



## Scientific Committee on Antarctic Research

# Proposal for a New SCAR Action Group

### **Name of the Proposed Group:**

ICEPRO (An International Collaboration Effort for Improving Paleoclimate Research in the Southern Ocean)

### **Name(s) of the lead proponent(s)**

Johan Etourneau, EPHE/PSL Research University, UMR 5805 EPOC, University of Bordeaux, France  
Carlota Escutia, IACT-CSIC, Granada University, Spain

### **Sponsoring Science Group(s) or Standing Committee(s):**

Geosciences Science Group

### **Summary of Group**

ICEPRO aims to improve our understanding of past ocean-ice-earth interactions by linking modern observations and paleo-records by facilitating transnational collaborations on (paleo)environmental studies in the Southern Ocean. To reach this goal, ICEPRO will bring together international partners to coordinate and harmonize joint research activities in terms of sampling strategies, methodologies, proxy calibrations and the development of future Antarctic expeditions.

### **Introduction and Background**

The Southern Ocean (SO) and the Antarctic cryosphere are active regulators of global climate through their influence on (i) the modulation of the global ocean circulation (GOC), (ii) the regional and distal phytoplankton productivity and ocean nutrient cycles, (iii) the transfer of energy and gas between the ocean and the atmosphere, and (iv) sea level. Historical and instrumental data have allowed a robust assessment of recent environmental changes in the SO but, due to the brevity and sparse distribution of observations, their attribution is still under debate. For example, misrepresentation and/or missing processes, data and feedbacks may explain why climate models simulate a decline in total sea ice extent over the last decades whereas observed trends show the opposite. Paleoclimate data are essential to document the natural variability of environmental conditions and identify their drivers from decadal to glacial-interglacial timescales. They are also pivotal to unravel the resulting climate responses under different mean conditions, as well as on the potential reversibility of these responses. Of particular importance is that paleoclimate data allow to

assess past climatic fluctuations and represent a prognosis tool to estimate near-future changes in such vulnerable polar region.

Reconstructions of the past hydrological, biogeochemical cycling and sea ice variability are based on many micropaleontological, inorganic and geochemical proxies preserved in marine sediments that have been developed, validated and sometimes calibrated over the past decades. However, key outstanding questions about the mechanisms that affect SO physical drivers, biogeochemical composition, and ecosystem structure and dynamics remain unaddressed partly due to the lack of robust calibration of proxies through the water column and in sediments to present day conditions and observations. While some tools are better constrained than others (e.g., diatoms vs organic compounds as proxies for presence/absence of sea ice), the mechanisms controlling their seasonal distribution or abundance are not fully understood. Thus, an improved understanding of their locus of production is needed to quantitatively assess the information preserved in the sediment record, and to reliably use these proxies in paleoclimate studies.

A critical step to improve their use is to conduct a systematic multi-annual collection of water and sediment samples and data throughout the SO. It is not uncommon that proxy development results from a single team effort, based on an internal protocol, and are sometimes only valid for a region, defined by national program logistic constraints for vessel operation. Thus, a first step is to develop and apply a consistent methodology. This will undoubtedly help to better elucidate the processes (i.e., strong changing seasonality, regional features involving chemical, physical and biogeochemical processes) controlling the modern spatial and temporal evolution of the different proxies before extensively combining traditional and new proxy data in sediment archives and comparing them to ice core data and model simulations.

Each year, several oceanographic cruises are conducted around Antarctica to investigate recent and past climate variability. However, most of these expeditions are performed independently in the areas of operations of the different national programs, even though their objectives are relatively similar: to get the best combination of proxy records to robustly constrain paleoclimate fluctuations (e.g., ocean temperature, sea ice conditions, ice shelf dynamics, position and strength of the Antarctic Circumpolar Current, Southern Westerlies and Polar Frontal Zone, Southern Ocean water column structure, open water and sea ice-associated phytoplankton productivity, nutrient cycles) during various periods of time. To advance in such understanding, it is therefore urgent to (1) improve the coordination of the sampling efforts by the different programs and develop new ones; and (2) apply common and comparable methodologies to aid the development and interpretation of paleorecords.

