

SANAP 3 MARION



SOUTH AFRICAN NATIONAL ANTARCTIC PROGRAMME (SANAP) VOYAGE PARTICIPATION DETAILS

Applicants wishing to participate in the SANAP Marion relief voyage should describe their plans in detail on this form and submit it to DEAT by no later than Monday 22 January 2007 for approval. A copy of the completed form will be attached to the Sailing Instructions for the voyage.

Please complete this form carefully and legibly (typed). Add additional sheets if necessary.

1. PRINCIPAL INVESTIGATOR & CONTACT DETAILS

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2. AFFILIATION/INSTITUTION/GROUP

OCEANOGRAPHY DEPARTMENT, UNIVERSITY OF CAPE TOWN

3. NAME OF RESEARCH PROJECT/PROGRAMME

1. SOUTHERN OCEAN CLIMATE AND BIODIVERSITY STUDY AND
2. DYNAMICS OF THE SUBTROPICAL CONVERGENCE IN THE SOUTH ATLANTIC OCEAN.

4. FULL NAME(S) OF PARTICIPANTS

(Including overwintering expedition members (for permitting purposes ONLY), and indicating who the group leader for the whole group will be when there are two or more persons in the group)

Relief voyage (takeover) personnel:

Dr Isabelle Ansorge (Group Leader)
Dr Wan Loy Chu
Miss Ceridwen Fraser - **WILL BE ISLAND BASED**
Mr Sebastiaan Swart
Mr Isufo Halo
Mr Brett Kuyper

Miss Caran George

Mr Frank Pey

Miss AN Other (UCT honours student name to be confirmed)

Mr AN Other (UCT honours student name to be confirmed)

Mr AN Other (MCM technician name to be confirmed)

5. **LOGISTIC REQUIREMENTS & OTHER DETAILS**

(Please provide details of location and number of visits to each area, special support required such as air support, dinghy support, camping equipment, specific food requirements etc., laboratory/work space required ashore or aboard, and details of any other important factors/requirements which the Departmental Coordinating Officer should be aware of. For ship-based activities, please also provide survey routes and/or station positions and attach a diagrammatic representation of these. Logistical support and maintenance/construction personnel should describe their activities (attach work schedule), areas of work etc.)

1. Understanding the temporal behaviour of processes at the Subtropical Convergence

The Southern Ocean plays a major role in the global ocean circulation and in particular on present day climate. However, our understanding of the Antarctic Circumpolar Current (ACC) and the impact the exchange and modifications of water masses have on the climate system remains rudimentary. The oceanic thermohaline circulation, often referred to as the ocean's "conveyor belt", is a vital link in the global transport of heat from the tropics to higher latitudes. The physical structure of this circulation belt and its efficiency in regulating climate is substantially influenced by the nature of water mass exchange between ocean basins (Rintoul, 1991; Gordon, 1986; Speich et al., 2001). The ACC is by far the largest conduit for such exchange. Extending unbroken around Antarctica it is the primary means by which water, heat and salt are transferred between different ocean basins. The Southern Ocean plays also a key role in the global carbon cycle due to unique features involving both physical circulation and biological processes. In particular, the outcropping of deep water masses allows for the exchange of gases such as CO₂ between the deep sea and the atmosphere, while the incomplete utilization of nutrients by marine phytoplankton allows the concentration of CO₂ in the atmosphere to be substantially greater than would be the case if these nutrients were used efficiently. The polar-extrapolar communication of heat, freshwater and CO₂ helps to close the hydrological cycle through the production of Antarctic Intermediate Water and Subantarctic Mode Water (AAIW and SAMW). These water masses transport nutrients northward of the Subtropical Convergence: by vertical mixing and advection, these nutrients could sustain a large part of the primary and export productions of the world ocean (up to 75%, Sarmiento et al., 2004). As these exchanges play an important role in regulating mean global climate, sustained hydrographic observations are essential in order to describe and understand better the physical and dynamic processes, which are responsible for the variability of the ACC (Budillon and Rintoul, 2003).

