Dear SASSCAL colleagues,

spring is definitely upon us in the Southern African Region, bringing with it the promise of new beginnings. In that light, SASSCAL can report on a lot of exciting activities, including on the progress made with drafting the SASSCAL 2.0 Strategy. It has generally been a successful period for SASSCAL. In particular, we want to congratulate Dr. Vera De Cauwer, who successfully defended her PhD in Belgium during September, and another scientist, Josefina Hamutoko, for winning the NCRST National Research, Science, Technology and Innovation Award for Young Scientist of the Year.

We are also proud to publish an article by Dr. Nicky Knox from NUST who reports on the NASA ORACLES project, that has recently had the Namibian media excited.

The SASSCAL Editorial Team

SASSCAL Management Team compiles a first draft of the SASSCAL 2.0 Strategy

The Management Team of SASSCAL, consisting of the Acting Executive Director, the 3 Directors of the Regional Secretariat and the 5 National Directors representing the African member countries, met in Windhoek during late September, 2016, to draft the SASSCAL Strategy 2.0 for submission to the Governing Board.

Inputs for the Strategy were collected during national and regional workshops that were conducted during late 2015 and in 2016 (refer to a report on the Regional Science Workshop in the 2nd edition of the SASSCAL News, and on the Capacity Development and Services Brokerage Workshops in the current issue). The document will be scrutinized and debated by the Board in Windhoek on 20 and 21 October 2016 during a joint workshop with the Management Team. Once amendments and improvements have been incorporated, the Strategy will be finalized for submission to the Council of Ministers in early November 2016. It is expected that the Council of Ministers will sign-off the SASSCAL 2.0 Strategy during their inaugural meeting to be held on 24 November 2016 in Windhoek.

The Governing Board decided in 2015 that a new 5-year regional strategy should guide SASSCAL’s direction in terms of future funding, long-term sustainability and institutional transformation. The strategy needs to follow a bottom-up approach in setting the new regional knowledge agenda and has to be based on national concerns that were refined into regional priorities.

A value chain approach has been followed in developing the SASSCAL 2.0 Strategy and in determining the three pillars of SASSCAL, namely research management, service brokerage and capacity development.

Building on the achievements of the first phase of SASSCAL, the new Strategy focuses more on regional relevance and demand-driven efforts to produce useful services and capacities to address climate change, land use management and other human-environment problems.

In this way, the SASSCAL 2.0 Strategy will ensure that SASSCAL’s interventions are for the benefit of those people most vulnerable to the effects of climate change and unsustainable and destructive land management practices.

by Yonah Seleti
SASSCAL Acting Executive Director
SASSCAL Regional Workshops on Capacity Development and Services Brokerage

Following the successful hosting of the Regional Science Workshop in June 2016 (refer to the June-July 2016 edition of SASSCAL News, Volume 1 Issue 2), regional workshops on Capacity Development and on Services Brokerage were conducted in August, with the aim of providing input on the remaining two operational areas into the compilation of the SASSCAL 2.0 Strategy.

by Christoph Schumann
SASSCAL Director for Fundraising and Marketing

Capacity Development

One of the major challenges facing the SADC region is the lack of sufficient human resources and institutional capacity to conduct research in climate variability and land-use dynamics in order to inform climate change mitigation and adaptation strategies. The region still depends largely on information generated by collaborative research efforts and/or scientists from developed countries. A comprehensive capacity development strategy needs to be compiled so that a critical mass of expertise can be nurtured that is crucial for the region to better understand climate and land-use changes, and to be able to inform and implement mitigation and adaptation strategies.

During the preparatory deliberations for the regional science workshop, a number of capacity development needs were identified by workshop participants. The challenge is to develop an approach to capacity development that allows SASSCAL to address the concerns raised both meaningfully and sustainably.

