ANTARCTIC CIRCUMNAVIGATION EXPEDITION

ACE

SWISS POLAR INSTITUTE

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
WSL Swiss Federal Institute for Forest, Snow and Landscape Research WSL
ETH zürich
UNIVERSITÄT BERN
Paulsen

ABOUT THE ANTARCTIC CIRCUMNAVIGATION EXPEDITION (ACE)

ACE is the first project of the Swiss Polar Institute, a newly created entity founded by EPFL, the Swiss Institute of Forest, Snow and Landscape research WSL, ETHZ, the University of Bern and Editions Paulsen. It aims to enhance international relations and collaboration between countries, as well as to spark the interest of a new generation of young scientists and explorers in polar research.

From December 2016 to March 2017, scientific teams from all over the world will board the Russian research vessel Akademik Treshnikov for an unprecedented expedition around Antarctica. From biology to climatology to oceanography, researchers will work on a number of interrelated fields for the future of this Continent.

On the Akademik Treshnikov's way down from Bremerhaven to Cape Town, 50 young scientists will be on board following lectures and doing practical work and oceanographic work on board. The "ACE Maritime University" will be conducted under the auspices of the Russian Geographic Society and will start on 19 November from Bremerhaven.

A better understanding of Antarctica is critical, not just for its preservation, but for the whole planet. The poles are affected by climate change more than any other region on Earth. Moreover, they play a central role in providing oceans with strong underwater streams that regulate the world's climate from the poles to the equator.

ABOUT THE ANTARCTIC CIRCUMNAVIGATION EXPEDITION (ACE)

Today, scientific progress depends more than ever on collaboration between diverse scientific domains. Polar studies are no exception. For example, marine biology depends on complex mathematical models currently being developed by oceanographers. Meanwhile, microorganisms that play an important role in transforming the atmosphere, can help climatologists to make more accurate predictions.

In order to foster an interdisciplinary culture, ACE will combine competences and know-how from a broad range of scientific disciplines. We do believe that this is the only way to understand Antarctica and its global role in today and tomorrow's climate issues.

ANTARCTIC CIRCUMNAVIGATION EXPEDITION

INDICATIVE TRAVEL PLAN

SWISS POLAR INSTITUTE

ACE

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UNIVERSITÄT BERN

Paulsen

22 PROJECTS, ONE EXPEDITION

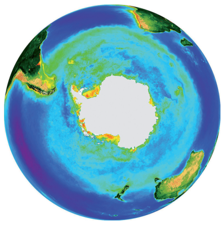
ACE is composed of 22 different projects bringing together research teams from six continents. They focus on different areas of study, all fundamental for a better understanding of Antarctica's ecosystems.

An open call for proposals was launched at the end of 2015, and over 100 projects were submitted. An international panel of distinguished experts was convened and selected the projects according to criteria of scientific excellence. This process was conducted with the help of the polar-research institutions located in ACE partner-countries including South Africa, Australia, Norway, the United Kingdom, France, Switzerland and the Russian Federation.

In the following pages, you will find a comprehensive list of all selected projects.

CURTIN UNIVERSITY PERTH

MEASURING PHYTOPLANKTON ABUNDANCE AND COMPOSITION



Crucial to synoptically monitoring phytoplankton biomass – the first link of the foodweb – over the Southern Ocean (SO) and understanding their temporal changes is our ability to obtain unbiased measurements from satellite ocean color radiometry (OCR).This is generally achieved though the estimate of a biomass proxy: the chlorophyll concentration [Chl].

Over much of the global ocean, these estimates are reliable and decadal studies can be carried out to examine, for instance, shifts in phytoplankton abundance and how they relate to environmental changes. However, large errors in the estimate of [Chl] from remote sensing occur in the SO because of a lack of observations and the consequent gap in our knowledge of the light-matter interaction.

To remedy this situation, the project aims at
1) Building a consistent data set of radiometric, optical and biogeochemical variables for the Southern Ocean
2) Using this unique data set in combination with historical and other contemporaneous data sets to describe regionally-specific bio-optical relationships, and to identify the origin of the biases in current satellite OCR observations
3) Applying this understanding to develop new algorithms that will allow robust studies of seasonal to decadal changes of phytoplankton abundance and species composition in the SO using satellite observations. Achieving these aims will allow us to address key questions about the bio-optics and the phytoplankton changes in the Southern Ocean.

PRINCIPAL INVESTIGATOR (PI)
David Antoine
Remote Sensing & Satellite Research Group (RSSRG)
Curtin University, Perth, Australia

A bio-optical approach to understanding long term changes in phytoplankton abundance and composition in the Southern Ocean and their impact on the biological productivity

PRINCIPAL INSTITUTION / COUNTRY
- CSIR / UCT, Cape Town (South Africa)
- NASA GSFC, Greenbelt (USA)
- University of Tasmania, Hobart (Australia)
- CSIRO O&A, Perth (Australia)
- University of Maine, Orono (USA)
- CNRS-LOG, Wimereux (France)
- CNRS-LOV, Villefranche sur mer (France)
- University of Sherbrooke (Canada)
- CNRS-LOCEAN, UPMC, Paris (France)
- Bigelow lab for ocean sciences (USA)

MONASH UNIVERSITY

STUDYING BIODIVERSITY IN THE ANTARCTIC

Using powerful new genetic and computational approaches, we will address a major, unresolved question in modern biology: how has life evolved and spread around the Antarctic region, both in the past and today? In doing so we expect to find species new to science in areas that are rarely visited. The new fundamental discoveries we make will improve conservation in the region. We will devise ways to help predict what the impacts of rapid climate change will be on the region's biodiversity, providing assistance to decision-makers seeking to reduce them. Our research will also provide innovative tools to help decision-makers determine whether newly recorded species are local or from elsewhere in the world. Invasive species are the region's largest conservation problem – a problem expected to increase with climate change.

Our project will leave a substantial legacy: Resolution of fundamental questions about how life has evolved in the Antarctic. Discovery of species new to science. Improved understanding of the region to the benefit of conservation management during times of rapid change. Publicly accessible information and products to improve knowledge and appreciation of the Antarctic's wilderness value, conservation significance, and sheer beauty. Education and inspiration of a new cohort of polar scientists.

