UNDER THE SPOTLIGHT

Giuliana Panieri

During the last week of June, I had the pleasure of accompanying a group of colleagues from the CNR on an institutional visit to our Arctic Station "Dirigibile Italia" in Ny-Ålesund, Svalbard. It was a truly valuable opportunity to give them a firsthand look at one of the most important infrastructures for Italian research in the Arctic—important not just scientifically, but also strategically.

We invited key staff and representatives from CNR offices who, although often working behind the scenes, play a crucial role in managing the station. Being able to welcome them here on site, show them our daily work, the logistical challenges, and the incredible potential of what we do, was incredibly rewarding. They got to experience what it really means to carry out research in such an extreme—yet fascinating—environment.

For me personally, it was a moment of great pride. I had the chance to share the projects we're developing at the Institute of Polar Sciences (ISP), and to highlight the support we provide to other CNR institutes, as well as to Italian and international universities and research bodies working in the Arctic.

The visit also had an important diplomatic value: we further strengthened our ties with our Norwegian partners, with whom we've built a solid and productive collaboration over the years. Coming back from Ny-Ålesund with this shared sense of purpose and enthusiasm is, for me, an even greater motivation to continue our efforts in such a delicate and meaningful part of the planet.

Giuliana Panieri at the Arctic Station Dirigible Italia

IN THIS ISSUE:

INSIDE ISP: seminars from the series "Polar Science Talks: Research and Future Perspectives"

1 - May the Data be with you: unlocking polar mysteries with Large Language Models (LLMs)

Alice Cavaliere

In this seminar, a preliminary presentation was given on the Arctic and Antarctic data centers managed by ISP. Some key highlights were shared about the Italian Arctic Data Center (IADC), established under the PRA initiative. The IADC collects datasets and corresponding metadata from missions and research campaigns conducted in the Arctic Circle, with a strong focus on the Svalbard region. Structurally, the IADC is composed of two integrated components: ERDDAP, which manages data storage and

Image generated using ChatGPT by OpenAI

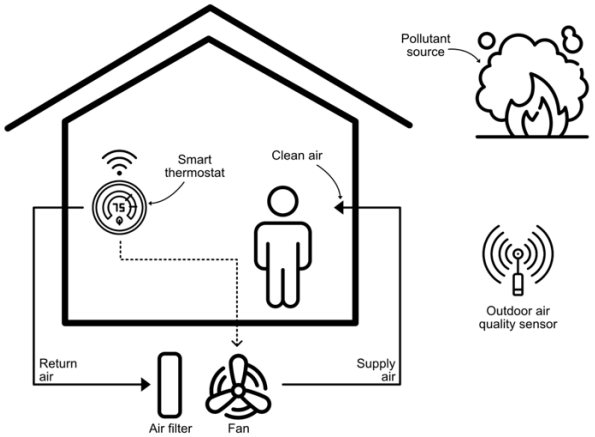
GeoNetwork, which handles metadata management. These components are interconnected: metadata records in GeoNetwork include direct links to the corresponding datasets in ERDDAP. This architecture was designed to enhance both the functionality and accessibility of the data system, in line with FAIR (Findable, Accessible, Interoperable, Reusable) principles. The GeoNetwork search catalog, powered by Elasticsearch, allows users to explore a wide range of geospatial datasets, maps, and services. It offers useful filters such as dataset type, location, time range, and keywords. However, Elasticsearch does not understand natural language or the meaning behind complex questions, which can limit how users interact with the system. To overcome this, Large Language Models (LLMs) can add a conversational layer on top of traditional search tools. LLMs understand natural language, allowing users to ask questions more freely and receive helpful, human-like answers. They can also summarize content, answer questions automatically, and interpret user-generated text—capabilities that go far beyond simple keyword search. In the second part of the presentation, we demonstrated how LLMs can support polar research by enabling fast and

intuitive dataset searches in GeoNetwork using natural language queries. A key focus was the development of a Retrieval-Augmented Generation (RAG) application tailored for a polar research repository. Using open-source, distilled models like DeepSeek, we built a tool that translates natural language questions into GeoNetwork-compatible metadata search queries. In addition, the system can automatically generate code to analyze the datasets retrieved—streamlining the path from query to insight. Finally, we addressed the environmental impact of these AI technologies, which can be significant due to the energy required for training and running large models. To help minimize this impact, we highlighted good practices such as using energy-efficient models, deploying models locally when possible, and favoring smaller, purpose-trained models over larger general-purpose ones when appropriate.

