

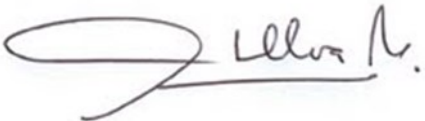

ANNUAL REPORT 2023

Name of the Center: MILLENIUM INSTITUTE OF OCEANOGRAPHY	
Type (Institute or Nucleus)	INSTITUTE ICN12_019N
Acronym	IMO
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Web Page	https://www.imo-chile.com/
Host Institution(s)	Universidad de Concepción, Chile, and Pontificia Universidad Católica de Chile
Address	Cabina 7, UdeC, Barrio Universitario S/N, Concepción
Stage	Continuity
Year of Execution	2023
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Total amount	USD \$10.173.646 for 10 years
Total amount for the reported period	USD \$1.014.388

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Declaración de Singapur

Por este medio declaro que la información entregada en esta memoria anual es fidedigna, y que adhiero a la Declaración de Singapur, contenida en la Resolución Exenta N° 157 del 24 de enero de 2013 de Conicyt, como guía global para una conducta responsable en la investigación.

<i>Institute / Nucleus Director Name</i>	<i>Institute / Nucleus Alternate Director Name</i>
<i>Dr. Oswaldo Ulloa Quijada</i>	<i>Dr. H. Rubén Escribano Veloso</i>
<i>Director's Signature</i>	<i>Alternate Director's Signature</i>
	

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1.1 Executive Summary

IMO investigation is focused on two primary research lines: Adaptation to a Changing Ocean (Line I) and the Deep Ocean Ecosystem (Line II). In Line I, key scientific questions relate to how biogeochemical flows, community composition, and population structure of key species correlate with physical oceanographic drivers. This includes comparing how biogeochemical processes are affected in norm-oxic zones, the oxygen minimum zone (OMZ), and the anoxic marine zone (AMZ), as well as how key communities and organisms respond to a changing ocean. Line II examines the physical, geophysical, and biogeochemical characteristics of deep and ultra-deep waters of the Eastern South Pacific and how these factors can affect the diversity and functional structure of pelagic communities. Since 2022, IMO has also integrated a geoscience program (within Research Line II) by linking oceanography with geology and geophysics.

Technology Development

Since 2016, IMO has had a technology development and transfer unit. However, since 2022, the objectives and activities of this unit have been incorporated into the newly established Center for Oceanographic Instrumentation (CIO) at UdeC. With its own funding, CIO is tightly associated with IMO, operates under the same roof, and is led by one of IMO's principal investigators.

Main Achievements in 2023

- **Research and Publications:** IMO produced 34 peer-reviewed journal articles, with significant contributions from graduate students and young investigators. Notable publications include a review article addressing the mystery of phytoplankton minimums at the oxycline base, proposing a new hypothesis with implications for primary production and the expansion of oxygen-minimum zones. Additionally, IMO conducted the first assessment of zooplankton molecular diversity in deep eastern South Pacific waters and isotopic signals of particulate organic matter in the Atacama Trench.
- **Technological Innovations:** IMO deployed the first Integrated Deep-Ocean Observing System (IDOOS) in the eastern South Pacific.
- **Educational Impact:** IMO graduated 3 PhDs and 1 MSc.
- **Outreach and Public Engagement:** IMO premiered the documentary “Atacama Hadal,” launched the exhibition “Atacamex: Science of the Deep Ocean,” which attracted over 32,000 visitors, developed the educational video game “Audacity: Hadal Challenge,” with over 5,200 downloads, produced the fourth season of the children’s TV series “Bichitos,” and published and distributed the book “Tales from the Ocean,” reaching over 700 children through storytelling shows.
- **Collaboration and Networking:** IMO strengthened national and international collaborations, particularly in the Latin American Ocean Acidification Network (LAOCA) and the Partnership for Ocean Global Observations (POGO) initiatives.

Conclusion

IMO continues to be a significant player in oceanographic research, technological innovation, and public outreach, contributing to a deeper understanding of the ocean and its role in global change on both the national and international stages.

1.2 Resumen Ejecutivo

Líneas de Investigación

El IMO centra su investigación en dos líneas principales: Adaptación a un Océano Cambiante (Línea 1) y el Ecosistema del Océano Profundo (Línea I). En la Línea 1, las principales preguntas científicas se relacionan con cómo los flujos biogeoquímicos, la composición de la comunidad y la estructura poblacional de especies clave se correlacionan con los factores físicos oceanográficos. Esto incluye comparar cómo los procesos biogeoquímicos se ven afectados en zonas normóxicas, la zona de mínimo de oxígeno (OMZ) y la zona marina anóxica (AMZ), así como cómo las comunidades y organismos clave responden a un océano cambiante. La Línea II examina las características físicas, geofísicas y biogeoquímicas de las aguas profundas y ultraprofundas del Pacífico Sur Oriental y cómo estos factores pueden afectar la diversidad y la estructura funcional de las comunidades pelágicas. Desde 2022, el IMO también ha integrado un programa de geociencias (dentro de la Línea de Investigación II) al vincular la oceanografía con la geología y la geofísica.

Desarrollo Tecnológico

Desde 2016, el IMO ha tenido una unidad de desarrollo y transferencia tecnológica. Sin embargo, desde 2022, los objetivos y actividades de esta unidad se han incorporado al recién establecido Centro de Instrumentación Oceanográfica (CIO) en la UdeC. Con su propio financiamiento, el CIO está estrechamente asociado con el IMO, opera bajo el mismo techo y es dirigido por uno de los investigadores principales del IMO.

Principales Logros en 2023

- **Investigación y Publicaciones:** El IMO produjo 34 artículos en revistas revisadas por pares, con contribuciones significativas de estudiantes de posgrado e investigadores jóvenes. Publicaciones notables incluyen un artículo de revisión que aborda el misterio de los mínimos de fitoplancton en la base de la oxiclina, proponiendo una nueva hipótesis con implicaciones para la producción primaria y la expansión de las zonas de mínimo de oxígeno. Además, el IMO realizó la primera evaluación de la diversidad molecular del zooplancton en las aguas profundas del Pacífico Sur Oriental y las señales isotópicas de la materia orgánica particulada en la Fosa de Atacama.
- **Innovaciones Tecnológicas:** El IMO desplegó el primer Sistema Integrado de Observación del Océano Profundo (IDOOS) en el Pacífico Sur Oriental.
- **Impacto Educativo:** El IMO graduó a 3 doctores y 1 magíster.
- **Alcance y Compromiso Público:** El IMO estrenó el documental “Atacama Hadal,” lanzó la exposición “Atacamex: Ciencia del Océano Profundo,” que atrajo a más de 32,000 visitantes, desarrolló el videojuego educativo “Audacity: Hadal Challenge,” con más de 5,200 descargas, produjo la cuarta temporada de la serie de televisión infantil “Bichitos,” y publicó y distribuyó el libro “Cuentos del Océano,” alcanzando a más de 700 niños a través de espectáculos de cuentacuentos.
- **Colaboración y Redes:** El IMO fortaleció las colaboraciones nacionales e internacionales, particularmente en la Red Latinoamericana de Acidificación del Océano (LAOCA) y las iniciativas de la Asociación para la Observación Global del Océano (POGO).

Conclusión

El IMO continúa siendo un actor significativo en la investigación oceanográfica, la innovación tecnológica y la divulgación pública, contribuyendo a una comprensión más profunda del océano y su papel en el cambio global, tanto en el nivel nacional como internacional.

1.3 Brief History of the Center

The Millennium Institute of Oceanography (IMO, Instituto Milenio de Oceanografía) is a center of excellence established at the end of 2013, with the aim of exploring and researching the open and deep ocean. Its vision is to be an internationally recognized institute in oceanographic research and education, leading exploration in the central and eastern area of the South Pacific Ocean, with impact on the country and society in general.

IMO's research is organized along two Research Lines: I. A Variable and Changing Ocean and II. The Deep Ocean. In Line I the key scientific questions relate to how the biogeochemical flows, community composition, and population structure of key species correlate with physical and geochemical oceanographic drivers. Additionally, Line I asks how key communities and organisms respond to a changing ocean, in particular to ocean acidification and deoxygenation. Line II deals with the physical, geophysical, and biogeochemical characteristics of deep and ultra-deep waters of the Eastern South Pacific, including the Atacama Trench, and how these can affect the diversity and functional structure of pelagic communities. Since 2022, IMO has also added a geoscience program (within Research Line 2) by linking oceanography with geology and geophysics.

Regarding Research Line I, for the first 5 years of IMO's existence there were four research themes, and three of these were consolidated into the single Research Line A Variable and Changing Ocean in the second 5 years. This change reflects how major advances have been made in understanding the physical mechanisms underlying environmental variability, from local scale (sub-mesoscale and mesoscale processes such as fronts, jets, and eddies generated by upwelling or interactions with oceanic islands), to basin-scale (e.g., Rossby waves, El Niño-Southern Oscillation) processes. Now the focus is integrating the physical analysis as the foundation for all biological, ecological, and biogeochemical work of IMO on three fundamental questions, all relating to how ocean variability and global change affect biological function across all levels of organization, as well as biogeochemical function at the ecosystem and biosphere levels. Using the mosaic of high pCO₂/low pH/low O₂ waters of the Southeast Pacific as a natural laboratory, IMO has become the leading Latin American center for Ocean Acidification research as well as pioneering work in understanding the consequences of low O₂.

Regarding Research Line II—The Deep Ocean—IMO has pioneered developing Chile's capacity for deep-ocean research and exploration, implementing novel technologies to reach and sample the deep and ultra-deep waters of the eastern South Pacific. Results from this effort have, so far, resulted in the discovery of high and novel genetic diversity of deep-ocean pelagic species and a new species of a giant trench amphipod, and in providing evidence for the multiple origin of the organic matter in the hadal environment. A most important milestone has been taking part in the first crewed expedition to the bottom of the Atacama Trench. IMO is now the leading Latin American center for deep-ocean science, and—for the first time—Chilean researchers are repeatedly accessing the deepest waters of national territory.

1.4. Outstanding Achievements

Research Line I: In a collaborative effort involving three IMO PIs and two IMO postdocs, a review article was published in L&O highlighting the mystery of why there is a minimum in phytoplankton at the base of the oxycline despite sufficient light and abundant nutrients. A hypothesis was proposed to explain this phenomenon, and the study highlights a previously unidentified effect that could result in missing primary production and an unexpected feedback, which could determine the expansion of oxygen-minimum zones in the future.

Research Line II: First assessment of the zooplankton molecular diversity in the deep waters (down to 5000 m) of the eastern South Pacific, and of the isotopic signal of the particulate organic matter in the waters of the Atacama Trench.

Deployment of the first Integrated Deep-Ocean Observing System (IDOOS) in the eastern South Pacific:

(<https://pogo-ocean.org/news/chile-completes-the-installation-of-its-first-integrated-deep-ocean-observing-system/>)

Graduation of 3 PhDs and 1 MSc.

Premiere of IMO's new documentary "Atacama Hadal".

2. Introduction

a) *Description of the Institute:*

The Millennium Institute of Oceanography (IMO, Instituto Milenio de Oceanografía) is a center of excellence, established at the end of 2013, with the aim of exploring and researching the open and deep ocean. Its vision is to become an internationally recognized institute in oceanographic research and education, leading exploration in the central and eastern area of the South Pacific Ocean, with impact on the country and society in general. IMO's commitment is to provide an intellectually stimulating environment for the production and dissemination of scientific knowledge that generates new understanding about the ocean, from a creative, daring and collaborative perspective. IMO's mission is: i) to conduct pioneering and interdisciplinary research in oceanography, addressing scientific problems in an integrative and collaborative manner; ii) to develop and apply new technologies and platforms for observational and experimental work in the ocean, including the use of the Chilean research vessel Cabo de Hornos, and to reach unexplored areas of the South Pacific; iii) to increase human resources in ocean sciences in Chile and South America, through higher education and training in research based on direct observation and experimentation in the sea, and by attracting ocean scientists from all over the world to work in Chile; and iv) to inform and create awareness among the general public and decision makers about the importance of the ocean, its conservation and its relationship to humans and global change.

IMO has become a Latin American regional center of excellence in oceanography through:

- An increasing number of publications in top-ranked international journals, reflecting IMO's cutting-edge research
- Integration of the new Chilean research vessel R/V Cabo de Hornos for fundamental ocean research.
- Implementation of advanced sampling technologies, including the use of an innovative submarine lander to repeatedly sample the deepest depths of the Atacama Trench.
- High impact in human capacity building at regional, national and international levels.
- High impact in dissemination of science to society at large through an internationally recognized outreach program.
- Becoming integrated into and recognized in the international research community through extensive networking.
- In ocean policy, IMO has been called on a) to provide logistical-technical support for reacting to a massive toxic algal bloom, b) to communicate the state-of-the-art of scientific understanding of the ocean to authorities and policymakers reacting to a foreign company's controversial bid to conduct commercial iron fertilization in Chilean waters, c) to participate in the formation of the Chilean National Ocean Policy. This Annual Report is for the tenth year of activities.

b) Research Lines:

I. A Variable and Changing Ocean: This research line is organized around three grand questions:

- a. How well do biogeochemical flows, community composition, and even population structure of key species correlate with physical oceanographic drivers?
- b. How does biogeochemical function differ among norm-oxic, OMZ, and AMZ marine systems?
- c. What is the resilience of key communities and organisms to a changing ocean, and can that be predicted by their origin?

II. The Deep Ocean: This research line is organized around a single grand question:

What are the physical and biogeochemical characteristics of deep and ultra-deep waters of the eastern South Pacific, and which of those determine the diversity and functional structure of their pelagic communities?

Additionally, IMO has a strong Outreach Program and continues with a Geoscience Program (within Research Line II), aimed at linking oceanography with geology and geophysics.

c) Organization of research teams:

During 2023, its tenth year, IMO consisted of 32 researchers: 6 principal investigators (PIs), including Dr. Marcos Moreno, a previous Adjunct Investigator who was promoted to PI; 4 senior researchers, including the former associate researcher Dr. Samuel Hormazábal, 11 adjunct researchers, 6 young researchers and 5 postdocs. The principal researchers in 2023: Drs. Osvaldo Ulloa (Director), Rubén Escribano (Deputy Director), Oscar Pizarro, Wolfgang Schneider, and Cristian Vargas (from University of Concepción, UdeC) and Peter von Dassow and Marcos Moreno (from Pontifical Catholic University of Chile, PUC). They are distributed in Concepción and Santiago, respectively. IMO also includes 17 professionals/technicians and assistants, 7 administrative staff, as well as 42 students (13 undergraduate, 14 M.Sc., and 15 Ph.D.).

During this period, IMO was organized around the 2 research lines, an outreach team (led by Pablo Rosenblatt, Director of Outreach), and a central administrative office based at UdeC (led by Atilio Morgado, Executive Director).

IMO had also three senior researchers during the period: Prof. Juan Carlos Castilla (PUC) and Dr. Gerrit van den Engh (MarCy, USA), both as advisors to the institute, and Dr. Samuel Hormazábal (a former associate researcher). At the beginning of 2024, Dr. Schneider retired and became a senior researcher.

Scientific and technical personnel, laboratories, and equipment are shared across the research lines, and also contribute to outreach and technology development. Drs. Cristian Vargas and P. von Dassow lead Research Line I and Drs. R. Escribano and O. Ulloa led Research Line II. Drs. M. Moreno and O. Pizarro are responsible for the Integrated Deep-Ocean Observing System (IDOOS).

From 2022, the Center of Oceanographic Instrumentation (CIO) was established as funded by ANID and led by IMO associate Researcher O. Pizarro. This Center became a key component of IMO in the framework of Technological Development and links with other Centers and Universities in Chile and the region.

Each year, associate researchers meet at the beginning to define annual research priorities for each line—as well as for education, outreach, and technology development and transfer—and the budget is allocated according to these priorities. Meetings are held throughout the year to follow specific priorities. An annual meeting with all IMO's members is held yearly.

3. Scientific and technological research: (Máximo 12 páginas para Institutos)

a) Current status of research lines:

1) Research Line I: Adaptation to Changing Ocean

During 2023, IMO has continued to advance in studying the implications of a changing ocean across different biological models, including phytoplankton organisms, planktonic copepods, and other crustaceans, up to socio-economically important mollusks. Young researchers and postdoctoral fellows led several of these studies in our institute. For instance, as part of a collaborative effort led by Dr. Vargas with researchers from the Austral University of Chile, **Benítez et al. (2023)** assessed how variability in pH and temperature determines differential gene expression in the northern scallop, *Argopecten purpuratus*, a species inhabiting the northern Chile upwelling system. The work demonstrates how this species expresses certain genes under conditions of low pH and high temperature to mitigate cellular damage and maintain homeostasis. A study addressing a similar issue was conducted by our adjunct researcher, V. Aguilera (**Aguilera et al. 2023**), who, in collaboration with several investigators from IMO (Vargas, von Dassow, and Mesas) evaluated whether extreme low pH conditions in estuarine and upwelling environments in northern Chile could modulate the phenotypic plasticity and genetic diversity of natural populations of the copepod *Acartia tonsa*. To test this hypothesis, they explored the relationship between local-scale extreme low pH events, genetic diversity, and variation in fecundity-related traits in this broadly dispersed copepod species. Copepods exposed to more frequent extreme low pH events (< 7.7) exhibited consistent phenotypic variations in body size, egg size, and egg production rate across different cohorts of adult females. Both studies demonstrate how natural variability in upwelling systems characterized by low temperature, low oxygen, and low pH/high $p\text{CO}_2$ can promote mechanisms of plasticity in these populations. This established line of work at IMO, developed over several years, is gradually building a roadmap aimed at utilizing environmental variability throughout Chile as a natural laboratory for studies on phenotypic plasticity, local adaptation, and evolutionary potential in different marine populations. In this context, the estuarine copepod *Acartia tonsa* has become a suitable model, although a detailed molecular analysis has shown this is actually a new undescribed endemic species in the coastal zone of Chile (**Mesas et al., 2024**).

