification, Nature Climate Change, 3, 487-491, 2013.

Liu et al., The absorption Ångström exponent of black carbon: from numerical aspects, Aerosol Chemistry and Physics, 18, 6259–6273, 2018.

The very stable boundary layer as a driver of the dynamics and thermodynamics of the atmosphere at high latitudes

D. Cava (1), L. Mortarini (1,2), U. Giostra (3)

1 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
2 - Università Federale di Santa Maria – Santa Maria, Brazil
3 - Dipartimento di Scienze Pure e Applicate – Università degli Studi di Urbino Carlo Bo, Italy

Abstract

It is well known that mesoscale and global models struggle in describing the dynamic and thermodynamic coupling between surface and atmosphere in condition of stable or very stable stratification – a condition typically found in the Arctic atmosphere, and, consequently, they fail in estimating the planetary boundary layer (PBL) depth. Recently, Davy and Esau ("Differences in the efficacy of climate forcings explained by variations in atmospheric boundary layer depth", Nature Communications, 2016, DOI: 10.1038/ncomms11690) demonstrated as the efficacy of a climate forcing is determined by the effective heat capacity of the atmosphere, which in cold and dry climates is dependent by the depth of the planetary boundary layer. The PBL schemes commonly adopted in numerical models are based on similarity theory, which cannot be applied to a stable boundary layer (SBL) because of its low turbulence level and the presence of strong intermittent events and submeso motions, e.g. gravity waves and horizontal meandering among others. In presence of strong stratification the use of standard parameterisations produces processes, such as the runaway cooling, which do not represent the real boundary layer dynamics and alter the performances of numerical models. Therefore, the use of correct parameterisations for the exchanges of mass, heat and energy in the stable boundary layer is fundamental for the meteorology and climatology at the high latitudes. The research group studies the dynamics of the stable boundary layer, focusing its interest on problems related to the weak coupling between surface and atmosphere. A combined experimental and modellistic approach is used by comparing experimental data and results from direct numerical simulations (DNS) in order to verify the significance of 'single point' measurements and in order to find new parameterisations for developing Eulerian and Lagrangian models with numerous applications, from pollutant dispersion to climatic change. The research group collaborate with Italian universities (Torino, Piemonte Orientale, Urbino) and international groups (Duke University, NC, USA; Università Federale di Santa Maria, RS, Brasile). The poster present some important results on the study of the dynamics of the very stable boundary layer useful for improving the mass and energy exchanges between surface and atmosphere and to improve the parameterisation of turbulent parameters in conditions of strong and long-lasting atmospheric stability, characteristic of the polar regions.

References

Mortarini , Cava D , Giostra U, Denardin Costa F, Degrazia G, Anfossi D, Acevedo O. Horizontal meandering as a distinctive feature of the Stable Boundary Layer. Submitted to Journal of Atmospheric Sciences.

Cava D, Mortarini L, Giostra U, Anfossi D. Interaction of submeso motions in the Antarctic stable boundary layer. Boundary-Layer Meteorology. https://doi.org/10.1007/s10546-019-00426-7.

Cava D, Katul G, Mortarini L, Giostra U, Acevedo O. 2019. Submeso motions and intermittent turbulence across a nocturnal low-level jet: A Self-Organised Criticality Analogy. Boundary-Layer Meteorol. – in press.

Mortarini L, Cava D, Giostra U, Acevedo O, Nogueira Martins LG, Soares de Oliveira PE, Anfossi D. 2018. Observations of submeso motions and intermittent turbulent mixing across a low level jet with a 132-m tower. Q.J.R. Meteorol. Soc., 144: 172–183. doi: 10.1002/qj.3192.

Cava D, Mortarini L, Giostra U, Richiardone R, Anfossi D. 2017. A wavelet analysis of low wind speed submeso motions in a nocturnal, boundary layer. Quarterly Journal of Royal Meteorological Society, 143, 661-669.

Spring and Summer-time INP Observations at Ny-Ålesund by DFPC

M. Rinaldi (1), G. Santachiara (1), M. Mazzola (1), S. Decesari (1), N. Hiranuma (2), F. Belosi (1)

1 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
2 - Department of Life, Earth, and Environmental Science, West Texas A&M University, Canyon, TX, USA

Abstract

Not many measurements of Ice Nucleating Particle (INP) concentration exist in the Arctic at present; however, these particles play a fundamental role in the lifetime and radiative effects of Arctic stratiform clouds. A better knowledge of INP sources and dynamics over the Arctic is necessary for a better understanding of northern high latitudes climate and of the "Arctic amplification" itself. In this study, we present INP measurements performed in Ny-Ålesund (Svalbard), at the Gruvebadet Atmospheric Laboratory managed by CNR, in spring, during the Arctic haze period, and summer 2018. Aerosol samples were collected at Ny-Ålesund using a parallel PM_1 - PM_{10} sampling system mounting nitrocellulose filters. Two intensive measurements campaigns were carried on: from 17 April to 2 May 2018 (spring campaign) and from 11 to 27 July 2018 (summer campaign). The atmospheric concentration of INPs (*n*INP) was determined offline by analyzing the sampled filters in the diffusion filter processing chamber (DFPC) at the ISAC laboratories in Bologna. INPs were quantified at different activation temperatures (-15, -18 and -22°C) and both in sub- and supersaturation conditions with respect to water (Santachiara et al., 2010). Parallel aerodynamic particle sizer (APS) measurements provided the particle number concentration from 0.5 to 10 µm ($N_{0.5\text{-}10}$) necessary to calculate the INP activated fraction (AF = *n*INP / $N_{0.5\text{-}10}$). *n*INP at Ny-Ålesund in the PM_{10} size interval, in spring and summer 2018, ranged 40-180, 5-110 and 3-70 m^{-3}, for T = -22, -18 and -15°C, respectively, consistently with previous observations in the Arctic (e.g., Conen et al., 2016; deMott et al., 2016; Mason et al., 2016). Contrary to the recent results by Wex et al. (2018), a significant ($p<0.01$) decrease of *n*INP was observed at T=-22°C, passing from spring to summer. On the other hand, a modest but significant ($p<0.05$) increase of *n*INP, from spring to summer, was observed for T=-15°C, while at T=-18°C no difference was observed. A small contribution from coarse INPs characterized the spring campaign (~20% at -22°C), suggesting that the main INP sources affecting Ny-Ålesund during spring were located at long distance from the sampling site, while a significant increase of coarse INPs was observed during summer, likely resulting from the activation of local sources after snow and ice melting. A significant increase of the AF was observed from spring to summer ($4.1\text{x}10^{-7}$ - $3.0\text{x}10^{-6}$ vs $2.5\text{x}10^{-6}$ - $7.6\text{x}10^{-6}$), suggesting that the Arctic haze contributes scarcely to the INP population. The results of this study contribute to fill the present gap of INP observations in the Arctic environment. A further investigation of INP sources in spring and summer is currently in progress, and will likely contribute to a better understanding of the aerosol-cloud interactions at high latitudes.

The authors thank DSSTTA-CNR and its staff for the logistical support that allowed the realization of this experiment.

References

Conen, F., et al., (2016). Atmos. Environ., 129, 91–94.
deMott, P. J., et al., Proc. Natl. Acad. Sci., 113, 5797–5803.
Mason, R. H., et al., (2016). Atmos. Chem. Phys., 16, 1637–1651.
Santachiara, G., et al., (2010). Atmos. Res., 96, 266-272.
Wex, H., et al., (2018). Atmos. Chem. Phys. Discuss., in review.

Biogenic Aerosol, oceanic Primary production and Nucleation Events in the Arctic – BioAPNEA

L. Caiazzo (1), S. Becagli (1), R. Traversi (1), A.G. di Sarra (2), D. Meloni (2), M. Mazzola (3), A. Lupi (3), K. Park (4), Ji. Park (4), C. Melillo (5), C. Marchese (6)

1 – Dipartimento di Chimica, "Ugo Schiff", Univerisità di Firenze, Sesto Fiorentino, Italy
2 - ENEA, Laboratorio di Analisi e Osservazioni sul Sistema Terra, Roma, Italy
3 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
4 - Korea Polar Research Institute, Incheon, Republic of Korea
5 – Dipartimento di Biologia, Università di Firenze, Sesto Fiorentino, Italy
6 - Département de Biologie, Chimie et Géographie, Université du Québec à Rimouski, Canada

Abstract

BioAPNEA is a project approved by SIOS – Svalbard Integrated Arctic Earth Observing System. This project aims at improving the knowledge of the ocean-atmosphere interconnection by the investigation of the link between measured primary production, sea ice melting, gaseous DMS and aerosol MSA atmospheric concentration and occurrence of New Particle Formation (NPF) events. In this project we combine in situ marine seawater sampling and measurements in Kongsfiorden with atmospheric measurements and sampling at Ny-Ålesund (Gruvebadet and Zeppelin). Dymethyl sulphide (DMS) is produced by marine phytoplankton and it is related to the physiological state of the cells, increasing under stressed conditions, such as nutrient-limitation and Fe-limitation. Once in atmosphere, DMS is oxidized to sulphate and methanesulfonate (MSA). These oxidised sulphur compounds can directly act as cloud condensation nuclei (CCN) or increase the hygroscopicity of already formed particles, enhancing their capability to form CCN, exerting a negative (mitigation) feedback on solar irradiation. MSA also serves as a tracer for aerosol oceanic sources and changes in MSA may reflect changes in the availability of such sources. In this framework BioAPNEA project aims to combine surface measurements of atmospheric gaseous DMS and MSA concentrations in PM10 with measurements of Chl-a and primary production, focusing on the effects on parameters related to biogenic production, and to the variations in sea ice extent (SIE) and its melting dynamics. All the field activities will be carried out in May when the maximum concentration of DMS and MSA occurs (Becagli et al., 2016). The dataset that will be produced in the framework of this project is short in time (about 31 days) but a large number of parameters will be measured contemporaneously. The main measured parameters are:

-irradiance in the PAR spectral range and the behaviour of the PAR actinic flux at surface, in the air-sea interface, and under water, in order to estimate the primary production;

-determination of phytoplanktonic biomass, chlorophyll-a concentration, phytoplankton absorption coefficients;

-suspended particulate, pigments, macronutrients, Fe and other oligo elements in sea water;

-photosynthetic performance of phytoplankton surface assemblages;

-gaseous DMS at Zeppelin station;

-MSA and $nssSO_4^{2-}$ in PM10 sampled at Gruvebadet and their size distribution in the range 0.05 to 10 µm;

-comparison between trace metals (in particular Fe and other oligo elements) in seawater and in PM10 sampled at Gruvebadet;

-aerosol size distribution in the sub-micrometric fraction (10-500 nm) of atmospheric aerosol at Gruvebadet and the number of nucleation events during the field campaign. All the PM10 samplings and the aerosol size distribution measurements will be carried out in collaboration with the ongoing

project at Gruvebadet laboratory in Ny-Ålesund: Gruvebadet atmospheric laboratory project (Gruvelab). In particular in this laboratory, a Tecora Skypost PM for the daily samples form PM10 aerosol and a Dekati 4 stages impactor are installed since 2010. These instruments will provide samples for the analysis of both sulphur compounds and trace metals. In addition, instruments for continuous size distribution measurements are installed and will be used for analysing the nucleation events. New information on the correlation and factors affecting NPF events in relation with biogenic aerosol formation and sea ice parameters (melting and ice marginal zone extent) will be useful for interpreting long term DMS and MSA trend and their connection with global change and "Arctic amplification". The latter result is of particular relevance in the framework of the SIOS observing system as it takes advantage of long-term observatory data to interpret change in the Arctic environment. Moreover, it will allow to design new strategies to fill current knowledge gaps and to propose future prioritisation in optimising the observing system.

