IV ROSS SEA CONFERENCE 2023

3-7 July 2023, Naples, Italy

Sponsored by

NORTEK

上海交通大學 SHANGHAI JIAO TONG UNIVERSITY | SO 海洋学院 SCHOOL OF OCEANOGRAPHY

CODEVINTEC
Tecnologie per le Scienze della Terra e del Mare

ALSEAMAR
ALCEN

Under the patronage of

MUR Ministero dell'Università e della Ricerca

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

SOUTHERN OCEAN OBSERVING SYSTEM

Commissione Oceanografica Italiana

Programma Nazionale di Ricerche in Antartide

© n.k.

Ross Sea 2023 Naples

IV ROSS SEA CONFERENCE 2023 PROGRAM

3-7 July 2023, Naples, Italy

Monday, July 3rd	
Università degli Studi di Napoli "Parthenope" Via Amm. F. Acton 38, 80133 Naples	
09:00	
	Room availability for side meetings from 9 to 12 a.m.
12:00	**Conference Opening – Registration on site**
Welcome Speech **Chair: Giorgio Budillon**	
13:30	**- Dean of the Parthenope University: Prof. A. Garofalo** **- Director of Hydrographic Institute, Italian Navy: Rear Admiral M. Nannini** **- General director for Researche of the Ministry of University and Research: Dr. V. Di Felice** **- Councillor for Research, Campania Region: Dr. V. Fascione** **- Representant of the Italian Ministry of Foreign Affairs: Dr. O. Guanciale** **- President of the Italian Scientific Commitee for Antarctica: Prof. S. Onofri** **- Prof. Emeritus of the Parthenope University: Prof. G. Spezie**
Physical Oceanography Session - Part 1 **Chairs: Karen Heywood, Craig Stevens**	
14:15	Current observations in the Ross Sea *Pasquale Castagno*
14:35	Terra Nova Bay and its far-reaching oceanographic impacts on the Ross Sea *Stefan Jendersie*
14:55	HSSW production in TNB, Ross Sea from high-resolution near-surface salinity observations *Christopher Zappa*
15:15	Investigation of the recent salinity variations of HSSW in the TNB Polynya, West Antarctica *Hyun A Choi*
15:35	Stratification Breakdown in Antarctic Coastal Polynyas *Weifeng Zhang*
15:55	**Coffee Break**
16:30	An update on the outflow of dense water from the western Ross Sea *Melissa Bowen*
16:50	Dynamics for cross-slope water exchange in the Ross Sea, Antarctica *Yuanjie Chen*
17:10	Cross-Isobath Transport Driven by JEBAR over the Ross Sea Continental Shelf Break *Chuning Wang*
17:30	The role of the Pacific-Antarctic Ridge in establishing the northward extent of Antarctic sea-ice *Antonino Ian Ferola*

Tuesday, July 4th	
Università degli Studi di Napoli "Parthenope" Via Amm. F. Acton 38, 80133 Naples	
Physical Oceanography Session - Part 2 **Chair: Enrico Zambianchi**	
09:00	**Invited Talk: The complexities of estimating sea-ice production and the implications for ice-climate and ice-ecosystem interactions in the Ross Sea** ***Sharon Stammerjohn***
09:30	Study of the fresh-water inflow through the eastern gate of the Ross Sea *Naomi Krauzig*
09:50	Summer physical and biogeochemical conditions in the Ross Sea polynya: description & drivers *Esther Portela*
10:10	New insights into winter-time dynamics of the Ross Sea: an analysis of grounded Argo floats under ice *Pierpaolo Falco*
10:30	Temperature data collected in the Pacific Sector of the Southern Ocean since 1994 *Yuri Cotroneo*
End of Physical Oceanography Session	
10:50	**Coffee Break**
Ocean-ice-atmosphere Interactions Session **Chairs: Melissa Bowen, Christopher Zappa**	
11:20	Analysis of fine-scale dynamics of the Drygalski ice tongue in Antarctica using satellite SAR data *Mozhgan Zahribanhesari*
11:40	Observations of baroclinity at grounding lines with and without subglacial discharge: The Kamb Ice Stream *Craig Stevens*
12:00	Water masses beneath the Ross Ice Shelf *Karen Heywood*
Sponsor Session 1	
12:20	**School of Oceanography - Shanghai Jiao Tong University (China)**
12:40	**CODEVINTEC (Italy)**
End of Sponsor Session 1	
13:00	**Lunch Break***
14:00	Organic proxies reveal the Ross ice shelf retreat and sea ice dynamics in the Joides Basin, Ross Sea, Antarctica *Chiara Pambianco*
14:20	Mapping and sampling supercooled water and platelet ice in McMurdo Sound *Natalie Robinson*

14:40	Assessing the vulnerability of fast ice in McMurdo Sound, Antarctica to winter storms. *Leonard Greg*
15:00	Robotic-based invESTigation and mOnitoring of Ross sEa with PROTEUS - The RESTORE project *Gabriele Bruzzone*
15:20	Remote sensing of the summer expansion for Ross Sea polynyas *Xi Zhao*
15:40	TNB Polynya dynamics and its impact on surface heat fluxes and thermohaline variability *Giannetta Fusco*
16:00	**Coffee Break**
16:30	The response of sea ice and High Salinity Shelf Water in the RIS Polynya to cyclonic atmosphere circulations *Xiaoqiao Wang*
16:50	Effects of Projected Changes in Wind caused by Amundsen Sea Low on the High Salinity Shelf Water in the Ross Sea *Xie Chuan*
17:00	Connection of Dense Shelf Water Variability in the Western Ross Sea to the Southern Annular Mode *Zhaoru Zhang*
17:20	Decadal Variability of Ice-Shelf Melting in the Amundsen Sea and its impact on Ross Sea salinity *Alessandro Silvano*
End of Ocean-ice-atmosphere Interactions Session	
18:00	**Poster Session and Icebreaker with drinks**

Wednesday, July 5th	
Stazione Zoologica Anton Dohrn Villa Comunale, 80121 Naples	
Marine Biology and Ecology Session - Part 1 **Chairs: Olga Mangoni, Walker Smith**	
09:00	UV-resistant bacteria in Antarctic aquatic environment of the Ross Sea *Daniela Giordano*
09:20	Scale-related dynamics of Ross Sea phytoplankton communities in a changing Southern Ocean *Francesco Bolinesi*
09:40	Shift in phytoplankton communities below the Antarctic Landfast Ice During the Melt Season Between Late Spring and Early Summer in Terra Nova Bay *Maria Saggiomo*
10:00	Microzooplankton and phytoplankton communities' structure in two polynya areas of the Ross Sea *Marina Monti*
10:20	Intra-annual analysis of mesozooplankton sampled in the Ross Sea (Antarctica) *Marco Grillo*
10:40	**Coffee Break**
11:10	Three-dimensional abundance quantification for four Antarctic copepods from the Ross Sea *Marco Grillo*
11:30	Larval and juvenile fish community in the Bay of Whales (eastern Ross Sea): species composition, relative abundance and spatial distribution *Mario La Mesa*
11:50	The impact of simulated diel vertical migration and sea ice drift on the connectivity of krill in the Ross Sea *Michael Dinniman*
12:10	Comparison between trophic and taxonomic species-based food webs under pressure of sea ice changes in Antarctica *Simona Sporta Caputi*
12:30	Ecological responses to changes in sea ice coverage in Antarctic marine Communities *Edoardo Calizza*
13:00	**Lunch Break***
Chairs: Isabella Moro, Enzo Saggiomo	
14:00	A journey through the cryptic diversity of Fragilariaceae and the description of a new Antarctic species, *Gedaniella antarctica* sp. nov. (Bacillariophyta) from Terra Nova Bay *Riccardo Trentin*
14:20	Spatio-temporal variation in the diet of Adélie Penguins (*Pygoscelis adeliae*) in the Ross Sea *Giulio Careddu*
14:40	Remote sensing and telemetry tracking of Adelie penguin population on Inexpressible Island *Peng Zhao*
15:00	Macrobenthic indicators as descriptors of the environmental status of shallow Antarctic coasts *Luigia Donnarumma*

15:20	Antarctic cushion star *Odontaster validus* larval performance is negatively impacted by long-term parental acclimation to elevated temperature *Miles Lamare*
15:40	Biodiversity of Anisakid Nematodes from the Antarctic Sea over a temporal scale level *Simonetta Mattiucci*
16:00	**Coffee Break**
16:30	The Antarctic sponge *Haliclona* sp. and its associated bacterial community as pollution indicators in the remote Antarctic region *Maria Papale*
16:50	Exploring the diversity of bacterial communities living in the mucus and in association with the Antarctic sponges *Mycale acerata* and *Dendrilla antarctica* (Terra Nova Bay, Ross Sea) *Carmen Rizzo*
19:30	***Transfer to Villa Doria d'Angri*** ***Meeting point: Via Acton 38 - University Parthenope***
20:00	***Social Dinner at Villa Doria d'Angri*** ***Scheduled return afterwards to Via Acton 38 - University Parthenope***

Thursday, July 6h	
Università degli Studi di Napoli "Parthenope" Via Amm. F. Acton 38, 80133 Naples	
Marine Biology and Ecology Session - Part 2 **Chair: Jack Di Tullio**	
09:00	**Invited Talk: The Interactive Influence of the Micronutrients Iron, Zinc, and Vitamin B12 on Ross Sea Primary Productivity** ***Makoto Saito***
09:30	Circumpolar sampling reveals high genetic connectivity of Antarctic toothfish across their spatial distribution. *Dale Maschette*
09:50	Integrated approach to climate change impacts on pteropods abundance and distribution in the western ross sea (Antarctica) *Alessandro Bergamasco*
10:10	Autonomous and Intelligent Long-Term Video Monitoring of Antarctic Fauna *Simone Marini*
10:30	Resurgence of the anthropocene in the ross sea, Antarctica *David Ainley*
End of Marine Biology and Ecology Session	
10:50	**Coffee Break**
Biogeochemistry Session **Chairs: Emanuele Magi, Makoto Saito**	
11:10	**Invited Talk: The Ross Sea Region Marine Protected Area: the science behind it, your science to keep it** ***Anna Maria Fioretti***
11:40	Mixing under ice in spring and the initiation of the Ross Sea phytoplankton bloom *Walker Smith*
12:00	Quantifying Seasonal Particulate Organic Carbon Concentrations and Export Potential in the Southwestern Ross Sea Using Autonomous Gliders *Meredith Meyer*
Sponsor Session 2	
12:20	**ALSEAMAR (France)**
12:40	**NORTEK (Norway)**
End of Sponsor Session 2	
13:00	**Lunch Break***
14:00	Phytoplankton seasonal cycle and carbon export in the Ross Sea: A modeling study *Elodie Salmon*
14:20	Shifts in microbe-mediated organic matter degradation patterns in relation to sea-ice dynamics in a coastal area of the Ross Sea *Vincenzo Manna*
14:40	High dissolved inorganic carbon uptake by Bacteria and Archaea in the deep-water masses of the Ross Sea

	Mauro Celussi
15:00	Strong transport of anthropogenic carbon from the Antarctic shelf to deep Southern Ocean triggers rapid acidification *Yingxu Wu*
15:20	Physical and biological controls on anthropogenic CO_2 sink of the Ross Sea *Gianmarco Ingrosso*
15:40	From New Zealand to Antarctica (Ross Sea): the fatty acid composition of marine suspended particulate matter *Federico Girolametti*
16:00	**Coffee Break**
16:30	Multiple Nutrient Co-Limitation Impacts on the Phytoplankton Community Structure and Coastal Biogeochemistry on a Transect from the Amundsen Sea to the Eastern Ross Sea *Jack Di Tullio*
16:50	Estimation of phytoplankton composition and uptake elemental stoichiometry ratios (N:P:trace metals) in the Ross and Amundsen Seas *Ruifeng Zhang*
17:10	Dissolved iron speciation and first characterization of organic ligands in the eastern Ross Sea *Paola Rivaro*
17.30	Oceanography of the Edisto Inlet (Western Ross Wea): first results from the XXXVIII Italian Antarctic expedition *Giuseppe Aulicino*
17:50	The Ross Sea in the Anthropocene: reconstructing the N cycle dynamics and ecosystem impacts with nitrogen isotopes. *Simone Moretti*
18:10	Radioisotope research in the marine environment, methodologies, and perspectives *Petros Leivadaros*
End of Biogeochemistry Session	
18:30	**Poster Session and Icebreaker with drinks**

Friday, July 7th	
Università degli Studi di Napoli "Parthenope" Via Amm. F. Acton 38, 80133 Naples	
Marine Geology and Geophysics Session **Chair: Karen Gariboldi**	
09:00	The Italian Southern Ocean Bathymetry for the exploitation of opportunistic seafloor datasets in the Antarctic water and surrounding areas (ISOBatA). *Daniela Accetella*
09:20	Bottom current control on sediment deposition between the Iselin Bank and the Hillary Canyon (Antarctica) since the late Miocene: An integrated seismic-oceanographic approach *Laura De Sanctis*
09:40	New offshore geological and geophysical investigations at the Pennell Coast of North Victoria Land (PNRA_BOOST Project) *Matilde Ferrante*
10:00	Utilizing Siple Coast fossil marine diatoms from subglacial sediments to reconstruct ice sheet and marine history of West Antarctica. *Jason Coenen*
10:20	Relationship among rifting, magmatism and mantle melting of the West Antarctic Rift System. Jinyao Gao
End of Marine Geology and Geophysics Session	
10:40	**Coffee Break**
Emerging Pollutants Session **Chair: Paola Rivaro**	
11:10	Influence of Australian Black Summer smoke in Antarctic aerosol collected on board during the R/V Laura Bassi first campaign in the Ross Sea *Elisa Scalabrin*
11:30	Processes affecting the distribution of PCBs in the Southern Ocean *Sarah Pizzini*
11:50	Coupled influence of ice melting and feeding habits on bioaccumulation of trace elements in Antarctic fish *Geraldina Signa*
12:10	Passive sampling of emerging contaminants in water at Terra Nova Bay (Antarctica) *Emanuele Magi*
12:30	Textile microfibers in wild specimens of the Antarctic scallop Adamussium colbecki (Smith, 1902), from Terra Nova Bay, Ross Sea Antarctica *Emma Ferrari*
End of Emerging Pollutants Session	
12:50	**Closing Speech & End of Ross Sea Conference 2023**
13:30	**Lunch Break***
14:30	**Social activity 1: Visit to the R/V Laura Bassi**
16.30	**Social activity 2: Visit to the Pausilypon archeological site & the Seiano Grotto**

Transfer by bus from Via Acton 38 - University Parthenope

Poster Sessions

Physical Oceanography

1. Glider measurements in the Ross Sea during January 2020
Annunziata Pirro

2. Ocean currents and sea ice drift observations in the Ross Sea (Antarctica)
Milena Menna

3. Long-term temperature variability over the New Zealand – Antarctica chokepoint of the ACC during the last three decades
Antonino Ian Ferola

Ocean-ice-atmosphere Interactions

4. A novel system for quantitative sampling of sub-ice platelet layers
Natalie Robinson

5. Simulated Last Deglaciation oceanic circulation in the Ross Sea: ice-sheet-ocean interactions during the Antarctic Ice Sheet retreat
Enrico Pochini

6. Preliminary atmospheric observation collected during the Laura Bassi Antarctic Cruise in the framework of PNRA CAIAC Project
Angelo Lupi

7. Analysis and interpretation of sea ice dynamics depending on large-scale weather pattern in the Ross Sea
Daniela Flocco

Marine Biology and Ecology

8. Molecular time-capsules – reconstructing the Ross Sea ecosystem using eDNA obtained from marine sponge specimens
Miles Lamare

9. Virus-prokaryote interactions in the sea ice and underlying water of the Ross Sea
Michael Tangherlini

10. Investigating the Molecular Adaptation of the Parasite Species *Contracaecum osculatum* D (Nematoda: Anisakidae) to Extreme Antarctic Environment.
Marialetizia Palomba

11. Response of *Phaeocystis antarctica* and *Chaetoceros* sp. from the Ross Sea to strong salinity stress: Ecological implications
Emanuela Serino

12. Krill dynamics in the Ross Sea pelagic ecosystem
Iole Leonori

13. Integrated approach to climate change impacts on pteropods abundance and distribution in the western Ross Sea (Antarctica)
Alessandro Bergamasco

Marine Geology and Geophysics Session

14. pre-LGM paleoenvironmental evolution at Central Basin (Western Ross Sea, Antarctica)
Fiorenza Torricella

15. The challenges of assessing gas hydrate potential in the Ross Sea
Michela Giustiniani

16. The early retreat of the Western Antarctic Ice Sheet documented by ultra-high-resolution Holocene paleoclimate record from the Edisto Inlet fjord (northern Victoria Land, Antarctica)
Francesca Battaglia

Emerging Pollutants Session

17. Highlighting distributions and potential origins of major and trace elements in the atmospheric and marine systems of the Ross Sea
Francisco Ardini

18. Are migrating seabirds nesting along the Ross Sea coast (Antarctica) biovectors of emerging and legacy persistent organic pollutants (POPs) to Adèlie penguin rookeries?
Nicoletta Ademollo

19. Effluent wastewater as local source of contamination at the Mario Zucchelli Station (Antarctica)
Elisa Scalabrin

*** all coffee breaks, lunch and icebreaker sessions from Tuesday to Friday are fully covered by the conference**

Sponsor Session

IV ROSS SEA CONFERENCE 2023

Università degli Studi di Napoli "Parthenope"
Via Amm. F. Acton, 38 - 80133 Napoli, ITALY
3-7 July 2023, Via Acton 38, Naples-Italy

School of Oceangraphy,Shanghai Jiao Tong University

Shanghai Jiao Tong University(SJTU) is one of the most prestigious universities in China. The School of Oceanography (SOO), previously Institute of oceanography in SJTU， was established in 2013. The mission of SOO is seeking scientific and technological solutions for basic and emerging questions in the global ocean and ocean governance, providing a vigorous educational program in ocean sciences for both undergraduate and graduate students. SOO is striving for excellence in research, education and service to our global communities.

SOO has established academic disciplines of physical, chemical, biological and geological oceanography, marine technologies and ocean governance, with a global vision on international collaborations in research, education and services. It has been carrying out a number of international collaborative research projects with institutions around the world, including organizing and participating international research cruises, symposiums and academic exchange programs.

SCHOOL OF OCEANOGRAPHY
SHANGHAI JIAO TONG UNIVERSITY

SOO currently has around 110 faculty and staff members, 150 undergraduate students and 250 graduate students. It possesses the Ministry of Education Key Laboratory for Polar Ecosystem & Climate Change, and Shanghai Key Laboratory for Polar Life Sciences and Environment. SOO is currently recruiting new faculties in all ranks around the world.

The present work describes a newly-developed Acoustic Doppler Current Profiler (ADCP) that has a fully integrated single-beam wide-band biological echosounder, thus serving a dual purpose: current measurement and biomass assessment. The system comprises a traditional 4-beam Janus configuration head, which is responsible for profiling the currents, with a vertically oriented center beam for collecting high-resolution acoustic backscatter data for subsequent biomass analysis. The system belongs to the Signature Series family of ADCPs launched in 2013 by Norwegian scientific instrumentation company Nortek. Named Signature100, it is powered by the AD2CP electronics platform, described in United States Patent 7.911.880. The four slanted beams (current profiling beams) operate at a center frequency of 100 kHz and have a range of up to 400 m with 4 m spatial resolution and sampling rate up to 1 Hz. The center vertical beam (echosounding beam) has a wider frequency band of approximately 70-120 kHz with a high dynamic range (~130 dB), and presently operating in up to three discreet pulse characteristics from a single beam set: 1) 70 kHz monochromatic, 2) 120 kHz monochromatic, and 3) 91 kHz chirp with 50 percent bandwidth and pulse compression. Acoustic pulses from the echosounder beam are interweaved with pulses for the current profiling beam for synchronous data collection.

This work we describe the system's configuration, capabilities and results from initial trials.

CODEVINTEC

Tecnologie per le Scienze della Terra e del Mare

Nicola Catalano – Codevintec

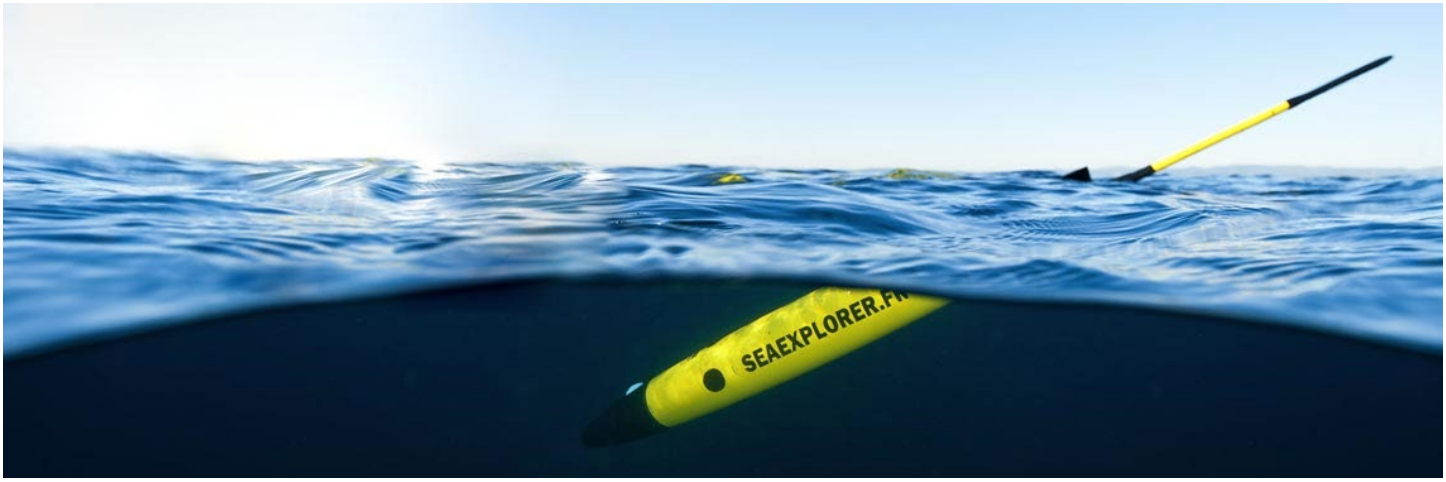
Which technologies for extreme applications?

Extraordinary environments put men and equipment to the test. There is often no margin for error. Scientific projects are studied for months or years and once in the field the instrumentation must be reliable, strong, safe.

Codevintec presents a quick overview of the geophysical and seismological systems that have found application in Antarctica and other extreme environments and the new, state-of-the-art models.

ALSEAMAR

ALCEN



https://www.alseamar-alcen.com/

Abstracts of oral and poster presentations

IV ROSS SEA CONFERENCE 2023

Oral Contributions

Physical Oceanography

Current observations in the Ross Sea

Pasquale Castagno[1], Pierpaolo Falco[2], Naomi Krauzig[2], Angela Garzia[2], Francesco Memmola[2], Yuri Cotroneo[3], Giorgio Budillon[3]

[1]*University of Messina*
[2]*Marche Polytechnic University*
[3]*University of Napoli Parthenope*

The Ross Sea is a crucial region of the Earth's Climate. Approximately 25% of Antarctic Bottom Water (AABW) originates from the Dense Shelf Water (DSW) produced on its continental shelf. Changes in AABW properties and formation rate propagate into the global ocean and affect stratification, sea level, heat content, and the carbon cycle. Understanding the long-term variability of the Ross Sea DSW physical properties and its controlling factors is critical to assessing the AABW variability. The Italian Marine Observatory in the Ross Sea (MORSea) project, funded by the Italian National Program of Research in Antarctica (PNRA), has a network of moorings in crucial areas of the Ross Sea, collecting multi-decadal physical observations, Since 1995. Many studies have analyzed the DSW properties changes of the Ross Sea, but few have focused on continental shelf circulation. Here using mooring and LADCP data we present a study on the Ross Sea circulation and its role in the dense water formation. In particular, we analyzed the circulation in Terra Nova Bay where the saltiest AABW precursor is formed and then compared the current-meter time-series of the mooring situated in the polynya with the other MORSea moorings located close to the shelf break in the western and central Ross Sea. Recent studies have suggested that the tides are the dominant source of currents in the Ross Sea, and have a central role in shaping the AABW outflow, therefore we have performed and compared spectral and tidal analyses of the current measurements registered on those moorings.

Terra Nova Bay and its far-reaching oceanographic impacts on the Ross Sea

Stefan Jendersie[1], Stevens Craig[2]

[1]*Victoria University of Wellington*
[2] *National Institute of Water and Atmospheric Research* (NIWA)

Terra Nova Bay (TNB) in the western Ross Sea of Antactica has received increasing attention recently by international oceanographic and sea ice observation campaigns. In Terra Nova Bay strong katabatic events create one of the most intense sea ice producing polynyas (TNBP) in Antarctica. The associated deep convection drives the formation of HSSW, the precursor of AABW. It also facilitates the oceanic heat exchange with the adjacent ocean cavities beneath the Nansen Ice Shelf (NIS) and beneath the Drygalsky Ice Tongue (DIT). TNB presents us with the unique opportunity of studying many of the primary interactive processes of atmosphere, ocean, ice shelves and sea ice, in a relatively confined region. We will show results of a high resolution, coupled ocean-ice shelf modeling study that synthesizes and contextualizes available data sets from various recent observation campaigns. Our results include: the first tidal model of Terra Nova Bay and the NIS cavity, the seasonal heat budget of the cavity and the formation of meso-scale eddies inside the polynya. We have also investigated the oceanographic role of erosion features at the base of the NIS and associated ice shelf melt rates. A second study

investigates the oceanographic effects of a removed DIT and the corresponding shut down of the TNBP. The Ross Sea continental shelf cools by 0.2 degrees and freshens due to lack of winter HSSW supply form the TNBP. Heat advection underneath the Ross Ice Shelf reduces by 15-20%, melting is lower by 10%. The results also show how the physical presence of the DIT has far reaching consequences for the ocean circulation over the Ross Sea continental shelf.

