Here Dirigibile Italia

May 15th, 2022: the Arctic station Dirigibile Italia of the CNR turned 25 years old.

This issue of the newsletter is intended to be a brief account of the scientific, technological, and organizational path that has seen this outpost of the CNR and Italian polar research in the Arctic grow as a protagonist in these 25 years. The station, called "Dirigibile Italia" in honor of the victims of the tragic expedition by Umberto Nobile in 1928 was built in the village of Ny-Ålesund in Svalbard (Norway), an ideal place for multidisciplinary studies aimed at improving knowledge of the complex processes and interactions between the different components of the Arctic climate system. Between 1997 and 2004, scientific activities were carried out within the Arctic Strategic Project of the CNR, subsequently they were supported by the Earth and Environment Department of the CNR which provided significant support in maintaining the station's activities and the international collaborations, established mainly with German, Norwegian, US and Canadian institutions. The research activity carried out at the Italy Dirigible Station is in the following scientific fields:

- Atmosphere and climate: Ozone, UV radiation, aerosol chemistry, nitrogen chemistry, mercury, CFC, radiation balance, effects of clouds and aerosols on the radiation balance, PBL processes, lower troposphere processes, radionuclides, heavy metals.
- Upper Atmosphere (National Institute of Geophysics and Volcanology, CNR and National Institute of Astrophysics): Ionosphere and magnetosphere processes, auroral observations (Rete dei Miracoli), cosmic radiation, ionospheric scintillations.
- Biology and Biomedicine: Molecular, physiological and biochemical basis of the adaptations of organisms; biological response to climate change, biodiversity, and ecosystem functioning.
- Marine and environmental sciences: Kongsfjord hydrology, marine corrosion of metals, marine robotics, paleolymnology, permafrost, spectral signature of snow (350 - 2500 nm), biogeochemical cycles.
- Human sciences: History of Italian exploration, ecotourism, Arctic peoples (in collaboration with the "Silvio Zavatti" Museum of Fermo).

ARTIST: the first European project

Angelo P. Viola

Since its opening, the Italian Dirigible Station has allowed numerous research groups of national and international research institutions and universities to be successfully involved in national (PRIN and PNRA) and European projects and programs, among which we mention ARTIST, NICE, ENVINET, ARCFAC, and MIRACLE. The importance of climate and environmental studies was sustained with the participation of the CNR in the European project ARTIST in 1998, just one year after the opening of the base, which will is an example of international cooperation that will fully exploited the resources of the young station Dirigibile Italia.

Research station Dirigibile Italia: year 2000 (interiors)

The ARTIST project (*Arctic Radiation, and Turbulence Interaction Study*) involved several European institutions including the Alfred Wegener Institute for Polar and Marine Research, the University of Bremen and the GKSS-Forschungszentrum Geesthacht Gmbh (Germany), the Finnish Institute of Marine Research and the University of Helsinki (Finland), and the National Research Council (Italy).

The objective of the project was the study of the interaction processes between sea, clouds, and sea ice, using research aircraft to measure the physical properties of clouds, satellite measurements, to derive the cloud cover, the extension and the concentration of sea ice, the radiation balance, and ground measurements to study the exchange processes between the surface and the lower atmosphere. The CNR contributed by providing ground-based measurements of wind profiles in the atmosphere up to 800 m using a Sodar, continuous

Project ARTIST: sodar, year 1998

measurement at the surface of the radiation balance and turbulent exchanges at the surface and the measurement of the profiles of meteorological parameters up to 700 m. using a tethered balloon for the first time in Ny-Ålesund. After the success of this and other projects and activities, research on environmental issues, in particular on the chemical-physical characteristics of the atmosphere and snow, continued to be supported by the strategic projects of the CNR from 2002 to 2004, which contributed to the development and strengthening of the Dirigibile Italia station and the growth of Italian research in the Arctic.