Application of Low-Cost Sensors in Extreme Environments: One Year of Measurements

F. Carotenuto (1), G. Gualtieri (1), B. Gioli (1), C. Vagnoli (1), M. Mazzola (2), A. Viola (2), V. Vito (2), C. Taejin (3), A. Zaldei (1)

1 - Istituto di Biometeorologia (CNR IBIMET), Italy
2 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
3 - Korean Polar Institute (KOPRI), Republic of Korea

Abstract

The recent appearance in the market of low-cost environmental sensors and programmable microcontrollers allowed the creation of new, cheap scientific tools for monitoring applications. The possibility of making devices that are both cheap, accurate and reliable allows the deployment of multiple measurement points and obtain an in-depth knowledge of spatial and temporal features of environmental phenomena such as the presence and distribution of air pollutants. Such knowledge becomes of even greater importance in critical environments such as the Arctic and the Antarctic ones, where complex logistic issues prevent the deployment of multiple high-cost reference sensors. The aim of this poster is to show the performance of the AIRQino sensors boards developed by CNR IBIMET (Florence, Italy). These boards, developed with open-source low-cost hardware, allow for the simultaneous monitoring of multiple pollutants such as CO_2, particulate matter, VOCs, O_3 and NO_2. One of these AIRQino boards has been deployed in the Gruvebadet observatory since 30/03/2017 and is still working without substantial maintenance interventions. The poster sums up the performance of this board and its potential for future deployment in dense unattended networks. During the sampling period the board performances have been tested in extreme meteorological conditions and with close-to-zero pollution levels.

Lidar measurement in the arctic Planetary Boundary Layer

L. Di Liberto (1), A. Viola (1), M. Mazzola (1), S. Ciampichetti (1), D. Cappelletti (2), F. Cairo (1)

1 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
2 – Dipartimento di Chimica, Biologia e Biotecnologie, Università di Perugia, Italy

Abstract

There is no region on earth where the climate is changing faster than in the Arctic. Clouds and aerosol play a particularly important role in the Arctic climate, being the single-most important factor influencing the surface radiation budget. In the Arctic, low-level boundary layer clouds dominate. A thorough understanding of their role, together with the role of the aerosols in the Artic climate, requires a detailed knowledge of the effects of atmospheric aerosols and clouds on radiative processes, which is actually lacking. Several initiatives have been taken by the scientific community to provide more data and a better comprehension of radiative and microphysical processes in the boundary layer. A significative contribution can be supplied by lidar measurements in the Planetary Boundary Layer in the Artic and for this purpose a compact and portable polarization diversity Rayleigh Lidar (microlidar) was developed. The system can be run unattended and remotely controlled. The lidar has been deployed in Ny-Ålesund, after a first campaign in 2010 over the AWI Koldeway Station, in March 2018 and performed measurements of the PBL in the spring and summer season, often working in conjunction with a minisodar and during tethered balloon aerosol profiles. An overview of the database will be presented and a case study will be discussed, where vertical distribution of aerosol is compared with the thermodynamical features of the PBL and with in-situ aerosol measurements from instruments on a tethered balloon.

Free and combined L- and D-amino acids in Arctic aerosol

M. Feltracco (1), E. Barbaro (2), A. Spolaor (2), C. Turetta b (2), R. Zangrando (2), C. Barbante (1)(2), A. Gambaro (1)(2)

1 - Dipartimento di Scienze Ambientali, Informatica e Statistica - Ca' Foscari, Università di Venezia, Italy
2 - Istituto Dinamica dei Processi Ambientali (CNR-IDPA), Venezia, Italy

Abstract
Aerosol samples were collected with a high-volume cascade impactor with a 10-day sampling frequency at the Gruvebadet observatory, close to Ny-Ålesund (Svalbard Islands). A total of 42 filters were analysed for free and combined amino acids, as they are key components of bio-aerosol. The main aim of this study was to determine how these compounds are distributed in size-segregated aerosols after short-range and long-range atmospheric transport and understand the possible sources of amino acids. The total load of free amino acids ranged from 2.0 to 10.8 pmol m^{-3}, while combined amino acids ranged from 5.5 to 18.0 pmol m^{-3}. Levoglucosan, methanesulfonate (MSA) and non-sea salt sulfate (nss-) were used as specific markers for biomass burning, and phytoplankton blooms and were used in comparison with the concentration of free amino acids to confirm potential emission sources. Back-trajectories analysis and factor analysis were used to describe the geographic origin of the air masses and to explain how biomass burning events and phytoplankton blooms may influenced the free amino acids concentration. Free and combined amino acids were mainly found in the fine aerosol fraction (<0.49 mm). This study provides the first investigation of free and combined L- and D-amino acids in Arctic atmospheric particulate matter.

Moon-Photometric Observations during the Polar Night

M. Mazzola (1), V. Vitale (1), N. Kouremeti (2), J. Grobner (2)

1 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
2 - Physikalisch-Meteorologisches Observatorium Davos / World Radiation Center PMOD/WRC, Davos, Switzerland

Abstract

The monitoring of the columnar content of aerosols is fundamental for the evaluation of their radiative forcing as well as for the detection of long range transport processes. This is usually obtained by means of global networks of ground-based instruments such as Sun-photometers, or by satellite sensors, which easily cover the entire globe. Being most of these passive instruments, they can operate only during day-light periods, leaving a lack of information during the night. For polar regions, this represents a tremendous loss in terms of continuity of the measurements. During recent years, a new cost-effective technique that makes use of the Moon as source of radiation is starting to spread out in the scientific community, which is also working on refining both the instrumental setup and the analysis procedures. This will contribute to fill the gap that exists in the polar climatologies, as well as to the validation of LIDARS product and studies on the indirect effect of aerosols. Since 2014, a prototypal lunar-photometer is installed in Ny-Ålesund during the winter period and is jointly managed by CNR-ISAC and PMOD/WRC with the support of the Norwegian Polar Institute. In this work, we will illustrate the details of the technique of analysis and show the results obtained so far, comparing them to other obtained by use of star-photometry, a technique much more expensive in terms of costs and man-power.

Organic contaminants in the atmosphere of Ny-Ålesund

A. Cecinato, M. Cerasa, R. Mabilia, G. Esposito, C. Balducci, M. Perilli

Istituto sull'Inquinamento Atmosferico (CNR-IIA), Italy

Abstract

In-field measurements of atmospheric contaminants were undertaken in 1998 and 1999. Our concern was focused on organic chemicals, as important contributors to ambient toxicity, tracers of sources and indicators of meteo-climatic contour. As for gaseous chemicals, focus was on semi-volatile aldehydes; among particulate organics, n-alkanes, PAHs and Nitro-PAHs were investigated. Carbonyls were collected on June 1998 on Zeppelin mount (ZM) and at CNR Scientific Base CSB). Samplings lasted 2 h, starting at 8:00 h, and contaminants were collected on silica gel cartridges loaded with pentafluorophenyl hydrazine (PFPH). Degradation of hydrazones was prevented by applying ozone scrubbers. Characterization of C_3-C_{14} aldehydes was carried out through GC-MS analysis [Cecinato et al., Chromatographia 54 (2001), 263]. Formaldehyde, acetaldehyde and acetone were not determined due to interferences. Suspended particulates (PM_{10} fraction) were collected at high-volume conditions on quartz filters, during summer 1998 and spring 1999. In 1998 a pair of 3-day sampling periods were undertaken in June (sunny hours); in 1999 (April-May) three sampling periods were selected, each day between last night and sunrise. Organic fraction was extracted in ultra-sonic bath, separated into three fractions through alumina column chromatography (non-polar aliphatics, polycyclic aromatics and polar organics), and analyzed for contents in n-alkanes, PAHs, Nitro-PAHs and fatty acids by means of GC-MSD. About carbonyl during June 1998, the concentrations at the two locations investigated were different and showed important daily variability. Also their percent profiles and concentration ratios between the two stations changed widely. Total carbonyls ranged ~8-45 μg/m^3 at ZM and ~2-7 μg/m^3 at CSB. The concentrations of n-alkanes in PM_{10} were different in 1998 and 1999 (~19 vs. 100 ng/m^3 as period average), as well as percent distribution of $<C_{24}$ homologues. According to that, in the summer bacteria and microorganisms provided important contribution to n-alkane occurrence, whilst in spring the petroleum exhausts were predominating. The emission of vegetation was scarce (CPI_{25}≈1.4). Total PAHs were, as average, more in Apr-May 1999 (~1.4 vs. 0.6 ng/m^3) and distinct distributions were identified. It could depend in part on ambient temperature (semi-volatile compounds are enriched on particulate during winter). Nonetheless, a role was played also by the nature of emission sources (as suggested by changes in PAH concentration ratios), while reactivity of the atmosphere was unimportant (BaP/BeP ratio). Though only nitrated fluoranthenes and pyrenes were investigated, Nitro-PAHs merited concern. Nitro-PAHs were more in the spring (~135 vs. 10 pg/m^3) and, overall, the percent profiles were very different: 1-, 7-, 3-NFAs and 1-NPY, typical of direct emission, occurred in spring, 2-NFA and 2-NPY (generated by photochemical reactions) in the summer. Fatty acids (ranging ~20-40 ng/m^3 as total) were indicative of bacterial and small vegetation sources.

