

**Nansen-Tutu Centre for Marine
Environmental Research**

Cape Town, South Africa
affiliated with the University of Cape Town

2011 – report from THE BOARD

VISION

The vision of the Nansen-Tutu Centre for Marine Environmental Research is to serve Africa through advancing knowledge of the marine environment and climate system in the spirit of Nobel Peace Laureates Desmond Tutu and Fridtjof Nansen.

RESEARCH ACTIVITIES

The aim of the Centre is to improve the capacity to observe, understand and predict marine ecosystem variability on timescales from days to decades in support of scientific and societal needs including fisheries, coastal management, maritime security, recreation and tourism. To this end, one of the core activities at the Centre will focus on education and exchange of young researchers and students from different cultures and countries through the Nansen-Tutu Scholarship Program. The approach adopted by the Nansen-Tutu Centre is to develop and implement state-of-the-art ocean observing and modelling systems related to the unique position of South Africa at the meeting place of the cool Benguela Current adjacent to the warm Agulhas Current, and close proximity to the Southern Ocean. The focus is to study the variability of these current and ocean systems on a variety of time-scales in relation to their mutual local and regional interaction with the atmosphere and land, rainfall patterns, and other weather patterns vital to society.

In developing and implementing the technology and expertise to observe and model ocean and climate variability, the skills needed in southern Africa will be updated and expanded through priority research and development activities.

Cover image: Decadal trend in eddy kinetic energy computed over the period 1993-2009 using AVISO satellite altimetry data. Courtesy: Björn Backeberg (Nansen-Tutu Centre for Marine Environmental Research, UCT, Cape Town, SA)

ORGANIZATION

The Nansen-Tutu Centre is a non-profit research institute hosted at the Marine Research Institute and the Department of Oceanography at the University of Cape Town. The administrative and legal responsibilities reside with the University of Cape Town. It is a joint venture agreement between the founding partners: Marine Research Institute (MA-RE)/Department of Oceanography, University of Cape Town, Cape Town, South Africa, African Centre for Climate and Earth System Studies (ACCESS), Council for Scientific and Industrial Research (CSIR), South Africa, the Nansen Environmental & Remote Sensing Centre (NERSC), Bergen, Norway, Institute of Marine Research (IMR), Bergen, Norway, Geophysical Institute, University of Bergen, Bergen, Norway, and Princeton University, USA. The Nansen-Tutu Centre conducts marine environmental research, with a particular focus on southern Africa and research and development underpinning operational oceanography. Funding for projects is applied for externally. Potential funding agencies include South-African and Norwegian bodies, bilateral funding agreements, the European Union's Framework Programmes, space agencies, industry and private sponsors.

STAFF

Since its inception in May 2010 and up to December 2011, the Nansen-Tutu Centre comprises 12 persons, including seconded researchers from the Nansen-Tutu Centres founding partners, namely the Marine Research Institute and the Department of Oceanography at the University of Cape Town, the African Centre for Earth System Science at the Council for Scientific and Industrial Research, Princeton University, the Institute for Marine Research, the University of Bergen and the Nansen Environmental and Remote Sensing Center.

SCIENTIFIC PRODUCTION

In 2011, 5 papers were published in international refereed journals, 7 articles in conference proceedings, 3 technical and other reports, as well

as 1 popular science article – totaling 16 publications.

After completing their studies with supervision from Nansen-Tutu Centre senior scientists, one PhD student and one MSc student graduated at the University of Cape Town this year:

- Dr Marjolaine Rouault (nee Krug). *Agulhas Current variability determined from space: a multi-sensor approach*. Doctoral Thesis, Department of Oceanography, University of Cape Town, South Africa. Supervisor at the Nansen-Tutu Centre: F. A. Shillington.
- Ms Marie Smith. *The assessment of optimal MERIS Ocean colour products in the shelf waters of the Natal Bight, South Africa*. Masters Thesis, Department of Oceanography, University of Cape Town, South Africa, 2011. Supervisors at the Nansen-Tutu Centre: F. A. Shillington, S. Bernard (CSIR).

NATIONAL COOPERATION

The Centre has been actively involved with driving the collaborative "Operational Oceanography Group" **OceanSAfrica** Technical Task group (TTG), whose aim is the effective monitoring and forecasting of the ocean around southern Africa. Close coupling between in situ monitoring, remote sensing and modelling activities is required and the OceanSAfrica TTG endeavours to provide a forum for this cooperation.

Agulhas Bank Cruise-March 2011

Drs Backeberg and Rouault were actively involved in the planning of the COLDEX cruise on the Agulhas Bank, south of Africa. This cruise involved participation from Oceans and Coasts (DEA), NTC, UCT, Bayworld Centre for Research, SAEON, SAIAB, and Birdlife SA & DAFF. Dr Backeberg participated at sea on the *RV Algoa*, and Dr Rouault provided essential near real time satellite remote sensing data to guide the research vessel cruise track on a day to day basis (see Figure 1).

The main objectives of the cruise were to:

- Survey the Cold Ridge phenomenon on the Agulhas Bank,
- Measure aspects of the spatial distribution of chokka squid paralarvae (*Loligo reynaudii*) on the Agulhas Bank linked to squid recruitment,
- Understand the spatial dynamics of zooplankton in the Agulhas Bank for comparison with previous cruises,
- Collect seabird abundance and distribution data, as part of a long-term seabird atlas project.

A successful African Operational Oceanography training workshop was held in the Department of Oceanography at the University of Cape Town, from 9th June - 1st July 2011. The workshop attracted twenty-nine attendees from fourteen institutes across nine African countries. Training was given in four modules: GEONETCast Receiving Station Operations; Marine Earth Observation; Ocean Modelling; and Data Analysis. Lecturers and teachers came from many disciplines and institutes, both in

Cape Town and abroad:

Frank Shillington, Christo Whittle, Bjorn Backeberg, Mathieu Rouault, Francois du Fois, Mark Matthews, Fialho Nehama and Andy Rabagliati (UCT); Stewart Bernard and Marjolaine Rouault (CSIR); Pierrick Penven and Steven Herbertte (IRD); Helen Snaith (National Oceanography Centre, Southampton, UK); Johnny Johannessen and Francois Counillon (NERSC, Norway).