Subantarctic islands are classified as isolated, hostile, impoverished regions, in which the terrestrial and marine ecosystems are relatively simple and extremely sensitive to perturbations. They provide an ideal ecological laboratory for studying how organisms, ecological processes and ecosystems respond to a changing climate in the Southern Ocean (Smith 2002). Moreover, the Subantarctic archipelagos south

of South Africa, the Prince Edward Islands, lie at the crossroad between the Indian and Atlantic sector of the Southern Ocean, and therefore are ideally located to undertake a long-term monitoring study of the interocean exchange and its influence on climate change. The relatively easy accessibility of these islands from South Africa and their location between the main frontal systems enable high resolution synoptic field studies to be undertaken. Such studies will provide further information on the role mesoscale processes have on the large scale ocean dynamics, their impact on the local and remote climate as well as on the local ecosystems. Furthermore, these islands are seasonally characterised by enormous populations of top predators and subsequently any changes in the frontal dynamics, either in the vicinity of these islands or further afield, may have strong implications on their foraging behaviour as already shown from studies on the grey-headed albatrosses (Nel et al., 2000). As a consequence, the Prince Edward Islands can be considered as biodiversity hot spots within the Southern Ocean (Froneman *pers comms*). The energy necessary to sustain such large numbers of top predators is derived from the close interaction between the oceanic environment and the islands themselves. Changes in the intensity and geographic position within these frontal systems are likely to coincide with dramatic changes in the distribution of species and total productivity within the Southern Ocean. An even greater threat is that a warmer climate, brought on by a shift in the ACC (Gille 2002), will increase the ease in which the Subantarctic islands can be invaded by alien species (Smith, 2002).

Further investigations need to explore and monitor the role the meandering dynamics of the Antarctic Circumpolar Current and its associated fronts have in influencing the macro- and mesoscale oceanographic, climatic and background

The main aim of our study during the 2007 Prince Edward Island relief voyage will be to study the temporal behaviour of processes at the Subtropical Convergence directly north of the islands. The Subtropical Convergence forms the generic, equatorward border of the Southern Ocean. In the western part of the Indian sector it is one of the strongest fronts in the world ocean (Lutjeharms 1985). In this region, the extension of the Agulhas Current, the Agulhas Return Current (Lutjeharms and Ansorge, 2001) strengthens the horizontal gradients of this front considerably, leading to the formation of intense mesoscale eddies. These heat anomalies have been shown to have a marked influence on the overlying atmosphere and on local biota. Recent investigations at the Subtropical Convergence, using both satellite remote sensing as well as modelling (Llido et al., 2004) have demonstrated the climatological importance of primary production here. It has been shown that primary production at this front occurs as event-scale blooms and not as persistent enhancement as was suggested previously (Weeks and Shillington, 1996).