Ten invited experts, representing academic and research networks and institutions of higher education, and 10 SASSCAL officials participated in the workshop that was conducted in Pretoria, South Africa, on the 18th and 19th of August 2016 in the form of plenary and break-away group discussions. A presentation was made by the Programme and Network Coordinator, Botha Kruger, on behalf of the Southern African Regional Universities Association (SARUZA). The presentation illustrated the way networks are being formed, managed and utilised to the benefit of its members.

Dr Yonah Seleti continued by providing a roadmap for capacity development that provided the guiding principles that eventually shaped the output from the workshop. According to Dr Seleti, the process of implementing a knowledge value chain starts by setting the agenda (knowledge governance), followed by the process of directing and administering the knowledge for the benefit of society (knowledge management). Scientists and scholars will produce data (knowledge generation) utilising a network of stakeholders and engaging in mutually beneficial partnerships (networks and partnerships). The knowledge gained will be translated into products and services (knowledge brokerage) and eventually transferred to and made use of by the decision- and policy-makers (knowledge utilisation).

The objective of the workshop was two-fold: firstly, to identify internal capacity development needs within SASSCAL that will ensure full functionality, and, secondly, to identify external capacity building needs among SASSCAL stakeholders that will facilitate the establishment of a full value chain.

The workshop participants agreed on the following interventions needed to help close capacity gaps: the establishment of graduate programmes and centres of excellence; the founding of graduate scholarship programmes, research chairs, post-doctorate programmes; participation in conferences and exchange programmes; networking; and the establishment of platforms for citizen science initiatives. Most importantly, SASSCAL was urged to favourably consider the establishment of a Competence Centre that will provide a broad umbrella for the Open Access Data Centre (OADC).

Service Brokerage

The overarching objective of SASSCAL’s service delivery component is to provide an appropriate range of information, data and knowledge-based services and products to a broad range of users and practitioners, including research institutions, government departments and agencies, tertiary institutions, service providers, communities, non-governmental organizations (NGOs) and extension services. These services and products will include short courses, policy briefs and advice, more comprehensive data bases (baseline information) as well as integrated, improved and strengthened institutional cooperation and support in the region. The development of these services and products will depend on the ongoing demand as articulated by users and practitioners.

Currently, SASSCAL focuses on the compilation of research data for the five thematic areas of food and water insecurity, declining and threatened biodiversity, reliable climate data at geographic and temporal scale, and the degradation of forest resources and eco-systems services. The data is used to document global change and, in particular, change in relation to climatic conditions. SASSCAL makes this data available through its OADC and interprets the datasets for decision makers. The Centre will support research to help understand the observed trends and put these into perspective, as well as guide research tasks so that appropriate datasets can be compiled.

A number of invited experts, representing academic and research networks as well as institutions of higher education, and SASSCAL officials participated in the workshop that was conducted in Pretoria, South Africa, on the 17th and 18th of August 2016 in the form of plenary and break-away group discussions and presentations.

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Dr Yonah Seleti delivered an introductory statement, while Dr Jörg Helmschrot, Director of Science and Technology / Capacity Development, Erik Voges, Systems Engineer at the OADC, and Farai Marumbwa, a Theme Expert of MESA (Monitoring for Environment and Security in Africa), provided background and topical presentations.

Dr Seleti highlighted the fact that the framework of research management, capacity building and services constitute the key elements of the SASSCAL 2.0 package. He stressed that in developing a strategy for service brokerage, the value chain approach will be followed. This entails that, firstly, an attempt has to be made to define what type of science services will be provided under SASSCAL 2.0. Secondly, it must be understood that SASSCAL will not be a service provider but rather a broker of the science services available within the member countries. Before this can be accomplished, the interface with the national systems of innovation has to be assessed so that research programmes can be transformed into user-defined knowledge products. Throughout the process, all stakeholders in the value chain must be represented as the value chain begins with the demands of the users who must regard themselves as owners of the process.

