



VIII NATIONAL CONVENTION APECS ITALY

Book of Abstract

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CNR

Rome

8-9 October 2026



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Conference venue:

Sede Centrale del CNR, Piazzale Aldo Moro 7, 00185 Roma, Italia

VIII National Convention APECS Italy
Rome, 8-9 October 2026

Program

Thursday 8 October 2026

PROGRAM - OCTOBER 8		
SESSION	TIME	TITLE AND SPEAKER
<u>Intro</u>	8:30 - 9:00	REGISTRATION
	9:00 - 9:15	CONFERENCE OPENING AND OFFICIAL GREETINGS
<u>Invited speaker</u>	9.15 - 9:45	International Science & Infrastructure For Synchronous Observation: The Antarctica Insync Initiative <i>Chiara Vernier</i> - CNR-ISP
<u>Cryospheric Processes, Snow Hydrology, and Radiative Properties</u>	9:45 - 10:00	Analysis Of Glacier Impurities And Weathering Crust In Southeast Greenland* <i>Giacomo Traversa</i> - Meteorological Research Institute (Giappone) & CNR-ISP
	10:00 - 10:15	Sunlight Radiative Transfer In Arctic Snowpacks <i>Luca Teruzzi</i> - Università degli Studi di Milano
	10:15 - 10:30	From PRISMA To Sentinel-2: A Framework For The Retrieval Of Snow Properties And Radiative Forcing At Plateau Rosa And Cime Bianche <i>Claudia Ravasio</i> - Università di Milano-Bicocca
	10:30 - 11:00	BREAK
	11:00 - 11:15	Antarctic Snowfall: From Ground To Space, Bridging In-Situ And Remote Sensing Observations <i>Giacomo Roversi</i> - Ca' Foscari Università di Venezia & CNR-ISAC
	11:15 - 11:30	First Rain On Snow Event In Winter Recorded At THAAO: Preliminary Results <i>Monica Tosco</i> - Ca' Foscari Università di Venezia & INGV
<u>Invited speaker</u>	11.30 - 12:15	Towards IPY5: Polar Educators International And The Legacy Of IPY4 In Polar Education* <i>Maria Pia Casarini</i> - PEI
<u>APECS Italy</u>	12:15 – 12:30	ACTIVITIES PLANNED FOR 2026-2027
	12:30 - 14:00	LUNCH BREAK
<u>Paleoclimate Proxies, Deep Time, and Ocean-Ice Dynamics</u>	14:00 - 14:15	Discovering Past Climates Through Hidden Molecular Fossils: An Introduction To Biomarker Proxies In Polar Environments <i>Letizia Roscelli</i> - Ca' Foscari Università di Venezia & CNR-ISP
	14:15 - 14:30	Digital Holography For The Reconstruction Of Particles Suspended In Diamagnetic Droplets Levitated In A Magneto-Gravitational Trap** <i>Sofia Biscotti</i> - Sapienza Università di Roma
	14:30 - 14:45	Deep Sea Warming In The Eastern Fram Strait Driven By Atlantic Water Intrusions <i>Lorenzo Pasculli</i> - OGS
	14:45 - 15:00	Variability Of Water Masses, Circulation And Freshwater Sources In The Ross Sea: Insights From Long-Term Hydrographic And Velocity Records And Recent Geochemical Tracers* <i>Angela Garzia</i> - Università Politecnica delle Marche
	15:00 - 15:15	Infrasound Monitoring Of Glacier Calving: From Event Detection To Quantifying Ice Loss At Grey Glacier, Patagonia* <i>Claudia Sánchez</i> - INGV
	15:15 - 15:30	BREAK

**VIII National Convention APECS Italy
Rome, 8-9 October 2026**

PROGRAM - OCTOBER 8		
SESSION	TIME	TITLE AND SPEAKER
<u>Volcanism & Aerosol Transport</u>	15:30 – 15:45	Deciphering Magma Plumbing Systems And Glacial Interactions In Northern Victoria Land: Insights From The Pleiades And Mount Melbourne Volcanic Fields <i>Irene Rocchi</i> - Università di Pisa
	15:45 - 16:00	Complex Open-System Magma Evolution At The Pleiades Volcanic Field (Antarctica) Revealed By In Situ Radiogenic Isotopes <i>Stefano Iannini Lelarge</i> - CNR-GEO
	16:00 - 16:15	The Role Of Light Absorbing Aerosol On The Atmospheric Heating Rate In Remote Areas (Arctic Region: Ny-Ålesund)** <i>Sofia Cerri</i> - Ca' Foscari Università di Venezia & Università di Milano-Bicocca
	16:15 - 16:30	Study Of The Sources And Atmospheric Transport Processes Of Crustal-Origin Particulate Matter In Antarctica** <i>Caterina Parodi</i> - INFN Firenze & Università di Torino
	16:30 – 17:00	BREAK
<u>Polar Exploration & Data Governance</u>	16:45 - 17:00	High-Resolution Characterisation Of Arctic Ocean Cold-Seep Habitats <i>Fereshteh Hemmateenejad</i> – Università di Milano-Bicocca
	17:00 - 17:15	The Securitization of Scientific Data in the Arctic: Between Scientific Openness and Strategic Interests <i>Marco Dordoni</i> - Università per Stranieri di Perugia
<u>Invited speaker</u>	17:15 - 17:45	The United States in Antarctica: the political, military and scientific dimensions of Operation Highjump (1946-1947)** <i>Pier Paolo Alfei</i> - Royal Historical Society
<u>Conclusion</u>	17:45 - 18:00	SUMMARY OF THE CONFERENCE FIRST DAY

**VIII National Convention APECS Italy
Rome, 8-9 October 2026**

Friday 9 October 2026

PROGRAM - OCTOBER 9		
SESSION	TIME	TITLE AND SPEAKER
<u>Intro</u>	8:45 - 9:00	REGISTRATION AND OPENING OF CONFERENCE SECOND DAY
<u>Polar Ecosystems in a Changing Environment</u>	9:00 - 9:15	Nutrient Distribution And The Carbonate System In The Glomar Challenger Basin: Implications For The Biogeochemical Cycles Of The Ross Sea (Antarctica)* <i>Michele Torri</i> - Università degli Studi di Genova
	9:15 - 9:30	Phytoplankton Bloom Dynamics And Functional Traits At The Sea Ice-Water Interface In Terra Nova Bay (Ross Sea)** <i>Emanuela Serino</i> - Università degli Studi di Napoli Federico II
	9:30 - 9:45	Sea Ice Melting Shifts Microbial Food Web Architecture From Chemoautotrophy To Phytoplankton-Based Heterotrophy In Coastal Antarctic Waters <i>Marco Basili</i> - CNR-IRBIM
	9:45 - 10:00	Resolving The Spatial And Environmental Organization Of Antarctic Desert Soil Microbial Communities <i>Fabiana Canini</i> - Università degli Studi della Toscana
	10:00-10:15	Fungal-Mineral Interactions In Antarctic Cryptoendolithic Communities: Phenotypic And Genomic Insights <i>Giorgia Cavallini</i> - Università degli Studi della Toscana
	10:15 - 10:30	Microfibers Pollution In Antarctic Coastal Ecosystems: Evidence From Multiple Benthic Species From The Fildes Peninsula To The Ross Sea* <i>Silvia Simonetti</i> - Università di Siena
	10:30 - 10:45	Decadal Reorganization Of Soil Microbial Communities In A Warming High-Mountain Ecosystem <i>Francesca Contemori</i> - Università degli Studi della Toscana
	10:45- 11:15	BREAK
<u>Invited speaker</u>	11:15 - 11:30	The International Science Council and IPY* <i>Salvatore Aricò</i> - ISC
<u>Space, High Atmosphere, & Ice Cores</u>	11:30 - 11:45	Precision Cosmology From The Antarctic Plateau: The COSMO Experiment <i>Alessandro Capponi</i> - Ca' Foscari Università di Venezia & Sapienza Università di Roma & INFN
	11:45 - 12:00	Multi-Instrument Observations Of Ionospheric Irregularities Associated With A STEVE Event <i>Carlos Castillo-Rivera</i> - Sapienza Università di Roma & INGV
	12:00 - 12:15	Investigating Ionospheric Dynamics In Antarctica: Multi-Method Velocity Analysis During The Mother's Day Superstorm <i>Rebecca Ghidoni</i> - INGV
	12:15 - 12:30	Tritium Activity Analysis By Liquid Scintillation Counting For Dating The "ADA270" Ice Core <i>Ellen Barlow</i> - Università di Bologna
	12:45 - 13:00	Dansgaard-Oeschger Events: An Open Question In Polar Research <i>Rocco Cogliati</i> - Università di Torino
<u>Conclusion</u>	13:00 - 13:15	SUMMARY OF THE CONFERENCE AND FINAL GREETINGS