In terms of our study of ocean deoxygenation and oxygen minimum zones (OMZs), an interesting theoretical study aimed at developing a hypothesis to explain the disappearance of most phytoplankton organisms beneath the oxycline in OMZs was published in *Limnology and Oceanography*. The work was led by one of our IMO postdocs and IMO PI Von Dassow, in collaboration with two other IMO PIs (Ulloa, Vargas) (**Wong, et al. 2023**). By utilizing previously published information, the researchers support the idea that top-down grazing, respiratory demand, and irradiance are insufficient to fully explain the vertical distribution of phytoplankton. Instead, they propose that a hypothetical dependence on photorespiration or water-water cycles could explain how phytoplankton adapted to an oxygenated ocean are excluded from the sunlit oxycline in OMZ regions. Additionally, data collected by a Biogeochemical Argo (BGC-Argo) float were used to study the dynamics of and to model a unique low-oxygen-adapted phytoplanktonic community in the eastern tropical North Pacific (**Cox et al., 2023**). IMO researchers also participated in a research cruise to the Oxygen Minimum Zone off northern Chile and southern Peru on board the US R/V *Roger Revelle* (November-December 2023). In the same context, we have shown species-dependent adaptation (or lack of adaptation) of planktonic copepods to hypoxia caused by a shallow OMZ in the upwelling zone. IMO PhD. student L. Frederick revealed novel metabolic adaptations of copepods inhabiting hypoxic waters in the Chilean coast (**Frederick et al. 2023**). Frederick also reviewed the implications of increasing ocean deoxygenation on zooplankton upon changing upwelling

intensity due to global warming, and concluded that hypoxia is major stressor threaten zooplankton populations with future implications for the pelagic food web (**Frederick et al. submitted to Biogeosciences**) Regarding this zooplankton community, copepods comprise most of the zooplankton biomass in the upwelling zone, and they are strongly subject to a highly unstable coastal system where advective forces mostly explain the majority of the zooplankton variability observed in time series studies of zooplankton biomass, as shown by IMO PhD. student A. Venegas (**Venegas et al. 2023**).

As mentioned above, planktonic copepods are highly sensitive organisms, rapidly responding to a changing ocean. In this regard, our postdoctoral Dr. R. Rivera showed that an endemic copepod of the Chilean coast, *Calanus chilensis*, is a very suitable model to predict spatial patterns of zooplankton populations as forced by changing ocean conditions (**Rivera et al., 2023**). This despite the low coverage and sampling gaps of zooplankton in the southeast Pacific which can be partially overcome by proper statistical models (**Rivera et al. 2024**).

As a first step to understanding coastal vs. open ocean adaptations in a very species-rich phytoplankton genus, PI von Dassow led a study, which also included Dr. Aguilera, comparing species of the potentially toxic diatom *Pseudo-nitzschia* found in inland seas, coasts, and offshore environments. This study included the description of a new oligotrophic species *P. dampieri* (von Dassow et al. 2023).

In a significant study by **Carrasco et al. (2023)**, the main drivers of marine heat waves (MHWs) in the eastern South Pacific were analyzed, highlighting the increasing frequency and duration of these events. Their research identified that MHWs in this region are primarily driven by diminished heat loss due to reduced evaporation and enhanced insolation, as well as heat advection associated with anomalous eastward surface currents. The study underscores the strong influence of El Niño events in intensifying these heat waves, which have profound impacts on marine ecosystems, affecting primary production and altering the spatial distribution of marine species. The comprehensive heat budget analysis offers valuable insights for predicting future MHW occurrences and their potential impacts, supporting efforts to mitigate their negative effects on marine ecosystems and the fishing industry.

The consequences of the atmospheric response to mesoscale SST anomalies ("Thermal Feedback") was investigated over the global ocean (**Renault et al., 2023**) and over the South-East Pacific (**Oerder et al., 2024**). We showed that the heat flux response to the oceanic mesoscale damp the oceanic mesoscale worldwide. In the South-East Pacific upwelling system, we showed that the wind stress response to the coastal SST gradient also feedbacks on the upwelling system, reducing surface current, vertical velocities and the Eddy Kinetic Energy generation.

The study by **Pinto-Juica et al. (submitted to JGR)** investigated the mechanisms contributing to the ventilation of the Oxygen Minimum Zone (OMZ) off Central Chile. Their research revealed that salt finger instabilities beneath the salinity maximum significantly enhance diapycnal oxygen transport within the OMZ. Utilizing microstructure, current, and oxygen measurements, they demonstrated that the diffusivity due to salt fingers can be up to two orders of magnitude greater than that from mechanical turbulence. The findings emphasize the crucial role of these salt fingers in OMZ dynamics, particularly in promoting vertical oxygen transport and mitigating hypoxia. This study provides vital insights into the processes affecting oxygen distribution in the eastern South Pacific, with broader implications for understanding OMZ dynamics globally.

In the framework of IMO's contribution to science focused on policymakers and stakeholders, our PI Vargas had the honor of being invited by the editor of *Nature Ecology & Evolution* to participate in a 'Viewpoint' article, led by the renowned marine biologist, Jane Lubchenco, which focused on identifying and discussing the priority actions at a global scale to address ocean health and marine biodiversity for

the next seven years, within the framework of achieving half of the period for the *Sustainable Development Goals (SDGs)* (Lubchenco et al. 2023).

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2) Research Line II: The Deep Ocean

In 2023 IMO achieved important goals in the context of exploration and observation of the deep ocean and oceanic ecosystems in the southeast Pacific. Here, some of those achievements are reported and research highlights are presented from the ongoing studies.

From the SONNE SOI-261 expedition carried out in February 2018, during which we were able to deploy the zooplankton net MOCNESS down to more than 5000 m, an assessment of the zooplankton diversity from surface to deep waters was realized using metabarcoding analysis with two molecular markers, also revealing a large amount (>50%) of unknown diversity of metazooplankton in the deep dark ocean (**González et al., 2023a**). This lack of knowledge on zooplankton diversity is also applicable to large regions of the south Pacific Ocean, even in the upper 200 m, largely due to spatial-temporal sampling gaps, as shown through the analysis of existing global data bases of zooplankton (**Pérez-Aragón et al., submitted to Plos One**). In this context, we are currently developing analytical methods to overcome biases derived from these sampling gaps, such that spatial patterns of diversity can be assessed and predicted under a scenario of climate change (e.g. **Rivera et al., 2024**).

This high diversity of the zooplankton community in the deep southeast Pacific seems largely sustained by the rich biological production taking place in the coastal upwelling zone, which can be laterally transported to the offshore zone above the Atacama Trench by mesoscale circulation during wind-driven upwelling (**González et al., 2023b**).

Across the coastal-oceanic gradient in the southeast Pacific, trophic interactions and variable sources of organic carbon can modulate the size and taxonomic structure of surface, mid-water, and deep-sea zooplankton assemblages (**Fernandez-Urruzola et al., 2023**). These trophic interactions also promote ecological connectivity with the deep-fish community over the Atacama Trench, as revealed by isotopes composition of C and N (**Ñacari et al., 2023**).

During 2023 we also continued the analysis of hadal fauna that was captured by means of our autonomous lander “Audacia” during the SONNE and Hadal cruise onboard the R/V Pressure Drop in January 2022. In collaboration with Dr. Johanna Weston at the Wood Hole Oceanographic Institute (USA), a phylogenetic analysis of our previously described hadal amphipod *Eurythenes atacamensis*, the evolution and radiation of the *Eurythenes* genus across global trenches was performed using genetic markers and revealing the connection between the global scale deglaciation process and the trenches colonization and speciation of this group (**González et al. submitted to Ecol. Evol.**). In the seafloor of the Atacama Trench, we are currently describing new amphipod species (work in progress) and revealing an exceptionally high

endemism in this trench. The rich benthic and benthic-pelagic community inhabiting this hadal system has evolved as sustained by a rich variety of sources of organic carbon (Li et al., 2023), which becomes available by novel transport mechanisms to ultra-deep waters (>4000 m) (Flores et al., 2023).

A major achievement of IMO in 2023 regarding Research Line II, 'The Deep Ocean,' was the complete deployment and setup of the IDOOS platform. Between February and April 2023, IMO, in collaboration with GEOMAR (Kiel, Germany), installed the five pressure sensors of IDOOS during the cruise SO297. The pressure sensors were installed in the seismic gap of the Atacama region in Chile, which last experienced large earthquakes in 1819 (Mw8.0) and 1922 (Mw8.4). This region is considered a mature seismic gap at risk of rupture by a large earthquake in the near future.

In September 2023, IMO installed the **two deep ocean mooring** to complete the **IDOOS observatory**. This activity was conducted aboard the R/V Abate Molina and partially supported by the project AUB2200007, presented to the 2022 ANID Scientific Research Vessel Access Competition. These moorings are to be recovered annually for maintenance and data analysis. The cruise was carried out aboard the R/V Abate Molina and included the following key activities: **Lander Deployment:** A free-fall vehicle (lander) was deployed in the Atacama trench to measure temperature, salinity, dissolved oxygen, and collect water and organism samples from depths of approximately 7700 m. **Drifting Sediment Traps:** These traps collected sediments at various depths, providing insights into organic matter flows and their relationship with the oxygen minimum zone. **CTD-Rosette Stations:** 19 casts were conducted to record profiles of salinity, temperature, and dissolved oxygen, and to collect water samples from depths of up to 4200 meters. **Zooplankton Sampling:** Using a multi-net system, zooplankton samples were collected from different strata (0-800 meters) to analyze biodiversity and taxonomy. **Additional Measurements:** Various physical and biogeochemical measurements were taken, including RNA, DNA, POC, DIC, TA, Carbon-13, phytoplankton, and primary productivity experiments.

During the IDOOS cruise, IMO also started developing new approaches to understand metabolic adaptation to deep low-oxygen waters. Thus, deep zooplankton samples were collected along the vertical gradient of oxygen off Antofagasta (23°S). Metabarcoding techniques are being used to characterize the diversity, along with transcriptomic and proteomic analyses to identify metabolic pathways to test the hypothesis that low oxygen is a key evolutionary driver shaping diversity and metabolic patterns of mesopelagic zooplankton.

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b) Productivity:

<u>Category of Publication</u> ¹	<u>MSI Center Members</u>	<u>Number of Publications co-authored by students</u>	<u>Total Number of Publications</u>
ISI/WOS Publications or Similar to ISI/WOS Standard	Principal Researchers	5	21
	Other Researchers	1	13
SCOPUS Publications or Similar to SCOPUS Standard	Principal Researchers	0	0
	Other Researchers	0	0
SCIELO Publications or Similar to SCIELO Standard	Principal Researchers	0	0
	Other Researchers	0	0
Scientific Books and chapters	Principal Researchers	0	0
	Other Researchers	0	0
Other Scientific Publications	Principal Researchers	0	0
	Other Researchers	0	0
<u>Total number of Publications</u>		6	34

The categorization was obtained using webofscience.com, scopus.com, and scielo.org/es as sources.

c) Outstanding publications:

- Fernandez-Urruzola, I., Bode, A., Loick-Wilde, N., Schneider, W., Lindsay, D., Escribano, R. 2023. Trophic ecology of midwater zooplankton along a productivity gradient in the Southeast Pacific. *Frontiers in Marine Science*. 10:1057502. DOI <https://10.3389/fmars.2023.1057502>

This article represents how the IMO continues to lead in studies of midwater ecology of the Southeast Pacific, going beyond descriptions of species present to tackle questions of how energy flow varies by depth, size-category, and productivity. It also shows how IMO continues to go far beyond the scarce opportunities for ocean-going research aboard Chilean vessels, as this was the result of a cruise aboard a Japanese vessel.

- Flores, E., Fernández-Urruzola, I., Cantarero, S.I., Pizarro-Koch, M., Zabel, M., Sepúlveda, J., Ulloa, O., 2023. Particulate Organic Matter in the Atacama Trench: Tracing Sources and Possible Transport Mechanisms to the Hadal Seafloor. *J. Geophys. Res. Biogeosciences* 128, e2023JG007401. <https://doi.org/10.1029/2023JG007401>

This study shows that IMO is now routinely publishing science from the Hadal Zone. The Atacama Trench is special as it is below one of the most productive surface waters. However, this study shows how nearby bathyal sediments are perhaps even more important, suggesting that the trench acts as a funnel to concentrate material from neighboring bathyal and abyssal seafloors.

- Wong, JCY, Raven J.A., Aldunate, M., Silva, S., Gaitán-Espitia, JD, Vargas, C.A., Ulloa, O., von Dassow, P. 2023. Do phytoplankton require oxygen to survive? A hypothesis and model synthesis from oxygen minimum zones. *Limnology & Oceanography* 68, 2023, 1417–1437. <https://aslopubs.onlinelibrary.wiley.com/doi/abs/10.1002/lno.12367>

This study, a collaboration involving three IMO PIs and two IMO postdocs, highlighted the mystery of why there is a minimum in phytoplankton at the base of the oxycline despite sufficient light and abundant nutrients. One hypothesis was explored, but more importantly the study highlights a previously unidentified effect that could result in missing primary production and an unexpected feedback that could determine oxygen-minimum zone expansion in the future.

- Carrasco, D., Pizarro, O., Jacques-Coper, M., & Narvaez, D. A. (2023). Main drivers of marine heat waves in the eastern South Pacific. *Frontiers in Marine Science*, 10, 1129276. <https://doi.org/10.3389/fmars.2023.1129276>.

This study, with IMO PI Pizarro as corresponding author, produces a new analysis that will be crucial for understanding and anticipating how marine heatwaves will impact the Southeast Pacific in the future.

- Lubchenco, J., Camp, E.F., Vargas, C.A. et al. 2023. Priorities for progress towards Sustainable Development Goal 14 ‘Life below water’. *Nature Ecology & Evolution* 7, 1564–1569. <https://doi.org/10.1038/s41559-023-02208-4>

This article highlights how IMO researchers are helping translate science into international policy recommendations with high level publications.

d) Congress Presentations:

ASLO 2023 Aquatic Science Meeting, Palma de Mallorca, Spain, 4-9 June. This meeting brings together the worldwide community of the American Association for Limnology and Oceanography with more than 3000 presenters. IMO participated with the Associate Researcher R. Escribano, the young researcher V. Aguilera, the Postdoctoral C. González, and the PhD student L. Frederick presenting relevant research dealing with adaptation of zooplankton to increasing hypoxia and ocean acidification in the context of Research Line 1 of IMO “Adaptation to a changing ocean”.

International Symposium Observing Climate Change in Coastal Ecosystems: The Nearshore Perspective Along Upwelling Coasts, Las Cruces, Chile, 10-12 November. This highly relevant scientific event allowed our Associate Researcher C. Vargas to present and discuss with the

international oceanographic community his recent findings on phenotypic plasticity of invertebrates inhabiting the upwelling zone of Chile in the context of Research Line 1 of IMO.

XIV Simposio Internacional del Carbono en México. This annual symposium allows most Latin American Scientist involved in research related to the C cycles in land and in the ocean to get together, present and discuss their ongoing research. Also, as an opportunity to collaborate in the subject. Our Associate Researcher C. Vargas actively participated and presented at the meeting.

II Congreso Nacional sobre Ciencias de la Vida. Lima, Peru, 6-8 August. This National Congress of Peru gives the opportunity for Peruvian and Latin American collaborators to join and present ongoing works on a wide variety of themes about life strategies on earth. Our Adjunct Researcher M. Oliva participated and presented at the event on parasites colonizing deep-sea fishes.

XI Congreso Parasitología Neotropical. Ciudad del Carmen, Mexico, 8-11 November. This is an annual specialized scientific event to gather worldwide experts on parasitology of tropical and subtropical regions in the ocean and land systems. Our Adjunct Researcher M. Oliva participated and presented ongoing work on deep-sea fishes infected by invertebrate parasites in the southeast Pacific in the context of IMO Research Line 2 “The Deep Ocean”.

The XLII Chilean National Congress on Marine Sciences, Puerto Montt, Chile. This annual event congregates the entire Chilean community in the broad scope of marine sciences. IMO always has a very active participation with most researchers and students attending the meeting as presenters, conveners and giving plenary talks. IMO also organized and sponsored two Mini Symposiums in the Congress about the Deep Ocean Biodiversity (conveners C. González and R. Escribano), and the ecological Impact of Hypoxia (conveners P. Hidalgo and P. Ruz). Our Associate Researcher C. Vargas also presented one of the Plenary Conferences at the Congress.

Summary Table

Type of presentation	Type of presentation	National Events [Number]	International Events [Number]
Principal Researchers	Conferences, oral communications, poster communications, others (specify)	6	2
	Invited presentations (not included in the above row)	1	0
Other researchers (Adjunct, Senior, Young, Postdoctoral Researchers)	Conferences, oral communications, poster communications, others (specify)	14	4
	Invited presentations (not included in the above row)	0	0
Students	Conferences, oral communications, poster communications, others (specify)	13	1
	Invited presentations (not included in the above row)	0	0

Other achievements:

- **Patents:** No patents during this period.
- **Intellectual property:** No intellectual property.
- **Organization of Scientific Events:**

O. Ulloa: Organizing and planning committee of the Inaugural Science Symposium of the Trevor Platt Science Foundation, Plymouth, U.K. (<https://trevorfoundation.org/symposium-2023/>)

▪ **Scientific Editorial Boards:**

O. Ulloa:	2021 to present Associate Editor for Limnology and Oceanography 2023 to present Editorial Board Member for The ISME Journal
R. Escribano:	2020 to present Associate Editor Frontiers in Marine Sciences
P. von Dassow:	2015 to present Associate Editor Journal of Plankton Research 2022 to present Associate Editor Frontiers in Marine Sciences
C. Vargas:	2019 to present Review Editor Frontiers in Physiology 2019 to present Review Editor Frontiers in Marine Science 2023 - 2024 Guest Editor Special Volume Sustainability

- **Awards:** IMO’s Director, O. Ulloa, was awarded the Municipal Science Award 2023 by the Municipality of Concepción, Chile, and the Royal Society Wolfson Visiting Fellowship to carry out research at the Plymouth Marine Laboratory, U.K.

Associate Researcher, Dr. Marcelo Enrique Oliva Moreno was awarded with the Premio Honor en Scientia Marina 2023 (Scientia Marina 2023 Honor Prize), by Sociedad Chilena de Ciencias del Mar (Chilean Society of Marine Science).