Poster Session

Oceonagraphy And Marine research

First evidence of microplastics ingestion in benthic amphipods from Svalbard

V. Iannilli (1), V. Pasquali (2), A. Setini (2), M. Vardè (3), F. Corami (3)

1 - ENEA, C.R. Casaccia, Roma, Italy
2 – Università di Roma La Sapienza, Italy
3 – Istituto Dinamica dei Processi Ambientali (CNR-IDPA), Venezia, Italy

Abstract

Environmental contamination by plastic debris is documented in marine environment from the 1970's and now dispersion in aquatic environments shows a worldwide diffusion, including pristine areas such as deep sea, Arctic Ocean and Antarctica. It is a top emerging global issue of the last decade, due to persistence, ubiquity and threat posed to biota. Plastic litter can be degraded in progressively smaller pieces, classified as microplastic when their size is between 5 mm and 1 µm. Microplastics are the most abundant and pervasive components, because these small particles can be ingested and accumulated within organisms, causing physical and mechanical damages, obstructions of gastrointestinal tract and a consequent pseudo-satiation resulting in reduced food intake that may lead to mortality. Toxic effects due to organic compounds and trace elements adsorbed on the microplastics may be a potential hazard, as well. The plastic pollution at Svalbard is a significant threat for the environment. An important source of microplastics comes from marine environment, but the increasing human activities observed over the last years could have increased microplastics in coastal areas, with consequences for its food chain. To investigate the uptake of microplastics by the biota, the presence of microplastic particles ingested by the amphipod benthic species *Gammarus setosus* (Crustacea, Amphipoda) was studied. This species is a common, circumpolar arctic organism living in subtidal and low intertidal environments that exclusively inhabits the Arctic. They are primarily detritivores, but, depending upon food availability, they may also be predators of small invertebrates. Specimens of *G. setosus* were collected during April 2018 on the coastal zone of Ny-Ålesund. The digestive tubes of 20 specimens were analysed by fluorescence microscopic observation after Nile red staining. Some selected samples of the particles were also analysed with Micro-FTIR (NicoletTM iN10TM, Thermo-Fisher) to identify their polymeric composition. All the samples analysed contained microplastics and most of them were fragments. The very abundant populations of *G. setosus*, reaching densities of 3000 ind/m^2 in some spots, makes these macroinvertebrates often dominant in terms of biomass, significantly contributing to the energy flow by decomposing organic material and serving as both predator and prey in the arctic ecosystem. The microplastic particles ingested may be available for uptake to predators that consume this Arctic amphipod. Our results demonstrate that studied species is a suitable biological indicator for future monitoring programs. The ARAMIS project will help to understand the spatial and temporal trends and detrimental effects in these benthic organisms from the Arctic and sub-Arctic regions. The project will also allow to enlarge our studies to freshwater macroinvertebrates species and to investigate the microplastic contamination in these environments, less studied than marine ones.

Real-time acoustic monitoring system in Ny-Ålesund

R. Grammauta (1), M. Ceraulo (1), E. Papale (1)(2), S. Mazzola (1), G. Buscaino (1)

1 - Istituto per lo Studio degli Impatti Antropici e la Sostenibilità in Ambiente Marino (CNR-IAS), Italy
2 - Dipartimento di Scienze della Vita e Biologia dei Sistemi, Università di Torino, Italy

Abstract

The passive acoustic monitoring is a key instrument to study marine ecosystems. Throughout the analysis of different acoustic components, it is possible to investigate on the ecosystem processes, their changes along the time and the effects of human activities on these. A lot of information can be collected without a direct interaction of the researchers and this is essential especially for critical and extreme environments as the artic ones. In this framework, from September 2015 to August 2017, an acoustic marine cabled station was installed on the Ny-Alesund harbour for a real time acoustic data collection. The monitoring station consisted on two hydrophones with different acoustic sensibility (-171 dB re 1V/uPa@5KHz and -178 dB re 1V/uPa@10KHz) adapted to study low-medium frequencies (5 – 90000 Hz) and high frequencies (5-170000 Hz). The hydrophones were connected to an underwater box, where the analogic datum was digitalized and temporally stored. The box was connected with a land station located on Ny-Ålesund harbour by 500 m of armoured cable. It allowed a bidirectional transmission of information: towards the land station to transmit the acoustic data recorded, towards the underwater box to remotely control the acquisition parameters and to give energy supply. In the land station a computer managed by remote control saved and transmitted (after appropriate under sampling processes) the data collected to the laboratory of the Bioacoustic Group of the CNR in Capo Granitola (Italy). The system was integrated with a software structure abled to automatically analyse the recorded files. In detail, the principal acoustic parameters were computed: Power Spectrum Density PSD (dB re µPa/Hz) and octave bands Sound Pressure Level SPL (dB re µPa) centred on 16 Hz, 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 8000 Hz e 16000 Hz frequencies. The measures were daily averaged and transmitted as report to monitor the acoustic condition of the study area. An “ALERT” system was implemented to notify by email in case of malfunction (missed data transmission, corrupted data, etc.). Many vantages characterize the use of an acoustic marine cabled station. Firstly, the possibility to obtain continuous (duty cycle 100%) long time series without data storage or energy supply limitations that characterize autonomous recorders. Indeed, data are directly stored in servers immediately after the acquisition and the energy alimentation is furnished from land station. Secondly, the possibility of remotely control the acquisition and transmission parameters. This characteristic is essential to reduce management costs in studying extreme environments. This kind of infrastructure, using a broadband frequency, allows a high-resolution monitoring of biological (marine mammals, fish, crustaceans), physical (ice melting and calving, earth-quakes, etc.) and anthropic (marine traffic, geo-seismic surveys, etc.) sources.

A new methodology for studying ice calving events from underwater acoustic data

G. Alonge (1), A. Köhler (2), P.M. Lefeuvre (2), C. Nuth (2), M. Ceraulo (3), M. Gregorietti (3), G. Buscaino (3)

1 – ENEA, Laboratorio di Osservazione e Analisi della Terra e del Clima, Italy
2 - Department of Geosciences, University of Oslo, Norway
3 - Istituto per lo Studio degli Impatti Antropici e la Sostenibilità in Ambiente Marino (CNR-IAS), Italy

Abstract

Global warming effects extend downstream on all the ecosystems and they are amplified on polar zones. The study of ice melting on long temporal scale is a key element to understand the environmental changing trends. On this framework, the acoustic method is extremely efficient in terms of data to effort ratio, allowing real time and long-term monitoring actions. Among different approaches used to study glacier dynamics as satellite, radar or lidar, only acoustic and seismological methods lead to obtain high temporal resolution and long series of data (Kohler et al., 2016). Moreover, only the underwater acoustic, using high frequency sample rate (up to hundred kHz), permits to acquire such as broad amount of information. All these data could be used for the study of ice-calving phenomenon, identifying the single and multiple events of ice detachment and fall. Acoustic data analysis could lead to obtain information not only about the number of events but also to quantify the ice mass involved in the phenomenon (Kohler et al in prep.). The aim of this work was to develop a new algorithm to individuate, count and acoustically characterize the ice-calving events, discriminating these from biological and anthropic acoustic sources. The algorithm amplifies the signal to noise ratio in order to distinguish low intensity phenomenon during high levels of background noise. The code was developed in Matlab environment. From data acquired with a sample frequency of 16 kHz, it allows to: a) increase the signal to noise ratio considering the intrinsic acoustic characteristics of ice-calving – low frequency and high energy – that identify them from natural background noise; b) identify regions of interest (ROI) using as discriminant parameters duration and intensity of the events; c) extrapolate the events from the envelopes of the signal in the ROI; d) acoustically characterize the events. During the last step, some parameters (as peak to peak, energy, duration etc.) are estimated. Their analysis allows to classify the different types of ice-calving recorded (Glowacki et al 2015). The algorithm was tested on 24 hours of recordings collected the 28th of August 2016 close to the front of Kronebreen glacier. On 264 ice-calvings manually detected, the code identified 244 events (92%) and it estimated the correct start and ending points of the 85% of these. The next step will be the validation of the code on recordings with anthropic noise to apply it on the long time series of data acquired by the Bioacoustic Group of CNR of Capo Granitola. It will allow to study the dynamics of Kronebreen glacier. In the framework of the CALVINGSEIS project, in order to calibrate the acoustic measures for ice mass estimation, synchronized data of ice-calving were collected using different methods: acoustic, photographic, seismic, and through radar and lidar systems. Correlating different methodologies, future analysis will lead to understand if the acoustic acquisitions can represent a new instrument to study the drop of ice mass and their modalities.

References

Glowacki O, Deane GB, Moskalik M, Blondel P, Tegowski J, & Blaszczyk M (2015). Underwater acoustic signatures of glacier calving. Geophysical Research Letters, 42(3), 804-812.

Köhler A., Petlicki M., Lefeuvre PM., Buscaino G., Nuth C., Weidle C. Calving quantification from seismic and hydro-acoustic observations calibrated with lidar volume measurements. In prep., rivista selezionata “The Cryosphere”.

Köhler, A., Nuth, C., Kohler, J., Berthier, E., Weidle, C., Schweitzer, J. A 15 year record of frontal glacier ablation rates estimated from seismic data (2016) Geophysical Research Letters, 43 (23), pp. 12,155-12,164.