PRINCIPAL INVESTIGATOR (PI)
Steven L Chown
Monash University
Australia
Settling Decades of Debate: A Dynamic, Functional Biogeography of the sub-Antarctic

PRINCIPAL INSTITUTION / COUNTRY

- Australian Antarctic Division (Australia)
- British Antarctic Survey, United Kingdom CSIRO (Australia)
- Department of Conservation, New Zealand
- National Institute for Agricultural Research, INRA (France)
- Moscow State Pedagogical University (Russian Federation)
- Muséum national d'Histoire naturelle (France)
- South Australian Museum (Australia)
- Université de Rennes 1 (France)
- University of Johannesburg (South Africa)
- University of Kentucky (USA)
- University of Queensland (Australia)
- University of Stellenbosch (South Africa)
- University of Waikato (New Zealand)
- Zool. Staatssammlung München (Germany)

BRITISH ANTARCTIC SURVEY, NERC

EVALUATING CARBON STORAGE CAPACITY IN SEABED ORGANISMS

Polar continental shelves are one of the few places on the planet that are accumulating more carbon as climate change increases – this is called a negative feedback. How will regional warming influence how much carbon (*blue carbon*) is captured and accumulated by life on the seabed around Antarctica? To answer this question, our project will deploy camera-equipped Agassiz trawls and box cores to collect benthos (organisms living on, in, or near the seabed). The samples will enable us to quantify how much carbon is held within seabed animals, how this varies around Antarctica and how it changes in response to climate. Previous work (by members of our team) has shown that life on continental shelves of Atlantic sector islands around Antarctica are an important and increasing carbon sink. Although poorly studied and understood, this appears to be a powerful negative feedback against climate change that this project attempts to better understand. Our team of international benthic experts will sample the shelf around each island and evaluate seabed carbon capture and storage in organisms by identifying the composition of biodiversity and how much organic and inorganic carbon is present. They will examine the skeletons of long-lived organisms to determine how carbon accumulation has varied over years and decades.

PRINCIPAL INVESTIGATOR (PI)

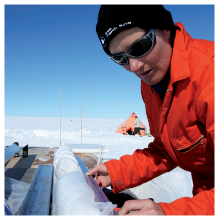
David K A Barnes
British Antarctic Survey, NERC
UK
Antarctic Seabed Carbon Capture Change

PRINCIPAL INSTITUTION / COUNTRY

- University of Tasmania (Australia)
- University of Bruxelles (Belgium)
- University of Bourgogne (France)
- Alfred Wegner Institut & Senckenberg (Germany)
- University of Bergen (Norway)
- University of the South (Peru)
- P.P. Shirshov Institute (Russia)

BRITISH ANTARCTIC SURVEY

READING ANTARCTIC'S PAST IN ICE CORES



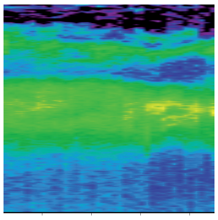
The sub-Antarctic islands (SAI) are uniquely located to capture changes in the globally significant circumpolar westerly winds and the Antarctic circumpolar current, key to the mixing and ventilation of the world's deep oceans. The Sub-Antarctic - ice coring expedition (SubICE) is an international collaboration to provide the first glaciological and palaeoclimate records from the remote and globally significant SAI's, before glacial retreat and warming surface temperatures destroy this valuable palaeoclimate archive forever. The experienced team will drill several shallow ice cores (~20m), at both high and low elevation sites, and conduct state-of-the-art helicopter radar surveys at a number of glaciated SAI's to improve our understanding of southern hemisphere climate dynamics. We will retrieve records of past climate and atmospheric circulation patterns, including the variability of the southern ocean winds, measure atmospheric pollutants, and estimate ice volume, its internal structure and basal conditions, to provide a much needed benchmark for future glacial retreat. The ice dynamics and proxy preservation determined as part of ACE is essential to determine the optimal location for future deep ice core drilling projects.

PRINCIPAL INVESTIGATOR (PI)
Elizabeth (Liz) Thomas
British Antarctic Survey, UK
Sub-Antarctic - ice coring expedition (SubICE) - LEAD

PRINCIPAL INSTITUTION / COUNTRY
- Centre for Ice and Climate, Copenhagen (Denmark)
- Australian Antarctic Division, Hobart (Australia)
- University of Magallanes (Chile)
- Climate Change Institute, University of Maine, (USA)
- Earth and Space Sciences, University of Washington, USA.

UNIVERSITY OF ST ANDREWS

UNCOVERING THE MYSTERY OF THE OCEAN'S "FALSE BOTTOM"



We will operate scientific echosounders continuously on the circum-Antarctic voyage to map the depth and biomass of acoustic Deep Scattering Layers (DSLs), also sometimes called the "false bottom." DSLs are ubiquitous features of the world ocean, but data on DSLs in the Southern Ocean are sparse. They comprise communities of fish (lantern fish, myctophids) and zooplankton. Our previous work has revealed pronounced differences in DSL depth and biomass across frontal zones and suggests the possibility of a global DSL biogeography. The ACE cruise will add a Southern Ocean component to that global biogeography.

The daily vertical migrations of animals in DSLs, from deep water in daylight to shallower water to feed at night, make an important contribution to the 'biological pump' that moves carbon from the surface to the ocean interior. Fish in DSLs are hunted by diving predators such as elephant seals and king penguins and are also potentially of commercial interest. Data on Southern Ocean DSLs are needed to improve ecosystem-based management and to improve our understanding of biogeochemical cycling and drivers of predator foraging behavior.

To examine associations between the DSL prey-field and predator foraging behavior we will work with biologists tagging elephant seals and penguins on islands along the voyage track. We will analyze the dive depths and duration of predators in the context of DSL depth and biomass: we hypothesize strong correlation.