There was an invaluable contribution from the Departments Post Doctoral and Postgraduate students who acted as Teaching Assistants during afternoon hands on tutorials. Emlyn Balarin of the MA-RE Institute, UCT, handled the travel and accommodation logistics.

Feedback from the "students", mostly either professional scientists or post-graduate students, was extremely positive (notwithstanding some of the occasional very weary faces!). A typical day consisted of several lectures in the morning followed by practical sessions in the afternoon e.g. BILKO, SEADAS or BEAM lessons for processing satellite earth observation data; Matlab based Regional Ocean Modelling Systems (ROMS) lessons for ocean numerical modeling, and internet based marine and atmosphere data analysis. The Post Doctoral and PhD students from the

Department of Oceanography UCT, who acted as teaching assistants for the practical sessions, helped create lively discussion and networking sessions.

The two day GEONETCast module was specific to new EAMNet users in the process of installing their satellite receiving stations at Eduardo Mondlane University in Mozambique, NIOF in Egypt, Université d'Abomey-Calavi in Benin, Université de Cocody in Cote D'Ivoire, and Makerere University in Uganda. The Earth Observation module in the second week also served the very specific purpose of transferring teaching expertise in the new M.Sc. module in marine Earth Observation to lecturers from the Universities of Ghana and Dar-es-Salaam. Lectures were recorded and will be made available as an online resource, and attendees left the workshop with all lectures, practical material, and relevant open source software on DVDs. Many of them also left with sizeable regional portions of the marine EO archives held by the Marine Remote Sensing Unit in Cape Town, and further plans for African collaborative research. The data analysis week was also attended by the ten BSc (Hons) and five Applied Marine Masters Students from the Department of Oceanography, UCT.

Financial contribution to the workshop included the Nansen Scientific Society through the kind offices of Prof Ola Johannessen, the Norwegian Embassy in Pretoria, ACCESS, the Europe-Africa Marine Earth Observation Network project and the Institut de Recherche pour le Développement (IRD). We are grateful for the substantial funding and sponsorship of the major Oceanographic partner institutes and the support of many senior researchers given pro bono. Without these generous actions, the workshop could not have been held.

Visit to NERSC, Norway – Prof F A Shillington and Dr Backeberg 4-20 November 2011

Prof Shillington and Dr Backeberg visited Bergen for two weeks in early November 2011, where they discussed various collaborative proposals, and attended the Sea

Algoa Voyage 181 station positions + ETOPO2 bathymetry

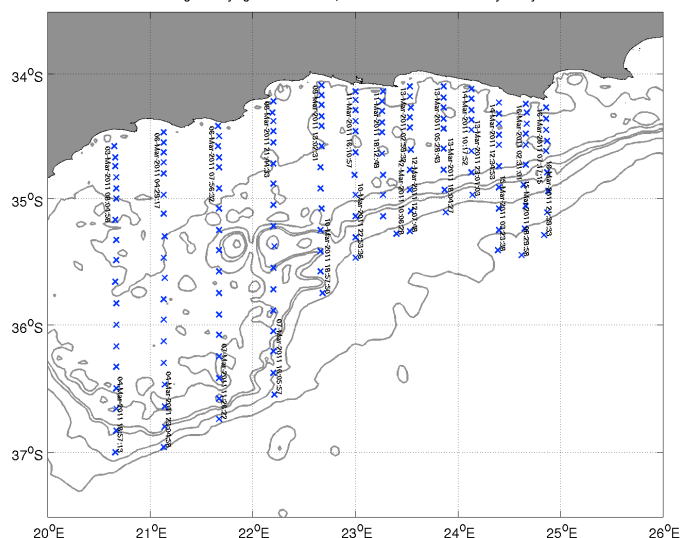


Figure 1: Map showing the location of the CTD stations obtained during the COLDEX cruise. The bathymetry is marked with the black lines.

An important contribution from the NTC was the actual positioning of the near shore boundary of the Agulhas Current, which just prior to the departure of the vessel to sea, had developed a large offshore meander. Thus the influence of the Agulhas Current on the circulation of the Agulhas Bank "cold Ridge" was not as strong as had been anticipated. The cruise track was adjusted so as to account for these aspects, in light of the satellite remote sensing of SST and Chl *a*. Dr Backeberg is continuing to analyse the ADCP current data.

INTERNATIONAL ACTIVITIES

African Operational Oceanography Workshop 9 June – 1 July 2011 (organized by F. Shillington, S. Bernard, B. Backeberg and J.A. Johannessen)

Level Workshop organized by S. Sandven, the NERSC Council Meeting and the 25 year NERSC anniversary meeting. Prof Shillington gave a report to the Nansen Scientific Council on the Nansen Tutu Centre 2010 activities. Dr Backeberg gave a presentation on changes in the Agulhas Current System at the 25 year Anniversary meeting. Full details of the programme are available at <http://www.ner-sc.no/news/presentations-nansen-center%C2%B4s-25-years-colloquium-available>.

FINANCIAL SITUATION

The Nansen-Tutu Centre is a non-profit joint venture agreement hosted at the Department of Oceanography at the University of Cape Town. For the financial year 2011, the Nansen Tutu Centre received very generous direct funding from the Nansen Environmental and Remote Sensing Center, the Institute for Marine Research, the Nansen Scientific Society, the University of Bergen, the Applied Centre for Climate and Earth System Science and the Norwegian Embassy in Pretoria, SA amounting to 1,819,942 ZAR (1,577,334 NOK). The University of Cape Town provided in kind contributions in the form of infrastructure and administrative support for the centre.

PROSPECTS FOR 2012

- Hire two new masters students.
- Hire an additional post-doctoral research fellow.
- Establish service level agreement with MyOcean.
- Continue the very successful cooperation with ICEMASA and other programmes at UCT.

Cape Town, 2011

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SCIENCE report for 2011

IMPACT OF EL NIÑO SOUTHERN OSCILLATION ON THE UPWELLING AND RAINFALL OF SOUTH WEST AFRICAN

Mathieu Rouault

Whereas the impact of El Niño Southern Oscillation (ENSO) on the Southern African summer rainfall regions is largely well documented (Rouault et al, 2011), little is known about its impact on the winter rainfall regions located at the south-western tip of Africa or on the wind system and related upwelling (Figure 2) in austral summer. Yet this region is densely inhabited and is an net exporter of high quality agricultural and fish products of substantial importance to the national economy. Following the methodology of Rouault et al. (2010), who illustrated the impact of ENSO on the South African upwelling system, a rainfall database of 682 rain gauges with daily data documenting the period 1950-1999 was examined (Phillipon et al., 2011).