ORALS

Tritium activity analysis by liquid scintillation counting for dating the "ADA270" ice core

Ellen Barlow*

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The study of glaciers is essential to understanding past and ongoing climate change. Alpine glaciers are undergoing rapid mass loss, which puts at risk the climate signals preserved within them. Among these signals, anthropogenic radioactive isotopes such as tritium (^3H) are valuable time markers. Tritium activity rose sharply during the last century as a result of atmospheric nuclear weapons testing, which peaked in 1963. This peak in radioactive activity can still be detected today in ice accumulated during that period and provides a reference horizon for its age determination. Previous studies have shown that tritium can be used as a chronological marker, although meltwater percolation and melting may affect the distribution of the signal in a temperate glacier. Ice samples from a core drilled on the Adamello glacier were examined to verify the presence of tritium and to study its behaviour. The samples were analysed by liquid scintillation counting. Comparing the depth of the isotope's activity peak with the one found in a previous core from the same site makes it possible to quantify the ice mass lost to melting and to assess how fast temperate Alpine glaciers are disappearing. Overall, this work aims to improve the accuracy of tritium as a tool for dating environmental samples, contributing to a better understanding of atmospheric changes and hydrological cycles.

**Sea ice melting shifts microbial food web architecture from chemoautotrophy to
phytoplankton-based heterotrophy in coastal Antarctic waters**

Marco Basili*, Vincenzo Manna, Roberta Piredda

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The Southern Ocean plays a cornerstone role in Earth's biogeochemistry, absorbing ~10% of anthropogenic CO₂ emissions. Its marginal seas are productivity hotspots, with the Ross Sea supporting ~40% of the global downward carbon export. This biogeochemical engine runs on microbial food webs: primary producers dictate the magnitude of carbon entering the ocean, while protists and prokaryotes tune carbon export efficiency by channelling organic matter (OM) through the biological and microbial carbon pumps. Sea ice is the master switch of these processes, controlling light penetration and nutrient input, thereby influencing plankton phenology and OM fluxes. Yet, major regime shifts are underway in Antarctic sea ice, with unknown consequences on the Southern Ocean's biogeochemistry. Through a weekly time-series spanning the austral spring–summer transition, we investigated microbiome structure and functioning by assessing microbe-mediated OM processing alongside metabarcoding-based community dynamics. Integrating these data into an interkingdom interaction network, we aimed at resolving microbial food web architecture during sea ice seasonal changes in the coastal Ross Sea.

**Digital holography for the reconstruction of particles suspended in diamagnetic droplets
levitated in a magneto-gravitational trap**

Sofia Biscotti*

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The present research was conducted independently and outside any university research program. In the context of polar research, the morphological and dynamic analysis of microparticles trapped within the glacial matrix provides fundamental insights into past and present environmental changes. This theoretical study proposes a conceptual methodological framework based on the use of two distinct experimental stations on different samples, minimizing sample preparation procedures and allowing for the generation of statistics regarding the geographical provenance of the particles, linked to wind currents and the epoch of their deposition. One of the methodologies relies on an innovative laboratory platform for three-dimensional investigation, designed to analyze particles ranging from 1.5 μm to 6.0 μm in size directly within their native environment. This system combines digital holography, magneto-gravitational trapping, and a cryogenic microcell to induce controlled ice melting; digital holography thus makes it possible to reconstruct the volume, exact geometry, and microscopic variations of the particle in contact with water. A second methodology, already widely studied to determine whether the deposit is ancient or recent, involves the analysis of a different sample from the same area and depth, to be conducted using synchrotron light applied to micro-X-ray fluorescence. By integrating data derived from digital holography and synchrotron analysis, it becomes possible to study the morphology of pollutant particles in detail, gaining deeper insight into their dynamic behavior, motion, and associated binding mechanisms within the aqueous matrix generated after ice melting. Furthermore, this approach allows for the identification of competitive adsorption phenomena, identifying which natural, non-polluting mineral particles are capable of inactivating the surface of contaminant agents, thereby inhibiting or blocking their chemical bonds in the liquid phase. The synergy between the two techniques could allow for an accurate estimation of the time elapsed since the deposition of the various analytes, providing the elements needed to predict the ecological and toxicological issues that may emerge as a result of progressive global warming and the ensuing melting.

Precision Cosmology from the Antarctic Plateau: The COSMO Experiment

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The Antarctic Plateau provides exceptionally favorable conditions for observing the Universe at millimeter and sub-millimeter wavelengths. It also one of the most extreme environments on Earth. Its high altitude, extremely cold and dry atmosphere, and low atmospheric variability make Antarctica a unique platform for precision cosmology. Cosmic Microwave Background (CMB) is a key observable in modern cosmology. The CMB is the relic radiation released when the Universe became transparent. While CMB temperature and E-mode polarization anisotropies have been measured with extraordinary precision, major observational challenges remain, including the detection of primordial B-mode polarization. In addition, its absolute frequency spectrum has been characterized with comparatively lower precision. Tiny departures from a perfect blackbody spectrum, known as spectral distortions, are expected to be produced by energy exchanges between matter and radiation throughout the thermal history of the Universe. Their measurement would therefore provide an independent window on physical processes ranging from the early Universe to the formation of cosmic structures. COSMO, the COSmic Monopole Observer, is a ground-based experiment designed to search for these small spectral distortions from the Italian-French Concordia Station at Dome C, Antarctica. The instrument is based on a cryogenic differential Fourier Transform Spectrometer that compares the brightness of the sky with that of an internal blackbody calibrator. Arrays of Lumped Element Kinetic Inductance Detectors observe the millimeter-wave sky, while rapid scans at different elevations are used to distinguish the atmospheric emission, which varies with airmass, from the nearly isotropic cosmological signal. COSMO shows both the opportunity and the challenges of performing precision cosmology from the ground. In this contribution, I will discuss why the Antarctic Plateau represents an exceptional environment for CMB observations, the scientific motivation for measuring CMB spectral distortions, and the observing strategy and instrumental concept of COSMO. More broadly, this experiment highlights how polar research infrastructures can provide access not only to the study of the Earth system, but also to the study of the Universe on the largest scales.