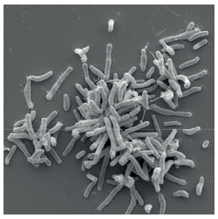
PRINCIPAL INVESTIGATOR (PI)
Andrew Brierley
University of St Andrews
UK

Circum-Antarctic distribution of acoustic deep scattering layers, and associated foraging behaviour of deep-diving predators

PRINCIPAL INSTITUTION / COUNTRY
- Macquarie University (Australia)
- Sea Mammal Research Unit (UK)
- Australian Antarctic Division (Australia)
- British Antarctic Survey (UK)
- Muséum National d'Histoire Naturelle, (France)
- Sydney Institute for Marine Science, (Australia)

NORTHUMBRIA UNIVERSITY

DISCOVERING THE RICHNESS OF MICROORGANISMS ON CONTINENTAL ANTARCTICA



The way ecosystems function, evolve and adapt to new conditions depends directly on the species they contain. This, at the same time, is influenced by the ability of organisms to disperse and establish themselves in these ecosystems. For Antarctic microorganisms, this might represent a particular challenge, as air and water currents form a potential barrier around the continent. However, both cosmopolitan organisms and microbes adapted to Antarctic conditions are known to live, even thrive, within the Antarctic continent, challenging the belief that Antarctica is the most isolated place on Earth. Here, within the BIOAIR project, an international group of microbiologists, meteorologists, physicists and chemists will gather to identify whether microorganisms living in the Antarctic are related to those living elsewhere, whether they can travel to the Antarctic from the surrounding continents in the air, and ultimately whether they might influence communities already established in the Antarctic, in a first ever circum-Antarctic aerobiology expedition. Thus, we will be able to identify where Antarctic microbial colonists are likely to come from. This information will help proposing Antarctic conservation measures. The link with global circulation patterns in the Earth's atmosphere would also help predicting future changes in Antarctic diversity based on current climate models.

PRINCIPAL INVESTIGATOR (PI)

David A Pearce

Northumbria University

UK

BIOAIR - Aerobiology over Antarctica

PRINCIPAL INSTITUTION / COUNTRY

- Northumbria University (UK)
- Uppsala University (Sweden)
- Sanger Institute (UK)
- University of Cardiff (UK)
- University of York (UK)
- GFZ Potsdam (Germany)
- Arctic & Antarctic Institute (Russian Federation)
- Australian Antarctic Division (Australia)
- University of Liège (Belgium)
- U Autónoma de Madrid (Spain)
- Aberystwyth University (UK)
- University Grenoble Alpes (France)
- University of Innsbruck (Austria)
- Brigham Young University (USA)
- University of Porto (Portugal)
- International Medical University (Malaysia)
- Princeton University (USA)
- University of Waikato (NZ)
- NASA Ames (USA)
- Colorado State University (USA)
- De la Republica University (Uruguay)
- Rhodes University (South Africa)
- University of Bristol (UK)
- DLR, Berlin (Germany)
- University of South Bohemia (Czech Republic)
- University of Ljubljana (Slovenia)
- British Antarctic Survey (UK)
- KOPRI (Korea)
- Auckland University of Technology (NZ)
- University de Sao Paulo (Brazil)
- Université Laval (Canada)

PAUL SCHERRER INSTITUTE

ANTARCTICA TO REVEAL PRE-INDUSTRIAL ATMOSPHERE

While we understand the effects of carbon dioxide emissions on climate quite well, there are other substances and atmospheric processes that are not yet well characterized. Among these processes are aerosol-cloud interactions. To understand the anthropogenic influence on aerosol-cloud processes, we need to know what these processes are like without human impact. More specifically, we need to know how small particles in the atmosphere interact with clouds in pristine conditions. This is challenging, because there are hardly any places left on Earth with conditions similar to the preindustrial age. The region that qualifies best is the Southern Ocean.

During the expedition, we will operate a number of scientific instruments on-board the research vessel that will help us understand how emissions from the ocean to the atmosphere influence particles, how these particles form and grow in the air, and what they are chemically composed of. We will test whether these particles can form cloud droplets or ice crystals. These on-board measurements will help us to improve satellite data retrieval methods and global climate model simulations.

PRINCIPAL INVESTIGATOR (PI)

Julia Schmale

Paul Scherrer Institute

Switzerland

Study of Preindustrial-like Aerosol - Climate Effects (ACE-SPACE)

PRINCIPAL INSTITUTION / COUNTRY

- Paul Scherrer Institute (Switzerland)
- Leibniz Institute for Tropospheric Research, Leipzig (Germany)
- University of Leeds, Leeds (UK)
- The Hebrew University of Jerusalem, Jerusalem (Israel)
- University of Cranfield (UK)
- Federal Institute of Technology Zurich (Switzerland)

INSTITUT DE CIÈNCIES DEL MAR, ICM-CSIC

TRACING THE INVISIBLE NATURE THAT MAINTAIN EARTH'S CLIMATE

The Southern Ocean is an important short-term regulator of the Earth's climate through air-sea exchanges of water vapour, heat, reactive gases and aerosol precursors. SORPASSO (Surveying Organic Reactive gases and Particles Across the Surface Southern Ocean) aims to conduct the first observations of the circumpolar distribution of surface ocean trace gases and particles important for atmospheric chemistry and climate, and decipher their biological, chemical, hydrological and optical drivers.

We will combine ocean and atmospheric measurements with remote sensing data and numerical modelling to extrapolate observations into a regional context and outline projections of future trends under global warming. The particular multi-jet structure of the Antarctic Circumpolar Current and the occurrence of strong biological production gradients caused by the effects of islands on currents make a Southern Ocean circumpolar expedition like ACE exceptionally valuable to attain a large scale process-based understanding. The international team of SORPASSO gathers a blend of experienced and young scientists, all highly motivated, to obtain the best knowledge out of this unique opportunity, while providing public and educational awareness on the importance of 'invisible nature' (microbes, gases) in maintaining the Earth's climate.

PRINCIPAL INVESTIGATOR (PI)
Rafel Simó
Institut de Ciències del Mar, ICM-CSIC
Barcelona, Catalonia, Spain

Surveying Organic Reactive gases and Particles Across the Surface Southern Ocean (SORPASSO)

PRINCIPAL INSTITUTION / COUNTRY

- Plymouth Marine Laboratory (UK)
- Plymouth University (UK)
- University of Warwick (UK)
- Takuvik-Université Laval, Québec (Canada)
- University of Technology Sydney (Australia)
- INIBIOMA Bariloche (Argentina)
- IQFR-CSIC (Spain)

BRITISH ANTARCTIC SURVEY

MEASURING THE CHANGES IN THE OCEAN'S CAPACITY TO ABSORB CO_2

Concentrations of CO_2 in the atmosphere have increased since 1750 AD as a result of human activity. This is linked to warming of the atmosphere and oceans, changes in climate, recession of ice sheets and sea level rise. More than one quarter of this CO_2 is absorbed by the oceans; the Southern Ocean accounting for 43%. The capacity of the Southern Ocean to absorb CO_2 has recently been limited (according to some models) by an increase in the strength of the Southern Hemisphere Westerly Winds (SHW), which draw CO_2 saturated waters back to the surface. This will potentially drive up atmospheric greenhouse gases and accelerate rates of global warming.