High Salinity Shelf Water production in Terra Nova Bay, Ross Sea from high-resolution near-surface salinity observations

Christopher J. Zappa[1], Una Miller[1], Arnold L. Gordon[1], Seung Tae Yoon[2], Craig Stevens[3], Won Sang Lee[4]

[1]Lamont-Doherty Earth Observatory of Columbia University
[2]Kyungpook National University
[3]National Institute of Water & Atmospheric Research (NIWA)
[4] Korea Polar Research Institute

High Salinity Shelf Water (HSSW) is a precursor to Antarctic Bottom Water (AABW), a water mass that facilitates the sequestration of atmospheric heat and carbon into the deep ocean. The salinity of HSSW in the Ross Sea is sensitive to both local and broader regional forcing, with implications for the density of downstream AABW and the ocean's ability to buffer against climate change. One poorly constrained source of HSSW variability in this region is its rate of production within Terra Nova Bay (TNB) in the western Ross Sea. Here, we use an unprecedented set of near-surface salinity, current velocity, and acoustic surface tracking timeseries, collected from a mooring in TNB in austral winter 2017, to estimate HSSW production rates. In one of few studies at the resolution of individual katabatic wind events, we find that HSSW production rates correlate with katabatic wind event frequency in early winter and with frequency, strength, and duration in late winter, suggesting a complex dependence on polynya dynamics. We calculate an average HSSW production rate of ~0.6 Sverdrups (10^6 m^3 s^(-1)) that allows us to validate an approach for estimating production rates from parametrized net surface heat fluxes, which we use to examine interannual variability in production rates across the decade. Though further mooring-based estimates are needed for confirmation, results suggest HSSW production in TNB has been mostly increasing since 2015 and could play a previously unrecognized role in the recently observed recovery of HSSW salinity in this region.

Investigation of the recent salinity variations of HSSW in the TNB Polynya, West Antarctica

Hyun A Choi, Seung-Tae Yoon[1], Won Sang Lee[2], Sukyoung Yun[2], Jiyeon Lee[2]

[1]Kyungpook National University
[2]Korea Polar Research Institute

Monitoring the property change in High Salinity Shelf Water (HSSW) in the Ross Sea is important as HSSW is a precursor for the Antarctic Bottom Water (AABW) that regulates the global overturning circulation. HSSW is formed by polynya activity in the coastal regions of the Ross Sea and 33% of HSSW is produced in the Terra Nova Bay Polynya. According to observational records in the Ross Sea (including Terra Nova Bay), salinity of HSSW has been decreasing for decades since the 1950s (~ -0.027 /decade) although 'Rebound' that dampens the freshening trend occurred in the mid-2010s. It was suggested that the 'Rebound' was caused by more active polynya activity due to stronger westerly wind and reduced sea ice import from the Amundsen Sea linked to the anomalous climate condition during 2015-2018. Therefore, after 2018 when the anomalous climate condition ended, it was expected that the salinity of HSSW in the Ross Sea would return to decrease. However, CTD dataset collected in Terra Nova Bay from 2019 showed that the salinity of HSSW continues to increase, maintaining the 'Rebound' trend. The salinity of HSSW increased about 0.023 kg/g from 2019 to 2022, indicating more HSSW

approximately 0.7 Sv was produced. Moreover, the salinity of HSSW observed in 2022 was the highest (S = 34.9980 kg/g) among that observed over the past 15 years. It was found that such an active HSSW formation in 2022 would be related to the strongest wind in the austral winter of 2022 among the austral winter of the 2010s period and the delay in the sea ice melting period than usual. Our findings suggest that local conditions (i.e. wind and sea ice) still need to be carefully monitored to predict the future variations of HSSW and the AABW, although the effects of remote forcing on the change of HSSW salinity are expected to be significant due to climate change.

Stratification Breakdown in Antarctic Coastal Polynyas

Weifeng Zhang[1]

[1] *Woods Hole Oceanographic Institution*

This study examines the process of water-column stratification breakdown in Antarctic coastal polynyas adjacent to an ice shelf with a cavity underneath. The goal is to quantify the influence of winds, air temperature, initial ambient stratification, neighboring ice tongue and headland on the timescales of polynya destratification through combining process-oriented numerical simulations and analytical scaling. In particular, the influence of wind-driven circulation on the lateral transport of dense water in polynyas, a process often neglected in the literature, is systematically examined here. An ice-shelf/sea-ice/ocean coupled numerical model is adapted to simulate the process of dense water formation in polynyas of various configurations. The simulations highlight that i) before reaching the bottom, majority of the dense water is actually carried away from the polynya by katabatic wind-induced offshore outflow, diminishing water-column mixing in the polynya; ii) alongshore coastal easterly winds, through inducing onshore Ekman transport, reduce offshore loss of the dense water and enhance polynya mixing; iii) an ice tongue next to a polynya tends to break the alongshore symmetry in the lateral return flows toward the polynya, creating a relatively stagnant region in the corner between the ice tongue and polynya where horizontal outflow of the dense water in the water column is suppressed and vertical mixing is enhanced; and iv) a headland to the other side of the polynya tends to restore the alongshore symmetry in the lateral return flows, which increases the offshore dense water transport and slows down destratification in the polynya. This work stresses the importance of resolving small-scale local processes in simulating vertical mixing in the polynya. It also provides insights into the mechanisms that drive temporal and cross-polynya variations in stratification and dense water formation in Antarctic coastal polynyas, and establishes a framework for studying differences among the polynyas in the ocean.

An update on the outflow of dense water from the western Ross Sea

Melissa Bowen[1], Denise Fernandez[2], Arnold Gordon[3], Bruce Huber[3], Pasquale Castagno[4], Pierpaolo Falco[5], Giorgio Budillon[6]

[1] *University of Auckland*
[2]*National Institute of Water & Atmospheric Research (NIWA)*
[3]*Lamont-Doherty Earth Observatory of Columbia University*
[4]*University of Messina*
[5]*Marche Polytechnic University*
[6]*University of Napoli Parthenope*

Dense water from the western Ross Sea exits the Drygalski Trough and flows out of the region along the slope at Cape Adare to form ~25% of the global Antarctic Bottom Water. Ten years of measurements of near-bottom water properties have been collected from moorings deployed at Cape Adare between 2007-2011 and 2018-2023. Here we present the most recent observations in the time series and review key findings to date. The density of the near-bottom water has distinct semi-annual and interannual variability. Dense water flows past

Cape Adare in two pulses a year, near the March and September equinoxes, with more saline water released in March than the pulse later in the year. Interannual changes in salinity in the dense water follow the changes in salinity measured in Terra Nova Bay, suggesting advection of dense water between the polynya and the deep ocean within a year. Recent work suggests the tides and density of water in Terra Nova Bay are regulating the release of water from the trough and may provide a prediction of density and transport of the outflow.

Dynamics for cross-slope water exchange in the Ross Sea, Antarctica

Yuanjie Chen[1], Zhaoru Zhang[1], Xiaohui Liu[2], Michael Dinniman[3], Zhiqiang Liu[4], Lixin Qu[1], Chuning Wang[1], Meng Zhou[1]

[1]School of Oceanography, Shanghai Jiao Tong University, Shanghai, China
[2]State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou, China
[3]Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, Virginia
[4]Department of Ocean Science and Engineering, Southern University of Science and Technology, Shenzhen, China

Water mass exchange across the slope of the Ross Sea has a critical impact on not only the physical and biological processes of the Ross Sea shelf, but also the meridional overturning circulation. This study reveals the dynamics controlling the cross-slope exchange of the Circumpolar Deep Water (CDW) and Dense Shelf Water (DSW) near the Glomar Challenger Trough in the Ross Sea, based on numerical simulations from a coupled ocean-sea ice-ice shelf model at eddy-permitting resolution. Momentum balance analysis indicates that the onshore transport of CDW is geostrophically controlled by the along-isobath pressure gradient force, which is mainly contributed by a surface elevation gradient associated with the DSW accumulation. The offshore transport of DSW is driven by the ageostrophic pressure gradient force related to advection and viscosity in the along-isobath direction. The bottom Ekman transport induced by the strong along-slope current propels the outflow of DSW. Supported by vorticity balance analysis, the upslope transport of CDW is associated with vortex squeezing which is driven by the curl of nonlinear advection, and the downslope transport of DSW is associated with vortex stretching which is regulated by vorticity dissipation in the bottom layer.

The role of the Pacific-Antarctic Ridge in establishing the northward extent of Antarctic sea-ice

Antonino Ian Ferola[1], Yuri Cotroneo[1], Peter Wadhams[2], Giannetta Fusco[1], Pierpaolo Falco[2], Giorgio Budillon[1], Giuseppe Aulicino[1]

[1]University of Napoli Parthenope
[2]Marche Polytechnic University

Monitoring the Antarctic sea-ice is essential for improving our knowledge of the Southern Ocean. We used satellite sea-ice concentration data for the 2002-2020 period to retrieve the sea-ice extent (SIE) and analyze its variability in the Pacific sector of the Southern Ocean. Results provide observational evidence of the recurring formation of a sea-ice protrusion that extends to 60 ° S at 150 ° W during the winter season. These activities are carried on in the framework of the ACCESS and SWIMMING projects of the PNRA. Our findings show that the northward deflection of the southern Antarctic Circumpolar Current front is driven by the Pacific Antarctic Ridge (PAR) and is associated with the enhanced sea-ice advance. The PAR also constrains anticyclonic and cyclonic eddy trajectories, limiting their interaction with the sea-ice edge. These factors, within the 160 ° W - 135 ° W sector, determine an average SIE increase of 61,000 km2 and 46,293 km2 per year more than the upstream and downstream areas, respectively.

Study of the fresh-water inflow through the eastern gate of the Ross Sea

Naomi Krauzig[1], Pasquale Castagno[2], Marianna Del Core[3], Fabio D'Agostino[3], Pierpaolo Falco[1], Riccardo Martellucci[4], Elena Mauri[4], Milena Menna[4], Annunziata Pirro[4], Angela Garzia[1], Paola Rivaro[5], Mario Sprovieri[3], Davide Vivado[5], Enrico Zambianchi[6]

[1]*Marche Polytechnic University*
[2]*University of Messina*
[3]*Consiglio Nazionale delle Ricerche - Istituto per lo studio degli impatti antropici e sostenibilità in ambiente marino*
[4]*National Institute of Oceanography and Applied Geophysics*
[5]*University of Genova*
[6]*University of Napoli Parthenope*

The production of Antarctic Bottom Water (AABW) plays a major role in determining the strength of the Meridional Overturning Circulation and, therefore, is an important element in the ocean's contribution to global climate. AABW is formed in few areas around the Antarctic continent, especially in the Ross and Weddell Seas, with distinct thermohaline characteristics. Observations within the Southern Ocean's Pacific sector indicate a decadal trend of reduced salinity of the shelf waters which are related to the AABW modification. Specifically in the Ross Sea, CTD data and moored observations are showing changes in the thermohaline characteristics of the shelf waters, precursors of the AABW, since 1995. A freshening was observed in the western Ross Sea both at the shelf water formation area and at the Ross Sea shelf break, where the AABW is formed and cascades to fill the Pacific Ocean deep basins. Despite the negative salinity trend, a rebound in salinity has been observed for the last 5 years. The Ross Sea freshening was attributed to the inflow of waters from West Antarctica where a dramatic melting of glaciers is occurring. To determine the freshwater inflow from West Antarctica and the role of these waters in the salinity field variability, an oceanographic cruise was carried out during austral summer 2020 in the eastern sector of the Ross Sea. Additionally, a section of the same CTD grid was repeated during January 2021. Using physical data from the CTD and LADCP casts, glider deployment and drifters, we estimated water mass characteristics and dynamical features. Eventually, discrete sea water sampling for chemical analyses (nutrients, carbonate system, trace metals, persistent organic compounds) has been carried out to provide new information about the biogeochemistry of the area and origin of the water masses.

Summer physical and biogeochemical conditions in the Ross Sea polynya: description & drivers

Esther Portela[1], Heywood Karen[1], Peter Sheehan[1], Gillian Damerell[1], Walker Smith[2]

[1]*University of East Anglia*
[2]*Virginia Institute of Marine Science*

Two Seagliders equipped with sensors measuring temperature, salinity, dissolved oxygen, chlorophyll and optical backscatter, were deployed in the Ross Sea between early December 2022 and late January 2023. The two gliders simultaneously sampled the Ross Sea polynya between 170-172 °E and 77.4-76.4 °S. We obtained nearly two months of high resolution full-depth profiles (up to 800 m depth) that allowed the detailed description of the water-mass properties in the polynya in summer. The water column consists in an surface layer of fresh (absolute salinity between 33.5 and 34 g kg-1) water that extends up to 50 m depth and captures the seasonal progressive warming and sea ice melting. Over the almost two months of sampling, the surface temperature varied between -1.8 and 0.5 °C. Then, strong temperature and salinity gradients result in a shallow mixed layer depth with local maxima of 50 m. The interior ocean exhibits conservative temperatures near the surface freezing point and absolute salinity up to 35 g kg-1. Additionally, we have information on the regional circulation from the dive

averaged currents estimated from the gliders trajectories. During their journey, the gliders sampled several eddies (cyclonic and anticyclonic) as well as a phytoplankton bloom and decay. We observe that dissolved oxygen and optical backscatter are highly directly correlated to temperature. However, in the case of the Chlorophyll this correlation varies with depth, time/location, and distance from the sea ice. In this presentation we will discuss the physical forcings behind the observed hydrographic and biogeochemical variability with particular focus on the eddy field and their role in water-mass transport.

New insights into winter-time dynamics of the Ross Sea: an analysis of grounded Argo floats under ice

Pierpaolo Falco[1], Naomi Krauzig[1], Riccardo Martellucci[2], Annunziata Pirro[2], Pasquale Castagno[3], Milena Menna[2], Yuri Cotroneo[4], Massimo Pacciaroni[2], Angela Garzia[1], Francesco Memmola[1], Giulio Notarstefano[2], Elena Mauri[2], Giorgio Budillon[4], Enrico Zambianchi[4]

[1]Marche Polytechnic University
[2]National Institute of Oceanography and Applied Geophysics
[3]University of Messina
[4]University of Napoli Parthenope

The Ross Ice Shelf (RIS) floats over the southern sector of the Ross Sea tapping an enormous volume of water beneath, creating an area, called cavity, where sea/ice interactions are extremely important. the Ice Shelf Water (ISW), the coldest waters of the world, forms in the cavities; the intrusion of warm water into the cavities can affect the stability of ice shelves, ultimately determining their collapse with an effect on the sea level. While RIS is not directly threatened by the intrusion of extremely warm Circumpolar Deep Water (CDW), High Salinity Shelf Water (HSSW, precursor of Antarctic Bottom Water)) and seasonally warmed Antarctic Surface Water (AASW) are expected to cause basal melting. Of particular concern is the RIS north-western edge sector, which is directly exposed to solar-heated AASW and where melt rates nearly triple during the summer months. In this work, we present unprecedented in-situ observations collected from Argo floats under the north-western sector of the RIS during the period 2020-2022. These data are unique because the floats gathered data during the whole year in crucial areas along the RIS edge and under the RIS, in winter too, when the ocean is covered by sea ice. New insights are now available from such observations as for instance the complete cycle of the water column stratification changes occurring in the transition between summer and winter and the warm surface water intrusion into the shelf cavity during the summer. Some Argo floats were deployed in the RIS polynya area describing the formation of HSSW. Finally, an Argo float spent about 6 months under the RIS collecting data even at the sea/ice interface and capturing the intrusion of summer warm surface waters into the cavity.

Temperature data collected in the Pacific Sector of the Southern Ocean since 1994

Yuri Cotroneo[1], Giuseppe Aulicino[1], Pasquale Castagno[2], Arturo De Alteris[1], Massimo De Stefano[1], Vincenzo De Stefano[1], Pierpaolo Falco[3], Antonino Ferola[1], Giannetta Fusco[1], Naomi Krauzig[3], Giancarlo Spezie[1], Giovanni Zambardino[1], Enrico Zambianchi[1], Giorgio Budillon[1]

[1]University of Napoli Parthenope
[2]University of Messina
[3]Marche Polytechnic University

Since 1994 the temperature of the Southern Ocean between New Zealand and the Ross Sea is monitored by the University of Naples Parthenope in the framework of the Italian Antarctic Programme (Programma Nazionale di Ricerche in Antartide - PNRA) with the involvement of more than 50 scientists and technicians. Temperature and salinity data in the upper 800m of the ocean are collected during each austral summer through regular XBT sampling as well as underway collection of sea surface temperature, sea surface salinity and samples. During the

first 30 years of activity, several projects have been in charge of data collection. Since 2011, these activities are carried out by the Marine Observatory of the Ross Sea (MORSea) which is coordinated by the University Parthenope of Naples. Throughout the cruises, XBT T7 probes by Sippican/Lockheed Martin were used, with a vertical resolution of 65 cm and a maximum nominal depth of 760 m. Each transect was completed in approximately 6 days to provide a synoptic picture of the thermal structure of the upper Southern Ocean. A regular 20 nm spatial sampling rate was adopted across the frontal regions of the Antarctic Circumpolar Current. The corresponding data were quality controlled based on international standards and then made available on the NOAA/NCEI public repository. This long-term dataset reveals interesting aspects of the Southern Ocean and allows us to focus on peculiar aspects of the Antarctic Circumpolar Current (ACC) characteristics and its variability. Here, we present some highlights from published studies focusing on: - The long-term variability of ACC fronts - The calculation of ACC transport from XBT data - The properties of cold core eddies detaching from the ACC Future perspectives are linked to a larger exploitation of these data, but also to the new possibilities in terms of navigation offered by the I/B Laura Bassi and the associated opportunity of data collection during a longer season.

Ocean-ice-atmosphere Interactions

Analysis of fine-scale dynamics of the Drygalski ice tongue in Antarctica using satellite SAR data

Mozhgan Zahribanhesari[1], Nunziata Ferdinando[1], Giuseppe Aulicino[1], Andrea Buono[1], Maurizio Migliaccio[1]

[1]*University of Napoli Parthenope*

This study focused on the analysis of the time variability of the morphology of the Drygalski ice tongue (DIT), Antarctica, using - for the first time - satellite synthetic aperture radar (SAR) images. A time series of Sentinel-1 interferometric wide swath SAR imagery collected from 2016 to 2023 is considered and an unsupervised methodology, based on a global threshold constant false alarm rate approach, is used to extract the boundary between the DIT and the surrounding ice-free/ice-infested sea water. The most prominent rifts/fractures identified on the extracted profiles and the ice front are selected to analyse the DIT time variability. The feature tracking allows deriving information on the morphological evolution of the DIT, including the annual displacement and average surface velo- city. Experimental results show that the DIT ice front calls for a relatively stable motion trend towards the sea with an average surface velocity. Our outcomes show a fairly good agreement with similar studies appeared in the scien- tific literature, which are mostly based on optical imagery.

Observations of baroclinity at grounding lines with and without subglacial discharge: The Kamb Ice Stream

Craig Stevens[1], Natalie Robinson[1], Craig Stewart[1], Gavin Dunbar[2], Christina Hulbe[3], Justin Lawrence[4], Alena Malyarenko[1], Andrew Mullan[4], Britney Schmidt[4], Peter Washam[4], Arran Whiteford[2], Huw Horgan[2]

[1] *National Institute of Water and Atmospheric Research (NIWA)*
[2]*Victoria University of Wellington*
[3]*University of Otago*
[4]*Cornell University*

Antarctic grounding zones are a critical but poorly understood environment, hosting ice-ocean-seafloor interactions that have implications for global ocean circulation and sea level rise over the coming century and beyond. The region is where the polar ice sheets first leave continental bedrock to float over the ocean, encountering the heat content of the ocean. Due to the extreme difficulty of direct access, grounding zone environments have been sampled only a handful of times, and then usually only to obtain a brief snapshot of data. Here we present recent ocean profile and time series data from two locations at the Kamb Ice Stream (KIS)

grounding zone of the Ross Ice Shelf. One location (KIS1) is a few km from the actual grounding line with a 30m water column beneath 600 m of ice and snow. The ocean observations reveal significant two-layer stratified flow behaviour clearly modulated by tidal processes. The second site (KIS2) is a channel incised into the base of the ice sheet, upstream of what would be considered the grounding line, and is dominated by a modest subglacial discharge. The resulting water column is around 250 m high but only 150 m wide and stratified into several distinct layers. These unique data provide new understanding of how heat is delivered to the ice base as the resultant melting within the grounding zone drives cavity-scale density-driven overturning and sets up basal boundary conditions across the entire cavity.

Water masses beneath the Ross Ice Shelf

Karen Heywood[1], Peter Sheehan[1], Esther Portela[1], Gillian Damerell[1], Walker Smith[2]

[1]*University of East Anglia*
[2]*Virginia Institute of Marine Science*

In December 2022, an ocean glider made an unauthorised foray beneath the Ross Ice Shelf, surveying the upper 200 m of the water column in high resolution beneath an ice shelf base at about 80 m. 12 dives were obtained beneath the sea ice adjacent to the ice shelf, followed by 64 dives beneath the ice shelf, followed by 4 further dives beneath the sea ice; these provide a fascinating comparison of the two under-ice environments. Each dive yields two profiles, from the descent and the ascent, sampling right up to the ice base, revealing details of the boundary layer beneath the ice. The glider carried sensors measuring temperature, salinity, dissolved oxygen, chlorophyll fluorescence and optical backscatter. We observe solar-warmed water penetrating beneath the ice shelf with elevated chlorophyll fluorescence, optical backscatter and oxygen, and low salinity. We explore mechanisms for the advection of this water beneath the ice shelf. Also beneath the ice shelf we observe water colder than the surface freezing point, lower in oxygen, higher salinities and no chlorophyll, likely to contain ice shelf meltwater. Here we discuss these water masses and the processes that these observations reveal.

Organic proxies reveal the Ross ice shelf retreat and sea ice dynamics in the Joides Basin, Ross Sea, Antarctica

Chiara Pambianco[1], Lucilla Capotondi[2], Federico Giglio[3], Gesine Mollenhauer[4], Jens Hefter[4], Alessio Di Roberto[5], Simon T. Belt[6], Alessio Nogarotto[3], Francesca Battaglia[3], Tommaso Tesi[3]

[1]*Ca' Foscari University of Venice*
[2]*National Research Council of Italy, Institute of Marine Sciences ISMAR*
[3]*National Research Council of Italy, Institute of Polar Sciences ISP*
[4]*Alfred Wegener Institute for Polar and Marine Research*
[5]*National Institute of Geophysics and Volcanology*
[6]*Biogeochemistry Research Centre, School of Geography, Earth and Environmental Sciences, University of Plymouth*

Quaternary glacial terminations are periods of rapid warming during which climate and carbon cycles experience large-scale reorganization. The last glacial termination (ca. 18-11.5 Ka), in particular, is the temporally closest timeframe from which we can gather information regarding processes and feedbacks that lead to such climatic reorganization. Here we present results from the Southern Ocean, a region which during the Last Deglaciation was affected by strong CO2 outgassing in relation to the resumption of the thermohaline circulation and ice shelf retreat. Our study focuses on a series of sedimentary cores collected in the JOIDES trough, Ross Sea. The studied area is characterized by complex ice shelf-ocean dynamics and represents one of the sites of Antarctic Bottom Water (AABW) formation which originates from a mixture of cold Ice Shelf Waters (ISW) and impinging modified Circumpolar Deep water (mCDW) from the outer shelf. Sea ice and open water dynamics, including information

on trophic levels and paleo-seawater temperatures, were reconstructed using a suite of organic biomarkers that includes Highly Branched Isoprenoids (e.g. IPSO25 and HBI III), sterols (Brassicasterol and Cholesterol) and Glycerol Dialkyl Glycerol Tetraethers (GDGTs). Biomarker profiles were also compared to bulk organic carbon and stable carbon isotope data (δ 13C), as well as sedimentary facies reconstructed from grain-size information, XRF analyses and IRD presence. Our results depict a coherent and rapid transition from a sub-ice shelf environment (during the Last Glacial Maximum, LGM) to a distal ice shelf system, evolving then into an open marine system. At the LGM the central JOIDES through was covered by the paleo-Ross Ice Shelf. Impinging warmer waters at the onset of the deglaciation likely caused the paleo - Ice Shelf to retreat southward, freeing the JOIDES trough from the thick ice cover and allowing pelagic primary productivity. Enhanced upwelling of warm and nutrient-rich waters (presumably paleo mCDW) caused persistent blooming of the open water organisms during the whole deglaciation, stabilizing during the Holocene. Collectively, our datasets illustrate the value of combining environmental organic proxies with sedimentary facies for the reconstruction of rapid changes in glacio-marine environments.

Mapping and sampling supercooled water and platelet ice in McMurdo Sound

Natalie Robinson[1], Pat Langhorne[2], Wolfgang Rack[3], Christian Haas[4]

[1]*National Institute of Water and Atmospheric Research (NIWA)*
[2]*University of Otago*
[3]*University of Canterbury*
[4]*Alfred Wegener Institute*

McMurdo Sound is characterised by year-round outflow of Ice Shelf Water (ISW) from the McMurdo/Ross Ice Shelf cavity, with much of the upper ocean significantly supercooled (i.e. colder than the local freezing point) through pressure relief. This supports the development of sub-ice platelet layers (SIPLs) - layers of individual ice discs that buoyantly accrete at the base of the sea ice. The layers may extend several metres into the upper ocean and are known to support the marine ecosystem by providing a quiescent and nutrient-rich habitat. Over the past two decades we have developed and deployed both in-situ and remote sensing capability to map the spatial distributions of snow, consolidated sea ice, sub-ice platelet layers, and supercooled water in McMurdo Sound. This integrated approach has revealed interdependencies between the physical components of the system and provides a foundation data series from which seasonal and interannual variability is beginning to emerge. The survey work has identified a persistent local plume of ISW, which extends north-north-westward from the front of the McMurdo Ice Shelf, running parallel to the Victoria Land Coast. The SIPL is present, and progressively thins, for ~100 km along this axis, while the supercooling in the frazil-laden upper ocean is thought to persist for approximately twice this distance. This work has recently been expanded to encompass the development of a bespoke, custom-engineered system which can quantitatively core the SIPL, without destroying it delicate structure. This new capability is now being used to investigate the connections between the physical environment of the SIPL and the extremely high concentrations of primary productivity within it. We will briefly introduce the system and describe results from its initial deployment.