AR-DIS-CO_2: Arctic Dissolved CO_2 project

M. Lelli, I. Baneschi, M. Doveri, B. Raco

Istituto di Geoscienze e Georisorse (CNR-IGG), Italy

Abstract

The study of gases concentrations and fluxes in the climate system ocean-atmosphere-land represents a suitable and valid tool to monitor the climate conditions and its evolution and effects at global scale. Polar Regions, far from urban and industrial sites, represent a suitable natural laboratory to monitor the global changes in the equilibrium of greenhouse gases within ocean-atmosphere-land ecosystem. In these regions, main sources of dissolved gases come from the atmosphere and glacier drainage, although some gases in the ocean also come from marine organisms. As for atmospheric CO_2 (Bates and Mathis, 2009), low temperature waters of the Arctic Ocean can act as a sink for others gas species (Ar, O_2, N_2, CH_4, H_2S). Together with $CO_3^{=}$, HCO_3^{-} and carbonic acid, the dissolved CO_2 contributes to the Total Dissolved Inorganic Carbon (TDIC). Therefore, TDIC and concentrations of dissolved gases represent suitable parameters to study and monitor the temporal evolution of the ocean carbonate chemistry in relation to the increasing in atmospheric CO_2 concentration and contributions by glacier melt drainage. The ARDISCO2 project tackles the dynamics of dissolved gases in the ocean water of the Kongsfjorden (Svalbard islands, W archipelago). Focus of the research activities is to monitor and understand the processes involving major dissolved gas species. The project also aims to develop a portable instrument for on-site measurements of TDIC and dissolved gases (in particular CO_2, but also O_2, N_2, Ar, CH_4, H_2) in ocean water into the Kongsfjorden. Main goals of the project are: i) first characterization and monitoring of Kongfjorden's water in terms of dissolved gases species; ii) identification and understanding of the relationships between dissolved gases time-variations with glaciers melting dynamics. In 2018 taking into account the information obtained in the framework of the ISMOGLAC project, we performed preliminary samplings and analyses of dissolved gas from two sites of the fjord along a vertical profile, together with TDIC measurements performed on laboratory. The selection of measurement sites was addressed to obtain data at least from one of the most deep vertical profile and also from profiles close to main glaciers drainages (Bayelva basin and Kronebreen-Kongsvegen glaciers). These preliminary activities represent a good reference to identify others potential measurements sites. In 2019, a new sampling trip for dissolved gases has been planned, together with on-site TDIC measurements, using a modified version of the portable device developed by Cioni et al. (2007). Measurements of T, pH, Electrical Conductivity, Redox Potential and Dissolved Oxygen will be performed using suitable and portable instruments. During these firsts sampling trips, samples for dissolved gas analysis will be taken using a pre-evacuated glass bottles with 3-way valve.

References

Bates, N.R., Mathis, J.T., 2009. Biogeosciences 6, 2433-2459.
Cioni R. et al. 2003. J. of Volcanol. Geoth. Res., 120: 179.
Cioni R. et al. 2007. Geothermics, 36: 47.

Seasonal distribution of vocalizations and analysis of some acoustic parameters of haddock fish *Melanogrammus aeglefinus* in Kongsfjorden (Svalbard)

G. Buscaino (1), D.E. Canale (1), M. Ceraulo (1), E. Papale (1)(2), G. Alonge (3), C. Giacoma (2)

1 - Istituto per lo Studio degli Impatti Antropici e la Sostenibilità in Ambiente Marino (CNR-IAS), Italy
2 - Dipartimento di Scienze della Vita e Biologia dei Sistemi, Università di Torino, Italy
3 – ENEA - Laboratorio di Osservazione e Analisi della Terra e del Clima, Italy

Abstract

The haddock (*Melanogrammus aeglefinus*) is a fish belonging to the *Gadidae* family and represents an important target species for the fishing industry. It lives in the Atlantic and in the Barents Sea at the latitudinal range between 38 ° and 79 ° N. It is more present between 80 and 200 meters deep and at temperatures between 4 ° and 10 ° C. As many *Gadidae,* it is able to produce sounds especially during the reproductive period (February - June). The sounds consist of a series of audible impulses (knocks) made up of two short pulses at low frequency (Hawkins and Amorim 2000). Reproductive maturity is reached at 4 years. A study, carried out by Casaretto et al (2016) in tank, found that knocks are produced by both sexes and also by juvenile individuals. In particular, the study found a significant difference in some acoustic characteristics in the sounds emitted by females, males or juvenile individuals (and for the same individual, in relation to the period of the year). These differences were justified by a sexual dimorphism in the muscle involved in sound production.

The acoustic data object of this study come from two acoustic recorders (SM2U, Wildlife Acoustics, USA) placed at 80 m depth in the Kongsfjorden. The two sites represent two different environments from an ecological and oceanographic point of view, as one is located at the entrance to the fjord and the other is about 4 km from the Kronebreen seafront. A Matlab code was developed to identify the impulses and characterize them (peak frequency of the first and second pulses, temporal duration between the two impulses, duration of the pulse, relative amplitudes). Subsequently an operator, using a second code, manually checked the identification and automatic characterization of each signal. In total, about 5000 hours of recording were analysed (corresponding to 26400 wav files sub-sampled at 2000 kHz) for a total period of one year (April 2014 - March 2015).

Only the site at the mouth of the fjord recorded knocks, with a regular presence from the beginning of June to October and with a peak in September, for which we recorded an average number of signals per minute equal to 1.1 ± 0.1 (± standard error). The signals (n = 18693) had characteristics that vary significantly with the months, with a peak of frequency of the first impulse which constantly decreased between July (172.8 ± 0.8 Hz) and October (163.9 ± 0.6), and duration (20.5 ± 0.0 ms) and relative amplitude that exhibited opposite increase.

Comparing our results with those reported by Casaretto et al. (2016), where the presence of knocks occurred mainly between January and April, here, acoustic signals were found outside the reproductive period. Moreover, the measurements relating to frequency peaks showed lower values on average than those described previously. However, the measurements of Casaretto et al. were collected in the tank and, therefore, all the parameters concerning the frequency are to be considered indicative.

Considering the temporal distance between the two impulses, it is possible to hypothesize a greater presence of juvenile individuals (> 13.5 ms, 95%), then of females (12.7-13.6 ms, 4%) and a negligible number of males (11.4-12.6 ms, 1%) (following Casaretto et al). From these results, we assume that the fjord could be a growth site for juveniles, and that the recorded sounds could be linked to the defence of the territory, rather than to reproductive activities.

This hypothesis is supported by catches through fishing gear in the fjord (Brand and Fisher, 2016) of individuals of average length of 17 cm (corresponding to one year immature individuals). The presence of *Melanogrammus aeglefinus* only in the outer part of the fjord could be linked to higher

values of water temperature compared to the site near the glacier. Furthermore, this study shows an acoustically abundant presence of *Melanogrammus aeglefinus* at the northern edge of its areal. This datum, together with the lack of sounds deriving from the polar cod (Boreo gadussaida) (*work in progress*), a species that should instead occur in abundance on this site, could indicate a change taking place in the distribution of these two species, following the heating of the waters. In fact, the polar code prefers temperatures between -1 and 4 ° C (Drost et al, 2016) while the haddock adapts well to temperatures up to 10 ° C.

References

Brand M, Fisher F (2016) Species composition and abundance of the shallow water fish community of Kongsfjorden, Svalbard. Polar Biology, 39.11: 2155-2167.

Casaretto L, Picciulin M, Hawkins AD (2016). Differences between male, female and juvenile haddock (*Melanogrammusaeglefinus* L.) sounds. Bioacoustics, 25:2, 111-125.

Drost HE, Carmack E, Farrell AP (2016) Acclimation potential of Arctic cod (*BoreogadussaidaLepechin*) from the rapidly warming Arctic Ocean. Journal of Experimental Biology 219(19):jeb.140194.

Hawkins, A. D. &Amorim, M. C. P. (2000). Spawning sounds of the male haddock, *Melanogrammusaeglefinus*. Environmental Biology of Fishes 59, 29–41.

Riera A, Rountree RA, Pine MK, Juanes F (2018). Sounds of Arctic cod (*Boreogadussaida*) in captivity: A preliminary description. The Journal of the Acoustical Society of America 143, EL317.

Glacial drivers of marine biogeochemistry in an Arctic fjord: the Kongsfjorden case study

C. Cantoni (1), S.C. Jennifer (2), S. Cozzi (1), M. J. Hopwood (2), J. Chiggiato (1), E.P. Achterberg (1)

1 - Istituto di Scienze Marine (CNR-ISMAR), Italy
2 - GEOMAR, Helmholtz Centre for Ocean Research, Kiel, Germany

Abstract

The Arctic region represent a climate change hot-spot and is experiencing an increase in temperatures faster than other regions and a general retreat of glaciers and ice sheet (IPCC, 2014). The marine ecosystem is also threaten by the «ocean acidification» process that is lowering the concentration of carbonate ions available for calcifying organisms, a situation which can be amplified by increasing freshwater runoff. Glaciated catchments are also exemplified by high turbidity and imbalanced nutrient loads. The polar fjords are thus experiencing the combined effects of multiple stressors that could lead to dramatic ecosystem changes in coming decades. To increase our understanding of the biogeochemical processes in these areas and the role played by different drivers becomes crucial to infer the future functioning of these ecosystems. The harsh environmental conditions have limited the studies in these polar zones. Recent works in Greenlandic fjords (Hawkings et al, Glob. Biogeochem. Cycles, 2016) hypothesized that pro-glacial streams are important sources of nutrients for coastal environments and suggest that they will enhance marine productivity in the next decades. Are glacial streams importan nutrient source also for the Kongsfjorden? Does the nutrient input offset the negative effects of freshwater outflow? The studies on the carbonate system of Svalbard fjords are based on a small dataset and limited to the outer area (Frasson et al., JJR, 2015; Frasson et al, Pol Biol, 2016) and they highlight an increase of «corrosivity» (reported as decrease of aragonite saturation state) at lower salinities. In which way do the different freshwater sources (ice melt, runoff, sub-glacial discharge) influence the properties of the carbonate system in the fjord? Which is the role of icebergs in the biogeochemistry of the Kongsfjorden? In summer 2016, in the framework of Ocean-Certain project (EU-FP7), a multi domain fieldwork, aiming at answering these questions, was undertaken. The data gathered represent one of the most complete and detailed datasets for the inner part of the fjord and include physical data encompassing the meltwater season. It includes nutrients and carbo chemistry data from all the more relevant water streams both on the southern and the northern coast and from several icebergs. Here we present the first scientific results based on of a dilution model approach.

The Northern Ocean Biosphere Ice Land Ecosystem model (NOBILE model): Development of an integrated high-resolution modelling system for an Arctic Fjord (Kongfjorden, Svalbard)

A. Bergamasco (1), J. Chiggiato (1), F.M. Falcieri (1), M. Miglietta (2), A. Provenzale (3), U. Rizza (2)

1 – Istituto di Scienze del Mare (CNR-ISMAR), Italy
2 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
3 - Istituto di Geoscienze e Georisorse (CNR-IGG), Italy

Abstract

The overall aim of this project is to develop a limited-area Regional Arctic Modelling system that consists of fully coupled ice-ocean-atmosphere-land models. This system will be able to reproduce the Arctic environment as a whole and its variability at different time-scales. To start the activities however, we focus on the development and implementation of a limited-area domain for the Kongsfjorden area, able to incorporate the atmospheric, marine, cryospheric, terrestrial and ecosystem components and some of their main interactions at this scale. The ocean component with sea-ice dynamics will be implemented at the scale to resolve the fjord dynamics The atmospheric component will be implemented in both stand alone (WRF-Polar) and coupled with aerosols (WRF-Chem). Three nested grid will considered at resolution 20-5-1 km. For process study a high-resolution (10-100 m) artic-LES may be implemented, it will be offline coupled with the atmospheric model. The system will increase our understanding of fjord dynamics and the available observations will be used to assess the ongoing “atlantification” and impacts; interaction with boundaries, in particular the melt water export from the inner fjord to the outer shelf and its characteristic; the impact of extreme atmospheric events (heat waves, polar lows) on the regional dynamics; the role of aerosols on the climate and on the weather at local scale.