Thus reconstructing past changes in the SHW and their impact on the oceanic CO_2 sink is now a major priority for palaeoclimate science. Our objectives are to:

A. determine the Holocene (last 12000 yrs) changes in the strength of the SHW over the Southern Ocean by generating records of wind-driven aerosols and other proxies in sediment records from lakes and bogs on the west coasts of sub-Antarctic islands and,

B. use these data in global climate models to test if past changes in the SHW explain past variations in atmospheric CO_2.

PRINCIPAL INVESTIGATOR (PI)

Dominic A. Hodgson

British Antarctic Survey

UK

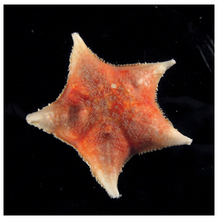
Southern Ocean westerly winds and the global CO_2 sink

PRINCIPAL INSTITUTION / COUNTRY

- British Antarctic Survey (UK)
- Universities of Exeter and Cambridge (UK)
- Oeschger Centre, University of Bern (CH)
- ANSTO: Australian Institute of Nuclear Science and Engineering (Australia)
- Dept. Biology, University of Ghent (Belgium)
- Lab. Ecologie Fonctionnelle et Environ. (CNRS) Universtity of Toulouse (France)
- Earth and Environmental Sciences, Lehigh University (USA)
- Quaternary Science, Lund University (Sweden)

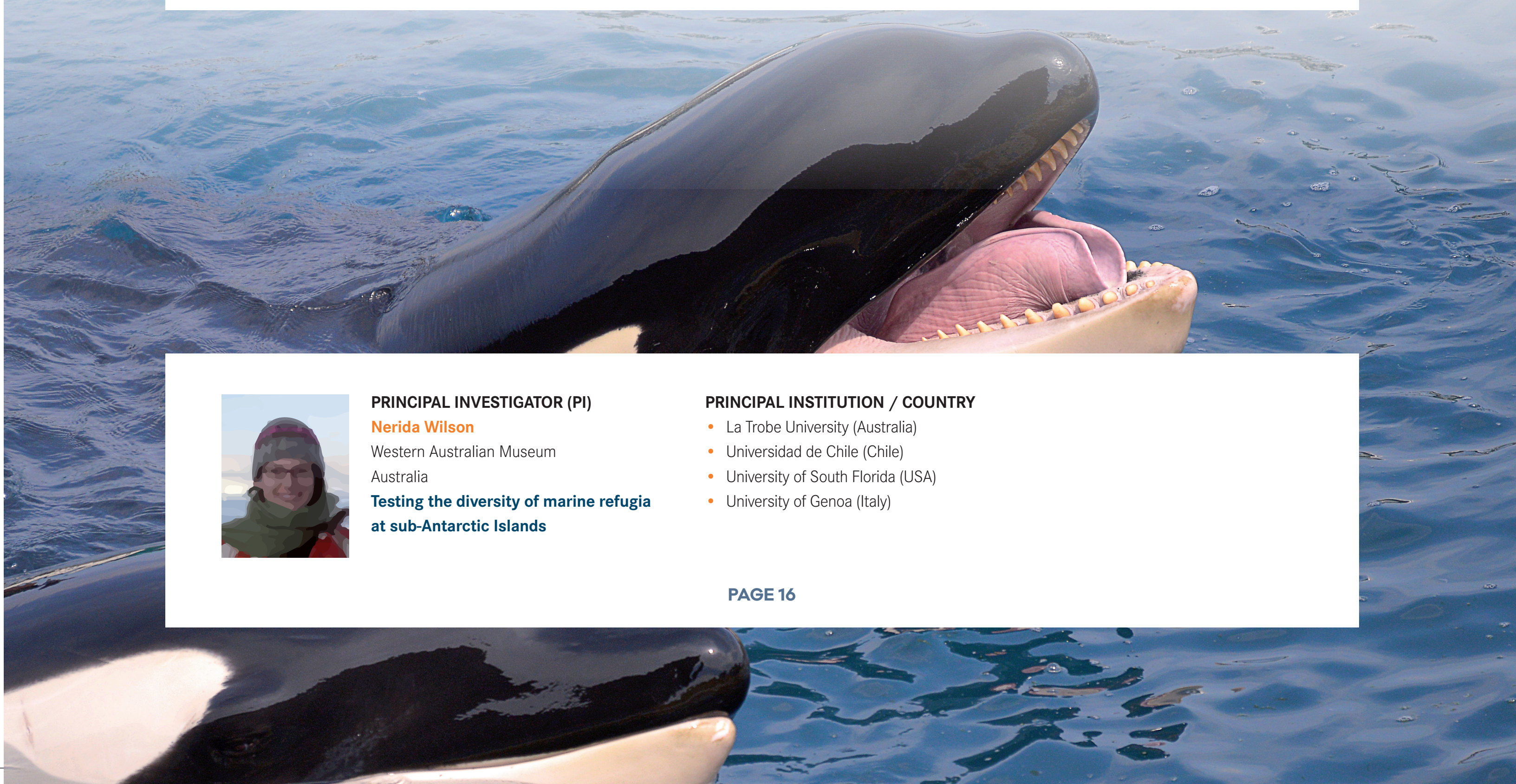
WESTERN AUSTRALIAN MUSEUM

TESTING THE DIVERSITY OF MARINE REFUGIA ON SUB-ANTARCTIC ISLANDS



Antarctica provides a challenging environment for animals to live in. In the past, its climate has regularly been even harsher, with ice-impacted conditions extending even further towards the equator. The sub-Antarctic was also regularly impacted by glacial cycling, and climatic conditions were more like those in Antarctica today. These previous glacial periods appear to have completely wiped out the animals living there, and it is most likely that the animals living there today have only 'recently' recolonized these sub-Antarctic outposts after the Last Glacial Maximum.