2 - Smart Thermostats Can Help Protect Homes from Wildfire Smoke. Here's How

Federico Dallo

Fine particulate matter (PM2.5) causes millions of premature deaths worldwide each year. Wildfires are a major contributor, producing dangerously high levels of air pollution that can spread across vast regions. The risk of wildfires is expected to increase because of global warming and climate change.



Sheltering indoors makes homes the primary barrier against exposure to harmful concentrations of PM2.5. In addition, using portable air purifiers and mechanical ventilation systems equipped with high-quality filters can further reduce indoor exposure to PM2.5.

During the 2020 California wildfire season, we analyzed data from nearly 5,000 homes equipped with smart thermostats to understand how residents used their central air systems during episodes of hazardous air quality.

Despite public health recommendations from agencies like the EPA, we found that most households did not use their central air systems for air filtration, and usage decreased on the smokiest days.

Using simulations grounded in real-world data and detailed building characteristics, we demonstrated that automating smart thermostats to activate the fan whenever outdoor PM2.5 levels exceed 35 µg/m³, a setting we call "wildfire mode", can significantly reduce indoor exposure. This strategy was found to be as effective as running four portable air purifiers in the average California home.

Key Benefits

• up to 61% reduction of exposure to harmful level of PM2.5 during wildfire smoke events.

• $29 million in monetized health benefits, partially balancing the estimated $5/month energy cost per household during wildfire seasons.

• Low-income households, often located in older, leakier buildings, stand to benefit the most from this approach.

Our findings point to a critical communication gap between public health guidance and everyday behavior. More importantly, we show that existing infrastructure such as central air systems and smart thermostats, remains an untapped resource in protecting indoor air quality during wildfires.
With one in three U.S. homes already equipped with smart thermostats, this is a scalable, low-cost solution to reduce exposure during extreme pollution events.
Our work offers a practical, actionable intervention to enhance the resilience of buildings to wildfire-related air pollution. The results are valuable for public health authorities, support future policy development, and promote collaboration between research and industry to improve building resilience to air pollution.

3 - Tracking Arctic Coastal Dynamics and Change: Evidence from Svalbard's Marine Observing System

Francesco Paladini de Mendoza, Gianmarco Ingrosso, Patrizia Giordano, Alice Cavaliere, Giulio Verazzo, Maurizio Azzaro, Francesco Filiciotto, Manuel Bensi, Mauro Mazzola, Federico Giglio, Tommaso Tesi, Leonardo Langone, Stefano Miserocchi

The seminar titled "Tracking Arctic Coastal Dynamics and Change: Evidence from Svalbard's Marine Observing System" highlighted the evolution of a marine research infrastructure established by the Institute of Polar Sciences of Italy's National Research Council since 2010 in the Arctic region. Svalbard's coastal waters are shaped by two main currents: the Spitsbergen Polar Current, a colder, fresher Arctic current and the West Spitsbergen Current, a warmer, saltier Atlantic current. The interaction between these currents, terrestrial runoff, and local atmospheric circulation governs the composition of water masses, particularly within the fjords. The marine observatory was developed in response to key global questions, such as the impact of global warming and Atlantification on marine biogeochemical processes and ecosystems, as well as the increasing anthropogenic pressure on the Arctic. The infrastructure includes: 3 coastal moorings (MDI, MAP, KIM), 1 coastal buoy, 1 offshore mooring (S1) — operated in collaboration with National Institute of Oceanography and Applied Geophysics. Currently, around 104 sensors are deployed, continuously measuring physical, biological, and biogeochemical parameters — including ocean sounds — thanks also to the PNRR ITINERIS project. All data are archived in the Italian Arctic Data Centre. The strategic locations of the observatory in the Kongsfjorden-Krossfjorden system allow comparative studies of a tidewater glacier (MDI), a land-terminating glacier (MAP), a coastal system more exposed to ocean currents (KIM). Recently, the long-term observations of MDI and S1 are included in the most comprehensive compilation of long-term mooring data from Svalbard to date (ARIS chapter - SESS REPORT 2025, Bensi et al., 2025).