The chemistry laboratory: year 2000

Gruvebadet: the atmosferic laboratory, year 2000

25 YEARS AT DIRIGIBILE ITALIA

Vito Vitale

From the early 1990s the Italian research presence in Ny-Ålesund has lived through two important seasons. The first, which started a few years before the opening of the station and continued until 2005, saw the growth of a community interested in extending a range of actions to the Arctic that were until then limited to Antarctica. With the support of a CNR Strategic Plan, it was possible to give continuity to this interest and to the Italian presence in Arctic, providing a concrete contribution to the development of Ny-Ålesund and the common infrastructures, such as the Marine Lab. The second season that can be assumed to have started in 2007 - 2008, saw (and continues to see) an expansion of the observation platforms and long-term observations carried out throughout the year, with the aim of giving ever greater support to the development of Ny-Ålesund as a supersite for monitoring and studying the Arctic climate system. Around this strategic objective, the commu-nity of Italian researchers has broadened the research themes in an increasingly multidisciplinary way contributing to the establishment of an important element to the vast international community that makes Ny-Ålesund a unique example in the world panorama, with 11 countries who permanent-ly conduct research and maintain research stations.

At the 25th anniversary of Dirigibile Italia, Italian researchers and the CNR are able to launch a third season, thanks to the birth of the Institute of Polar Sciences of the CNR. The Institute will act to catalyze skills acquisition and projects within the framework of the Research Program in the Arctic (PRA) which will acquire continuity and join (not replace) to the economic support that the CNR has never stopped providing in all these years.

Even if there have been two seasons, the strategic lines of research at Ny-Ålesund have never changed: studying and understanding of processes, and a contribution to monitoring climate change. These lines, firmly anchored to the 4 flagship programs through which the variegated community of Ny-Ålesund aims to coordinate and optimize everyone's efforts, will still be the basis of Italian research during this third season that is just starting. Keywords such as multi-disciplinarity, international cooperation, technological development of observations, expansion of observation platforms, integration of ground and satellite observations, clearly indicate the way, guiding the efforts and the definition of activities and projects.

(Credit: Vito Vitale)

THE ITALIAN RESEARCH AT NY-ÅLESUND

1 - How many "years" do Svalbard glaciers lose each year?

Andrea Spolaor

Activity on snow deposition at the Dirigible Italian station began in 2012, initially with the intent of learning about the snowpack, its condition, and its chemical composition. Soon the activities focused on producing a historical dataset of physical and chemical parameters of the annual snowpack, to study the impact of ongoing climate change and what the possible effect will be on the Archipelago's glacial system.

(Credit: Andrea Spolaor)

Annual snow deposition is critical to sustaining and feeding the Svalbard glacial system, but equally important is the amount of snow that is melted each summer.

In general, snow cover survives summer melt at above 600 m of elevation (referred to as the equilibrium line), which accounts for about 50 percent of the archipelago's territory. Although annual snowfall in the archipelago has significantly increased since the 1990s, it has become evident from studies over the years that the duration of annual snow cover is decreasing, and the equilibrium line is rising: the "blanket" protecting the archipelago's glaciers is getting shorter and shorter!

The most vulnerable glaciers are those glaciers whose tops are close to the equilibrium line. They are moving, due to the changes taking place, from a condition of accumulation\stationary mass loss or gain to a condition of ablation\mass lost. Studies and data on the mass balances of Svalbard glaciers have been available since 1960 and constitute a unique historical record. Such historical records, however, give us no indication of "how many years of ice" we are losing each summer. A project, called "BC14" and funded by the Research Council of Norway, is currently active and aims to understand how many ice years we lose each year to summer melt, as well as to studying the origin of black carbon deposited on the snow. During the last spring campaign, samples were collected from four glaciers in the Ny-Ålesund area, glaciers characterized by different morphology, elevation and dynamics: two valley glaciers that develop below the equilibrium line (whose summit is between 450 and 500 m altitude), an additional valley glacier whose summit is close to the equilibrium line (610 m altitude) and a fourth, much larger glacier whose summit is located at about 800 m altitude, which means it is above the equilibrium line.