Multi-Instrument Observations of Ionospheric Irregularities Associated with a STEVE Event

C. Castillo-Rivera*, L. Alfonsi, B. Gallardo-Lacourt, L. Spogli, R. Ghidoni, C. Cesaroni, Y.J. Morton

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Strong Thermal Emission Velocity Enhancement (STEVE) represents a distinctive manifestation of the coupled magnetosphere–ionosphere system whose underlying generation mechanism is still not fully understood. Unlike conventional auroral emissions, STEVE is not primarily associated with energetic particle precipitation and is characterized by a broadband continuum optical spectrum. Its occurrence under different geomagnetic and ionospheric conditions therefore offers an opportunity to investigate the electrodynamic processes involved in its formation. Here, we examine an unusual STEVE event observed on 27 March 2023 at higher geomagnetic latitudes than typically reported and during the late recovery phase of a geomagnetic storm, when geomagnetic activity was relatively low. We use a multi-instrument approach to characterize the ionospheric and plasma conditions associated with the event. Ionospheric scintillation monitoring receivers from the Canadian High Arctic Ionospheric Network (CHAIN) in Alaska and northern Canada, Global Navigation Satellite System receivers from the Canadian Active Control System, and stations from the NOAA Continuously Operating Reference Stations network are used to investigate scintillation indices, Total Electron Content (TEC), and the Rate of TEC Index (ROTI). These ground-based observations are complemented by measurements from the Swarm satellite constellation and digital ionosondes, providing information on the spatial distribution and evolution of the associated plasma structures. Preliminary results indicate distinct temporal and spatial variations in ionospheric irregularities occurring during the STEVE event. These observations contribute to a better characterization of the ionospheric environment associated with STEVE and provide further constraints on the electrodynamic processes involved in its generation.

Dansgaard-Oeschger events: an open question in polar research

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Dansgaard-Oeschger events are an open research area in the study of climate variability. These are abrupt events which took place over the last glacial period, consisting in a fast warming phase followed by a slow cooling phase, observed in the isotopic fractionation record of Greenland ice cores. Their causes and effects are still unconstrained, and are the subject of numerous research efforts in current climate science. Leading theories suggest a strong oceanic component, possibly linking similar events at both poles with a 180° phase difference, while other theories point to ice sheet instability. In this presentation I will present an overview on what these events are, what the current theories are for their causes and their effects, and what research efforts are currently being made to further characterize them.

Discovering past climates through hidden molecular fossils: an introduction to biomarker proxies in polar environments

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Climate change is one of the major challenges facing society today. To improve our understanding of ongoing anthropogenic climate change and increase confidence in future projections, it is essential to investigate how the Earth's climate system responded to environmental forcings in the past. Because direct observations are limited to recent decades, past climate variations must be reconstructed using indirect indicators, known as climate proxies. Among these, biomarker proxies have emerged over the last decades as powerful tools for reconstructing past environmental and climatic conditions. Biomarker proxies are molecular fossils produced by living organisms and preserved in natural archives such as marine and lake sediments. They can provide information on variables including temperature, sea-ice extent, hydrology, vegetation dynamics, and ecosystem change. Biomarkers offer unique opportunities to investigate multiple aspects of past environments and have become an integral component of the paleoenvironmental toolkit. This presentation will provide an accessible introduction to biomarker proxies and their applications in paleoenvironmental and paleoclimatic research, with a particular focus on polar regions. After introducing the principles behind commonly used biomarkers and the environmental information they record, two case studies from ongoing PhD research will be presented. The first explores the use of highly branched isoprenoids (HBIs) and glycerol dialkyl glycerol tetraethers (GDGTs) in the Edisto Fjord (Antarctica), where modern biomarker distributions are compared with contemporary physical observations to improve proxy calibration and interpretation. The second case study focuses on a sediment core from Tuktoyaktuk Harbour in the Canadian Arctic, where a multiproxy biomarker approach based on HBIs, n-alkanes and long-chain diols (LCDs) is used to reconstruct environmental changes over the last 10,000 years. By combining an overview of biomarker science with practical examples from polar research, this contribution aims to demonstrate how molecular evidence can help us better understand past climate variability and environmental change, while also highlighting the importance of modern calibration studies for improving future paleoenvironmental reconstructions.

Fungal-mineral interactions in Antarctic cryptoendolithic communities: phenotypic and genomic insights

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Antarctica is one of the most inhospitable environments on Earth, characterized by extreme conditions such as low temperatures, limited water and nutrient availability, and high UV radiation. Under these constraints, cryptoendolithic colonization represents the predominant survival strategy for microbial communities and has been widely documented in sandstone across Victoria Land. While previous research has mainly addressed the biodiversity of these communities, the interactions between endolithic fungi and the rock matrix, particularly those involving biomineralization, remain poorly characterized. This study investigates the biomineralization potential of eleven fungal strains, including black meristematic fungi and yeasts, commonly isolated from Antarctic sandstone, by combining phenotypic assays with bioinformatic analyses of genomes. Selective media were used to test for urease activity, calcium oxalate and calcium carbonate precipitation, and siderophore production, with mineral formation monitored through macroscopic and microscopic observation, colorimetric assays and pH indicators. Results revealed a differentiated pattern among species, with most strains showing clear biomineralization activity, including urease activity, calcium oxalate and calcium carbonate precipitation, and siderophore production, while a few strains displayed only limited or no activity. This pattern suggests a possible functional partitioning within the cryptoendolithic community, where more active species may interact directly with the mineral substrate, whereas less active, melanized species may rely primarily on cell-wall pigmentation for protection against environmental stress. Notably, phenotypic and genomic data were not always consistent: despite variable phenotypic responses, genomic analysis showed that nearly all strains possess the gene repertoire for the biomineralization pathways examined, suggesting that observed differences likely reflect regulatory or expression-level variation rather than gene absence. This study provides an initial framework for understanding fungal-mineral interactions in Antarctic cryptoendolithic communities, with potential implications for astrobiology, biotechnology and environmental sciences.

The role of light absorbing aerosol on the atmospheric heating rate in remote areas (Arctic region: Ny-Ålesund)

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The Arctic experiences Arctic amplification (AA), caused by complex climate feedback acting on different temporal and spatial scales, which result in a temperature increase up to four times greater than the global average. In this context, Light-Absorbing Aerosols (LAAs), as short-lived climate forcers, represent a source of uncertainty in our understanding of AA. By interacting with solar radiation, LAAs release energy into the atmosphere, resulting in a specific atmospheric HR, whose estimation is crucial for understanding their radiative effects and feedback. This study aims, through an approach based on continuous, fixed-point experimental data, to assess the HR, BC concentrations, the background atmospheric characteristics of Ny-Ålesund, and the role of LAAs in AA. The BC concentrations were measured at Gruvebadet over the three-year period 2022–2024, at high temporal resolution, using the AE33 instrument, along with meteorological and radiation data collected at the AWIPEV station. We estimated the HR values, the relative source and species apportionment, and the BC sources apportionment. Our results suggest a relevant contribution of snow reflection to atmospheric-HR, more evident in spring, and a decrease in diffuse radiation-HR consistent with the dissipation of Arctic Haze. The total-HR estimates are almost equal to that inferred from previous Arctic estimates. This study represents a first significant experimental contribution both in understanding the effect of LAAs on the atmospheric-HR in the Arctic and, more generally, in clarifying their role in the Arctic Amplification phenomenon, providing data useful for comparison with models and to support mitigation strategies.

