



GLOBAL CLIMATE CHANGES



ATMOSPHERIC SCIENCE



OCEANOGRAPHY



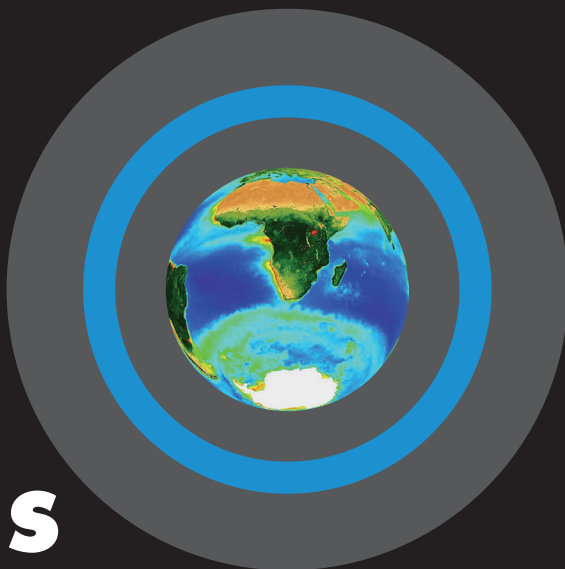
CARBON CYCLE



BIODIVERSITY



ENVIRONMENTAL SECURITY



ACCESS

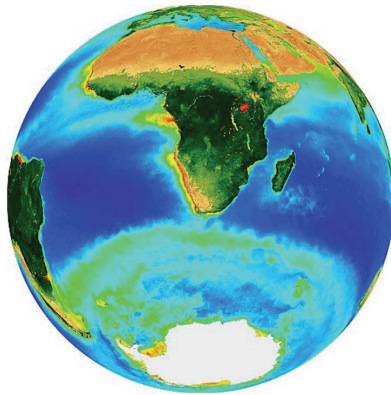
**AFRICA CENTRE FOR CLIMATE
AND EARTH SYSTEM SCIENCE**

INTRODUCTION	3
THE GOALS OF ACCESS	4
SCIENTIFIC RESEARCH PROGRAMME	5
Focus Area A: Seasonal and Inter-annual Climate Fluctuations	
Coastal Oceanography	
Ocean-Atmosphere-Land Interactions	
Focus Area B: Long-Term Climate Changes	8
Regional Climate Changes	
The Fate of Anthropogenic Carbon	
Past Climate Changes	
Focus Area C: Environmental Security	12
Relating scientific knowledge to knowledge	
about the governance of humans	
Engaging poor constituencies and	
seeking ways for beneficial action	
KNOWLEDGE TRANSFER	13
Operational Oceanography	
Seasonal and Inter-annual Climate Predictions	
Regional Global Warming Scenarios	
CAREER ADVANCEMENT	15
Undergraduates at universities	
Post graduate programme, at the master's level	
Post-doctoral Fellows program	
Visiting Scientist Programme	
Ongoing Professional Education	
Public Outreach	
Influencing policy direction through active engagement	
ACCESS GOVERNANCE STRUCTURE	18
COLLABORATING INSTITUTIONS AND AGENCIES	19

INTRODUCTION

Humans, and others species, have flourished on the planet over several thousands of years as a consequence of temperature ranges that have varied within a relatively narrow range. This range has been maintained by complex earth systems. The ability of these systems to maintain these ranges is being threatened as a consequence of human activity, in particular the use of fossil fuels. This use has had, and continues to have, enormously positive effects for the flourishing of human life in ways that has supported core values – for example, improved health and poverty alleviation. Established and emerging fossil use patterns has had and is having serious detrimental consequences that may well if continued threaten human existence (and other life forms).

Finding ways of reducing these effects and enabling human beings to adapt to them will require massive changes in the established behaviours of humans. Achieving this will require relating scientific knowledge to knowledge about the governance of humans.



ACCESS explores this nexus through an “environmental security” focus that studies how this might be done globally, regionally, nationally and locally.