Assessing the vulnerability of fast ice in McMurdo Sound, Antarctica to winter storms

Greg Leonard[1], Maren Richter[1], Inga Smith[1], Kate Turner[2], Maddy Whittaker[1]

[1]*University of Otago*
[2]*National Institute of Water and Atmospheric Research (NIWA)*

McMurdo Sound sea ice can generally be partitioned into two regimes: (1) a stable fast-ice cover, forming south of approximately 77.6 ◦S around March - April and then breaking out the following January - February, and (2) a

more dynamic region north of 77.6 ◦S that the McMurdo Sound and Ross Sea polynyas regularly impact. In 2019, a stable fast-ice cover formed unusually late due to repeated break-out events. Here we analyse the 2019 sea-ice conditions and relate them to a modified storm index (MSI), a proxy for southerly wind events. We determined there is a strong correlation between the timing of break-out events and several unusually large MSI events and our key finding is that an increase in the frequency of intense winter storms in 2019 resulted in a delayed formation of a stable fast-ice cover in McMurdo Sound. Further, recent observations (post 2019) demonstrate that the fast-ice conditions in 2019 were not unique and suggest that the fate of fast ice in the sound may be a symptom of some larger change. Winter fast-ice dynamics in the sound appear to be largely driven by synoptic events as there are no identifiable trends in monthly-averages of atmospheric drivers (e.g. air temperature, mean sea level pressure and wind speed and direction) of fast-ice breakout in the period 1985-2022. This study offers new insights into the mechanisms behind individual break-out events and is one of a few case studies that investigate the stability of a fast-ice cover, an area that is in need of future research to improve the parameterization of fast-ice processes in large-scale sea-ice models.

Robotic-based invESTigation and mOnitoring of Ross sEa with PROTEUS - The RESTORE project

Gabriele Bruzzone[1], Simona Aracri[1], Maurizio Azzaro[2], Marco Bibuli[1], Giorgio Bruzzone[1], Massimo Caccia[1], Gabriele Capodaglio[3], Roberta Ferretti[1], Mauro Giacopelli[1], Roberta Ivaldi[4], Corrado Motta[1], Angelo Odetti[1], Marta Radaelli[3], Alessandro Remia[5], Edoardo Spirandelli[1], Marco Taviani[5], Enrica Zereik[1], Angelina Lo Giudice[2], Gabriella Caruso[2]

[1]National Research Council of Italy, Institute of Marine Engineering INM
[2]National Research Council of Italy, Institute of Polar Sciences ISP
[3] Ca' Foscari University of Venice
[4]Istituto Idrografico della Marina
[5]National Research Council of Italy, Institute of Marine Sciences ISMAR

In the framework of the PNRA RESTORE (Robotic-based invESTigation and mOnitoring Ross sEa) project, during the XXXVIII Italian Expedition in Antarctica (2022-2023), the PROTEUS unmanned marine vehicle (UMV) was used for carrying out multi-disciplinary scientific surveys in the Ross Sea. PROTEUS (Portable RObotic TEchnology for Underwater Surveys) is an innovative UMV, developed by the Marine Robotics research group of CNR-INM, which is particularly suitable, thanks to its reduced size and weight, modularity, reconfigurability, and open hardware and software architectures, to operate in extreme environments as the polar ones. One of the most important peculiarities of PROTEUS is its capability of easily changing shape in order to operate underwater (as an ROV - Remotely Operated Vehicle) semi-submersed (as a USSV - Unmanned Semi-Submersible Vehicle) and in surface (as a USV - Unmanned Surface Vehicle) and thus to adapt to the specific needs of the different surveys it is called to carry out. In the first part of the Antarctic scientific expedition PROTEUS was used underwater, in ROV configuration, for performing a multi-sensor 3D mapping of Tethys Bay (Ross Sea; East Antarctica). For carrying out this survey seven holes were drilled in the ice pack from which it was possible to deploy the robot in the seawater. In a second phase PROTEUS was transformed in a USSV for operating semi-submersed and thus permitting marine scientists to collect data in the proximity of the Campbell Glacier tongue. In particular, for this survey the robotic vehicle was equipped with an additional remotely-operated winch for releasing a multi-parametric sensor probe along the water column down to a depth of 100 m. Moreover, an automatic water sampler (8 independent sterile bottles with 0.5 l capacity) was also mounted on PROTEUS. Successively PROTEUS was transported in helicopter to test the limnological versatility and used, always in USSV configuration, to perform a multi-parametric data survey and a complete bathymetry of a lake at Tarn Flat. Finally, PROTEUS was further transformed in a USV vehicle for operating on the sea surface. More precisely, PROTEUS took the shape of a catamaran, so guaranteeing a better naval stability and the possibility to mount on its bow a Harvey cylinder aimed at collecting the superficial micro-layer of the sea water. Furthermore, on the robotic vehicle was also

installed an automated hydraulic plant comprehending water containers, remotely controlled electro-pumps and electro-valves that allowed to also collect water just under the sea surface. Thanks to the versatility and the open architectures of PROTEUS, during the activities performed at field it was possible to install manifold sensors and acquire a comprehensive collection of bio-geo-chemical and physical parameters of the water column (acoustic, conductivity/salinity, temperature, depth, dissolved oxygen, turbidity and chlorophyll), acoustic and video data of the ice.

Remote sensing of the summer expansion for Ross Sea polynyas

Xi Zhao[1], Yifan Wu[1], Xuejiao Hou[1], Xiang Zhang[1]

[1] *Sun Yat-Sen University*

The previous research on polynya mainly focus on the ice production and Ocean-ice-atmosphere interactions in winter. One reason is that remote sensing products such as ice thickness and ice types are not reliable in summer. Besides, more parameters like solar radiation needs to be considered in summer processes. However, as a complete cycle of a polynya, its expansion speed, start and end and duration of ice melting in summer will have an impact on the initial state of ice formation in autumn. The expansion of the polynya also directly affects the ocean chlorophyll and primary productivity, and thus researchers call it "post-polynya" because of its important significance in ocean ecosystem. We propose to use a combination of optical, thermal infrared and SAR images to carry out large-scale remote sensing observations and get better mapping of post-polynyas in Ross Sea. Then pattern of the summer expansion of the three polynyas from 2002 to 2022 will be explored using spatiotemporal statistics. We finally build models to describe the phenology of ice melting for various regions and correlated them with the phenology of ocean chlorophyll.

Terra Nova Bay Polynya dynamics and its impact on surface heat fluxes and thermohaline variability

Giannetta Fusco[1], Giorgio Budillon[1], Yuri Cotroneo[1], Vincenzo Capozzi[1], Massimiliano Esposito[1], Giuseppe Aulicino[1], Manuela Sansiviero[1]

[1]*University of Napoli Parthenope*

The Terra Nova Bay (TNB) polynya is important in the modification of the thermohaline structure of the whole Ross Sea. Brine release during sea ice formation increases the salinity of the subsurface water, resulting in the formation of High Salinity Shelf Water (HSSW), the densest water mass of the Southern Ocean. This study aims to investigate the processes that occur in the TNB polynya and the role of the air-sea interactions in the determination of its opening, activity and on the HSSW production that can ventilate the abyssal ocean circulation. First, we analyzed the role of the katabatic winds using meteorological data by the AWSs and ECMWF data, since 1994. In the second step the open water fractions from 2005 and 2021, detected by the Ice Surface Temperature (IST) imagery derived from the MODIS data, were used to estimate the opening and the activity of the polynya during the winter season. Then, we estimated the surface heat budget via empirical formulae in the investigated period. During the freezing season, heat flux from the ocean to the atmosphere can be assumed to result directly in ice production considering that ocean column is at its freezing point. Assuming that ice production rate depends on the net heat flux and on the polynya extension, it is possible to calculate the total production of salt released during sea ice formation and HSSW volume. Finally, a comparison between the estimated HSSW production and the salinity observed within the TNB water column is carried out.

The response of sea ice and High Salinity Shelf Water in the RIS Polynya to cyclonic atmosphere circulations

Xiaoqiao Wang[1], Zhaoru Zhang[1], Michael S. Dinniman[2], Petteri Uotila[3], Xichen Li[4], Meng Zhou[1]

[1] School of Oceanography , Shanghai Jiao Tong University
[2]Old Dominion University
[3]University of Helsinki
Institute of Atmospheric Physics, Chinese Academy of Sciences

Coastal polynyas in the Ross Sea are important source regions of high salinity shelf water (HSSW) - the precursor of Antarctic Bottom Water that supplies the lower limb of the thermohaline circulation. Here, the response of sea ice production and HSSW formation to synoptic- and meso-scale cyclones was investigated for the Ross Ice Shelf Polynya (RISP) using a coupled ocean-sea ice-ice shelf model targeted on the Ross Sea. When synoptic-scale cyclones prevailed over RISP, sea ice production (SIP) increased rapidly by 20-30% over the entire RISP. During the passage of mesoscale cyclones, SIP increased by about 2 times over the western RISP but decreased over the eastern RISP, resulting respectively from enhancement in the offshore and onshore winds. HSSW formation mainly occurred in the western RISP and was enhanced responding to the SIP increase under both types of cyclones. Promoted HSSW formation could persist for 12-60 hours after the decay of the cyclones. The HSSW exports across the Drygalski Trough and the Glomar Challenger Trough were positively correlated with the meridional wind. Such correlations are mainly controlled by variations in geostrophic ocean currents that result from sea surface elevation change and density differences.

Effects of Projected Changes in Wind caused by Amundsen Sea Low on the High Salinity Shelf Water in the Ross Sea

Xie Chuan, Zhaoru Zhang[1], Meng Zhou[1], Chuning Wang[1], Yuanjie Chen[1]

[1]*School of Oceanography , Shanghai Jiao Tong University*

The Amundsen Sea Low (ASL) is a low-pressure system that dominates the West Antarctic climate variation, and its future changes and impacts on the ocean are of great concern. In this study, we used the CMIP6 multi-model ensemble to project the future changes of the ASL and obtained the future changes of winds associated with the ASL over the Ross Sea and the Amundsen Sea on decadal time scales. Using a high-resolution sea ice-ocean-ice shelf model covering the Ross Sea and the Amundsen Sea, we examined the influence of projected changes in wind on the formation of High Salinity Shelf Water (HSSW) formation, which is the precursor of Antarctic Bottom Water. By forcing the model with changes in wind over different key regions, this study quantifies the respective impacts of different wind-driven oceanic processes on the formation of HSSW. Results from wind sensitivity experiments show that projected deepening of the ASL will lead to increased wind speed in the Ross Sea by 2.5% in 2050 and 7% in 2100, which will drive an increase in sea ice production by 2.3% and 7.5% over the Ross Sea continental shelf and increase in HSSW formation in the Ross Sea by 0.2% and 5.6% in 2050 and 2100 respectively. In the western Amundsen Sea, the future southward shift of the ASL center leads to enhancement in westerly winds, which reduces the amount of meltwater entering the Ross Sea from the Amundsen Sea ice shelves by about 8.7% and 20.19%, resulting in an increase in the volume of HSSW in the Ross Sea by 1.17% and 3.10% in 2050 and 2100, respectively. In the eastern Amundsen Sea, the future southward shift of the ASL will strengthen westerly wind at the shelf break dramatically and enhance the intrusion of CDW by affecting the strength of the undercurrent near the slope, resulting in an increase of 0.2-0.7 m yr-1 in the basal melting rate of the Amundsen Sea ice shelves. Meanwhile, the enhanced westerly wind also increases the offshore Ekman transport of glacial meltwater, which finally results in decrease in glacial meltwater transport from the Amundsen Sea into the Ross Sea and increase in the HSSW formation in the Ross Sea.

Connection of Dense Shelf Water Variability in the Western Ross Sea to the Southern Annular Mode
Zhaoru Zhang[1]

[1]*School of Oceanography , Shanghai Jiao Tong University*

Antarctic Bottom Water (AABW), which supplies the lower limb of the global thermohaline circulation, originates from dense shelf water (DSW) formed in Antarctic polynyas. Polynyas are opened by strong offshore wind from the Antarctica continent, driving offshore sea ice motion and low ice concentrations. The direct contact of the ocean with cold air results in intense sea ice production and brine rejection in the polynyas, forming saline DSW via strong ocean convection. The temporal variations of DSW production in Antarctic polynyas is important for modulating AABW variability, but the controlling climate drivers of DSW formation are not yet fully understood. In this study, combining satellite products, mooring observations and numerical simulations from a coupled ocean-sea ice-ice shelf model, we investigate the connections between sea ice production and DSW formation in the Terra Nova Bay polynyas (TNBP) of the Ross Sea with the dominant mode of southern hemisphere extratropical climate variability - the Southern Annular Mode (SAM). The potential influence of SAM variations on the bottom water properties in the slope region of the western Ross Sea are also examined. The results are important to help understand the potential interplay between changes in climate modes across the southern hemisphere extratropical regions, and future variations in DSW and AABW.

Decadal Variability of Ice-Shelf Melting in the Amundsen Sea and its impact on Ross Sea
Alessandro Silvano[1]

[1]*Ocean and Earth Science, National Oceanography Centre, University of Southampton*

Warm ocean waters drive rapid ice-shelf melting in the Amundsen Sea. In situ and satellite observations reveal strong decadal variability in basal melting of these ice shelves. Here we describe the mechanisms that drive decadal changes in melting of Amundsen ice shelves and discuss how this variability can affect Ross Sea salinity further downstream. We find that decadal ocean surface cooling in the tropical Pacific results in cyclonic wind anomalies over the Amundsen Sea. These wind anomalies drive a westward perturbation of the shelf-break surface flow and an eastward anomaly (strengthening) of the near-bottom undercurrent, leading to increased ice-shelf melting. This contrasts with shorter time scales, for which surface current and undercurrent covary, a barotropic (depth-independent) behavior previously assumed to apply at all time scales. This suggests that interior ocean processes mediate the decadal ice-shelf response in the Amundsen Sea to climate forcing, potentially influencing variability in the salinity of the Ross Sea.

Marine Biology and Ecology

UV-resistant bacteria in Antarctic aquatic environment of the Ross Sea
Daniela Giordano[1,2], Daniela Coppola[1], Chiara Lauritano[1], Maria Costantini[1], Cinzia Verde[2], Maddalena Cervelli[2]

[1]*Stazione Zoologica Anton Dohrn, Department of Ecosustainable Marine Biotechnology*
[2]*Institute of Biosciences and BioResources (IBBR), National Research Council (CNR)*

Antarctic aquatic microorganisms are exposed to extreme conditions of temperature, UV radiation and ice and have developed unique strategies to cope with these harsh environments. In this context, photoprotective defense mechanisms are fundamental to counteract UV-damage due to the solar UV-B radiation including both

a non-enzymatic and enzymatic antioxidant systems. The aim of this study is to improve the knowledge on the biodiversity of UV-resistant bacterial communities, inhabiting the marine area of the Ross Sea (Antarctica). We isolated and identified thirty-one UV-resistant Antarctic bacteria collected from surface sea waters/ice and shallow lake sediments in Tethys Bay, Road Bay, Edmonson Point and Inexpressible Island. Phylogenetic analysis, based on 16S rRNA gene sequence, assigned the isolates to the Proteobacteria phylum encompassing five genera (Brevundimonas, Psychrobacter, Qipengyuania, Sphingorhabdus, Sphingobium), to Actinobacteria including seven genera (Kocuria, Gordonia, Rhodococcus, Micrococcus, Arthrobacter, Agrococcus, Salinibacterium) and Firmicutes represented by only two genera, i.e. Staphylococcus and Bacillus. Strains belonging to Proteobacteria and Actinobacteria phyla were detected in all sites and were the most abundant species in all different environments considered in this study. Many of these bacteria showed pigmentation, suggesting that pigments may represent an important antioxidant defence against exposure to UV radiation in the extreme Antarctic environment.

Scale-related dynamics of Ross Sea phytoplankton communities in a changing Southern Ocean

Francesco Bolinesi[1], Giacomo Di Tullio[2], Maria Saggiomo[3], Vincenzo Saggiomo[4], Nicole Schanke[2], Olga Mangoni[1]

[1]University of Naples Federico II
[2]Hollings Marine Laboratory, College of Charleston
[3]Stazione Zoologica Anton Dohrn
[4]Department of Research Infrastructures for Marine Biological Resources, Stazione Zoologica Anton Dohrn and Fondazione Dohrn

The Ross Sea (RS) is considered to be the most productive region of Antarctica, where intense phytoplankton blooms trigger the sequestration of large amounts of atmospheric carbon until iron limitation makes the RS an HNLC region. Phytoplankton dynamics in the area have been described with respect to the physical and chemical properties of the water column. For example sea-ice coverage, nutrient availability and water stratification in the upper mixed layer (UML) can play a pivotal role in defining the community structure and the productivity of the system. Beyond auto ecological mechanisms involved in the succession, the classical Antarctic paradigm posits that the RS phytoplankton community is mainly represented by diatoms and haptophytes, with different temporal and spatial patterns of distribution. Diatoms dominate in marginal ice zones (MIZ) and coastal areas during summer while haptophytes dominate coastal polynyas in the early spring, or in the presence of a deeper upper mixed layer in open waters. However, variability in phytoplankton community dynamics have been frequently observed in recent years. For example, high biomass accumulation has occurred during summer in off-shore systems. In addition, the presence of intense P. antarctica blooms in coastal areas during summer in the presence of a shallow UML with an increased contribution of small size cells. These observations point to a revaluation of biological dynamics in the RS, especially in light of ongoing climate changes such as increased glacial melting processes. The present communication will deal with variability observed within phytoplankton communities of the RS in the last 20 year of Italian Antarctic Expeditions, and emphasize the cross-scale variability of phytoplankton communities in different subsystems often contrasting the classical Antarctic ecosystem paradigm.

Shift in phytoplankton communities below the Antarctic Landfast Ice During the Melt Season Between Late Spring and Early Summer in Terra Nova Bay

Maria Saggiomo[1], Laura Escalera[2], Vincenzo Saggiomo[3], Francesco Bolinesi[4], Vittoria Roncalli[1], Olga Mangoni[4]

[1]Stazione Zoologica Anton Dohrn
[2]Instituto Espanol de Oceanografia- C.O.Vigo (IEO-CSIC)

[3]*Department of Research Infrastructures for Marine Biological Resources, Stazione Zoologica Anton Dohrn and Fondazione Dohrn*
[4]*University of Naples Federico II*

In the last decade it has become clear that the ongoing climate changes have direct impact on the microalgal communities of the Terranova Bay (TNB), one of the most productive areas in the Ross Sea. Changes in physical forcing, biogeochemical cycling might affect the phytoplankton bloom dynamics and composition in the water column under the landfast ice and at the platelet ice interface. Diatoms are known to dominate the the water column under the landfast ice although to date, scarce information is available on the phytoplankton bloom dynamics and how this might be affected by climate changes. In this study, phytoplankton abundance and species composition were investigated in the first 50 m of the water column under the 2.5 m thick landfast ice from December 2015 to January 2016 in TNB. For the first time, we report two intense blooms (mid-December, late December) dominated by nanoflagellates (<15 µm) which included Chrysophyceae, Bolidophyceae, Prymnesiophyceae and Chlorophyceae, typically found in fresh waters. These species represented from 40% to 91% of the total phytoplankton community, a data never reported before in an area that several studies consider to be dominated by diatoms. The increasing inflow of continental water into the marine environment and the reported changes in phytoplankton species composition may directly affect the lower levels of the food web, with consequences on grazing and nursery of zooplankton species, and therefore the whole biogeochemical cycles. Our results could represent an early sign of climate change effects shaping Antarctic communities in one of the most important region of the entire Southern Ocean.

Microzooplankton and phytoplankton communities' structure in two polynya areas of the Ross Sea
Marina Monti[1], Diociaiuti Tommaso[1], Francesco Bolinesi[2], Maria Saggiomo[3], Olga Mangoni[2]

[1]*National Institute of Oceanography and Applied Geophysics - OGS*
[2]*University of Naples Federico II*
[3]*Stazione Zoologica Anton Dohrn*

The Ross Sea is made up of a series of subsectors with different ecological peculiarities. To shed light on the microzooplankton composition in relation with phytoplankton community and physical-chemical properties in two different RS areas, seawater samples were collected during the Austral summer 2017, between Cape Washington and the northern shores of the Drygalskii Ice Tongue (Area 1) and in the South-Central Ross Sea (Area 2). The global pictures highlight that the two areas showed a similar carbon content and heterotrophic dinoflagellates as the dominant group, representing 62% of total microzooplankton, followed by tintinnids (31%), aloricate ciliates (6%) and other groups (1%). Significant differences between Area 1 and 2 emerged in terms of abundance and taxonomic composition. Heterotrophic dinoflagellates, in fact, were the most abundant organisms in Area 1, where large amount of phytoplankton biomass, mainly diatoms, were reported in presence of a shallow mixed layer. On the contrary, tintinnids were the most representative group in Area 2, where phytoplankton was characterized by the coexistence of diatoms and Phaeocystis antarctica, and the upper mixed layer showed a deepening owing to atmosphere forcing. The most representative microzooplankton species were Protoperidinium defectum, P. applanatum and P. incertum among dinoflagellates, Codonellopsis gaussi, C. gaussi forma cylindroconica, Lackmanniella prolongata and Cymatocylis drygalskii among tintinnids. As concerns phytoplankton, Fragilariopsis cylindrus and F. curta were the most abundant species in Area 1, while beyond P. antarctica, Pseudo-nitzschia subcurvata and Dactyliosolen sp. were the most abundant species in Area 2. Our data confirms a net ecological differentiation in different Ross Sea sectors and highlight the importance of a multidisciplinary approach in studies investigating on the ecology and functioning of one of the most productive regions of the Southern Ocean.

Intra-annual analysis of mesozooplankton sampled in the Ross Sea (Antarctica)

Marco Grillo[1], Stefano Schiaparelli[2], Simone Moretti[3], Lukas Gerber[3], Leonardo Langone[4], Patrizia Giordano[4]

[1]*University of Siena*
[2]*University of Genoa & Italian National Antarctic Museum (MNA, Section of Genoa)*
[3]*Max Planck Institute for Chemistry (MPIC)*
[4]*National Research Council of Italy, Institute of Polar Sciences (ISP)*

Zooplankton is a fundamental group in aquatic ecosystems representing the basis of the food webs and playing an important role in the field of benefit for humans such as ecosystem services. Zooplankton communities are sensitive to changes in environmental conditions, which result in community fluctuations and variations in species composition, making them a good environmental indicator to identify and evaluate any alteration in the water column. This study presents the qualitative-quantitative analysis of the mesozooplankton community collected between Jan 2004 and Jan 2005 by a time-series sediment trap moored in the Joides Basin (Ross Sea, Antarctica), at 530 m depth. The aim of this study is to observe the intra-annual variation of the abundance and relative diversity of zooplankton species at mesopelagic bathymetries, little studied depths. Thirty-eight species, twenty-seven zooplankton families and twenty orders were classified in the analysed samples and the most frequent taxa resulted to be Copepoda (39.6%), Phyllodocida (8.4%), Pteropods (9.1%) and Ostracods (8.4%). Sediment traps have proved to be valid tools for collecting zooplankton also during the winter season under the sea ice cover, and have allowed to implement the state of the art on the composition, ecology, diversity and management of these organisms within the marine area of the Ross Sea (Antarctica).

Three-dimensional abundance quantification for four Antarctic copepods from the Ross Sea

Marco Grillo[1], Falk Huettmann[2], Letterio Guglielmo[3], Antonia Granata[4], Stefano Schiaparelli[5]

[1]*University of Siena*
[2]*EWHALE Lab- Institute of Artic Biology, Biology & Wildlife Department, University of Alaska*
[3]*Stazione Zoologica Anton Dohrn*
[4]*University of Messina*
[5]*University of Genoa & Italian National Antarctic Museum (MNA, Section of Genoa)*

Zooplankton communities are known to react with strong changes in their population structure in relation to environmental shifts. Marine copepods, in particular, by representing ~70% of zooplankton abundance, are thus helpful indicators of changes occurring in the water column. In this study, we used legacy data at F.A.I.R. collected in the Ross Sea in the 1980s by the Italian National Antarctic Program (P.N.R.A.) from the GBIF.org webportal. Moreover, we present maps in which we have quantified, for the first time in the Ross Sea area, the 3D abundances for four Antarctic copepod species obtained by applying machine learning and artificial intelligence techniques based on "grey literature" data. The data analysed were acquired in the Ross Sea during the IIIrd, Vth and Xth expeditions of the P.N.R.A. The predicted distribution models of the species were obtained using RandomForest algorithm that analysed the abundance of copepods throughout the Ross Sea area and at the 0-750 meters depth class as a function of 40 environmental descriptors obtained from Polar Macroscope Layers present Quantarctica. These predictive maps quantify, in three-dimensions, the standing crops for the individual depth classes for each copepod analysed in the Ross Sea area. These maps are useful tools as a quantitative baseline explicit in space and time for the conservation, ecology and management of zooplankton biodiversity, now and in the future. The results obtained show that there are marked differences on the abundance distribution of the copepods. These innovative techniques are good tools, in terms of accurate prediction, to

assess the abundance of Antarctic copepods, help guide future sampling, management and preserve copepod communities. This is of special relevance considering the monitoring activities that will have to be performed for the Ross Sea Region Marine Protected Area.

Larval and juvenile fish community in the Bay of Whales (eastern Ross Sea): species composition, relative abundance and spatial distribution

Mario La Mesa[1], Federico Calì[2], Antonio Di Franco[3], Emilio Riginella[3], Chiara Papetti[4], Enrico Zambianchi[5]

[1]*National Research Council of Italy, Institute of Polar Sciences (ISP)*
[2]*National Research Council of Italy, Institute for Marine Biological Resources and Biotechnology (IRBIM)*
[3]*Stazione Zoologica Anton Dohrn*
[4]*University of Padova*
[5]*University of Napoli Parthenope*

Early life stages of fish represent a key component in the food chain of the pelagic ecosystem of the Southern Ocean, connecting producer trophic levels to those of higher predators. In particular, pelagic larvae and early juveniles of notothenioid fishes overwhelmingly dominate the ichthyoplankton community living on the continental shelf. Scientific research surveys targeting early life stages of fish in the pelagic realm have been mainly carried out in the western Ross Sea, whereas the eastern side can be considered unexplored. As source of high primary production, the presence and timing of formation of wide ice-free areas throughout the year (polynyas) in the Ross Sea play a fundamental role in structuring larval fish community. The Ross Ice Shelf Polynya (RISP) is a large coastal polynya, which is driven and maintained by local prevailing winds and oceanic currents. RISP is located in the southern Ross Sea, extending eastwards from Ross to Roosevelt Islands. In the present study we report the first data on species composition, relative abundance and spatial distribution of larval and juvenile fish community found off the Bay of Whales in the eastern Ross Sea. As reported for other areas of the Ross Sea, the Antarctic silverfish Pleuragramma antarcticum was by far the most abundant species, followed by other nototheniids and channichthyids in smaller amounts, all mainly distributed in the upper water layers. In addition, consistent aggregations of early larvae of P. antarcticum seem to confirm the presence of a potential nursery area in proximity of the Bay of Whales, as hypothesized in a previous study. Present results strongly advocate for future investigations in these poorly known and remote areas.

