

# Warming on Antarctica's western fringes

The IPY programme clicOPEN, currently continuing as an ESF funded research initiative 'IMCOAST', is looking at the impact of global warming along the Western coast of the Antarctic Peninsula. We talked to project leader [Dr Doris Abele](#) (DA) and project partners [Dr David Barnes](#) (DB), [Dr Matthias Braun](#) (MB) and [Dr Ricardo Sahade](#) (RS) about their various involvements in the project.

## Can you explain a little about the background of your project, its aim and where the concept came from?

**DA:** The clicOPEN IPY-activity was initiated during the planning phase for the International Polar Year (IPY) 2007-2009. At that time (2006) I had 10 years of field work experience at the West Antarctic Peninsula (WAP) during which we observed a change of winter sea ice cover and glacier retreat that resulted in massive changes in the coastal ecosystems we were studying. These could be related to a dramatic trend of mean air warming by 2.5C within a period of only 50 years based on recordings at different positions along the peninsula. This local warming at WAP, and also in the Arctic region, clearly exceeded the global warming trend, and the velocity with which this change happened was unprecedented in geological history records and thus presumably related to anthropogenic activities, burning of fossil fuels causing increased atmospheric CO<sub>2</sub> levels, in other words: it was man-made. This was disturbing, but also opened a chance to study ecosystem change while it was happening. A group of colleagues working on different national field stations along WAP decided to join forces studying the nature of change in the coastal ecosystems at different locations on a North-South gradient along the Antarctic Peninsula.

**MB:** Our sub-project target was to determine the glacier mass balance, glacier retreat and increased fresh water contribution from glacier melt to the coastal ecosystems. We used satellite data and glacier mass balance models based on meteorological observations to quantify these volumes. Additionally, we conducted repeat DGPS measurements for direct determination of surface lowering of the ice masses in several areas. I started my research work (PhD thesis) on King George Island in 1995/96 on a related topic – melt modelling on this island. Current activities are strongly based on the approaches developed

before and form a consequent application to the specific test sites on Potter Cover, but also a filling of research gaps that we were not able to target before. For example, we would like to measure over several consecutive summers, year round, with better instrumentation and also have respective satellite acquisitions in these periods for model validation/calibration. It's something we haven't managed to get together so far, but now we have the high resolution radar satellites and the potential for the fieldwork.

**RS:** Our part of the programme is more focused on the benthic ecosystem responses, and it started some years ago when we detected unexpected shifts on benthic communities in a very short term. At the beginning it was difficult to interpret the causing factors that triggered the change, and also to link them to the warming process the WAP was experiencing. Thus, we first observed the impact and then, thanks to the interdisciplinary approach of international cooperation programs like clicOPEN, we were able to find explanatory processes, like increased sediments on the coastal ecosystem due to the glacier retreating which in turn is caused by the global warming.

## How did you first become involved with the programme and what has your input been thus far?

**DA:** The IPY initiative which I was then organising with colleagues (mainly from Argentina, Brazil, Poland, Britain, Germany, Spain, Belgium, Ukraine and Korea) gave us a platform to discuss recent observations of change in many areas of the Antarctic Peninsula. We could use our field stations and the background information obtained in the national polar programmes at each site to discuss how systems were affected on a gradient between the warmer Northern tip and the colder Southern parts of the Peninsula where the Ukrainian Vernadski Station is

located. We could now start to build and extend our observational networks, and decide on common experimental strategies that should be shared using model organisms in different locations of the Peninsula region.

**MB:** We've been part of clicOPEN since the very beginning. One outcome of my PhD work was a satellite image map of the island – still used as a reference by many groups. We are currently finalising an updated map and we'll summarise our findings on the surface lowering and retreat of the ice cap.

## What are the expectations and objectives of the project?

**MB:** With clicOPEN and in particular IMCOAST we want to better link our research activities with work by other groups, especially those conducting direct discharge measurements, but also for a better understanding of the impacts of the changing cryosphere on the adjacent ecosystems. What are the processes and process chains and how strong are the impacts are the sort of questions we are asking.

**DB:** We hope to massively improve our understanding of the complexity of interlinked physical processes in climate change and how they are impacting the ecosystem in different areas and across spatial scales.

**RS:** Well, I think we are trying to improve our understanding on the functioning of polar ecosystems and how they will respond to the current process of climate change.

## How it has progressed thus far?

**MB:** clicOPEN was very successful and brought scientists of different disciplines and nations together including coordinated field research. I think the coordination effort and projects such as IMCOAST or coordinated national funding under this umbrella are certainly major outcomes.