ACCESS facilitates research on how this might best be accomplished within an African context in ways that will support and benefit Africa, as well as the world. The projects within this focus area focus on ways of achieving “earth cooling” and adaptation to “earth warming” that effectively mobilize a very wide gamut of knowledge and capacity in ways that will produce equitable results. An important thrust of this focus is on finding ways to engage poor constituencies (a crucial feature of African populations) while at the same time seeking ways of ensuring that action taken will benefit them.



THE GOALS OF ACCESS

ACCESS (African Centre for Climate and Earth System Science) takes advantage of ongoing activities in the earth sciences in Africa by building on, coordinating closely with, and complementing those activities. The focus is on climate related phenomena that range from the transient fluctuations in conditions on land and in the adjacent oceans, to future climate changes associated with global warming.

It will achieve these goals by means of the following activities:

RESEARCH has as its goal the prediction of changing climatic conditions on time-scales from seasons to decades. This will require measurement programmes using tools such as ships and satellites, the continuous monitoring of key environmental conditions, and the use of computer models to simulate conditions in the ocean, atmosphere and land.

KNOWLEDGE TRANSFER, to the public, business community, and government officials, concerns a variety of regional and global environmental problems, for the purpose of improved management of coastal zones, fisheries, shipping, agriculture, energy, water use, etc.

CAREER ADVANCEMENT includes efforts to make the public at large, students in high schools, and undergraduates at universities aware of exciting developments and opportunities in the earth sciences. ACCESS therefore participates in the development of e-courses, documentaries etc. However, the core of ACCESS is a post-graduate degree in earth system science. This is integrated with the research projects by involving, in the mentoring and tutoring of students, local and foreign scientists and post-doctoral fellows.



RESEARCH PROGRAMME

Forecasts of changes in weather patterns over the next few days have reached a high level of skill, but predictions of fluctuations in climatic conditions over the next several months, and of global climate changes over the next several decades are in their infancy.

The ACCESS research programme, which has as a goal the improvement of climate forecasts, focuses on a better understanding of the interactions between the atmosphere, land and oceans that determine climate, and especially on the role of the oceans in those interactions. Of special interest is the development of an operational oceanographic capability for coastal zones, one that will permit the sounding of timely alerts of the onset of unusual coastal conditions. To test the validity of theories for and models of climate changes over periods of decades and more, geological records of the different climates in Earth's distant past – the recurrent Ice Ages for example – are invaluable. The ACCESS research programme therefore includes the study of paleo-climates.

The projects described below concern mainly phenomena in southern Africa and the surrounding oceans. These are the initial foci of ACCESS which, in due course, will expand to include phenomena in other parts of Africa, the Atlantic and Indian Oceans.



SEASONAL AND INTERANNUAL CLIMATE FLUCTUATIONS

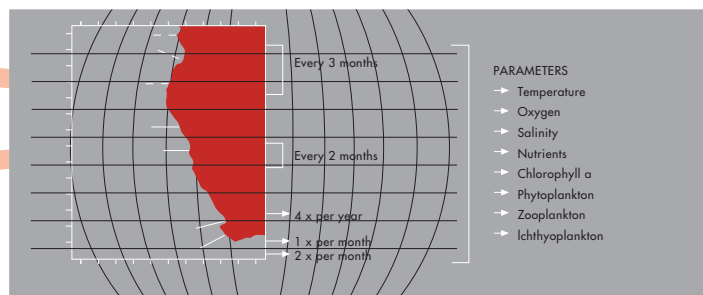
Benguela Niños, the Atlantic counterparts of El Niño in the Pacific Ocean, are associated with the appearance of exceptionally warm water and heavy rains along the south-western coast of Africa. These are examples of climate fluctuations that include prolonged droughts and severe floods, all of which can have a huge impact on agriculture, fisheries, tourism and other aspects of the economy. A major step towards the prediction of such fluctuations, is the initiation of operational oceanography, for coastal zones at least.

