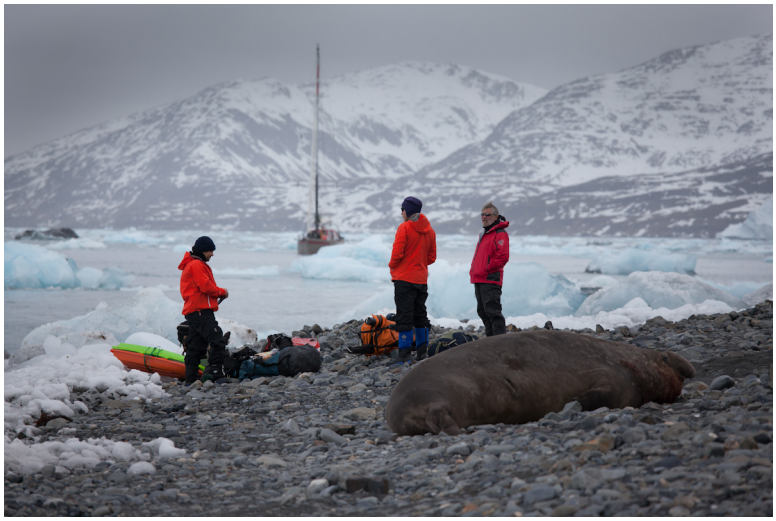
The Climate Change Institute (CCI)
Kuli South Georgia Expedition (KSGE)
End of Season Report to the
Government of South Georgia and the South Shetland Islands (GSGSSI)

Submitted by Paul Andrew Mayewski, Director, Climate Change Institute,
University of Maine, USA



(Three members of KSGE, an elephant seal and *Pelagic Australis* in Cumberland Bay.) Photo M. Potocki

KSGE members: The professional glaciology team included: Paul Mayewski (field leader, research scientist, mountaineer), Gino Casassa (research scientist, mountaineer), Dan Dixon (research scientist, mountaineer), Bjorn Grigholm (research scientist, mountaineer), Mario Potocki (research scientist, mountaineer, navigator), Marcelo Arévalo (mechanical engineer, mountaineer, boat captain). In addition Alex Kuli served as Emergency Medical Technician (EMT licensed, sailing experience) and Alex Kuli (Jr) as a free-lance journalist.

Expedition notes and pictures: A log and selected pictures documenting the trip appear at the end of this report and can also be found on the Climate Change Institute expedition report website.
http://climatechange.umaine.edu/kuli_south_georgia_expedition
Alex (George) Kuli the freelance journalist attached to our expedition produced his own blog for the expedition - http://www.expenews.com/en/expeditions.

Expedition movie: An ~12 minute long movie documenting the expedition was produced by Bjorn Grigholm. It is available at the following site and will soon be available on YouTube.
http://climatechange.umaine.edu/cci_videos

Acknowledgements: CCI and the KSGE team greatly appreciate the advice, opportunities and support provided by: The Kuli Foundation, The Government of South Georgia and South Shetland Islands, The Government of the Falkland Islands, British Antarctic Survey, South Atlantic Environmental Research Institute and of course the crew of *Pelagic Australis* (Magnus Day, Kali Kahn, Edd Hewitt, Will Whately) and Skip Novak who made the travel to/from/around South Georgia a safe, highly enjoyable and memorable experience. Fair winds and following seas to all.

Summary of scientific activities:

Introduction: The Climate Change Institute (CCI) has a long tradition of research in remote regions of the world including: Antarctica, the Arctic, Himalayas, Tibetan Plateau and the Andes. Many of these regions have experienced dramatic warming in the last few decades. This warming (and associated feedbacks) has resulted in massive losses of: land-based glaciers, floating ice shelves and sea ice. Dramatic consequences for ecosystems have resulted as well as important opportunities for understanding Antarctic, Southern Hemisphere and global future climate.

With warming ice core records that provide unique, highly robust reconstructions of past climate are fast disappearing. South Georgia's glaciers may no longer preserve easily interpreted ice core derived environmental records, but if they do the records will provide a critical view of climate change for much of the South Atlantic and Southern Ocean. These records offer unique understanding of changes in past: temperature, precipitation, atmospheric circulation, air chemistry, sea ice extent, volcanic and human activity and much more. They offer views at storm event resolution ranging decades to thousands of years in the past. They offer a framework for assessing future climate and environmental change. Loss of these records through melting is tantamount to losing the "Rosetta Stone" for these regions.