4. Education and Capacity Building

- a) **Education, Training and Capacity Building:** In 2023, IMO promoted and supported educational and capacity building activities and actions at PhD, MSc, and Undergraduate levels, as well supported postdoctoral positions, and early career scientists. In association with formal programs at Chilean universities, IMO sponsored students in 5 programs in oceanography and marine sciences: i) Doctoral Program in Ecology (PUC), ii) Doctoral Program in Oceanography (UdeC), iii) Doctoral Program in Ecology of Aquatic Systems at University of Antofagasta, iv) Doctoral Program in Ecology and Systematics (UdeC), and v) Master Program in Oceanography (UdeC). Funding and sponsoring for undergraduate careers and degrees were also provided at 4 undergraduate professional careers: Marine Biology at PUC and UdeC, Oceanography at PUCV and Geophysics at UdeC. In addition, our sponsoring program for Early Career Scientists (IECS), implemented in 2019, continued supporting young scientists. Two IECS were supported by IMO during 2023, Francisco Díaz and Monserrat Aldunate (until May 2023). IMO also continued supporting the young scientist Dr. Matias Castro, who became involved in the study of microbial ecology in deep waters and sea floor of hadal systems (Theme 2 of IMO). IMO also continued funding three postdoctoral positions: Dr. Igor Fernandez-Urruzola, Dr. Andrés Mesas and Dr. Reinaldo Rivera, while the research of two postdoctoral positions funded by ANID were also sponsored by IMO Drs. Monserrat Aldunate and Carolina González.

The total number of IMO students in 2023 was 30 (graduate and undergraduate), 10 undergraduate, 7 MSc, and 13 PhD. Our efforts in 2023 we mostly provided support to new MSc and undergraduate students, while providing complementary support to PhD students who had not finished their thesis and whose ANID scholarship ended during 2023. Fig. a1 shows the different sources of funding (scholarships) for students doing their thesis at IMO during 2023.

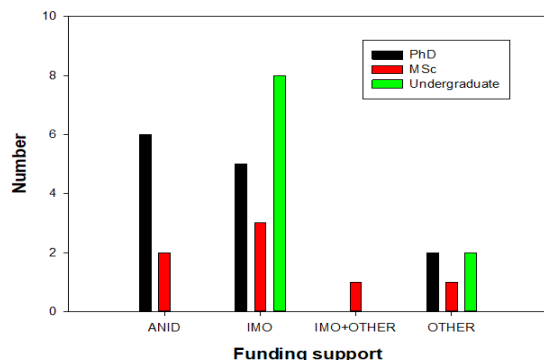
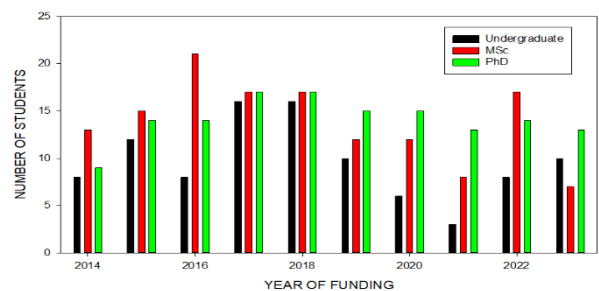


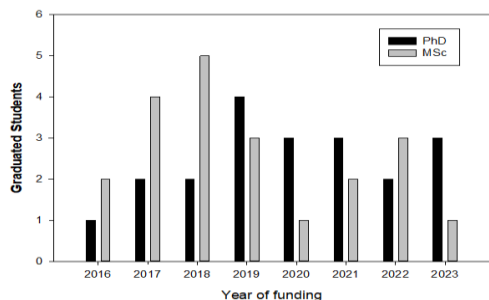
Figure a1: The different sources of funding to support undergraduate and graduate students carrying on their thesis at IMO during 2023. IMO/Fondecyt are concurrent grants complemented with IMO funding.

b) Achievements and results:

In graduate and undergraduate programs. During 2023, IMO researchers invested time and resources through 5 undergraduate and 6 graduate programs, including lecturing basic and advanced courses, practical work, and thesis supervision and co-supervision: Undergraduate Programs in Marine Sciences: Marine Biology at UdeC, PUC, and UCN, Geophysics at UdeC, and Oceanography at PUCV. Graduate Programs in Marine Sciences: M.Sc. in Oceanography at UdeC, M.Sc. in Oceanography at PUCV, M.Sc. in Ecology of Aquatic Systems at U. Antofagasta, Ph.D. in Oceanography at UdeC, Ph.D. Ph.D. in Biological Sciences at PUC. The total number of students directly associated with IMO has fluctuated year-after-year and is shown in the following Figure b1:

Figure b1: Total number of students since 2014 doing their thesis work at IMO. In 2022 there were 8 undergraduates, 12 in M.Sc., and 12 in Ph.D. Programs. IMO Associate Researchers are or were co-tutoring 50% or more students in each of these categories.





With respect to graduation, in 2022 IMO graduated 3 PhD and 1 MSc students. The evolution of graduating students each year does not show a clear trend through the years and (Figure b2). The main outcome indicates that IMO has graduated 17 PhD and 21 MSc students since 2014 and up to early 2024.

Figure b2: the number of new graduated students per year after carrying on their thesis at IMO.

All PhD students graduated at IMO are currently active scientists in Chile and abroad. The present position and destiny of the newly graduated PhD from IMO is shown in the Table in Annex 5.3.

Regarding new graduated MSc at IMO, several of them have started PhD programs in Chile or abroad, while some are working as highly qualified technicians at Chilean University or Research Centers. See Table b2 in Annex 5.4.

The sources for recruitment of IMO students

IMO conducts an open call for undergraduate scholarships twice a year (March and August). The selection criteria are based on the academic records of the candidates, the needs of each IMO research theme, and the potential for interaction through co-tutoring their thesis work and/or professional qualification. In the case of graduate students, IMO associate researchers are asked twice a year to propose candidates, including first year and advanced students with a thesis proposal already approved. First year students who applied to an ANID scholarship but were not awarded are also considered for IMO support if they have a high academic record and, in some cases, they are already linked to IMO from their undergraduate formation. IMO support extends for up to 1 year and these students are asked to apply again for external funds. Graduate students finishing their thesis work are also supported for periods of less than 1 year if they have completed an important part of their thesis requirements. IMO also supports students with partial grants when IMO researchers can make contribution to these grants through other funding sources available to them. In 2022, IMO awarded new scholarships to a total of 17 students, 8 at undergraduate level and 9 at graduate level (5 M.Sc. and 4 Ph.D.). In addition, 9 graduate students working at IMO received ANID scholarship during 2022, whereas the rest had full or partial support from other funding sources (institutional scholarships or associated grants from IMO researchers).

Graduate theses completed in 2023:

- Edgart Flores, Ph.D. Thesis, “Characterization of the organic matter in the Atacama Trench using lipid markers”. Co-supervisors: Dr. O. Ulloa and Dr. J. Sepúlveda (thesis defense in March 2023).
- Luis Ñacari, Ph.D. Thesis “Trophic ecology in deep sea fishes using isotopic composition of C and N”. Co-supervisors: Dr. M. Oliva and Dr. R. Escribano (thesis defense in April 2023)
- Ana Belén Venegas. Ph.D. Thesis "Interacciones físicas-biológicas que determinan la variabilidad en biomasa y producción del zooplankton en la zona de surgencia de Chile - Centro Sur: el rol de procesos advectivos y la interacción fitoplancton-zooplankton". Co-supervisors Dr. R. Escribano, Dr. C. Parada. (Thesis ended in December 2023, defense in March 2024).
- David Carrasco. M.Sc. Thesis “Main forcings of ocean heat waves in the southeast Pacific”. Supervisor Dr. O. Pizarro. (thesis defense in April 2023)

Theses in progress during 2023:

- Manuela Pérez. Ph.D. Thesis “Vertical-layered biogeographic patterns of pelagic copepods in the South Pacific Ocean. Ph.D. Program in Oceanography, University of Concepción. Supervisor: Dr. Rubén Escribano.
- Susana Cabrera Ph.D. Thesis “Interacciones tróficas y migración vertical como mecanismos de transferencia de C hacia el océano profundo.” Ph.D. Program in Oceanography, University of Concepción. Supervisor: Dr. Rubén Escribano
- Leissing Frederick Ph.D. Thesis “The effects of deoxygenation and in coastal upwelling systems: Adaptive Molecular Response to hypoxia in zooplankton. Ph.D. Program in Oceanography, University of Concepción. Co-supervisors: Dr. Mauricio Urbina and Dr. Rubén Escribano. Thesis ended by January 2024 and defended in April 2024.
- Cristina Carrasco Ph.D. Thesis at UdeC “Deep-ocean circulation processes in the eastern South Pacific” Supervisor Dr. O.Pizarro.
- Paula Ruiz, Ph.D. Thesis at UdeC “Quimiotaxis en el océano profundo”. Supervisor Dr. O. Ulloa, co-supervisor Dr. P. Hidalgo.
- Esteban Fernández Ph.D. Thesis at UdeC “Modelling large-scale ocean circulation forced by climate change”. Co-supervisor Dr. O. Pizarro.
- Nadín Ramírez R. MSc thesis, “Estudio de la variabilidad de submesoescala en Chile central (~36°30’S) y de eventos de oxigenación de la zona de mínimo de oxígeno mediante observaciones realizadas con planeadores submarino”. Supervisor: Dr. O. Pizarro.
- Enrique Ascencio, MSc. Thesis, “Respuesta fisiológica de dinoflagelados mixotróficos del género *Alexandrium* y *Prorocentrum* frente a condiciones de alto pCO₂/bajo pH”; Supervisor: Dr. Cristian A. Vargas, co-supervisor: Dr. Patricia Gómez (Departamento de Botánica, UdeC).
- Tomás Llona, MSc Thesis at UdeC
- Mauro Pinto, MSc Thesis “Mezcla diapicnica en la zona de mínimo oxígeno frente a Chile central: el rol de los dedos de sal”. Supervisor O. Pizarro.

Additional actions and outcomes

During the year 2023, IMO experienced a significant growth in organizing research courses and workshops stemming from collaborative efforts among millennium institutes. For instance, in 2023, both IMO and the **Coastal Social-Ecological Millennium Institute (SECOS)** were involved in organizing the Workshop "**Experimental and Statistical Design for Global Change Biology Studies**"(Fig. b3), which brought together researchers from various Chilean and foreign institutions, with a focus on young researchers and postdoctoral fellows. The course featured lectures by **Dr. Cristian Vargas (IMO organizer)**, **Dr. Juan Diego-Gaitan Espitia** from the Evolutionary Ecology Research Lab at the University of Hong Kong, and **Dr. Hannes Baumann** from the College of Liberal Arts and Sciences (Marine sciences), University of Connecticut, United States. A total of 12 researchers participated in the activity.

Destinations of students: Find the table in Annex 5.5.

5. Networking and other collaborative work

a) **Redes Formales de Colaboración:**

During 2023, IMO further strengthened its collaboration network both nationally and internationally. IMO continued its leadership in the Latin American Ocean Acidification Network (LAOCA), with PI Vargas serving as Co-Chair until December 2023, after which he stepped aside following over 4-5 years of dedicated work focused on generating capacity-building actions in Latin America. Starting in January of the current year, Dr. Victor Aguilera (adjunct IMO investigator) has been elected as a new member of the Executive Committee of LAOCA.

IMO has also been very actively involved in the international program POGO (Partnerships for Observation of the Global Ocean). During 2023, IMO Director O. Ulloa was part of the organizing and planning committee for the POGO-sponsored Inaugural Science Symposium “The Trends, Reflections, Evolution, and Visions in Ocean Research Symposium,” celebrating the scientific life of the late Trevor Platt (<https://trevorfoundation.org/symposium-2023/>). Additionally, several IMO researchers, including PI Escribano, Johana Medellin, and the young researcher Carolina Gonzales, are actively participating alongside colleagues from Chile, Colombia, the Dominican Republic, and France in the POGO Working Group "Marine eDNA monitoring network in Latin America and the Caribbean." The project aims to fill a gap in the implementation of the Ocean Biomolecular Observing Network (OBON) within the Latin American and Caribbean regions. The network is implementing an already-designed framework to create an open resource for interoperable and standardized biological data sharing and querying. Through this research initiative, scientists also aim to evaluate and establish a monitoring framework for marine biodiversity, aligning with the CBD Kunming-Montreal Global Framework Goal A targets to tackle the biodiversity crisis affecting the ocean. More details at: <https://pogo-ocean.org/innovation-in-ocean-observing/activities/marine-edna-monitoring-network-in-latin-america-and-the-caribbean/>

IMO has also been an active collaborator of the worldwide project Ocean Biogeographic Information System (OBIS) sponsored by the IODE Program of UNESCO. OBIS is recognized as the largest network and database portal on marine biodiversity. Our researcher Dr. Pamela Hidalgo is member of the OBIS Steering Committee, and she has maintained a regional node of OBIS for the southeast Pacific hosted at University of Concepción as sponsored by IMO.

IMO has also maintained its involvement in several Scientific Committee on Oceanic Research (SCOR) Working Groups. PI Vargas is part of the project 'Changing Ocean Biological Systems (COBS).' This project aims to advance novel methodologies for evaluating the collective impact of multiple environmental variables on marine organisms. It originated from the recognition among scientists studying individual environmental factors (such as pH, temperature, and oxygen) that experiments focusing solely on one factor were insufficient to capture the complexity of oceanic changes. Further information is available at: <https://scor-int.org/project/changing-ocean-biological-systems-cobs/>. PI Escribano co-chaired the SCOR WG 155 on Eastern Boundary Upwelling Systems (WG ended by November 2023), and IMO members YR González and PI Escribano participated in the SCOR WG 157 "MetaZooGene", a worldwide initiative to census global marine zooplankton using metabarcoding analysis. The young researcher Natalia Osma has kept her active collaboration as a full member on the SCOR WG 161 “REMO: Respiration in the mesopelagic Ocean”, which is focused on constraining respiration uncertainties and improving quantifications of organic matter flux and remineralization rates in the global ocean. As part of this group, she is leading a mentoring program with the aim of connecting early career scientist with experienced researchers in the field of

microbial respiration. More information can be found here: <https://www.remo-scor-wg161.com/>. Likewise, since December 2023, YR. Osma has established a new collaboration with colleagues from the University of Tasmania by participating as a co-investigator in the “Ocean Alkalinity Enhancement (OAE) Pelagic Impact Intercomparison Project”. This international project seeks to evaluate the potential impact of increased alkalinity on the plankton communities, by conducting standardized OAE experiments worldwide. N. Osma will be leading the experiments in South America. More recently, N. Osma has also joined the South American Node of the Global Network of SOLAS mCDR Nodes-SCOR, a capacity that aims to build a global network of ocean experts that work in regional nodes to develop standards for marine Carbon Dioxide Removal (mCDR) initiatives especially concerning Monitoring, Reporting, and Verification (MRV). Finally, PI von Dassow is a member of the National Committee representing Chile in SCOR.

Within the framework of our research line 2 “The Deep Ocean”, IMO leads the IDOOS project and has strengthened its cooperation with GEOMAR in Kiel, Germany. Between February and April 2023, IMO's researcher and Director of IDOOS, Dr. Marcos Moreno, participated in the Sonne Cruise SO297, during which the IDOOS geophysical instruments were installed. The purpose of these instruments is to advance our understanding of oceanic and seismic activity in the region. Dr. Juan Diaz from the Universidad de Católica de Valparaíso, Chile also participated in the Sonne Cruise as a researcher for the IDOOS project, contributing his expertise in marine geophysics. This collaboration aims to promote greater knowledge sharing and technological innovation by pioneering a geophysical-oceanographic observing platform in Chile by IMO and its international and national partners.

IMO has also continued to develop international collaboration projects led by both associated and adjunct researchers. AI Aguilera, along with PI Vargas, have continued the development of their REDES-ANID project (Project FOVI210058) titled 'International Alliance for the Generation of Knowledge and Capacities to Detect Remote and Local Processes of Ocean Acidification on the Coasts of Chile (INRELOAD).' The project has strengthened international cooperation between the Lyell Centre in the United Kingdom and the Center for Marine Environmental Sciences (MARUM) in Bremen, Germany. PI von Dassow continues to be a Research Fellow at Stazione Zoologica Anton Dohrn, Italy.

b) Redes de Colaboración:

At the national level IMO has continued its close collaboration with the Program for Climate Action Planning (CLAP), a project led by Dr. B. Dewitte of CEAZA. During the year 2023, PI Pizarro coordinated 2 measurement campaigns with ocean gliders carried out off the coast of Coquimbo in coordination and co-financed by IMO and CLAP. In addition, Dr Pizarro participated as a guest professor at the GOOD-OARS-CLAP-COPAS International Summer School 2023 on Ocean Deoxygenation organized by CEAZA in Coquimbo between November 6 - 12, 2023.

Many of the open questions about the deep-sea ecosystem functioning have been approached through international collaborations. For example, the IMO young researcher Dr. Igor Fernandez-Urruzola was invited to participate in the Sonne 296 cruise off Concepcion together with researchers from the Leibniz Institute for Baltic Sea Research (IOW, Germany). This effort served to collect day and night stratified samples of micronekton and zooplankton to better understand how the vertical movements across the water column regulate the carbon transfer to the deep ocean. Dr. Fernandez-Urruzola

maintains an active collaboration with researchers from the Hadal Centre (Southern Denmark University, Denmark) through his FONDECYT 11221079 project; in this context, he has carried out experimental work to detect pressure effects on the plankton physiology and the biochemical machinery behind it.

In other collaborative initiatives, our young researcher Dr. Vera Oerder was invited to the "Atmosphere-ocean coupling at (sub)mesoscales" workshop at Lorentz Center (Leiden, Netherlands), organized by the Delft University of Technology, the University of Maryland College Park, the University of Milan-Bicocca and the Oregon State University with the aim to identify emerging grand challenges in (sub)mesoscales air-sea coupling.

Also, IMO researcher, Dr. Mauricio Urbina, opened a very active collaboration between IMO and Exeter University, UK. During 2023, such that Dr. Rober Ellis, senior lecturer in Ecophysiology and co/director of Global Engagement from the University of Exeter (UK), visited us in March 2024 and conducted field sampling along the Chilean Coast, also meeting with relevant people at UdeC (IMO included) aiming to foster cutting edge science between IMO and Exeter University.

6. Outreach and connections with other sectors

a) Outreach:

The general aim of outreach activities is to spread knowledge about marine sciences and our center’s investigations focusing on Chilean society. The criteria to enhance these activities are rooted in identifying needs in the target audience, using diverse technological and pedagogical resources to reach a wide range of audiences with varied interests and profiles. During 2023, one of our most important goals was to strengthen the transmedia strategy we have been developing around the great milestone that has been the exploration of the Atacama Trench. In this context, among the activities and projects we developed, the premiere of the new documentary “Atacama Hadal” and related outreach activities stand out:

The Exhibition “Atacamex: Science of the Deep Ocean”: Developed with “Ciencia pública” funds and private sponsors, this exhibition was produced along with The Technology, Arts and Sciences Interactive Center (CICAT) and it is still active in CICAT, where people can enjoy the immersive experience, feel emotions and be enchanted by our oceans, through experiments, illustrations, models of the two vehicles that reached the bottom of the Atacama Trench, 3D sculptures of some deep ocean organisms and the sensory room with VR lenses allowing participants to submerge to the Atacama Trench. Between its inauguration in May 2022 and March 2024, it has received more than 32,000 visits, including school students, preschoolers, university students, families, etc.