COASTAL OCEANOGRAPHY

The west coast of southern Africa, a rich fishing ground and one of our planet's most productive upwelling zones, is prone to abnormal events that affect not only the living marine resources, but also offshore activities such as mining or gas exploration. Examples of unusual events include the intrusion of low oxygen waters from the tropics, and the occurrence of Benguela Niño. The strikingly different conditions along the eastern coast of southern Africa – surface waters are much warmer, marine life is very different – are also subject to variability, associated with changes in the warm Agulhas Current.

The simulation by means of computer models, and monitoring of the constantly changing coastal conditions, build on existing efforts which include measurements of physical, chemical and biological parameters by means of ships, satellites and unattended, instrumented moorings.

THE MONITORING OF CONDITIONS OFF SOUTHWESTERN AFRICA

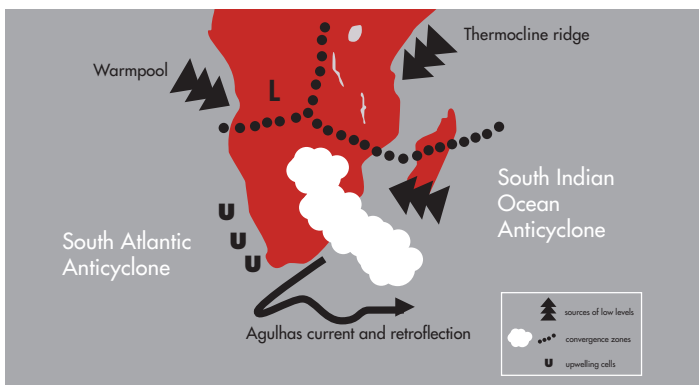


The Benguela Current Large Marine Ecosystem project initiated the regular monitoring of temperature, oxygen chlorophyll and other oceanic parameters along the indicated sections.

Because coastal phenomena have small spatial scales, computer models of two types are necessary: limited region, coastal models with very high resolution and open boundary conditions; and a relatively coarse resolution global model that provides boundary conditions for the regional model. The High Performance Computing Centre (of the Council for Scientific and Industrial Research (CSIR)) in Cape Town provides the necessary resources. The regional model is flexible and can be configured for any coastal zones (of other African or South American countries for example) by merely changing parameters such as the coastal geometry. The global model serves several purposes, those of coastal oceanographers, of climate modellers studying seasonal and inter-annual fluctuations, and of bio-geochemists exploring large scale features of the Atlantic and Indian Oceans and the Antarctic Circumpolar Current.

OCEAN-ATMOSPHERE-LAND INTERACTIONS

Africa's great diversity of climatic zones are all connected, to each other and to zones elsewhere on the planet, by the global atmospheric circulation. Southern Africa, in particular, is impacted by changes in the Atlantic, Indian and Southern Oceans, and also by El Niño and La Niña episodes in the tropical Pacific. The impact varies from region to region in the topography, vegetation, and proximity to the ocean. How do these features affect the onset and characteristics of the main rainy season and of wet and dry spells within it? What aspects of the non-local forcing contribute to extreme events and changes in the frequency and intensity of these events? These are some of the questions being addressed by means of models that simulate regional ocean-atmosphere-land interactions over a spectrum of spatial and temporal scales.



Features important during the summer rainy season – after Reason et al. (2006)

LONG-TERM CLIMATE CHANGES

REGIONAL CLIMATE CHANGES

As the atmospheric concentration of carbon dioxide continues to rise over the next several decades, how will the climate change? The international scientific community makes such information available on a global scale, but not regionally. To make societal forecast scenarios meaningful and to implement effective adaptation strategies therefore requires regional projections by means of a “downscaling” approach that use both dynamical and statistical methods.