Particulate organic carbon fluxes off Storfjorden (SW Spitsbergen margin, Arctic)

L. Langone (1), M. Bensi (2), S. Aliani (1), A. D'Angelo (1), P. Giordano (1), V. Kovacevic (2), F. Giglio (1), S. Miserocchi (1), I. Conese (1)

1 - Istituto di Scienze del Mare (CNR-ISMAR), Italy
2 - Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Trieste, Italy

Abstract

The export of particulate organic carbon (POC) from the sea surface is an essential part of the biological pump. POC from the upper layers is delivered to the deep ocean, which retains CO_2 for a relatively long period compared with the epipelagic CO_2 residence time. In the last decades, the Arctic region has gained a large interest because of climate changes and relevant effects on ice melting and global warming. Abrupt changes in the atmosphere are responsible for significant changes in ocean water masses and large-scale circulation patterns, which in turn affect the global climate. Studying ocean circulation and related processes in the Fram Strait (Western Svalbard) is essential to describe the thermohaline circulation and the dense water formation in the Arctic, and the way they contribute to the global thermohaline circulation. From 2002, the decrease of sea-ice in the Fram Strait has been significant, the water temperature is increasing in general, while POC fluxes tend to decrease. Starting from 2010, moored sediment traps have been deployed also in SW Spitsbergen slope in an joint effort including Italian, French, Spanish, Norwegian, Polish, German and Swedish researchers. Our data highlight the presence of a stable signal of Norwegian Sea Deep Water influenced by occasional intrusions of warmer (up to +2.7°C), saltier (up to ~35), and less dense (down to 27.98 kg m^{-3}) water during fall-winter periods. Interestingly, such intrusions occur simultaneously at different sites, despite their distance (~170km), suggesting also that winter meteorological perturbations may play a role in triggering dense shelf plumes. Marine POC fluxes show the typical temporal variability of high latitudes with greater content of biogenic compounds in spring–summer linked to phytoplankton blooms. However, most of the POC is laterally advected in late winter by occasional intrusions of warmer, saltier, less dense and more oxygenated water.

Modern sediment distribution and composition in Kongsfjorden, Svalbard

S. Miserocchi (1), L. Langone (1), F. Del Bianco (2), F. Giglio (1), T. Tesi (1), S. Aliani (1)

1 - Istituto di Scienze del Mare (CNR-ISMAR), Italy
2 - Proambiente Scrl, Bologna, Italy

Abstract
The Kongsfjorden is a small fjord located in western Svalbard. Twelve short sediment cores were sampled in 2011 to describe modern sediment distribution and geochemical composition. Core locations were chosen based on a high resolution seismic survey in order to delineate surficial seismo-stratigraphic features. Based on the different acoustic response, seismic reflectors are continuously or irregularly laminated, transparent-chaotic, or continuous and highly reflective. Maximum sediment thicknesses (~10 m) were recorded close to the calving line of ice tongues. Sedimentation rates, based on seismic and radionuclide profiles, resulted in high values (up to 10 cm/y) in the laminated fine mud near the glaciers, and lower sedimentation rates (0.2-0.6 cm/y) in the bioturbated muddy sediment of the outer fjord. Organic carbon content of surface sediments showed values decreasing toward the inner fjord, reflecting the higher accumulation rates and the lower biological production in the turbid water near glacial fronts. High Br/Cl in outer fjord sediments reveals the presence of organic matter of marine origin consistent with the bulk organic carbon data. High Ca/Ti ratios measured in inner fjord sediments prove the deposition of Ca-rich sediments supplied by the catchment of Kronebreen-Kongsvegen glaciers. In contrast, Ca/Ti is lower in the outer fjord. However, the down core distribution suggests the occurrence of past events during which the glacier influence extended further seaward. The cm-scale lamination together with sediment accumulation rate of 10 cm/y in the inner fjord sediments imply sedimentary processes with fluctuations at sub-annual (monthly?) scale. As a working hypothesis, we suggest that tidal currents are able to modulate the subglacial supply of meltwater and associated sediment at the glacier fronts.

Paleo climate reconstruction in Kongsfjorden over the last 1k years: preliminary results of C^3 project

T. Tesi (1), C. Ceccarelli (1), L. Capotondi (1), A. Nogarotto (1), G. Mollenhauer (2), S. Miserocchi (1), F. Giglio (1), P. Giordano (1), L. Langone (1)

1 - Istituto di Scienze del Mare (CNR-ISMAR), Italy
2 - Alfred Wegener Institute (AWI), Bremerhaven, Germany

Abstract

Future climate projections in a global warming scenario remain uncertain because of poorly constrained Earth system feedbacks (IPPC-2013). The enormous quantities of carbon (C) presently stored in frozen Arctic soils (1,300 Peta g C) – i.e., over twice as much as the pre-industrial C stock in the atmosphere – and the loss of sea ice may be the most significant examples. Global warming is in fact amplified in Arctic where permafrost soils are expected to release substantial Greenhouse Gases (GHG; CO2 and CH4) to the atmosphere coupled with a progressive reduction of the sea ice with unknown feedbacks to global climate. However, the future climate evolution will largely depend on how climate, cryosphere and carbon reservoirs will interact with each other and, thus, more work in this direction is crucial. Within the C^3 project, we investigate the link between Climate, Cryosphere and Carbon (here referred as the C^3 system) using a new and multifaceted organic proxy approach. We implemented our study in the Kongsfjorden (Svalbard) as a natural laboratory to examine the climate-induced destabilization of sea ice and permafrost carbon over the last 1000 years focusing on three key periods: (i) the Medieval Warm Period (MWP, ca. 1000 years ago), (ii) the Little Ice Age (LIA, ca. 400 years ago) and (iii) the modern global warming (last couple of decades). To do so, we used sediment cores as archives of past permafrost and sea ice dynamics. By targeting well known past events (MWP and LIA), our overarching goal is to better understand the Arctic amplification in fjord environments in terms of natural and modern human-induced climate changes.

Acoustic detection of white whale (*Delphinapterus leucas*) occurrence in Kongsfjorden (Svalbard Islands)

E. Papale (1)(2), G. Alonge (3), R. Grammauta (1), C. Nuth (4), M. Ceraulo (1), S. Mazzola (1), G. Buscaino (1)

1 - Istituto per lo Studio degli Impatti Antropici e la Sostenibilità in Ambiente Marino (CNR-IAS), Italy
2 - Dipartimento di Scienze della Vita e Biologia dei Sistemi, Università di Torino, Italy
3 – ENEA - Laboratorio di Osservazione e Analisi della Terra e del Clima, Italy
4 - Department of *Geosciences*, University of Oslo, Norway

Abstract

Marine mammals occurring in the waters of Svalbard (Norway) can be classified as strictly dependent on the Arctic ecosystem for all aspects of their life, or sub-Arctic species during whose life show a seasonal migration in the Arctic area. The strong environmental alteration taking place in the ecosystem, influences species differently in relation to the habitat use and behavioral activity. The white whale (Delphinapterus leucas) is a species linked to the ice and strongly associated with feeding hot spots, represented by the fronts of the marine terminating tidewater glaciers. In the Kongsfjorden (Western Svalbard), most of the glaciers are retreating, leading the white whales to face a changing environment. Since passive acoustic monitoring can provide useful information on spatial and temporal movements of vocalizing marine mammals, and on potential responses to ongoing changes, we studied the possibility of using white whales clicks as a tool to detect the acoustic presence of the species. Three autonomous hydrophones were located at a depth of 80 m in the fjord: at the entrance, near the port of Ny-Ålesund, and near the Kronebreen glacier, recording at a sampling frequency of 192 kHz, 2 minutes per hours. 64 822 files were collected and analyzed from February 2014 to August 2018. Automatic detection was carried out through a software developed in Matlab, based on a series of filters (high pass at 10 kHz, Teager Kaiser, and thresholds previously identified on the basis of clicks recorded simultaneously with white whales sightings), with the aim of automatically identifying impulsive sounds. However, given the presence of noise from other sources, which can affect the detection, only the files, visually validated, which included trains of clicks attributable to white whales, were considered. The preliminary analysis of a sub-sample (N = 7109) of clicks showed that the recorded impulsive sounds have average duration values of 0.0003 seconds (sd = 0.0001), of the first frequency peak at 42015 Hz (sd = 12416), of the centroid frequency 44749 Hz (sd = 9178), of the 3dB band 7325 Hz (sd = 5182), and of a number of peaks equal to 6.23 (sd = 3.30). The analysis of temporal and spatial presence is currently underway. The validation of the method and the results will provide more information on how this species moves in the fjord, how its seasonal and daily presence varies and about any relationships between movements, oceanographic variables (currents, surface temperature) and ice distribution (surface cover and due to ice calving) in the fjord, with the aim of supporting any conservation strategies for the species in the Svalbard Islands.