New ice core records from sensitive regions like South Georgia are needed to address major scientific questions:

(1) How will the behavior of major climate features such as the westerlies that transport heat and moisture throughout much of the Southern Hemisphere change in the future and how fast might a change occur? As an example CCI has demonstrated that recent changes in the westerlies, associated with greenhouse gas warming and the Antarctic ozone hole are anomalous relative to the last 5000 years.

(2) How much has the chemistry of the atmosphere changed in response to human activities in both hemispheres? As an example CCI recently discovered a near 1000x rise in the levels of uranium input to the Antarctic Peninsula associated with Australian mining activities.

Direct value of KSGE to South Georgia:

(1) KSGE proposed to conduct ground based ice-penetrating radar to test against published estimates of ice thickness made remotely through examination of glacier surface slopes. To the best of our knowledge these would be the first such ground based measurements for South Georgia. Understanding ice thickness and subglacial topography is key to understanding the future health of South Georgia's glaciers in a warming world.

(2) KSGE proposed to provide the first estimate of change in the chemistry of the atmosphere over South Georgia. Pollutant levels in the Southern Hemisphere are rising as a consequence of increased industrial and mining activity. Knowledge of the existence and magnitude of change should be of value to researchers study flora and fauna on South Georgia.

(3) KSGE proposed to find a location from which to develop a record of past behaviour of the position and intensity of atmospheric circulation systems that deliver moisture, heat and storms to South Georgia. With recent contraction and intensification of the Southern Hemisphere westerlies it is important to assess past and present atmospheric circulation conditions to assess future changes.

(4) All resulting data will be submitted to the Antarctic Digital Database and any other sites requested by GSGSSI.

While the final scientific results from KSGE will not be available for some months the following provides a summary of our scientific accomplishments as of the end of the expedition:

Ice thickness: Chilean members of the KSG team Gino Casassa and Marcelo Arévalo provided ice penetrating radar capability. They conducted a survey of much of the Szielasko Ice Cap.

Contribution: This ice thickness survey is to our knowledge the first such attempt at calculating ice thickness on South Georgia. Comparison between digitized maps/photographs revealing past glacier extent and current ice thickness from this survey will allow ice volume loss reconstructions and an estimate of the future health of Szielasko Ice Cap.

Snow chemistry sampling: A 2.7m snowpit was recovered from the top of the Szielasko Ice Cap (686 masl) on the Barff Peninsula by CCI. The snowpit was sampled at 1 cm resolution to allow possible detailing of individual winter storm events. The winter snow at this elevation was starting to melt by the time of sampling (Oct. 17, 2012) and the sampling stopped at 2.7m once ice was hit indicating either significant melting of the pre-2012 winter snow or a hiatus between last winter's snow and possibly many years down to glacier ice. The Szielasko Ice Cap has been decaying for some years as demonstrated by on-site comparison compared to maps as is the case throughout much or all of South Georgia. In general the southern half of South Georgia is ~1°C colder on average than the northern half so sampling at Szielasko is equivalent to sampling at ~100-150m higher on the northern half of the island. Our original plans were to sample at ~800-900 masl on the northern end of the island so sampling at close to ~700 masl on the southern half is not significantly lower with respect to temperature than our original plan and it demonstrates that recovery of a continuous, well preserved ice core will have to be conducted at elevations well above 1000 masl. See suggestions later in this summary.

Contribution: To our knowledge the Szielasko snowpit may be the first sampling of the chemistry of the atmosphere over South Georgia. It provides a basis for comparing changes in the chemistry of the atmosphere between winter 2012 and chemistry to be derived from significantly older ice discussed below.

Ice coring: Two short ice cores were recovered from the snout regions of Nordenskjold (2.5m, 18 Oct.) and Fortuna (1.5m, 19 Oct) Glaciers. We chose these sites to be able to examine the chemistry of the past atmosphere over South Georgia.

Contribution: Although extremely short these may be the first ice cores recovered from South Georgia.

By comparing the snowpit chemistry from Szielasko Ice Cap with the "old" ice chemistry from Nordenskjold and Fortuna Glaciers ice cores we will provide the first estimate of difference in atmospheric chemistry between the industrial and the pre-industrial eras.