**Antarctic Snowfall: From Ground to Space, Bridging In-Situ and Remote Sensing
Observations**

Giacomo Roversi*, Luca Baldini, Alessandro Bracci, Kaori Sato, Hajime Okamoto

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Snowfall plays a fundamental role in the Earth's water cycle and energy budget, particularly in polar regions, where it represents the main input to the surface mass balance of ice sheets. However, quantifying snowfall in remote regions remains challenging and subject to large uncertainties. Ground-based measurements are sparse and require overcoming significant logistical and instrumental challenges under extreme environmental conditions, while remote sensing techniques are affected by the large microphysical variability of frozen hydrometeors. Addressing these limitations requires moving beyond the traditional single-instrument approach and exploiting the synergy between complementary observing systems. Previous studies (e.g. Bracci et al., 2022) have shown that a K-band (24 GHz) Doppler radar profiler, such as the Micro Rain Radar (MRR, Metek), can provide reliable local snowfall estimates when combined with a co-located optical laser disdrometer (e.g. OTT Parsivel) characterising the hydrometeor size distribution at the surface. At the Italian "Mario Zucchelli" Research Station (Terra Nova Bay, Antarctica), within the PNRA-funded APP project, an MRR and a Parsivel have been operating quasi-continuously since late 2018, providing more than five years of observations. Their combined measurements have enabled the microphysical characterisation of precipitation throughout the observational period. Building on the combined MRR and disdrometer observations, the K2W approach (Bracci et al., 2023) was implemented and subsequently refined. K2W enables the simulation of W-band (94 GHz) radar profiles from K-band Doppler spectra and surface disdrometer measurements, allowing direct validation of W-band profiles measured by the Cloud Profiling Radars (CPRs) aboard the CloudSat (NASA, now retired) and EarthCARE (ESA-JAXA) satellites. EarthCARE entered its operational phase two years ago and is currently undergoing validation by the scientific community. The resulting ground-based profiles overlap with satellite observations in the upper part of their vertical extent, enabling direct comparison, while providing additional information in the lower layers that is inaccessible to satellites because of ground clutter. This complementary view allows a more complete characterisation of precipitation processes, which can undergo significant changes near the surface, such as hydrometeor sublimation leading to virga. The resulting improved linkage between ground-based and satellite observations provides a basis for better constraining satellite snowfall estimates and ultimately for developing a long-term climatological precipitation record for Antarctica.

Decadal reorganization of soil microbial communities in a warming high-mountain ecosystem

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High-mountain environments are increasingly viewed as a global “third pole”: climate-sensitive ecosystems that share with the Arctic and Antarctic rapid warming, persistent or seasonal cryospheric influence, and strong constraints on biological activity. Mountain soils are warming rapidly due to elevation-dependent warming, yet empirical evidence for long-term in situ microbial shifts remains scarce, as most research relies on short-term simulations such as open-top chambers or soil transplants. To address this gap, we investigated decadal changes in soil bacterial and fungal communities beneath three dominant plant species (*Calluna vulgaris*, *Nardus stricta*, and *Vaccinium uliginosum*) at Alpe di Mommio in the Northern Apennines. This high-altitude site belongs to the GLORIA network and has experienced sustained regional warming and shifts in the vegetation cover. The same sites were first sampled in 2012 and resampled in 2024 following standardized field procedures and analyzed using identical laboratory protocols. We combined 16S rRNA gene and ITS1 amplicon profiling with soil physicochemical measurements, putative fungal-guild annotation, ordination, constrained analyses, and family-level association networks. Fungal Shannon diversity increased significantly in 2024, whereas bacterial diversity remained unchanged. Permutational analyses showed that sampling year explained substantially more variation in fungal composition than in bacterial composition, accompanied by contrasting shifts in multivariate dispersion. Biomarker analysis revealed a pronounced temporal asymmetry in fungi, with 41 of the 46 discriminant genera enriched in 2024, including putative litter saprotrophs across all plant species. Host-dependent increases were also observed, involving root endophytes beneath *Vaccinium* and plant pathogens beneath *Calluna*. In contrast, bacterial biomarkers were evenly distributed between sampling years, with 2024 taxa comprising actinobacterial and rhizobial lineages. Soil physicochemical properties accounted for a significant fraction of community variation, with pH as the sole marginal predictor of bacterial composition in 2024. Co-occurrence networks revealed diverging domain trajectories: bacterial networks became denser and less modular, shifting from oligotrophic hubs like Acidobacteriaceae toward stress-tolerant Sphingomonadaceae. Fungal networks expanded taxonomically but became more fragmented, dominated by ascomycetous hubs such as Venturiaceae and Pyronemataceae. Despite hub turnover, cross-domain modularity was preserved. These results identify fungi as the more responsive component of the subalpine soil microbiome to decadal environmental change. The observed reorganization reflects the combined influence of changing plant inputs, snow regimes, and edaphic filtering. Our findings highlight the

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crucial value of long-term in situ resampling over short-term experimental simulations for understanding belowground climate change impacts.

**Microfibers pollution in Antarctic coastal ecosystems: evidence from multiple benthic species
from the Fildes Peninsula to the Ross Sea**

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Microfiber (MF) and microplastic (MP) pollution is increasingly recognized as a pervasive threat to marine ecosystems, reaching even remote regions such as Antarctica through long-range transport and local anthropogenic activities. This work integrates multiple studies that investigate the occurrence, characteristics, and potential sources of MFs in marine benthic species across different Antarctic coastal areas. Furthermore, a preliminary assessment of MF associated chemical additives has been applied in one of the organisms studied. The study encompassed key Antarctic species with different feeding strategies, including the gastropod *Nacella concinna* (grazer) from the Fildes Peninsula (King George Island) and the sea urchin *Sterechinus neumayeri* (grazer and scavenger) and scallop *Adamussium colbecki* (filter-feeder) from the Ross Sea. MFs and MPs were consistently detected across all investigated species, with 100% occurrence in sea urchins and scallops and 25% in the gastropods. Differences in particle abundance and size distribution were observed among species, with higher loads and longer fibers in the filter-feeding scallops compared to grazing organisms, suggesting a key role of feeding strategy in exposure and accumulation dynamics. Polymer characterization revealed a dominance of natural and semi-synthetic fibers, but also polyester and PET. Comparisons with reference materials from research station activities highlighted a strong similarity with textiles used on site. Furthermore, the co-occurrence of plastic additives, including phthalates and organophosphate esters, supports the potential role of MFs as vectors of chemical contaminants. Notably, additive concentrations in *A. colbecki* exceeded those reported for bivalves in other regions, suggesting a combined influence of local emissions and long-range transport. Partial characterization of particles indicates a likely underestimation of total contamination, and more studies are needed to confirm results. However, these findings provide evidence of MF pollution across Antarctic coastal ecosystems, highlighting the influence of biological traits on particle uptake and the relevance of local anthropogenic sources even in remote environments. The results support the use of Antarctic benthic invertebrates as bioindicators of MF contamination and underline the need for improved monitoring and mitigation strategies in polar research infrastructures.