We will compare the genetic signatures of animals in sub-Antarctic and compare these to data from Antarctica. We will also compare the natural chemical defenses found in many marine organisms. Finally, we will compare biological interactions between the two regions, comparing symbioses among regions to understand the biological history of sub-Antarctic marine fauna in a comprehensive and unified manner.

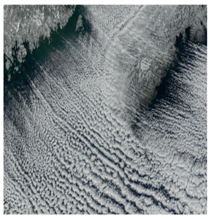


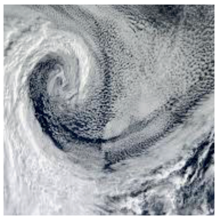
PRINCIPAL INVESTIGATOR (PI)
Nerida Wilson
Western Australian Museum
Australia
Testing the diversity of marine refugia at sub-Antarctic Islands

PRINCIPAL INSTITUTION / COUNTRY
- La Trobe University (Australia)
- Universidad de Chile (Chile)
- University of South Florida (USA)
- University of Genoa (Italy)

ETH ZÜRICH

INVESTIGATING AIR-SEA INTERACTIONS





The Southern Ocean is characterized by diverse weather systems, which lead to severe weather conditions - heavy precipitation, wind storms, fog - and impact ocean evaporation, the water budget of the remote islands, and Antarctic precipitation. Quantifying these processes and their interplay is essential for understanding Earth's climate. Stable water isotopes (SWI), which occur naturally in the ocean, land surface waters and the atmosphere, can be used as tracers of the complex processes that govern the global and regional water cycle.

Therefore, we will measure SWI in atmospheric vapour during the ship cruise and observe the variability of precipitation events with a micro-rain radar. Liquid samples will be collected from precipitation events, from the ocean and from accessible surface waters on the islands. Together with trajectory-based analysis methods, these observations provide a unique opportunity to investigate the variability of ocean evaporation conditions as recorded in SWI signals in vapour, the variability of precipitation processes revealed by the radar and combined SWI measurements in vapour and precipitation, and oceanic source conditions of water that is later deposited in Antarctic ice cores.

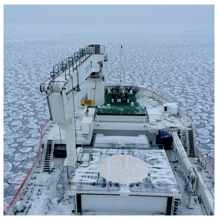
PRINCIPAL INVESTIGATOR (PI)
Heini Wernli
Institute for Atmospheric and Climate Science
ETH Zürich
Switzerland

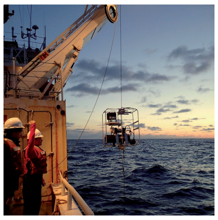
Investigation of air-sea interaction in the Southern Ocean from stable water isotope measurements

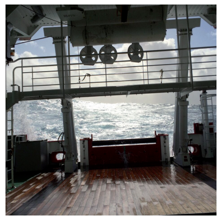
PRINCIPAL INSTITUTION / COUNTRY
- EPFL (Switzerland)
- University of Bergen (Norway)
- Lund University (Sweden)

UNIVERSITY OF CAPE TOWN

PROFILING THE SOUTHERN OCEAN'S MICROBIAL COMMUNITY







The Southern Ocean plays an important role in Earth's climate, storing more heat and carbon dioxide (CO_2) than any other ocean region. However, this capacity of the global ocean to absorb CO_2 is actually limited by the Southern Ocean because phytoplankton - the microscopic plants living in surface waters that convert CO_2 to organic carbon through photosynthesis - do not fully consume the macronutrients (nitrogen and phosphorus) supplied to Southern Ocean surface waters. While this is generally thought to result from a combination of iron and light limitation, the role of phytoplankton, bacterial, and zooplankton (i.e., "microbial") diversity is less well understood.

We seek to understand how microbial community composition affects organic carbon export in the Southern Ocean, and how this changes with changing nitrogen source. Using a combination of cutting-edge chemical, biological, and computation techniques, we aim to answer the following questions regarding the microbial community in the open Southern Ocean: *Who is there? What are they doing? Why are they doing it? What are the implications for Antarctic nitrogen cycling, ecosystem function, and atmospheric CO_2 absorption, today and in a warming world?* This work has implications for South Africa's Oceans Economy, as Antarctic waters currently support globally-significant fisheries, as well as for the management of vulnerable ecosystems.

PRINCIPAL INVESTIGATOR (PI)
Sarah E. Fawcett
Department of Oceanography,
University of Cape Town, South Africa

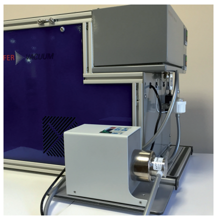
A multi-disciplinary, multi-resolution approach to understanding nutrient cycling and microbial diversity in changing Subantarctic ecosystems

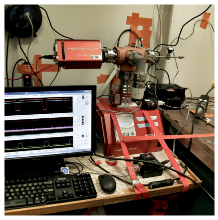
PRINCIPAL INSTITUTION / COUNTRY

- Cape Peninsula University of Technology (South Africa)
- Department of Environmental Affairs (South Africa)
- Nelson Mandela Metropolitan University (South Africa)
- Princeton University (United States of America)
- Rhodes University (South Africa)
- South African Environmental Observation Network

DUKE UNIVERSITY AND LABEXMER-IUEM

PHYTOPLANKTON AS A CLIMATE REGULATOR





Photosynthesis at the ocean surface by phytoplankton contributes to half of primary production on Earth. In the process, it draws carbon dioxide from the atmosphere and converts it to organic carbon, which then settles to the deep ocean and ocean floor, where it is isolated from the atmosphere for thousands to millions of years. This process in great part controls the distribution of carbon between the atmosphere and the deep ocean and influences climate over geological timescales. Phytoplankton therefore provides invaluable services including regulating climate and supporting Antarctic ecosystems from krill to whales. In light of these critical roles, it is alarming to note that we have a very limited understanding of Antarctic plankton communities and their impact on carbon cycling.

To address this issue, we will deploy a shipboard mass spectrometer for underway estimates of net community production. Our observations will be compared to plankton community characteristics as estimated by imaging flow cytometry through a collaboration with other ACE projects. Microbial diversity patterns will be complemented by next-generation environmental DNA sequencing methods. Our observations will allow us to explore at unmatched spatial scales and precision how plankton communities regulate oceanic fluxes of energy and mass, thereby providing a more mechanistic understanding of Antarctic carbon cycling.