Our previous research suggests that well insulated glacier ice (as found at the two sites sampled) can contain well-preserved records of past climate despite the elevation. By examining the water isotope content of these ice cores we may be able to estimate whether the ice is several hundreds to many thousands of years old allowing the first estimate of the age of the oldest ice on South Georgia. If the cores hold well preserved records we also expect to be able to investigate these cores at sub-annual resolution using our newly developed laser sampling technology (10 um and finer sampling resolution capability) to gain insight into what deep ice (the expected source region for our sampled ice) near the center of South Georgia might hold for a climate record in anticipation of proposed future ice core drilling.

A Record of Past Climate from South Georgia: It is clear that warming is severely impacting South Georgia's glaciers and that even seasonal temperature estimates using climate reanalysis available from several sources (eg., NCEP/NCAR, ERA Interim) may be underestimating the significance of temperature change during recent decades. To this end it is apparent that to recover a well-preserved ice core from South Georgia it is necessary to go considerably higher than 1000 masl.

Our investigations in Cumberland Bay suggest that sufficiently high (>2000m) and sufficiently thick (>150m) ice can be accessed and will likely offer a well-preserved record that may be frozen to the bed (polar ice) and as such could yield a record of past climate change extending back in time several hundreds to thousands of years. We plan to develop a Cumberland Bay region ice core drilling site plus South Georgia spatial shallow sampling plan for future activities intended to capture the past climate of South Georgia and the South Atlantic. To this end we will plan to assemble a team of partners such as: GSGSSI, British Antarctic Survey, North Atlantic Environmental Research Institute and others.

KSGE Log:

10th October 2012 – Fourth Day On Open Ocean

53 degrees, 27.08' South / 42 degrees, 36.36' West

Our expedition started out on the morning of October 2nd at the Concord Bus Station in Bangor, Maine. Five of us (Alex, Paul, Dan, Mario, Bjorn) arrived by 6:30am with 17 bags, each weighing ~50lb. The bus crews gave us a puzzled look but were helpful loading the bags nonetheless. Roughly four hours later we arrived at Logan airport and proceeded to check in our mountain of bags.

Our first flight was relatively short, to New York JFK where we boarded a much larger plane ready for our 11-hour flight to Santiago, Chile. It is always somewhat nerve-wracking traveling with so much gear… One always wonders if it will all make it. Upon arrival at Santiago on the 3rd, we passed through immigration and then on to customs… to our surprise all the bags made it through and we promptly re-checked them in again for our next flight – to Punta Arenas. While in Santiago we met up with an old Chilean friend from previous expeditions, Gonzalo Campos. Gonzalo had some business to attend to in Punta Arenas and had timed his flight so that we could travel together. It is always good seeing Gonzalo in Chile. We stepped off the plane in Punta Arenas around noon and were pleasantly surprised to see all our bags once again! Gonzalo spoke to one of the airport staff in Punta Arenas and arranged for us to store all of our gear in a small building close to the airport, thus saving us the trouble of moving our mountain of bags across town in a fleet of cabs. Later that night, Alex Junior flew in from Budapest, Hungary. Paul and Alex Senior (Alex Junior's Dad) took a cab out to the airport to greet him. To resolve the confusion of having two Alexes in tow, we decided to call Alex Junior by his middle name, George.

We spent October 4th and 5th in Punta Arenas catching up with work, meetings, and last minute preparations for the expedition. Gino and Marcelo flew in and met up with us by the evening of the 5th. On the 6th we once again headed to Punta Arenas airport, this time to catch our flight to the Falkland Islands. The crunch this time was that the Falkland Islands flight only flies once per week… So if one of our bags should not make it, it could spell the end of the expedition – each bag is critical. With the addition of Gino and Marcelo we now had over 20 bags! To give all of our bags a fighting chance of making the flight we arrived at the airport by 9am… Hopefully plenty of time to get the bags loaded for a 1pm take off.

Upon arrival at Mount Pleasant military base we were very happy, and relieved, to see that our bags had all made it once again. We piled our bags and ourselves into two vans that were waiting for us and began the long drive along mostly gravel roads to the only permanent large settlement on the Falkland Islands, the town of Stanley. Along the way we saw several farms, a few with cows, but mostly with sheep. The landscape is very flat and dry, almost no trees and lots of scrub – a very windy place to live. We also caught sight of several minefield warnings, a stark reminder of the 1982 Falklands war.