High-resolution characterisation of Arctic Ocean cold-seep habitats

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Cold seeps are distinctive seafloor environments generated by the migration and release of methane-rich fluids through marine sediments. Seepage interacts with the surrounding geological and geomorphological setting, influencing seafloor morphology, substrate characteristics, and the distribution of specialised benthic communities. These interactions produce complex and heterogeneous habitats that can vary considerably over small spatial scales. In the Arctic Ocean, however, the detailed characterisation and classification of cold-seep habitats remain challenging due to the remoteness and complexity of these environments and the limited availability of high-resolution seafloor observations. This research investigates Arctic cold-seep habitats through the integration of high-resolution seafloor mapping, Remotely Operated Vehicle (ROV)-based observations, underwater photogrammetry, biological annotation, and geospatial analysis. The approach combines observations acquired at different spatial scales, from regional seafloor morphology to centimetre-scale observations of individual habitat components. ROV imagery provides detailed information on seafloor characteristics, seep-related structures, and associated benthic communities, while photogrammetry enables the reconstruction of high-resolution orthomosaics and three-dimensional models for quantitative analysis of seafloor morphology and habitat distribution. Standardised classification of biological and geological components further supports the comparison of habitats across different seep environments. The approach has been applied across Arctic cold-seep environments. These studies demonstrate how high-resolution seafloor observations can resolve fine-scale patterns in habitat composition and reveal spatial relationships between seep-related geological features and associated biological communities. The integration of three-dimensional seafloor models with biological and environmental observations further provides a means of linking local habitat characteristics with the broader geomorphological setting of cold-seep systems. Together, these results demonstrate the potential of integrating high-resolution imaging, photogrammetry, and geospatial modelling for the characterisation and classification of complex Arctic cold-seep habitats. Combining observations across spatial scales provides a more comprehensive understanding of how geological processes, seafloor morphology, and biological communities interact within seep environments, while supporting non-destructive approaches to the study of fragile polar ecosystems.

Investigating Ionospheric Dynamics in Antarctica: Multi-Method Velocity Analysis During the Mother's Day Superstorm

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The unique geomagnetic positioning of Antarctica makes it a critical natural laboratory for space weather research. However, the region remains notably underrepresented in ionospheric research due to its extreme environmental conditions and significant logistical constraints. To address this gap, our research focuses on the formation and the dynamic of high-latitude ionospheric irregularities using data acquired from dedicated GNSS Ionospheric Scintillation Monitoring (ISM) receivers located near the Concordia station at Dome-C, Antarctica (75°S, 123°E). These instruments provided crucial observations during the Mother's Day superstorm in May 2024, the biggest geomagnetic storm of the last two decades. The propagation of trans-ionospheric radio signals is significantly impacted by these irregularities. Known as ionospheric scintillations, these effects present a considerable challenge to the accuracy and robustness of Global Navigation Satellite Systems (GNSS) services. Ensuring the resilience of these systems requires a deeper understanding of the physical processes governing such plasma structures. Our primary methodology involves the spectral analysis of raw GNSS measurements, specifically focusing on the Power Spectral Density (PSD) of signal amplitudes to extract the characteristic Fresnel frequencies for estimating irregularity drift speeds. Additionally, a complementary cross-correlation technique, based on the data collected concurrently by nearby GNSS stations, was implemented. This dual-approach validation for the velocity reconstruction, not only minimizes potential instrumental biases and increases confidence in the estimated plasma movement but also allows for a more precise determination of the north-south and east-west drift velocity components. Finally, the confrontation of the velocities reconstructed by those two independent methods, can help in the reconstruction of the effective altitude of the ionospheric irregularities affecting the GNSS signals. This comparative method provides vital information on ionospheric dynamics both prior to and during the storm, offering a more comprehensive view of plasma behavior in this sensitive polar region during both quiet and geomagnetically active time.

**Study of the Sources and Atmospheric Transport Processes of Crustal-Origin Particulate
Matter in Antarctica**

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Antarctica provides a unique natural observatory for the study of global atmospheric circulation and long-range aerosol transport. Within the framework of the SIDDARTA project, this study investigated the elemental composition, seasonal variability, and potential source areas of mineral particulate matter reaching Concordia Station, located at Dome C, East Antarctica. PM₁₀ samples were analyzed and compared with PM_{2.5} aerosols obtained through the controlled resuspension of soils from Australia and Patagonia, both considered potential source areas of Antarctic dust. Following acid digestion, major, minor, and trace elements were determined by ICP-OES, ICP-QQQ, and HR-ICP-MS. The reliability of the analytical procedure was assessed using certified reference materials and procedural blanks. Potential sources contribution was evaluated using crustal and marine enrichment factors, while principal component analysis and hierarchical cluster analysis were applied to identify compositional patterns and seasonal variability, also taking into account Antarctic PM₁₀ data collected between 2017 and 2023. Al, Fe, K, Mg, Na, and Ca were the most abundant elements in the Antarctic PM₁₀ samples. Winter samples showed a greater contribution from marine-derived elements, whereas summer samples were relatively enriched in crustal elements and rare earth elements. The resuspended soil fractions generally showed higher elemental concentrations than the corresponding bulk soils, highlighting the influence of particle-size selection on aerosol composition. Furthermore, ternary diagrams showed that Antarctic PM₁₀ was enriched in Ca and Na and depleted in Al compared with the resuspended soils. These compositional differences may result from transformation processes occurring during atmospheric transport, the mixing of material from different sources, or an incomplete representation of the relevant potential source areas. Overall, the results reveal a marked seasonal pattern in the elemental composition of Antarctic particulate matter. However, a larger number of atmospheric and soil samples, including material from additional potential source areas, is required to achieve a more robust geographical attribution of the mineral dust reaching inland East Antarctica.

Deep sea warming in the eastern Fram Strait driven by Atlantic Water intrusions

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Atlantification has progressively intensified in the Arctic Ocean, increasing heat and salt content within intermediate and upper layers. Along Svalbard's southwestern continental slope, Atlantic Water (AW) coexists with deeper water masses, such as Norwegian Sea Deep Water (NSDW) and dense shelf- and fjord-formed waters. Using a decade (2014 – 2024) of oceanographic mooring data alongside atmospheric reanalysis, this study evaluates temperature, salinity, and current variability to understand the mechanisms driving deep-layer warming. Key findings indicate that while the deep layer (> 900 m depth) consists mainly of NSDW, it experiences intermittent intrusions of warmer, saltier AW. These intrusions peak during winter (October–March) and show a marked increase in frequency on an interannual basis over the study period, although mean duration and ocean heat content do not exhibit significant long-term trends. The cumulative effect of these events contributes to measurable warming of the deep layer ($\sim 0.07^{\circ}\text{C}$ per decade). Atmospheric forcing is a key driver of both short- and long-term thermohaline and deep-current variability. Over the decade, higher wind speeds and lower mean sea level pressure were associated with stronger deep currents and increased AW intrusions. Short-term observations show that variations in wind regimes modulate dynamics, influencing exchanges between the shelf and the continental slope, the formation of internal oscillations, and vertical mixing processes. Southerly winds enhance the deepening and intrusion of AW through the interaction of strong currents and the continental slope, whereas northerly winds promote changes in stratification, reduced mixing, and the thickening of the deep layer. These insights underscore how the interplay between continental slope processes and atmospheric drivers regulates vertical exchanges in the eastern Fram Strait, offering further evidence of ongoing Arctic and sub-Arctic warming and highlighting the necessity of continuous long-term observations and integrated numerical model outputs to better constrain the dynamics of this area.