The May, June and July (MJJ) seasonal rainfall amount shows a positive correlation with the Niño3.4 index that becomes significant since the mid seventies. Wet spell properties (length, frequency and intensity) at the rain gauge scale indicate that high MJJ seasonal rainfall amounts recorded during El Niño events are the result of longer wet spells in the Cape Town area and more frequent wet spells north of 33°S. Wet spells with daily rainfall amounts ranging between 10 and 50 mm are also more frequent. Atmospheric dynamic fields during wet spells feature lower pressure and north-westerly wind anomalies in the troposphere over the region. This suggests that rain bearing

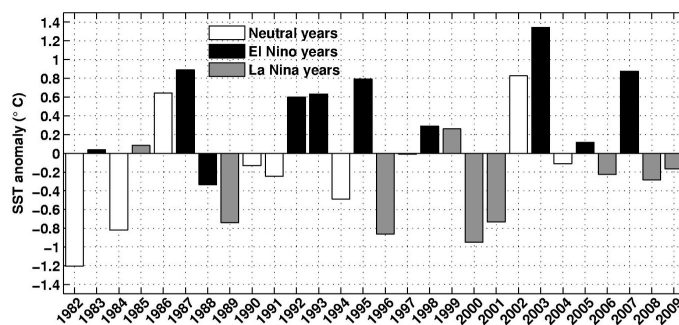


Figure 2: SST anomaly (°C) from the climatology averaged from January to May using Pathfinder over False Bay

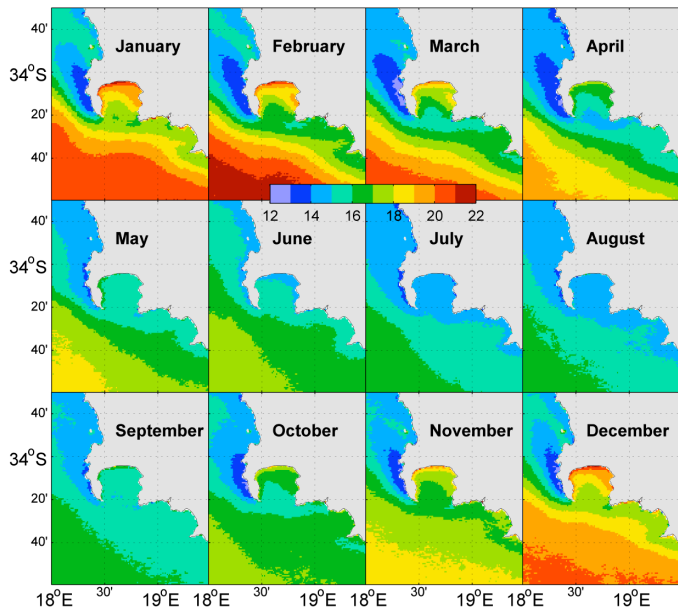


Figure 3: Monthly SST (°C) climatology from 2000 to 2010. Computed with MODIS TERRA data from averaging monthly composites.

systems are deeper and larger in extent, and located further north during El Niño events while the opposite holds during La Niña. Additionally, there is a similar impact in austral summer in the region with a weakening of the upwelling favourable south-easterly wind during El Niño with considerable impact on the sea surface temperature of the Cape Peninsula upwelling system and False Bay as shown in Figure 3 (Dufois et al, 2011). The study offer predictability for the region for rainfall, wind and intensity of the upwelling system during El Niño and La Niña.

COMPARING THREE MODEL SIMULATIONS OF THE AGULHAS CURRENT TO MEASUREMENTS FROM THE ADVANCED SYNTHETIC APERTURE RADAR

Björn C. Backeberg, Johnny A. Johannessen, Marjolaine Krug and Jennifer Veitch

The Agulhas Current has been described as the strongest western boundary current in the world's ocean. It flows poleward along the eastern coast of southern Africa from about 27° to 40°S, where it retroflects, sheds eddies into the South Atlantic, and for the most part returns eastward back into the South Indian Ocean. The Agulhas Current core is strongly steered by topography, closely following the continental shelf, which in the north

south-westward along the Agulhas Bank, the current is allowed to become more unstable and begins to exhibit numerous meanders, plumes and eddies. Over the past few years, high performance computing has advanced to a stage where it has become possible to integrate ocean general circulation models that resolve high resolution temporal and spatial scales, important for understanding the mesoscale variability of the ocean, over long periods. Modelling the Agulhas Current system at such high resolutions is a challenging task, in particular in the very energetic and chaotic retroflection region. Developing model simulations useful for both research and operational activities requires rigorous validation of the model fields, comparing their output to *in-situ* and satellite remote sensing observations.

is very steep and lies very close to the coast. In this region the Agulhas is very stable, meandering less than 15 km from its mean path. Observations from a current meter mooring near 32°S have shown that the current lies within the 31 km from the coast almost 80% of the time, displaying surface currents up to 2 m/s. At 35°S the current separates from the coast, and while it still follows the shelf edge

In this regard satellite remote sensing has played a very important role. Satellite remote sensing observations, and in particular satellite altimetry data, are regularly used to validate ocean general circulation models. However, near coastal regions, satellite altimeter measurements are hampered by atmospheric corrections, inaccuracies of the tidal models, complex sea surface height variability, land contamination, as well as limitations of the knowledge of the geoid. In particular in its northern parts, the proximity of the Agulhas Current to the coast makes it very difficult to use altimetry to study the region. Furthermore, recent comparisons of satellite altimetry and synthetic aperture radar derived currents show that the altimeter data still clearly underestimates the velocity magnitudes of the Agulhas Current