We were greeted in Stanley by the crew of the Pelagic Australis, Magnus Day (the Skipper), Kali Kahn (first mate), and Edd Hewett (second mate). Light was beginning to fade so we immediately began to load our gear onto the boat. The Pelagic Australis is to be our transport to the island of South Georgia. She is a fine vessel, a 74-foot ocean-going one-off, built in 2003 from sheet aluminum.

We set sail on the 7th and have spent the last few days 'getting our sea-legs' as we experience every type of weather imaginable (excluding calm sunny conditions of course!). The Pelagic crew is second-to-none and they handle the boat with a calm experience that instills trust. We have had a lot of fun helping to crew the boat and learning some of the ins-and-outs of open ocean voyaging.

12th October 2012 – Land Ho!

54 degrees, 16.897' South / 36 degrees, 30.467' West

The island of South Georgia is in sight. Two days ago, after four days of open ocean sailing, we got our first glimpse of South Georgia. It was a snow capped peak shrouded in clouds. We sailed another few hours along the coast before we reached Right Whale Bay. The calm waters of the bay were a welcome relief for us as it meant ship activities (e.g. eating) were not concurrent with large rocking motions. Looking onto the shore we could see clusters of elephant and fur seals, penguin colonies, and various other sea birds (blue petrel, southern giant petrel, snowy sheathbill, Antarctic tern, snow petrel, black-browsed albatross, and cape petrel). The anchor was put down a few hundred meters from shore. The plan, weather dependent, was to stay the night sheltered in the bay and head out early the next morning to our final destination: Possession Bay (~30 miles to the east). At dinner, Paul and Magnus downloaded and reviewed weather reports. The reports predicted rough weather with increasingly heavy winds (up to 60 knots) over the next few days. It was decided that the Possession Bay landing would be postponed until the weather lightened. Instead, we would travel to King Edward Point (KEP) with a short stop in Possession Bay to scout potential landing sites. The stop in Possession Bay gave us views of two possible access routes to the drill site on Esmark glacier. Both routes are roughly 11 miles and entail climbing the glacier that sits on the slopes of the southwest side of the bay. The glacier leads up to a region named Murray Snowfield which then needs to be crossed to reach Esmark glacier (our drill site at 900 meters elevation). After an hour or so in the bay we were off again and headed to KEP.

King Edward Point is the location of a British Antarctic Survey (BAS) research station and the local Government Authority of South Georgia and the South Sandwich Islands (SGSSI). Upon arrival, visitors must show permits and be inspected by bio-security. The island is particularly susceptible to invasive species; rats are a prime example of a non-native species that is harmful to the South Georgia ecosystem. Rats have decimated bird populations at certain locations on the island. Animal species are not the only environmental threat, foreign vegetation is also a serious concern. During the early 20th century, along with rats, whalers brought with them reindeer and dandelion, both of which are still found on the island.

We arrived at KEP in the early evening and tied the ship to the station dock. After our inspection, the setting sun gave us a little time to explore the area. A 20 minute walk brought us around the bay, through the abandoned whaling settlement of Grytviken, to

Ernest Shackleton's grave. The following morning Paul met with a British couple, Pat and Sarah Lurcock, who have spent the last 20 years working on the island. Pat has spent a great deal of time climbing in the area so Paul was very interested to hear his accounts on the glaciers here, especially his thoughts on our proposed route up to the drill site on Esmark Glacier.
Currently, we are waiting at KEP and are planning to return to Possession Bay tomorrow.

13th October 2012 – Change Of Plans
Reconnaissance Operations: Nordenskjold Glacier. Due to a poor weather forecast, the plan to sail to Possession Bay had to be postponed. Instead, we motored the Pelagic Australis over to the Nordenskjold Glacier on the other side of Cumberland Bay to assess the possibility of recovering some good quality basal ice. Unfortunately, the winds were too high to conduct zodiac operations safely and we had to return to KEP. A zodiac is a name for a heavy-duty inflatable motor boat. The zodiac aboard Pelagic Australis is ~12 feet long with a 25 horsepower outboard motor. What seems a small swell aboard the 74-foot Pelagic Australis, often proves to be unmanageable to a 12-foot zodiac loaded with gear and personnel. We spent the rest of the day preparing our gear for tomorrow's mission, exploring the BAS station at KEP, and looking around the Grytviken museum.