Video game “Audacity: Hadal Challenge”: This video game was created as a pedagogical tool for use in the classroom, providing a fun moment for children, as well as an opportunity to learn more about the ocean, the oceanic trenches, and the organisms that inhabit these environments. Through the game, users can discover the fascinating organisms that inhabit the deep sea, as well as their formation, the characteristics of these ecosystems which are inhospitable to humans and the challenges of their exploration. This project was developed by IMO with financing from the “Ciencia pública” program. Since its creation in November 2022, the video game been downloaded more than 5,200 times. Recently, a new version of the video game was developed to be used by Teleton children, which was financed by the Regional Government of Biobío and is currently being used by Teleton to enhance the physical and intellectual abilities of children with different degrees of disability. Web site: Audacia : Desafío Hadal (audaciagame.cl).

We also developed several other projects, including:

Season four of “Bichitos”: During 2023 we produced the fourth season of this TV series, focused on the exploration of human beings to unknown places and environments. Children from different regions of Chile star in this series, asking and sharing their opinions and knowledge about the the ocean and marine plankton, including their importance and role in climate, as well as the impact of climate change on society. The series seeks to reveal what boys and girls think and feel about the issues raised. This is carried out through interviews, where they answer questions and share their experiences about the contents. This season was financed by a coproduction with “CNTV Infantil” and PME funds, and will be released in May 2024. The series already has 4 seasons and has been shown on 70 channels throughout the country and on different digital platforms.

Book “Tales from the Ocean”: In 2022, a collection of eight digital stories titled “Tales from the Ocean: The Scientific Recipe of Tony Tonina” was developed, written and illustrated by members of our team. In the stories, Tony Tonina and his friends, live adventures, explore and discover

environments, species and incredible curiosities of our oceans. During 2023, we developed 12 Storyteller shows, in the Biobío and Metropolitan regions, reaching more than 700 children. In the show, the narrator not only tells the story, but also interacts with the audience and with the puppets of the main characters, generating an interactive, playful and magical space for children, who are amazed with the ocean and its importance. In 2023, the project was awarded funds from the “Ciencia Pública” program for the Distribution of outreach products, which allowed us to print 1000 copies of the book and its subsequent distribution through storytelling shows throughout the Biobío and Ñuble region during the present year.

In order to increase impact and promote inclusion, the stories were narrated in audio-story, and are available on YouTube and Spotify platforms. These products are added to the animated children's series “Tony Tonina’s Scientific Recipe”. In this way, Tony Tonina and his friends remain present over the years to continue charming and educating our children.

International ocean film festival: For the second time in Chile, within the framework of the second version of Puerto de Ideas Biobío Festival, IMO organized, together with Puerto Ideas, the second version of this international festival. We received more than 1,200 documentary films from all over the world, of which a selection of 18 productions was made. The winner in the feature film section was “Hijos del Hielo” (Colombia, 2022) and in the short film section “Pepedrilo” (Mexico, 2022).

Explorers: “From the atom to the cosmos”: The 8th season of the show was produced. This consists of interviews and reports with research centers of excellence in different areas of knowledge. In IMO’s episode, our researcher Oscar Pizarro was interviewed about the 3 reports: the first one, about the exploration of the Atacama Trench through the installation of an integrated system of oceanographic instruments that are carrying out measurements and taking samples over a period of 5 years; the second one, about trying to understand how fauna evolved to resist environmental conditions as extreme as those found at depths of more than 5,000 meters. These studies have allowed us to understand, among other things, that more than 50% of the diversity found in the deep ocean is not registered in genetic databases and that the regulation of life in the depths of the ocean is determined by a series of factors, among which the availability of oxygen and temperature stand out; the third topic was about the study of the oxygen minimum zones in the Pacific Ocean found in the north of Chile, which may be expanding and intensifying due to climate change. The study of these extreme environments implies a great technological challenge associated with a high economic cost. It is a collaborative effort of global scientific community that helps build the capabilities of young professionals who cover different disciplines of marine and oceanographic sciences.

IMO’s episode reached 300,000 viewers, and its reports, as well as all those produced for the program, can be viewed at: Exploradores: del átomo al cosmos – YouTube.

In the communication area, the main goal has been to consolidate the Institute as a national and international reference in the study of the open and deep ocean, with special emphasis on the Southeast Pacific. During 2023, our greatest communication milestone was the premier of the documentary “Atacama Hadal”. Subsequently, the communications plan has focused on the different projects that make up the transmedia strategy, among other activities to the general public.

Our projects also have international reach. Part of our outreach team participated in two important scientific communication events:

- PCST (Public Communication in Science and Technology), Rotterdam, Netherlands, between April 11 and 14, 2023. Where Bárbara Léniz, together with Julián Rosenblatt from “Ciencia y Vida” Foundation and director of the documentaries, made the oral presentation:

“Demonstration: 360° communication in science: Transmedia strategy regarding the journey to the hadal zone of the Atacama Trench”. The oral presentation covered our communication and dissemination strategy around the exploration of the Atacama Trench, from ExploSub underwater

robotics project in 2018, to the documentaries, including the book, video game and the Atacamex exhibition. In this sense, we highlight the collaborative and interdisciplinary work of our team, as well as the particularities of the development of each project and the interaction with different audiences.

- XVIII RedPOP 2023 Conference in Rio de Janeiro, Brasil, where Edwin Rodríguez attended with the aim of presenting Video game “Audacity: Hadal Challenge”. The project was presented as a success case of an innovative science dissemination product, exhibiting the development method, the scientific content and the impact and the scope it has had on children, teenagers and the community in general. In addition, the documentary “Atacama Hadal” received the award for best documentary feature film at the “Actrum International Film Fest”, held on October 21, 2023 in Madrid, Spain. The award was received by Aida Granell, communications manager, who attended on behalf of our Institute. This award corroborates the good reception that our audiovisual production has had at an international level, connecting and thrilling viewers with a story that combines science and art. In this way, the documentary is showing the world how we are moving forward the frontier of exploration in Chile.

b) Connections with other sectors:

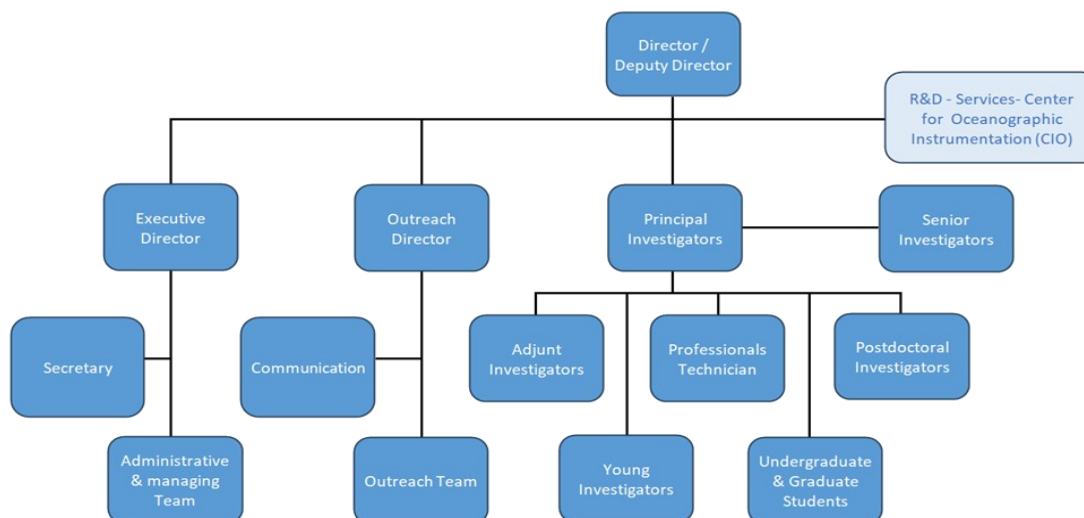
Many of our researchers have sustained their collaboration with governmental agencies, particularly in the context of climate change and global environmental concerns. For example, our associate, PI Vargas has been actively involved as a permanent member of the "Technical Advisory Committee on Climate Change (GTA-Cambio Climático Subpesca)" at the Undersecretary of Fisheries. In this capacity, he offers guidance and advice on various matters, including the application of insights derived from IMO's research, such as assessing the impact of ocean acidification on marine populations. PI Vargas has also continued his role as a member of the Technical Advisory Committee and National Node of the Chilean Nuclear Energy Commission (CcheN) in the Climate Change area. In this committee, Vargas serves as Chile's representative to the IAEA Ocean Acidification International Coordination Centre (OA-ICC), a group that fosters international cooperation on ocean acidification. The OA-ICC conducts training courses in Member States and facilitates access to data and resources to further ocean acidification research. The Centre advocates for the establishment of data portals, standardized methodologies, and best practices. PI von Dassow is part of the working group for the UN Decade of the Comité Oceanográfico Nacional (CONA) organized by the Chilean Navy.

c) Other achievements: No other achievements.

7. Administration, Governance and Financial Status

a) Organization and administration:

The following chart represent the organization during this period:



The following table shows the technicians, administrative and housekeeping personnel:

Category	Female	Male	TOTAL
Assistant & Technicians	6	8	14
Administrative Staff	3	3	6
TOTAL	9	11	20

b) Financial Status:

The structure of income of IMO has been composed by 3 funds managed by our institution and another groups of 3 funds which we didn't manage but contributed directly or indirectly to our research lines. During this period, the structure of IMO's managed Income was based on the MSI funds representing 76%, and from other public funds (24%), mainly represented by funds to pay vessel time granted from ANID.

In terms of expenses, considering the last twelve months, the structure is characterized by the largest share of spending on scientific and technical personnel (60%), followed by spending on administration and communications personnel (15%) and operational expenses (14%).

The cost sharing in personnel during this period is shown at Table 9.2.

8. Annexes:

1.- Institute Researchers

1.1 Summary researchers of the center

Category of researcher	Quantity	Average age	Nationality		Distribution Gender		
			National	International	Male	Female	Not stated
Director	1	62	1	0	1	0	0
Alternate Director	1	67	1	0	1	0	0
Principal Researcher	6	56	5	1	6	0	0
Adjunct Researchers	10	55	10	0	8	2	0
Senior Researcher	4	71	2	2	4	0	0
Young Researcher	7	42	4	3	3	4	0
Postdoctoral	5	38	4	1	3	2	0

1.2 Principal Researchers

Name	Research Line	Nationality	Gender	Date of birth dd/mm/yy	Profession	Academic Degree	Affiliation	Current Position	Relation with Center
Osvaldo Ulloa Quijada	2	Chilean	M	21/05/61	Marine Biologist	D	University of Concepcion	Responsible Director	2
Oscar Pizarro Arriagada	1 and 2	Chilean	M	28/03/63	Oceanographer	D	University of Concepcion	Research Associate	2
H. Rubén Escribano Veloso	1 and 2	Chilean	M	16/04/57	Marine Biologist	D	University of Concepcion	Substitute Principal	2
Peter Von Dassow	1	American	M	31/03/74	Bachelor of Science in Cellular and Molecular Biology	D	Pontifical Catholic University of Chile	Research Associate	2
Marcos Moreno Switt	2	Chilean	M	27/08/74	Geologist	D	Pontifical Catholic University of Chile	Associate Professor	2
Cristian Vargas Galvez	1	Chilean	M	26/12/72	Marine Biologist	D	University of Concepcion	Research Associate	2

Adjunct Researchers

Name	Research Line	Nationality	Gender	Date of birth dd/mm/yy	Profession	Academic Degree	Affiliation	Current Position	Relation with Center
Víctor Miguel Aguilera Ramos	1	Chilean	M	01/11/76	Marine Biologist	D	CEAZA- Northern Catholic University	Assistant Professor	2
Marcela Alejandra Cornejo D'Ottone	1	Chilean	F	20/07/77	Oceanographer	D	Pontifical Catholic University of Valparaiso	Associate Professor	2
Marcos Simón Moreno Swit	2	Chilean	M	24/08/74	Geologist	D	University of Concepción	Assistant Professor	2
Ramiro Antonio Riquelme Bugueño	1,2	Chilean	M	07/09/78	Marine Biologist	D	University of Concepción	Assistant Professor	2
Julio Cesar Sepúlveda Arellano	1	Chilean	M	25/02/77	Marine Biologist	D	University of Colorado Boulder	Assistant Professor	2
Marcelo Enrique Oliva Moreno	1,2	Chilean	M	17/03/52	Biologist	D	University of Antofagasta	Full Professor	2
Pablo Rosenblatt Guelfenbein	1,2	Chilean	M	06/01/55	Biologist	M	Millennium Institute of Oceanography	Adjunct Researcher	2
Pamela del Carmen Hidalgo Diaz	1,2	Chilean	F	07/06/66	Aquaculture Engineer	D	University of Concepción	Adjunct Professor	2
Mauricio Andrónico Urbina Foneron	1	Chilean	M	07/09/78	Aquaculture Engineer	D	University of Concepción	Assistant Professor	2
Víctor Enrique Villagrán Orellana	1,2	Chilean	M	02/03/73	Electronic Engineer	M	University of Concepción	Chief MIDGEO Laboratory	2
Atilio Edison Morgado Malebrán	1,2	Chilean	M	23/05/60	Marine Biologist	M	Millennium Institute of Oceanography	Adjunct Researcher	2
Vera Oerder Gautron	1,2	French	F	22/07/87	PhD in Oceanography and Climatology	D	University of Concepción	Associate Professor	1

Young Researchers

Name	Research Line	Nationality	Gender	Date of birth dd/mm/yy	Profession	Academic Degree	Affiliation	Current Position	Relation with Center
Montserrat Aldunate Chinchón	1,2	Chilean	F	10/02/84	Marine Biologist	D	Millennium Institute of Oceanography	Young Researchers	1
Natalia Osma Prado	1,2	Spanish	F	29/01/83	PhD in Biological Oceanography	D	Millennium Institute of Oceanography	Young Researcher	2
Diana Johanna Medellín Mora	1	Colombian	F	18/01/83	Marine Biologist	D	Millennium Institute of Oceanography	Young Researcher	2
Matías Esteban Castro González	1,2	Chilean	M	28/12/81	Molecular Biotechnology engineer	D	University of Chile, Santiago	Young Researchers	2
Salvador Francisco Ramírez Flandes	1,2	Chilean	M	07/01/75	Engineer	D	Millennium Institute of Oceanography	Young Researchers	1
Francisco Javier Díaz Rosas	1,2	Chilean	M	24/12/80	Marine Biologist	D	Pontifical Catholic University	Young Researchers	1

Postdoctoral Researchers

Name	Research Line	Nationality	Gender	Date of birth	Profession	Academic Degree	Affiliation	Current Position	Relation with Center
				dd/mm/yy					
Igor Fernandez Uruzola	1	Spanish	M	18-03-1983	Biologia Marina	Doctor en Oceanografía	Instituto Milenio de Oceanografía	Postdoctoral researcher	1
Carolina Andrea Gonzalez Espinoza	1 and 2	Chilean	F	20-06-1990	Biologia Marina	Doctorado en Oceanografía	Instituto Milenio de Oceanografía	Current Position	1
Andres Alberto Mesas Palma	1	Chilean	M	13-05-1988	Biologia Marina	Doctor en ciencias mención en Ecología y Evolución	Instituto Milenio de Oceanografía	Current Position	1
Reinaldo Javier Rivera Jara	1 and 2	Chilean	M	30-11-1984	Licenciado en Recursos Naturales	Doctor en ciencias mención en Ecología y Evolución	Instituto Milenio de Oceanografía	Postdoctoral researcher	1
Paula Ruz Moreno	1	Chilean	F	07-07-1983	Ecologia Marina	Doctor en Oceanografía /	Pontificia Universidad catolica de Valparaiso	Postdoctoral researcher	2

3 Senior Researchers

Name	Research Line	Nationality	Gender	Date of birth dd/mm/yy	Profession	Academic Degree	Affiliation	Current Position	Relation with Center
Juan Carlos Castilla zenobi	1 and 2	Chilean	M	19/08/40	Biologist	D	Pontifical Catholic University of Chile	Professor	2
Gerrit Van den Engh	1 and 2	Holland	M	06/03/49	Biophysicist expert cytometry	D	Becton Dickinson	Senior Researcher	2
Wolfgang Schneider	1	German	M	16/02/54	M.Sc Oceanographer	D	University of Concepcion	Research Associate	2
Samuel Hormazabal Fritz	1	Chilean	M	08/12/67	Oceanographer	D	Pontifical Catholic University of Chile	Associate Professor	2

<u>NOMENCLATURE:</u> [Gender] [M] Male [F] Female [ND] Does not Declare	[Academic Degree] [U] Undergraduate [M] Master [D] Doctoral	[Relation with Center] [1] Full time [2] Part time
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Annex 2.- Research Lines

N°	Research Line	Research Line Objectives	Description of Research Line	Researcher	Research Discipline	Starting Date [dd/mm/yy]	Ending Date [dd/mm/yy]	Status
1	A Variable and Changing Ocean	The goals of this theme I will be organized around three grand questions: A: How well do biogeochemical flows, community composition, and even population structure of key species correlate with physical oceanographic drivers? B: How does biogeochemical function differ among norm-oxic, OMZ, and AMZ marine systems? C: What is the resilience of key communities and organisms to a changing ocean, and can that be predicted by their origin?	Dominant environmental drivers, such as naturally high pCO ₂ /low pH conditions partially coupled to naturally low O ₂ or anoxic waters, must be crucial in shaping ecosystem and biogeochemical functioning in the ESP. Additionally, as the global ocean is both acidifying (due to absorption of anthropogenic CO ₂) and losing O ₂ (due to warming and increased stratification), the ESP also provides one of the most important natural laboratories for predicting future ocean function in the Anthropocene by understanding how biological systems adapt to and function under these conditions. The first period showed us the need to more effectively integrate the physical and chemical oceanographic understanding of the drivers of ocean variability, at the (sub)mesoscale (former Line 1) and on inter-annual to longer time scales (former line 2), with investigation of the consequences and responses at biogeochemical, ecological, and even organismal levels (former line 3). While the physical drivers are relatively well understood, the frontier of investigation is to understand the consequences for chemical, biogeochemical, and biological function, including potential adaptive responses.	Oscar Pizarro Arriagada. Wolfgang Schneider. Cristian Vargas Gálvez. Samuel Ernesto Hormazábal Fritz. Peter von Dassow. Víctor Miguel Aguilera Ramos. Heraclio Rubén Escribano Veloso. Víctor Enrique Villagrán Orellana. Pablo Rosenblat Guelfenbein. Montserrat Gabriela Aldunate Chinchón. Diana Johanna Medellín Mora. Juan Carlos Castilla Zenobi. Gerrit van den Engh. Ramiro Riquelme Antonio Bugueño. Julio César Sepúlveda Arellano. Marcelo Enrique Oliva Moreno. Pamela del Carmen Díaz Hidalgo. Mauricio Andrónico Urbina Fonerón. Atilio Edison Morgado Malebrán, Vera Oerder.	Biología marina. Ecología y ciencias ambientales. Oceanografía. Biología molecular. Física. Geoquímica. Química del ambiente.	02/01/2019		Current