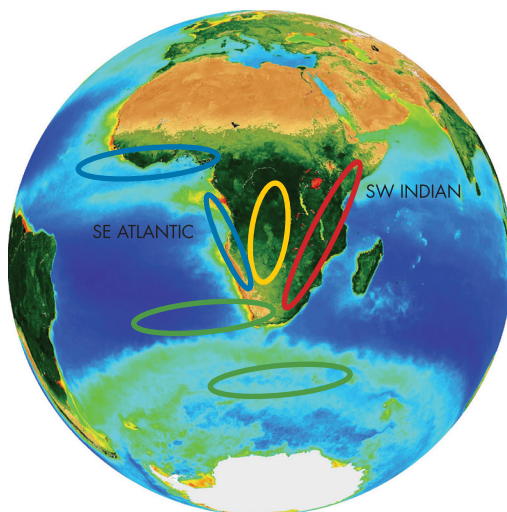
One of the primary tasks of the ACCESS research program is to provide multi-model probabilistic climate change projections on the basis of methodological approaches that are tailored to specific stakeholders. This requires:

- the generation and acquisition of multi-model ensemble simulation data for past and future climate;
- the nesting of regional climate models to generate high resolution scenarios; and
- the processing of scenario data in relation to sector-relevant parameters, including extreme events.



THE FATE OF ANTHROPOGENIC CARBON

Of the carbon that we inject into the atmosphere by burning fossil fuels, how much will remain in the atmosphere? The complex bio-geochemical processes that hold the answer to this question are of special interest in southern Africa and its surrounding oceans..



The **terrestrial domain** covers a wide range of regions from wet equatorial forests, to savannah, grasslands, semi arid Karoo and arid Namib environments;

The **South East Atlantic** encompasses the eastern equatorial system and the wider Benguela upwelling system where cold, nutrient-rich water rise to the surface;

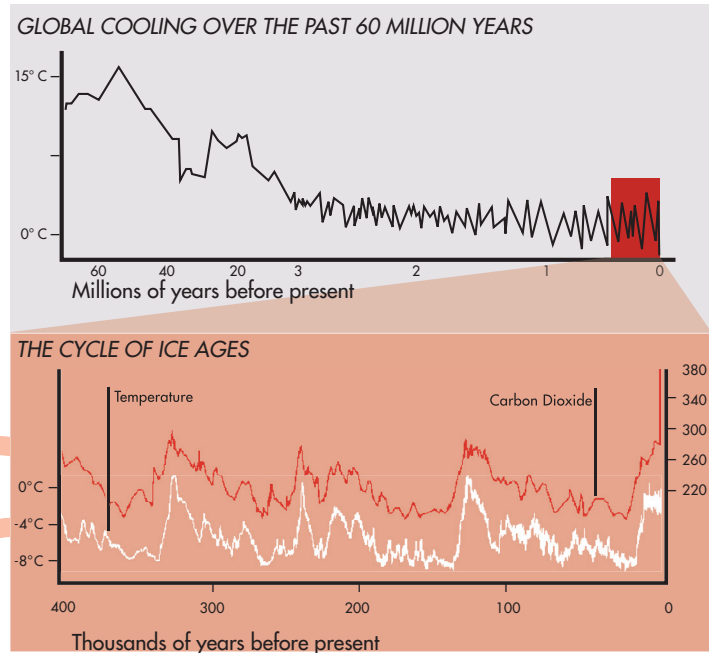
The **South Atlantic Zone and Southern Ocean**, which are characterized by the sub-tropical convergence zone and by energetic oceanic meso-scale eddies, pose the major puzzle of being rich in nutrients but low in chlorophyll concentration.

In the **South West Indian Ocean** which is the “inverse” of the SE Atlantic Ocean, productivity in the coastal zone depends, not on oceanic upwelling, but instead on terrestrial sources in the form of river flows which govern salinities and nutrients, both dissolved and particulate. The unique character of this part of ocean basin is that its biogeochemical characteristics are also sensitive to human activities that change river flow, nutrient fluxes and sediment loads.