14th October 2012 – The Barff Peninsula
At daybreak we left KEP and headed to the Barff Peninsula. Paul had identified a potential drill site with relatively easy access from the shore, the Szielasko Ice Cap. Once we reached the beach, the team split into two groups; one began searching for a base camp location and the other for a route to the ice cap. By the end of the day the weather had progressively grown worse and we had to decide whether to remain on the peninsula or return to the Pelagic Australis. In order to take advantage of any sudden improvements in the weather conditions, we decided that three KSG expedition members would stay at the emergency hut on Barff Peninsula and the rest of the team would return to the boat. The three (Bjorn, Mario, and Marcelo) that remained would continue to scout a route to the ice cap should conditions permit. The hut had two small bunks, two chairs, a paraffin lamp, a small shelf of books, and a barrel full of emergency supplies.

15th October 2012 – Weather Closing In
Driving wind, rain, and snow all day prevented all of us (notably the Barff Peninsula team) from working due to lack of visibility.

16th October 2012 – Success On Barff
Today the weather improved and the Barff team successfully scouted a route to the Szielasko Ice Cap and identified a potential drill site location. We discussed the change in plan with the SGSSI representative at KEP, Pat Lurcock, and received approval. The team aboard Pelagic Australis resupplied the Barff Peninsula base camp in the afternoon and left Gino to conduct radar surveys with the Barff team.

17th October 2012 – Snow Pit On Szielasko
Second attempt to collect basal ice from Nordenskjold Glacier by the KSG Pelagic Australis team… Unfortunately, conditions were too rough to launch the zodiac and we returned to KEP. Meanwhile, the Barff team successfully collected snow samples from a ~3m snow pit and conducted radar surveys on the Szielasko Ice Cap.

18th October 2012 – Nordenskjold Glacier

Early this morning we picked up Bjorn and Mario from the Barff Peninsula, leaving Gino and Marcelo behind to finish up radar surveys. The KSG Pelagic Australis team's third attempt to collect basal ice was a Success! No wind all day - perfect weather for drilling. After several unsuccessful borings, we collected ~2.5m of good quality basal glacier ice from the debris-covered ice margin of the Nordenskjold Glacier. We collected Gino and Marcelo from Barff on the way back to KEP. Our team is whole once again.

19th October 2012 – Fortuna Glacier

Today we sailed to Fortuna Glacier and recovered a second core of basal ice from an ice-cored moraine. On the way back to KEP significant ocean swell was hitting Pelagic Australis on the port side causing the boat to heel significantly. A few of us felt a little green, perhaps a warning of things to come. In the evening, Paul gave a lecture to the BAS Staff at KEP. Afterwards, Magnus checked the weather forecast and the decision was made to head for Stanley before conditions worsened significantly (since it is a 6-10 day trip under reasonable conditions).

20th October 2012 – Exit Strategy

We decided, weather permitting, that we would attempt a short stop in Possession Bay to collect more data on our way back to Stanley. The majority of the morning was spent preparing for tomorrow's mission. We hiked to Penguin River in the afternoon, a popular spot for local penguins to gather and molt. As we photographed the penguins, the wind picked up and it started snowing. We had a near-whiteout for about 20 minutes and then it was sunny again! The South Georgia weather changes frequently and drastically, often in mere minutes! This means that best laid plans can be thwarted with but a moment's notice.

Unfortunately, our first mate, Kali, has hurt her back and cannot accompany us for the journey back to the Falkland Islands. Luckily for us, Will Whatley, a competent and experienced BAS First Mate is on hand at the station and willing to take Kali's place for the journey back to the Falkland Islands. James Wake, BAS Base Commander at KEP, kindly came by with a fork lift to pick up our snow and ice samples for transport back to BAS in Cambridge, UK. They will arrive in May and we will go to Cambridge to bring them back for analysis at CCI.

21st October 2012 – Thwarted By Weather

Our first attempt to reach Possession Bay, at midnight last night, was unsuccessful. We had to turn around due to bad weather and heavy steep seas. We failed again in our second attempt at 9am this morning. We spent the rest of the afternoon hiking to the local Gentoo penguin colony ~11km from Grytviken.