2	The Deep Ocean	The goal of this theme II will be organized around a single grand question: What are the physical and biogeochemical characteristics of deep and ultra-deep waters of the eastern South Pacific, and which of those determine the diversity and functional structure of their pelagic communities?	In spite of the inexperience and logistical challenges in deep-sea oceanography, initiating the exploration and studying of the deep and ultra deep waters of the South Pacific proved to be extremely rewarding, and constitute one of the most promising research goals for the next phase. As for Research Theme I, the first period showed us the need to more effectively integrate the physical, chemical and biological aspects of the study of the deep ocean.	Heraclio Rubén Escribano Veloso. Osvaldo Iván Ulloa Quijada. Marcelo Enrique Oliva Moreno. Pamela del Carmen Hidalgo Diaz. Wolfgang Schneider. Oscar Roberto Pizarro Arriagada. Peter von Dassow. Cristián Antonio Vargas Galvez. Pablo Rosenblatt Guelfenbein. Ramiro Antonio Riquelme Bugueño. Víctor Enrique Villagrán Orellana. Gerrit van den Engh.Montserrat Gabriela Aldunate Chinchón. Juan Carlos Castilla Zenobi. Samuel Ernesto Hormazábal Fritz.Marcos Simón Moreno Switt. Atilio Morgado. Andrés Alberto Mesas Palma. Reinaldo Javier Rivera Jara. Matías Estebán Castro González.	Biología marina.Biología molecular.Ecología y ciencias ambientales. Geofísica. Bioquímica. Genética y evolución. Geoquímica. Ingeniería. Ingeniería electrónica. Ingeniería mecánica. Ingeniería oceánica. Oceanografía. Geología. Tectónica. Zoología.	02/01/2019		Current
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Annex 3.- Publications (Total or partially financed by MSI)**3.1.- ISI/WOS Publications or Similar to ISI/WOS Standard****3.1.1 Principal Researchers**

N°	Title	Authors	Source (Name of the Journal) [1]	DOI	Quartile*	Lines of Research	N° principal researchers of the center	Number of researchers of the center another category	N° students	Date of publication
1	Distinct habitat and biogeochemical properties of low-oxygen-adapted tropical oceanic phytoplankton	Isabelle Cox, Robert J. W. Brewin, Giorgio Dall'Olmo, Katy Sheen, Shubha Sathyendranath, Rafael Rasse, Osvaldo Ulloa	Cox, I., Brewin, R.J.W., Dall'Olmo, G., Sheen, K., Sathyendranath, S., Rasse, R., Ulloa, O., 2023. Distinct habitat and biogeochemical properties of low-oxygen-adapted tropical oceanic phytoplankton. <i>Limnol. Oceanogr.</i> 68, 2022–2039.	10.1002/ino.12404	Q1	1. A Variable and Changing Ocean	1	0	0	19-07-2023
2	Do phytoplankton require oxygen to survive? A hypothesis and model synthesis from oxygen minimum zones	Jane C. Y. Wong, John A. Raven, Montserrat Aldunate, Sebastián Silva, Juan Diego Gaitán-Espitia, Cristian A. Vargas, Osvaldo Ulloa, Peter von Dassow	Wong, J.C.Y., Raven, J.A., Aldunate, M., Silva, S., Gaitán-Espitia, J.D., Vargas, C.A., Ulloa, O., von Dassow, P., 2023. Do phytoplankton require oxygen to survive? A hypothesis and model synthesis from oxygen minimum zones. <i>Limnol. Oceanogr.</i> 68, 1417–1437.	10.1002/ino.12367	Q1	1. A Variable and Changing Ocean	3	1	0	07-05-2023
3	A compendium of bacterial and archaeal single-cell amplified genomes from oxygen deficient marine waters	Julia Anstett, Alvaro M. Plominsky, Edward F. DeLong, Alyse Kiesser, Klaus Jürgens, Connor Morgan-Lang, Ramunas Stepanauskas, Frank J. Stewart, Osvaldo Ulloa, Tanja Woyke, Rex Malmstrom & Steven J. Hallam	Anstett, J., Plominsky, A.M., DeLong, E.F., Kiesser, A., Jürgens, K., Morgan-Lang, C., Stepanauskas, R., Stewart, F.J., Ulloa, O., Woyke, T., Malmstrom, R., Hallam, S.J., 2023. A compendium of bacterial and archaeal single-cell amplified genomes from oxygen deficient marine waters. <i>Sci. Data</i> 10, 332.	10.1038/s41597-023-02222-y	Q1	1. A Variable and Changing Ocean	1	0	0	27-05-2023
4	Combined use of carbon, nitrogen and sulfur stable isotopes reveal trophic structure and connections in deep-sea mesopelagic and demersal fish communities from the	Luis A. Nacari, Ruben Escribano, Chris Harrod, Marcelo E. Oliva	Nacari, L.A., Escribano, R., Harrod, C., Oliva, M.E., 2023. Combined use of carbon, nitrogen and sulfur stable isotopes reveal trophic structure and connections in deep-sea mesopelagic and demersal fish communities from the Southeastern Pacific Ocean.	10.1016/j.dsr.2023.104069	Q2	2. The Deep Ocean	1	1	1	13-05-2023

	Southeastern Pacific Ocean		Deep Sea Res. Part Oceanogr. Res. Pap. 197, 104069.							
5	Two New Species of Encotyllabe (Monogenea: Capsalidae) from Brazil: Morphological and Molecular Evidence	Naraiana Taborda; Fabiola A. Sepulveda ; Jose L. Luque; Rubén Escribano; Marcelo E. Oliva	Taborda, N., Sepulveda, F.A., Luque, J.L., Escribano, R., Oliva, M.E., 2023. Two New Species of Encotyllabe (Monogenea: Capsalidae) from Brazil: Morphological and Molecular Evidence. Diversity. 15, 706.	10.3390/d15060706	Q2	2. The Deep Ocean	1	1	0	09-05-2023
6	Differential gene expression analysis in the scallop <i>Argopecten purpuratus</i> exposed to altered pH and temperature conditions in an upwelling-influenced farming area	Samanta Benítez; Álvaro Figueroa; Nelson A. Lagos; Andrea X. Silva; Cristian Duarte; Cristian A. Vargas; Marco A. Lardies; Leyla Cárdenas	Benítez, S., Figueroa, Á., Lagos, N.A., Silva, A.X., Duarte, C., Vargas, C.A., Lardies, M.A., Cárdenas, L., 2023. Differential gene expression analysis in the scallop <i>Argopecten purpuratus</i> exposed to altered pH and temperature conditions in an upwelling-influenced farming area. Comp. Biochem. Physiol. Part D Genomics Proteomics 45, 101046.	10.1016/j.cbd.2022.101046	Q3	1. Variable and Changing Ocean	1	0	0	01-03-2023
7	Modeling present and future distribution of plankton populations in a coastal upwelling zone: the copepod <i>Calanus chilensis</i> as a study case	Reinaldo Rivera; Rubén Escribano; Carolina E. González; Manuela Pérez-Aragón	Rivera, R., Escribano, R., González, C.E., Pérez-Aragón, M., 2023. Modeling present and future distribution of plankton populations in a coastal upwelling zone: the copepod <i>Calanus chilensis</i> as a study case. Sci. Rep. 13, 3158.	10.1038/s41598-023-29541-9	Q1	1. A Variable and Changing Ocean	1	2	1	23-02-2023
8	Trophic ecology of midwater zooplankton along a productivity gradient in the Southeast Pacific	Igor Fernández-Urruzola; Antonio Bode; Natalie Loick-Wilde; Wolfgang Schneider; Dhugal Lindsay ; Ruben Escribano	Fernández-Urruzola, I., Bode, A., Loick-Wilde, N., Schneider, W., Lindsay, D., Escribano, R., 2023. Trophic ecology of midwater zooplankton along a productivity gradient in the Southeast Pacific. Front. Mar. Sci.	10.3389/fmars.2023.1057502	Q1	2. The Deep Ocean	1	2	0	15-02-2023
9	Ecophysiological basis of spatiotemporal patterns in picophytoplankton pigments in the global ocean	Sornsiri Phongphattarawat; Heather A. Bouman; Michael W. Lomas; Shubha Sathyendranath; Glen A. Tarran, Osvaldo Ulloa; Mikhail V. Zubkov	Phongphattarawat, S., Bouman, H.A., Lomas, M.W., Sathyendranath, S., Tarran, G.A., Ulloa, O., Zubkov, M.V., 2023. Ecophysiological basis of spatiotemporal patterns in picophytoplankton pigments in the global ocean. Front. Mar. Sci. 10.	10.3389/fmars.2023.1112177	Q1	1. A Variable and Changing Ocean	1	0	0	14-02-2023
10	Particulate Organic Matter in the Atacama Trench: Tracing Sources and Possible Transport Mechanisms to the Hadal Seafloor	Edgart Flores; Igor Fernández-Urruzola; Sebastian I. Cantarero; Matías Pizarro-Koch; Matthias Zabel; Julio Sepúlveda; Osvaldo Ulloa	Flores, E., Fernández-Urruzola, I., Cantarero, S.I., Pizarro-Koch, M., Zabel, M., Sepúlveda, J., Ulloa, O., 2023. Particulate Organic Matter in the Atacama Trench: Tracing Sources and Possible Transport Mechanisms to the Hadal Seafloor. J. Geophys. Res. Biogeosciences 128, e2023JG007401.	10.1029/2023JG007401	Q2	2. The Deep Ocean	1	2	2	07-08-2023
11	Revealing zooplankton diversity in the midnight zone	Carolina E. González; Leocadio Blanco-Bercial; Rubén Escribano; Igor	González, C.E., Blanco-Bercial, L., Escribano, R., Fernández-Urruzola, I., Rivera, R., Ulloa, O., 2023a.	10.3389/fmars.2023.1252535	Q1	2. The Deep Ocean	2	3	0	07-12-2023

		Fernández-Urruzola; Reinaldo Rivera; Osvaldo Ulloa	Revealing zooplankton diversity in the midnight zone. <i>Front. Mar. Sci.</i> 10, 1252535.							
12	Fast relocking and afterslip-seismicity evolution following the 2015 Mw 8.3 Illapel earthquake in Chile	Joaquín Hormazábal; Marcos Moreno; Francisco Ortega-Culaciati; Juan Carlos Báez; Carlos Peña, Christian Sipp;Diego González-Vidal;Javier Ruiz, Sabrina Metzger; Shoichi Yoshioka	Hormazábal, J., Moreno, M., Ortega-Culaciati, F., Báez, J.C., Peña, C., Sippl, C., González-Vidal, D., Ruiz, J., Metzger, S., Yoshioka, S., 2023. Fast relocking and afterslip-seismicity evolution following the 2015 Mw 8.3 Illapel earthquake in Chile. <i>Sci. Rep.</i> 13, 19511.	10.1038/s41598-023-45369-9	Q2	2. The Deep Ocean	1	0	0	11-09-2023
13	A machine learning approach for slow slip event detection using GNSS time-series	Felipe Donoso ;Vicente Yáñez;Francisco Ortega-Culaciati; Marcos Moreno	Donoso, F., Yáñez, V., Ortega-Culaciati, F., Moreno, M., 2023. A machine learning approach for slow slip event detection using GNSS time-series. <i>J. South Am. Earth Sci.</i> 132, 104680.	10.1016/J.JSAM ES.2023.104680	Q3	2. The Deep Ocean	1	0	0	01-12-2023
14	The lateral transport of zooplankton explains trophic and taxonomic similarities over the zonal gradient of central Chile	Carolina E. González; Antonio Bode; Igor Fernández-Urruzola; Pamela Hidalgo; Vera Oerder; Rubén Escribano	González, C.E., Bode, A., Fernández-Urruzola, I., Hidalgo, P., Oerder, V., Escribano, R., 2023b. The lateral transport of zooplankton explains trophic and taxonomic similarities over the zonal gradient of central Chile. <i>J. Mar. Syst.</i> 238, 103840.	10.1016/j.jmarsys .2022.103840	Q1	1. A Variable and Changing Ocean 2. The Deep Ocean	1	4	0	01-02-2023
15	Main drivers of marine heat waves in the eastern South Pacific	David Carrasco; Oscar Pizarro;Martín Jacques-Coper; Diego A. Narváez	Carrasco, D., Pizarro, O., Jacques-Coper, M., Narváez, D.A., 2023. Main drivers of marine heat waves in the eastern South Pacific. <i>Front. Mar. Sci.</i> 10.	10.3389/fmars.2023.1129276	Q1	1. A Variable and Changing Ocean	1	0	1	10-02-2023
16	On the interpretation of changes in the subtropical oxygen minimum zone volume off Chile during two La Niña events (2001 and 2007)	Matías Pizarro-Koch; Oscar Pizarro; Boris Dewitte; Ivonne Montes;Aurélien Paulmier; Véronique Garçon;Hector Hito Sepulveda; Andrea Corredor-Acosta; Catalina Aguirre; Marcel Ramos	Pizarro-Koch, M., Pizarro, O., Dewitte, B., Montes, I., Paulmier, A., Garçon, V., Sepulveda, H.H., Corredor-Acosta, A., Aguirre, C., Ramos, M., 2023. On the interpretation of changes in the subtropical oxygen minimum zone volume off Chile during two La Niña events (2001 and 2007). <i>Front. Mar. Sci.</i> 10.	10.3389/fmars.2023.1155932	Q1	2. The Deep Ocean	1	0	0	04-07-2023
17	The ENSO-induced South Pacific Meridional Mode	Boris Dewitte; Emilio Concha; Diego Saavedra; Oscar Pizarro;Cristian Martínez-Villalobos; Daria Gushchina; Marcel Ramos; Aldo Montecinos	Dewitte, B., Concha, E., Saavedra, D., Pizarro, O., Martínez-Villalobos, C., Gushchina, D., Ramos, M., Montecinos, A., 2023. The ENSO-induced South Pacific Meridional Mode. <i>Front. Clim.</i> 4.	10.3389/fclim.2022.1080978	Q1	1. A Variable and Changing Ocean	1	0	0	25-01-2023
18	Priorities for progress towards Sustainable Development Goal 14 'Life below water'	Jane Lubchenco, Emma F. Camp, Cristian A. Vargas, Dyhia Belhabib, Zuzu Anna, Diva J. Amon, Anna	Lubchenco, J., Camp, E.F., Vargas, C.A., Belhabib, D., Anna, Z., Amon, D.J., Metaxas, A., Harden-Davies, H., 2023. Priorities for progress towards Sustainable Development Goal 14	10.1038/s41559-023-02208-4	Q1	1. A Variable and Changing	1	0	0	02-10-2023

		Metaxas; Harriet Harden-Davies	'Life below water.' Nat. Ecol. Evol. 7, 1564–1569.			ng Ocean				
19	Land–Sea Interactions and Ecosystem Services: Research Gaps and Future Challenges	Matías Barceló; Cristian A. Vargas; Stefan Gelcich	Barceló, M., Vargas, C.A., Gelcich, S., 2023. Land–Sea Interactions and Ecosystem Services: Research Gaps and Future Challenges. Sustainability 15, 8068.	10.3390/su15108068	Q2	1. A Variable and Changing Ocean	1	0	0	16-05-2023
20	Diversity and toxicity of the planktonic diatom genus Pseudo-nitzschia from coastal and offshore waters of the Southeast Pacific, including Pseudo-nitzschia dampieri sp. nov.	Peter von Dassow , Marta Mikhno , Isabella Percopo, Valentina Rubio Orellana, Víctor Aguilera, Gonzalo Alvarez , Michael Araya , Sebastian Cornejo-Guzman, Tomas Llona , Jorge I. Mardones, Luis Norambuena , Victoria Salas-Rojas , Wiebe H.C.F. Kooistra , Marina Montresor , Diana Sarno	von Dassow, P., Mikhno, M., Percopo, I., Orellana, V.R., Aguilera, V., Álvarez, G., Araya, M., Cornejo-Guzmán, S., Llona, T., Mardones, J.I., Norambuena, L., Salas-Rojas, V., Kooistra, W.H.C.F., Montresor, M., Sarno, D., 2023. Diversity and toxicity of the planktonic diatom genus Pseudo-nitzschia from coastal and offshore waters of the Southeast Pacific, including Pseudo-nitzschia dampieri sp. nov. Harmful Algae 130, 102520.	10.1016/j.hal.2023.102520	Q1	1. A Variable and Changing Ocean	1	1	2	18-12-2023
21	Local scale extreme low pH conditions and genetic differences shape phenotypic variation in a broad dispersal copepod species	Victor M. Aguilera; Fabiola Sepulveda; Peter von Dassow; Juan Diego Gaitán-Espitia; Andrés Mesas; Cristian A. Vargas	Aguilera, V.M., Sepulveda, F., von Dassow, P., Gaitán-Espitia, J.D., Mesas, A., Vargas, C.A., 2023. Local scale extreme low pH conditions and genetic differences shape phenotypic variation in a broad dispersal copepod species. Front. Mar. Sci. 10.	10.3389/fmars.2023.1221132	Q1	1. A Variable and Changing Ocean	2	2	0	07-12-2023

***Q4: Ingresar esta opción para aquellos artículos que no posean cuartil.**

3.2.- SCOPUS Publications or Similar to SCOPUS Standard:

3.2.1 Principal Researchers:

N°	Title	Authors	Source (Name of the Journal)	DOI	Quartile	Lines of Research	N° principal researchers of the center	Number of researchers of the center another category	N° students	Date of publication
1										
2										
3										

3.3.- SCIELO Publications or Similar to SCIELO Standard

3.3.1 Principal Researchers

N°	Title	Authors	Source (Name of the Journal)	DOI	Quartile	Lines of Research	N° principal researchers of the center	Number of researchers of the center other category	N° students	Date of publication
1										
2										
3										

3.4.- Scientific Books and Chapters

3.4.1 Principals Researchers

N°	Title	Principal Researcher	Source (Name of the Journal)	ISBN	Lines of Research	N° principal researchers of the center	Number of researchers of the center another category	N° students	Date of publication
1									
2									
3									

3.5.- Other Publications

3.5.1 Principals Researchers: *Listado de otras publicaciones en que participe como autor a lo menos un Investigador Principal del centro*

Autores (año), título artículo, nombre revista, número revista, páginas.