PRINCIPAL INVESTIGATOR (PI)
Nicolas Cassar
Duke University and LabexMER-IUEM
(USA & France)

Antarctic Circumpolar Study of the relation of Carbon Export Production to Plankton Community Characteristics

PRINCIPAL INSTITUTION / COUNTRY
- Duke University-LabexMER IUEM (USA / France)

AUSTRALIAN ANTARCTIC DIVISION

ACOUSTIC MAPPING OF ENDANGERED SOUTHERN OCEAN WHALES

During the 20th century, more than 2 million Antarctic whales were killed. The present-day status of many of these populations remains poorly known. Yet, precise information on post-exploitation recovery of these whales is critical for broader ecological conservation and management of the Antarctic marine environment. Many species of Antarctic whales make loud distinctive sounds, and within a species these sounds may vary with the geographic region in which they are recorded. Newly validated instrumentation and methods for listening to whales have resulted in the ability to detect and reliably locate sounds produced by some species, such as blue whales, over extreme distances.
On the ACE voyage we propose to apply these new methods for listening to and locating Antarctic whales throughout the Southern Ocean. This work would be the first ever circumpolar survey for Antarctic whales to be completed in a single season. The data from this voyage will also provide more detailed knowledge of the geographic distribution of Antarctic, sub-Antarctic, and sub-tropical whales, especially blue and fin whales that make very loud, long-travelling sounds. The locations of groups of whales collected during the ACE voyage will be compared with environmental data from satellites, existing long-term underwater listening stations, and with historical whaling catch data and contemporary sighting survey data to better understand how they are distributed in the Southern Hemisphere.

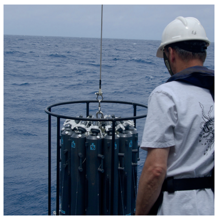
PRINCIPAL INVESTIGATOR (PI)
Brian Miller
Australian Antarctic Division
Australia
Circumpolar acoustic mapping of endangered Southern Ocean whales

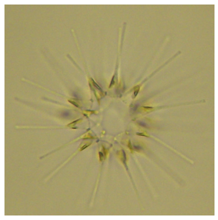
PRINCIPAL INSTITUTION / COUNTRY

- IWC-SORP Antarctic Blue Whale Project, PAMTech.eu (UK)
- University of Aberdeen (UK)
- University of Washington, Seattle (USA)
- Mammal Research Institute Whale Unit, University of Pretoria (South Africa)
- PELAGIS Observatory CNRS-UMS 3462, University of La Rochelle (France)
- NOAA Ocean Acoustics Program (USA)
- Centre for Research into Ecological and Environmental Modelling, University of St Andrews, Scotland (UK)
- Alfred-Wegener Institute for Polar and Marine Research, Bremerhaven (Germany)
- Curtin University Centre for Marine Science and Technology, Perth (Australia)
- Australian Marine Mammal Centre (Australia)

RESEARCH SCHOOL OF EARTH SCIENCES
AUSTRALIAN NATIONAL UNIVERSITY

UNDERSTANDING THE PLANKTON'S STRATEGY TO SURVIVE





The Southern Ocean plays a key role in regulating global climate as it contains regions where deep, carbon dioxide-rich water comes to the surface and communicates with the atmosphere. Southern Ocean surface waters are also perennially anaemic (iron impoverished), and as a result plankton growth is stifled. In this project we hope to understand the strategies that plankton use to survive in this harsh environment.

We will do this through a combination of field experiments and shore-based analysis of samples collected from this region. The results from this research program will help us develop a greater understanding of the adaptability of Southern Ocean plankton, which will hopefully feed into public policy on the role that the Southern Ocean plays in moderating climate.

PRINCIPAL INVESTIGATOR (PI)
Michael Ellwood
Research School of Earth Sciences Australian National University
Australia

Linking marine primary production to the cycling of dissolved organic compounds and trace elements in Southern Ocean waters.

PRINCIPAL INSTITUTION / COUNTRY

- University of Bern (Switzerland)
- University of Geneva (Switzerland)
- ETH (Switzerland)
- University of Canberra (Australia)
- CNRS (France)
- University of Otago (New Zealand)
- University of British Columbia (Canada)
- AWI (Germany)

UNIVERSITY OF GENEVA

THE ROLE OF BACTERIA AND VIRUSES IN CARBON AND IRON CHEMISTRY

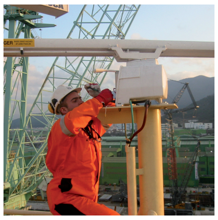
The Southern Ocean is key for the global carbon cycle and hence the regulation of our climate. However, in this region the fate of carbon in surface waters is largely influenced by iron, which acts as a limiting nutrient. Here we propose to revisit the role of bacteria and viruses on elemental transformations, recycling and export by documenting bacterial and viral biodiversity and exploring virus ecology. Our effort will contribute to the first report of viral biodiversity from contrasted regions around the South Pole. We will also bring live bacteria and viruses back to our home laboratory to explore the interactions between bacteria, dissolved organic matter and viruses and their impact for carbon and iron biogeochemistry. This new and unique collection of bacterial and viral strains will be freely shared with the scientific community to further stimulate Antarctic research, likely generating outputs beyond environmental and marine science per se.

PRINCIPAL INVESTIGATOR (PI)
Christel S. Hassler
Earth and Environmental Science,
Institute F.-A. Forel,
Marine and Lake Biogeochemistry Group
University of Geneva, Switzerland
Biodiversity and isolation of bacteria and viruses in contrasted regions from the Southern Ocean

PRINCIPAL INSTITUTION / COUNTRY
- INRA Thonon (France)
- University of Western Brittany (USA)
- Ohio State University (USA)
- CNRS, CERMAV (France)
- University of Geneva (Switzerland)

UNIVERSITY OF MELBOURNE

OBSERVING INTERACTIONS BETWEEN WINDS, WAVES, CURRENTS AND ICE



Waves in the Southern Ocean are the biggest on the planet. Thus, they exert extreme stresses on the coastline of Sub-Antarctic Islands and the Antarctic sea ice cover. Because of the lack of field data, wave models are not well calibrated and perform poorly in the Southern Ocean, undermining our current understanding of these delicate ocean and coastal environments and our ability to protect them.