The impact of simulated diel vertical migration and sea ice drift on the connectivity of krill in the Ross Sea

Michael Dinniman[1], Kim Bernard[2], Cassandra Brooks[3], Victor Pham[4], Zephyr Sylvester[3], Sally Thorpe[5], Abigail Williams[4]

[1]*Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, Virginia*
[2]*Oregon State University*
[3]*University of Colorado*
[4]*Virginia Beach City Public Schools Environmental Studies Program*
[5]*British Antarctic Survey*

The Ross Sea region contains one of the healthiest marine ecosystems on the planet. In 2016, the Commission on the Conservation of Antarctic Marine Living Resources created one of the largest Marine Protected Areas (MPA) in order to protect “the structure and function” of this ecosystem. As part of a study to examine the movement of one particular species, Antarctic krill (Euphausia superba), between and within key regions of the Southern Ocean including the Ross Sea MPA, we are modeling Lagrangian drifters to simulate pathways during early life stages. The simulated drifters are embedded within a 5-km horizontal resolution ocean/sea ice/ice shelf Regional Ocean Modeling System circulation model of the Southern Ocean. The drifters include simplistic

behavior of the early life stages of krill including the initial descent/ascent cycle, diel vertical migration (DVM), and advection with simulated sea ice velocity (instead of ocean velocity) under certain conditions. It has been previously shown (e.g. Behrens et al., JGR, 2021; Hudson et al., JGR, 2022) that advective pathways of simulated drifters can change significantly when sea ice advection or DVM is added. Here, we explore changes in the pathways in the Ross Sea when changes are made to when sea ice advection occurs, when and to what depth DVM occurs, and the vertical rates in the initial descent/ascent cycle based on krill physiology. For example, when sea ice advection is added to the krill behavior, drifter pathways are less constrained to stay along the continental slope in areas where sea ice is advected off the continental shelf, and this changes the number of drifters that transit through specific parts of the Ross Sea MPA.

Comparison between trophic and taxonomic species-based food webs under pressure of sea ice changes in Antarctica

Simona Sporta Caputi[1], Giulio Careddu[1], Edoardo Calizza[1], Loreto Rossi[1], Maria Letizia Costantini[1]

[1]Department of Environmental Biology, Sapienza University of Rome, Rome, Italy; National Interuniversity Consortium for Marine Sciences (CoNISMa)

The tropho-functional role of the single benthic individuals in the food web has been studied to assess the effect of sea ice cover change on the Antarctic biodiversity architecture. Based on each individual's δ 13C and δ 15N, we described minimum isotopic areas including the benthic individuals (1 ‰ by 1 ‰ - hereinafter referred to as -ITU-) in a bidimensional graph, regardless of their taxonomy. Using Bayesian Mixing Model, the ITUs were used to reconstruct trophic species-based food webs, which were compared with taxonomic species-based food webs, when sea ice cover reduced its extension and new food items were available. The food web metrics were quantified and both the trophic species (-ITU-) and taxonomic species playing key role in the community organisation were identified. Foraging optimization by consumers led to a simpler community structure when resources were abundant. This reduced the vulnerability to diversity loss. The intrapopulation differentiation of the diet seems to determine not only the structure but also the stability of the Antarctic benthic communities.

Ecological responses to changes in sea ice coverage in Antarctic marine Communities

Edoardo Calizza[1], Giulio Careddu[1], Gerladina Signa[2], Simona Sporta Caputi[1], Cecilia Tramati[2], Matteo Ventura[3], Antonio Mazzola[2], Loreto Rossi[1], Salvatrice Vizzini[2], Maria Letizia Costantini[1]

[1]Department of Environmental Biology, Sapienza University of Rome, Rome, Italy; National Interuniversity Consortium for Marine Sciences (CoNISMa)
[2]Department of Earth and Marine Sciences (DiSTeM), University of Palermo, Palermo, Italy; National Interuniversity Consortium for Marine Sciences (CoNISMa)
[3]Department of Environmental Biology, Sapienza University of Rome, Rome, Italy

Climate change is expected to affect resource-consumer interactions underlying stability and productivity in the Ross Sea food web. Benthic species have adapted to the marked sea-ice seasonality characterising the Ross Sea by concentrating their activity in summer months, when food inputs from primary producers increase. While this allows biodiverse food webs to persist, the mechanisms underlying changes in resource use and energy transfer along food webs are poorly understood, impairing predictions of the effects of climate change on Antarctic communities. Ultimately, changes in trophic links within food webs depend on individual feeding choices. The generation of individual isotopic data is now enabling us to move away from describing food webs based on population-averaged data and to start exploring patterns based on individual response to changes in resource availability (Rossi et al. 2019). Such improvements enable us to address mechanisms linking individual feeding traits to food web structure and functioning. Here, we report a synthesis of 10 years of research following

an initial project designed to understand the role of climate change in Antarctica. Based on individual C and N isotopic data of numerous species and Bayesian mixing models, we explored the effects of changes in sea ice coverage on the structure and functioning of marine coastal communities in Terra Nova Bay (Ross Sea). We were interested in understanding if changes in feeding links at the individual level after seasonal sea ice break up scaled-up producing predictable changes at the population and the food web level. Observed changes across hierarchical levels were explained by mechanisms of foraging optimization by organisms. Indeed, after sea ice break up and the consequent release of sympagic food, organisms narrowed the range of resources consumed and lowered their trophic position. This has resulted in populations with more specialised and less overlapping trophic niches, which in turn has led to food webs characterised by lower levels of competition, omnivory and overall complexity, shortest food chains and higher food web stability. Our results highlight the key role of the seasonal sea ice break up and the consequent release of sympagic productivity in the stability of Antarctic biodiversity, and pave the way for predicting how changes in environmental conditions relevant to individual activity (e.g temperature and food availability) may rebound into a rewiring of Antarctic food webs under climate change scenarios.

A journey through the cryptic diversity of Fragilariaceae and the description of a new Antarctic species, Gedaniella antarctica sp. nov. (Fragilariales, Bacillariophyta) from Terra Nova Bay (Ross Sea)

Riccardo Trentin[1], Schiaparelli Stefano[2], Isabella Moro[1], Emanuela Moschin[1]

[1]Department of Biology, University of Padua
[2]Department of Earth, Environment and Life Sciences, University of Genoa

The araphid diatoms of the Fragilariaceae family are commonly used as bio-indicators in environmental assessments and as feedstock for different industrial applications. Recent taxonomic research highlighted significant limitations in the study of these microalgae based solely on the morphological features. Most Fragilariaceae display a broad spectrum of morphologies and many diagnostic characters are indistinguishable if observed only through light microscopy. In this sense, sample misidentification is common and could have serious implications on environmental surveys and laboratory experiments. To overcome to this issues, we 1) combined phylogenetic analyses of the small subunit rDNA (18S rDNA), rbcL and psbC genes, with key morphological features used in the traditional identification of Fragilariaceae, 2) tested alternative tree topologies to evaluate the relationships among existing taxa and 3) traced the evolution of morphological traits using a phylogenetic context. Molecular phylogeny and topology tests suggested that the latest combinations of the genus Pseudostaurosira and the recent revision of genera Gedaniella, Serratifera, Sarcophagodes and Nanofrustulum were not monophyletic. Our results supported the monophyly of a group of Fragilariaceae within small araphid diatoms, including the genera: Cratericulifera, Plagiostriata, Castoridens, Opephora, Staurosira, Staurosirella, Punctastriata, Psammotaenia, Hendeyella, Stauroforma, Pseudostaurosira sensu Li, Nanofrustulum sensu Li, Serratifera sensu Li and Gedaniella sensu Li. Analyses of the Antarctic strain IMA070A collected during the XXXIV Italian Antarctic Expedition using fine structural features of the frustule and molecular data revealed that this diatom belongs to a distinct lineage within the genus Gedaniella, which we describe here as Gedaniella antarctica sp. nov.

Spatio-temporal variation in the diet of Adélie Penguins (Pygoscelis adeliae) in the Ross Sea

Giulio Careddu[1], Simona Sporta Caputi[1], Edoardo Calizza[1], Loreto Rossi[1], Maria Letizia Costantini[1]

[1]Department of Environmental Biology, Sapienza University of Rome

The Adélie penguin, Pygoscelis adeliae, is one of the most abundant bird species in the Antarctic continent and is an important meso-predator in the Antarctic food web. It is an endemic species, one of two penguin species

living in the Ross Sea, and its survival depends on the presence of prey closely related to the sea ice. By affecting sea-ice persistence, climate warming could thus affect penguin diet. The aim of this study is to investigate, by means of stable isotope analysis, the penguin's diet in colonies characterized by different persistence of sea ice. By analyzing satellite images and δ 13C and δ 15N values of adult and juvenile penguin's guano, we assessed the sea-ice persistence and compared the diet in four penguin colonies in Ross Sea. Penguin's guano is a low-cost biological matrix, easily available and its collection did not interfere with penguin's activities allowing us to reconstruct the short-term diet of several individuals, with a not invasive method. Results highlighted the persistence of sea-ice as a key driver of variability in the diet of penguins. We observed that in the Ross Sea a higher consumption of krill was linked to a longer persistence of sea-ice between colonies, while fish contribution to diet increased in the colonies characterized by shorter sea-ice persistence. Differences were also observed in δ 13C and δ 15N values between juveniles and adults. In colonies characterised by longer ice persistence, contribution of fish was lower in the first than in the latter. This information can help to predict the effects of the expected change in sea ice persistence, due to climate change, on the trophic ecology of the Adélie penguin.

Remote sensing and telemetry tracking of Adelie penguin population on Inexpressible Island, Ross Sea

Peng Zhao[1], Hao Liu[1], Pengjia Liu[1], Yufei Deng[1], Ziqing Yang[1], Dinghua He[1]

[1]*Hainan University*

Imagery from satellite and drones can be used to estimate population size and distribution of animals, which are critical factors for wildlife conservation and management. Comparing with traditional animal census methods, Remote sensing makes animal census more economical, precise and easier. Telemetry is a method of tracking the movement and behavior of animals using electronic devices, such as GPS tags or radio transmitters. Combining remote sensing and telemetry techniques can provide a comprehensive understanding of wildlife population and distribution. We mapped the habitat of Adelie penguins on the Inexpressible Island with drones. By distinguishing morphometric and spectral differences, standing adults, lying adults, separate chicks and creche were separated. 22419 standing adults, 7064 lying adults, 22529 separate chicks and 5051 creches were identified on 10th Jan, 2020. The average accuracy is 87.4±2.06%. 15 trackers were installed on adelie penguins, and their range of predation, migration routes, circadian rhythms were studied. The results showed significant circadian rhythms in the breeding period (49.01h) and migrating period (24.55h), but no significant circadian rhythm in the moulting period. A migrating route is along the nearshore of Victoria Land. These information can be used to inform conservation and management decisions, such as identifying critical habitats or assessing the impacts of climate change on the penguin population.

Macrobenthic indicators as descriptors of the environmental status of shallow Antarctic coasts

Luigia Donnarumma[1], Luca Appolloni[1], Elena Chianese[1], Federica Ferrigno[1], Paola Di Donato[1], Giovanni Fulvio Russo[1], Roberto Sandulli[1]

[1]*University of Napoli Parthenope*

Benthic communities exert a key function in the Antarctic marine ecosystem since they play a central role in the food web pathway. They consist of sedentary, sessile and motile species, belonging to all the domains of life, and represent the environmental "biological memory" able to provide information about the type and quality of the area where they are sampled. In this framework, the goal of this study is to evaluate differences in the composition and community structure of macrozoobenthic assemblages potentially affected by external pressures carried out by the human presence and penguin colony on the Antarctic coasts of Tethys Bay (Ross Sea). Four sites were sampled, accounting for different types and levels of pressure (anthropic vs. natural vs. two control non-impacted areas), during the two Italian expeditions in the austral summer of 2017/18 and 2018/19.

The site neighbour the Italian Station is altered by ions and heavy metals, among which dominate nitrate (34%) and cadmium (40%), while the site affected by organic load from a close penguin colony is rich in phosphate ion (70%; among sites). Although the community patterns do not differ significantly among sites, the composition structure follows the environmental parameters. The disturbed areas are also validated by the dominance of few opportunistic polychaete species that are known to show adaptations in disturbed environments, such as the motile deposit feeder Leitoscoloplos kerguelensis (McIntosh, 1885) and the tube-dwelling Spiophanes tcherniai Fauvel, 1950. In the same way, the control sites are characterized by the dominance of large suspended feeder bivalve Adamussium colbecki (E. A. Smith, 1902) due to the high concentrations of total organic carbon (40%; among sites), and by the important presence of the deposit feeder Aequiyoldia eightsii (Jay, 1839) where the highest percentage of sandy sediment (52%) occurred, in agreement with species habitat preference. These results, together with future monitoring programs of macrozoobenthic communities, allow us to evaluate the magnitude of assemblage modifications over time in stressed environments and to suggest a management plan aimed to maintain a good environmental state of the ecosystem functioning.

Antarctic cushion star Odontaster validus larval performance is negatively impacted by long-term parental acclimation to elevated temperature

Miles Lamare[1]

[1]*University of Otago*

Cross generational responses (i.e. transgeneration plasticity and carryover effects), when the environment of the parents influences their offspring (i.e. larval stages), may determine species responses to climate change. To examine this, adult O. validus acclimated to two temperature treatments (ambient (0°C) and warming (+3°C)) for two years were spawned and the response of their larvae to four temperatures (0°C, 1°C, 2°C, 3°C, and 4°C) was examined over 145 days. Adults acclimated to 3°C had less gonad material and produced significantly smaller eggs compared with those from 0°C acclimated adults. Following fertilisation, performance (larval size and survival) was initially better in offspring from the 3°C conditioned compared with those from the 0°C adults. At 34 days development, while survival was greater in larvae from 3°C adults, reduced average larval size emerged in these larvae, a time that coincided with the transition from the gastrula the bipinnaria larval. This was reflected in larval morphometric analysis at day 65, with rearing temperature having a positive effect on larval size across all larval treatment, but adult origin explaining 63% of the variation in larval morphology. After around 50 days, survival in larvae from 3°C acclimated adults became greater than from 0°C adults. By the end of the experiment (145 days) greater survival (17.6% to 34.3%) and growth (697 to 773 um) was evident larvae from 0°C acclimated adults, compared to survival (7.0% to 19.3%) and growth (380 to 624 um) in larvae from the 3°C acclimated adults. Our results suggest that acclimation of adults to warmer temperatures resulted in negative carryover effects in terms of offspring performance, a pattern that emerged over time. This indicates that while O. validus adults may survive exposure to moderate warming and produce viable gametes, their larvae offspring may be less able to complete development. The downstream effects of poor recruitment of a key species such as O. validus would have important outcomes for coastal Antarctica ecosystems.

Biodiversity of Anisakid Nematodes from the Antarctic Sea over a temporal scale level

Simonetta Mattiucci[1], Beatrice Belli[2], Paolo Cipriani[1], Mario Santoro[3], Armando Macali[2], Giuseppe Nascetti[2], Maria Letizia Palomba[2]

[1]*Department of Public Health and Infectious Diseases, Sapienza-University of Rome*
[2]*Department of Ecological and Biological Sciences (DEB) Tuscia University*
[3]*Stazione Zoologica Anton Dohrn*

Parasites constitute a neglected part of marine ecosystems. The Antarctic Sea is considered a “pristine marine ecosystem”. This provides a chance to investigate the parasite fauna in a marine ecosystem scarcely impacted by humans. Anisakid species of the genus Contracaecum, here considered (i.e. Contracecum osculatum sp. D, C. osculatum sp. E, C. radiatum), are nematode parasites with indirect life-cycle having in the Antarctic seals their definitive hosts, free-living first stages, while invertebrates and fish are hosting their third stage larvae. Quantifying population density and estimating the genetic diversity of these anisakids, whose life cycle is embedded in a marine ecosystem food webs, could be an indirect analysis of the demographic reductions and population bottlenecks (due to anthropogenic causes such as habitat fragmentation, and over-exploitation) of those definitive and intermediate/paratenic hosts which are involved in their life-cycle. The completion of such life-cycle requires marine stable trophic webs. As a result, the life cycle of anisakid nematodes in marine ecosystems characterized by various degrees of habitat disturbance could be affected by changes in host population size. Indeed, when the population size of the hosts participating in the life-cycle of these parasites is reduced, due to different causes, the population size of their anisakid endoparasites could also be reduced. This would result in a higher probability of genetic drift phenomena in the parasite gene pools. A comparative analysis of genetic variability values (at both nuclear and mitochondrial levels) and the infection levels (as a proxy of parasite population size) of anisakid species here considered (i.e. C. osculatum sp. D, C. osculatum sp. E, C. radiatum) in fish from the Ross Sea, was performed, over a temporal scale level (25 years). High values of genetic variability and parasitic infection were observed; they appear to show a stable tendency, over a temporal scale level. These findings seem to suggest that the low habitat disturbance of the Antarctic region permits the maintenance of stable ecosystem trophic webs, which contributes to the maintenance of large populations of anisakid nematodes with high genetic variability Monitoring the demography of anisakid parasites and their genetic variability values would be future tools to be considered for monitoring the impact of habitat disturbance on the Antarctic Sea. biodiversity, at both species and gene levels, over a spatial and temporal scale level. Acknowledgements: Research granted by PNRA2019_00125.

The Antarctic sponge Haliclona sp. and its associated bacterial community as pollution indicators in the remote Antarctic region

Maria Papale[1], Carmen Rizzo[2], Stefania Giannarelli[3], Gabriele Costa[4], Marco Bertolino[5], Maurizio Azzaro[1], Angelina Lo Giudice[1]

[1]Institute of Polar Sciences, National Research Council (CNR-ISP)
[2]Stazione Zoologica Anton Dohrn, National Institute of Biology, Sicily Marine Centre, Department Ecosustainable Marine Biotechnology
[3]Department of Chemistry and Industrial Chemistry, University of Pisa
[4]Department of Earth and Environmental Sciences, University of Milano-Bicocca
[5]Department of Earth, Environmental and Life Sciences (DISTAV), University of Genoa

Global industrialization releases a huge amount of pollutants into the Earth’s atmosphere and the accumulation of pollutants is observed in the most remote regions of the planet. Emissions and long-range transport of pollutants, such as metals and metalloids and, persistent organic pollutants (POPs), threaten ecosystems, especially when these pollutants reach remote and pristine areas. Several studies carried out in the Ross Sea, particularly on water and sediment samples, showed that two classes of POPs (polychlorobiphenyls, PCBs, and polycyclic aromatic hydrocarbons, PAHs) were the most abundant in this area. Similarly, results regarding heavy metals highlighted that Fe, Al, Mn, Pb, Tl, and as are generally retrieved in relevant quantities. Sponges are extremely efficient filter feeders. This ability makes them an excellent accumulation system and an important sentinel for pollution in remote areas. In fact, some studies conducted on Ross Sea sponges underlined that the contribution of metals (Cd, Pb, and Cu) to sponges tissues was around 85%. Sponges also represent important

habitats for a community of associated (micro)organisms, and few investigations have been performed on Antarctic sponge-associated bacteria. In this context, our work aims at investigating pollutant (POPs and heavy metals) concentration in the sponge Haliclona sp. compared to that retrieved in water and sediment samples, to explore the possibility to use this sponge species as a sentinel of pollution. Furthermore, sponge bacterial-associated community composition and activity, and its relationships with pollutant concentration were evaluated. Three specimens of Haliclona sp. were collected from two different sites at Thetys Bay (Terra Nova Bay, Ross Sea,) together with sediment and water samples. Results showed that these sponge specimens represent an incredible sentinel for environmental pollution, with some metals (e.g., Hg, Ni, Zn and Cd), almost all tested PAHs and, PCB congeners that were more concentrated in the sponge tissues than in sediment. The associated bacterial community was dominated by bacteria frequently found in marine environments of polar regions, but the diversity indices evidenced a higher alpha diversity compared with previous studies. The microbial community associated was differentiated by sites and some interesting differences were also underlined among water, sediment, and sponge samples. Our results evidenced that Antarctic sponges could be an excellent sentinel of environmental pollution and that differences within the bacterial communities may be site-driven and dependent on specific ecological interactions between bacteria and their benthic hosts. Funding: this research was financially supported by the Programma Nazionale di Ricerche in Antartide (project PNRA2016/AZ1.08, “Antarctic Porifera: Hot-spots of Prokaryotic diversity and biotechnological Potentialities - P3”).

Exploring the diversity of bacterial communities living in the mucus and in association with the Antarctic sponges Mycale acerata and Dendrilla antarctica (Terra Nova Bay, Ross Sea)

Carmen Rizzo[1], Maria Papale[2], Alessandro Ciro Rappazzo[2], Maurizio Azzaro[2], José Paulo Da Silva[3], Marco Bertolino[4], Gabriele Costa[4], Angelina Lo Giudice[2]

[1]Stazione Zoologica Anton Dohrn, National Institute of Biology, Sicily Marine Centre, Department Ecosustainable Marine Biotechnology
[2]Institute of Polar Sciences, National Research Council (CNR-ISP)
[3]CCMAR - Centro de Ciências do Mar Universidade do Algarve
[4]Department of Earth, Environment and Life Sciences (DISTAV), University of Genoa

Marine sponges are in close contact with the surrounding environment. Being filtering organisms, they often accumulate the contaminants present in the water and sediments, but can also sequestrate the microorganisms from the water bodies, implementing an active selection of them to establish symbiotic association. Here because they are vulnerable to biological and chemical forms of pollution and have been proposed as sentinels and purifying components of waters. Microbe-invertebrate associations, commonly occurring in marine environment, play a fundamental role in the life of symbionts, even in hostile habitats, assuming a key importance for both ecological and evolutionary studies. The special dynamics occurring in the relationship organism-environment and host-symbiont are reflected for example in the isolation of heavy metal resistant bacteria from sponges living in metal-polluted environments. Current data related to the composition, host- and site-relatedness of the bacterial communities associated with Antarctic sponges are limited to few works, resulting in a still fragmented and incomplete knowledge. In this context, it is difficult to ascertain which microorganisms are intimately associated with the host as core microbiome symbionts, which are transients and consequently their possible role in the symbiosis relationship. Many marine invertebrates produce mucosal layers - whose role has not been fully clarified yet - generally constituted of high percentages of water, polysaccharide and protein mixtures. Several functions were attributed to such special layers, i.e. adhesion enhancement, water preservation, movement helping, heterotrophic feeding, and they are considered a survival strategy for sessile marine organisms, highly vulnerable to external disturbing factors or to infections. The present work was aimed at exploring the bacterial communities associated with the Antarctic sponges Mycale

(Oxymycale) acerata (Kirkpatrick, 1907) and Dendrilla antarctica (Topsent, 1905) collected during the XXXIV Antarctic Expedition in the Thetys Bay (Terra Nova Bay; Ross Sea), and those present in their mucus layers. The inorganic content of the mucus and the presence of metals was estimated by MP-AES analysis. Total HCN content of dried samples was determined using an elemental analyser. The mucus samples evidenced a high amount of Na and Mg, but also presence of Ca, Fe, K, Se, V, trace of some heavy metals and other chemical elements. Data obtained highlighted the predominance of Proteobacteria, mainly affiliated to Alpha- and Gammaproteobacteria, with some dissimilarities between the two sponge species, especially at genus level. The present study represents a meaningful contribute to the scant knowledge of the structure and biochemistry of Antarctic marine sponge mucus matrices and provides useful insights for biotechnological applications. Funding: this research was supported by the Programma Nazionale di Ricerche in Antartide (project PNR).

Circumpolar sampling reveals high genetic connectivity of Antarctic toothfish across their spatial distribution

Dale Maschette[1]

[1]*University Of Tasmania*

Antarctic Toothfish are a circumpolar species which are targeted in multiple fisheries around Antarctica covering nine statistical areas within the Convention for the Conservation of Antarctic Marine Living Resources. Despite this, it is still unclear whether the species forms a single stock across its circumpolar distribution, shows a pattern of isolation by distance, or exhibits discrete stock structure between different regions. Recent genetics studies of Antarctic toothfish have shown connectivity between two areas (Ross Sea and Antarctic Peninsula), but earlier studies with smaller number of markers produced inconsistent results with regards to genetic connectivity between other geographic locations. Here we present a range-wide population genetic study of Antarctic toothfish using > 11,000 nuclear single nucleotide polymorphisms from 715 fish collected. Our results indicate that genetic diversity of the Antarctic toothfish is very low, with only 0.1% of genetic variability associated with geographic location. Multiple clustering methods, both supervised and unsupervised, indicated no distinct breeding populations. These results are consistent with current theories of egg and larval dispersal by the predominant Antarctic currents.

Winter movement and foraging behavior of Weddell Seals in the Ross Sea

Won Young Lee[1], Seung-Tae Yoon[2], Hyunjae Chung[1], Jikang Park[3], Sukyoung Yun[1], Won Sang Lee[1]

[1]*Korea Polar Research Institute*
[2]*School of Earth System Sciences, College of Natural Sciences, Kyungpook National University*
[3]*Department of Biology, Kyung Hee University*

For Antarctic animals, wintering period is important for survival and reproduction. However, our understanding of their wintering behavior is limited, and we need to have knowledge on their seasonal movements and habitat uses for better understanding of ecology and conservation. In this study, we tracked Weddell seals, an Antarctic circumpolar mesopredator, at Terra Nova Bay, in the Ross Sea, by instrumenting CTD-Satellite Relay Data Loggers. We aimed to investigate their winter movements and foraging behavior from Argos satellite locations and 3D acceleration data as well as the physical oceanographic (temperature and salinity) data. In total, we acquired 33 Weddell seal data from February to July in 2021 and 2022. Among the 33 individuals, 14 seals migrated to northeast or southeast for more than 400 km away (up to 930 km) from the summering site from March to early April while 29 seals remained within 200 km at Terra Nova Bay. In the austral winter season, from April to June, the 14 migrants had higher prey capture attempts than other seals which mainly stayed in Terra Nova Bay. It was also found that the seawater properties at depths where the migrants showed active prey capture attempts were relatively warmer (> –0.5℃) than those within Terra Nova Bay. That is, despite the energy consumption

and potential risks for long migration, seals moved to near edges of continental shelf regions for taking nutrient warm water, such as modified shelf water or modified circumpolar deep water. These results suggest that Weddell seals may have different wintering strategies with a trade-off between migratory risks and feeding advantages.