(Credit: Andrea Spolaor)

At the summit part of each glacier, 6 cores of surface ice (with a depth of about 50 cm) were taken through a hand ice core driller with the


Hand ice core driller. (Credit: Andrea Spolaor)

intention of collecting enough organic material trapped in the ice to perform Carbon 14 dating. The age that will be estimated in the surface ice collected during the last campaign will then be compared with the age of the samples that will be collected at the same sites over the next spring campaign. Through comparison we will be able to estimate on average how many years of ice each year we are losing .... forever!

2 – Ny-Ålesund ecosystems and the "Climate Canary" metaphor

Maurizio Azzaro

The settlement of Ny-Ålesund overlooking Kongsfjorden in the archipelago of the Svalbard


(Credit: Maurizio Azzaro)

Islands, is the northernmost town in the world, and a strategic site where its proximity to cryo-, geo-, limno- and thalasso-ecosystems are accessible during a large part of the year. The archipelago is currently exposed to some of the fastest climate change on Earth, and has also experienced an increase in research and tourism in recent years. This makes it a unique place, on one hand it is a "hot-spot" for the study of ecosystems and the consequences of environmental change for the Arctic and on the other it is a "canary in the coal mine" that highlights the risks that ecosystems run throughout the Arctic. In the past, in fact, coal miners brought small birds such as canaries with them to mines to monitor air quality and then use them as sentinels allowing them to escape to safety.


(Credit: Maurizio Azzaro)

Compared to other Arctic ecosystems, the Svalbard Islands generally have a relatively simple plant and animal life, however the close coexistence of the different ecosystems that exist in the Ny-Ålesund area determines a considerable environmental heterogeneity along physical, chemical, hydrological, climatic and ecological gradients. The Italian scientific community in its 25 years of research done in Ny-Ålesund has studied a large part of both the terrestrial and marine ecosystems present. However, research was often spot sampling and not based on multi-year monitoring. In 2010, a time series systematically studying the marine environment began, adding to those of the air, and subsequently terrestrial environments, which provide useful direct and

indirect information on the abiotic, biotic and biological processes that govern ecosystems. Increases in air temperature and precipitation (especially rain), advanced melting of spring snows, intensification of warming of the active layer of permafrost, increase in runoff and turbidity, Atlantification, marine acididification, increases in pollutants, retreat of glaciers, new colonization and entry of alien species are among the host of threats.

(Credit: Maurizio Azzaro)

The current challenge is to observe the Ny-Ålesund area with a holistic vision in which neighboring ecosystems interact and co-evolve together, in the light of climate change. The synergistic increase in observation sentinels will serve to protect this threatened extreme environment, where it is not infrequently possible to see the iconic Polar Bear.

(Credit: Marco Casula)

3 - Atmospheric effects and air-snow interactions

Antonietta Ianniello

In 1998 the discovery of the photochemical production of nitrogen oxides (NO_x = NO + NO_2) and nitrous acid (HONO) from the snow surfaces in polar regions at Summit (Greenland), Alert (Nunavut, Canada) and Neumayer (Antarctica) revolutionized the understanding of atmospheric nitrogen chemistry in the following years. This finding showed that the emission of these species above snow surfaces was sufficient to alter the composition of the overlying atmosphere, impacting the global budget of NO_x and ozone (O_3), and was attributed to the photolysis of nitrate ion (NO_3^-) contained in snow.

For this reason, the polar research activity of the Institute of Atmospheric Pollution Research of the CNR (CNR-IIA) was oriented towards the study of the chemical and physical evolution of atmospheric pollutants, to their air-snow interactions, and to the development of analytical methodologies with high sensitivity and accuracy to measure chemical species present at very low concentration levels.

The performance of the first measurements in 1994 at Ny-Ålesund and the start-up of the Italian base "Dirigibile Italia" and of the Strategic Arctic Project of the CNR in 1997 provided the possibility of strengthening and developing the sampling systems suitable for determining air pollutants in polar regions. The measurements were obtained during the spring of 1997, 1998 and 1999 at the Zeppelin Observatory at 474 m a.s.l., coordinated by the Norwegian Polar Institute (NPI) and the Norwegian Institute for Air Research (NILU).