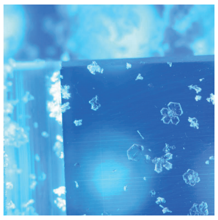
This project aims at collecting an uninterrupted set of wind, wave, and surface current data using state-of-the-art marine radar technology. Instrumentation will be installed on the research vessel and collect data throughout the entire expedition. The measurements will be complemented by data from numerical waves-in-ice models and satellite observations of sea ice. This unique database will be used to model the complex wave physics in the Southern Ocean and to calibrate and validate available wave forecasting models.

PRINCIPAL INVESTIGATOR (PI)
Alessandro Toffoli
University of Melbourne, Australia
Metocean properties of the Sub-Antarctic and Antarctic waters: winds, waves, currents, ice, and their interactions

PRINCIPAL INSTITUTION / COUNTRY
- University of Adelaide (Australia)
- Coastal Marine Technology (South Africa)
- German Aerospace Center, DLR (Germany)

EPFL

ANALYZING WHY THE OCEAN HAS BECOME LESS SALTY



The Southern Ocean has become less salty in recent years, though the cause of this trend is not yet clear. There are three significant sources of freshwater to the surface of the Southern Ocean: melting of the Antarctic ice sheet and icebergs calved from it, sea ice, and precipitation. Of these, precipitation is the least well known. Direct measurements of precipitation during the ACE cruise will be combined with evaluation of the larger scale weather and sea ice patterns to determine how precipitation influences the ocean. Our team will also collect samples of ocean water and precipitation at regular intervals for laboratory analysis of its oxygen isotopic composition.

PRINCIPAL INVESTIGATOR (PI)
Katherine C. Leonard
CRYOS Lab, EPFL
Switzerland

Quantifying snowfall and its contribution to surface freshening in the Southern Ocean

PRINCIPAL INSTITUTION / COUNTRY
- Australian Antarctic Division/ACE CRC, University of Tasmania (Australia)
- Australian Bureau of Meteorology
- Austrian Polar Research Institute University of Innsbruck (Austria)
- British Antarctic Survey (UK)
- Brown University (USA)
- Katholieke Universiteit Leuven (Belgium)
- University of Colorado Boulder (USA)

AUSTRALIAN ANTARCTIC DIVISION

THE IMPACT OF MICROPLASTIC POLLUTION ON THE FOOD WEB

While plastic pollution is a major, long-term global environmental issue, there is growing concern around tiny particles of plastics called microplastics (<5mm) that enter marine ecosystems. As well as affecting local waterways, microplastics can be transported long distances to remote and thought to be pristine polar regions due to the ocean currents. They can enter food webs at various points through accidental ingestion by animals. Furthermore, these plastics can attract and accumulate chemical pollution on their surfaces, which can further affect the health of animals that have ingested them.

The ACE voyage, in association with current Australian Antarctic science projects, offers a timely opportunity to evaluate the impact of microplastics on the Southern Ocean through a unique circumpolar survey of the ocean and elements of the food web (plankton including krill, fish, and seals, penguins and albatross). The project will communicate the results of this cutting edge-science through traditional and creative channels including generating widespread community awareness of the hazards of microplastics through a children's book and other means.

PRINCIPAL INVESTIGATOR (PI)

Dana Bergstrom

Australian Antarctic Division

Australia

The Impact of Microplastic Pollution on the Southern Ocean Food Web

PRINCIPAL INSTITUTION / COUNTRY

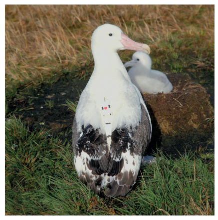
- Antarctic Cooperative Research Centre (ACE-CRC), Tasmania (Australia)
- Institute for Marine and Antarctic Studies (IMAS), University of Tasmania (Australia)
- University of Pretoria (South Africa)
- University of Cape Town (South Africa)
- International Pellet Watch (Japan)
- Griffith University, Queensland (Australia)
- Award winning writers and illustrators, Alison Lester & Coral Tulloch (Australia)

Pure Antarctic

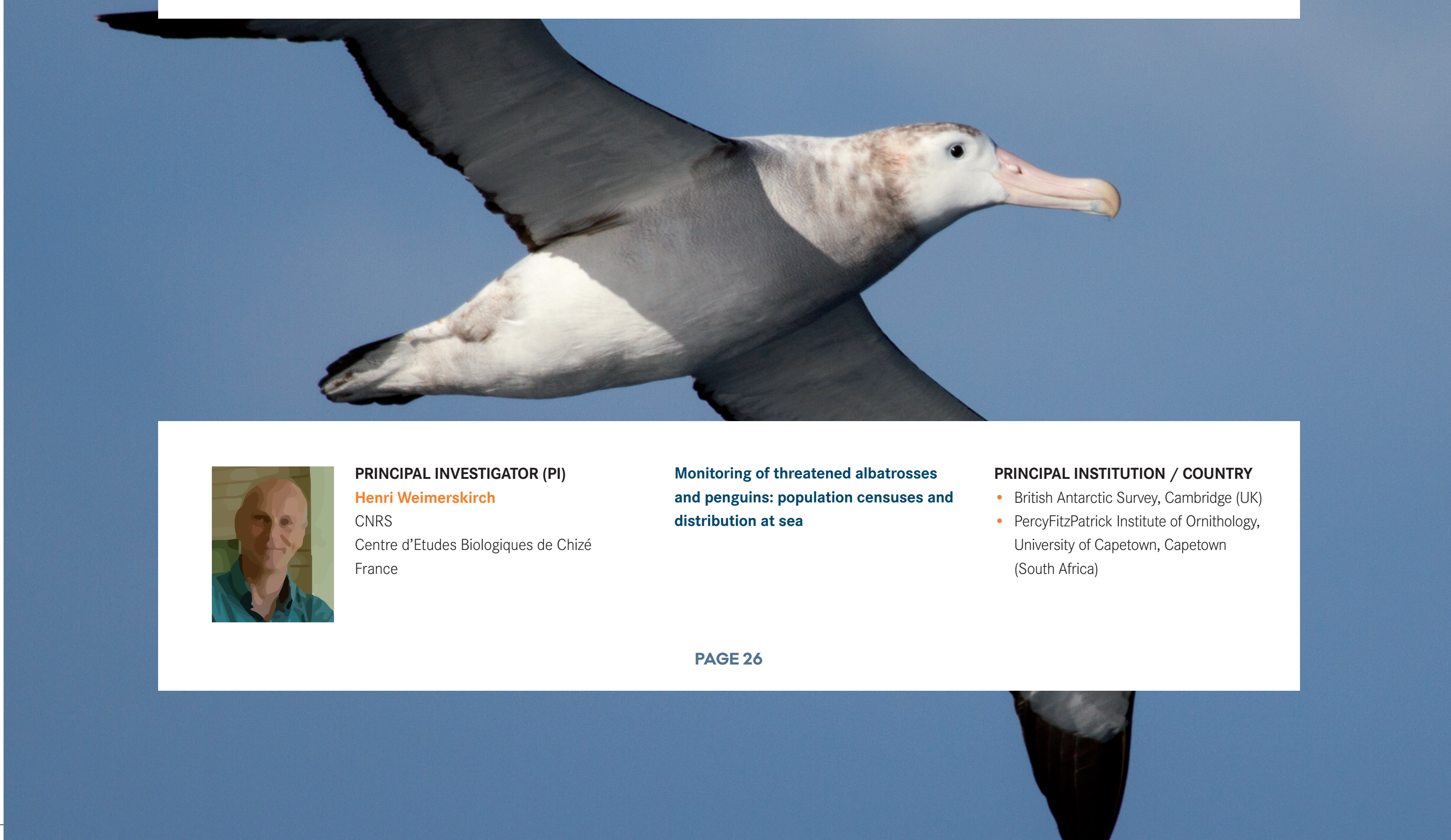
CNRS ET CENTRE D'ETUDES BIOLOGIQUES DE CHIZÉ