Autonomous and Intelligent Long-Term Video Monitoring of Antarctic Fauna

Simone Marini[1,2], Ennio Ottaviani[3], Tommaso Occhipinti[4], Andrea Bordone[5], Giancarlo Raiteri[5], Chiara Lombardi[5], Andrea Peirano[5]

[1]National Research Council of Italy (CNR), Institute of Marine Sciences, La Spezia, Italy
[2]Stazione Zoologica Anton Dohrn, Naples, Italy
[3]On AIR srl
[4]OEngineering srl
[5]ENEA-Marine Environment Research Centre Santa Teresa

In situ long-term monitoring of aquatic organisms is one of the major challenging goals in ocean studies, particularly difficult in polar areas due to the extreme environmental conditions and the complicated logistic. Nevertheless, biological in situ observations extended in time allow to generate big data which are crucial to understand the marine ecosystem functioning and their modifications due to climate change. For this purpose, the intelligent and autonomous imaging device GUARD1, for non-invasive and autonomous underwater monitoring, was used for acquiring a high-resolution long-term image dataset of the Antarctic macrozoobenthos. The imaging device was deployed in Tethys bay, near Mario Zucchelli Station (Terranova Bay, Ross Sea), from January to November 2017 (11 months) collecting time-lapse images every nine hours. After the recovery of the instrument, the acquired images were visually inspected in order to recognize the local species and to determine their temporal distribution along the monitoring period. Subsequently, the image dataset was analyzed through computer vision and machine learning techniques in order to capture the long-term cross-seasonal dynamics of the macrozoobenthos. The results of the monitoring experiment demonstrate the effectiveness of such an autonomous imaging device for acquiring relevant long-term visual data and the effectiveness of the proposed image analysis algorithms for extracting relevant scientific knowledge. The changes in the dynamics of the observed ecosystems can only be detected through in situ continuous observation systems, hardly accessible with the current state-of-the-art monitoring approaches often implemented in polar studies. Such a long-term monitoring experiment is a step toward the automated collection of continuous environmental data in the coastal Antarctic areas and in general in all the remote and extreme underwater habitats. In addition, the stand-alone and autonomous imaging device GUARD1 can be used for increasing the number of the autonomous monitoring sites in remote environments and, when combined with multi-proxy probes for physical and chemical data acquisitions, will make a major contribution to increasing the collection of ocean big data. A summary of the past monitoring experiences performed with the autonomous intelligent imaging device GUARD1 will be provided and the new device architecture, together with the ongoing and forthcoming applications will be presented. We will focus on the autonomous onboard detection and classification of the underwater organisms and on the capability to transmit image-content relevant data to a land station.

Resurgence of the Anthropocene in the Ross Sea, Antarctica

David Ainley[1], Virginia Morandini[2], Leonardo Salas[3], Nadav Nur[3], Jay Rotella[4], Kimberly Goetz[5], Michelle LaRue[6], Rose Foster-Dyer[6], Claire Parkinson[7], Kevin Arrigo[8], Gert van Dijken[8], Roxanne Beltran[9], Stacy Kim[10], Cassandra Brooks[11], Fiona Shanhun[12], Gerald Kooyman[13], Paul Ponganis[9], Dean Anderson[14]

[1]H.T. Harvey and Associates
[2]Spanish National Research Council (CSIC)

[3]*Point Blue Ecosystem Science*
[4]*Montana State University*
[5]*National Marine Fisheries Service*
[6]*University of Canterbury*
[7] *National Aeronautics and Space Administration - NASA*
[8]*Stanford University*
[9]*University of California*
[10]*Moss Landing Marine Laboratory*
[11]*University of Colorado*
[12]*Environment Canterbury*
[13]*Scripps Institution of Oceanography*
[14]*Landcare Research*

The Ross Sea, during the late 20th century, was classified as the ocean area least affected by human activities, despite appreciable exploitation of whales and seals as well as intense local pollution before the period of classification. Those direct impacts were removed by the 1980s under the Antarctic Treaty and International Whaling Commission. Subsequently (2019), the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) included most of the Ross Sea within a marine protected area (MPA), proposed proposing "to protect [undefined] ecosystem structure and function [undefined]." CCAMLR selected three upper-trophic-level species to be "indicator species": Adélie Penguin (Pygoscelis adeliae), Emperor Penguin (Aptenodytes forsteri), and Weddell Seal (Leptonychotes weddellii). Populations of each in the southwestern Ross Sea, monitored for several decades, were stable for a couple decades, but during 1998-2018 increased to attain or surpass historical levels. Therefore, ecosystem structure and function is changing. We review historical impacts to populations and trends, decadal data sets of ocean climate, as well as fishing pressure of a trophic competitor and another selected indicator species, the Antarctic Toothfish (Dissostichus mawsoni). Statistical modeling for populations having sufficiently continuous data sets --- Adélie Penguins and Weddell Seals --- indicates that variability in a few climate factors, plus cumulative extraction of toothfish, may well explain the indicator trends. Some effects were expected, e.g. negative correlation with large-scale sea ice extent (noted in previous studies for an earlier time period), but reasons behind effects of other variables are less certain. These mesopredators, and the toothfish, prey heavily on Antarctic Silverfish (Pleuragramma antarcticum). The fishery targets the oldest, largest toothfish, which owing to an extreme k-selected demography are not easily replaced, indicated by decreasing prevalence in the catch, supported by independent scientific fishing and CCAMLR modeling. Despite decades of ocean/weather variables changing, penguin and seal increase began only after fishery initiation. We hypothesize that toothfish removal may be altering intraguild predation dynamics, leading to competitive release of the intraguild prey, the silverfish. The fishery has reduced toothfish spawning biomass by >25% since initiation; management should be re-evaluated in keeping with the rational use, ecosystem-based viewpoint espoused by CCAMLR and its Ross Sea Region MPA.

Biogeochemistry Session

Mixing under ice in spring and the initiation of the Ross Sea phytoplankton bloom
Walker Smith[1], Yisen Zhong[1]

[1]*Shanghai Jiao Tong University*

Various hypotheses have been proposed to explain the timing of the initiation of phytoplankton blooms in temperate and polar systems. The Sverdrup critical depth hypothesis has been most commonly invoked, but other hypotheses have been proposed as well. Nearly all of these invoke the concept of mixed layer depths, and

assume that active mixing occurs in some or all of the mixed layer. This in turn controls the integrated (through time and depth) amount of irradiance available for phytoplankton photosynthesis. Despite the critical biogeochemical importance of understanding the bloom initiation controls in polar systems, few data are available on the appropriate time and space scales to adequately test any of the available hypotheses. Data from cruises to the southern Ross Sea in early October, when ice cover is extensive, are used to evaluate mixed layer depths. The data used include temperature, salinity and density vertical distributions, as well as chlorophyll and particulate organic carbon measurements derived from optical sensors. Mixed layer depths are estimated using a variety of techniques (both parametric and non-parametric methods) and the results are surprisingly different. The presence of ice cover restricts air-sea interactions, but ice can continually release brine to drive convection. Stations were occupied at two locations, and vertical distributions were assessed over 24 h through multiple casts. Station were also re-occupied through time. The results suggest that mixed layers as defined by multiple criteria change rapidly on diel scales and emphasize the importance of brine formation. Chlorophyll concentrations were exceptionally low at the earliest occupied stations (ca. 0.01 µg L-1), but increased 5-fold over 10 days, suggesting that phytoplankton growth had been initiated. Estimates of critical depth suggest and biological variables suggest that mixing depths best explain the regulation of the bloom onset in the Ross Sea. The earliest proposed dates of bloom initiation are in early October (Smith and Gordon, 1997), but these new analyses suggest that growth likely begins substantially earlier.

Quantifying Seasonal Particulate Organic Carbon Concentrations and Export Potential in the Southwestern Ross Sea Using Autonomous Gliders

Meredith Meyer[1], Randolph Jones[2], Walker O. Smith Jr.[3]

[1]Department of Earth, Marine and Environmental Sciences, University of North Carolina at Chapel Hill
[2]Antarctic Support Contract
[3]School of Oceanography, Shanghai Jiao Tong University; Virginia Institute of Marine Science

Biogeochemical dynamics of the Ross Sea have been observed for decades, but logistical and environmental constraints have limited the scope and continuity of data, leading to an incomplete understanding of these process in space and time. However, technological advances, such as autonomous vehicles, have allowed researchers to expand the scope of observation. To assess the temporal biological and hydrographic features of the southwestern Ross Sea, we deployed a glider in a spatially restricted, ice-free area during the austral summer (Dec. 1 – Feb. 6) and quantified from sensor measurements the particulate organic carbon (POC; via particulate backscatter) concentrations, their changes through time, and net community production (NCP; via dissolved O2 concentrations). The POC levels could be divided into three distinct phases (I, II, and III, respectively) characterized by changes in NCP, surface-layer POC concentrations, remineralization, and export. Surface POC concentrations increased from 215 mg C m-3 in early December to a peak of >400 mg C m-3 by mid-December, before decreasing to 227 mg C m-3 in late January- early February. NCP was highly variable throughout the summer, becoming maximal in mid-December. By constructing a carbon budget, we estimated rates of change of POC and export potential to the mesopelagic in each phase. Changes in euphotic zone POC concentrations and NCP suggested that the system is slightly net autotrophic during the observational period (average NCP is 0.05 g C m-2 d-1), and POC removal from the top 240 m of the water column averaged 0.22 g C m-2 d-1. Our data confirm that the southern Ross Sea during the ice-free season is a high productivity, low export system while providing high-resolution POC dynamics that had not been previously observed. Although the Ross Sea is a site of substantial carbon fixation, there remains an incomplete understanding both of the processes involved in export and the rates and controls of remineralization. This study serves as one of the first high resolution surveys of changes in POC, NCP, and export potential to which future glider deployments can be compared.

Phytoplankton seasonal cycle and carbon export in the Ross Sea: A modeling study

Elodie Salmon, Eileen E. Hofmann[1], Michael S. Dinniman[1], Walker O. Smith Jr.[2]

[1]Old Dominion University, Center for Coastal Physical Oceanography
[2]Virginia Institute of Marine Science, William & Mary

A previous modeling study that used a one-dimensional biogeochemical model implemented for the Ross Sea showed that the temporal progression of blooms of the haptophyte Phaeocystis antarctica and diatoms is sustained by dissolved iron (dFe) supplied by sea ice, benthic and Circumpolar Deep Water sources, and light availability, which is moderated by sea ice. This modeling study extends the one-dimensional biogeochemical model to the Ross Sea shelf. The biogeochemical model is embedded in a three-dimensional coupled circulation-sea ice-ice sheet model implemented for the Ross Sea. The expanded model allows simulation of the space and time progression of P. antarctica and diatom blooms and identification of the processes that govern these blooms. Initial simulations consider the effect of opening of the polynya and winter recharge of surface dFe concentrations on spring phytoplankton blooms. Preliminary results suggest the opening of the polynya enables early availability of light, which coupled with enhanced dFe concentrations, favors P. antarctica dominated blooms in the spring. Simulated bloom progression along across-shelf transects shows the relative importance of dFe and light availability in controlling the phytoplankton assemblage in the western and eastern Ross Sea, with implications for patterns of primary production in different regions of the Ross Sea.

Shifts in microbe-mediated organic matter degradation patterns in relation to sea-ice dynamics in a coastal area of the Ross Sea

Vincenzo Manna[1], Cecilia Balestra[1], Marco Basili[2], Antonio Dell'Anno[3], Marco Lo Martire[3], Grazia Marina Quero[2], Maria Saggiomo[4], Diana Sarno[4], Mauro Celussi[1], Gian Marco Luna[2]

[1]National Institute of Oceanography and Applied Geophysics – OGS
[2]National Research Council of Italy, Institute for Marine Biological Resources and Biotechnology (IRBIM)
[3]Department of Life and Environmental Sciences, Polytechnic University of Marche
[4]Stazione Zoologica Anton Dohrn

The Ross Sea is one of the most productive areas of the Southern Ocean and plays an important role in biogeochemical cycles. Significant yet variable changes in sea-ice cover extent have been observed in the recent past and these are expected to continue in the light of the ongoing and future global climate scenarios. The consequences of such sea-ice dynamics have been mainly focused on phytoplankton with cross-food web links from krill to large vertebrates, neglecting the response of microbial food webs. Aiming to fill this gap in the framework of a multidisciplinary investigation, we assessed microbially mediated hydrolysis rates of carbohydrates, lipids, sulphate esters and proteins, along a three-station coast-offshore transect in Tethys Bay (Terra Nova Bay) from early November 2022 to late January 2023. Sampling was carried out on a quasi-weekly basis, aiming to cover a wide array of physical-chemical, as well as trophic, conditions in relation to sea-ice dynamics. In early November, at the beginning of the sampling period, all three stations were covered by sea-ice and characterized by generally low carbohydrate, lipid and protein hydrolysis rates (<2 nM h-1, <20 nM h-1 and <15 nM h-1, respectively). Following sea-ice fragmentation, lipase and aminopeptidase activities abruptly increased (>200 nM h-1 and >70 nM h-1, respectively), while carbohydrates degradation rates remained relatively slower, suggesting that carbon mobilization following sea-ice melting occurred primarily through lipid rather than polysaccharide pools. By late January, lipase activity was comparable to values measured during the sea-ice cover period, while carbohydrate degradation rates increased. This pattern may be explained by the development of a massive Phaeocystis sp. bloom in late December which represented a source of freshly

produced carbohydrates for the heterotrophic microbial assemblages. Sulphatase activity was a notable exception to the general pattern observed for the other exoenzymes, with higher rates under sea-ice cover conditions and a barely detectable signal during and after sea-ice fragmentation and algal bloom development. While data on sulphate esters degradation assessed through fluorogenic substrate analogues are scarce in pelagic ecosystems, there is evidence of the inducibility of this enzyme under low sulphur concentrations. Considering that Phaeocystis sp. copiously produces S-rich molecules during bloom conditions, it is plausible that sulphatase expression may have been reduced in response to this readily available sulphur source. These preliminary data shine a light on organic matter degradation dynamics under different regimes of sea-ice cover, providing insights into the functioning of the microbial food webs during the transition between sea-ice fragmentation and algal bloom development.

High dissolved inorganic carbon uptake by Bacteria and Archaea in the deep-water masses of the Ross Sea

Mauro Celussi[1], Elisa Banchi[1], Paola Del Negro[1], Viviana Fonti[1], Vincenzo Manna[1], Pasquale Castagno[2], Giorgio Budillon[3], Marco Basili[4], Grazia Marina Quero[4], Gian Marco Luna[4]

[1]National Institute of Oceanography and Applied Geophysics – OGS
[2]University of Messina
[3]University of Napoli Parthenope
[4]National Research Council of Italy, Institute for Marine Biological Resources and Biotechnology (IRBIM)

A deep knowledge on the ocean C cycle functioning is fundamental to predict the consequences of increased CO2 in the atmosphere. Current research indicates that the amount of CO2 fixed in deep marine systems via chemosynthetic processes is comparable to the one taken up by photosynthetic organisms in the lit portion of the water column. Despite the pressing need, we still lack information on the deep sea biodiversity and metabolism of the Southern Ocean. The Ross Sea represents a key study area because (1) it is a system where dense water masses with distinct features, potentially involved in different quantity and quality of organic matter export to the deep sea, are formed and (2) these water masses, eventually forming the Antarctic Bottom Water (AABW), act as an engine for global ocean circulation, ventilating 60% of the whole ocean mass. During two oceanographic cruises in Southern Ocean (austral summers 2014 and 2016) we have performed 64 incubation experiments in order to understand the C fluxes in the dark portion (200-2000 m) of the Ross Sea. We evaluated dissolved inorganic C uptake (via chemosynthesis or anaplerosis) and production (via respiration) together with dissolved organic C utilization (via heterotrophic production) and release (via excretion or viral lysis). The study focused on the newly formed oxygen-rich High Salinity Shelf Water (HSSW), on the oxygen-depleted Circumpolar Deep Water (CDW), and on the Antarctic Bottom Water. Results indicate that in the three water masses (in the same depth range) the metabolism of marine microbes proceeds at different rates. The fastest bulk inorganic C fixation, heterotrophic production and respiration were measured in HSSW. Significantly lower values were found in CDW, whereas AABW maintained the metabolic signature typical of both parental water masses showing intermediate values. Prokaryotic abundance mirrored the trend observed in metabolic activities. The per-cell normalization of C uptake and production did not reveal significant differences among the water masses indicating that metabolism do not spatially vary at the single organism-level. Noteworthy, the relative abundance of putatively chemosynthetic prokaryotes was significantly (yet slightly) higher in CDW suggesting that, in an environment with lower palatable organic C concentration, a higher number of microbes access its need for energy and C via autotrophic pathways. Overall, these data indicate that the signature of newly-formed water masses significantly affects the metabolism of microbes living in Antarctic Bottom Water possibly having profound implications for the global bathypelagic biogeochemistry.

Strong transport of anthropogenic carbon from the Antarctic shelf to deep Southern Ocean triggers rapid acidification

Yingxu Wu[1], Di Qi[1]

[1]*Polar and Marine Research Institute, Jimei University, Xiamen, Fujian, China*

Flows of dense shelf water are an efficient way for pumping CO2 to deep ocean along the continental shelf-slope, particularly around the Antarctic Bottom Water (AABW) formation area where much of the global bottom water is formed. However, the contribution of the formation of AABW to sequestering anthropogenic carbon (Cant) and its consequence are unknown. Here, using an integrated observational dataset, we find that the CO2 sink at Antarctic coastal regions reaches 44 Tg C yr-1, accounting for 22% of the global coastal CO2 uptake, which is twice higher than previous estimates. Moreover, we show that the strong CO2 uptake is attributed to the AABW-formation-driven mechanism, which transports Cant towards the deep sea (>2000 m) in the Pan-Antarctica. As a consequence, such transport would accumulate Cant in deep-water and trigger rapid acidification, i.e., pH declines at 0.0007±0.0002 yr-1, far faster than that of any other open ocean deep waters (<0.0002 yr-1). Our findings elucidate the prominent role for AABW in controlling the Southern Ocean carbon uptake and storage to mitigate climate change, whereas its side effects also warrant more attentions.

Physical and biological controls on anthropogenic CO2 sink of the Ross Sea

Gianmarco Ingrosso[1,2], Michele Giani[2], Martina Kralj[2], Cinzia Comici[2], Paola Rivaro[3], Giorgio Budillon[4], Pasquale Castagno[5], Luca Zoccarato[6], Mauro Celussi[2]

[1]*National Research Council (CNR), Institute of Polar Sciences (ISP)*
[2]*National Institute of Oceanography and Applied Geophysics – OGS*
[3]*Department of Chemistry and Industrial Chemistry, University of Genova*
[4]*University of Napoli Parthenope*
[5]*University of Messina*
[6]*Department of Plankton and Microbial Ecology, Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB)*

The Antarctic continental shelf is a significant sink for anthropogenic CO2 (Cant) due to its cold waters, high primary productivity, and unique circulation that allows it to store large amounts of organic and inorganic carbon into the deep ocean. However, climate change is currently altering the Antarctic marine carbon cycle, making predictions of future ocean acidification in polar regions highly uncertain. In this study, we examined the marine carbonate system in the Ross Sea to assess the current anthropogenic carbon content and how physical-biological processes control Cant sequestration along the shelf-slope continuum. We found that winter water masses generated by convective events had high Cant levels (28 µmol kg-1) as a result of mixed layer break-up during the cold season. Old and less ventilated Circumpolar Deep Water entering the Ross Sea revealed little anthropogenic carbon (7 µmol kg-1). Cant concentrations also varied between polynya areas and the shelf break, due to their specific hydrographic characteristics and biological processes. Surface waters of polynyas in the Ross Sea and Terra Nova Bay acted as strong CO2 sinks (up to –185 mmol m-2) due to the remarkable net community production, but much of the particulate organic carbon produced was quickly consumed by intense microbial activity, returning back carbon dioxide into intermediate and deep layers of the continental shelf zone. In addition, High Salinity Shelf Water produced during winter sea ice formation (25 µmol kg-1) added Cant to the dense shelf waters, which was ultimately stored in the abyssal sink through continental slope outflow (19 µmol kg-1). Our results suggest that summer biological activity over the Ross Sea shelf plays a critical role in the transfer of anthropogenic CO2 between organic and inorganic carbon pools, leading significant acidification of the upper mesopelagic zone and contributing to the long-term sequestration of Cant into the deep ocean.

From New Zealand to Antarctica (Ross Sea): the fatty acid composition of marine suspended particulate matter

Federico Girolametti[1], Anna Annibaldi[1], Silvia Illuminati[1], Matteo Fanelli[1], Behixhe Ajdini[2], Francisco Ardini[2], Cristina Truzzi[1]

[1]*Department of Life and Environmental Sciences, Polytechnic University of Marche*
[2]*University of Genoa*

The study of the lipidic component in aquatic ecosystems is crucial as it represents a structural component in all marine organisms, and it can be used as a source of energy. Furthermore, fatty acids (FAs) can be used as biomarkers to investigate community composition and assess ecosystem nutritional status, since the distribution of FAs fractions is closely related to the presence of different phytoplankton taxa [1]. The FAs profile associated with marine suspended particulate matter (SPM) collected during the XXXV Italian Expedition in Antarctica (January 2020) from 48 to 76 °S was investigated using a Gas-Chromatography Mass Spectrometry technique [2], in terms of both percentage of FAs vs total FAs and content of FAs in µg L-1 of filtered seawater. The trends of FAs biochemical indices used to elucidate the dominant sources of SPM have also been investigated. The Folch method [3] was found to be more accurate during the evaluation of the most accurate lipid extraction method. The distribution of FAs before and after the Antarctic Convergence zone was found to be significantly different. In particular, the total FAs content varied across the Pacific Ocean, Convergence zone, Southern Ocean, Ross Sea offshore, and Antarctic coast, with the highest concentrations found in the convergence zone and along the Antarctic coast. The saturated FAs were the most prevalent fraction in all sampling stations, but their percentage vs total FAs decreased near the Antarctic continent's coast. In contrast, the fractions of several lipid markers of biological activity, such as polyunsaturated fatty acids, were more widely distributed at southern latitudes, increasing in term of both percentage vs total FAs and absolute content, with respect to northern latitudes. Furthermore, the levels of FAs were also investigated in relation to the trend of the main oceanographic parameters (temperature, salinity, dissolved oxygen, nutrients, and chlorophyll a). A Principal Component Analysis revealed that FAs can be successfully used as tools to identify different geographical areas in the investigated zone. This study is the first performed on a transect ranging from 48 to 76 °S, expanding knowledge on the FAs composition of suspended particulate matter in the Pacific and Southern Ocean, including Ross Sea, in relation with oceanographic parameters. References 1. Cañavate, J.P. Rev Aquac 2019, 11, 527–549. 2. Truzzi, C., et al. Chemosphere 2017, 173, 116–123. 3. Parrish, C.C. Lipids in Freshwater Ecosystems; Springer New York, 1999, 4–20.

Multiple Nutrient Co-Limitation Impacts on the Phytoplankton Community Structure and Coastal Biogeochemistry on a Transect from the Amundsen Sea to the Eastern Ross Sea

Giacomo Di Tullio[1], Nicole Schanke[1], Lauren Lees[2], Francesco Bolinesi[3], Pasquale Castagno[4], Giorgio Budillon[5], Olga Mangoni[3], Robert Dunbar[6], Mak Saito[7]

[1]*College of Charleston*
[2]*University of California, Irvine*
[3]*University of Naples Federico II*
[4]*University of Messina*
[5]*University of Napoli Parthenope*
[6]*Stanford University*
[7]*Woods Hole Oceanographic Institute*

After decades of international research investigating the Ross Sea ecosystem there remains no definitive understanding of the relative importance of various physical, chemical, and biological factors that regulates the annual competition between seasonal blooms of diatoms and Phaeocystis populations. On a coastal transect

from the Amundsen Sea into the eastern Ross Sea during austral summer 2018 we measured various biogeochemical parameters to understand how phytoplankton community composition may be influenced by micro-nutrient variability and physical factors including variables directly related to climate change processes (e.g. glacial meltwater). Bioassay incubation experiments conducted at a few stations on the coastal transect revealed the potential for the ecosystem to become prone to fluctuating multiple co-limiting nutrients. Results from these micronutrient bioassay studies performed on the expedition will be presented and used as a framework for describing and understanding the spatial variability of Phaeocystis antarctica and diatom blooms along the coastal transect. We posit that a new biogeochemical paradigm is emerging wherein transitory alleviation of iron and light limitation from glacial ice melt can trigger significant biogeochemical changes that will facilitate and trigger new co-limiting nutrients in the region. These changes will directly impact the phytoplankton community structure and carbon export efficiency in coastal waters of the western Antarctic region. Hence, physical factors (e.g. stratification, salinity), circulation patterns and biogeochemical studies investigating the potential interactive effects of multiple co-limiting micronutrients such as cobalt, zinc, manganese, and Vitamin B12 (and perhaps other micronutrients) will become increasingly more relevant in the coming decades as the impacts of climate change processes accentuate changes in ecosystem dynamics in the Ross Sea and coastal waters of western Antarctica.