In those years, the CNR-IIA was able to create international collaborations. Two main measurement campaigns were carried out in the Arctic: the first, concerning the Polar Sunrise Experiment 2000 program, which took place in February and April 2000 at Alert, and the second, as part of the European project NICE (The NItrogen Cycle and Effects on the oxidation of atmospheric

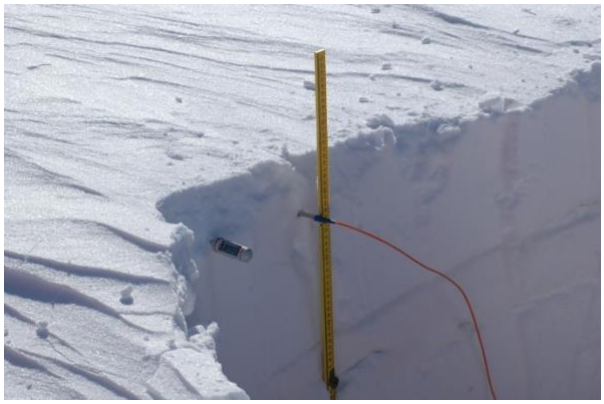
trace species at high latitudes) coordinated by the CNR-IIA, which took place from February to April 2001 at Ny-Ålesund. During these campaigns, the CNR-IIA carried out for the first time measurements of the atmospheric fluxes of nitrogen containing compounds and halogens above snow surfaces and of the chemical-physical properties of snow, to identify the atmospheric source of snow NO_3^-, to improve the understanding of the air-snow interactions, to quantify active nitrogen emissions and to assess the importance of the snow surface on these reactions.

The experimental site near Gruvenbadet Observatory for the atmospheric fluxes determination in the April 2010, as part of PRIN projects. (Credit: Antonietta Ianniello)

These studies continued during the springtime of the years 2003, 2004, 2006, 2010, 2011, and 2015, including the determination of carbonyl compounds and the atmospheric stability by high resolution measurements of radon and its progeny in order to identify the sources and the transport of pollutants.

The data obtained from the measurement campaigns in the Arctic have been shown to be important scientific results for polar tropospheric chemistry and demonstrated that the reactivation of NO_x from the snow NO_3- is an important source of NO_x over snow surfaces.

This mechanism is universal and could be much higher in polluted European snow-covered environments, such as in mid-latitudes (e.g. Alpine regions), where air-snow interactions have not yet been investigated. Furthermore, these exchange processes can provide an important feedback mechanism for global change due to the change in temperatures and snow cover that will also change the evolution of air pollutants in the polar regions.



Chemical and physical measurements of the snow. (Credit: Antonietta Ianniello)

Consequently, it is necessary to continue observations in the Arctic with particular attention to the change over time of climate and, thus, of the snow cover and its impurities within; and to the long-range transport of pollution, the production of ozone and organic compounds, and the deposition of chemical species.

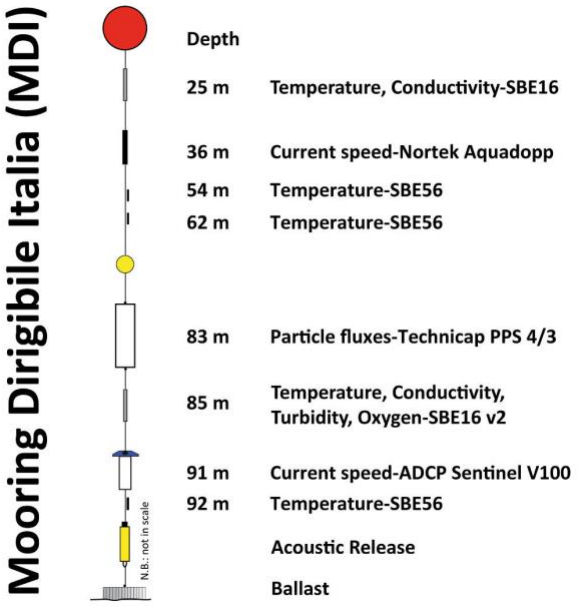
4 – CNR marine research in Kongsfjorden

Leonardo Langone

The first oceanographic studies in the fjord were carried out by CNR researchers together with colleagues from ENEA in the early 2000s. These involved the deployment of oceanographic anchorages and hydrological surveys to trace the pattern of marine circulation within the fjord. These early studies showed that the innermost part of the fjord has sedimentation rates of up to 20 cm during the summer. Based on this experience, geophysical exploration of the seabed began in 2010, in the least studied part of the fjord, because until a few decades ago it was still covered by glacial fronts. The seismic-stratigraphic