**DB:** Most of the international collaborative



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work focussed on the detail around King George Island, but scaling up and wider assessment is important especially considering the unevenness of climate change. For example, at local scale, within bays of KGI, they recorded strong freshening, whilst in the surrounding Bellingshausen Sea salinity has significantly increased seasonally. Thus the British effort concentrated on context to the KGI work; firstly by measuring similar variables 6° further south around Rothera Base and secondly by looking at processes at an Antarctic Peninsula-wide scale. We found similar rapid and accelerating retreat of glaciers, which produced many icebergs. These icebergs are hitting the seabed more frequently because there is now less sea-ice (the sea freezes over a smaller area and for less time). More seabed impacts have a devastating influence on life on the seabed. At larger scale we found that the collapse of ice shelves and retreat of floating glaciers is creating a considerable negative feedback mechanism. This is because where ice was, there are now intense phytoplankton blooms and animals which sequester CO<sub>2</sub> from the air to the seabed.

**RS:** clicOPEN has demonstrated the fundamental role of the interdisciplinary approach and joint efforts of scientists and institutions have and will have in the understanding of processes and impacts driven by warming in the Peninsula. Of course not all the countries and institutions grant the projects with enough resources, so sometimes it is necessary to cope with very limited budgets as well. Then, the importance of international cooperation allowing joint efforts and resources accessibility is shown again.

#### What is the wider impact of your research?

**DA:** Only if we get a clear and convincing understanding of the causal links that form the basis of the ongoing system change in such remote places as the Antarctic and the Arctic regions, will we ever have a chance to convince

the public and the policy makers that these changes are real and caused by man, and that we must face the consequences. Given the present economic crisis and the changes in US governmental directions, this seems to me to be a great moment to adjoin societal awareness, especially in the industrialised countries, that we must limit our exploitative usage of energetic resources to protect the earth climate and ecosystems for future generations.

Only if scientists from the less wealthy countries can be sufficiently involved in this research will our findings be rated important and have a chance to cause some change in thinking and policies in those countries.

**MB:** King George Island can certainly be regarded as a test-bed for other sites on the South Shetland Islands. It is one of the best researched areas where we can first establish and hopefully quantify such impacts of the regional observed warming on ecosystems. The results can certainly be transferred to sites with similar boundary conditions. Moreover, from our sub-project perspective there are only very few quantitative studies on melt water amounts and changing mass balance of small ice caps and glaciers on the peninsula. We have good ideas about area changes and possible speed-up, but not too much about the regional pattern on mass loss. So here we provide a mosaic piece for a larger picture of the Antarctic peninsula cryosphere.

**DB:** Our findings will provide local scale detail and wider scale pattern of physical change and biological responses in one of the fastest changing parts of the planet. Our data should greatly improve models of what is happening and insight into the consequences.

**RS:** Although we are working on a small scale at Potter Cove, the processes we observed there were unique and now the challenge is to infer what could happen at a larger scale. Then, together with ice action (sea

ice coverage, iceberg impacts, etc.), water salinity and temperature shifts predicted as important factors driving the marine ecosystem responses, our findings suggest that sedimentation processes will also play a fundamental role if glacier retreatment is going on along the WAP.

#### Can you tell us if you faced any major challenges so far?

**DA:** A major challenge was to finally obtain funding for coordination and sustainable data management that we are now gaining for our follow-up programme IMCOAST which was approved by the ESF PolarCLIMATE and financed by the European National funding bodies (BMBF in Germany, NWO in the Netherlands, MICINN in Spain, NCBiR in Poland and FWO in Belgium). Although coordination and sustainable data management are always seen as major issues, little money for these tasks is made available, this is still a fact.

**MB:** The nature of many of our measurements are based on a long-term perspective. This means quantifying ice mass loss can of course be done over a three-year period, but in fact meaningful results can really be achieved if the measurements are repeated every couple of years or even on a yearly basis. Finding funding for such fundamental measurements in polar areas are always difficult for small institutions/universities like us, as most funding agencies only commit on a project basis for short runtimes.

**RS:** Working in polar areas is a challenge, an expensive challenge, and finding out the necessary resources to go on is a daily challenge.

#### What is the expected output of the project?

**DA:** The final output should be a jointly used open access system for data collection and visualization for WAP coastal climate change research that supports scientific interaction as well as outreach purposes.

# A valuable resource for an understanding of climate change processes

International Innovation looks at the comprehensive IPY programme clicOPEN (currently continuing as research initiative 'IMCOAST'), as it dissects the impact of global warming in the Antarctic Peninsula

**THE INCREASE IN** air temperature over the last 50 years on the Western Antarctic Peninsula (WAP) is exceptional and unprecedented. Observers at Vernadsky Station (the former British Faraday Station) have recorded aerial warming averages of 0.56 degrees centigrade every decade since the 1950s. As we are constantly being made aware, the Polar Regions are touchstones for global response to climate change, particularly in terms of ice retreat and increased melt water production.