22nd October 2012 – Escape from Grytviken Part III... Success!

Our plan to stop in Possession Bay had to be scrapped as we have run out of time and the weather seemed to be worsening. However, we motor-sailed to the Bay Of Isles and managed a very brief visit to the King Penguin colony on Salisbury Plain. Dan and Alex were the first to land on the beach, shortly afterwards the wind picked up significantly and zodiac operations had to be cut short. After Alex and Dan were returned to Pelagic Australis safely we headed out to sea and set our autopilot for the Falkland Islands.

23rd October 2012 – Second Day On Open Ocean

Weather seems to be moderating. We were beginning to think we could have squeezed in a few more days on South Georgia... However, a big storm looms in the weather prediction and we are well underway with too little time to turn around.

24th October 2012 – Third Day On Open Ocean
Wind ~15 knots from the north. Nice calm sailing at ~8 knots. Crossing the Antarctic convergence.

25th October 2012 – Fourth Day On Open Ocean
Some sun today!

26th October 2012 – Fifth Day On Open Ocean
Short seas and strong winds meant much heeling and hull banging throughout last night. The ongoing motion overwhelmed a few expedition members today… Seasickness for some! The storm took longer than expected to catch us, but it appears to be here with a vengeance.

27th October 2012 – Sixth Day On Open Ocean
Still pitching, rolling, and banging… Only 100 nautical miles away from Port Stanley! We had to heave-to for a while in order to fix our electrical generator and replace two broken alternator belts on the main engine.

28th October 2012 – On Dry Land
51 degrees, 41.509' South / 57 degrees, 51.292' West
After battling head-on against 45 knot winds for much of the night and 50 knot winds through mid-morning, we arrived in Port Stanley, Falkland Islands - much to the relief of our seasick expedition members. Had we not heeded Magnus' advice, this most certainly would have been a much rougher crossing and perhaps closer to the 10 day estimate which might have conflicted with the next scheduled trip to South Georgia for Pelagic Australis.
We had to remain on board until a customs and immigration officer paid us a visit. Once we were cleared to go ashore, we headed straight to Shorty's Diner for a full English breakfast… Yum! Since the once-weekly flight to Punta Arenas left yesterday, it seems we will be spending several days here. This gives us plenty of time to explore and get to know the place.

29th October 2012 – In Stanley
We all spent the day exploring around town, catching up on email, and eating naughty food from the local diners and pubs.

30th October 2012 – Hurricane At Home
Today was dedicated to unpacking and repacking our gear ready for the final leg of the expedition back to Maine. Hurricane Sandy plowed into the east coast of the United States last night and we are seeing many scenes of coastal destruction and flooding on the television here in Stanley.

31st October 2012 – Rain Rain Rain
It was a very soggy day for Halloween, but that did not deter the local children from trick-or-treating.

1st November 2012 – Falkland Islands Weather
Today we explored out of town. The weather alternated frequently between rain, sleet, hail, and snow. Later, one of the locals assured us that these are typical conditions for the Falkland Islands. You have to be of hardy stock to live here!

2nd November 2012 – Last Day In Stanley

Most of us spent the day exploring and taking photos. Paul gave a scientific presentation at Government House in the afternoon. He also did a radio and a TV interview describing our expedition and the value of future work.