The Kongsfjorden. (Credit: Elena Barbaro)

investigations revealed the main sedimentary structures of the basin together with the identification of areas of recent sediment accumulation. One of these areas was chosen for the deployment of the oceanographic anchorage Dirigibile Italia (MDI) with the aim of acquiring a long series of data for climatic purposes.



The main chemical-physical characteristics of the water masses (temperature, salinity, O2, intensity and direction of currents) and particulate fluxes have been continuously monitored since September 2010. Every year the anchorage is hauled out, the data are downloaded, and the instruments after maintenance are returned to the sea for a further year of measurement. At the same time, a hydrological survey is carried out to examine the spatial variations in the summer season of the fjord's thermohaline properties. Recently, the MDI mooring was upgraded with fluorescence and nitrate sensors, a carbonate system and instruments for bioacoustic monitoring. Two new moorings have also been installed, one in front of the mouth of the Bayelva River and the other in Krossfjorden.

Recently, marine research in the fjord has been further enriched with marine biological studies, tracing of the origin of water masses using stable isotopes, sampling of sediments for palaeoclimatic studies (e.g. reconstruction of the beginning of the natural Atlantification of the Arctic from the early 20th century), estimates of sedimentation rates, and verification of the level of contamination of the seabed due to anthropogenic inputs from local or remote sources. The data collected so far have shown a clear upward trend in water temperature (approx. 0.9*/decade) due to the progressive increase in the volume of Atlantic water intruding into the fjord. In the near future, it will be necessary to consolidate the marine observation network and to clarify the impacts of the changes on the fjord's ecosystems.

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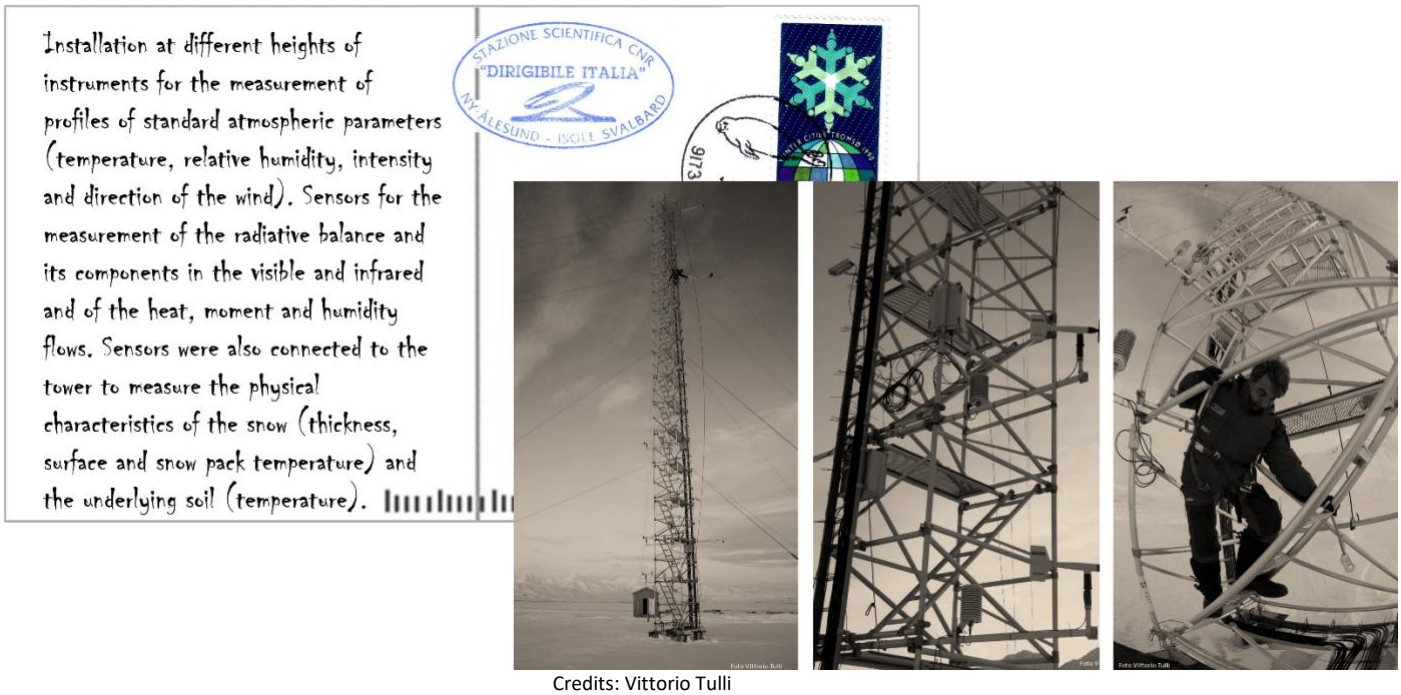
To the next 25!!!