The services that could be provided by SASSCAL include utilising remote sensing data to collect baseline data and identify land-use options, data aggregation utilisation in dashboards and mapping services; collaboration with national and regional disaster management units by providing early warning services; providing platforms for citizen science for collecting data on rainfall, biomass, wildlife, recording indigenous knowledge, etc.; maintain and manage observation networks (e.g. biodiversity observatories and Automatic Weather Stations); knowledge brokering/management (facilitate the sharing, transfer and management of knowledge); research management by coordinating research tasks (e.g. for the BMBF); advice on the establishment of scientific infrastructure; baseline information for researchers and planners on infrastructure, biodiversity, climate, land cover, etc.; and the provision of decision support tools to policymakers and planners in the form of maps, dashboards and forecasting models.
SASSCAL’s University of Hamburg Team

The SASSCAL team of the University of Hamburg (UHH) is based at the Biocenter Klein Flottbek and Botanical Garden in Hamburg, Germany.

by the University of Hamburg Team

The main tasks of the UHH team are to support and monitor the scientific performance of the first research portfolio in SASSCAL.

The members of the team are Prof. Dr. Norbert Jürgens (Scientific Coordinator), Dr. Manfred Finckh, Dr. Ingo Homburg, Dr. Kristin Krewenka, Monika Petersen, Dr. Ute Schmiedel and the SASSCAL IT-UHH team, consisting of Dr. Gerhard Muche, Thomas Hillmann and Katrin Josenhans.

In all of the above roles, the UHH team is supporting the SASSCAL Regional Secretariat based in Windhoek. This support encompasses scientific and technical assistance for the scientists working within SASSCAL as well as supporting networking between the many research and capacity development tasks and their institutions. Furthermore, the team provides logistic and scientific input at technical meetings, and finally the conceptual development and planning of scientific workshops and meetings related to SASSCAL.

Together with the Regional Secretariat and the National Nodes, the UHH team also coordinates the extensive reporting and feedback to the main donor of SASSCAL (German Federal Ministry of Education and Research, BMBF).

During the remaining twelve months of SASSCAL’s first research portfolio until October 2017, the team UHH will focus on its coordinating role for the research network of the first SASSCAL research portfolio. This includes support and scientific supervision of research tasks, whenever requested by the partners. In addition, several workshops are planned that will bring together partners from different countries contributing to the same topic.

The SASSCAL IT-UHH team develops and supervises various websites, web-tools and databases for environmental and biodiversity research within the structure of the SASSCAL’s Open Access Data Centre (OADC) in Windhoek.

Major products and services are:

- the data portal of the SASSCAL WeatherNet with 141 automatic weather stations in five SASSCAL-countries (featured in May 2016, Volume 1, Issue 1 SASSCAL Newsletter)

  www.sasscalweathernet.org

- the database-tool (available for download) BIOTABase for recording and analyzing vegetation data from the SASSCAL biodiversity observatories and the vegetation mapping initiatives

  continued on next page...
• the emerging website presenting Biodiversity Observatories continued on next page...

www.sasscalobservationnet.org

• the Photo Guide to Plants of Southern Africa

www.southernafriicanplants.net

that supports scientists and students with respect to the identification of plant species, based on a systematic presentation of photos and information of Southern African plant species. This makes the Photo Guide an information tool that is used by many researchers for the identification of plants in the Southern African region.

The UHH team also coordinates the German teams of scientists, who are involved in SASSCAL tasks.

As one final output during the next year the UHH team will work on assembling a SASSCAL publication that compiles the scientific results of the research tasks of the first research portfolio.

Some SASSCAL Research Portfolio Fact Sheets from German Tasks 008, 018 and 037

From top to bottom: Katrin Josenhans and Thomas Hillmann, during a recent visit in Namibia
The SASSCAL Acting Executive Director (ED), Dr. Yonah Seleti, visited Zambia on a two day mission to conduct meetings with various stakeholders. The visit took place between the 21st and 22nd September, 2016.

The ED’s visit started with a meeting with SASSCAL Zambia staff where he gave an indication of the roles and responsibilities of each member of staff, spelt out the new vision of SASSCAL going forward as well as the work being done towards the development of a strategy for 2017-2020 to be presented at the Ministerial conference on 24th November, 2016.