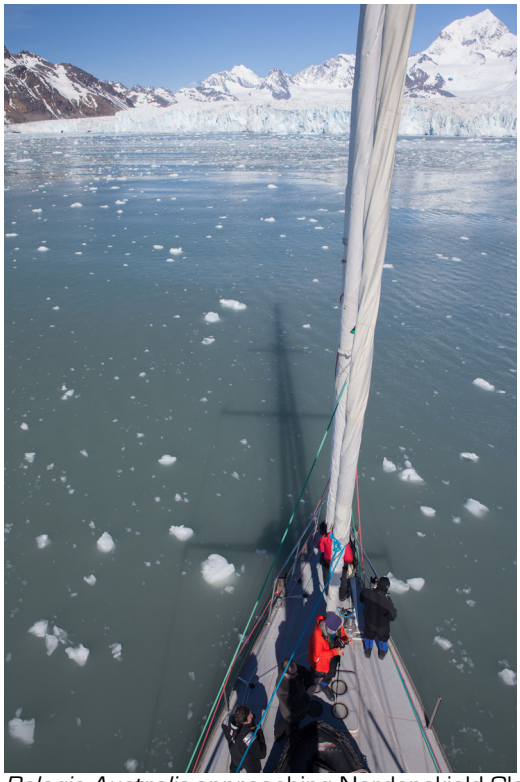
3rd November 2012 – Journey Home

Today begins our long journey back to Maine. We fly from the Falkland Islands to Punta Arenas, to Santiago, to Miami, to Boston, and finally board a bus bound for Maine. We are due to arrive in Bangor, Maine at 9pm on Sunday. Let's hope all the gear, fifteen fifty-pound bags, makes it back intact...It did!

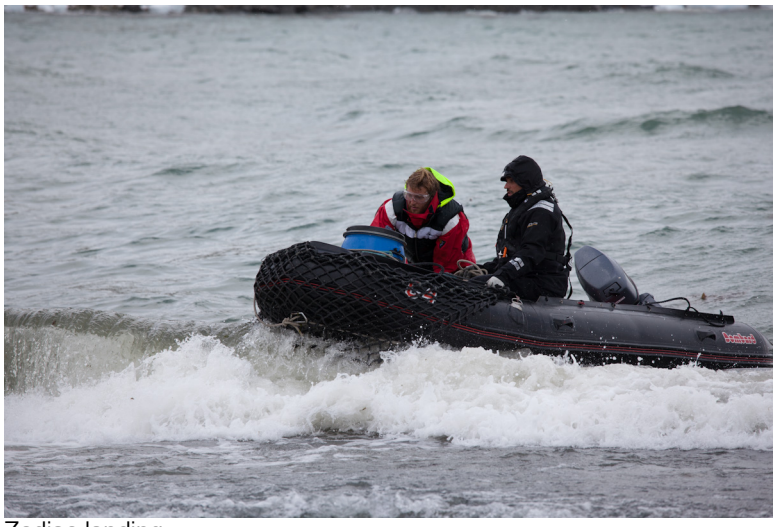
Thank you to the Government of South Georgia and the South Sandwich Islands, the crew of Pelagic Australis, the British Antarctic Survey and the many friends we made along the way. There is much much more to be done to understand South Georgia's past climate and through this to make better predictions for future climate in the South Atlantic.

The previous log was prepared by Dan Dixon, Bjorn Grigholm, Mario Potocki and Paul Mayewski

Examples of pictures from the Climate Change Institute Kuli South Georgia Expedition provided by Mario Potocki.

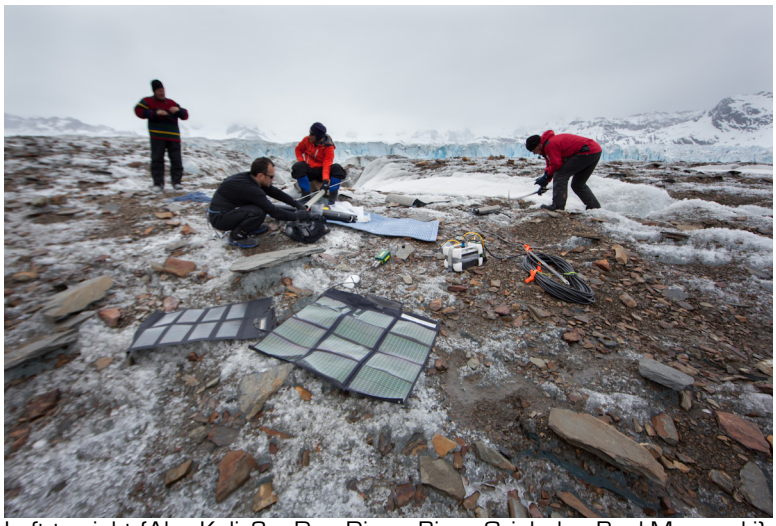


Pelagic Australis approaching Nordenskjold Glacier.



Zodiac landing.

Mario Potocki and Bjorn Grigholm approaching Szielasko Ice Cap, Barff Peninsula.



Left to right (Alex Kuli, Sr., Dan Dixon, Bjorn Grigholm, Paul Mayewski) preparing ice drill and solar panels for drilling on Nordenskjold Glacier.

Marcelo Arévalo and Gino Casassa preparing for Szielasko ice thickness survey.