Variability of water masses, circulation and freshwater sources in the Ross Sea: insights from long-term hydrographic and velocity records and recent geochemical tracers

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The Ross Sea is one of the main sites of dense water formation around Antarctica. Exchanges of heat, salt and freshwater between the open ocean, the continental shelf and the Ross Ice Shelf (RIS) cavity regulate ice shelf basal melt and Antarctic Bottom Water production, which ultimately influence the global overturning circulation. This research investigates how these exchanges vary in space and time, combining physical and geochemical observations collected during several Italian Antarctic expeditions. The first part of the work builds the most consistent and detailed multi-decadal hydrographic time series along the RIS front, spanning 1995 to 2025, from Conductivity-Temperature-Depth (CTD) profiles and Lowered Acoustic Doppler Current Profiler (LADCP) velocity data. This record allows us to describe the spatio-temporal evolution of the key water masses along the ice shelf front, from High Salinity Shelf Water (HSSW), a precursor of Antarctic Bottom Water, to Ice Shelf Water, which forms as HSSW interacts with the base of the ice shelf, highlighting the close link between shelf water properties and conditions beneath the RIS. LADCP data are used to estimate cross-shelf heat fluxes and to identify the pathways of water mass transport towards the ice shelf cavity, pointing to a more complex and dynamic circulation along the RIS than previously assumed. The second part, carried out within the GLOB project in 2025, focuses on the Glomar Challenger Basin (GCB), a key gateway channelling warm modified Circumpolar Deep Water (mCDW) from the ocean towards the RIS. Here, recent hydrographic observations are combined with seawater $\delta^{18}\text{O}$ and nutrient measurements, used as tracers of water mass origin and freshwater sources. $\delta^{18}\text{O}$ helps trace glacial meltwater content in the water column, while nutrients allow the identification of the main water masses, their mixing and the intrusion pathways of mCDW within the basin. Together, these tracers show how glacial meltwater spreads in the GCB and how fresher waters from the Amundsen Sea enter the Ross Sea continental shelf, potentially modifying its freshwater content and stratification. These results highlight the importance of sustaining long-term, continuous observations in the Ross Sea, which are essential to capture how shelf water masses evolve over decades and respond to a changing climate. Combining physical measurements with geochemical tracers further strengthens this approach, providing a more complete picture of water mass origin, freshwater sources and transformation processes, key to understanding ocean-ice shelf interactions in one of the most important regions of the Earth.

From PRISMA to Sentinel-2: a framework for the retrieval of snow properties and radiative forcing at Plateau Rosa and Cime Bianche (Aosta Valley)

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Mineral dust deposited on snow lowers surface albedo and accelerates melt, but quantifying its radiative impact at catchment scale remains difficult because dust load, grain size and liquid water content alter snow reflectance simultaneously. Spaceborne imaging spectroscopy can help disentangle these effects, provided retrieval methods are efficient, physically consistent and validated against field data. We present a multi-sensor framework to retrieve snow properties and dust radiative forcing at Plateau Rosa and Cime Bianche (Pennine Alps, Italy) following the Saharan dust event of late June 2024. A K-Nearest Neighbors (KNN) algorithm, trained on a lookup table of BioSNICAR-simulated spectra, was applied to PRISMA hyperspectral imagery to retrieve dust concentration, grain size, broadband albedo (BBA) and instantaneous radiative forcing (iRF), while liquid water content (LWC) was estimated with the SSWI spectral index. The results were compared with those of the S-ART asymptotic radiative transfer model and validated using measurements collected during a PRISMA overpass on 4 July 2024. These included field reflectance spectra, snow density, LWC, grain size, and dust concentrations measured using a Coulter Counter. KNN and S-ART agreed closely ($R^2 = 0.99$ for grain size, 0.89 for BBA) and were generally consistent with field observations, particularly for dust and BBA. Dust accounted for about 42% of the total positive radiative forcing, with a mean daytime of $13 \pm 7 \text{ W m}^{-2}$ averaged over the PRISMA study area, corresponding to $2.1 \pm 1.1 \text{ mm w.e.}$ of dust-induced melt. To capture temporal dynamics, the KNN approach was adapted to Sentinel-2 bands, yielding snow parameter time series at Cime Bianche site. Satellite-derived BBA compared well with automatic weather station measurements ($R^2 = 0.75$) and peak instantaneous iRF 300 exceeded 300 W m^{-2} during the 2024 melting season. These results demonstrate the transferability of the KNN retrieval, which was developed and validated on PRISMA, to Sentinel-2 multispectral bands, enabling continuous monitoring of dust-driven changes in snow properties beyond single hyperspectral acquisitions. This provides a basis for future integration with snowpack modelling to quantify the effect of dust on melt-out timing and runoff.

The Securitization of Scientific Data in the Arctic: Between Scientific Openness and Strategic Interests

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The Arctic is increasingly becoming a critical space for scientific research, environmental monitoring, and geopolitical competition. As climate change accelerates the transformation of the region, scientific missions have multiplied with the aim of studying phenomena of global relevance, including the melting of sea ice, changes in marine ecosystems, biodiversity, ocean circulation, and the effects of climate change on Arctic communities. These activities are generally presented as serving universal and collective interests, with scientific knowledge being understood as a public good that should contribute to a better understanding of a rapidly changing environment. However, the production and circulation of scientific knowledge in the Arctic increasingly intersect with national security and strategic interests. The logistical challenges and high costs associated with operating in such a remote and demanding environment often require substantial financial, technological, and infrastructural support. In some cases, this support is provided by defence institutions, coast guards, military organisations, or other security-related actors possessing the vessels, satellite capabilities, communication systems, personnel, and logistical infrastructure necessary to operate in the region. While such cooperation can significantly expand scientific capabilities, it also raises important questions concerning the accessibility, ownership, and subsequent use of the data collected. This presentation examines the emerging process of scientific data securitization in the Arctic: the transformation of information initially produced for scientific or environmental purposes into data considered relevant to national security and strategic interests. Scientific observations of the seabed, bathymetry, oceanographic conditions, sea-ice dynamics, marine traffic, and biological environments can have applications extending beyond academic research. The same datasets that contribute to climate science and environmental protection may also provide valuable information for navigation, resource exploration, infrastructure development, maritime domain awareness, or military planning. The central problem addressed by this presentation is therefore the tension between scientific openness and strategic secrecy. To what extent can scientific missions remain genuinely open and internationally collaborative when the infrastructure supporting them is increasingly connected to security institutions? What happens when certain datasets are classified, restricted, delayed, or excluded from public dissemination? And how might growing geopolitical tensions affect scientific cooperation and data-sharing practices in the Arctic? By examining these questions, the presentation seeks to explore the Arctic not only as an environment undergoing profound physical transformation, but also as a space in which the boundaries between science, security, and geopolitics are becoming increasingly difficult to separate. It argues that

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understanding the governance of Arctic scientific data is essential for assessing the future of international scientific cooperation and the emergence of new forms of strategic competition in the region.