Extrapolation and identification of biological patterns from acoustic multibeam data collected in Kongsfjorden

G. Giacalone (1), I. Fontana (1), S. Aronica (1), A. Bonanno (1), M. Calabrò (1), S. Genovese (1), G. Basilone (1), S. Mazzola (1), R. Rizzo (2), G. Lo Bosco (3), M. Barra (4), P. Rumolo (4), M. Ceraulo (1), R. Noormets (5), C. Nuth (6), G. Buscaino (1)

1 - Istituto per lo Studio degli Impatti Antropici e la Sostenibilità in Ambiente Marino (CNR-IAS), Italy
2 - Istituto di Calcolo e Reti ad Alte Prestazioni (CNR-ICAR), Italy
3 - Università di Palermo, Italy
4 - Istituto di Scienze del Mare (CNR-ISMAR), Italy
5 - The University Centre in Svalbard (UNIS) Longyearbyen, Norway
6 - The University of Oslo, Norway

Abstract

Climate change is causing a structural and functional modification of Arctic ecosystems. In the Svalbard islands these changes are determining a modification of the composition and distribution of species present in the area (Renauld et al 2012). The influx of warm Atlantic water on the west coast of Svalbard, caused a northward expansion of Atlantic boreal cod (*Gadus morhua*) and the haddock (*Melanogrammus aeglefinus*) disadvantaging the presence of the native polar cod (*Boreogadus saida*), that it was the predominant species in this area. In this work we have developed a new methodology able to identify and extract biological patterns from acoustic data acquired by Simrad multi-beam technology EM2040. Data were collected in Kongsfjorden (Svalbard) in the framework of the CalvingSEIS - Glacier dynamic ice loss quantified through seismic eyes- project funded by the "Norwegian Research Council", KLIMAFORSK program. The multibeam data, collected to study the morphometric characteristics of the bottom close to the Kronebreen glacier front, were exploited to identify three dimensional geometries along the water column. A series of procedures have been performed aiming to identify and cluster reflecting potential fish targets. For each cluster the shape, the centroid amplitude, depth and its energy were assessed. The characteristics of the patterns here extracted were compared with that ones extracted using specific analysis software. Once the method was validated and all the patterns information were collected, the results have been divided into more or less homogeneous groupings using an algorithm partition clustering called K-means, providing for an appropriate data pre-processing. The results showed 3 distinct clusters as the most correct interpretation, and each cluster probably represents a different shoal of fish. We found a spatial distribution pattern of these clusters: one was found near the glacier front, an area characterized by coldest and lower salinity waters, and the other in the middle of the fiord, distributed in two main depths. Our hypothesis is that these three shoal types belong to two species inhabiting the Kongsfjorden: the polar cod (*Boreogadus saida*), and the Atlantic cod (*Gadus morhua*). In particular the shoal found in the middle of fjord could belong to the Atlantic cod, that lives in warmer water compared to the polar cod that we assumed was recorded in the shoal near the glacier front, with colder and lower salinity water. Moreover, the adult and juvenile of Atlantic cod inhabit two different depths and this reflects our results in the middle of fjord, where two similar shoals but with different depth location were found. The method implemented in this work is useful for extracting biological information from multibeam instrumentation which is generally used for geophysical and geological investigations. This will increase the quantity and the quality of information available (generally considered as “noise”) to researchers involved in the CalvingSEIS project. Moreover, in the future we could use multibeam data already collected in other sites for geological aims to explore the fish shoals biomass and distribution.

References Renaud P.E., Berge J., Varpe Ø., Lønne J., Nahrgang J., Ottesen C., Hallanger I.(2012). Is the poleward expansion by Atlantic cod and haddock threatening native polar cod, *Boreogadus saida*? Polar Biol (2012) 35:401–412.

Poster Session

Cryosphere

Free amino acids in the Arctic snow and ice core samples: Potential markers for paleoclimatic studies

E. Barbaro (1), A. Spolaor (2), O. Karroca (2), K. Park (3), T. Martma (4), E. Isaksson (5), J. Kohler (5), J.C. Gallet (5), M.P. Bjorkman (6), D. Cappelletti (7), G. Spreen (8), R. Zangrando (1), C. Barbante (1,2), A. Gambaro (1,2)

1 – Instituto di Dinamica dei Processi Ambientali (CNR-IDPA), Venezia, Italy
2 – Dipartimento di Scienze Ambientali, Informatica e Statistica, Ca' Foscari Università di Venezia, Italy
3 - Korea Polar Research Institute, Yeonsu-gu, Republic of Korea
4 - Department of Geology, Tallinn University of Technology, Tallinn, Estonia
5 - Norwegian Polar Institute, Tromsø, Norway
6 - University of Gothenburg, Department of Earth Sciences, Göteborg, Sweden
7 - Dipartimento di Chimica, Biologia e Biotecnologie, Università degli Studi di Perugia, Italy
8 - University of Bremen, Institute of Environmental Physics, Bremen, Germany

Abstract

The role of oceanic primary production on climate variability has long been debated. Defining changes in past oceanic primary production can help understanding of the important role that marine algae have in climate variability. The changes in primary production could have influenced CO_2 sequestration into the ocean and hence affect the radiative forcing of the Earth's atmosphere. Methanesulfonic acid (MSA) is the chemical marker in the ice core archive commonly used for assessing changes in past primary production. MSA is produced by the marine biota but its concentration could be influenced by other environmental parameters such as changes in sea ice extension. Although MSA concentrations were preserved in cold storage conditions for up to 15 years, MSA is able to diffuse through solid ice cores. The determination of other compounds, able to give an indication of past marine productivity, is crucial. Other organic compounds, such as free amino acids, can be produced and emitted into the atmosphere during a phytoplankton bloom. For the first time, free L- and D-amino acids in Arctic snow and firn samples were determined by a sensitive and selective analytical method based on liquid chromatography coupled with tandem mass spectrometry. The new method for the determination of free amino acids concentrations was applied to firn core samples collected on April 2015 from the summit of the Holtedahlfonna glacier, Svalbard (N 79'08.424, E 13'23.639, 1120 m a.s.l.). Here we also investigate the correlation between the concentration of chlorophyll-a, marker of marine primary production, and amino acids present in an ice core to evaluate the possible application to paleoclimatic studies. The main results of this work are summarized as follows: (1) glycine, alanine and proline, were detected and quantified in the firn core samples; (2) their concentration profiles, compared with that of the stable isotope $\delta^{18}O$ ratio, show a seasonal cycling with the highest concentrations during the spring and summer time; (3) back-trajectories and Greenland Sea chlorophyll-a concentrations obtained by satellite measurements were compared with the amino acids profile obtained from ice core samples, this provided further insights into the present results. This study suggests that the amino acid concentrations in the ice samples collected from the Holtedahlfonna glaciers could reflect changes in oceanic phytoplankton abundance.

Reference

Barbaro E., Spolaor A., Karroca O., Park K.T., Martma T., Isaksson E., Kohler J., Gallet J.C., Bjorkman M.P., Cappelletti D., Spreen G., Zangrando R., Barbante C., Gambaro A., "Free amino acids in the Arctic snow and ice core samples: Potential markers for paleoclimatic studies", 2017. Science of Total Environment, 607-608, Pages 454-462, doi: 10.1016/j.scitotenv.2017.07.041.

Change in chemical composition of the annual snow layer: the effects of rain event and melting processes

E. Barbaro (1), C. Varin (2), X. Pentelli (2), J.M. Christille (3,4), T. Kirchgeorg (2), F. Giardi (5), D. Cappelletti (6), C. Turetta (1), A. Gambaro (2), A. Bernagozzi (3), J.C. Gallet (7), M.P. Björkman (8), E. Bertolini (3), C. Barbante (1,2), A. Spolaor (1)

1 – Instituto di Dinamica dei Processi Ambientali (CNR-IDPA), Venezia, Italy
2 – Dipartimento di Scienze Ambientali, Informatica e Statistica, Ca' Foscari Università di Venezia, Italy
3 - Osservatorio Astronomico di Saint Barthélemy Val D'Aosta (OAVdA), Nus (AO), Italy
4 - Dipartimento di Fisica e Geologia, Università degli Studi di Perugia, Italy
5 – Dipartimento di Chimica, Chimica Analitica, Scienze Polari, Università di Firenze, Sesto Fiorentino, Italy
6 - Dipartimento di Chimica, Biologia e Biotecnologie, Università degli Studi di Perugia, Italy
7 - Norwegian Polar Institute, Tromsø, NO-9296, Norway
8 - University of Gothenburg, Department of Earth Sciences, Göteborg, Sweden

Abstract

The annual snow layer is an extremely dynamic portion of the cryosphere and can be defined as the snow accumulated and present on the ground during the year. The snow deposited and accumulated over the glaciers reflects the average atmospheric composition and preserves some information about the transport processes of atmospheric aerosol. In the polar region, the annual snow strata can be preserved and the snow accumulation from year to year then forms proxies for climate reconstructions. However, several processes can influence the annual signal in the accumulated snow. To better interpret the chemical signal in ice archive is crucial to investigate the effect of the surface melting and the effect of water percolation due to some atmospheric events such as rain. A daily sampling of the first meter of snowpack was carried out in the Austre Brøggerbreen glacier (Spitsbergen, Svalbard Islands) from 27th March to 31st May 2015. During the experiment a rain event occurred 16th to 17th of April while from the 15th of May the snow had an homogeneous thermal profile. The main aim of this experiment was to describe the daily physical and chemical changes of snowpack occurred during a rain event and when the melting phase is on-going. This is the first field experiment about the evolution of chemical composition of snowpack in a Svaldard glacier. The presented dataset is unique and help to clarify the behaviour of cations (K^+, Ca^{2+}, Na^+, Mg^{2+}) anions (Br^-, I^-, SO_4^{2-}, NO_3^-, Cl^-, MSA) and two carboxylic acids (C_2-glycolic and C_5-glutaric acids) in the snow pack during this melting period. Understanding the dynamic of ions during these specific events is mandatory to use these species as climatic proxies in the ice cores archive.

Degradation of the climate signal preserved in Svalbard ice archive.

A. Spolaor (1), C. Barbante (1,2), E. Barbaro (1), F. Burgay (1), M. P. Bjorkman (3), D. Cappelletti (4), G. Cozzi (1), F. Dallo (1), F. De Blasi (1), D. Divine (5), G. Dreossi (1), J. Gabrieli (1), J.-C. Gallet (5), J. Kohler (5), E. Isaksson (5), D. Iovino (6), T. Martma (7), M. Maturilli (8), T. V. Shuler (8), B. Stenni (1,2), C. Turetta (1).