N°	Title	Publication Category	Other Category	Authors	Source (Name of the Journal)	DOI	Quartile	Lines of Research	N° principal researchers of the center	Number of researchers of the center another category	N° students	Date of publication
1												
2												
3												

3.6.- “ISI/WOS Publications or Similar to ISI/WOS Standard”, “SCOPUS Publications or Similar to SCOPUS Standard” “SCIELO Publications or Similar to SCIELO Standard”, “Books and chapters in books” y “Other Publications [Other Researchers]”:

3.6.1 Other researchers:

N°	Publication Category	Other Category	Title	Authors	Source (Name of the Journal)	DOI	Quartile	Lines of Research	N° researchers of the center	N° students	Date of publication
1	ISI/WOS		Modulation of the Oceanic Mesoscale Activity by the Mesoscale Thermal Feedback to the Atmosphere	Lionel Renault; S. Masson; V. Oerder ; F. Colas; J.C. McWilliams	Renault, L., Masson, S., Oerder, V., Colas, F., McWilliams, J.C., 2023. Modulation of the Oceanic Mesoscale Activity by the Mesoscale Thermal Feedback to the Atmosphere. J. Phys. Oceanogr. 53, 1651–1667.	10.1175/jpo-d-22-0256.1	Q1	1. A Variable and Changing Ocean	1	0	01-07-2023
2	ISI/WOS		A Spatial-Spectral Classification Method Based on Deep Learning for Controlling Pelagic Fish Landings in Chile	Jorge E. Pezoa; Diego A. Ramírez; Cristofner A. Godoy; María F. Saavedra; Silvia E. Restrepo; Pablo A. Coelho-Caro; Christopher A. Flores; Francisco G. Pérez; Sergio N. Torres; Mauricio A. Urbina	Pezoa, J.E., Ramírez, D.A., Godoy, C.A., Saavedra, M.F., Restrepo, S.E., Coelho-Caro, P.A., Flores, C.A., Pérez, F.G., Torres, S.N., Urbina, M.A., 2023. A Spatial-Spectral Classification Method Based on Deep Learning for Controlling Pelagic Fish Landings in Chile. Sensors 23, 8909.	10.3390/s23218909	Q2	1. A Variable and Changing Ocean	1	0	02-11-2023
3	ISI/WOS		Digital Classification of Chilean Pelagic Species in Fishing Landing Lines	Vincenzo Caro Fuentes; Ariel Torres; Danny Luarte; Jorge E. Pezoa; Sebastián E. Godoy; Sergio N. Torres; Mauricio A. Urbina	Caro Fuentes, V., Torres, A., Luarte, D., Pezoa, J.E., Godoy, S.E., Torres, S.N., Urbina, M.A., 2023. Digital Classification of Chilean Pelagic Species in Fishing Landing Lines. Sensors 23, 8163.	10.3390/s23198163	Q2	1. A Variable and Changing Ocean	1	0	29-09-2023
4	ISI/WOS		Does the loss of diadromy imply the loss of salinity tolerance? A gene expression study with replicate nondiadromous populations of <i>Galaxias maculatus</i>	M. Lisette Delgado; Aliro Manosalva; Mauricio A. Urbina ; Anne C. Dalziel; Evelyn Habit; Oscar Link; Daniel E. Ruzzante	Delgado, M.L., Manosalva, A., Urbina, M.A., Dalziel, A.C., Habit, E., Link, O., Ruzzante, D.E., 2023. Does the loss of diadromy imply the loss of salinity tolerance? A gene expression study with replicate nondiadromous populations of <i>Galaxias maculatus</i> . Mol. Ecol. 32, 2219–2233.	10.1111/mec.16866	Q1	1. A Variable and Changing Ocean	1	0	30-01-2023
5	ISI/WOS		Microbial and Biogeochemical Shifts in a Highly Anthropogenically Impacted Estuary (“El Sauce” Valparaíso)	Francisco Pozo-Solar; Marcela Cornejo-D’Ottone ; Roberto Orellana; Carla Acuña; Cecilia Rivera; Polette Aguilar-Muñoz; Céline	Pozo-Solar, F., Cornejo-D’Ottone, M., Orellana, R., Acuña, C., Rivera, C., Aguilar-Muñoz, P., Lavergne, C., Molina, V., 2023. Microbial and Biogeochemical Shifts in a Highly Anthropogenically Impacted Estuary (“El Sauce” Valparaíso). Water 15, 1251.	10.3390/w15061251	Q2	1. A Variable and Changing Ocean	1	0	22-03-2023

			Lavergne; Veronica Molina								
6	ISI/WOS	Potential effects of shoaling of oxygen minimum zone on the population of <i>Acartia</i> (<i>Acanthacartia</i>) <i>tonsa</i> in the Humboldt Current Upwelling System (23°S)	Paula M. Ruz-Moreno; Pamela Hidalgo; Marcela Cornejo-D'Ottone; Pamela Fierro-González; Javier Babbonney; Kam W. Tang	Ruz-Moreno, P.M., Hidalgo, P., Cornejo-D'Ottone, M., Fierro-González, P., Babbonney, J., Tang, K.W., 2023. Potential effects of shoaling of oxygen minimum zone on the population of <i>Acartia</i> (<i>Acanthacartia</i>) <i>tonsa</i> in the Humboldt Current Upwelling System (23°S). <i>J. Sea Res.</i> 193, 102372.	10.1016/j.seares.2023.102372	Q2	1. A Variable and Changing Ocean	3	1	01-06-2023	
7	ISI/WOS	High variability in organic carbon sources and microbial activities in the hadopelagic waters	Xinxin Li; Xin Zhao; Hongyue Dang; Chuanlun Zhang; Igor Fernández-Urruzola; Zhiqiang Liu; Frank Wenzhöfer; Ronnie N. Glud	Li, X., Zhao, X., Dang, H., Zhang, C., Fernández-Urruzola, I., Liu, Z., Wenzhöfer, F., Glud, R.N., 2023. High variability in organic carbon sources and microbial activities in the hadopelagic waters. <i>Limnol. Oceanogr.</i> 68, 1704–1718.	10.1002/lno.12379	Q1	2. The Deep Ocean	1	0	13-06-2023	
8	ISI/WOS	Evolutionary responses of energy metabolism, development, and reproduction to artificial selection for increasing heat tolerance in <i>Drosophila subobscura</i>	Andrés Mesas; Luis E. Castañeda	Mesas, A., Castañeda, L.E., 2023. Evolutionary responses of energy metabolism, development, and reproduction to artificial selection for increasing heat tolerance in <i>Drosophila subobscura</i> . <i>Evolution</i> 77, 509–518.	10.1093/evolut/qpac033	Q2	1. A Variable and Changing Ocean	1	0	01-02-2023	
9	ISI/WOS	Could an event of extreme drought (2019-2020) affect the feeding ecology of <i>Bubo magellanicus</i> (Gmelin 1788) (Strigiformes: Strigidae) in a Mediterranean region of Chile?	Sam Catchpole Ahumada; Luis Carrera Suárez; Reinaldo Rivera	Ahumada, S.C., Suárez, L.C., Rivera, R., 2023. Could an event of extreme drought (2019-2020) affect the feeding ecology of <i>Bubo magellanicus</i> (Gmelin 1788) (Strigiformes: Strigidae) in a Mediterranean region of Chile? <i>PeerJ</i> 11, e15020.	10.7717/peerj.15020	Q2	1. A Variable and Changing Ocean	1	0	01-05-2023	
10	ISI/WOS	Population and reproductive structure in the endangered and highly endemic freshwater crab <i>Aegla conceptionensis</i> (Decapoda:Pleocyemata:Aegliidae) from Chile	Sam Catchpole; Erwin M. Barría; Pablo S. González; Reinaldo Rivera	Catchpole, S., Barría, E.M., González, P.S., Rivera, R., 2023. Population and reproductive structure in the endangered and highly endemic freshwater crab <i>Aegla conceptionensis</i> (Decapoda:Pleocyemata:Aegliidae) from Chile. <i>Acta Zool.</i> 104, 216–230.	10.1111/azo.12408	Q3	1. A Variable and Changing Ocean	1	0	01-04-2023	
11	ISI/WOS	Citizen scientists study beach litter along 12,000 km of the East Pacific coast: A baseline for the International Plastic Treaty	Diamela De Veer; Jostein Baeza-Álvarez; Solange Bolaños; Sebastián Cavour Araya; Jodie J. Darquea; Manuel A. Díaz Poblete; Gustavo Domínguez; Geraldine Holtmann-Ahumada; Daniela Honorato-Zimmer; Nikita Gaibor; María de los Ángeles Gallardo;	De Veer, D., Baeza-Álvarez, J., Bolaños, S., Cavour Araya, S., Darquea, J.J., Díaz Poblete, M.A., Domínguez, G., Holtmann-Ahumada, G., Honorato-Zimmer, D., Gaibor, N., Gallardo, M. de los A., Guevara Torrejón, V., León Chumpitaz, A., Marcús Zamora, L., Mora, V., Muñoz Araya, J.M., Pernía, B., Purca, S., Rivadeneira, M.M., Sánchez, O.A., Sepúlveda, J.M., Urbina, M. , Vásquez, N., Vélez Tacuri, J., Villalobos, V., Villanueva Brücher, B., Thiel, M., 2023. Citizen scientists study beach litter along 12,000 km of the East Pacific coast: A baseline for the International Plastic Treaty. <i>Mar. Pollut. Bull.</i> 196,	10.1016/j.marpolbul.2023.115481	Q1	1. A Variable and Changing Ocean	1	0	17-10-2023	

			Valeska Guevara Torrejón; Alejandra León Chumpitaz; Lara Marcús Zamora; Valentina Mora; Juan Manuel Muñoz Araya; Beatriz Pernía; Sara Purca; Marcelo M. Rivadeneira; Osmel Alberto Sánchez; José Miguel Sepúlveda; Mauricio Urbina ; Nelson Vásquez; José Vélez Tacuri; Vieia Villalobos; Bernardita Villanueva Brücher; Martin Thiel	115481. https://doi.org/10.1016/j.marpolbul.2023.115481							
12	ISI/WOS	Cellulosic and microplastic fibers in the Antarctic fish <i>Harpagifer antarcticus</i> and Sub-Antarctic <i>Harpagifer bispinis</i>	Mauricio Ergas; Daniela Figueroa; Kurt Paschke; Mauricio A. Urbina ; Jorge M. Navarro; Luis Vargas-Chacoff	Ergas, M., Figueroa, D., Paschke, K., Urbina, M.A. , Navarro, J.M., Vargas-Chacoff, L., 2023. Cellulosic and microplastic fibers in the Antarctic fish <i>Harpagifer antarcticus</i> and Sub-Antarctic <i>Harpagifer bispinis</i> . <i>Mar. Pollut. Bull.</i> 194, 115380. https://doi.org/10.1016/j.marpolbul.2023.115380	10.1016/j.marpolbul.2023.115380	Q1	1. A Variable and Changing Ocean	1	0	08-08-2023	
13	ISI/WOS	Behavioural and physiological responses to salinization and air exposure during the ontogeny of a freshwater South American snail	Rocio Barrios-Figueroa; Mauricio A. Urbina	Barrios-Figueroa, R., Urbina, M.A. , 2023. Behavioural and physiological responses to salinization and air exposure during the ontogeny of a freshwater South American snail. <i>Conserv. Physiol.</i> 11, coac089. https://doi.org/10.1093/conphys/coac089	10.1093/conphys/coac089	Q2	1. A Variable and Changing Ocean	1	0	01-01-2023	

3.5.- Collaborative publications:

Category of Publication	1 researcher		2 researchers		3 researchers		4 or more researchers	
	Nº	%	Nº	%	Nº	%	Nº	%
<i>ISI/WOS Publications or Similar to ISI/WOS Standard</i>	23	67,6	3	8,8	4	11,7	4	11,7
<i>SCOPUS Publications or Similar to SCOPUS Standard</i>	0	0	0	0	0	0	0	0
<i>SCIELO Publications or Similar to SCIELO Standard</i>	0	0	0	0	0	0	0	0
<i>Books and chapters</i>	0	0	0	0	0	0	0	0
<i>Other Publications</i>	0	0	0	0	0	0	0	0
<u>Total of publications</u>	23	67,6	3	8,8	4	11,7	4	11,7

Annex 4.- Organization of Scientific Events

Scope	Title	Type of Event	City	Country	Responsible Researcher	URL
National	Diseño experimental y estadístico para estudios de biología del cambio global (Experimental and statistical design for biology studies of global climate change.)	Workshop	Chillán, Ñuble (Pinto)	Chile	Cristian Vargas	https://mail.google.com/mail/u/0/#advanced-search/from=cvargas%40udec.cl&subset=all&has=actividades+cient%C3%ADficas&within=1d&sizeoperator=s_sl&sizeunit=s_smb&query=from%3A(cvargas%40udec.cl)+actividades+cient%C3%ADficas/WhctKZPCPzwcMIGDNPGRtpcgQVRWqzhNzXZTzrqHwtZmmnVBrSkBDQmPDwmNGIVnGSVPjQ?compose=fwmvGMCLBTggGJmSCvLlpvFZfzLJqRpmJVTCMDVxQHnJvSxwxrcMqhnDCGRQPmtfSRKPtWwtWtcDNQXxxsgrGBqTXNzxxDsBHVKLJjJwkfQlldgDDQ&projector=1&messagePartId=0.1
International	Ecology and Diversity of Marine Microorganisms ECODIM XI (https://ecodim.imo-chile.cl/)	Course	Dichato y Hiunay	Chile	Oswaldo Ulloa	https://ecodim.imo-chile.cl/home/

Annex 5.- Education and capacity building**5.1 Capacity Building inside MSI Centers**

MSI RESEARCHER	NUMBER									TOTAL NUMBER PER MSI RESEARCHER
	Undergraduate students			Graduate students						
				Masters			Doctoral			
	F	M	ND	F	M	ND	F	M	ND	
Oswaldo Ulloa	1	0	0	0	0	0	0	1	0	2
Oscar Pizarro	1	0	0	1	5	0	3	1	0	11
Ruben Escribano	1	0	0	0	0	0	5	0	0	6
Peter Von Dassow	1	2	0	0	0	0	0	0	0	3
Cristian Vargas	0	0	0	0	1	0	0	0	0	1
Ruben Escribano, Mauricio Urbina	0	0	0	1	0	0	1	0	0	2
Oscar Pizarro, Samuel hormazabal	0	0	0	1	0	0	0	0	0	1
Rubén Escribano, Marcelo Oliva	0	0	0	0	0	0	0	1	0	1
Rubén Escribano, Pamela Hidalgo	4	2	0	0	0	0	0	0	0	6
Oswaldo Ulloa, Pamela Hidalgo	0	0	0	0	0	0	1	0	0	1
Oswaldo Ulloa, Montserrat aldunate	0	0	0	0	1	0	0	0	0	1
Peter Von Dassow, Julio Sepulveda	0	0	0	0	0	0	0	1	0	1
Oscar Pizarro, Samuel Hormazabal, Marcela Cornejo	0	0	0	2	0	0	0	0	0	2
Ruben Escribano, Mauricio Urbina, Ramiro Riquelme	0	0	0	0	0	0	1	0	0	1
Ruben Escribano, Carolina Gonzalez	0	1	0	0	0	0	0	0	0	1
Oswaldo Ulloa, Peter Von Dassow	0	0	0	0	1	0	0	0	0	1
Samuel Hormazabal	0	0	0	1	0	0	0	0	0	1
TOTAL	8	5	0	6	8	0	11	4	0	42

Annex 5.2. - Short-term Traineeships of MSI students**Listado de Pasantías**

Student name	Institution	Country	Advisor	Project Description	Starting Date [dd/mm/yy]	Ending Date [dd/mm/yy]
Paula Ruiz	Leibniz Institute of Baltic Sea Research	Germany	O. Ulloa (Chile) K. Jürgens (Germany)	Microbial metatranscriptomics in low-oxygen waters	31 October 2023	01 February 2024

Listado de Pasantías Externas

Intern Type	Intern Name	Academic Degree	Home Institution	Destination Institution	Country	Project Description	Starting Date [dd/mm/yy]	Ending Date [dd/mm/yy]
internship	Yannick Nicolle	Master	Ecole Nationale de la Meteorologie	IMO	France	Modeling of the ENSO impact on air-sea CO2 flux in the Peru-Chile upwelling system	15/06/2023	15/09/2023

Annex 6.- Networking and other collaborative work**6.1 Formal Collaboration networks**