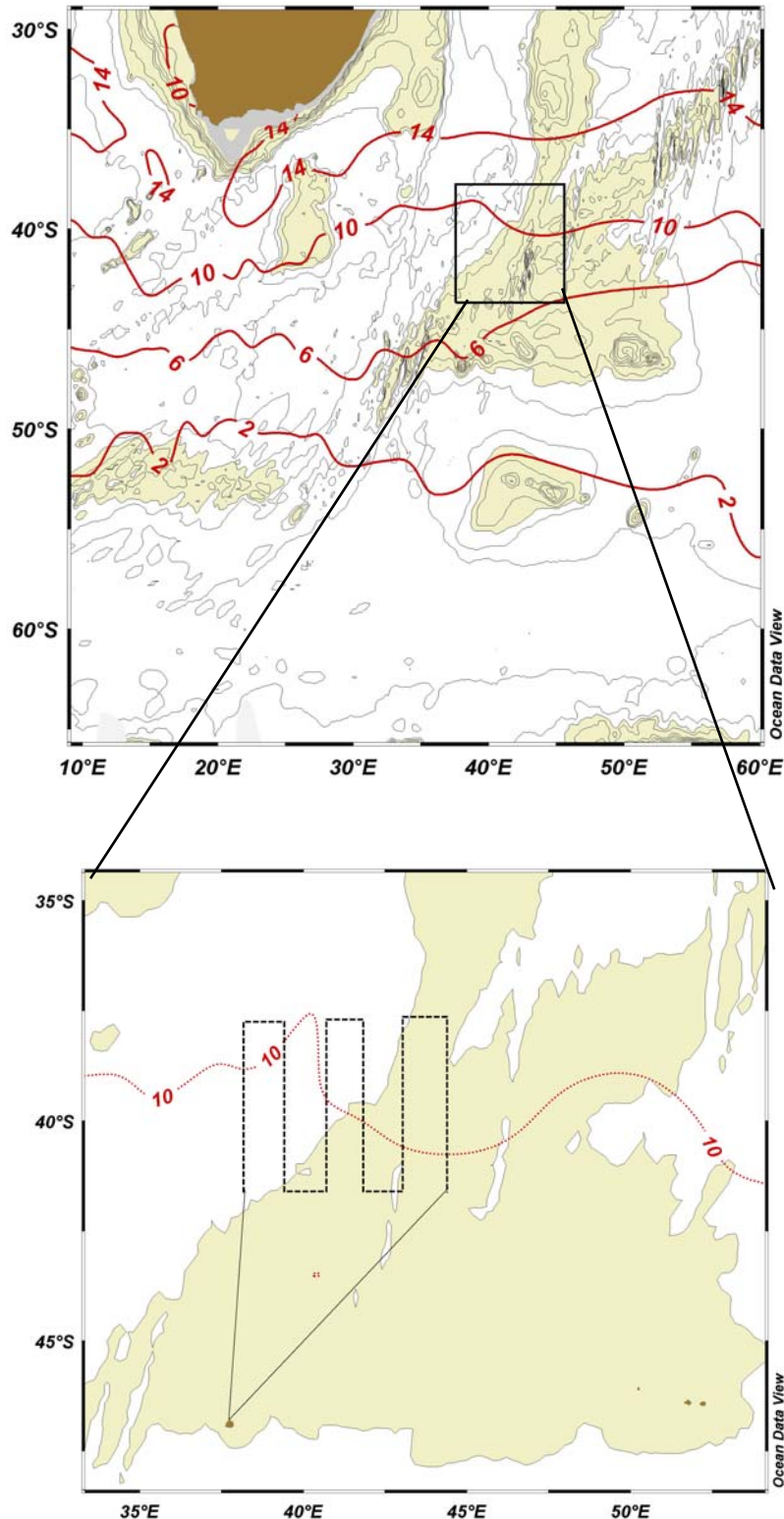
References

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Smith V.R. (2002). *Climatic change in the Sub-Antarctic: an illustration from Marion Island*. *Climate Change* 52, 345–357.

Speich S, B. Blanke, and G. Madec (2001): *Warm and cold water paths of a GCM thermohaline conveyor belt*. *Geophys. Res. Lett.*, 28, 311-314.

Survey Plan: The STCZ will be studied using a grid survey in which approximately 8 CTD/BONGO/RMT-8 stations at between 30 and 50 nm intervals will be undertaken. A total of 6 meridional transects are planned (Figure 1 below). It is expected that the survey will cover an area of 38° – 42°S and 38° – 44°E



A TOTAL OF 16 DEDICATED SEA DAYS ARE REQUIRED TO COMPLETE THIS SURVEY.

PLEASE NOTE: THE SUCCESSFUL COMPLETION OF THIS RESEARCH REQUIRES THE PARTICIPATION OF AN MCM ELECTRONICS OFFICER DURING THE CRUISE.

2. Biogeography and genetic connectivity of bull kelp in the Southern Ocean – a link to the ocean fronts?

Introduction: To assess the importance of rafting as a means of dispersal for bull kelp within frontal locations and its associated invertebrate fauna using molecular techniques. This project aims to understand better whether high rates of rafting can be reflected in low genetic distances, perhaps shared haplotypes, among isolated populations in the Subantarctic. Conversely, if regional phylogeographic signal is strong, multispecies analysis will allow one to identify the geographic sources of drifting holdfasts and their fauna.