1 – Instituto di Dinamica dei Processi Ambientali (CNR-IDPA), Venezia, Italy
2 – Dipartimento di Scienze Ambientali, Informatica e Statistica, Ca' Foscari Università di Venezia, Italy
3 - University of Gothenburg, Department of Earth Sciences, Box 60, 40530 Göteborg, Sweden
4 - Dipartimento di Chimica, Biologia e Biotecnologie, Università degli Studi di Perugia, 06123 Perugia, Italy
5 - Norwegian Polar Institute, Tromsø, Norway
6 - Foundation Euro-Mediterranean Center on ClimateChange. Viale Berti Pichat 6/2, 40127 Bologna (Italy)
7 - Department of Geology, Tallinn University of Technology, Ehitajate tee 5, 19086 Tallinn, Estonia
8 - Alfred Wegener Institute, Division of Climate Sciences and Atmospheric Physics, Potsdam, Germany

Abstract

The whole Arctic regions is undergoing to a rapid warming, faster than the global average with a direct impact on all Arctic environmental sectors. Decrease in summer sea ice extension, changes in the atmospheric transport and composition, shorten the snow season and increasing the melting periods on the main Arctic Ice cap are just part of observed changes. The Svalbard archipelago is particularly sensitive to the temperature increasing due to its location and the moderate altitude of the main ice caps. Though the greater temperature rising has been observed during the winter periods, the enhanced summer temperatures are extending and prolonged in time the glaciated areas affecting by melting. Svalbard has four main ice caps: Austfonna, Lomonosofonna, Asgardfonna and Holthedalfonna. These ice fileds are situated between 800 m a.s.l. of Austfonna to the 1250 of the Lomosofonna and the Asgardfonna while the Holthedalfonna is located at 1100 m a.s.l.. Several ice cores have been recovered from this ice caps covering back to 1000 year ago. From 2012 to 2017 three shallow core, covering the periods 2016 - 2003 have been collected from the Holthedalfonna summit. The stable isotope datasets obtained have been compared with the longer ice core record collect in 2006 that extend back to the 17th century. Though the rise of the Arctic temperature, the shallow core shows a more negative stable isotopes value compare the long Holthedalfonna ice record. Meteorological measurements as well re-analysis conducted at the drilling site show a clear increasing of days with average temperature above zero, the increasing of summer melting and the strong decreasing of the summer snow accumulation. The combination of ice core data, meteorological re-analysis, mass balance calculation suggest that the Svalbard higher ice cap might have reach a tipping point where the summer accumulation is almost fully removed causing a bias on the isotopic signal. Thought the climate signal is still preserve in the buried ice the climatic signal recorded in the upper part cannot longer be compared and might representative only of winter deposition. These unique results underline the impact of Arctic amplification on Svalbard ice caps and the effect on climate signal preserved in its. Considering the similar altitude for the main Svalbard ice field, the results suggest that a tipping point might have been reached for the entire archipelago and, considering the likely temperature increase predicted for the close future, the impact detected might be extended to the older ice.

Diurnal cycle of iodine and mercury concentrations in Svalbard surface snow

A. Spolaor (1), E. Barbaro (1), D. Cappelletti (2), C. Turetta (1), M. Mazzola (3), F. Giardi (4), M.P. Bjorkman (5), F. Lucchetta (6), F. Dallo (1), K. Aspmo Pfaffhuber (7), H. Angot (8), A. Dommergue (9), M. Maturilli (10), A. Saiz-Lopez (11), W. RL Cairns (1)

1 – Instituto di Dinamica dei Processi Ambientali (CNR-IDPA), Venezia, Italy
2 - Dipartimento di Chimica, Biologia e Biotecnologie, Università degli Studi di Perugia, Italy
3 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
4 – Dipartimento di Chimica "Ugo Schiff", Università di Firenze, Sesto Fiorentino, Italy
5 - University of Gothenburg, Department of Earth Sciences, Göteborg, Sweden
6 – Dipartimento di Scienze Ambientali, Informatica e Statistica, Ca' Foscari Università di Venezia, Italy
7- Norwegian Institute for Air Research (NILU), Kjeller, Norway
8 – Institute for Arctic and Alpine Research (INSTAAR), University of Colorado, Boulder, USA
9 – Institut des Géosciences de l'Environnement, Univ. Grenobles Alpes / CNRS, France
10 – Alfred-Wegener-Institut (AWI), Germany
11 - Institute of Physical Chemistry Rocasolano, Spain

Abstract

Sunlit snow is highly photochemically active and plays an important role in the exchange of gas-phase species between the cryosphere to the atmosphere. Here, we investigate the behavior of two selected species in surface snow: mercury (Hg) and iodine (I). Hg can deposit year-round and accumulate in the snowpack. However, photo-induced re-emission of gas phase Hg from the surface has been widely reported. Iodine is active in new particle formation, especially in the marine boundary layer, and in the destruction of atmospheric ozone. It can also undergo photochemical re-emission. Although previous studies indicate possible post-depositional processes, little is known about the diurnal behaviour of these two species in surface snow. The mechanisms are still poorly constrained and no field experiments have been performed in different seasons to investigate the magnitude of re-emission processes. Three high temporal resolution (hourly samples) 3-day experiments were carried out near Ny-Ålesund (Svalbard) to study the behaviour of Hg and I in surface snow under different sunlight and environmental conditions (24h-darkness, 24h-sunlight and day/night cycles). Our results indicate a clearly different behaviour of Hg and Iin surface snow during the different experiments. The 24h day/night experiments demonstrate the existence of a diurnal cycle in surface snow for Hg and I, indicating that these species are indeed influenced by the daily solar radiation cycle. Differently Br does not show any diurnal cycle. The diurnal cycle disappears during the 24h-sunlight period (and during the polar night) supporting the idea ofthe occurrence (absence) of a continuous recycling / exchange at the snow-air interface. These results demonstrate that this surface snow recycling is seasonally dependent. They also highlight the non-negligible role that snowpack emissions have on ambient air concentrations and potentially on iodine-induced nucleation processes.

Iron speciation on Svalabard ice cores. First results and future perspectives

F. Burgay (1,2), E. Barbaro (2), C. Turetta (2), J.C. Gallet (3), E. Isaksson (3), B. Stenni (1,2), G. Dreossi (2), A. Saiz-Lopez (4), K. Kim (5,6), C. Barbante (1,2), A. Spolaor (2)

1 - Dipartimento di Scienze Ambientali, Informatica e Statistica, Ca' Foscari Università di Venezia, Italy
2 – Instituto di Dinamica dei Processi Ambientali (CNR-IDPA), Venezia, Italy
3 - Norwegian Polar Institute, Tromsø, Norway
4 - Department of Atmospheric Chemistry and Climate, Institute of Physical Chemistry Rocasolano, CSIC, Madrid, Spain
5 - Korea Polar Research Institute (KOPRI), Incheon, Republic of Korea
6 - Division of Environmental Science and Engineering, Pohang University of Science and Technology (POSTECH), Republic of Korea

Abstract

Iron (Fe) is the fourth most abundant metal of the Earth's crust and the study of its biogeochemical cycle is crucial to understand how the biological carbon pump might evolve under a global warming scenario. It is a coenzyme in several biological processes such as atmospheric nitrogen fixation and photosynthesis. Its presence may limit primary productivity in the so-called High-Nutrient Low-Chlorophyll (HNLC) regions, which are characterized by a high concentration of nutrients (e.g. nitrate and phosphate) but a low marine productivity. Thus, understanding the processes that can influence Fe solubility and bioavailability is fundamental to evaluate how the Fe supply can influence the productivity in those areas. Even though Svalbard Islands are not a Fe-limited ecosystem, they represent a perfect location where it is possible to perform studies on the Fe biogeochemistry. In Spring 2017, a pioneering study was performed to understand which elements can influence Fe solubility in ice and snow matrices. Thanks to the Iron Speciation in Svalbard Ice Core and Snow (ISSICOS) project, a 10-meters long ice core was taken and analyzed to evaluate the Fe^{2+} concentration. Linking its concentration with other organic and inorganic compounds, it was observed that organic ligands (acetate, formiate and glycolate) were significant correlated with Fe^{2+}, suggesting that they can play a role in keeping it in its soluble form. Unfortunately, due to summer snow melting that has affected the sampling site, it was impossible to state whether the organic ligands were produced by *in situ* bacteria or they were transported by the wind. Nevertheless, our study, with the validation of a new analytical method, represents a starting point to evaluate which processes may intervene in influencing Fe speciation and solubility in ice and snow matrices.

Local and long-range sources of fragrances in snow and seawater of Ny-Ålesund

M. Vecchiato (1,2), E. Barbaro (2), E. Gregoris (1), A. Spolaor (2), C. Turetta (2), C. Barbante (1,2), R. Piazza (1,2), A. Gambaro (1,2)

1 – Dipartimento di Scienze Ambientali, Informatica e Statistica, Ca' Foscari Università di Venezia, Italy
2 – Instituto di Dinamica dei Processi Ambientali (CNR-IDPA), Venezia, Italy

Abstract

Fragrance Materials (FMs) are ubiquitous components of household and Personal Care Products (PCPs), whose environmental fate is still largely unknown. Even less information is available about the environmental distribution of PCPs in polar regions: beyond local human contamination, these fragile ecosystems are also threatened by long-range atmospheric transport (LRAT) of contaminants. We chose 17 among the longest-lasting and most stable fragrance ingredients that are commercially available (Givaudan®) to assess their persistence, distribution and transport in the ecosystem. The selected fragrances were initially found as contaminants in the Venice Lagoon: urban sewages largely emit these FMs into the surface seawater This pilot study reported the first detection in environmental samples for most of the selected FMs. These compounds were later detected in open sea areas of the Mediterranean, highlighting the role of mesoscale hydrodynamics and LRAT as key factors nd in the coastal seawater of the Ross Sea, Antarctica The distribution of these FMs in polar environments was studied in seawater and snow samples of Ny-Ålesund (Svalbard) Concentrations of FMs up to 72 ng L-1 were detected in the surface snow near the settlement and at increasing distances, in relation to the prevailing winds, due to local emissions. However, the snow seasonal deposition of FMs was estimated in a snowpit dug at the top of the Austre Brøggerbreen glacier, indicating the LRAT of these compounds. Moreover, the snow deposition is likely to play a major role, constituting a possible secondary source of contamination during the seasonal snowmelt. In each of the investigated environments the allergenic and oestrogenic Salicylate compounds resulted in general the most abundant and widespread components, probably due to their large global consumption. Peonile, Ambrofix and Oranger Crystals followed as major FMs. These findings support the hypothesis of the environmental persistence of the selected FMs, highlighting future research priorities.

References

Vecchiato, M., Gregoris, E., Barbaro, E., Barbante, C., Piazza, R. and Gambaro, A.: Fragrances in the seawater of Terra Nova Bay, Antarctica, Sci. Total Environ., 593–594, 375–379, 2017.

Vecchiato, M., Turetta, C., Patti, B., Barbante, C., Piazza, R., Bonato, T. and Gambaro, A.: Distribution of fragrances and PAHs in the surface seawater of the Sicily Channel, Central Mediterranean, Sci. Total Environ., 634, 983–989, 2018a.

Vecchiato, M., Barbaro, E., Spolaor, A., Burgay, F., Barbante, C., Piazza, R. and Gambaro, A.: Fragrances and PAHs in snow and seawater of Ny-Ålesund (Svalbard): Local and long-range contamination, Environ. Pollut., 242, 1740–1747, 2018b.