The ED also took time to meet with the management of the National Executing Agency (NEA) with whom he discussed possible future collaboration on capacity development issues and harvesting of research results because of the institution’s strengths in that area. The NEA team together with SASSCAL staff later visited the site where the SASSCAL Zambia offices will be constructed.

In an effort to seek the involvement of users in the development of SASSCAL products and services that will be user-driven, the ED held a meeting with various stakeholders affiliated with SASSCAL to seek their involvement. The stakeholders were pleased with the update and committed themselves to making an input into the SASSCAL strategy and keeping avenues for collaboration open.

On his second day, Dr. Seleti met with SASSCAL Zambia Principal Investigators (PIs). In his message, he provided the background on some of the Board resolutions on the new thrust of SASSCAL. He indicated that research has progressed successfully but nothing much has been achieved on the provision of products and services and capacity development beyond training of Masters and PhD students. This, he indicated, is being seriously considered as part of the process of development of SASSCAL as an international organisation. This will be characterised by a shift in strategy of SASSCAL to capacity building and provision of services some of which can be paid for by beneficiaries. He further emphasised the need for regionality and transdisciplinarity in research tasks in Phase II of SASSCAL.

The ED further stressed the need to institutionalise capacity development for sustainability purposes so that more people can benefit.

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The ED’s visit ended with a series of meetings with officials of the Ministry of Higher Education (MoHE) and with stakeholders involved in the SASSCAL National Node construction programme preparations. The MoHE senior officials’ meeting was chaired by the Acting Permanent Secretary, Mr. David Ndupu. Dr. Seleti thanked everyone for the warm welcome to the Ministry and said his main task in the meeting was to mobilise commitment by Government to SASSCAL Phase 2.0.

The Acting Permanent Secretary appreciated the efforts of the Executive Director and everyone present at the meeting and assured the ED of Government’s commitment to the SASSCAL agenda. He indicated that already the benefits that SASSCAL has generated for Zambia were immense and that the efforts of SASSCAL are consistent with Government plans and programmes. The Government of the Republic of Zambia cannot afford to be left out from such a cooperation.

At the end of the visit, Dr. Seleti acknowledged SASSCAL Zambia for facilitating the meetings and anticipates more such fruitful meetings.

Top to bottom:
Meeting with Stakeholders;
Meeting with PIs;
Right to Left: SASSCAL Acting Executive Director Dr. Yonah Seleti, MoHE Acting Permanent Secretary Mr. David Ndupu and SASSCAL Governing Board Chairperson, Jane Chinkusu during the meeting with senior officials.
Introducing and congratulating Dr. Vera De Cauwer

SASSCAL whole heartedly congratulates their colleague and friend, Dr. Vera De Cauwer, on her recent successful PhD defence in Leuven, Belgium.

On Friday 9 September, the PI of SASSCAL Task 038 successfully defended her PhD at the Arenberg campus of K.U. Leuven (Katholieke Universiteit) University, Belgium. During a 40 minute presentation, she outlined her dissertation "Autecological aspects of the African timber tree Pterocarpus angolensis in support of its sustainable management" to jury and public. The study aimed at gaining more insight into the environmental factors that influence the distribution and productivity of the P. angolensis, also named Kiat, Dolf or Mukwa.

Ecological methods were applied on a large dataset for southern Africa and a study area in the open Baikiaea – Pterocarpus forests at the border between Namibia and Angola. Questions were asked by the jury which consisted of 6 experts of the universities of Leuven, Arizona and Stellenbosch, and the Royal Museum for Central Africa. The public session was immediately followed by a short deliberation and the jury awarded Vera the degree of Doctor of Bioscience Engineering. Afterwards, a reception at the 14th century Arenberg “Kasteel” Castle crowned the event.