The study revealed multi-year cycles, such as: Warm/salty and Cold/fresh periods with an

exceptional influx of Atlantic Water between 2012 - 2018. Beyond long-term trends, the observatory captures seasonal biogeochemical dynamics driven by complex environmental interactions. Years with contrasting conditions reveal key insights: Air temperatures greater than 5°C are critical for sediment release from melting tidewater glaciers. Particulate flux and precipitation do not correlate with nitrate replenishment. Instead, Atlantic Water intrusions drive rapid nitrate renewal in autumn. The controls on primary production dynamics are complex. No simple correlation exists between environmental variables and bloom timing. Instead, water column stratification, mixing, ice cover, wind patterns, nutrient availability and photosynthetically active radiation collectively influence bloom intensity and its timing. The continuation of the observation activity is essential to understanding how climate change reshapes the Arctic coastal environment.

REPORT

National Astrobiology Conference 2025: ISP's Contribution

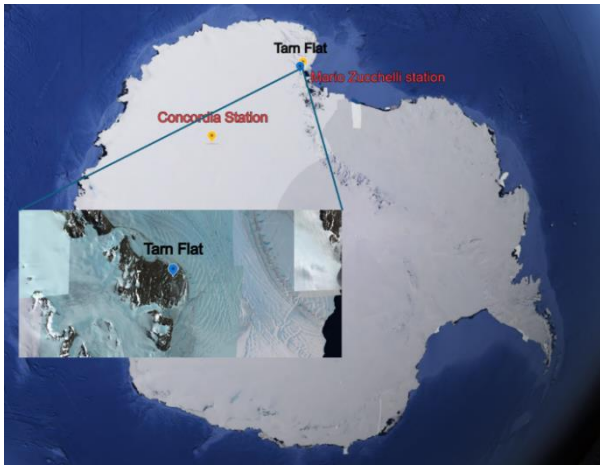
Maria Papale

At the recent National Astrobiology Conference 2025, held in Messina from June 11 to 13, researchers from the CNR Institute of Polar Sciences presented the results of a study conducted within the framework of the CLIPERECO project (PNRA – National Antarctic Research Program). The study, titled “Stratified Microbial Communities in Antarctic Brines: Ecological and Astrobiological Insights from Tarn Flat (Northern Victoria Land)”, provided new insights into the composition and vertical distribution of microbial communities in Antarctic brines sampled at Tarn Flat, a rocky ice-free plateau located approximately 6 km from Italy’s Mario Zucchelli Station (Terra Nova Bay, Ross Sea). These hypersaline brines, which remain liquid at sub-zero temperatures, represent an extreme environment of high interest to both microbial ecology and planetary science, as they are considered terrestrial analogues of potentially habitable systems such as the subglacial ocean of

Maria Papale presenting the contribution of the Institute of Polar Sciences, CNR-ISP

Jupiter’s moon Europa. Metagenomic analyses conducted on samples collected at multiple depths (down to 510 cm) and from underlying sediments revealed a clear vertical stratification of microbial assemblages. In the upper layers (TF1, TF2, TFB), psychrophilic and halotolerant taxa, such as Algoriphagus and Marinobacter, were predominant. In contrast, deeper layers showed a shift towards genera like Gillisia, Lutibacter, and Thiomicrorhabdus, indicative of adaptation to gradients in salinity, pressure, and nutrient availability. Sediment samples revealed the

abundant presence of anaerobic sulfur- and iron-reducing bacteria (e.g., Desulfoconvexum, Geopsychrobacter), suggesting the existence of anoxic micro-niches and redox-stratified conditions. Multivariate analysis (PCA) highlighted ecological patterns consistent with the vertical distribution of the dominant phyla and genera, confirming a progressive functional and physiological specialization with depth. Particularly significant was the detection of chemoautotrophic microorganisms capable of thriving without sunlight by harnessing chemical energy, which is an essential trait in the context of defining extraterrestrial habitability.