Poster Session

Technological and scientific innovation

The Italian Arctic Data Center (IADC): an integrated interoperable digital system for arctic data management

A. Viola (1), C. Elefante (2), M. Mazzola (1), V. Vitale (1), S. Longo (3), C. Leone (3)

1 - Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Italy
2 - Università del Salento Lecce, Italy
3 - Dipartimento Scienze del Sistema Terra e Tecnologie per l'Ambiente (CNR-DSSTTA), Italy

Abstract

Many data sets are not yet interoperable and accessible because they do not accomplish to international standard formats. To have an organized and distributed information system to store, record information (metadata), validate and view the captured data becomes mandatory for most of research infrastructures. The working group for Arctic Research in Svalbard appointed by the Department of Science of Earth System and Technology for the Environment (DSSTTA) of the National Council of Research (CNR) has established the infrastructure IADC (Italian Arctic Data Center) to provide the polar scientific community the discovery and access to environmental data through the interconnection with systems compliant with the global environmental observation network of GEOSS. The Italian Arctic Data Center is a digital infrastructure created with the aim to store, visualize and download metadata and data collected in the Arctic region by scientific facilities operated by the Dirigibile Italia Station owned by CNR. This infrastructure implements multi-disciplinary interoperability following a brokering approach, supporting data policy and in accordance with European and international standards, including GEO/GEOSS, INSPIRE. Beside its primary objective (data management) the IADC also ensure researchers of national institutions, services to manage projects, instrumentation, field works, and scheduling the presence at the Dirigibile Italia. The IADC is based by the CNR headquarter in Rome and is coordinated by the working group for Arctic Research in Svalbard. The architecture of IADC is based on the application of model software to ensure the management of different type of environmental data and is supported by a hardware infrastructure (servers and mass storage) distributed between Rome and Ny-Ålesund. The data collected flow by the local computer in Ny-Ålesund to the database in Rome. There are two level of data management provided by IADC: real-time data acquisition and off line data recovering. In the first case the data are collected by continuous online instruments and directly transferred to the database. In the second case the data are provided after a preliminary processing and data analysis. The infrastructure is provided with services to allow real time updates on data and metadata directly from remote sensors. Moreover, as CNR is representative of the Italian partnership in Svalbard Integrated Observing System (SIOS) the interoperability between the data centers and integration of IADC in the SDMS (SIOS Data Management System) is formally requested as Italian contribution to SIOS. The first step has been achieved: the metadata recorded by IADC are compliant with GCDM and are interoperable with SDMS. An operational, test has been provided using the data collected at the Amundsen – Nobile Climate Change Tower installed in Ny-Ålesund. The second step will be to timely complete the metadata records compliant with the EU inspire directive of all other instruments to full accomplish the EU open data policy.

NARWHALS, an ESA funded project to support the maritime navigation in Arctic

V. Romano (1), L. Alfonsi (2), U. Apponi (1), V. Cannas (1), C. Cesaroni (2), G. De Franceschi (2), P. Di Vito (3), H. Ghobadi (2), I. Hunstad (1), L. Pilosu (4), S. Pisu (5), O. Terzo (4), P. Testa (6)

1 - SpacEarth Technology Srl, INGV spin-off, Roma, Italy
2 - Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy
3 - European Space Agency, Didcot, United Kingdom
4 - Istituto Superiore Mario Boella, Torino, Italy
5 - Torino Wireless, Torino, Italy
6 - Noveltis, Toulouse, France

Abstract

NARWHALS (Navigation in ARctic With gnss High Accuracy Low power Solution) is an ESA funded project in the "Kickstart Activities", thematic call: "Arctic and sub-Arctic Regions". NARWHALS realised a feasibility study of a service capable to provide high accuracy positioning by monitoring and mitigating the ionospheric impact on GNSS navigation in Arctic and sub-arctic regions. To this end, the study foresees the deployment of an ad hoc regional network of GNSS stations. NARWHALS aims to individuate a solution specifically customised to support the Arctic shipping through the adoption of different technologies that can guarantee the operation of the proposed network in extreme environments. As confirmed by institutional and commercial key stakeholders involved in the feasibility study, the severe environmental conditions, the paucity of the land surface, the fragmentary coverage of power supply and connectivity and the low elevation locking of the GNSS satellites make the setup of robust GNSS networks in the Arctic and sub-Arctic highly challenging, highlighting the need for safer and more reliable maritime navigation systems. In this scenario, the solution proposed is based on the integration of the Istituto Superiore Mario Boella (ISMB) knowledges on low power systems' design with the SpacEarth Technology (SET/INGV) expertise in handling and interpreting the ionospheric data. Next steps will foresee the application for the ESA co-funded demonstration project in which a pre-operational service will be validated before evolving into an operational service to be commercialized first in the maritime market and then in other market sectors. The system architecture to demonstrate the feasibility of the solution foreseen two different scenarios: a) regional area, covered by measurement stations with a typical distance of tens of kilometers from each other and b) harbor, covered by a denser network of measurement stations. The chosen location for both scenarios is in the Svalbard Islands supported by the facilities at Ny-Ålesund.

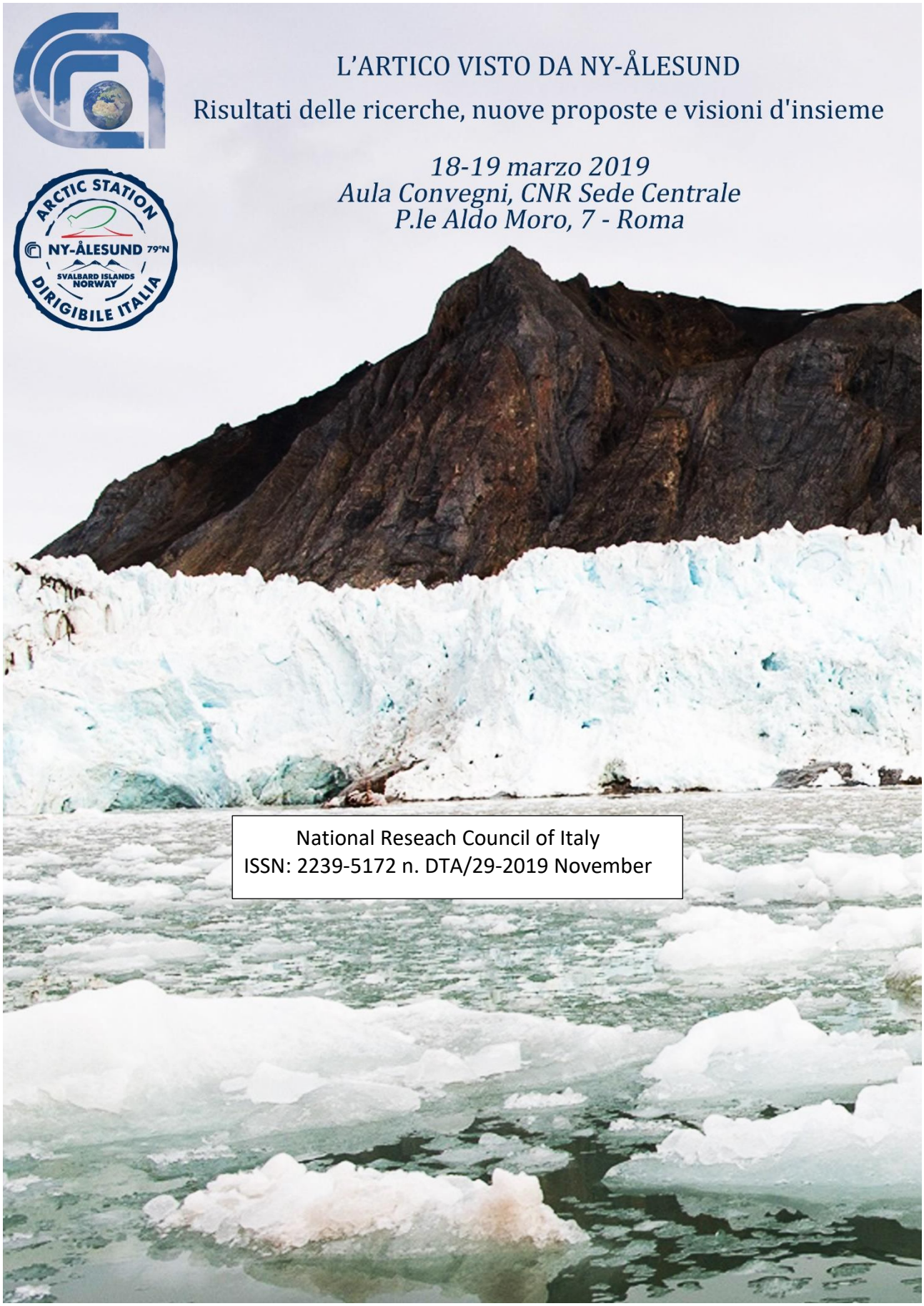
Autonomous marine and aerial vehicles for carrying out scientific surveys near Arctic tidewater glaciers

Ga. Bruzzone, Gi. Bruzzone, M. Caccia, R. Ferretti, A. Odetti, A. Ranieri, E. Spirandelli

Istituto di iNgegneria del Mare (CNR-INM), Italy

Abstract

Acquiring scientific data in polar regions is often problematic due to harsh weather and risky operating conditions. In the last decade the use of robots for substituting human beings in performing difficult, dangerous and burdensome tasks has become more and more frequent. According to this trend, in the summers 2015, 2017 and 2018, a group of researchers of ISSIA-CNR (now INM-CNR) carried out three scientific campaigns in the Kongsfjorden, an Arctic glacial fjord located in the Svalbard Archipelago, where autonomous vehicles both marine and aerial were used for collecting environmental physical, chemical and biological data. In particular, the USSV (Unmanned Semi-Submersible Vehicle) Shark, the USV/ROV (Unmanned Surface Vehicle/Remotely Operated Vehicle) PROTEUS (Portable Robotic TEchnology for Unmanned Surveys) and the UAV (Unmanned Aerial Vehicle) Otto were used to acquire both marine and atmospheric data in the proximity of tidewater glacier fronts. These areas are extremely hazardous and hardly accessible for human beings because of the possible sudden fall of massive ice blocks. Thanks to the open and modular software and hardware architectures of the robots developed by the INM-CNR robotics group, it was possible to integrate on the vehicles numerous instruments (e.g. automatic water samplers, CTD probes, multi-parametric probes, air quality sensors, sonars, etc.) that allowed to collect measurements of multiple environmental parameters. The success of the carried out campaigns demonstrated that autonomous marine and aerial vehicle technology is now mature and can be of great help to scientists involved in the acquisition of both atmospheric and marine data in polar regions.



National Reseach Council of Italy
ISSN: 2239-5172 n. DTA/29-2019 November