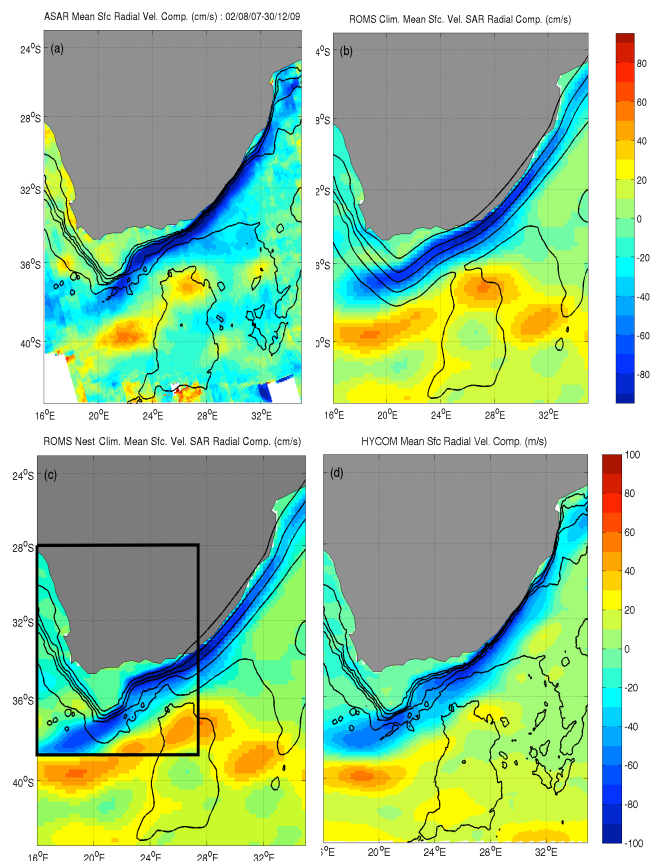


Figure 4: (a) Time-average map of ASAR range velocities from 2007-2009. The time-averaged surface velocities from the model simulation have been rotated by 15° for conform to the ASAR range velocities. (b) ROMS-SAFE configuration climatological run. ROMS- Agulhas Bank nest climatological run. (d) HYCOM regional model of the Agulhas. The 200, 500, 1000, 2000 and 4000 m isobaths are plotted in black. The colour bars mark the velocity scales.

(Johannessen et al., 2008). This has significant implications considering that altimetry data is routinely assimilated into operational ocean models.

The Envisat ASAR mean range velocity estimates provide a means to assess the strength and variability of the upper layer dynamics (e.g. Johannessen et al., 2008; Rouault et al., 2010). In particular for the Agulhas Current, where it lies close to the coast, and the altimetry measurements are limited and the geoid is not properly resolved. Comparing the surface velocities of ASAR, to the output from model simulations based on the Regional Ocean Modelling System (ROMS) and the Hybrid Coordinate Ocean Model (HYCOM) indicates that the models underestimate the mean velocity in the Agulhas Current, and generally simulate a broader current than observed from ASAR as shown in Figure 4. Moreover, there appear to be limitations in all models with respect to the topographic steering, especially in the southern Agulhas Current, where it follows the continental shelf of the Agulhas Bank.

An assessment of the vertical structure of the Agulhas Current in the model simulations, reveals that the layer distribution in HYCOM is uneven, with too many layers in the mixed layer, and too few layers in the deep, leading to an inaccurate and weaker representation of the simulated currents.

This study is a preliminary inter-model comparison of the Agulhas Current and requires more consistent model datasets for comparison against the ASAR range velocity estimates. The study would also greatly benefit from interannual data from a high-resolution z-level model, such as the model known as the Nucleus for European Modelling of the Ocean (NEMO) developed by the European DRAKKAR multiscale ocean-modelling project. Moreover further study will focus on the Agulhas leakage and how it varies in the presence of a strong or weak Agulhas Current. The Agulhas leakage has significant implications for regional and global climate, and models of the region need to be critically assessed and used in combination with observations to address this problem.

EDDY PROPERTIES IN THE MOZAMBIQUE CHANNEL: A COMPARISON BETWEEN OBSERVATIONS AND TWO NUMERICAL OCEAN CIRCULATION MODELS

Issufo Halo, Björn C. Backeberg, Pierrick Penven (IRD), Isabelle Ansorge, **Chris Reason**, Jenny E. Ullgren (Geophysical Institute, University of Bergen)

Analyses of in-situ data and altimetry observations, as well as the outputs from two different numerical ocean circulation models, the Regional Ocean Modelling System (ROMS) and the Hybrid Coo-ordinate Ocean Model (HYCOM), have been used to investigate the mesoscale eddy properties in the Mozambique Channel. ROMS was forced by climatology data and run at a spatial resolution of $1/5^\circ$, while HYCOM forced by interannual forcing has a grid resolution of $1/10^\circ$. The power spectral density of the model transports at 17°S , indicate the models ability to represent the transport variability at mesoscale frequencies (range between 3 y^{-1} and 10 y^{-1}). The models, in particular, show an exaggerated representation of the lower frequencies ($\sim < 3\text{ y}^{-1}$) suggesting a gradual increase in mesoscale variability and eddy generation. The eddies were identified

using an automatic eddy tracking scheme. Both anticyclonic and cyclonic eddies appeared to have a preferred site of formation within the channel. As shown in Figure 5. Eddy radius density distribution have shown that anticyclonic eddies exhibited a bi-modal distribution: the first mode was associated with the typical background oceanic turbulence, while the second mode was related to the passage of large anticyclonic eddies at a frequency of about 4 - 7 per year. On the other hand cyclonic eddies had a single mode distribution that follows the first baroclinic Rossby radius, suggesting their origin to be associated with the background turbulence of the system.