The PhD study would not have been possible without the support of The Future Okavango (TFO) and the SASSCAL projects, the Namibian University of Science and Technology (NUST) and the Namibian Directorate of Forestry.

by Dr. Vera De Cauwer
NUST

Dr. Vera De Cauwer in front of the 14th century Arenberg Kasteel of the K.U.Leuven in Belgium

NCRST National Research, Science, Technology and Innovation Award for Young Scientist of the Year:
Congratulations goes to
Josefina Hamutoko

Josefina won her award for her overall research work, publications etc. performed in the context of Task 007, “Improving knowledge and understanding of groundwater flow, water quality and quantity variations, improving methodology of groundwater availability study: Cuvelai—Kunene, Namibia”, under the supervision of Task PI Dr. Heike Wanke.

Josefina presented her work under the title “Analysis of major ions and stable isotopes in shallow and deep aquifers of the Ohangwena Region, Namibia” at the Award ceremony of the Science, Technology and Innovation Festival in September 2016, that was hosted by the NCRST.
The SASSCAL Zambia National Node, as part of its continued work with local partner institutions, organised a half-day end-of-tasks implementation workshop. The event was hosted at the Intercontinental Hotel in Lusaka on Friday the 5th of August 2016 and was officially opened by the Permanent Secretary at the Ministry of Higher Education, Mr. Owen Mugemezulu.

In his Opening Speech, Mr. Mugemezulu thanked the German Federal Ministry of Education and Research (BMBF) for providing research and capacity development funding at a scale never experienced before: "This is the first time in Zambia, in a long time, that we are having capacity being built at such a scale through projects or initiatives".

SASSCAL Board Chairperson and Ministry of Higher Education Director of Science and Technology, Ms. Jane Mubanga Chinkusu, said the successful completion of the first two SASSCAL research and capacity building projects in Zambia was a great achievement for SASSCAL in general, and the Department of Science and Technology in particular.

Tasks 221, ‘An assessment of the Colophospermum (Mopane) ecoregion’ and Task 300, ‘Capacity building in developing climate change related courses’ that were implemented by the Centre of Environmental Research, Education and Development (CERED) and the Zambia Air Services Training Institute (ZASTI) respectively, were concluded in October 2015 and are among the first tasks to be completed from the SASSCAL research portfolio in Zambia.

The two institutions submitted their end-of-project reports to the University of Hamburg in May 2016. The institutions were instrumental in organising the report back workshop and made their presentations on the recorded achievements, amongst others; the developed diploma training programme and tailor made short courses being the first to be offered in Zambia in which 40 staff in government agencies have been trained.

Furthermore, characterisation of land cover changes and status of the Mopane ecoregion in Zambia will go a long way in informing policy, as the region adapts to climate and land use changes.

At the end of the workshop, Prof. Patrick Matakala presented the report on the results of the assessment study of the Mopane ecoregion to the SASSCAL Governing Board Chairperson and Director of Science and Technology at the Ministry of Higher Education, Mrs. Jane Mubanga Chinkusu.

The workshop was attended by 37 participants representing different partner institutions, including the German Embassy and the German Development Bank (KfW).

From top to bottom right:
Some of the workshop participants
Ministry of Higher Education Permanent Secretary Mr. Owen Mugemezulu chats with German Embassy Representative Mr. Michal Kielar, SASSCAL Board Chairperson Ms. Jane M. Chinkusu and SASSCAL Zambia National Director Ms. Indie Dinala
ZASTI Representative Mr. Silumelume Nyambe presenting Task 300 achievements
Historical and ongoing climate data management (Task 123)

Climate information is needed to support climate research, climate adaptation measures and climate services. As an example, in 2015 and 2016 “El Nino” affected parts of the Southern African region (www.unocha.org/el-nino-southern-africa). Under such conditions, historic climate observations provide an important source of information for decision-makers to estimate the regional effect.

However, in comparison with other regions, the availability of high quality, high density climate data is still low in some parts of Southern African. The need to improve the capacities of such services is an accepted and frequently requested requirement for developing countries. Therefore, the World Meteorological Organization (WMO) founded the Global Framework for Climate Services (GFCS), a coordination framework in which capacity building is one of its key components. Cooperation is essential for the success of the GFCS, especially between national and regional meteorological services.