Estimation of phytoplankton composition and uptake elemental stoichiometry ratios (N:P:trace metals) in the Ross and Amundsen Seas

Ruifeng Zhang[1], Yuncong Ge[1], Zhu Zhu[1], Meng Zhou[1], Zhuoyi Zhu[1]

[1]School of Oceanography, Shanghai Jiao Tong University, Shanghai, China

The Southern Ocean contributes 40% of the ocean's absorption of anthropogenic CO2 emissions, 10% of which is sequestered in the deep ocean through biological carbon pump. Iron is an important influencing factor for biomass and phytoplankton composition in the Southern Ocean, and it has also been shown that in addition to iron, other trace metals such as zinc, cobalt and manganese are also limiting in the Southern Ocean. Therefore, it is important to understand the phytoplankton composition of the Southern Ocean, the relationship between phytoplankton distribution and environmental factors, and the elemental uptake stoichiometry of N, P and trace metals by phytoplankton. In this study, phytoplankton composition of the Ross and Amundsen Seas in January 2019 was obtained using pigments with chemical taxonomy, mainly diatoms and haptophytes. Redundancy analysis of environmental factors and phytoplankton composition showed that salinity was the main influencing factor and was negatively and positively correlated with haptophytes and diatoms, respectively; manganese, nickel, copper, zinc and silicon were negatively correlated with haptophytes; and cadmium, manganese, phosphorus and silicon were negatively correlated with diatoms. Meanwhile, based on the specificity of seasonal changes in the mixed layer of the Southern Ocean, this study used the difference in nutrient concentrations between the mixed layer and 300 m water depth in summer as the phytoplankton consumption, calculated the phytoplankton uptake elemental stoichiometry ratio, and explored the relationship between uptake ratio and phytoplankton composition. The results showed that N/P, P/Fe and P/Mn decreased with increasing diatom abundance. The elemental uptake stoichiometry ratios of the mixed layer were used to construct functions with phytoplankton composition to derive partial elemental uptake stoichiometry ratios of haptophytes, diatoms and cryptophytes.

Dissolved iron speciation and first characterization of organic ligands in the eastern Ross Sea

Paola Rivaro[1], Annalisa Salis[2], Enrico Millo[2], Davide Vivado[1]

[1]Department of Chemistry and Industrial Chemistry, University of Genoa
[2]Department of Experimental Medicine, Section of Biochemistry, University of Genoa

Iron (Fe) is the most important trace element in the ocean ecosystem, being a micronutrient required for phytoplankton growth and thus involved in marine primary productivity and carbon export. The dissolved Fe (dFe) is the most bioavailable fraction and about 99.9% of the dFe is complexed with organic ligands (L), the nature of which is largely unknown. The concentrations of L can be determined by the electrochemical technique of competitive ligand exchange-adsorptive cathodic stripping voltammetry (CLE-AdCSV), which also allow the binding affinity of Fe to be assessed through the values of the conditional stability constants (logK'Fe'L). However, CLE-AdCSV does not give details about the L nature. High performance liquid chromatography - electrospray ionization - mass spectrometry (HPLC-ESI-MS/MS) is a powerful new approach to characterize the Fe-binding ligands, thanks to the fragmentation pattern of the MS/MS spectra. To date, the eastern sector is the most unexplored area of the Ross Sea, but its study has high scientific interest. In fact, it is the area where water masses from the western sector of Antarctica pass through and it is the gateway for the iron and organic ligands rich glacial meltwater coming from the nearby Amundsen Sea. In this work, the total concentration and speciation data of dFe determined in seawater samples collected during the austral summer of 2019-20 in the eastern Ross Sea (ESRS) and along the Ross Ice Shelf (RIS) in the framework of the ESTRO (Effect of the eaSTern inflow of water on the ROss Sea salinity field variability) project are presented. Principal component analysis (PCA) was used to explore correlations between dFe, speciation parameters, and the biogeochemistry of the area. This allowed us to assess the possible sources of dFe and L and to highlight the differences between the different water masses in this area. The subsurface samples were characterized by greater spatial dFe variability than the deep samples. Dissolved Fe average concentrations were higher in the ESRS (2.21 ± 1.20 nM) than those sampled along the RIS (0.62 ± 0.10 nM). In the ESRS, the distribution of Fe parameters was more controlled by the physical parameters, rather than the biological component. Particularly stable complexes were identified by CLE-AdSV between dFe and L (average logK'Fe'L = 13.4) and the HPLC-ESI-MS/MS analyses showed the presence of several organic ligands having different masses in the seawater samples.

Oceanography of the Edisto Inlet (Western Ross Wea): first results from the XXXVIII Italian Antarctic expedition

Giuseppe Aulicino[1], Manuel Bensi[2], Federica Cerino[2], Vedrana Kovacevic[2], Olga Mangoni[3], Marina Monti[2], Caterina Morigi[4], Anna Sabbatini[5], Tommaso Tesi[6], Tommaso Diociaiuti[2], Angelo Carotenuto[3], Emanuela Serino[3], Francesca Caridi[5], Leonardo Langone[6]

[1]*University of Napoli Parthenope*
[2]*National Institute of Oceanography and Applied Geophysics – OGS*
[3]*University of Naples Federico II*
[4]*University of Pisa*
[5]*Marche Polytechnic University*
[6]*National Research Council of Italy, Institute of Polar Sciences (ISP)*

Laminated diatomaceous deposits have been documented in a few Antarctic regions, including the Antarctic Peninsula and the Ross Sea. In general, very high sedimentation rates can overwhelm limited bioturbation and thus foster the preservation of varves, for example in some glacio-marine settings. Laminated sediments, collected in the Edisto Inlet, western Ross Sea, showed well-defined dark and light laminae on mm- to cm-scale. Dark laminae contained relatively high concentrations of a biomarker of fast ice IPSO25, whereas, low IPSO25 concentrations characterized light laminae and the diatom Corethron pennatum became the dominant species. Based on these assumptions, fast ice dynamics were reconstructed over the last 2.6 ka for the western Ross Sea. Nevertheless, the absence of rigorous varve validation leaves uncertain the paleoclimatic and paleoceanographic interpretation of these laminated sediments. The project PNRA_LASAGNE (Laminated sediments in the magnificent Edisto Inlet (Victoria Land): What processes control their deposition and preservation?) proposes a multidisciplinary study integrating fast-ice, water column and surface sediment

characteristics, supported by biological data collected in situ and time-series of satellite images of sea-ice, to gain information on factors influencing the formation and preservation of laminated sediment in Edisto Inlet. It aims at providing new insights into the sub-seasonal formation of laminated sediments providing a backbone for the interpretation of paleoclimate sediment archives. Here, we show the preliminary results obtained from an extensive dataset collected in Edisto Inlet during the XXXVIII Italian PNRA expedition conducted onboard the I/B Laura Bassi in Feb 2023. Data includes CTD vertical profiles with additional parameters (DO, fluorescence, turbidity) spatially distributed within and at the entrance of the bay, which was still partially covered by seasonal sea ice at the time of the cruise. Moreover, vessel mounted (vm) and Lowered (L) ADCPs have been collected along transects and at each CTD station, respectively. The dataset also include time series from an oceanographic mooring between Feb 2022-Feb 2023. The cruise objective was to perform a synoptic survey during austral Antarctic summer to describe the water mass distribution and current dynamics in the bay, which are mainly driven by sea ice formation and melting, and by atmospheric and tidal forcing. To complement physical data, we collected 3 sea ice cores in Nov 2022, and 7 short sediment cores together with water samples during the cruise to have a picture of the phytoplankton and microzooplankton living in the platelet ice in spring and in open water in summer, respectively. Timing and composition of organic debris sinking in the water column are obtained by sediment trap samples. Early diagenesis has been also taken into account to define how the original signal is preserved in the sedimentary record.

The Ross Sea in the Anthropocene: reconstructing the N cycle dynamics and ecosystem impacts with nitrogen isotopes

Simone Moretti[1], Patrizia Giordano[2], Marco Grillo[3], Paolo Montagna[2], Federico Giglio[2], Leonardo Langone[2], Lukas Gerber[1], Stefano Schiaparelli[4], Marco Taviani[5], Alfredo Martinez-Garcia[1]

[1]Max Planck Institute for Chemistry (MPIC)
[2]National Research Council of Italy, Institute of Polar Sciences (ISP)
[3]University of Siena
[4]University of Genoa & Italian National Antarctic Museum (MNA, Section of Genoa)
[5]National Research Council of Italy, Institute of Marine Sciences (ISMAR)

As anthropogenic carbon continues to accumulate in the ocean-land-atmosphere system and global average temperature rises, understanding the future response of the ocean remains critical. About half of all the anthropogenic carbon is sequestered in the ocean, with 40% of this sink in the Southern Ocean. Multiple line of evidence, suggest that large changes are already occurring in the Southern Ocean circulation, ecosystems and biogeochemical cycles. However, available data is limited to the past few decades of observations, hindering our ability to disentangle the effects of natural variability from anthropogenic activity. Preliminary data indicates that the nitrogen (N) isotope composition of proteins trapped with the skeletal carbonate of Antarctic cold water corals (CB-δ15N) in the Ross Sea holds great potential to reconstruct Southern Ocean's overturning circulation and ocean's biological pump efficiency beyond the temporal extent of instrumental records. However the reliability this novel proxy relies on solid calibration to particulate organic matter (POM)-δ15N and seawater nitrate (NO3-)-δ15N. The deployment of Ross Sea moorings region during the last 3 decades of Italian "Programma Nazionale delle Ricerche in Antartide" (PNRA) offers a unique multipurpose resource by 1) providing a long-term high resolution window into the biogeochemical dynamics of this important region over the past 3 decades, 2) allowing a direct calibration of Ross Sea deep sea corals CB-δ15N to the particulate POM-δ15N upon which the corals feed on and 3) offering the opportunity to quantify the trophic structure of the food web with stable-isotope ecology δ15N analyses on specific classes of zoo- and phytoplankton. CB-δ15N could represent a novel application in the context of Ross Sea research, and Southern Ocean as a whole, by providing a temporal extension of the instrumental records for nutrient biogeochemistry, further back in time into the past centuries. In addition, we aim to establish a long-term seawater sampling effort in the Ross Sea region

surrounding sediment trap deployments to monitor the evolution of the seawater NO3--δ15N over the next years, tracking the baseline of the food web and its associated changes. Nitrogen isotopes are an established tool to reconstruct nutrient cycling dynamics, but their applicability has been limited to the last few years of Antarctic research. Their application in both instrumental record from sediment traps as well as their temporal extension into the past centuries with fossil corals holds great potential for reconstructing the biogeochemical cycle of nutrients and ecosystem changes in the polar regions in the context of the Anthropocene.

Radioisotope research in the marine environment, methodologies, and perspectives

Petros Leivadaros[1], Jan John[1], Mojmìr Němec[1]

[1]*Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague*

In environmental research and management, the observation and identification of the source of a phenomenon or a pollutant is of great importance and requires high accuracy. The isotopic ratio of specific elements, both man-made and natural, provides unique information about the source, its characteristics and the overall interactions with the wider area. A number of different sources, such as radioactive fallout from nuclear weapon tests, accidental releases and operational discharges from nuclear facilities, create a mixture of parameters that alter the internal composition and ratio of radionuclides on the planet. Isotopic ratio surveys are characterised by a huge difference in sensitivity and selection, in terms of overall methodology and target. In this presentation we are going to compare the results of previous investigations in the area of Aegean Sea where 137Cs used as a tracer in order to estimate and characterise the mixings and the subsurface flows of marine masses in the area, a study carried out some 30 years after the Chernobyl accident, with the ongoing isotopic survey of the 236/238U, 236/235U, 129/127I and 239/240/241/242Pu ratios aiming to clarify the conditions under which the radiological background of the Vefsna fjord (Norway) was formed. The overall aim is to develop a method to complete and support the traditional tools for water mass identification, which are mainly salinity and temperature, developing a standardised methodology and technical approach for radiochemical research in marine environment. Furthermore, within the presentation, we will compare a variety of technologies starting from HPGe gamma spectrometry to the highly sensitive Accelerator Mass Spectrometry (AMS).

Marine Geology and Geophysics Session

The Italian Southern Ocean Bathymetry for the exploitation of opportunistic seafloor datasets in the Antarctic water and surrounding areas (ISOBatA)

Daniela Accetella[1], Alessandra Savini[2], Cuffaro Marco[3], Paolo Diviacco[1], Filippo Muccini[4], Francesco Coslovich[1], Lorenzo Facchin[1], Roberto Romeo[1], Marco Santulin[1], Andreea Cova[1], Pasquale Castagno[5], Ester Colizza[6], Laura Crispini[7], Laura De Santis[1], Pierpaolo Falco[8], Luca Gasperini[9], Giulia Giorgetti[9], Giulia Matilde Ferrante[1], Nunziante Langellotto[10], Leonardo Langone[11], Tommaso Tesi[11], Riccardo Scipinotti[12], Vedrana Kovacevic[1]

[1]*National Institute of Oceanography and Applied Geophysics - OGS*
[2]*University of Milan- Bicocca - Dept. Of Earth and Environmental Sciences (DISAT)*
[3]*National Research Council of Italy, Institute of Environmental Geology and Geoengineering, CNR-IGAG*
[4]*National Institute of Geophysics and Volcanology – INGV*
[5]*University of Messina*
[6]*University of Trieste*
[7]*University of Genoa - Dept. of Earth, Environment and Life Science (DiSTAV)*
[8]*Marche Polytechnic University*
[9]*National Research Council of Italy, Institute of Marine Sciences (ISMAR)*
[10]*Italian Hydrographic Institute (IIM)*

[11]*National Research Council of Italy, Institute of Polar Sciences (ISP)*
[12]*Italian National Agency for New Technologies, Energy and Sustainable Economic Development – ENEA*

The Italian Southern Ocean Bathymetry for the exploitation of opportunistic seafloor datasets in the Antarctic water and surrounding areas (ISOBatA) is a project funded by the Italian Antarctic Research Program (PNRA) to improve the bathymetric coverage of the Southern Ocean (SO). ISOBatA acquisition was designed to collect data along the R/V icebreaker Laura Bassi main route: 1) back and forth New Zealand and Mario Zucchelli Station; 2) between mooring sites in the Ross Sea (MORSEA Observatory Project). Over the past 2 years, ISOBatA has succeeded in collecting a significative dataset of bathymetric, sub-bottom profiling and ADCP datasets during the MORSEA operations in the key areas of Mooring G (72° 24.4326'S, 173°03.1698'E) and B (73° 59.8118'S, 175°04.2660'E). Furthermore, ISOBatA has an open data policy and acquired data will made available to the scientific community boosting the knowledge of the covered area. Our experience has shown that opportunistic datasets collected during ship's free time can provide new insights for the various scientific projects in SO. The interactions and collaborations amongst scientists working in different disciplines and with a sound knowledge of the study area, all together onboard the R/V Laura Bassi, furtherly enriched ISOBatA results. We believe this approach can be extremely powerful, with many advantages, and we underline the need to open a discussion on a coherent Italian strategy for data acquisition in SO during transit times.

Bottom current control on sediment deposition between the Iselin Bank and the Hillary Canyon (Antarctica) since the late Miocene: An integrated seismic-oceanographic approach

Laura De Santis[1], Rudy Conte[1], Michele Rebesco[1], Florence Colleoni[1], Manuel Bensi[1], Andrea Bergamasco[2], Vedrana Kovacevic[1], Jenny Gales[3], Fabrizio Zgur[1], Daniela Accettella[1], Laura De Steur[4], Robert McKay[5], Laura Ursella[1], Sookwan Kim[6], Renata Giulia Lucchi[1]

[1]*National Institute of Oceanography and Applied Geophysics - OGS*
[2]*National Research Council of Italy CNR*
[3]*School of Biological and Marine Sciences, University of Plymouth*
[4]*Norwegian Polar Institute*
[5]*Antarctic Research Centre, Victoria University of Wellington*
[6]*Korea Institute of Ocean Science & Technology*

We analyze how oceanic circulation affects sediment deposition along a sector of the Ross Sea continental margin, between the Iselin Bank and the Hillary Canyon, and how these processes evolved since the Late Miocene. The Hillary Canyon is one of the few places around the Antarctic continental margin where the dense waters produced onto the continental shelf, mainly through brine rejection related to sea ice production, flow down the continental slope and reach the deep oceanic bottom layer. At the same time the Hillary Canyon represents a pathway for relatively warm waters, normally flowing along the continental slope within the Antarctic Slope Current, to reach the continental shelf. The intrusion of warm waters onto the continental shelf produces basal melting of the ice shelves, reduces their buttressing effect and triggers instabilities of the ice sheet that represent one of the main uncertainties in future sea level projections. For this study we use seismic, morpho-bathymetric and oceanographic data acquired in 2017 by the R/V OGS Explora. Seismic profiles and multibeam bathymetry are interpreted together with age models from two drilling sites (U1523 and U1524) of the International Ocean Discovery Program (IODP) Expedition 374. Oceanographic data, together with a regional oceanographic model, are used to support our reconstruction by showing the present-day oceanographic influence on sediment deposition. Regional correlation of the main seismic unconformities allows us to identify eight seismic sequences. Seismic profiles and multibeam bathymetry show a strong influence of bottom current activity on sediment deposition since the Early Miocene and a reduction in their intensity during the mid-Pliocene Warm Period. Oceanographic data and modelling provide evidence that the bottom currents are related

to the dense waters produced on the Ross Sea continental shelf and flowing out through the Hillary Canyon. The presence of extensive mass transport deposits and detachment scarps indicate that also mass wasting participates in sediment transport. Through this integrated approach we regard the area between the Iselin Bank and the Hillary Canyon as a Contourite Depositional System (ODYSSEA CDS) that offers a record of oceanographic and sedimentary conditions in a unique setting. The hypotheses presented in this work are intended to serve as a framework for future reconstructions based on detailed integration of lithological, paleontological, geochemical and petrophysical data.

New offshore geological and geophysical investigations at the Pennell Coast of North Victoria Land (PNRA_BOOST Project)

Matilde Ferrante[1], Laura Crispini[2], Michele Locatelli[2], Danilo Morelli[2], Ester Colizza[3], Daniela Accettella[1], Dario Civile[1], Valentina Volpi[1], Lorenzo Facchin[1], Andreas Läufer[4], Antonia Ruppel[4], Paola Cianfarra[2]

[1]National Institute of Oceanography and Applied Geophysics – OGS
[2]Department of Earth, Environmental and Life Sciences (DISTAV), University of Genoa
[3]University of Trieste
[4]Federal Institute for Geosciences and Natural Resources (BGR)

The PNRA_BOOST project (Bridging Onshore-Offshore STructures at the Pacific Coast of North Victoria Land, Antarctica: an integrated approach) is addressed to the study of the Pacific side of the North Victoria Land (NVL), i.e. Oates and Pennell Coasts, an un- and under-explored key area located in a critical position at the boundary region between East and West Antarctica. The interplay between the West Antarctic Rift System and the Australian-Antarctic plate divergence has played a crucial role in shaping the structure of the Antarctic lithosphere, growth of the cryosphere, formation of sub-ice topography, and uplift of the Transantarctic Mountains. At present, there still remain open questions and lack of data on rift-related structures and their Eocene to Recent geodynamic history. Brake and Anderson (1983) have already highlighted that the continental margin of NVL exhibits a complex bathymetry due to tectonic, glacial and marine processes; they hypothesize that the rugged geometry of the continental shelf is linked to the extension of the Balleny fracture zone and that the bathymetry is largely controlled by tectonics. Moreover, geomorphic analysis of onshore valley systems revealed that the fluvial basin evolution at the Pacific side of NVL is controlled by and adapted on the tectonic structure of the bedrock at least until the Eo-Oligocene boundary, and anomalies are compatible with the recent tectonic evolution. Our main aims are: to develop a morphotectonic model that correlates on- and offshore tectonic structures in order to link Cenozoic geodynamics to ice sheet evolution and to provide new answers to still open questions regarding Dynamic Earth and Antarctic Ice Sheet evolution and “boost” future international collaboration. To achieve our aim, we use a multimethodological approach including acquisition of new geological and geophysical data on land and at sea. Here, we present new data collected over a 5000 km2 area crossing the continental shelf and the ice grounding-zone during the XXXVIII Italian PNRA scientific expedition onboard of the R/V Laura Bassi in Feb 2023. These data include multichannel seismic reflection (MCS) measurements along a ca. 350 km profile carried out in parallel with magnetic and sub-bottom TOPAS measurement, and multibeam morphobathymetry and magnetic measurements. Three multicores and three gravity cores collected on the shelf integrate the geophysical dataset. Preliminary results will also serve for the design of a high-resolution aeromagnetic survey planned for the next Antarctic season within the frame of BOOST and the BGR GANOVEX research programme.

Utilizing Siple Coast fossil marine diatoms from subglacial sediments to reconstruct ice sheet and marine history of West Antarctica

Jason Coenen[1], David Harwood[2], Amy Leventer[3], Reed Scherer[1]

[1]*Northern Illinois University*
[2]*University of Nebraska-Lincoln*
[3]*Colgate University*

Siple Coast fossil marine diatom assemblages recovered from beneath the West Antarctic Ice Sheet identify past times of ice sheet retreat and marine incursion across West Antarctica. During these retreat events, conditions were favorable for siliceous biogenic productivity and deposition in sedimentary basins now covered by the West Antarctic Ice Sheet. Past glaciations led to erosion and transportation of these marine sediments that include diatom floras of mixed ages recording Paleogene and Neogene intervals of ice-free productive marine seas. Reported here are major findings from subglacial sediments studied from the Bindschadler, Kamb, and Whillans ice streams. The Whillans Ice Stream compares samples from three different subglacial environments from the Caltech UpB camp and the WISSARD Project (subglacial lake and grounding zone environment). The Kamb Ice Stream compares samples collected from the 1996 and 2000 seasons of Caltech drilling from the South Ice Stream Branch, Shear Margin, and Sticky Spot of the Kamb Ice Stream. The Bindschadler Ice Stream is compared to findings from the Kamb and Whillans ice streams, and one sediment core was collected in 1998 by Caltech. Preliminary findings highlight the utility of fossil marine diatoms in paleotopographic reconstructions for the Paleogene, and the Neogene findings are consistent with a Pleistocene ice sheet retreat. These observations will be integrated in the future with new results to be obtained through stratigraphic drilling planned for the international SWAIS 2C Project (Sensitivity of the West Antarctic Ice Sheet to 2 degrees C warming). Two new drill sites are planned at a location seaward of the Kamb Ice Stream grounding line, and at Crary Ice Rise. Both sites are expected to recover ~200 meter-long drill cores that will likely recover in situ marine diatom bearing Neogene sediments, and a mixture of diatom-bearing sediment clasts of multiple ages.

Relationship among rifting, magmatism and mantle melting of the West Antarctic Rift System
Jinyao Gao[1], Xiaoxian Cai[1]

[1]*Second Institute of Oceanography, Ministry of Natural Resources - MNR*

The West Antarctic Rift System (WARS) had undergone a transition from the Cretaceous diffuse rifting to the Cenozoic focused rifting, but its drive and transition mechanism are still obscure or controversial. Obviously, a geodynamic mechanism is necessary to address the relationship among rifting of the WARS magmatism, along the Terror Rift and melting of the mantle low-velocity zone (MLVZ). According to the global plate model, combined with the rotation parameters of 9 key time nodes and tectonic outlines of the Antarctic plate, we refined the relative movements between the East and West Antarctica since 100 Ma on the GPlates. We integrate structures of the Ross Sea basins indicated by geophysical data into the newly constructed plate kinematic model. The results show that the WARS rifting could be interpreted by the plate kinematic model, whose change of velocities corresponded to an event of episodic extensions in the Ross Sea basins. By establishing the relationship between the extensional deformation of the Ross Sea basins in different phases and the MLVZ now beneath the western Ross Sea, it is inferred that there could occur a coupling between the MLVZ development and its overlying basin rifting. This coupling possibly determines the transition of the WARS rifting modes and the magmatism along the Terror Rift. The transtension from the strike-slip faulting may import more water into upper mantle than the orthogonal extension with detaching faults, and promoted mantle melting and magmatism, especially at the two ends of the Terror Rift. It was just after the TR and the northeastern VL coast appeared above the LVZ, there have occurred magma intrusion and volcanic eruption during 8-5 Ma, especially at Ross Island and Mount Melbourne.