Along the Western Peninsula, changes were observed in the coastal systems initially less noticeable in the North and more pronounced in the South-Western parts. By this time, creeping glacial retreat opens new ice-free areas for the habitation of terrestrial and intertidal plant vegetation and animals all along the Western coast. The clicOPEN IPY Initiative ('climate change in coastal areas of the Antarctic Peninsula') is investigating ways in which terrestrial and marine coastal systems are responding to climate change in four areas along the Peninsula.

The follow-up ESF funded Program IMCOAST is now taking a dual approach to its objectives in a more closely defined model area at the Northern Peninsula tip. The first is to look at and quantify

the effects of glacial melting and rock erosion on ecosystems along the WAP. The project will also be a resource for an understanding of climate change processes along the peninsula that will link to present and future changes in more remote shelf regions of the Southern Ocean.

The project is based on 19 work packages from different scientific disciplines involving scientists and researchers from European and South American countries. It is centrally based on work in two Antarctic research stations, the Dallmann Laboratory run by the German Alfred Wegener Institute (AWI) and the Argentine Antarctic Institute (IAA) together with the Netherlands Organisation for Scientific Research (NWO) forms part of the Argentine Jubany Station, and the Polish Arctowski Research Station. Both laboratories are situated on the West Antarctic South Shetland Archipelago.

The individual packages active at both stations include sedimentology, glaciology and glacial hydrology, plus sediment core analyses to reconstruct past biotic and environmental change based on dating tracers. Changes of the pelagic and benthic communities in front of the retreating glaciers and their response to changing light climate are another important focus of the planned research. The main focus

of the new programme is on the WAP, but several subprojects are also working in the Arctic regions. This also applies to benthos community structure work carried out in the Arctic by different groups involved in clicOPEN.

Already in clicOPEN the station-based approach enabled to bring many scientists into cooperative and comparative work, make use of the existing logistic background provided by field stations and home institutions, and also to draw from historical data sets in locations of long-term scientific records, including temperature records and documented contours of ice caps and glaciers.

"The impact and success of the clicOPEN initiative is that the scientists involved are better able to place the results they obtain – sometimes in descriptive experiments with single species or experimental set-ups – into the context of the changing system," says Doris Abele, clicOPEN's project leader. "This worked better with the international frame and discussion platform. Working along a conceptual model has also greatly helped us to ask the right questions and win over excellent new collaborators and discussion partners from different countries to join our group and help with their expertise to answer these questions."

The programme has a number of key deliverables including:

- Identify sedimentological, geochemical and biological tracers for source and fate of coastal run-off
- Intercalibrate different archives of recent and past climate history
- Identify sensitive indicators for environmental change in benthic and pelagic coastal systems
- Develop physical and process-oriented, well-calibrated models that assimilate data from modern space-borne observing systems
- Develop conceptual as well as actual predictive models of the response of species and communities to the ongoing change

Naturally, a large amount of information will be generated over the life of the projects and a data-specific aim of both clicOPEN and the follow-

are built on open standards, making the project data interoperable and allowing the creation of generic portals, interactive map interfaces, and novel data visualisation and data mining tools.

As well as quantifying and understanding climate change along the Peninsula, the IPY has left several legacies. Most important for clicOPEN was a new laboratory that the Argentine Antarctic Institute (IAA) constructed in Esperanza Station (Hope Bay) for Argentinean scientists and international cooperating partners. Further, physiochemical monitoring stations implemented in primary catchment areas of glacial discharge will remain for continued data registration. On the Polish Arctowski Station, the fishing boat 'slon morski' has been repaired and can be used as a platform for studies in coastal areas that require multi-instrumented work.

The IPY initiative has also opened its resources for undergraduates and graduate students

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DEAD KRILL IS WASHED ON THE BEACH AT KING-GEORGE ISLAND AS A CONSEQUENCE OF BOTH FRESH WATER RELEASE FROM MELTING LAND GLACIERS, AND STARVATION OF THE ANIMALS DUE TO REDUCED PRIMARY PRODUCTION UNDER THE COASTAL SEDIMENT RUN-OFF PLUME

up activity are to establish a regional online gateway to share information collated from the WAP. Widespread access to and integration of the data will be facilitated by the use of advanced spatially enabled web services that

from across the world. Exchanges of students between participating nations are encouraged in the project, so that the cooperative educational efforts are not restricted to Antarctic field seasons.

## IMCOAST

**Impact of climate induced glacier melt on marine coastal systems in the West Antarctic Peninsula region**

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