POSTCARDS FROM THE FIELD ……

Credits: Vito Vitale



Credits: Vittorio Tulli

Credits: Antonietta Ianniello

Credits: Daniele Ceccato

UPCOMING EVENTS

- Cryosphere2022: an International Symposium on Ice, Snow and Water in a Warming World. August 21–26, 2022, Reykjavík, Iceland. To register for the conference, click here.
- The Year of Polar Prediction (YOPP) is the flagship activity of the WWRP Polar Prediction Project, with the aim of enabling a significant improvement in environmental prediction capabilities for the polar regions and beyond, by coordinating a period of intensive observing, modelling, verification, user-engagement and education activities. The YOPP Final Summit will be held in Montréal, Canada from 29 August - 1 September, 2022. Registration for the YOPP Final Summit is open!
- EMS Annual Meeting 2022 - 4-9 September 2022, Bonn, Germany. The call for abstracts is now open. The deadline for submitting abstracts is 26 April 2022. UP2.4 The cryosphere and cold region processes in the climate system.
- NORP-SORP workshop on polar fresh water: Sources, Pathways and ImpaCts of frEsh water in northern and soUthern Polar oceans and seas (SPICE UP). Online, 19-20-21 Sep (3 half-days), 2022. Register here now!
- Ice Core Science at the three Poles, the 3rd IPICS Open Science Conference - October 2 – 7, 2022, Crans-Montana (Switzerland). Ice cores provide information about past climate and environmental conditions as well as direct records of the composition of the atmosphere on timescales from decades to hundreds of millennia.
- ASSW 2023 Science Symposium Call for Sessions. ASSW 2023 will be held in Vienna, Austria from 17 - 24 February 2023. Session proposals will be reviewed in June 2022. A call for abstracts will open shortly thereafter and remain open until September 15, 2022.
- EUCOP6: The 6th European Conference on Permafrost (EUCOP6) will take place June 18-22, 2023, in a potentially hybrid format with online and in-person attendance to Puigcerdà, Catalonia, Spain. EUCOP6 1st Circular

NEWS

Arctic expedition NREP-22

June 9th, 2022 - The Arctic Expedition NREP-22 (Nordic Recognised Environmental Picture 22) on board the NRV Alliance departs today from the port of Tromsø. CNR-ISP researchers (L. Langone, P. Giordano, F. DeRovere) are involved, in collaboration with NATO-CMRE and OGS (P. Mansutti). The scientific aim of the expedition is to monitor the characteristics and dynamics of the ascent of Atlantic water masses up to the high latitudes of 80°N, and to study the physical and biogeochemical mixing processes of Atlantic and Arctic waters, the fluxes of organic and inorganic particulate matter, and planktonic biodiversity along the entire western escarpment of the Svalbard Islands.

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