MONITORING OF THREATENED ALBATROSSES AND PENGUINS





The aim of the project is to obtain vital new information on the population status of several threatened and/or globally important species of albatrosses and penguins. The islands to be visited during ACE are those identified as top priorities for surveys of specific populations by the Populations and Conservation Status working group of the Agreement on the Conservation of Albatrosses and Petrels (ACAP), or hold major populations of penguins for which no recent count data exists. We will also validate the use of satellite imagery for counting great Diomedea. Albatrosses. In addition, depending on permits for access to some islands, the tagging of several key populations of albatrosses will allow for the first time the evaluation of habitat preferences of these top predators during the breeding season, which is critical for modelling the potential impact of climate and oceanographic change. In addition, the tracking and isotopic sampling study will allow us to estimate the degree of overlap between albatrosses and penguins and the marine environment and measure overlap with fisheries, which are a major threat to several species.



PRINCIPAL INVESTIGATOR (PI)
Henri Weimerskirch
CNRS
Centre d'Etudes Biologiques de Chizé
France

Monitoring of threatened albatrosses and penguins: population censuses and distribution at sea

PRINCIPAL INSTITUTION / COUNTRY
- British Antarctic Survey, Cambridge (UK)
- PercyFitzPatrick Institute of Ornithology, University of Capetown, Capetown (South Africa)

CNRS AND UNIVERSITY LAVAL

CHANGES IN ECOSYSTEMS AFTER THE CALVING OF A GIANT ICEBERG

ACE-MIS is a multidisciplinary study aiming at better understanding the physics, biology, and geology of a key region in East Antarctica. As one of the few major areas for production of Antarctic Bottom Water, the Mertz area played a key role in global ocean circulation until the recent calving of a massive 80 km long iceberg from the glacier tongue. This event had profound impacts on regional sea surface conditions, bottom water production and, by snowball effect, on local ecosystems.

The overarching aim of our project will be to survey, in great detail, biological communities, sediments and oceanic conditions within the former polynya area, in locations recently opened up by the calving, but also, and for the first time, from under the Glacier. This will be achieved via the deployment of a combination of state-of-the-art autonomous or remotely operated airborne and under-water vehicles as well as ship borne instruments.

PRINCIPAL INVESTIGATOR (PI)
Guillaume Massé
UMI 3376
CNRS and University Laval, Canada
The ACE Mertz Ecosystem and Geosystem Studydistribution at sea

PRINCIPAL INSTITUTION / COUNTRY
- ISMER – U. Québec à Rimouski (Canada)
- UMR 7159 LOCEAN - CNRS (France)
- ACE CRC – U. Tasmania (Australia)
- Institute of Earth Science – U. Iceland (Iceland)
- Dept. Geography – Memorial Univ. (Canada)

ARCTIC AND ANTARCTIC RESEARCH INSTITUTE

TRACING BACK THE EVOLUTION OF SUB-ANTARCTIC ECOSYSTEMS

These project aims at understanding the evolution of the ecosystems of Sub-Antarctic islands during the Holocene and its modern conditions. It includes three work packages: 1) Terrestrial geomorphologic and paleogeographical studies, 2) The study of stable oxygen and hydrogen isotopes (ongoing measurements) and 3) The study of aerosols (ongoing measurements). The main project tasks are: measuring heights of terraces and coastlines of the islands that will be visited; sampling organic material and loose sediments from terraces and coastlines to carry out carbon-14, OSL- and ESR- dating; geomorphologic mapping of visited coastline areas of islands; sediment core sampling from the lakes located 10-15m above sea level; sampling ocean water vapor, ice, and snow from the islands' glaciers to analyze the ratio of oxygen isotopes; continuous sampling in the course of the cruise of aerosol particles in the air (concentration – hourly, chemical composition – daily).

PRINCIPAL INVESTIGATOR (PI)

Dmitry Bolshiyanov

Arctic and Antarctic Research Institute, Russia

Evolution of the ecosystems of Sub-Antarctic Islands during Holocene and its modern conditions

PRINCIPAL INSTITUTION / COUNTRY

- Laboratoire des Sciences du Climat et de l'Environnement, CEA/CNRS/UVSQ/IPSL (Gif-sur-Yvette/Saclay, France)
- Institute of Atmospheric Optics, RAS, Siberian Branch (Tomsk, Russia)

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The following partner organisations from all over the world are contributing to the implementation of project ACE:

- Switzerland: Swiss Polar Institute
- Australia: Australian Antarctic Division, AAD
- France: Institut Paul Emile Victor, IPEV
- Norway: Norwegian Polar Institute, NPI
- Russia: Arctic and Antarctic Research Institute, AARI
- South Africa: University of Cape Town - SANAP - NRF/DST
- United Kingdom: British Antarctic Survey, BAS

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