Emerging Pollutants Session

Influence of Australian Black Summer smoke in Antarctic aerosol collected on board during the R/V Laura Bassi first campaign in the Ross Sea

Elisa Scalabrin[1], Elena Barbaro[1], Sarah Pizzini[2], Marta Radaelli[3], Matteo Feltracco[3], Francisco Ardini[4], Federico Girolametti[5], Rossano Piazza[3], Andrea Gambaro[3], Gabriele Capodaglio[3]

[1]*National Research Council of Italy, Institute of Polar Sciences (ISP)*
[2]*National Research Council of Italy, Institute for Marine Biological Resources and Biotechnology (IRBIM)*
[3]*Department of Environmental Sciences, Informatics and Statistics, Ca'Foscari University of Venice*
[4]*Department of Chemistry and Industrial Chemistry, University of Genoa*
[5]*Department of Life and Environmental Sciences, Polytechnic University of Marche*

Biomass burning has been recognized as the largest source of primary fine carbonaceous particles, influencing the climate system and the Earth's solar balance. During the 2019-2020 Australian bushfire season, and particularly from December to January, a lot of wildfires impacted the south-east of Australia, affecting local air quality. The huge amount of emitted smoke influenced stratospheric temperature over Antarctica and stratospheric aerosol optical properties (Damany-Pearce et al., 2022; Tencé et al., 2022). Long-range atmospheric transport to Antarctica and South America was also hypothesized. Levoglucosan is an anhydrosugar widely recognized as a key tracer of biomass combustion, because it can be only produced by the combustion of cellulose. Polycyclic aromatic hydrocarbons (PAHs) are organic compounds typically produced during combustion processes and are known to be present in wildfire smoke. In this work, levoglucosan and PAHs, together with other complementary sugars, were determined in aerosol samples collected during the XXXV Italian Expedition in Antarctica on board the R/V Laura Bassi from 6th January to 16th February 2020, at the end of the so-called Australian Black Summer. Total suspended particles (TSP) with a diameter >1 mm were collected on a circular quartz fiber filter (Filtros Anoia S.A. Filter-Lab, Barcelona, Spain) using a TE 5000 High-Volume Air Sampler (Tisch Environmental Inc., Cleves, OH, USA). The sampling system was connected to a wind control system, to avoid contamination from the ship. For this reason, the sampling lasted between 2 and 7 days and was carried out mainly in the coastal area of the Ross Sea. The results clearly indicate a contribution of Australian wildfires on Antarctic aerosol composition, by comparison with the detected levels of the same compounds during previous sampling campaigns in the Ross Sea area (Barbaro et al., 2016; Zangrando et al., 2016). Back trajectories indicate a local source of aerosol, confirming the hypothesis of long-term persistence of smoke over the globe, with a long-lasting influence of general air quality. Together with biomass burning tracers, a marine biogenic component was also identified using other chemical tracers, such as monosaccharides. Barbaro, E., Zangrando, R., Kirchgeorg, T., Bazzano, A., Illuminati, S., Annibaldi, A., Rella, S., Truzzi, C., Grotti, M., Ceccarini, A., Malitesta, C., Scarponi, G., Gambaro, A., 2016. Environ. Chem. 13, 867–876. https://doi.org/10.1071/EN16056 Damany-Pearce, L., Johnson, B., Wells, A., Osborne, M., Allan, J., Belcher, C., Jones, A., Haywood, J., 2022. Sci. Rep. 12, 1–15. https://doi.org/10.1038/s41598-022-15794-3 Tencé, F., Jumelet, J., Bekki, S., Khaykin, S., Sarkissian, A., Keckhut, P., 2022. J. Geophys. Res. Atmos.
Topic: Emerging chemicals and pollutants

Processes affecting the distribution of PCBs in the Southern Ocean

Sarah Pizzini[1], Elisa Scalabrin[2], Marta Radaelli[3], Rossano Piazza[3], Gabriele Capodaglio[3]

[1]*National Research Council of Italy, Institute for Marine Biological Resources and Biotechnology (IRBIM)*
[2]*National Research Council of Italy, Institute of Polar Sciences (ISP)*
[3]*Department of Environmental Sciences, Informatics and Statistics, Ca'Foscari University of Venice*

Polychlorinated biphenyls (PCBs) are a broad class of globally distributed persistent pollutants that differ in their degree of chlorination and, thereby, in their volatility and are subject to long-range atmospheric transport (LRAT). Although their industrial production was discontinued in the early nineties, some PCB congeners are still released into the environment as unintentional by-products of dye manufacturing and other chemical productions. Among them, 3,3'-dichlorobiphenyl (PCB-11) has been detected at concentrations often higher than those of the other technical congeners (i.e. legacy Aroclor PCBs) in almost all the environmental compartments, even in polar areas [1]. It is known that the atmosphere plays a key role in transport and distribution of persistent organic pollutants (POPs) towards polar areas, through successive phases of volatilization and deposition that occur at the air/water interface. The low temperatures of the polar areas promote this partition between the atmosphere and the seawater surface via the cold trapping mechanism [2]. However, this process is reversible, so the partition of POPs moves in one direction or in the opposite one depending on the volatility of the molecules involved, their relative concentration in air and water, and changes in temperature [3]. As the surface water temperature decreases, lighter congeners, more prone to volatilization, tend instead to settle in the water surface layers. Indeed, in the Southern Ocean, where the temperature of surface water is reduced to values close to that of the air, a particularly high concentration of PCB-11 compared to that of other less volatile PCB congeners have been reported [1,4]. Instead, PCBs with a higher degree of chlorination are less prone to volatilization in temperate areas and, consequently, they would be preferentially transferred to the Southern Ocean through Modified Circumpolar Deep waters [5] rather than via LRAT. Against this background, it can be assumed that more processes are involved in the transport of PCBs towards the Southern Ocean, depending on the characteristics of the investigated molecules and, primarily, their volatility. In this work, the results of analyses of water samples collected along a transect from the Southern Pacific Ocean to the Ross Sea will be presented. Preliminary outcomes confirmed the hypothesis that more volatile PCBs reach the Southern Ocean preferentially through a cold condensation process, differently from heavier ones. Di- and Tri-chlorinated PCBs reached particularly high concentrations in water surface layers where there is a sharp decrease in temperature, in the Antarctic convergence zone, while this effect is much more limited for the less volatile investigated congeners.

Coupled influence of ice melting and feeding habits on bioaccumulation of trace elements in Antarctic fish

Geraldina Signa[1], Edoardo Calizza[2], Cecilia Tramati[1], Giulio Careddu[2], Giovanna Cilluffo[1], Simona Sporta Caputi[2], Maria Letizia Costantini[2], Antonio Mazzola[1], Loreto Rossi[2], Salvatrice Vizzini[1]

[1]Department of Earth and Marine Sciences (DiSTeM), University of Palermo; National Interuniversity Consortium for Marine Sciences (CoNISMa)
[2]Department of Environmental Biology, Sapienza University of Rome, Rome, Italy; National Interuniversity Consortium for Marine Sciences (CoNISMa)

Despite its remoteness, Antarctica is affected by environmental contamination due to global and local factors. Furthermore, it is among the most fragile and susceptible areas to climate change. Ocean warming is altering the seasonal dynamics of sea-ice melting, affecting the release of contaminants into the water column and their transfer to the biota. Endemic non-migratory fish are considered excellent bioindicators of trace element (TE) contamination over time. Here, the benthic emerald rockcod Trematomus bernacchii and the demersal icefish Chionodraco hamatus were sampled in Terra Nova Bay, within the Ross Sea, in winter and austral summer (2017/2018), to investigate the influence of ice melting on TE bioaccumulation patterns. The muscle and liver of both fish were analysed for TE concentration (As, Cd, Cr, Cu, Hg, Mn, Pb, Zn). Stable isotopes (d13C, d15N) were also analysed to assess the influence of trophic role and position on the observed patterns. Results highlighted that sea-ice melting plays a major role in modulating the accumulation of As, Cd, Mn, and Zn in the fish tissues. This can be explained by the release of trace elements into the water column as the sea ice melts, increasing the availability and the transfer to fish directly through gills or indirectly through diet. The occurrence of species-

and tissue-specific patterns of TE accumulation was also relevant. Specifically, T. bernacchi showed higher TE concentration than C. hamatus, reflecting different habitat use and feeding strategy. Moreover, higher TE concentration was found in the liver than in muscle, indicating detoxification processes. The only exception was represented by Hg, which was more concentrated in muscle, especially in C. hamatus, due to its higher position in the food web and biomagnification processes. These results represent baseline data for monitoring TE contamination levels in the Sea Ross Marine Protected Area under the climate change scenario.

Passive sampling of emerging contaminants in water at Terra Nova Bay (Antarctica)

Emanuele Magi[1], Chiara Scapuzzi[1], Barbara Benedetti[1], Henry Mackeown[1], Matteo Baglietto[1], Marina Di Carro[1]

[1]Department of Chemistry and Industrial Chemistry, University of Genoa

The Ross Sea, amongst the least human-impacted marine environments worldwide recently became the first protected area in Antarctica and the world's largest Marine Protected Area. The research project MATISSE strives to identify emerging contaminants and potential metabolites in several matrices of the coastal area of Terra Nova Bay during two consecutive austral summers (2021-2023). The final aim is to obtain an estimation of the contamination levels and of possible negative impacts of the scientific stations present to evaluate the potential environmental risk. Passive sampling of water contaminants have not been previously employed in Antarctica, nor in seawater, nor in wastewater. We report for the first time the results of passive sampling for polar emerging contaminants in this region. Passive sampling – as well as spot sampling for comparison – took place in the effluent of the wastewater treatment plant of the Italian research station Mario Zucchelli (MZS) and the receiving surface marine waters several hundred meters offshore. The Polar Organic Chemical Integrative Sampler (POCIS) was employed in both water matrices. POCIS were deployed at shallow depth offshore from the wastewater effluent outlet from MZS for two separate 3-week periods (November 2021 and January 2022). Grab water samples were collected on three occasions (at the beginning, in the middle and at the end of deployment) during both periods. Passive samplers were also deployed for six consecutive 2-week periods from November to February in a reservoir collecting the wastewater effluent. Grab water samples were collected and extracted once per week during the whole period. High performance liquid chromatography - electrospray ionization – tandem mass spectrometry (HPLC-ESI-MS/MS) was employed for quantification of 22 target analytes, including drugs, UV-filters, perfluorinated substances, caffeine, etc. 15 of the studied ECs were detected in both grab and passive sampling in the wastewater treatment plant effluent and followed similar concentration profiles in both types of sampling. Thus, passive sampling could be an effective method to limit time-intensive sample collection and processing. High concentrations of caffeine, naproxen and ketoprofen in the dozens of µg/L were measured in the wastewaters. The other drugs and several UV filters were detected in the µg/L range. In marine waters, only traces of naproxen and ibuprofen were detected. Thus, for the second campaign (November 2022-January 2023), marine samplers were placed closer to the wastewater treatment plant outlet. The results of both campaigns will be compared to obtain a better assessment of the impact of the Italian Station on the surrounding waters.

Textile microfibers in wild specimens of the Antarctic scallop Adamussium colbecki (Smith, 1902), from Terra Nova Bay, Ross Sea Antarctica

Emma Ferrari[1], Ilaria Corsi[1], Roberta Russo[1], Elisa Bergami[2]

[1]University of Siena
[2]University of Modena and Reggio Emilia (UNIMORE)

Plastic pollution has reached the most remote regions of our planet including the Southern Ocean and coastal Antarctica whose biodiversity is already under threats associated with an increasing human pressure. From

global long-range transport as well as local sources, a wide range of microplastic concentration (0.002-0.1 m-3) having various shape (fibers, beads, films) and polymer composition (cellulose and synthetic polymers) has been documented in Antarctic sea-ice, snow, water, sediments and biota. Microfibers (MF) have been recognized among the most frequent in terms of amount and distribution and mostly made of natural cellulose (~80%) and polyethylene terephthalate as prevalent synthetic polymer. Although fabric MF made of cellulose or wool can be considered not harmful being natural biodegradable polymers, toxic additives have been shown to resist washing and to remain attached to the released MF with serious consequences for marine species. Recently, we demonstrated that textile (semi-)synthetic/composite MF (polyethylene terephthalate and cellulose-polyamide composites; length range: 0.25–4.98 mm) found in specimens of Antarctic whelk Neobuccinum eatoni collected from Terra Nova Bay in the Ross Sea matched those of outdoor technical clothing in use by the personnel of the Italian "Mario Zucchelli" station. A most recent study analyzing wild specimens of the Antarctic scallop Adamussium colbecki collected in 2004 and 2019 from the same location further confirms microplastic contamination in Ross Sea benthic fauna. Two main target organs as gills and mantle were analyzed as main entrance of microplastics from water filtration and revealed that 91.6 % of individuals tested were contaminated by microplastics with a total of 79 MF and 20 fragments (74.68% and 25.31% respectively) and in number of 6.6 ± 1.94 microplastics in each individual. MF (length 0.06 – 9.2 mm) were classified by colors as black 47.45 %, blue 38.98 % and red 13.55 % while fragments were of different shapes and mainly blue and black. Scallop's mantle resulted more contaminated than gills (total amount 41 vs 28) and specimens collected in 2004 resulted all contaminated by microplastics (positive 100%) and in higher amount compared to those from 2019 (total amount 48 vs 31 and 8 ± 1.75/individual and 5.17 ± 2.09/individual respectively). The polymer characterization of the microplastics and microfibers has been done by Raman and FTIR. Overall findings further confirm that Terra Nova Bay benthic organisms are interested by microplastic contamination and local source as well long-range transport are indeed responsible for such treat. Therefore, future studies addressing either origin but more important ecological risks posed by microplastic and in particular MF on Antarctic marine coastal biodiversity are mandatory.

Poster Contributions

Physical Oceanography

Glider measurements in the Ross Sea during January 2020

Annunziata Pirro[1], Riccardo Martellucci[1], Milena Menna[1], Piero Zuppelli[1], Riccardo Gerin[1], Antonio Bussani[1], Massimo Pacciaroni[1], Stefano Kuchler[1], Pierpaolo Falco[2], Enrico Zambianchi[3], Pasquale Castagno[3], Naomi Krauzig[2], Elena Mauri[1]

[1]*National Institute of Oceanography and Applied Geophysics – OGS*
[2]*University of Napoli Parthenope*
[3]*Marche Polytechnic University*

During the 2020 austral summer a glider field campaign was carried out in the eastern sector of the Ross Sea from 18 to 26 January, as part of the ESTRO (Effect of the eaSTern inflow of water on the ROss Sea salinity field variability) project. The OGS seaglider was deployed at 77.16S, 162.47W, and recovered at 78.11S, 164.98W. During the glider mission, the physical and biogeochemical properties of the water column were sampled in the upper 500 m of depth along an approximately 130 km transect. Glider data were analyzed in conjunction with the hydrological measurements collected along the Ross Ice Shelf (RIS), and water mass characteristics and dynamical features were investigated. Considering that the area sampled by the autonomous vehicle was inaccessible to the ship due to the sea conditions, the use of the glider represented a significant improvement in the observation capabilities during the oceanographic cruise and made it possible to extend the measurements between the RIS and the open sea.

Ocean currents and sea ice drift observations in the Ross Sea (Antarctica)

Milena Menna[1], Giuseppe Aulicino[2], Yuri Cotroneo[2], Annunziata Pirro[1], Riccardo Martellucci[1], Pasquale Castagno[3], Naomi Krauzig[4], Pierre-Marie Poulain[1], Enrico Zambianchi[2], Elena Mauri[1], Antonio Bussani[1], Pierpaolo Falco[4]

[1]*National Institute of Oceanography and Applied Geophysics – OGS*
[2]*University of Napoli Parthenope*
[3]*University of Messina*
[4]*Marche Polytechnic University*

In January 2020, eleven SVP (Surface Velocity Program) drifters were deployed in the Ross Sea near the northeastern edge of the Ross Ice Shelf as part of the MORSea (Marine Observatory in the Ross Sea) project. This is the first dedicated experiment to deploy Lagrangian drifters in the interior of the Ross Sea. These drifters measured the currents and surface temperatures of the ocean for about a month before being affected by sea ice formation in early March 2020. Some of them survived the ice formation, were trapped by the ice, and were transported for several months. The few but valuable and unique data provided by these drifters offer the chance to analyse two different scenarios: an "oceanic" scenario, describing the late summer ocean conditions of the surface layer of the eastern Ross Sea (current strength, temperature, high frequency ocean signals, absolute dispersion); an "ice" scenario, capturing the exact time when the drifters came into contact with the ice (using SAR images), and comparing the satellite ice drift with the velocities measured by the drifters when embedded in the ice.

Long-term temperature variability over the New Zealand – Antarctica chokepoint of the ACC during the last three decades

Antonino Ian Ferola[1], Yuri Cotroneo[1], Pasquale Castagno[2], Giannetta Fusco[1], Pierpaolo Falco[3], Giorgio Budillon[1], Enrico Zambianchi[1], Giuseppe Aulicino[1]

[1]*University of Napoli Parthenope*
[2]*University of Messina*
[3]*Marche Polytechnic University*

A 29-year time series of XBT data collected along New Zealand - Antarctica 'chokepoint' of the Antarctic Circumpolar Current (ACC) enabled us to analyse the temperature variability of the surface and intermediate layers of the Southern Ocean (SO) over the last three decades (1994-2023). Our findings confirm previous studies, showing an overall warming trend in the SO over the past 30 years. Notably, the northernmost portion of the ACC exhibits significant warming, while the southern areas beyond the Polar Front experience no significant temperature trends. In particular, we focused on ACC's main water masses, i.e. Sub Antarctic Mode Water (SAMW), Antarctic Intermediate Water (AAIW), Antarctic Surface Water (AASW), and Circumpolar Deep Water (CDW). These water masses originate from different processes and geographical locations and can be representative of different regions of the SO on a variety of spatial and temporal scales. Our analysis reveals strong warming trends of approximately 0.20° C/dec for SAMW and 0.18° C/dec for AAIW over the study period, while AASW and CDW show negligible and/or not significant trends. Additionally, we explored temperature variations during each of the three decades (1994-2003; 2004-2013; 2014- 2023), providing the starting point for future discussion on temperature variability along depth, latitude and time over the study area.

Ocean-ice-atmosphere Interactions

A novel system for quantitative sampling of sub-ice platelet layers

Natalie Robinson[1], Craig Stewart[1], Ken Ryan[2], Steve Parker[3], Neill Barr[1]

[1]*National Institute of Water and Atmospheric Research (NIWA)*
[2]*Victoria University of Wellington*
[3]*Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)*

Hidden beneath the sea ice of Antarctica’s coastline exists a fragile, and ephemeral habitat which is thought to play a key role in underpinning the marine food web. Near the front of large ice shelves, outflowing seawater containing meltwater from deep beneath the ice shelf can become ‘supercooled’ – i.e., colder than the ambient freezing temperature. This supports the development of ‘sub-ice platelet layers’ (SIPLs) – accumulations of ice discs, each 2-5 mm thick, that buoyantly rise through the water column until they come to rest against the base of the sea ice. The discs coalesce to form an intricate 3-dimensional ice matrix that may extend several metres into the upper ocean, with seawater filling the interstitial spaces. The result is a quiescent and protective marine habitat that harbours some of the highest concentrations of primary productivity on Earth, but whose viability may be threatened by subtle climate shifts. In-situ, and while the interstices remain filled with ocean water, the 3-dimensional SIPL structure can be reasonably robust. However, when samples of the SIPL are extracted, and the interstitial fluid drains away to be replaced by air, the structure becomes very delicate and may disintegrate rapidly. Hence, until very recently, qualitative analysis of the integrated SIPL system – comprising the ice structure itself, the interstitial fluid, and any associated biology – has not been possible. Here we describe the development, testing, and initial deployment of a new, bespoke-engineered system for coring the SIPL. The system sequentially extracts segments of the SIPL without destroying the structure or disassociating the ice from the interstitial fluid or incorporated biology. The samples can then be analysed for ice/water fraction, physical

characteristics, or biological assemblage, each of which can be related to the environmental setting. Ultimately, the system will be used to inform assessment of the Ross Sea ecosystem's susceptibility to change as determined by the vulnerability of the unique SIPL habitat.

Simulated Last Deglaciation oceanic circulation in the Ross Sea: ice-sheet-ocean interactions during the Antarctic Ice Sheet retreat

Enrico Pochini[1,2], Florence Colleoni[2], Andrea Bergamasco[3], Manuel Bensi[2], Michael S. Dinniman[4], Laura De Santis[2], Emanuele Forte[1], Vedrana Kovacevic[2], Stefanie L. Mack[5]

[1]University of Trieste
[2]National Institute of Oceanography and Applied Geophysics – OGS
[3]National Research Council of Italy, Institute of Polar Sciences (ISP)
[4]Center for Coastal Physical Oceanography, Old Dominion University (CCPO-ODU)
[5]Centre For Climate Repair At Cambridge, (Ccrc)

During the last deglaciation (21-0 ka), the Antarctic Ice Sheet (AIS) in the Ross Sea retreated from the continental shelf break, where it was grounded, to its present-day configuration. The pathways and timing of grounding line retreat, as suggested by sedimentological, geomorphological evidence and by ice sheet modelling, hint for a possible role of the ocean as a trigger for AIS retreat. Overall the role and dynamics of the ocean during the last deglaciation in the Ross Sea remains largely unexplored. We investigate this by simulating the evolution of oceanic circulation in the Ross Sea over the last deglaciation (21-0 ka), at intervals of 1000 years, starting at the Last Glacial Maximum (21 ka). The MITgcm, in a new regional implementation of the Ross Sea, including sub-ice shelf circulation, is forced by outputs of the global transient paleoclimate simulation TraCE-21ka, with a basin geometry consistent with the AIS configuration during retreat adapted from existing paleo ice-sheet simulations and geological evidence. During the early deglaciation (21-17 ka), geological evidence suggest that the AIS was grounded up to the continental shelf break, with the exception of ice shelves located in the Drygalski, the Joides and the Pennel troughs, and by 17 ka, an ice shelf developed also in the Whales Deep trough. In our oceanic simulations, cold, salty High Salinity Shelf Water (HSSW) fills the entire cavities in the Drygalski and Joides troughs, whereas the Pennel and Whales Deep ice shelves are frequently reached by relatively warm Circumpolar Deep Water (CDW). During the Meltwater Pulse 1A (14.6-14.3 ka), the release of meltwater and icebergs in the North Atlantic yields a slow-down of the Atlantic Meridional Overturning Circulation in the TraCE-21ka paleoclimate simulation, with subsequent warming of the deep ocean and freshening of intermediate waters in the Southern Ocean. This weakens the Antarctic Slope Front in our Ross Sea simulation, fostering warm CDW intrusions beneath the Whales Deep ice shelf, causing intense basal melting. At last, during the Holocene (11.8-0 ka), the AIS retreat and the Ross Ice Shelf gradual formation lead to an increasing open-marine portion of the continental shelf: cold and salty Shelf Water becomes widespread over the Ross Sea, reducing the intrusions of the CDW by strengthening the Antarctic Slope Front. HSSW production restores strongly only since the Middle Holocene (~6 ka).

Preliminary atmospheric observation collected during the Laura Bassi Antarctic Cruise in the framework of PNRA CAIAC Project

Angelo Lupi[1], Niccolo Losi[2], Luca Ferrero[2], Flavio Esposito[3], Stefania Campopiano[3], Agostino Iadicicco[3], Michele Giordano[4], Federico Zardi[5], Marco Paglione[5], Matteo Rinaldi[6], Marco Ferriani[7], Andrea Gallerani[8]

[1]National Research Council of Italy, Institute of Polar Sciences (ISP)
[2]GEMMAcenter, Department of Environment and Earth Sciences, The University of Milano-Bicocca
[3]Department of Engineering, University of Naples Parthenope
[4]Institute for Polymers, Composites and Biomaterials, National Research Council of Italy (CNR)

[5]*Institute for Microelectronics and Microsystems, Italian National Research Council CNR-IMM*
[6]*Institute of Atmospheric Science and Climate ,National Research Council of Italy*
[7]*ENEA Italian National Agency for New Technologies*
[8]*Institute of Marine Sciences, National Research Council of Italy*

The CAIAC (oCean Atmosphere Interactions in the Antarctic regions and Convergence latitude is project aims to investigate the aerosol forcing and its role in Climate Change questions answering to specific experimental and modelling tool needs, exploiting the Laura Bassi Cruises during the PNRA campaign. The CAIAC project will exploit innovative tools to provide first results of georeferenced climatic direct effect of different aerosol sources and types in all sky conditions along the Ross Sea region and during the transect between New Zealand and the Antarctic Coast. A specific atmospheric observatory was installed on different part of the ship, and during the first campaign (January-February 2023) different data are collected: online measurements of downwelling (both shortwave [global and diffuse] and longwave) radiative fluxes, plus spectral signature of the sea/ice surface. Besides these radiometric measurements, an absorption photometer was used to evaluate the aerosol Black Carbon concentration in the pristine marine environment of the Ross Sea Area. Moreover, an array of thermo-hygrometer sensors based on optical fiber technology has been installed to investigate the vertical gradient of T e RH meteor variables during Laura Bassi Cruises. Optic fiber technology solutions are just starting in this application field offering advantages such as lightweight, high speed, high sensitivity and the absence of electronic components usually damaged from sea water and salt crystals. In addition, a series of offline aerosols collected filter were also installed to characterize the primary and secondary aerosols, and their climate-relevant properties.

Analysis and interpretation of sea ice dynamics depending on large-scale weather pattern in the Ross Sea
Daniela Flocco[1], Pierpaolo Falco[2], Enrico Zambianchi[3], Stefan Kern[4]

[1]*University of Naples Federico II*
[2]*Marche Polytechnic University*
[3]*University of Napoli Parthenope*
[4]*Integrated Climate Data Center (ICDC), CEN, University of Hamburg*

The Ross Sea is one of the most active sea ice regions in the Antarctic and it is known for its high variability in sea ice concentration, which is influenced by several meteorological factors. Meteorological data, including temperature, wind, and precipitation, play a significant role in determining sea ice concentration in the Ross Sea: sea ice in this region is in fact influenced by both local and large-scale weather patterns, e.g. the Amundsen Sea Low, making it a valuable location for understanding the dynamics of sea ice and its response to climate change. Several studies have shown that warming temperatures and increasing wind speeds are associated with decreased sea ice concentration in the Ross: strong winds can cause the formation of leads or open water areas in the sea ice cover, which can indirectly lead to a decrease in sea ice concentration caused to the extra heat stored in the exposed ocean. Additionally, winds can push sea ice around, causing it to compact or thin in certain areas. In this work, we provide an overview of the current state of knowledge on sea ice concentration fluctuation in the Ross Sea, including the role of meteorological data in driving these changes. Our research aims to further investigate the relationship between meteorological data and sea ice concentration fluctuation in the Ross Sea using observational data and numerical models. The findings of this research will contribute to the understanding of the dynamics of sea ice in the Southern Ocean and have important implications for predicting future sea ice change in the region.

Marine Biology and Ecology

Molecular time-capsules – reconstructing the Ross Sea ecosystem using eDNA obtained from marine sponge specimens

Miles Lamare[1], Jeunen Gert-Jan[2], Treece Jackson[2], Ferreira Sara[2], Mariani Stefano[3], Mills Sadie[4], Gemmell Neil[2]

[1]*University of Otago*
[2]*University of Otago, Anatomy Department*
[3]*Liverpool John Moores University*
[4]*National Institute of Water and Atmospheric Research (NIWA)*

Direct anthropogenic pressures and human-induced climate change are modifying our natural world at an unprecedented pace, radically affecting ecosystem stability and health. To understand the consequences of these changes, monitoring biodiversity trends is crucial. Obtaining such information for the Ross Sea marine ecosystem is challenging, however, due to the remoteness of the area, logistical constraints, and complexity of the biological community. Given the ecological and economic importance of the Ross Sea, it is imperative that additional biological monitoring approaches are explored. Recently, our team showed that marine sponges, which are frequently caught and discarded in Southern Ocean fisheries, naturally accumulate environmental DNA (eDNA). In this study, we compare fish and eukaryotic eDNA signals from marine sponge specimens to fish catch records and visual surveys for seventeen locations on the continental slope (887mt 1,612mt), nine locations on the continental shelf (523 m 709 m), and seven locations along the Ross Sea coastline (10mt 25mt). Overall, sponge eDNA signals detected a larger fraction of the Ross Sea fish and eukaryotic community compared to fish catch records and traditional monitoring approaches. Furthermore, a pairwise comparison between fish catch and sponge eDNA revealed eDNA signal strength correlating more strongly with fish abundance over biomass, thereby enabling the prediction of fish catch abundance through eDNA monitoring. Additionally, spatial biodiversity patterns were observed within our eDNA data, corresponding with known species distributions in the Ross Sea. Our results highlight the potential of sponge eDNA monitoring in the Ross Sea by detecting a larger fraction of the biological community, thereby increasing our knowledge of this understudied ecosystem and, ultimately, aid conservation efforts.