The SASSCAL Task 123 is an example of such a cooperative activity focused on improving local skills, to provide national meteorological services (NMSs) with better tools to advice for policy, decision makers and stakeholders.

by Dr. Frank Caspar, Deutscher Wetterdienst

The status of climate data availability

To reduce the lack of present-day ground-based climate observations, SASSCAL has supported the installation of Automatic Weather Stations (AWSs) in the region. Currently, the AWS Network of SASSCAL comprises over 141 stations and their data are openly accessible via the website of the SASSCAL-WeatherNet (www.sasscalweathernet.org).

However, very few stations in the region are transferring data to international data centres (Figure 1). The exchange of such data is essential to improve the reliability and accuracy of regional and global climate analysis, data products and numerical models.

The accessibility of historical climate records is also very limited in several Southern African countries. One reason is that, although observations have been performed over long periods, they have been documented on paper and are not available in digital form (Kaspar et al. 2015). SASSCAL contributes to improve this situation with the task “Historical and ongoing Climate data management” (Task 123)

Improvement of historical and current climate data management

In the context of SASSCAL, the NMSs of Angola (INAMET), Botswana (DMS) and Zambia (ZMD) are working closely together with Germany’s national meteorological service (Deutscher Wetterdienst, DWD) to improve the management of climate data. As a result of this cooperation, substantial progress in the storage, the quality control and the management of present and historic climate data at the NMS has been achieved. For Angola, the cooperation between the DWD and INAMET and the lessons-learned have been summarized in a peer-reviewed publication (Posada et al. 2016).

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It is noteworthy that this is an example of cooperation with a regional partner not funded by SASSCAL for this activity. The paper can also provide hints for capacity building activities in other countries.

In general, the cooperation between the NMS has focused on the following activities:

1. **Implementation of a Climate Data Management System (CDMS): CLIMSOFT**

During the SASSCAL Climate Workshop back in April 2014, the NMSs acknowledged “CLIMSOFT” as the preferred solution to store their climate data. CLIMSOFT is a CDMS developed by Africans and designed to store historical climatic data in computerized form (see www.climsoft.org). Therefore efforts where done to implement this software at the NMSs. Currently, all of them are running CLIMSOFT as their main CDMS.

One of the most important features of CLIMSOFT is its free availability and the fact that it is supported by an international community of developers (SASSCAL through DWD has become a member of this community). The next version of CLIMSOFT is being developed as a free open-source project, licensed under the GNU General Public Licence (GPL3) and is based on the Specifications for Climate Data Management Systems given by the World Meteorological Organization (WMO, 2014). Improvements in this software might therefore also be beneficial for countries outside the SASSCAL region. Consequently, interest in this activity was also indicated by WASCAL.

2. **Capacity building**

One focus of this task is capacity building. Visits of personnel from DWD to the NMSs are performed periodically and they are intended as an opportunity to transfer knowledge to the local staff in topics such as metadata, importance of data management, application of a CDMS, quality control, etc. Also, training in programming languages and international data transfer standards (e.g. via the global telecommunication system (GTS)) have been carried out. The following list provides an overview of the most relevant training activities carried out so far:

**DMS**
- Data Rescue (07.03-10.03.2016)
- R tool installation guidance for technicians (29.02. – 04.03.2016)
- Climate Data Management and R-Software (18.11.2015)
- Data Rescue (17.11.2015)
- Climate Data Management (24.02. – 25.02.2015)

**ZMD**
- R for Climate Products (22.01.2016)
- Importance of archiving on-paper documents (19.04. – 29.04.2016)
- Climate Data Management (22.06. – 02.07.2015)
- Climate Data Management Systems: CLIMSOFT (12.11. – 18.11.2014)

**INAMET**
- Climate Data Management (18.03. – 20.03.2015)
- CLIMSOFT and R-Software (24.03. – 25.03.2015)
- CLIMSOFT installation (08.08 – 13.08.2014)

3. **Data rescue**

Another important aspect of the cooperation is to ensure that historical climate data archived in the NMSs are securely stored and can be easily accessed. There is a large amount of meteorological records on-paper that is not yet digitized and, especially at the DMS and ZMD its digitization is of high priority.