Network Name	Network Scope	Researchers				Institutions
		From the Center		External		
		Researchers	Postdocs/ Students	Researchers	Postdocs/ Students	
ReMO SCOR WG 161	Internacional	1	0	20	1	IMO-Chile, SCOR WG 161:
POGO	Internacional	6	1	200	30	Institute for Marine and Antarctic Studies (IMAS) (Australia); University of Western Australia Oceans Institute (UWA) (Australia); Shahjalal University of Science and Technology (SUST) (Bangladesh); University of Western Australia Oceans Institute (UWA) (Australia); Flanders Marine Institute (VLIZ) (Belgium); Benin Consortium Consisting of: (Benin); ICMPA-UNESCO Chair (International Chair in Mathematical Physics and Applications (ICMPA) – Unesco Chair in Mathematical Physics and Applications) (Benin); Institut de Recherches Halieutiques et Océanologiques du Bénin (IRHOB) (Benin); Instituto Oceanográfico, Universidade de São Paulo (IOUSP) (Brazil); Ocean Frontier Institute (OFI) (Canada); Ocean Networks Canada (ONC) (Canada); Tula Foundation/Hakai Institute (Canada); Instituto do Mar I. P. (IMar) (Cape Verde); Chile Consortium Consisting of: (Chile); COPAS Coastal (Chile); Department of Oceanography (DOCE), University of Concepción (Chile); Millennium Institute of Oceanography (IMO) (Chile); First Institute of Oceanography (FIO), MNR (China); Institute of Oceanology, Chinese Academy of Sciences (IOCAS) (China); National Ocean Technology Center (NOTC) (China); Qingdao National Laboratory for Marine Science and Technology (QNLN) (China); Second Institute of Oceanography, Ministry of Natural Resources (SIO) (China); South China Sea Institute of Oceanology, Chinese Academy of Sciences (SCSIO) (China); State Key Laboratory of Marine Environmental Science (MEL), Xiamen University (China); Instituto de Investigaciones Marinas y Costeras (INVEMAR) (Colombia); Centre Universitaire de Recherche et d'Application en Télédétection (CURAT) (Cote D'ivoire); National Institute of Oceanography and Fisheries (NIOF) (Egypt); IFREMER (Institut Français de Recherche pour l'Exploitation de la MER) (France); IRD (Institut de recherche pour le développement) (France); GEOMAR Helmholtz Centre for Ocean Research Kiel (Germany); Leibniz Centre for Tropical Marine Research (ZMT) (Germany); University of Ghana

						<p>Department of Marine and Fisheries Sciences (MAFS) (Ghana); Indian National Centre for Ocean Information Services (INCOIS) (India); National Institute of Oceanography (NIO) (India); Indonesia Agency for Meteorology Climatology and Geophysics (BMKG) (Indonesia); Marine Institute (Ireland); Euro-Mediterranean Center on Climate Change (CMCC) (Italy); National Institute of Oceanography and Applied Geophysics – OGS (Italy); Japan Agency for Marine-Earth Science and Technology (JAMSTEC) (Japan); Department of Fisheries & Aquaculture Sciences, University of Liberia (Liberia); Centre for Marine and Coastal Studies (CEMACS) (Malaysia); Oceanology Division of The Center for Scientific Research and Higher Education at Ensenada (CICESE) (Mexico); Institut National de Recherche Halieutique (INRH) (Morocco); Royal Netherlands Institute for Sea Research (NIOZ) (Netherlands); Department of Marine Sciences, University of Lagos (UNILAG) (Nigeria); Nigerian Institute for Oceanography & Marine Research (NIOMR) (Nigeria); University of Calabar, Faculty of Oceanography (UNICAL) (Nigeria); Norwegian Polar Institute (NPI) (Norway); Algarve Centre of Marine Sciences (CCMAR) (Portugal); National Research Foundation’s South African Environmental Observation Network (NRF-SAEON) (South Africa); Korea Institute of Ocean Science and Technology (KIOST) (South Korea); Instituto Español de Oceanografía (IEO) (Spain); British Antarctic Survey (BAS) (United Kingdom); Marine Biological Association (MBA) (United Kingdom); National Oceanography Centre (NOC) (United Kingdom); Plymouth Marine Laboratory (PML) (United Kingdom); Scottish Association for Marine Science (SAMS) (United Kingdom); Geochemical and Environmental Research Group (GERG) Texas A&M University (United States); Monterey Bay Aquarium Research Institute (MBARI) (United States); National Oceanic and Atmospheric Administration (NOAA) (United States); Rutgers, The State University of New Jersey (United States); Scripps Institution of Oceanography (SIO) (United States); Woods Hole Oceanographic Institution (WHOI) (United States)</p>
MetaZooGene (SCOR WG 157)	Internacional	2	0	8	0	<p>Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (Bremerhaven, Germany), Atmosphere and Ocean Research Institute, University of Tokyo (Chiba, Japan), Australian Antarctic Division (Kingston, Tasmania), AZTI – Marine Research Division (Gipuzkoa, Spain), Bermuda Institute of Ocean Sciences (St. George's, Bermuda), Biodiversity Research Center, Academia Sinica (Taipei, Taiwan), Chungnam National University (Daejeon, Korean), College of Marine Science, University of South Florida (Tampa, Florida, USA), Department of Environmental Affairs (DEA, Cape Town, South Africa), Department of Integrative Marine Ecology, Stazione Zoologica Anton Dohrn (Napoli, Italy), Department of Marine Sciences,</p>

						University of Connecticut (Groton, CT USA), Department of Natural History, University Museum of Bergen (Bergen, Norway), Department of Oceanography, University of Hawaii at Manoa (Honolulu, HI USA), Helmholtz Institute for Functional Marine Biodiversity, University of Oldenburg (Oldenburg, Germany), Institute of Marine Research (His, Norway), Institute of Marine Science and Oceanology, University of the Philippines (Iloilo, Philippines), Institute of Oceanography, University of Gdańsk (Gdynia, Poland), Institute of Oceanology, Chinese Academy of Sciences (Qingdao, China), Institute of Oceanology, Russian Academy of Sciences (Moscow, Russia), Israel Oceanographic and Limnological Research (Haifa, Israel), Naturalis Biodiversity Center (Leiden) and University of Amsterdam (Amsterdam, The Netherlands), NOAA Fisheries (Silver Spring, Maryland, USA), Plymouth Marine Laboratory (Plymouth, UK), Universidad de Concepción, Instituto Milenio de Oceanografía (Concepción, Chile)
SCOR 155	International	2	2	9	0	Monterey Bay Aquarium Research Institute, USA; Institute of Marine and Coastal Sciences, Rutgers University, USA; IRD-LEGOS, France; CEAZA, Chile; Department of Oceanography, Universidad de Concepción, Chile; Department of Oceanography, University of Cape Town, South Africa; Programa de Ecología Pesquera. CIBNOR-CONACYT, México; Laboratoire de Physique de l'Atmosphere et de l'Océan Simeon Fongang (LPAOSF), University Cheikh Anta Diop of Dakar (UCAD), Senegal; Instituto Geofísico del Perú (IGP); Helmholtz-Zentrum für Ozeanforschung Kiel (GEOMAR), Germany; University of East Anglia (UEA), UK; Marine Technological Service" (SITMA) at the University of Las Palmas de Gran Canaria (ULPGC), Spain; CNRS-LOCEAN, Paris, France; Food and Agriculture Organisation (FAO); IRD, France; National Institute of Oceanography, Goa, India; University of Southern California, USA; Marine Research Institute, CSIRO Marine, Australia; Instituto Milenio de Oceanografía, Chile
LAOCA: Latin American Ocean Acidification Network	International	2	1	50	10	Autonomous University of Baja California, Mexico, Federal University of Rio Grande, Brazil, University of Concepción, National Institute for Fisheries Research and Development" (INIDEP), Argentina, Santo Tomás University, Chile; Millennium Institute of Oceanography, Chile
Red de Popularización de la Ciencia y	LA	1	2	0	0	Programa Nacional de Popularización de la Ciencia e Innovación. Ministerio de Ciencia, Tecnología e Innovación Productiva de la Nación (PNPCI). Argentina; Museo Interactivo de Ciencia, Puertociencia. Universidad de Entre Ríos. Argentina; Museo Interactivo de Ciencia,

<p>la Tecnología de América Latina y el Caribe (Red Pop)</p>					<p>Tecnología y Sociedad, Imaginario. Universidad Nacional de General Sarmiento. Argentina; Museo Participativo de Ciencias «Prohibido no tocar». Argentina; Programa de Popularización de las Ciencias Mundo Nuevo UNLP. Universidad Nacional de La Plata. Argentina; Universidad Nacional de Quilmes. Argentina; Universidad Nacional de Río Negro. Argentina; Diretoria de Divulgação Científica, Universidade Federal de Minas Gerais. Brasil; Instituto Ciência Hoje. Brasil; Fundação Cecierj, Museu Ciência e Vida. Brasil; Museu da Vida, Casa de Oswaldo Cruz, Fundação Oswaldo Cruz. Brasil; Museu do Amanhã. Brasil; Centro Interactivo de Ciencia, Arte y Tecnología (CICAT). Chile; Comunidad InGenio. Chile; Instituto Milenio de Oceanografía. Chile; Museo Interactivo Mirador (MIM). Chile; Programa de difusión de la ciencia «6 sentidos», Instituto Milenio de ecología y biodiversidad, Pontificia Universidad Católica. Chile; Instituto Milenio de Astrofísica. Chile; Centro de Comunicación de las Ciencias de la Universidad. Chile; Universidad Autónoma de Chile. Chile; Unidad de Comunicación y Vinculación de las Ciencias de la Universidad Austral de Chile Sede Puerto Montt. Chile; Centro Interactivo de Ciencia y Tecnología, MALOKA. Colombia; Observatorio Colombiano de Ciencia y Tecnología. Colombia; Museo del Agua de la Fundación EPM. Colombia; Museo de la ciencia y el juego. Colombia; Parque Explora. Colombia; Universidad de los niños, EAFIT. Colombia; Academia Nacional de Ciencias. Costa Rica; Universidad de Costa Rica. Costa Rica; Unidad de Divulgación Científica, Universidad Estatal a Distancia. Costa Rica; Colegio Científico Interamericano del CATIE. Costa Rica; EcoExploratorio: Museo de ciencias de Puerto Rico. Puerto Rico; Diplomado de Divulgación de la Ciencia, Universidad Nacional Autónoma de México (UNAM). México; Dirección de Comunicación de la Ciencia, Universidad Veracruzana. México; Fibonacci, Innovación y Cultura Científica. México; Museo de Ciencias Universidad Autónoma de Zacatecas. México; MILSET (Movimiento Internacional para el Recreo científico y técnico), Universidad Popular Autónoma del Estado de Puebla. México; Museo de la Luz, Dirección General de Divulgación de la Ciencia, Universidad Nacional Autónoma de México. México; Museo Interactivo de Economía, MIDE. México; Museo Universum, Dirección General de Divulgación de la Ciencia, Universidad Nacional Autónoma de México. México; Revista Ciencias, Facultad de Ciencias,</p>
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					<p>Universidad Nacional Autónoma de México. México; Revista ¿Cómo Ves?, Dirección General de Divulgación de la Ciencia, Universidad Nacional Autónoma de México . México; ITESO Maestría en Comunicación de la ciencia y la cultura. México; Sociedad Mexicana para la Divulgación de la Ciencia y la Técnica (Somedicyt). México; Recreación en Cadena A.C. Red Mexicana de Ciencia Recreativa. México; Divulgare - Comunicación Científica. México; Universidad Nacional Autónoma de México campus Morelia. México; Dirección General de Divulgación de la Ciencia, Universidad Nacional Autónoma de México. México; Fundación Ciudad del Saber. Panamá; SENACYT. Panamá; Fundación Panameña para la Promoción de las Matemáticas. Panamá; Consejo Nacional de Ciencia y Tecnología (CONACYT) de Paraguay. Paraguay; Museo de Ciencias del Paraguay. Paraguay; Ciencia Viva. Uruguay; Espacio Ciencia del Laboratorio Tecnológico del Uruguay (LATU). Uruguay; Oficina Regional de Ciencia y Tecnología de la UNESCO para América Latina y el Caribe. Uruguay; Química D+. Uruguay.</p>
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NOMENCLATURE:

[Network Scope]

[N] National [I] International [LA] Latin American

Annex 6.2.- Collaboration Networks

Activity Name	Objective	Description	Co-Participants Institutions	Number of Research from the Center	Number of Postdocs/Students from the Center	Number of External Research	Number of External Postdocs/Students	Product	Name of the Center Principals Researchers Participating in the activity
Program for Climate Action Planning (CLAP)	aims at providing an improved scientific understanding and more realistic/accurate local projections of ocean and land service pressures for the coastal region of Coquimbo on timescales of near-term to end-of-century climate change.	It targets the development of socio-ecological models that quantify and predict the services provided by the coastal ocean in this region. During its 1st phase (2021-2025, funded), CLAP will develop reliable regional to local projections of climate change of the ocean and atmospheric circulation, and of the biogeochemical environment. It will allow the development of an ecosystem service (ES) approach required for implementing ecosystem-based management strategies for the marine coastal zone off Coquimbo.	Centro de Estudios Avanzados en Zonas Aridas-CEAZA; Universidad de Concepción, Chile; Instituto Milenio de Oceanografía, Chile; Universidad del Norte, Chile.	1	1	4	2	Reliable regional to local projections of climate change of the ocean and atmospheric circulation, and of the biogeochemical environment	

Annex 7. - Outreach

7.1. - Outreach activities throughout the period

Event Title	Type of Event	Scope	Target Audience	Date	Country	Region	N° of Student from the Center	N° of Attendees	Duration in days	Participating Researchers	Responsible for the activity
Fair Congreso Futuro Chillán	Exhibition	National	Public sector	18-01-2023	Chile	Bío Bío	0	280	1		Bárbara Léniz Genta
Conference by Osvaldo Ulloa at Congreso Futuro	Conference	National	General public. Public sector	18-01-2023	Chile	Metropolitana de Santiago	0	1000	1	Osvaldo Iván Ulloa Quijada.	Osvaldo Ulloa
Conference Deep Ocean	Conference	National	General public	20-01-2023	Chile	Bío Bío	0	44	1		Bárbara Léniz Genta
Oceanic regional modeling	Summer school	Numerical Modeling	post-graduate students	28-02-2023	Chile	Los Lagos	1	12	9	Vera Oerder	Vera Oerder
Conference Deep Ocean	Conference	National	Undergraduate students	30-03-2023	Chile	Bío Bío	0	65	1		Bárbara Léniz Genta
Fair at Summer School of UdeC	Exhibition	National	General public	17-01-2023	Chile	Bío Bío	0	250	1		Bárbara Léniz Genta
Premiere documentary "Atacama Hadal"	Exhibition	National	General public. Public sector	15-05-2023	Chile	Metropolitana de Santiago	3	220	1	Pablo Rosenblatt Guelfenbein; Osvaldo Iván Ulloa Quijada; Heraclio Rubén Escribano Veloso; Pamela del Carmen Hidalgo Diaz; Atilio Edison Morgado Malebrán	Pablo Rosenblatt
FECI Concepción (Science Festival)	Exhibition	National	General public	07-10-2023	Chile	Bío Bío	0	10000	1		Bárbara Léniz Genta
Workshop of ecology	Workshop	National	Preschool boys and girls	16-10-2023	Chile	Bío Bío	0	30	1		Bárbara Léniz Genta
Meeting with basic and secondary teachers	Workshop	National	Basic and secondary teachers	07-09-2023	Chile	Bío Bío	0	22	1		Bárbara Léniz Genta
FECI Curanilahue (Science Festival)	Exhibition	National	Secondary and basic teachers, and general public	05-10-2023	Chile	Bío Bío	1	2000	1		Felipe Gamonal
Storytelling "Tony Tonina's scientific recipe"	Storytelling	National	Preschool boys and girls; Basic education students; General public	05-06-2023	Chile	Bío Bío	0	290	5		Bárbara Léniz Genta
Video games as a tool for scientific dissemination	Conference	National	Media; Professionals from	15-06-2023	Chile	Metropolitana de Santiago	0	50	1		Bárbara Léniz Genta

			other areas; Public sector.								
Conference Deep Ocean	Conference	National	Technical-professional institutions's students	17-05-2023	Chile	Bío Bío	0	45	1		Bárbara Léniz Genta
Student visit to UdeC	Visit	National	Secondary students	02-08-2023	Chile	Bío Bío	0	40	1		Bárbara Léniz Genta
Meeting with basic and secondary teachers	Workshop	National	Basic and secondary teachers	18-08-2023	Chile	Bío Bío	0	22	1		Bárbara Léniz Genta
Sea Film Festival	Festival	International	Professionals from other areas; Private sector; general public	21-08-2023	Chile	Bío Bío	0	500	7		Pablo Rosenblatt
Conversation activity "Ser mujer tras la cámara: Desafíos y experiencias de dos documentalistas"	Conversation activity	National	General public	24-08-2023	Chile	Bío Bío	0	30	1		Pablo Rosenblatt
Conference Deep Ocean	Conference	National	Basic education students	20-10-2023	Chile	Bío Bío	0	25	1		Bárbara Léniz Genta
Scholar Scientific Fair Santísima Trinidad School	Exhibition	National	Basic education students y enseñanza media	25-10-2023	Chile	Bío Bío	0	350	1		Bárbara Léniz Genta
Protagonists 2030	Seminar	National	Secondary school students, private sector	28-08-2023	Chile	Metropolitana de Santiago	0	2000	1	Pablo Rosenblatt Guelfenbein.	Pablo Rosenblatt
Participation in congress PCST (Public Communication in Science and Technology)	Exhibition	International	Professionals from other areas	11-04-2023	Holanda/ Países Bajos		0	28	4		Bárbara Léniz Genta
Conference Deep Ocean	Conference	National	General public	21-09-2023	Chile	Bío Bío	0	40	1		Bárbara Léniz Genta
Workshop about Ocean	Workshop	National	Basic schools teachers	29-09-2023	Chile	Bío Bío	0	31	1		Bárbara Léniz Genta
Mini Conference FECl (Science Festival) UdeC	Conference	National	General public	07-10-2023	Chile	Bío Bío	0	40	1		Bárbara Léniz Genta
Workshop "El Mar te Sana" ("Sea heals you")	Workshop	National	Adults and older people with disabilities,	17-10-2023	Chile	Bío Bío	0	22	1		Bárbara Léniz Genta

			dependency, who live alone or institutionalized and who belong to the poorest 40% of the population								
Visit to Laboratory	Exhibition	National	Secondary students	24-10-2023	Chile	Bío Bío	1	52	1	Pamela del Carmen Hidalgo Diaz.	Pamela Hidalgo
Storytelling "Tony Tonina's scientific recipe"	Storytelling	National	Basic education students	09-11-2023	Chile	Bío Bío	1	495	2		Bárbara Léniz Genta
Visit to Marine Biology Station, Dichato	Field activity	National	Basic education students	24-11-2023	Chile	Bío Bío	0	115	1		Bárbara Léniz Genta
Storytelling "Tony Tonina's scientific recipe"	Storytelling	National	Preschool boys and girls	29-11-2023	Chile	Bío Bío	0	49	1		Bárbara Léniz Genta
Scientific activities - Llico	Exhibition	National	Secondary students; General public	07-11-2023	Chile	Bío Bío	0	350	1		Felipe Gamonal
Biodiversity carnival	Exhibition	National	Basic and secondary teachers; General public	17-11-2023	Chile	Bío Bío	0	60	1		Felipe Gamonal
Regional Atmospheric Modeling	Summer school	Numerical Modeling	post-graduate students	21/11/2023	Chile	Los Lagos	2	11	9	Vera Oerder	Vera Oerder
Exhibition fair of marine biodiversity	Exhibition	National	General public	31-10-2023	Chile	Bío Bío	0	150	1		Felipe Gamonal