Virus-prokaryote interactions in the sea ice and underlying water of the Ross Sea

Michael Tangherlini[1], Antonio Dell'Anno[2], Gabriella Luongo[2], Antonio Pusceddu[3], Cinzia Corinaldesi[2]

[1]*Stazione Zoologica Anton Dohrn*
[2]*Marche Polytechnic University*
[3]*University of Cagliari*

The Ross Sea (Southern Ocean, Antarctica) is one of the globally most important area for the production of sea ice and represents an important CO2 sink. Antarctic sea ice hosts diversified biological assemblages comprising microeukaryotes (e.g. algae), prokaryotes, and viruses. Generally, in marine ecosystems, viruses are the most important cause of mortality of prokaryotic and eukaryotic organisms and can control biodiversity and ecosystem functioning with cascade effects on the carbon cycle and nutrient regeneration. However, information on virus-host interactions in Antarctic sea ice is limited. In the present study, we investigated the distribution of viruses and prokaryotes in the platelet and brown ice, as well as in the seawater collected below sea ice, in two different stations nearby the â€œMario Zucchelli Stationâ€ (MZS) of the Ross Sea. We also assessed the interactions between viruses and their hosts, and the potential influence on the structure of the prokaryotic assemblages. We found that prokaryotic biomass and abundance followed similar patterns in the two investigated stations, with higher values in seawater than in the brown ice. Conversely, viral abundance and infection showed opposite patterns. Prokaryotic assemblages showed a lower diversity in the samples with a higher viral pressure

suggesting a potential top-down viral control. We also found differences in the structure of prokaryotic assemblages in the two typologies of sea ice and in the underlying water. In particular, in the brown ice, Colwelliaceae (ca. 40%) represented the most relevant bacterial family while Pseudomonadaceae were mainly represented in the platelet ice (16%). Pseudomonadaceae were also the dominant taxa in seawater. However, we also observed that Colwelliaceae, Pseudoalteromonadaceae and Flavobacteriaceae, among the others, were shared among the different Antarctic matrices suggesting a stable core of bacterial members unaffected by the variability of environmental and biological conditions (including the viral pressure) in the different Antarctic matrices. Overall, this study provides new insights on viral-prokaryotic interactions and factors potentially influencing microbial diversity in one of the most extreme and dynamic ecosystems on Earth.

Investigating the Molecular Adaptation of the Parasite Species Contracaecum osculatum D (Nematoda: Anisakidae) to Extreme Antarctic Environment

Marialetizia Palomba[1], Xavier Roca-Geronès[2], Pietro Libro[1], Mario Santoro[3], Tiziana Castrignanò[1], Simonetta Mattiucci[4]

[1]Department of Ecological and Biological Sciences (DEB) Tuscia University
[2]Department of Public Health and Infectious Diseases, Sapienza-University of Rome
[3]Department of Integrative Marine Ecology, Stazione Zoologica Anton Dohrn
[4]Section of Parasitology, Department of Public Health and Infectious Diseases, Sapienza-University of Rome

Temperature is a critical environmental factor that affects the biology of animals, including parasites. However, while parasites of endothermic hosts are protected from low temperatures by the thermoregulatory abilities of their host, those parasites of ectothermic hosts may be exposed to subzero temperatures within their hosts. In this latter case, they can develop their own mechanisms for the cold tolerance adaptation. The anisakid nematode Contracaecum osculatum sp. D inhabits the Earth's coldest marine environment and is exposed to extreme temperatures for part of its life cycle. C. osculatum sp. D has a heteroxenous life-cycle, which includes a free-living larval stage, a third larval stage in ectothermic organisms (invertebrates and ice-fish) and the adult stage in homeothermic organisms (ie., Weddell seals, Leptonychotes weddellii). The aim of this study was to investigate the molecular adaptation speculated by C. osculatum sp. D to the extreme Antarctic environment, identifying the genes implicated in thermal tolerance and gene expression variation under temperature stress. To achieve this goal, the transcriptional response of C. osculatum sp. D L3 was analyzed after in vitro exposure to thermal variation (37°C, 1°C, −5°C) at different time points. A de novo transcriptome analysis for C. osculatum sp. D was also applied. Detailed differential expression analysis reveals a number of candidate genes that are potentially related to the cold tolerance of C. osculatum D. The achieved results will provide new insights into the response mechanisms of nematode species to chilling stress and advance our understanding of the molecular adaptations that allow parasites to survive in extreme environments. In addition, the ability of the parasite to exhibit phenotypic plasticity in its freeze tolerance could have significant implications for the dynamics of host-parasite interactions in a changing world. Granted by PRNA2019.

Response of Phaeocystis antarctica and Chaetoceros sp. from the Ross Sea to strong salinity stress. Ecological implications

Emanuela Serino[1], Francesco Bolinesi[1], Olga Mangoni[1]

[1]University of Naples Federico II

Coastal Antarctic pelagic food webs are primarily based on two main photoautotrophic functional groups: diatoms and haptophytes (e.g., Chaetoceros spp. and Phaeocystis antarctica). The relative dominance the two groups varies on different temporal and spatial scales, thereby affecting trophodynamics and CO2 drawdown

processes in the Ross Sea. Organisms in the Ross Sea must cope with multiple environmental perturbations, as shift in salinity driven by melting processes or sea-ice formation. In recent years, a refreshening of Ross Sea water have been reported in relation with ongoing climate changes, although there is still poor information on its effect on main phytoplankton species of pelagic food web. In the present study, we investigated the effect of salinity stress on P. antarctica and Chaetoceros spp. grown at salinity 20 (intense freshwater input), 34 (control), and 60 (brine channels). For all treatments, nutrient uptake, growth-rate and photosynthetic activity have been measured for 15 days in order to characterize the response of the two species under different saline conditions. Results indicate a different response of the two species contrasting rapid salinity changes, with different photosynthetic plasticity and relatively higher values of Fv/Fm at salinity 20 compaerd to 60.

Krill dynamics in the Ross Sea pelagic ecosystem

Iole Leonori[1], Andrea De Felice[1], Ilaria Biagiotti[1], Giovanni Canduci[1], Giordano Giuliani[1], Ilaria Costantini[1]

[1]National Research Council of Italy, Institute for Marine Biological Resources and Biotechnology (IRBIM)

Krill is a core resource for aquatic animals in the Ross Sea, being food basic element for whales, seals, penguins and many other marine birds and mammals. They are among the most important pelagic animals constituting the Middle Trophic Level that substantially link primary producers to top predators in the local pelagic ecosystem. Since 1989, with intervals of around 5 years in average between one campaign to another, acoustic surveys were held in western Ross Sea to estimate the biomass and spatial distribution of Euphausia superba and Euphausia crystallorophias, the two main krill species in the area and their evolution in relation to environmental changes. The results have shown that E. superba is by far the most abundant species over time and that the spatial distribution of the two species is more similar in austral spring (November), but tends to show separated patterns during austral summer (December-January), with E. superba moving northwards, reaching the border with the Southern Ocean, allowing a reduction of competition for food between the species. A different behaviour in relation to the environmental conditions was also observed in the two pelagic species.

Integrated approach to climate change impacts on pteropods abundance and distribution in the western Ross Sea (Antarctica)

Alessandro Bergamasco[1], Letterio Guglielmo[2], Andrea Bergamasco[3], K.M. Swadling[4], C. K. Weldrick[4], G. Yang[5], R. Minutoli[6], S. Schiapparelli[7], M. Grillo[8], A. Granata[6]

[1]National Research Council of Italy, Institute of Marine Sciences (ISMAR)
[2]Stazione Zoologica Anton Dohrn
[3]National Research Council of Italy, Institute of Polar Sciences (ISP)
[4]Australian Antarctic Program Partnership, Institute for Marine and Antarctic Studies, University of Tasmania
[5]Institute of Oceanology, Chinese Academy of Sciences (CAS)
[6]Department of Chemical, Biological, Pharmaceutical and Environmental Sciences
[7]Italian National Antarctic Museum, Department of Physical Sciences, Earth and Environment (DSFTA)
[8]Department of Physical Sciences, Earth and Environment (DSFTA), Department of Earth, Environmental and Life Sciences (DISTAV)

At present, we lack information on plankton distribution in large parts of the Southern Ocean surrounding Antarctica. Characterizing zooplankton communities in space and time is challenging: zooplankton communities are ecologically complex, spatial heterogeneity of zooplankton is high, intergenerational periods of zooplankton are short, and zooplankton can hardly be identified to the genus or species level by in situ instrumentation, though recent developments are promising (Pinkerton et al. 2020). Although Limacina helicina antarctica is a keystone species in the polar regions, information on its ecology and trophic functioning is scarce in the

northwestern Ross Sea. When they migrate to the surface, they may do so in unbelievably huge numbers. These aggregations usually attract their predators, like the sea angel Clione limacina, baleen whales, chunk salmon, pink salmon, herring and certain seabirds. The major aim of this study was to document pelagic pteropods with a detailed inventory recorded from the northwestern Ross Sea. Here we determine the population structure and standing stock biomass of Limacina helicina antarctica and Clione limacina, prey-predator species in the Ross Sea region, and use this information to derive estimates on their horizontal and vertical distribution, in relation to environmental parameters, different seasons and long-term time series. In 1987, Italy started a series of oceanographic cruises to the Southern Ocean. During the last 35 years we have collected zooplankton in all regions of the Ross Sea and adjacent waters, using both standard models of opening-closing plankton nets Bongo and WP2 and BIONESS electronic multinet 0.50 m-2 and 1-m-2 with 200- and 500-m standard mesh sizes. Global warming occurred in the Southern Ocean has a clear potential to affect zooplankton and ecosystems. This could form the basis for a Pan-Antarctic comparation of fauna, including vertical distribution of species richness and diversity and vertical structure of the zooplankton communities. In particular, data from the Ross Sea, will be compared with data collected by the Australian Antarctic Division and the University of Tasmania in the Indian Sector of Antarctica.

Marine Geology and Geophysics Session

pre-LGM paleoenvironmental evolution at Central Basin (Western Ross Sea, Antarctica)

Fiorenza Torricella[1], Ester Colizza[2], Romana Melis[2], Lucilla Capotondi[3], Paola Del Carlo[4], Alessio Di Roberto[4], Federico Giglio[5], Patrizia Macrì[4]

[1]*University of Pisa*
[2]*Department of Mathematics and Geosciences, University of Trieste*
[3]*National Research Council of Italy, Institute of Marine Sciences (ISMAR)*
[4]*National Institute of Geophysics and Volcanology – INGV*
[5]*National Research Council of Italy, Institute of Polar Sciences (ISP)*

We present a multiproxy investigation of three gravity cores collected in the Central Basin on western Ross Sea continental shelf margin. Central Basin is located at the mouth of JOIDES basin (Western Ross Sea, Antarctica) and it represents one of the possible preferential paths of the dense and salty High Salinity Shelf Water (HSSW) which forms in the Terra Nova Bay polynya and then descends from the continental shelf into the deep ocean mixing with the Antarctic Bottom Water (AABW). On the other hands the Central Basin represents one of the preferred pathways for warm Circumpolar Deep Water (CDW) which flows onto the continental shelf providing the main source of heat and nutrients to the Ross Sea continental shelf. A great deal of physical (paleomagnetism, magnetic susceptivity, grain size), chemical-geochemical (organic carbon, biogenic silica and CaCO3 content, major and trace elements) and biological (diatoms and foraminifera assemblages) analyses were performed on the studied sediments. The chronological framework obtained combining 14C radiocarbon dating on organic matter matrix, paleomagnetic measurement and diatom biostratigraphy indicates that the investigated sedimentary sequence covers the last geomagnetic reversal, the Matuyama-Brunhes transition. Here we present the main sedimentary facies recognized identifying the main sedimentological processes and characterizing different environments which permit to reconstruct the oceanographic dynamics in this area.

The challenges of assessing gas hydrate potential in the Ross Sea

Michela Giustiniani[1], Umberta Tinivella[1], Chiara Sauli[1]

[1]*National Institute of Oceanography and Applied Geophysics – OGS*

The theoretical gas hydrates stability zone in the Ross Sea was evaluated by a simple steady-state approach using literature data such as bathymetric data, sea bottom temperature, a variable geothermal gradient, and assuming that the natural gas is methane. As expected, the results of our study confirm that bathymetry and the potential distribution of gas hydrate are correlated; modeling indicates that gas hydrate stability reaches a maximum depth below the seafloor (ca. 400 m) in the basins, where the water temperature is the lowest, and decreases in the banks with thickness ranging between 7 and < 100 m. On the other hand, the existence and dynamics of the gas hydrate distribution are closely related to the existence and evolution of the superficial and shallowly buried geological and geomorphological features as has been suggested by several authors in the past.

The early retreat of the Western Antarctic Ice Sheet documented by ultra-high-resolution Holocene paleoclimate record from the Edisto Inlet fjord (northern Victoria Land, Antarctica)

Francesca Battaglia[1], Laura De Santis[2], Luca Baradello[2], Ester Colizza[3], Vedrana Kovacevic[2], Michele Rebesco[2], Florence Colleoni[2], Leonardo Langone[1], Danilo Morelli[4], Nicola Corradi[4], Daniela Accetella[2], Laura Ursella[2], Manuel Bensi[2]

[1]National Research Council of Italy, Institute of Polar Sciences (ISP)
[2]National Institute of Oceanography and Applied Geophysics – OGS
[3]University of Trieste
[4]University of Genoa, Department of Earth, Environment and Life Sciences – DISTAV

We report for the first time the discovery of an ultra-high resolution Holocene paleoclimate record from the Edisto Inlet fjord, located on the northern Victoria Land coast in the western Ross Sea. Edisto Inlet is a small fjord about 16 km long and 4 km wide, formed by glacial processes and separated from Moubray Bay by a sill. Bathymetric and seismic reflection data combined with geologic samples and oceanographic measurements indicate that most of the post-LGM sedimentation here was influenced by deposition of seasonally flourishing biogenic material (mainly diatom ooze) that was essentially redistributed locally by water currents. The interaction of rapid sediment deposition due to high productivity and persistent fjord-like circulation resulted in the formation of a confined drift and the accumulation of a sediment layer up to 130 m thick in the inner fjord. This indicates that the Edisto Inlet fjord was subject to seasonal sea ice-free conditions with regular warm water intrusions. The undisturbed acoustic character of sediment drift in the central parts of the fjord suggests that the fjord was not shaped by ground ice after the Holocene climatic optimum, when ice ran aground on the fjord margins. The results of this work, based on marine data, suggest that glaciers on the NVL coast retreated by about 11 Ky. This would preclude the presence of extensive ground ice on the northwestern Ross Sea continental shelf after the late Holocene.

Emerging Pollutants Session

Highlighting distributions and potential origins of major and trace elements in the atmospheric and marine systems of the Ross Sea

Francisco Ardini[1], Federico Girolametti[2], Marco Grotti[3]

[1]Department of Chemistry and Industrial Chemistry, University of Genoa
[2]Marche Polytechnic University
[3]University of Genoa

Antarctica is a vast area which is crucial for the understanding of the history of the climate of our planet and the impact of the human activities on the environment. In fact, its remoteness makes the Antarctic continent an ideal natural laboratory to examine the origin, the transport routes and the fate of the pollutants reaching the

area. The transportation and the distribution of the pollutants are influenced by processes involving the atmosphere, the marine system and the water-air interface. In particular, atmospheric aerosol and marine suspended particulate matter (SPM) constitute important long-range carriers of contaminants. Trace elements (TEs) represent a vast and variegate group of chemicals with different roles, typically distinguished as essential (e.g. Fe, Cu, Zn) or toxic elements (e.g. Cd, Hg, Pb). TEs are characterized by a complex biogeochemical cycle, with different origins and ways of global transfer. They are typically transported to Antarctica through the atmosphere, bounded to particulate matter, or via marine currents, as SPM provides adsorption sites for trace metals and can act as metal carrier. Moreover, their distribution in seawater is highly dependent on the factors controlling the dissolved/particulate partition. Therefore, the study of the distribution of TEs in different environmental compartments can provide considerable insight into their cycling through the Antarctic environment. In the framework of the project PROPOSE ("Processes controlling the presence and distribution of pollutants in Ross Sea Area") of the Italian National Research Program in Antarctica (PNRA), the atmospheric and marine system of the Ross Sea was investigated during Austral Summer 2019-2020 as a part of an oceanographic campaign on board the R/V Laura Bassi. In particular, PM10 was collected on cellulose membranes during the whole campaign, including the crossing from and to New Zealand, with temporal resolution varying from 4 to 12 days. In addition, seawater was collected at six stations at different depths by a Teflon GO-FLO bottle; the samples were filtered on polycarbonate membranes in order to separate the dissolved and particulate phases. All the samples were stored at -20°C and then analyzed by inductively coupled plasma techniques after proper treatment. The considered analytes were Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Sn, Sr, V, Zn and Pb isotope ratios. The results show values generally in agreement with data from literature for the Ross Sea. The data treatment and visualization allowed to evaluate marine and/or crustal enrichments, depth distributions for seawater, and spatial and temporal trends for PM10, highlighting different origins for the considered elements.

Are migrating seabirds nesting along the Ross Sea coast (Antarctica) biovectors of emerging and legacy persistent organic pollutants (POPs) to Adèlie penguin rookeries?

Nicoletta Ademollo[1], Nicolas Pala[2], Davide Baroni[2], Marco Vecchiato[1], Simonetta Corsolini[2]

[1]National Research Council of Italy, Institute of Polar Sciences (ISP)
[2]University of Siena, Department of Physical, Earth and Environmental Sciences

The ability of anthropogenic chemicals, which meet the criteria of persistent organic pollutants (POPs), to reach the Polar Regions through long range atmospheric and oceanic transport (LRAT, LROT) is well known. Concomitantly, the role of migratory animals in mediating the long-range transport (LRT) of POPs is less studied. They transport and concentrate these contaminants, sometimes over long distances, in places where they congregate in large numbers and where they discharge some or their entire contaminant load through the release of droppings, spawning, abandoned eggs, moulting, carcasses (Blais et al., 2007). Each spring, over 100 million birds breed around the rocky Antarctic coastline and offshore islands. In this particular ecosystem, migratory species, which spend part of their lives foraging at lower latitudes where the chemical impact can be much higher, act as contaminant biovectors also facilitated by the high bioaccumulation potential of POPs. Therefore they typically exhibit different profiles and higher levels of POPs compared to endemic and resident species foraging entirely south of the Antarctic Circumpolar Current (ACC; 50°S-60°S) (Corsolini et al., 2011). On large scales, the migratory species contribute to a much lesser extent to POP transport respect to other long range pathways (air and ocean currents). On a local scale, their contribution may exceed abiotic transport, especially at pristine receptor sites where migratory species group after a period of extensive dispersal (Mello et al., 2016). The role of biologically mediated environmental transport of chemicals to the Antarctic was explored in this study by targeting a range of POPs, both legacy and recently listed in the Stockholm Convention, as well as currentuse industrial contaminants. Chemicals were analyzed in unhatched eggs and carcasses (muscle and liver) of the migratory South Polar Skua (Chataracta maccormicki) and of resident Adèlie penguin (Pygoscelis

adèliae). Samples were collected in rookeries located along the Ross Sea coast (East Antarctica), from Cape Adare to Inexpressible Island during the XXXVII Italian expedition in Antarctica (2021-2022 Australian Summer season). Results confirm the presence of these contaminants in both species with higher concentrations in skua than in penguin. It is important to assess the role of these seabirds in the dispersal and concentration of pollutants in areas of high biological and conservation importance. In fragile and low resilient ecosystem, they may contribute to a higher local chemical input, respect to other long range transport pathways at pristine sites, which are important to the life cycle of species like the Adèlie penguins. Although this pathway is still poorly understood and measured, POP biological transport is likely to be of increasing importance in the context of a warming Antarctica where unpredictably changed home ranges of species may affect the trophic relationships.

Effluent wastewater as local source of contamination at the Mario Zucchelli Station (Antarctica)

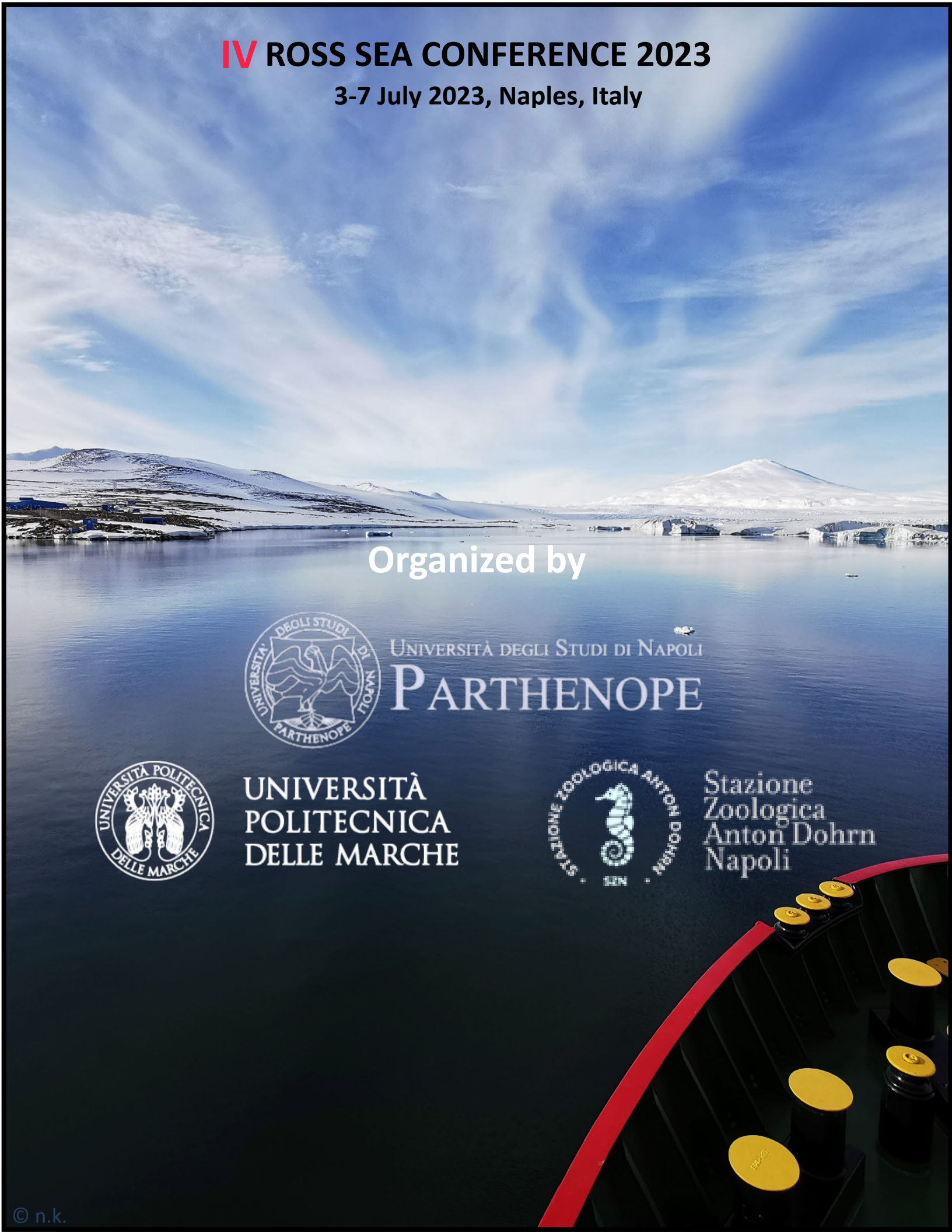
Elisa Scalabrin[1], Roberta Zangrando[1], Nicola Ceolotto[2], Marco Vecchiato[1], Emanuele Magi[3], Andrea Gambaro[4]

[1]National Research Council of Italy, Institute of Polar Sciences (ISP)
[2]Department of Chemistry, University of Bath
[3]Department of Chemistry and Industrial Chemistry, University of Genoa
[4]Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari University of Venice

The levels of pollutants in Antarctica are generally lower than somewhere else in the world. Since there isn't any industrial activity, but only a limited presence of human settlements, pollutants present in the Antarctic are mainly transported for long distances by atmospheric transport (atmospheric aerosols) and the ocean currents. Furthermore, research stations contribute as local pollution sources due to emissions and discharges of domestic waste, effluents, and incineration. For many years, organic micropollutants such as personal care products and hormones have been disregarded as an environmental risk by classical toxicology, since their environmental concentrations are below the toxic thresholds obtained from standardized dose-response curves. However, toxicants can exert biological activity well below their toxic threshold concentration. These sublethal effects are not directly associated with adverse events, but they may lead to the disruption of cell communication or endocrine regulation systems. Therefore, the study of new compounds used in everyday life, the so-called "emerging contaminants", have recently become more and more relevant; nevertheless, at present, only few data are available regarding Antarctica, especially in the Terra Nova Bay area. The aim of this work was the qualitative screening of effluents of Mario Zucchelli Station wastewater treatment plant, by suspects screening and untargeted analysis using high resolution mass spectrometry, in order to verify the presence of a wide range of emerging contaminants and/or metabolites. The integration of the two methods permit to obtain a complete profiling of water samples, including both known and unknown compounds. Among the tentative compounds detected there are personal care products (such as fragrances, detergents, sunscreen agents), pharmaceutical and drugs molecules, pesticide metabolites, surfactants. Other detected compounds, such as plasticizers, compounds used in construction and building materials, flame retardants, PFAS etc, have probably different sources. The obtained results could help in the evaluation of the impact of the scientific Station on the Ross Sea environment.

IV ROSS SEA CONFERENCE 2023

3-7 July 2023, Naples, Italy



Organized by

UNIVERSITÀ DEGLI STUDI DI NAPOLI PARTHENOPE

UNIVERSITÀ POLITECNICA DELLE MARCHE

Stazione Zoologica Anton Dohrn Napoli

© n.k.