PAST CLIMATE CHANGES

The present is a precarious moment in the eventful history of our planet. This is evident in the geological records that portray global climate changes since the sudden demise of the dinosaurs, some sixty million years. At that time the Earth was far hotter than it is today, but processes associated with the drifting of continents then caused gradual global cooling, leading to appearance of glaciers on northern continents around three million years ago. At that stage our planet's response to Milankovitch forcing – modest, periodic fluctuations in the distribution of sunlight – started amplifying, growing into dramatic oscillations between prolonged Ice Ages and brief interglacial periods. The present happens to be one of those temperate interglacial periods which, if the geological record is a guide, will end any millennium now with us sliding back into an Ice Age. That inference disregards the sharp, man-induced increase in the atmospheric concentration of carbon dioxide over the past century.



The geological record raises the possibility that the current increase in the atmospheric concentration of carbon dioxide will restore the warm world of three million years ago when the contrasts between the eastern and western coasts of southern Africa were minimal. It can also shed light on the evolution of hominids and, subsequently of Homo sapiens. These are some of the reasons why the ACCESS research programme includes studies of the Milankovitch Cycles which provide stringent tests for climate models, and which are recorded in the deserts of southern Africa; of atmospheric CO₂ drawdown into the oceans during glacial phases, especially in the Southern Ocean; of the assimilative and adaptive capacity of ecosystems during periods of very different climates in the past; and of the magnitude and frequency of extreme events in the distant past.



ENVIRONMENTAL SECURITY

Humans, and others species, have flourished on the planet over several thousands of years as a consequence of temperature ranges that have varied within a relatively narrow range. This range has been maintained by complex earth systems. The ability of these systems to maintain these ranges is being threatened as a consequence of human activity, in particular the use of fossil fuels. This use has had, and continues to have, enormously positive effects for the flourishing of human life in ways that has supported core values – for example, improved health and poverty alleviation. Established and emerging fossil use patterns has had and is having serious detrimental consequences that may well if continued threaten human existence (and other life forms).

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KNOWLEDGE TRANSFER

The primary role of the knowledge transfer activity in ACCESS is to turn scientific findings into knowledge that benefits society. Its effectiveness is measured through the impact on policy adjustment, adaptation strategies and in building societal resilience to global warming. Knowledge transfer is achieved through a dedicated programme directed to develop long-term dialogue with stakeholders. This builds on the experience of international partners.

OPERATIONAL OCEANOGRAPHY

In the same way that the daily weather forecast is of enormous value to many people, so routine descriptions of anticipated conditions in coastal waters over the next several days will be of immense value to those who are involved in fisheries, shipping, tourism and the management of coastal zones in general.

ACCESS is developing the tools necessary for this service and will initiate operational oceanography on a trial basis for the coastal zones of southern Africa. The long-term plan is to transfer this capability (computer models etc.) to agencies, such as weather services, that have the infrastructure and that are experienced in providing the public with operational services.

SEASONAL AND INTER-ANNUAL CLIMATE PREDICTIONS

Several weather services have already extended the range of their forecasts to include predictions of changes in climatic conditions several months hence. These long-term forecasts usually assume that the changes in sea surface temperature patterns will be in accord with the usual seasonal cycle. In reality, sea surface temperature patterns can change radically from one summer (or winter) to the next. To take that important factor into account requires the operational oceanographic activities mentioned above, and the use of coupled ocean-atmosphere-land models. Hence the research programme of ACCESS has as one of its goals improvements in the accuracy of predictions of climate fluctuations with which are associated phenomena such as prolonged droughts and severe floods.



REGIONAL GLOBAL WARMING SCENARIOS

A national response to climate changes associated with global warming, including policy development and adaptation, is predicated on the availability of contextualized climate projections. The development of such information is a process that requires climate modelling in both dynamic and statistical forms. The regional projections thus developed then need to be tailored to the needs of stakeholders. This activity is under way and the results are communicated to stakeholders through regular workshops, seminars, and web-based dissemination of projections. Their use includes the briefing of those who participate in climate change negotiation forums. The research programme of ACCESS will lead to a reduction in the uncertainties of these forecasts.