Data Collection: DNA sequencing of bull kelp (*Durvillaea antarctica*) and associated holdfast invertebrates from Marion island will be undertaken and compare. In addition, some data will be obtained from genetic analysis of 'beach wrack' holdfasts and associated animals that have washed up on various shores, including, shores where *Durvillaea antarctica* does not grow.

This research involves collection of samples from as many locations around Marion Island as possible.

Collecting methods: Most sampling will be collected in the intertidal zone accessible from land. Where logistically possible a small zodiac may be required to collect samples in Transvaal Cove.

Bad weather and rough seas can make sampling in the intertidal difficult. For this reason, and to allow time to reach all the sites around the island it will be necessary for Miss Ceridwen Fraser to stay for the entire takeover on Marion Island.

Sampling Strategy

- 8 to 10 sites will be sampled at Marion Island
- At each site, 10 to 15 holdfasts of *Durvillaea antarctica* will be collected
- Holdfasts will be cut from the intertidal rock platform using a sharp tool such as a slasher. Fronds will first be removed to reduce drag on the holdfast, and the holdfast itself will then be detached by lateral blows at its base.
- All invertebrates within each holdfast will be picked out using forceps. The holdfast may need to be broken up to achieve this, as many animals tunnel into it.
- The invertebrates will be directly placed into a large vial (one per holdfast) containing undiluted (~95%) ethanol, and a label
- In addition, the top 2-3 cm of the tip of a healthy frond will be cut from each of twenty *Durvillaea* plants, and placed into undiluted ethanol over silica gel.

- In addition the following samples will also be collected:
 - o 6 of each species of limpet found in the intertidal
 - o 40 *Dilomma nigerimma* (a marine snail) from the intertidal at one site only
 - o 10 small pieces of frond from each other species of marine algae (seaweed) found, particularly *Macrocystis*, *Lessonia* and *Margineriella*
 - o 10 individuals of the mussel *Aulacomya*
 - o A small rock with a variety of crustose algae attached
- In each case, samples will only be taken if they represent less than 10 % of the visible

population at each site (i.e., not more than one in ten will be collected).

LOGISTICAL REQUIREMENTS

We plan to carry out a large number of CTD stations with underway XBT stations.

- **Laboratory requirements:** access to all laboratories and trawling facilities. Exclusive use of acoustic, aft and hydrological laboratories.
- **Equipment requirements:**
 1. XBT Computer System to be up and running in the acoustic/geological lab. Alternatively access must be permitted to the Meteorological laboratory in order to use the SAWB XBT system software.
 2. Thermosalinograph to be calibrated prior to the cruise and also up and running on leaving Cape Town harbour. Special attention to the debubbler needs to be given to avoid spikes in the salinity data.
 3. SEABIRD CTD with Rosette and complete array of Niskin bottles to be installed onboard **AND CALIBRIATED PRIOR TO THE CRUISE.**
 4. Email facility.
 5. Access to a small dinghy during the takeover period in order for Miss Fraser to collect bull kelp holdfast samples
 6. Oceanographic Technician is required during the cruise!!

The physical component of the programme (managed from the University of Cape Town) will be complementary to and run in parallel to the biological component (run from Rhodes University).

6. TYPE OF PERMIT/S REQUIRED

(Zones 1, 2, 3 and 4 - Standard Entry/Research, Collection and/or Special Entry Permits - including names of permit holders, location of work (zone), number of samples/specimens to be collected, etc. – please refer to the Prince Edward Islands Management Plan for details)

Zone 1 permit enabling access for **all ship-board ocean scientists** to visit the island.

Zone 1-4 required for **Miss Ceridwean Fraser** during the entire take over period to collect and study bull kelp (*Durvillaea Antarctica*) around Marion Island

7. NAME OF COMPILER – SIGNATURE – DATE

Dr IJ Ansorge 19.1.2007.....