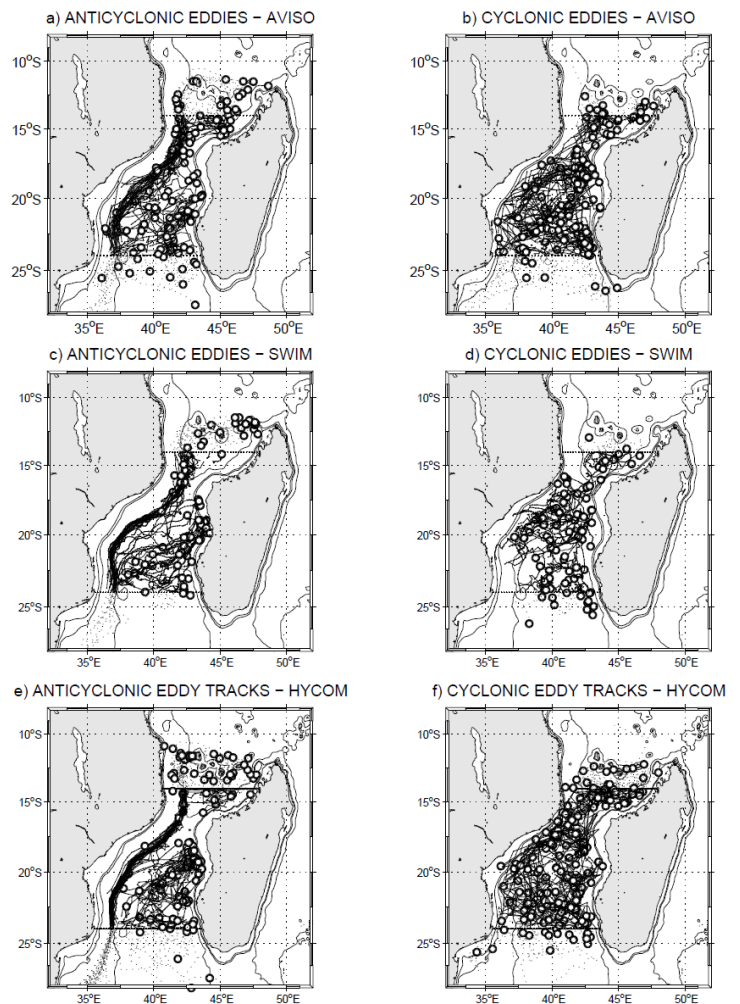


Figure 5. Tracks of eddies over a 7 year period and their formation sites. Left panels (anticyclonic eddies) and right panels (cyclonic eddies). Top for AVISO, middle for South Western Indian Model (ROMS – SWIM) and bottom for HYCOM. Solid black rings indicate the formation site, and the lines show their trajectories. Background contours are the isobaths at 500, 1000, 3000, 5000 m. The horizontal dashed-lines at 14°S and 24°S show the area in which the study was made.

CHARACTERIZATION OF AGULHAS BANK UPWELLING VARIABILITY FROM SATELLITE-DERIVED SEA SURFACE TEMPERATURE AND OCEAN COLOR PRODUCTS

Christo Peter Whittle (UCT and CSIR)

South of Africa, the Agulhas Bank forms a roughly triangular-shaped, broad extension of the continental shelf, ranging from Cape Point in the west to Port Elizabeth 800km in the east. It is a complex oceanic region influenced by coastal upwelling processes typical of the Benguela Upwelling System, as well as shelf-edge dynamic upwelling resulting from the intermittent presence of the Agulhas Current moving onto the shelf with cyclonic flow trapped within current meanders. During summer intermittent easterly winds drive coastal upwelling at several embayments and promontories along the South African southern

coast. On the eastern Agulhas Bank, “divergent upwelling” occurs as the Agulhas Current flows at the edge of a widening continental shelf. A subsurface ridge of cool water, extending along the 100 m isobath, appears to be a quasi-permanent feature of the shelf scale thermal structure along the eastern and central Agulhas Bank during spring and summer. These upwelling processes promote primary production at preferred locations on the Agulhas Bank, which is a spawning ground and nursery area for commercially exploitable fish species. The mesoscale surface signatures associated with these upwelling events are readily observed on satellite derived sea surface temperature (SST) and chlorophyll-a concentration [chl-a] images.

To investigate the seasonal and inter-annual variability of SST and [Chl-a] on the Agulhas Bank, monthly climatologies were produced from the Multi-sensor

Ultrahigh Resolution (MUR) level 4 blended SST dataset and the level 2 MODIS Aqua datasets respectively as shown in Figure 6 and Figure 7). MUR data were sourced from the Physical Oceanography Distributed Active Archive Centre (PODAAC) and MODIS data were sourced from the Ocean Biology Processing Group (OBPG). Strong seasonality is evident for both variables over most of the Agulhas Bank, but neither the distribution of SST or [Chl-a] were spatially uniform. There are clear differences

between the observed variability in coastal zones, the centre of the Agulhas Bank and the shelf edge. The warmest temperatures are found during February on the central Agulhas Bank and coolest temperatures in August. A ridge of cool water is evident from December-April, extending from the coast towards the tip of the Agulhas Bank. Higher [Chl-a] is also associated with this feature, but unlike the SST, the [Chl-a] signal remains fairly constant throughout the year. The shelf edge is influenced by the presence of the Agulhas Current clearly visible as a ribbon of relatively warm, low [Chl-a] water bordering the eastern Agulhas Bank.

There is distinct evidence of northward leakage of warm Agulhas Current water along the western Agulhas Bank shelf edge. These areas also exhibit the highest seasonal range in [Chl-a] with lowest values observed during December to February and highest values evident from August-October. A thin band of high [Chl-a] values closely hugs the South Coast and is most extensive during April-July. The highest values of [Chl-a] are found on the western coastline of the Agulhas Bank peaking during January-April. Relative to the central Agulhas Bank, both the eastern and western shelf edge also exhibit elevated [Chl-a] levels.

OPERATIONAL OCEANOGRAPHY AROUND SOUTH AFRICA

Nicolas Rascle, Marjolaine Krug (CSIR), Jenny Veitch (UCT), Bjorn Backeberg, Matthieu Rouault, Bertrand Chapron (IFREMER)

The objective of this project is to contribute to an operational oceanography system around South Africa, namely an operational data server with the latest observed data, using available operational large-scale model outputs from MERCATOR, and then operationally refining these model outputs (i.e. downscaling with ROMS).

This objective is part of the SimOcean initiative (operational ocean modelling of Southern Africa) and is part of the larger OceanSAfrica initiative (operational ocean modelling, in-situ and remote-

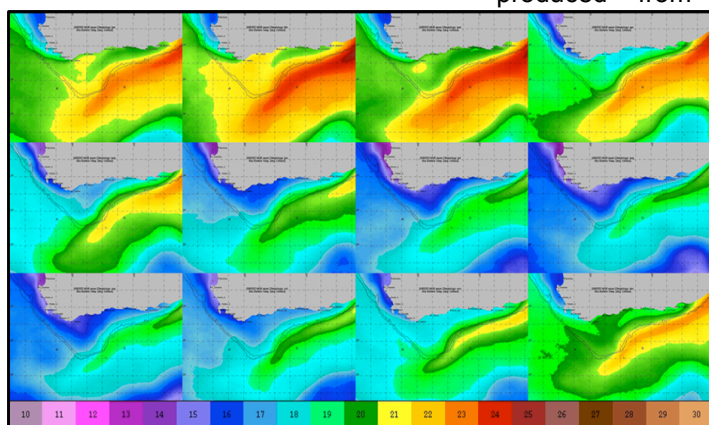


Figure 6: Monthly SST climatology (2003-2011) from GHRSSST MUR online database. The 500m and 1000m isobaths marking the shelf edge are shown as black contour lines.