CAREER ADVANCEMENT

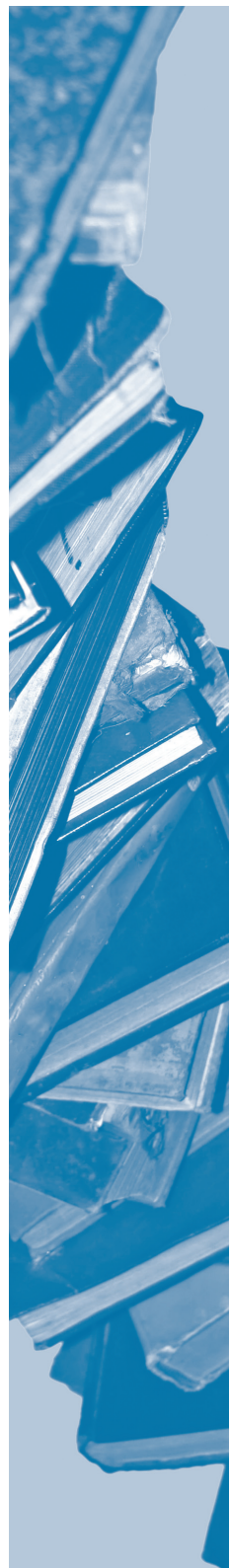
The training of young scientists in “Earth System Science” is one of the highest priorities of ACCESS. The main goal, producing the future scientific leaders for universities, government agencies, etc., requires efforts at several levels, ranging from communicating to high schools and the public at large, to the training of post-doctoral fellows and ongoing education of practising professionals.

Producing more scientists requires an increase in the number of people involved in the teaching and mentoring of students and post-doctoral fellows. This means that prominent foreign scientists need to be attracted to southern Africa. Given the demands on such people, this would be difficult if it were not for the exceptional research opportunities that southern Africa offers to earth scientists. Hence the ACCESS research programme is an integral part of its educational programme. The senior scientists and post-doctoral fellows who visit regularly for extended periods to participate in research also teach modules in larger courses, mentoring students at the graduate and undergraduate levels. They also are encouraged to participate in public lecture series and the production of online short- and full course modules.

ACCESS seeks to bring the best minds in the world in climate and earth system and governance and regulatory science to Africa and directly into African class rooms. A particular emphasis is the development of digitally-based courses that are used within African learning environments. A corollary of this is the transfer of knowledge and capacity from Africa to other parts of the world

UNDERGRADUATES AT UNIVERSITIES

Research in earth systems science requires rigorous training in the basic sciences, mathematics, physics and chemistry. The students studying those subjects often are unaware that their skills can be applied in a field such as the earth system science. As a consequence there is a need for courses that introduce them to this new inter-disciplinary field, courses that give them an overview of the phenomena to be studied and explained. ACCESS participates in the development of such courses which are made available to all aligned universities in Africa.



A POST-GRADUATE MASTERS PROGRAMME

A core of the ACCESS educational programme is the postgraduate programme, which offers courses to students with a strong background in mathematics, physics, and chemistry, in topics such as:

- (i) Weather, Climate, and Land-Ocean-Atmosphere Interactions
- (ii) Biogeochemical Cycles (of carbon, nitrogen, oxygen, rocks...)
- (iii) Dynamics of marine and terrestrial ecosystems
- (iv) The History of Planet Earth
- (v) Numerical (computer) Modelling
- (vi) Mathematical and Statistical Methods for Data Analyses
- (vii) Environmental Security

Topics (v) and (vi) introduce students to the numerical (computer) modelling of complex systems, and also to statistical methods for the analyses of large data sets. These powerful tools are widely used, not only in the environmental sciences, but also in business and industry. Hence all students will be provided with an education that is well-grounded in basics, and that is sufficiently wide in scope, to ensure flexibility for continuing growth should they choose to pursue careers outside academia, in business for example.

Topic (vii) specifically relates scientific knowledge to knowledge about the governance of humans. It establishes the link between climate change adaptation and the need for ensuring sustainable livelihoods in specifically developing nations.