**Complex open-system magma evolution at the Pleiades Volcanic Field (Antarctica) revealed
by in situ radiogenic isotopes**

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The Pleiades Volcanic Field (PVF), in northern Victoria Land (Antarctica), is a cluster of monogenetic cones and one of the most compositionally varied suites of the McMurdo Volcanic Group, with erupted products ranging from alkali basalts to trachytes. Activity spans from ~850 ka to the present, and the volcanic rocks follow two separate evolutionary trends: (1) a mildly Na-alkaline series and (2) a strongly Na-alkaline series. This is unusual for a field dominated by monogenetic activity. We integrate whole-rock Sr-Nd-Pb isotope data with new high-spatial-resolution in situ $^{87}\text{Sr}/^{86}\text{Sr}$ measurements, acquired by laser ablation on a Neoma MS/MS MC-ICP-MS. We use them to disentangle differentiation, crystal recycling and magma mixing in this complex alkaline system. The mafic rocks have OIB-like trace element patterns, low $^{87}\text{Sr}/^{86}\text{Sr}$ (0.7032–0.7037) and high $^{143}\text{Nd}/^{144}\text{Nd}$, pointing to a subcontinental lithospheric mantle source. With increasing differentiation, the two series follow different isotopic paths. Along the strongly alkaline trend, Sr-Nd isotope ratios remain almost constant, in agreement with closed-system fractional crystallization. The mildly alkaline series instead evolves towards higher $^{87}\text{Sr}/^{86}\text{Sr}$ (up to 0.7052) and lower $^{143}\text{Nd}/^{144}\text{Nd}$ (down to 0.51277), which requires substantial assimilation of shallow crustal material. At the crystal scale, in situ $^{87}\text{Sr}/^{86}\text{Sr}$ analyses reveal marked core-to-rim isotopic variations, commonly associated with oscillatory, reverse and complex zoning. These variations record repeated recharge events, crystal recycling, and mixing between melts with different degrees of evolution and distinct radiogenic isotope compositions. AFC/FC modelling requires volumes of primitive magma at least an order of magnitude larger than the erupted volumes. This implies long storage times and repeated replenishment by mafic magmas residing at different depths within a vertically extensive plumbing system. The PVF is therefore not a simple cluster of monogenetic centres. It is the surface expression of a polygenetic, multilevel magmatic system, whose evolution through time should also be evaluated against changes in ice load driven by climatic fluctuations.

Infrasound Monitoring of Glacier Calving: From event detection to quantifying ice loss at Grey Glacier, Patagonia

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Glacier calving is a key process controlling ice loss and glacier dynamics, yet individual calving events remain difficult to monitor continuously, particularly in remote and harsh environments. Here, we investigate the potential of atmospheric infrasound as a complementary tool for detecting and characterizing individual calving events at Grey Glacier, Patagonia, Chile. During a field campaign in February 2025, we deployed an infrasound array near the glacier front and continuously recorded atmospheric pressure fluctuations associated with glacier activity. After filtering detections according to signal coherence and source direction, we identified 60 independent infrasound events over nine days. The detected signals are characterized by impulsive waveforms and energy mainly concentrated between 2 and 20 Hz. The consistency of their arrival direction with the glacier front, together with camera observations, confirms their association with calving activity. These results demonstrate the potential of infrasound for continuous, remote monitoring of glacier calving, including events that may not be directly observable by optical instruments. Building on these results, a new RGS-funded field campaign will be conducted at Grey Glacier in December 2026 in collaboration with the University of Liverpool. The campaign will combine infrasound with complementary observations to investigate the physical mechanisms of calving and explore whether acoustic observations can be related to ice loss at the scale of individual events. This work aims to develop a non-invasive monitoring approach for glacier dynamics and, in the longer term, contribute to methodologies applicable to more remote Antarctic environments.

**Deciphering magma plumbing systems and glacial interactions in northern Victoria Land:
insights from The Pleiades and Mount Melbourne Volcanic Fields**

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In northern Victoria Land (Antarctica), Cenozoic intraplate alkaline magmatism associated with the West Antarctic Rift System offers a key window into mantle melting processes, crustal magma storage, and volcano-ice interactions. This contribution provides a comparative overview of our work on two contrasting volcanic systems within the Melbourne Volcanic Province, located approximately 180 km apart: The Pleiades Volcanic Field and the Mount Melbourne Volcanic Field. Despite sharing a common regional tectonic setting, these two fields display striking differences in volcanic architecture, magmatic evolution, and eruptive longevity. The Pleiades Volcanic Field comprises over twenty small scoria cones and lava domes erupted over the last 900 ka. Its erupted products define a continuous Na-alkaline differentiation trend from alkali basalts to trachytes. Petrographic disequilibrium textures, machine-learning thermobarometric constraints, and whole-rock and in-situ geochemical data reveal a complex, polybaric plumbing system dominated by open-system processes, including fractional crystallization, crustal assimilation, and magma recharge. These magmatic dynamics were probably modulated by fluctuations in glacial loading, where periods of ice thickening promoted prolonged crustal magma residence times. In contrast, the Mount Melbourne Volcanic Field represents a long-lived volcanic complex active since 4.1 Ma, dominated by a central stratovolcano alongside diverse peripheral centres (such as tuff cones, hyaloclastites, and scoria cones). Here, focus is placed on volcanic glass shards from proximal deposits (lapilli tuffs and hyaloclastites), which complement traditional lava and distal tephra studies by providing a previously underconstrained record of poorly to moderately evolved glasses. Geochemical fingerprinting of these proximal glasses via EPMA and LA-ICP-MS reveals systematic trace element variations (e.g., La/Nb, Th, Zr, REE), that record an evolving enriched mantle source and a shift toward higher degrees of partial melting at shallower conditions over time. By integrating micro-textural analysis, glass and crystal geochemistry, and thermobarometric modelling, this comparative approach highlights how mantle source dynamics and surface glacial and lithostatic forcing shape Antarctic magmatism, while providing critical geochemical fingerprinting tools for Antarctic tephrochronology and paleoclimate reconstructions.

**Phytoplankton Bloom Dynamics and Functional Traits at the Sea Ice-Water Interface in Terra
Nova Bay (Ross Sea)**

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The sea ice-water interface of Antarctic coastal ecosystems represents a highly dynamic transitional environment where physical, chemical, and biological processes interact over short spatial and temporal scales. Understanding how phytoplankton communities respond to these rapidly changing conditions is essential for predicting the effects of ongoing climate change on Southern Ocean trophic dynamics. This study investigates the temporal evolution of phytoplankton communities in Terra Nova Bay (Ross Sea, Antarctica) during two austral spring-summer periods, focusing on the relationships between environmental variability, nutrient availability, and phytoplankton functional structure. Physical parameters, inorganic nutrients, chlorophyll-a concentration, photosynthetic efficiency (Fv/Fm), and pigment composition were analysed in the upper water column beneath sea ice. Results revealed strong thermohaline stratification associated with sea-ice melting and freshwater inputs, generating highly variable microenvironments in the upper layers. Phytoplankton biomass exhibited rapid bloom events linked to changes in salinity, temperature, and nutrient dynamics. Pigment analyses indicated a transition from diatom-dominated communities, characterized by high fucoxanthin concentrations, toward an increasing contribution of haptophytes, particularly *Phaeocystis antarctica*, during periods of enhanced stratification. Multivariate analyses identified ice melt as the primary driver regulating phytoplankton distribution, productivity, and community composition. In addition, laboratory experiments on Antarctic *Chaetoceros* spp. exposed to different salinity treatments demonstrated that moderate salinity shifts can be tolerated through distinct acclimation strategies, whereas extreme hypo- and hypersaline conditions significantly impair photosynthetic performance, growth, and cellular integrity. These findings suggest that ongoing changes in sea-ice dynamics and freshwater inputs may alter phytoplankton community structure, with potential consequences for Antarctic food webs and carbon cycling. Overall, this work highlights the importance of phytoplankton functional traits as biological indicators of environmental change and contributes to a better understanding of ecosystem responses within Antarctic transitional systems.