While the need to conduct coordinated/collaborative multidisciplinary measurements is the only way forward to advance our understanding of the complicated ocean-ice-earth interactions, as already extensively mentioned within different national and international global initiatives, its concrete application, especially in the Southern Ocean, remains limited. For instance, two PAGES (Past Global Changes) working groups, CLIVASH2K and C-SIDE, one ongoing SCAR Research Programme, INSTANT, and SCAR SCOR-SOOS aim to disentangle the different records, identify the main drivers leading to the reconstructed climate variability over the last 2,000 years and older records, along with their forcings (e.g. the Southern Annular Mode (SAM), ENSO (El Niño/Southern Oscillation), the Interdecadal Pacific Oscillation (IPO)), and the Antarctic's contribution to sea level. In their respective reviews, each working/research group mainly lists all the existing proxy-based records and their associated uncertainties in the SO and reports on the gaps in our understanding of the different SO processes. They also point to the need for increasing partnerships on field campaigns. However, none of these working groups/research programs include a plan to facilitate a coordinated logistical and methodological approach to improve paleoclimate proxy calibration as the one proposed by the ICEPRO.

## Aims, Goals and Objectives

In this context, the main objective of ICEPRO is to go one step further by developing existing collaborations and creating new connections among several partners from Australia, Europe, India, Japan, New Zealand, South Korea, UK, USA and any other interested countries (e.g. China, Brazil) in close interactions with representatives and coordinators of CLIVASH2K (E. Thomas, C. Allen, A. Moy, B. Stenni, Y. Yu) and C-SIDE (K. Kohfeld, H. Bostok, Crosta, X., A. Leventer, V. Lowe, K. Meissner). All these research groups regularly cross the Southern Ocean through different transects and therefore have the opportunity to sample the water column and marine sediments spanning at least the last 2,000 years in their own study areas. Such collaborative work, which also aims to promote exchange of scientists among the different cruises, and to involve early career researchers, could therefore cover most of the important regions of the SO, thus allowing a better monitoring of modern environmental conditions, and ultimately improve calibration of the geochemical, sedimentological and micropaleontological tools commonly used for paleoreconstructions.

## Proposed Milestone Activities with Timeline

Years 1-2: Build working groups focusing on every traditional and newly-developed paleoproxies. Define common sampling strategy and harmonize analytical work at sea and onshore, including parameters to be primarily monitored (nutrients, phytoplankton species, hydrological settings (e.g. temperature, salinity, CO<sub>2</sub>, O<sub>2</sub>) and sea ice...) and equipment to be used onboard (e.g. nets, CTDs, multicores, sediment traps, sediment coring, etc). Identify vessels sailing the next seasons to Antarctica that can be part of the multi-ship multi-annual monitoring ICEPRO action.

Milestones at the end of Year 2: Coordinate multiple oceanographic cruises and sampling efforts across the SO and along the Antarctic coasts. Promote exchange of scientists among the different cruises, especially early career researchers, in order to cover most of the important regions of the SO.

Organize an open town hall meeting during the INSTANT Conference 11-14 September 2023.

Years 3-4: Summarize progress made during the previous field seasons, provide an extensive portfolio of research projects and initiatives to be undertaken all around Antarctica, define the remaining gaps in terms of spatial and temporal coverage, and prepare future proposals and expeditions.

Milestone at the end of Year 4: organize an open Townhall meeting at the SCAR conference, where we will orally and publically present the main outcomes of ICEPRO. Publications of the (inter-)calibration of the different geochemical, sedimentological and micropaleontological tools commonly used for paleoreconstructions as well as new paleoclimate records spanning the last 2,000 years and centuries around Antarctica. Create an online free-access dataset in the SCAR database and produce a map including all the measured parameters.