Although ACCESS has as a focus on the development and use of computer models of the Earth system, it is essential that students, as part of their education, participate in measurement programmes and field trips. The richly varied landscape of southern Africa, and the numerous oceanographic vessels that use Cape Town as a port, are therefore major assets of ACCESS.

This programme is offered jointly with several existing institutions of higher learning each of which has strengths in some of the topics listed above. In effect, ACCESS is the vehicle that enables several academic institutions, jointly, to offer this programme in Earth System Science.

Students register formally at one of the existing institutions of higher learning, chosen on the basis of the specialty that a student has chosen (e.g. oceanography, numerical methods etc.)

POST-DOCTORAL FELLOWS PROGRAM

Post-doctoral fellows, in addition to engaging in research, participate in the mentoring and tutoring of students, at the undergraduate and post-graduate level.

VISITING SCIENTIST PROGRAMME

The post-doctoral fellows themselves need mentoring in their research projects for example. To augment the body of scientists available for this purpose, foreign scientists are attracted, mainly to participate in research projects, but also to mentor post-doctoral fellows and students who have opportunities to visit the home institutions of these scientists. The programme allows for a number of experts in sub-disciplines to undertake a sabbatical of 6 to 9 months in South Africa.

ONGOING PROFESSIONAL EDUCATION

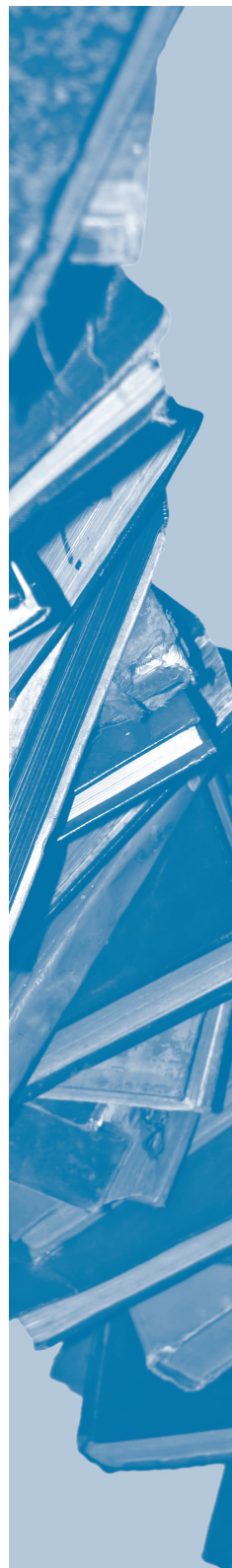
Knowledge advances at a remarkable pace and there is a need to establish mechanisms to facilitate the ongoing education of practising professionals throughout Africa. Providing decision influencers and decision takers with the latest information and knowledge through a series of short courses, seminars and self-teach online courses will elevate the level of understanding and influence more informed decisions.

PUBLIC OUTREACH

The spectacular landscape of southern Africa lends itself to the documentary films that introduce laymen to the earth sciences and the connections between its different branches. Increasing public realization that we not only inhabit an exceptional planet, the only one known to be blessed with a glorious diversity of life-forms, but do so at a precarious moment in its eventful history, can only increase everyone's awareness of our responsibilities as stewards of planet Earth.

INFLUENCING POLICY DIRECTION THROUGH ACTIVE ENGAGEMENT

The use of educational materials such as documentaries is complemented by "engagement forums" that seek to engage lay constituencies in considering how they can contribute to "earth cooling" and adaptation to "earth warming". An important focus is to provide avenues whereby these voices can be heard with respect to policy direction.



ACCESS GOVERNANCE STRUCTURE

ACCESS is constituted via a Memorandum of Agreement amongst the collaborating institutions that sets out the way it functions and coordinates activities. The document defines the following:

GOVERNANCE BOARD (GB)

This establishes ACCESS as an international not-for-profit centre.