7.2.- Articles and Interviews

<u>Type of media and scope</u>	<u>Local/Regional</u>		<u>National</u>		<u>International</u>		<u>TOTAL</u>
	<u>N° Interviews</u>	<u>N° Articles</u>	<u>N° Interviews</u>	<u>N° Articles</u>	<u>N° Interviews</u>	<u>N° Articles</u>	
<u>Written</u>	<u>0</u>	<u>5</u>	<u>3</u>	<u>16</u>	<u>1</u>	<u>0</u>	<u>25</u>
<u>Internet</u>	<u>0</u>	<u>14</u>	<u>2</u>	<u>14</u>	<u>0</u>	<u>4</u>	<u>34</u>
<u>Audiovisual</u>	<u>1</u>	<u>0</u>	<u>6</u>	<u>3</u>	<u>0</u>	<u>0</u>	<u>10</u>
<u>TOTAL</u>	<u>1</u>	<u>19</u>	<u>11</u>	<u>33</u>	<u>1</u>	<u>4</u>	<u>69</u>

Annex 8. - Connections with other sectors:

Activity	Type of Connection [Number]	Type of Activity [Number]	Institution Country	Agent Type [Number]	Economic Sector
Technical Advisory Committee on Climate Change	2	7	Undersecretary of Fisheries, Chile	2	Public sector
Technical Advisory Committee and National Node	2	7	Chilean Nuclear Energy Commission	2	Public sector
UN Decade	2	7	National committee of Oceanography (Chilean Navy)	2	Public sector

7: Advisory activity

NOMENCLATURE:**[Type of Connection]** [1] Services Contract [2] Cooperation Agreement**[Type of Activity]** [1] Development of Studies [2] Project Implementation [3] Training [4] Prospective Activity [5] Scientific Training [6] Installation of Scientists [7] Others (specify at the table foot other types of activity)**[Agent Type]** [1] Industry and Services [2] Organizations and Public Services [3] Educational Sector

Annex 9.- Total Funding:¹

Funds	2023 Sources of Funding	
	Amount [\$]	Percentage of resources used by the Center [%]
	Managed by IMO	
Public Funds: MSI IMO	846.000.000	56%
Other international Funds	5.000.000	0%
Public Funds: CONICYT OTRO	264.830.000	17%
	Funds no managed by IMO	
Public Funds: FONDECYT	324.149.000	21%
Public Funds: CONICYT ANILLO	27.000.000	2%
Public Funds: CONICYT OTRO	55.000.000	4%
TOTAL	1.521.979.000	100%

¹ Para aquellas fuentes de financiamiento con el mismo origen, se debe realizar sólo un ingreso con el valor total de la fuente de financiamiento y no ingresar uno a uno estos montos.

9.2 Share of expenses

Type of Expense	Total Amount [CLP \$]
Scientific Staff Personal Científica	273.296.468
Technical Staff Personal Técnico	135.632.335
Administrative Staff Personal Administrativo	28.992.884
Communications Staff Personal de Comunicaciones	59.673.258
Investments Inversiones	32.759.308
Infrastructure Infraestructura	4.575.550
Consulting Consultorías	43.992.901

Note: Expenses share for the 12 months period year 2023, for this items

Annex 10.- Outstanding Activities

Name of the activity relevant in your discipline	Type of activity relevant in your discipline carried out	Description of the relevant activity in your discipline	Importance in your discipline of the activity	Possibility to maintain or replicate this activity
R/V <i>Sonne</i> Cruise	Oceanography-geophysics expedition onboard the German R/V SONNE	Installation of geodesic sensors in the Atacama Trench (as part of IDOOS)	This is a major achievement upon international collaboration between IMO and German institutions to obtain a chain of high resolution and unique geodesic sensors recording the seafloor motion in the highly seismic Atacama Trench	As part of the ongoing IDOOS project and relying on a continuous collaboration with GEOMAR (Germany), it is expectable that similar activities will be repeated
IDOOS Cruise	Oceanographic expedition onboard the Chilean R/V <i>Abate Molina</i>	This cruise allowed the setup of the deep ocean observation mooring system. Also, oceanographic measurements and field experiments were performed	This is a key achievement of IMO and for the IDOOS project. It took two years to gain access to ship time to setup this unique oceanographic observing system in deep waters (>7000 m) of the Atacama Trench	IMO expects to be able to service this mooring system every year for the next 5 years (at least) to access the sensors data and samples from the sediment traps.

<p>Avant Premier Atacama Hadal documentary</p>	<p>Outreaching activity</p>	<p>The Atacama Hadal documentary on the R/V Pressure Drop cruise and the immersions of IMO researchers and Victor Vescovo to the bottom (>8000 m) of the Atacama Trench was presented to national authorities and public</p>	<p>This documentary has become highly relevant to highlight the importance of oceanography for Chile and to outreach the public community at large with respect to great scientific and exploration achievements by IMO</p>	<p>It is always possible to repeat this activity and IMO will continue making efforts to strengthen international collaboration which is extremely necessary for these challenges</p>
<p>R/V <i>Roger Revelle</i> Cruise</p>	<p>Participation in the international cruise to the Oxygen Minimum Zone (OMZ) off northern Chile and southern Peru</p>	<p>Experimental work to look at the effect of low oxygen on the phytoplankton community</p>	<p>Important for understanding the effect of ocean deoxygenation on phytoplankton distribution and primary production (research Line I)</p>	<p>IMO will continue to be invited to participate in international cruises to the OMZs</p>

Annex 11.- Negative or positive aspects that you would like to address in order to understand the context in which the center developed its work during the reported period.

Relevant Positive and Negative Aspects
<p>Negative aspects:</p> <ul style="list-style-type: none"> • Uncertain access to ship time during the first half of 2023. • Reduced number of days to carry out the IDOOS cruise due to limited funding for ship time. <p>Access to ship time in Chile continues to be an issue, both in terms of the number of days available as well as the uncertainty and timing of when vessels will be available. This limits the planning of the cruise and, for example, inviting international collaborators, as well as the number of activities that are possible to carry out.</p> <p>Positive aspects:</p> <ul style="list-style-type: none"> • International collaboration • Technological support <p>IMO's strong networking and international collaboration have allowed it to carry out an ambitious research program (e.g., cruises on the R/V Sonne and R/V Roger Revelle). This will continue in the future, as IMO's teams have been invited to participate in upcoming international oceanographic expeditions, even in other parts of the world's oceans.</p> <p>The CIO (Center for Oceanographic Instrumentation) hosted at IMO has become a key component of IMO's research activities (e.g., IDOOS) and highly recognized technological center for oceanography services in Chile.</p>

Annex 12.- Relevant materials, products and activities carried out by the center

1. Participation in Research Cruises

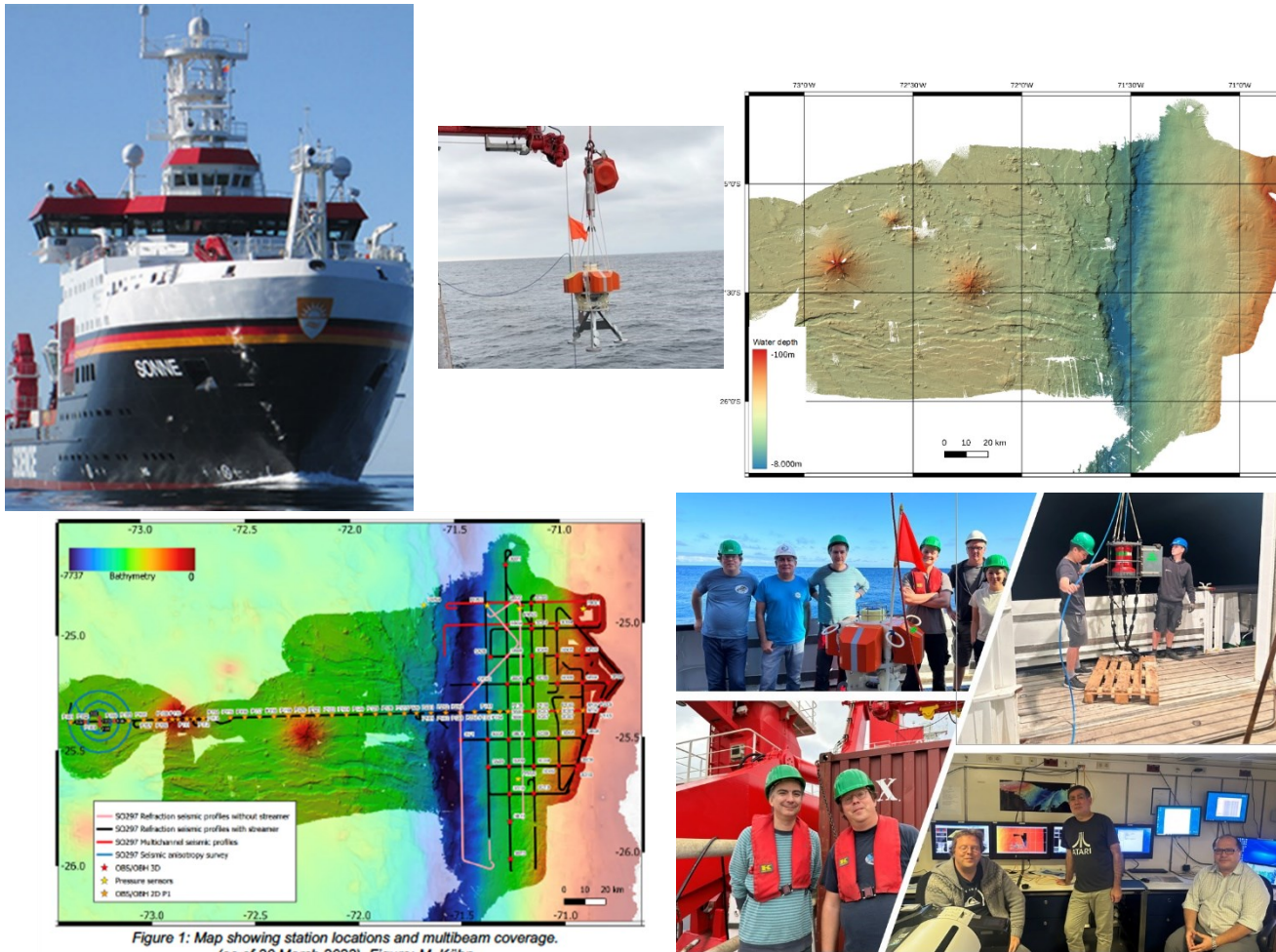
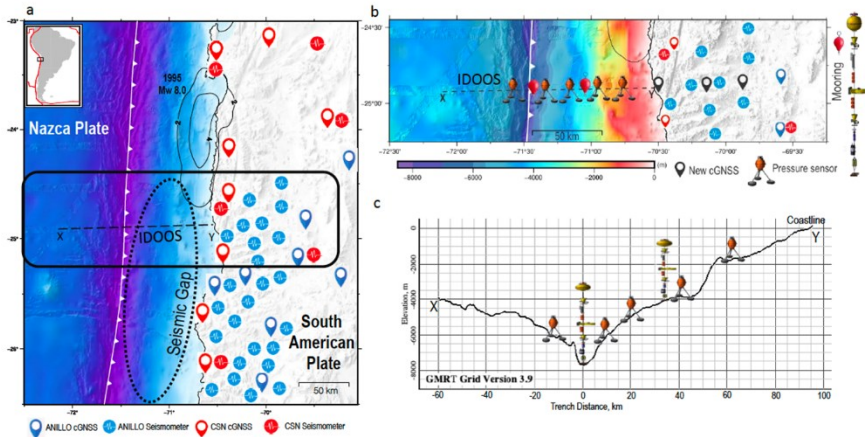
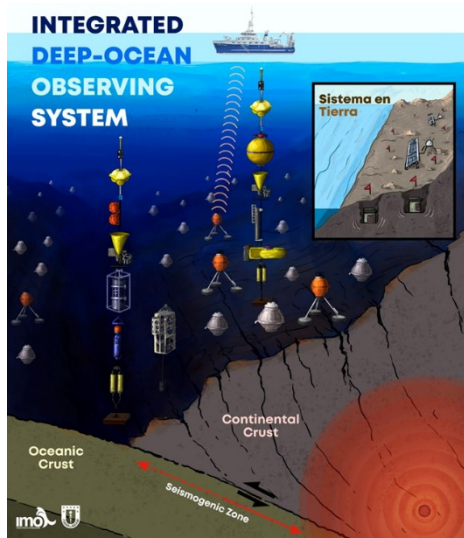
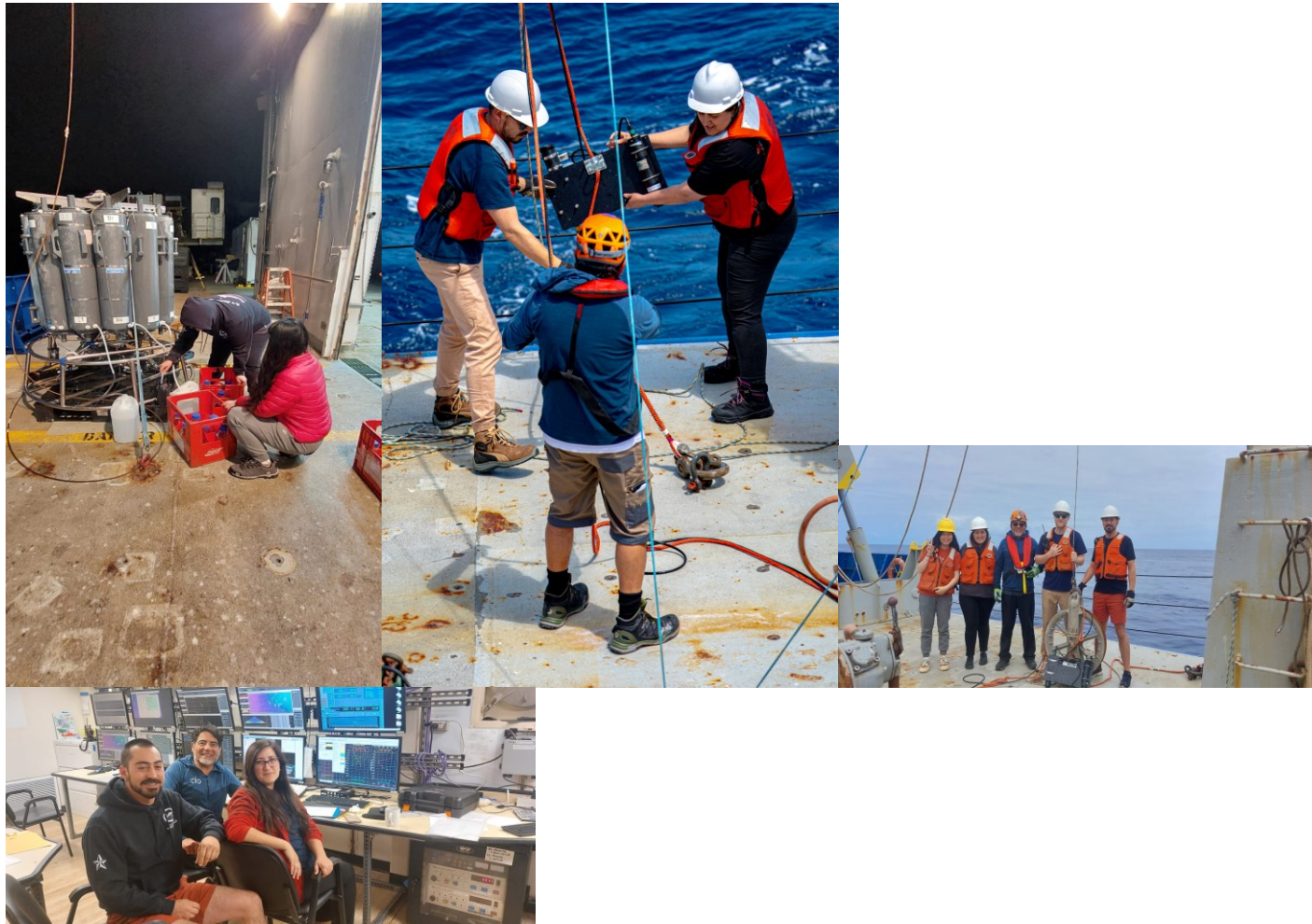


Figure 1: Map showing station locations and multibeam coverage. (as of 30 March 2023). Figure: M. Kühn

- Oceanographic cruise on R/V SONNE. Deployment of deep-ocean geodesic sensors of IDOOS.



- Installation of oceanographic moorings of IDOOS on board R/V *Abate Molina*.



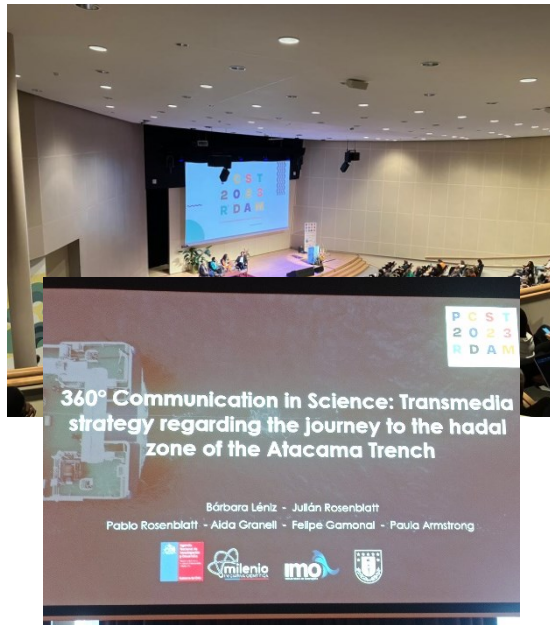
- Participating in the cruise to the Oxygen Minimum Zone on board the R/V *Roger Revelle*.

2. Annual Meeting



- IMO's annual meeting 2023.

3. *Outreaching*



- PCST PCST (Public Communication in Science and Technology) conference, Rotterdam, Netherlands.



- Storyteller show “Tales from the Oceano: The Scientific Recipe of Tony Tonina”



- Participation in Science Fairs



- “Atacama Hadal” documentary exhibition.