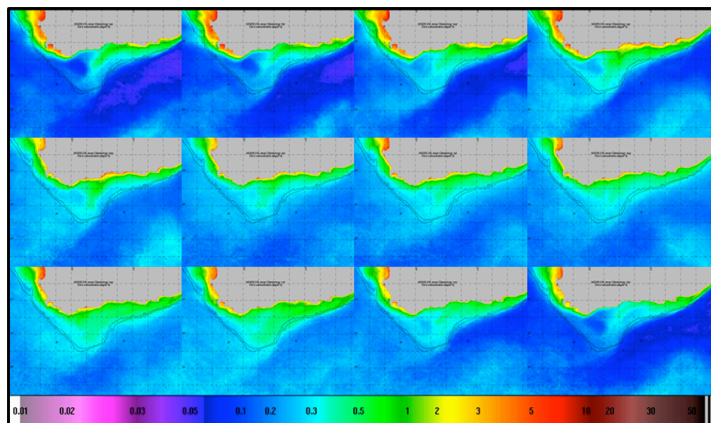


Figure 7: Monthly [Chl-a] climatology (2003-2011) from OBPG online MODIS Aqua database. The 500m and 1000m isobaths marking the shelf edge are shown as black contour lines.

sensing observations, and data dissemination).

Three domains have been defined according to different applications: - The Benguela domain, including “upstream” features from the whole Tropical Atlantic Ocean; - The Indian Ocean and the Mozambique Channel; - The Agulhas/Benguela currents all around South Africa. These domains are displayed in Fig. 8 (top).

user agreement has been signed with Mercator Ocean who provide this information in real-time every Wednesday as a two weekly hind cast and a two week forecast of the Ocean in a domain from 40°W-115°E and from 10°N-50°S. Two data sets are available, PSY3 at 1/4 degree resolution and PSY4 at 1/12 degree resolution. These hind casts and forecasts are then downloaded in real-time to a server in the Nansen-Tutu Centre.

Outputs from the global model PSY3 (1/4 degree resolution) are plotted in real time on the website (see Fig. 8, middle).

In order to begin to assess the usefulness of this data, a reanalysis since 1992 called GLORYS was obtained from Mercator Ocean. This reanalysis has been used to compute a daily climatology of the 17 years and to calculate meaningful anomalies from the climatology.

The anomalies are plotted on the website in real-time (see Fig. 8, bottom). Various special area integrations over the specific coastal domains have been made to provide important and useful indicators.

The existing website <http://realtime.sea.uct.ac.za> has been extended to include an additional domain around South Africa and to plot the raw Mercator data (absolute SST) as well as other products (filtered anomalies) and indicators (time series). In particular, the website has been transferred onto a new computer and rewritten in bash scripts and MATLAB scripts

which are easier to maintain and more suited for future use by students and researchers. This work has been done in collaboration with Marjolaine Rouault, who designed the initial website. Also, the Mercator reanalysis and climatology have been added to the Core Server at UCT, with the necessary documentation and tools to be used by future students and researchers. As an illustrative example, we focus on the Benguela Nino monitoring possibilities offered by such operational system. One useful indicator of a Benguela Nino event is the SST anomaly. Such an anomaly is available from the satellite observations. Our analysis of the Mercator products provides in addition, a two-week forecast of the possible development of the SST anomaly. The date of 30 November 2011 has been chosen as an example, with the SST anomaly for northern coastal Namibia plotted in Fig. 9. This information was produced and displayed online on 30 November 2011 and highlights the cold anomaly observed during the previous 3 weeks. The forecasted change for the following two weeks is also shown. (The SST situation for this time is interpreted as “normal”, with no indication of any previous Benguela Nino, or any change to the SST pattern).

We now focus on the Benguela Nino event, which occurred a few months earlier. The reanalysis for the period since August 2010 clearly shows the Benguela Nino of December 2010 - April 2011 (Fig. 10). Whether the Mercator forecast was able to predict such an event two weeks in advance has not been investigated but could be in the near future, as all the forecasted time series are ready to be analysed at the University of Cape Town.

In addition to a possibility of at least a two-week early warning of the development, it is currently believed that warm Benguela Nino events are often preceded by an anomalous southward coastal transport at 17°S (Rouault et al., 2012, submitted to *Geophysical Research Letters*). The transport has been calculated in the Mercator model outputs and its low-pass filtered anomaly is plotted in Fig. 11. The large anomalous southward transport in October 2010 was indicative two months in