The GB receives and discusses scientific programmes and business plans presented from time to time by the ACCESS Director. It meets at least annually to review and evaluate progress towards the fulfilment of ACCESS's declared mission. The Board has overall responsibility for the annual budget presented by the ACCESS Research Director, who acts as the responsible chief financial officer of the Board. Terms of reference for the Research Director include a requirement for distinguished leadership in research in fields relevant to the objectives of ACCESS.

SCIENTIFIC ADVISORY COMMITTEE (SAC)

The Director is advised by a SAC on research and funding proposals. The functions of the SAC are advisory to the Governing Board and the Research Director, evaluating and prioritization of specific proposals for research projects as well as providing more general advice to the Director and the Governance Board on particular directions for ACCESS's research activities. The SAC consists of a number of national and international scientists.

EDUCATIONAL ADVISORY COMMITTEE (EAC)

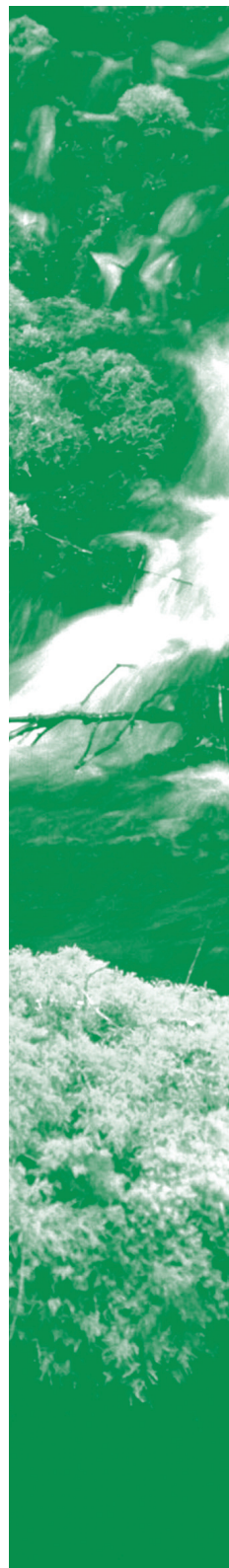
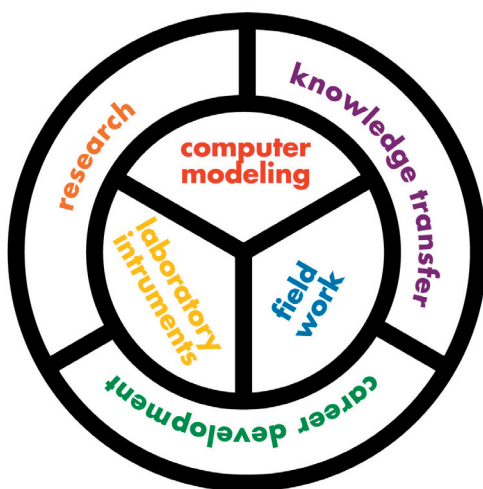
The Research Director is advised by an EAC on aspects related to the Research Career Development component of the Centre. The EAC consists of a number of national and international educational specialists.



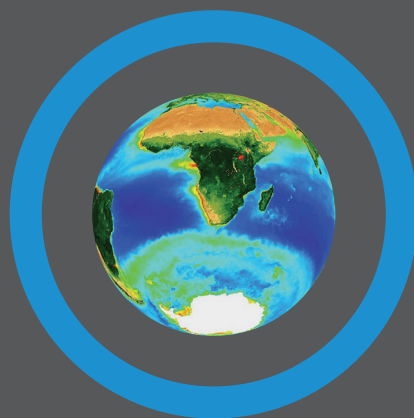
COLLABORATING INSTITUTIONS AND AGENCIES

To achieve the goals of ACCESS in research, career development and knowledge transfer requires the sharing, with other projects and institutions, of research staff (through secondment), facilities such as computers and computer codes, laboratory instruments, and equipment for field work, including ships and satellites. Discussions with potential partners are ongoing and a number of cooperation agreements have been established.

The objective is to make ACCESS a centre of excellence in earth system science for all Africans.



ACCESS



participants:



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA



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