## Capacity Building, Education and Outreach Plans

ICEPRO is committed to enable as many countries as possible to participate and to raise national scientific capacities, especially in developing countries. For this, we have assembled an initial Steering Committee with members from 11 countries. ICEPRO is also committed to include greater representation from Early Career Scientists in collaboration with APECS in the Steering Committee. Training and Education activities within ICEPRO include student exchange and training of early career scientist during oceanographic cruises. In addition, Each Antarctic cruise has its own way of communicating and interacting with schools. We will ensure that ICEPRO will be adequately promoted and support transnational school activities and interactions. The different national representatives involved in ICEPRO will also favour the embarkment of young students, from the Master

level or younger, to take part to the several oceanographic expeditions led each year around Antarctica. We also plan to collaborate with private companies, especially the touristic ones, as well as NGOs and other foundations in order to get access to recurrent measurements but also and mostly to sensibelize people (e.g. tourists, sailors, crew members) sailing towards Antarctica to past, present and future climate and environmental changes.

## Data Management Plans

As a SCAR product, we plan to create several publications and documents containing the sampling and methodology protocols developed in the frame of ICEPRO. Their links and pdf will be published on the ICEPRO SCAR webpage. All associated produced data (ocean and atmosphere temperatures, fluorescence, salinity...) will be freely accessible in the SCAR database and interactive maps (e.g. SOOS map). Given the large amount of diverse collected data, we will feed the respective SCAR databases such as the biodiversity.aq, the continuous plankton record database (CPR), DueSouth and OCEAN-READER. The data will start being added after the second year of the project, once the first collaborative work will have been done.

## Terms of Reference

The main goal of ICEPRO is to better understand past and present mechanisms that affect SO physical drivers, biogeochemical composition, and ecosystem structure and dynamics. As a SCAR Action Group, ICEPRO aims to:

- Bring together a wide scientific community coordinating their effort to provide robust paleoproxy calibration;
- Generate accurate and widely spread paleorecords spanning the last centuries and millennia;
- Closely cooperate with ice core and modelling scientists to define as much precise as possible the climatic baseline that will be used for future projections.

## Budget and Justification

We request 3000 €/year in order to partly cover the organization costs of the physical meetings planned within ICEPRO. We will cover the remaining costs by being co-sponsored by INSTANT, PRAMSO and any related scientific projects.

## Confirmed and/or Potential Members

Membership to ICEPRO is open to any scientists interested in marine polar science, with any related and complementary expertise (biology, physical oceanography, glaciology, ecology, modelers...). Several researchers have already expressed their interest from many countries (UK, France, Brazil...).

We have assembled an steering committee that at this time has the following membership:

|                 |   |        |
|-----------------|---|--------|
| Johan Etourneau | UMR EPOC, EPHE/PSL<br>Research<br>University/Bordeaux<br>University | France |
| Carlota Escutia | Instituto Andaluz de  | Spain  |

|                  |   |             |
|------------------|---|-------------|
|                  | Ciencias de la Tierra<br>-CSIC Granada  |             |
| Amy Leventer     | Colgate University  | USA         |
| Julianne Müller  | Alfred Wegener Institute  | Germany     |
| Linda Armbrecht  | Institute for marine and<br>Antarctic Studies (IMAS),<br>University of Tasmania | Australia   |
| Guiseppe Cortese | GNS Science   | New-Zealand |
| Jung-Hyun Kim    | Korean Polar Research<br>Institute  | South Korea |
| Minoru Ikehara   | Kochi University  | Japan       |
| Rahul Mohan      | National Centre for Polar<br>and ocean Research                                 | India       |
| Andrès Rigual    | Salamanca University  | Spain       |
| Laura de Santis  | OGS Trieste   | Italy       |
| Erin McClymont   | Durham University   | UK          |
| Rob Dunbar       | Stanford University   | USA         |

## Webpages and Communication Plans

Updates and progresses on ICEPRO will be regularly added in the news webpage of the SCAR Action group. We will also create a specific mailing list in addition to using that of INSTANT. Moreover, members of the project will communicate through their own institute and national Antarctic programmes. Any related programmes and projects (e.g. INSTANT, PRASMO, CLIVASH2K and C-SIDE) will also publish updates on ICEPRO.

## Other notes and comments