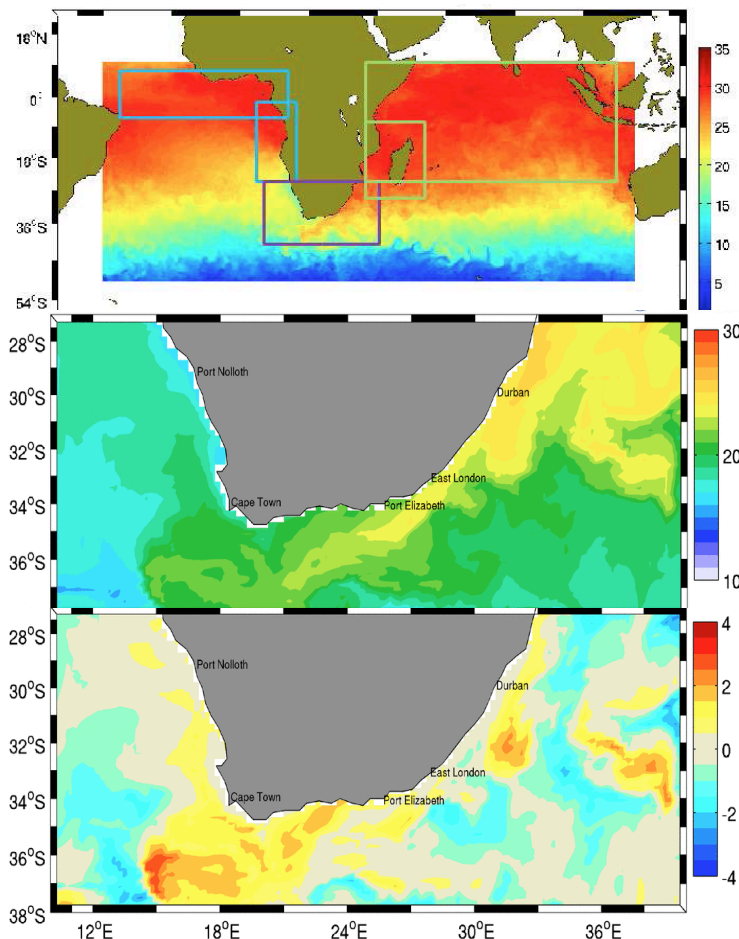


Figure 8. (top) The geographical domains superimposed on the SST field delivered by MERCATOR. (middle) 8 day SST forecast by Mercator on date of 30 November 2011. (bottom) SST anomalies calculated from the 17-year mean. (Image from the website <http://realtime.sea.uct.ac.za>).

The Tropical Rainfall Monitoring Mission (TRMM) SST data were downloaded and plotted in real time for the three domains. The anomalies and time series of the data are then calculated in order to compare them with the large-scale model SST outputs and to evaluate their accuracy for future assimilation in a higher resolution model (ROMS). As a first step for the modelling effort around Southern Africa, which is the main objective of the SimOcean initiative, real-time boundary conditions from a global model have been obtained. Thus a

Fig. 8, bottom). Various special area integrations over the specific coastal domains have been made to provide important and useful indicators.

The existing website <http://realtime.sea.uct.ac.za> has been extended to include an additional domain around South Africa and to plot the raw Mercator data (absolute SST) as well as other products (filtered anomalies) and indicators (time series). In particular, the website has been transferred onto a new computer and rewritten in bash scripts and MATLAB scripts

advance that a Benguela Nino could possibly occur at the end of 2010. The present work strengthens the operational oceanography capacity around South Africa. As highlighted as well, the simple tools (MATLAB and NETCDF) developed for the real-time analysis and dissemination will be easily adapted for other analysis and verifications, possibly by students to help capacity building in operational oceanography at the Nansen-Tutu Centre, University of Cape Town. It should be noted finally that the computer used for the real-time website lost all connection to the Internet in April 2012. A reinstallation and restart of the system on the computer has not been done yet. This emphasizes the need of a minimum of maintenance for the operational system to be able to run in real-time.

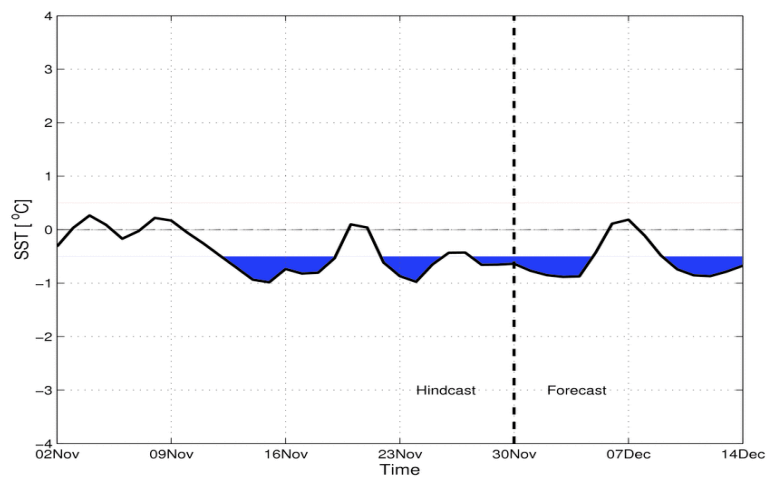


Figure 9. SST anomaly hind cast and forecast for 30 November 2011, for the northern coastal Namibia 19-24°S and within 1° from the shore). Image from the website realtime.sea.uct.ac.za.

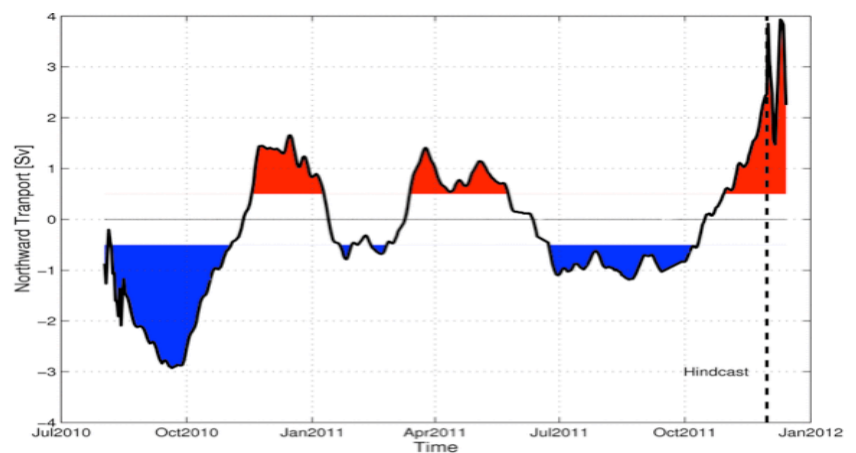


Figure 10. Long time series (since August 2010) of SST anomaly hind cast and forecast on 30 November 2011, for the Northern Namibia coastal domain (19-24°S and within 1° from the shore). Image from the website realtime.sea.uct.ac.za.



Figure 11. Time series (since August 2010) of the anomaly of the coastal transport at 17°S. The transport is integrated in the top 300 m of the ocean and within 2° from the shore). Image from the website realtime.sea.uct.ac.za.

PUBLICATIONS in 2011

REFEREED PAPERS IN INTERNATIONAL JOURNALS

CLIMATE RESEARCH

Cr  tat, J., Richard, Y., Pohl, B., **Rouault, M., Reason, C.** and Fauchereau, N. (2011) Recurrent daily rainfall patterns over South Africa and associated dynamics during the core of the austral summer. *Int. Jnl. of Climatology* doi: 10.1002/joc.2266.

Philippon, N., **M. Rouault**, Y. Richard and A. Favre (2011). The influence of ENSO on winter rainfall in South Africa. *Int. J. Climatol.* doi: 10.1002/joc.3403.