First Rain on Snow event in winter recorded at THAAO: preliminary results

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Climate change is affecting the Arctic more severely than the rest of the world. This enhanced warming, known as Arctic amplification, is driven in part by phenomena such as warm air intrusions, which transport warmer and moister air masses into the region and can trigger Atmospheric River (AR) events. In Greenland, these events typically occur in the north-west during summer months and in the south-east during winter. In March 2025, however, the Thule High Arctic Atmospheric Observatory (THAAO), located in north-west Greenland, and its surrounding area experienced a rain-on-snow (RoS) event associated with an intense atmospheric river. Between the evening of 13 March and the early hours of 14 March 2025, above-freezing temperatures ($>0^{\circ}\text{C}$) combined with precipitation resulted in liquid rainfall — the first such event recorded at THAAO. While RoS events have become increasingly common in the Svalbard Archipelago, they remain rare in north-west Greenland. This study investigates the atmospheric drivers of this event and assesses its impact on snow albedo and optical properties following the melt–refreeze cycle it induced. The event delivered approximately 2 mm of liquid precipitation over the 13–14 March period. To characterize the snow's response, this winter RoS event is compared with a summer rainfall event observed in June 2023.

Nutrient distribution and the carbonate system in the Glomar Challenger Basin: implications for the biogeochemical cycles of the Ross Sea (Antarctica)

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The Ross Sea is one of the most extensively sampled Antarctic continental shelves and represents a crucial region for global biogeochemistry, ocean circulation, and climate regulation. It serves as a fundamental sink for atmospheric carbon dioxide (CO₂), playing a key role in air-sea gas exchange. This research is based on sampling conducted during the XL Italian National Antarctic Research Program (PNRA) expedition in the austral summer of 2025, aboard the R/V Laura Bassi. The study covered 38 oceanographic stations aimed at characterizing the biogeochemical dynamics of the Glomar Challenger Basin (GCB), an under-explored area of the Ross Sea that acts as a transition zone between the eastern and western sectors and a pathway for Circumpolar Deep Water (CDW) intrusions toward the Ross Ice Shelf (RIS). Nutrient concentrations (NO₂⁻, NO₃⁻, NH₄⁺, PO₄³⁻, Si(OH)₄) were determined via colorimetric analysis, alongside potentiometric measurements for pH and Total Alkalinity (AT). These data were integrated with potential temperature and salinity to derive a comprehensive description of the carbonate system, including Total Inorganic Carbon (CT), carbonate saturation states for calcite and aragonite (Ω), and the Revelle factor. The application of multivariate statistical techniques, such as Principal Component Analysis (PCA), combined with nutrient drawdown and N/P and N/Si ratios, facilitated the interpretation of spatial variability and dominant processes in surface waters. These analyses revealed significant heterogeneity and widespread iron-deficiency conditions that limit primary production in the region. Various water masses were mapped and characterized, including High Salinity Shelf Water (HSSW), Ice Shelf Water (ISW), Low Salinity Shelf Water (LSSW), and CDW intrusions. The results confirmed that AT is a more effective chemical tracer than semi-conservative indices (NO and PO) for distinguishing different shelf waters within the GCB. Estimates of anthropogenic carbon (C_{ant}) using the TrOCA method showed significant enrichment in deep shelf waters (HSSW and ISW), demonstrating the efficiency of these masses in transferring human-derived CO₂ to the deep ocean. In conclusion, this study underscores the importance of the GCB as a natural laboratory for monitoring the impact of climate change on global biogeochemical cycles.

Analysis of Glacier Impurities and Weathering Crust in Southeast Greenland

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The optical properties of glaciers play a fundamental role in determining glacier mass balance. These properties contribute equally significantly to the surface energy balance, particularly in polar regions where extensive snow and ice covers dominate the landscape. In this context, the phenomenon of glacier darkening, resulting from reduced albedo due to the presence of glacier impurities, known as light-absorbing particles (LAPs), emerges as a critical factor influencing ice mass balance. Glacier darkening has been observed in several regions, including Greenland, and is characterized by the presence of LAPs such as black carbon, mineral dust, and biogenic particles. Biogenic particles, for instance, originate from algal blooms that develop on bare ice surfaces. Furthermore, interactions between LAPs and the weathering crust, a porous layer of white ice whose formation is induced by internal melting, also play a relevant role, as the degradation of the weathering crust leads to an increase in LAP coverage on the glacier, thereby further darkening its surface. This research focused on the characterization of algal blooms responsible for the darkening of the surface of Mittivakkat Glacier (southeastern Greenland) and on their relationship with the weathering crust through a combined field-based and remote sensing approach. Within the framework of a POLARIN TA (Horizon Europe) project, an international team of Italian and Japanese researchers monitored this glacier during the summer of 2026 through in situ sampling of surface ice, spectroscopic measurements, and UAV (drone) surveys, with the aim of characterizing both LAPs and the weathering crust. Here, the preliminary results of this field campaign are presented. This research is conducted within the framework of the project “A multidisciplinary approach with physically-based models for Greenland glacier darkening”, funded through the JSPS Postdoctoral Fellowships for Research in Japan FY2026 program.

Sunlight radiative transfer in Arctic snowpacks

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The snowpack is one of the most optically complex and dynamic components of the cryosphere: its reflection, absorption and transmission properties are extremely sensitive to altitude, latitude, season and the metamorphic history of individual layers. Such variability is of utmost importance to the climate system, strongly affecting surface energy balance and local temperatures, yet it is also the main obstacle to a realistic, generalizable description of light propagation. Snow covers of similar thickness or density can behave very differently from a radiative standpoint depending on grain size and shape, the presence of melt-freeze crusts or surface hoar, liquid water content, and the concentration of light-absorbing particles. Small reductions in albedo from any of these factors can trigger a positive feedback that accelerates melting and amplifies polar warming. Alongside energy balance, the fraction of sunlight that penetrates the snowpack, though confined to a shallow near-surface layer, is well known to sustain photosynthesis in snow algae and subnival vegetation and drives photochemical reactions that release and transform reactive species such as mercury, halogens, and organic compounds. Despite its relevance, light propagation through snow remains poorly constrained experimentally, relying largely on approximated solutions of radiative-transfer models or tailored Monte Carlo simulations. This knowledge gap is critical since albedo feedback is a major driver of enhanced polar warming: as snow and ice retreat, darker surfaces absorb more radiation, further amplifying climate change in polar regions. Here we present a compact and lightweight probe that performs in-situ, millimeter-resolution measurements of horizontally scattered sunlight flux at different depths inside the snowpack, in three visible spectral bands (red, green, blue), without the need for snowpit excavation. Within the diffusive regime, the measured decay of horizontally scattered light yields the asymptotic flux extinction coefficient and its associated e-folding depth, directly constraining snow density and grain size when compared against SNICAR simulations. The possibility to extend such investigation to UV spectral range will be also discussed. Field observations across diverse environments reveal that light penetration depth strongly depends on peculiar snow properties and can exhibit complex features not captured by existing models, highlighting the need for integrated experimental and modeling strategies.