Map of the Tarn Flat sampling area

These findings reinforce the idea that Antarctic brines can serve as valuable analogues for identifying potentially habitable environments beyond Earth and underscore the ecological and astrobiological relevance of microbial communities in extreme environments.

NEWS FROM DIRIGIBILE ITALIA

Mauro Mazzola

The Arctic summer is in full swing, and like every year, Dirigibile Italia confirms its position as a benchmark for polar science research in Italy and beyond. The 2025 season is characterized by a rich multidisciplinary program, with innovative projects ranging from marine biology to geophysics to terrestrial ecology.

Among the activities already underway, INFN performed its usual maintenance in May on the POLA-R detectors at the base and its infrastructure. These detectors, active since 2019 thanks to the INFN-CREF collaboration for the Extreme Energy Events (EEE) project, collect data on cosmic rays in the polar environment, contributing to a valuable time series useful for studying their origins and periodicity. In parallel, the SEDNA project (led by CNR-IAS) returned to the Arctic to investigate the effects of climate change on fin whales. Through acoustic monitoring and ecological observations, the team is studying variations in migratory routes, feeding habits, and seasonal presence of cetaceans, highlighting the importance of sustainable management of marine biodiversity. CNR-ISP and CNR-INM have successfully completed the NYA 2025 campaign, marking 15 years of continuous research in the Arctic. Achievements include climate data collection, deployment of oceanographic sensors from the ITINERIS project, activation of a buoy for real-time monitoring, and benthic sampling for the study of meiofauna. Finally, from June 30 to July 10, CNR-IRBIM is leading a campaign for the monitoring of alien marine species (NIMS) along the coasts of Svalbard, using advanced techniques (eDNA, hydrophones, underwater cameras). The study aims to identify potentially invasive alien species, such as pink salmon and Mnemiopsis leidyi, assessing the impacts of climate change on Arctic biodiversity. Next up will be the projects REMUS, BeyondSoil and Brismic (CNR-IRET), UNDER and Winter CZ (CNR-IGG), Fishmicro (CNR-IRBIM), and Ecoclimate (University of Sapienza).

The new autonomous marine platform of the ITINERIS project

We also wish to inform you that Dirigibile Italia is strengthening its online presence: the new official Instagram (@dirigibile.italia) and Bluesky (@dirigibile-italia) pages are now live, designed to share the behind-the-scenes stories of Arctic research and engage the public through images, updates from researchers, and curiosities from the CNR outpost in the Arctic. Follow us so you don't miss a single moment of this intense polar summer!

BEYOND THE POLES

EMSO-SA 2025 mission completed: new series of fundamental data for climate

Francesco Paladini de Mendoza and Stefano Miserocchi

The oceanographic cruise, which began in Naples and concluded in Ancona aboard the vessel GAIA BLU, successfully completed all planned activities. The two Adriatic moorings, BB and FF, which had been deployed since April 2024, were recovered and maintained, thus concluding the 23rd series of data acquisitions. The two moorings, located at depths of 600 and 700 meters along the southwestern margin of the Adriatic Sea, were subsequently redeployed, ensuring the continuity of the time series. The equipment was enhanced with two acoustic sensors for underwater noise monitoring. This allows the uninterrupted time series, ongoing since 2010, to continue — a crucial resource for understanding climatological trends in the Adriatic Sea and for analyzing dense water dynamics, a key process in the vertical transfer of oxygen and nutrients.

Preparation of a sediment trap prior to the redeployment of mooring BB

Water column profiles were successfully carried out using the Rosette CTD system along the Bari-Dubrovnik transect and at the E2M3A site, with samples collected for comparison with data from the namesake mooring. Together with BB and FF, this forms the Southern Adriatic Regional Facility of EMSO-ERIC. The Bari-Dubrovnik transect represents an observational section initiated in 1990 and is fundamental for the analysis of mesoscale oceanographic processes in the Southern Adriatic.