Dufois, F., **Rouault, M.**, (2011) Sea surface temperature in False Bay (South Africa): Towards a better understanding of its seasonal and interannual variability. *Continental Shelf Research*, 43, 24–35.

REMOTE SENSING

Rouault, M. J., and P. Penven (2011), New perspectives on Natal Pulses from satellite observations. *J. Geophys. Res.*, 116, C07013, doi:10.1029/2010JC006866.

Williamson, R., **J. G. Field, F. A. Shillington**, A. Jarre and A. Potgieter (2011). A Bayesian approach for estimating vertical chlorophyll profiles from satellite remote sensing: proof-of-concept. *ICES Journal of Marine Science*, 68 (4), 792–799. doi:10.1093/icesjms/fsq169

REPORTS

Bernard, S. and Smith, M. (2011). An investigation of the potential use of ocean colour remote sensing to assess the influence of variations in freshwater inputs to coastal ecosystems: Phytoplankton and sediment dynamics of the Natal Bight. WRC Report No. 1852/1/10 ISBN: 9781770059818

Rouault, M.; P. Penven and B. Pohl (2011) On the recent warming of the Agulhas current. In: *Observations on environmental change in South Africa*. Eds.; J. Pauw, A. van Jaarsveld, K. Wessels and L. Zietsman, SAEON, Pretoria. ISBN:9781920338244, (p. 268--269)

Lucas, M. and **M. Rouault** (2011). Scorched frozen or flooded! What's happening to the weather? *Quest* 7(1): 38---40

CONFERENCE PROCEEDINGS

Proceedings of the Joint Nansen-Tutu Scientific Opening Symposium & OceansAfrica Meeting, Nansen-Tutu Centre for Marine Environmental Research, Cape Town, South Africa, July 2011.

Welcome by J. Field and O.M. Johannessen and Introduction by B. Backeberg, S. Bernard, F. Shillington and J.A. Johannessen

Penven P., S. Herbette, and **M. Rouault** (2011). Ocean Modelling in the Agulhas Current System. Proceedings of the Joint Nansen-Tutu Scientific Opening Symposium & OceansAfrica Meeting, Nansen-Tutu Centre for Marine Environmental Research, Cape Town, South Africa, July 2011.

Rouault, M. (2011). Ocean atmosphere interactions in and around Southern Africa. Proceedings of the Joint Nansen-Tutu Scientific Opening Symposium & OceansAfrica Meeting, Nansen-Tutu Centre for Marine Environmental Research, Cape Town, South Africa, July 2011.

Penven, P., Herbette, S., and **Rouault, M.** (2011). Ocean modelling in the Agulhas Current System. Proceedings of the Joint Nansen-Tutu Scientific Opening Symposium & OceansAfrica Meeting, Nansen-Tutu Centre for Marine Environmental Research, Cape Town, South Africa, July 2011.

Johannessen, J. A., Chapron, B. and **Backeberg, B.** (2011). New gravity field, mean dynamic topography and surface geostrophic current derived from space. Proceedings of the Joint Nansen-Tutu Scientific Opening Symposium & OceansAfrica Meeting, Nansen-Tutu Centre for Marine Environmental Research, Cape Town, South Africa, July 2011.

Veitch, J. and Backeberg B. (2010). SimOcean: Simulating and forecasting Southern Africa's Ocean. Proceedings of the Joint Nansen-Tutu Scientific Opening Symposium & OceansAfrica Meeting, Nansen-Tutu Centre for Marine Environmental Research, Cape Town, South Africa, July 2011.

Roberts, M., Share, A., Johnson, A., Brundrit, G., Hermes, J., Bornman, T., Anson, I., Stander, J., Voudsen, D., Valentine, H., and Rossouw, M. (2011). The grand challenge of developing in situ observational oceanography in South Africa. Proceedings of the Joint Nansen-Tutu Scientific Opening Symposium & OceansAfrica Meeting, Nansen-Tutu Centre for Marine Environmental Research, Cape Town, South Africa, July 2011.

POPULAR SCIENCE ARTICLES

Backeberg, B., Shillington, F.A. and J. Johannessen (2011). African Operational Oceanography Training Workshop, *SANCOR Newsletter* 196, p 2-3, ISSN 03700-9026.

DOCTORAL DISSERTATION

M. J. Rouault (Awarded 2011) *Agulhas Current variability determined from space: a multi-sensor approach*. Doctoral Thesis, Department of Oceanography, University of Cape Town, South Africa, 2011.

STAFF in 2011

SCIENTISTS

Mathieu Rouault (50%) – Ocean-atmosphere interaction and climate

Frank Shillington (seconded) – Oceanography and remote sensing

Johnny A. Johannessen (seconded) – Oceanography and remote sensing

Chris Reason (seconded) – Climate variability and modelling

Jennifer Veitch (UCT seconded) – Oceanography and modelling

Juliet Hermes (SAEON seconded) – Oceanography and modelling

Stewart Bernard (CSIR seconded) – Remote sensing and ocean optics

POST-DOCTORAL RESEARCH FELLOWS

Bjorn Backeberg (100%) – Oceanography and modelling

Nicolas Rascle (100%) – Operational oceanography

PHD STUDENTS

Christo Whittle (seconded) – Oceanography and remote sensing

Marjolaine Rouault (seconded) – Oceanography and remote sensing

Roy van Ballegooyen (seconded) – Oceanography and modelling

ADMINISTRATION AND TECHNICAL STAFF

Mr. Emlyn Balarin (seconded) – Finances

useful LINKS

SimOcean: Simulating and forecasting southern Africa's ocean

<http://simocean.org.za>

OceanSAfrica

<http://cfoo.co.za/oceansafrica/>
(temporary development link)

Ocean modelling blog

<http://uctoceanmodelling.blogspot.com/>

Marine Remote Sensing Unit

<http://www.afro-sea.org.za/>



Staff and Students that participated in the African Operational Oceanography Workshop, which was co-coordinated and organised with the **Nansen-Tutu for Marine Environmental Research**, EAMNet, ACCESS, and the IRD. The work shop was held at the Department of Oceanography, University of Cape Town from 9 June-1 July 2011



Nansen-Tutu Centre for Marine Environmental Research

Cape Town, South Africa

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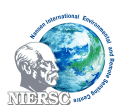
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