Two autonomous BGC-Argo profiling floats from CNR ISMAR were deployed successfully: one in the Ionian Sea (WMO7902260; PI: E. Organelli) and one in the Adriatic Sea (WMO3902641; PI: G. La Forgia). These contribute to the Euro-Argo research infrastructure, aiming to monitor plankton biodiversity, carbon fluxes from the surface to the seabed, and to understand their relationships with ocean circulation, thanks to sensors that capture essential geophysical, chemical, and biological variables, along with other innovative instruments.

Preparatory phase of the deployment of the BGC-Argo Float system in the central South Adriatic Basin

Researcher Carolina Cantoni successfully carried out the setup and initial measurements using an "underway" system composed of multiple sensors, allowing continuous semi-automated measurements of the carbonate system during navigation.

The activities of CNR-ISP and OGS within EMSO-ERIC are supported by the Italian Joint Research Unit of the consortium, and also by the PNRR-funded ITINERIS project, which financed the two BGC-Argo profilers and the new acoustic sensors installed on moorings BB and FF, managed by the Acoustics Group of CNR-ISP in Messina (Refs: Francesco Filiciotto and Virginia Sciacca).

The scientific team's activities were efficiently and professionally supported, in full compliance with safety protocols, by the technical and maritime staff of the GAIA BLU vessel, under the coordination of Captain Andrea Scotto di Perta, to whom we extend our special thanks.

POSTCARDS FROM THE ….. "FIELD"

From July 9 to 12, 2025, the Galassi Workshop 2025 took place at the Galassi Città di Mestre Mountain Hut (Forcella Piccola of Mount Antelao, Calalzo di Cadore - BL), under the title "Water Resources, from the Dolomites to the Sea. Glaciers and Their Conservation." Now in its fourth edition, the workshop this year focused on glaciers and strategies to preserve their memory. Representing the CNR-ISP, Andrea Securo, Fabrizio De Blasi, and Chiara Venier participated, presenting contributions on the evolution of Dolomitic glaciers and the Ice Memory and Beyond EPICA projects.

Chiara Andrea Fabrizio

Greetings from the R/V Le Commandant Charcot!

We are currently in the Arctic with the ELENO II project, studying the physical, chemical, and biological state of the Arctic Ocean. The route? From Longyearbyen to the North Pole and back, following the signals of climate change.

Maurizio

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UPCOMING EVENTS

- XIV International Symposium on Antarctic Earth Sciences (ISAES 2025) - 18-22 August 2025, Punta Arenas, Chile. The symposium reunites experts worldwide to discuss the latest research on Antarctica's geology, climate, and ecosystems.
- The Second Inter-Polar Conference Connecting the Arctic with the Third Pole HKH - Cryosphere, People, and Climate Change - 3-5 September, 2025, Kathmandu, Nepal. The conference will contribute to the objectives of the International Year of Glaciers' Preservation (IYGP) 2025, which aims at taking immediate action towards preserving the cryosphere for building a resilient future for all.
- 2025 All-Atlantic Forum - 25–26 September 2025, Brussels, Belgium. The European Union will host the 2025 All-Atlantic Ocean Research and Innovation Alliance (AAORIA) Forum, bringing together AAORIA Partners and stakeholders from across the Atlantic Ocean. The Forum intends to show its commitment to the future of AAORIA and to serve the local communities by continuing to work through ocean science diplomacy to promote a sustainable green and blue transition. Registration is now open
- Polar Data Forum VI (PDF VI) – 20-24 October 2025, Hobart, Tasmania, Australia. PDF is a place where polar data holders get together and make more use of data. The Forum has two main components: the Conference, where the border between funding, policy and data is explored through presentations and posters; and Workshop Sessions & Hackathons, where the Polar Data Community opens the dialogue to make progress on their shared objectives. Registration is now open
- Svalbard Science Conference 2025 - 28-29 October 2025 at Quality Hotel Expo, Fornebu (Oslo). Svalbard as an Arctic hotspot for climate change and international cooperation. Register for the conference here.
- 1st ACM SIGSPATIAL International Workshop on Polar Data Science (PolDS 2025) – 3 November 2025, Minneapolis, Minnesota, USA. The workshop aims to connect the polar science community with the spatial computing community to foster convergent approaches that will address significant questions in the Arctic and Antarctic regions.

STAY IN TOUCH:

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