The DMS applied for a grant of the Global Climate Observing System (GCOS; WMO) to get equipment for data rescue (cameras and scanners) as well as shelves and archive boxes for the storage of the on-paper documents. It was agreed between DMS, WMO and DWD that the role of SASSCAL task 123 is to provide the expertise (through DWD) on how to carry out the data rescue activity. For this, several trainings have been performed at DMS.

Concerning ZMD, the Climate Information and Early Warning Systems (CIEWS) project provides the NMS with the data rescue equipment and SASSCAL provides the archive boxes as well as the support for the rearrangement of the archive.

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Figure 2: Photo of the training on Climate Data Management at INAMET in March 2015 (Posada et al. 2016)
As shown with these examples, it is important for DWD and its partners to identify synergies between already existing projects and SASSCAL. The ongoing data rescue activities are a successful example for the optimization of such synergies.

4. Development of tools and products to take advantage of the data already available

An easy-to-use tool has been developed with R to create a variety of plots (time-series, histogram and wind roses) and facilitate the identification of inconsistencies within the datasets stored in CLIMSOFT. The interactivity of these graphics allows the user to analyze quality-related issues of the dataset when navigating through the graphic. It has been developed as part of a collaborative development project called ClimateObject; an R-package that aims to create a great number of graphical products based on climate data (for more information see: github.com/StatisticalServicesCentre/ClimateObject. This tool is already in use at INAMET, ZMD and DMS.

5. Application example: Gridded maps

For several applications, users prefer to get climate data on a regular grid without gaps. In a Bachelor thesis, several methods have been tested to provide interpolated temperature maps for the SASSCAL region, based on observation data from the SASSCAL Weathernet. The best result for the time period from 2014-2015 has been produced by the 3D interpolation with inverse distance weighing. The results were presented at this year’s Annual Meeting of the European Meteorological Society (EMS) (Eiselt et al. 2016).
Observing Fire Spread from Space

Southern African landscapes are amongst the most frequently burned areas in the world, nonetheless, fire spread information on a large scale is still a missing key layer for a complete description of these fire regimes.

by David Frantz, Dr. Marion Stellmes, Dr. Achim Röder
University of Trier

Detailed information of fire sizes and pattern in relation to different strata have been derived based on MODIS (Moderate Resolution Imaging Spectroradiometer) fire products, and a range of fire metrics such as fire frequency, fire intervals less than 5 years, fire seasonality and fire intensity allow for a more comprehensive assessment of ecological effects.

Further to this, exploring ignition points and density can provide valuable insight in the anthropogenic influence on fire regimes. Assimilating fire size distribution and fire propagation measurements into dynamic vegetation models improve simulations of global carbon fluxes. Similarly, learned knowledge will also be beneficial for the enhancement, calibration and validation of fire propagation simulations, e.g. ignition points may serve as more realistic seeds for the propagation, which in combination with fire risk simulation assessments might support adjusted fire management strategies.

We developed a novel multi-level object-based methodology that extracts valuable information about fire dynamics from MODIS burned area data.

The approach is a top-down approach and a multi-level segmentation strategy is used to gradually refine the individual object-membership. The multi-temporal segmentation alternates between recursive seed point identification and queue-based fire tracking.

Single fires are identified and described with respect to the timing and location of their ignition. The daily directional spread information of the fire events is also recorded during this process.

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Figure 1: Spatial visualization of various fire descriptors for the 2005 fire season. (a-e): Aggregated parameters; 1-degree cells were used for averaging. (a): Fire density, i.e. number of fires per grid cell. (b): Fire size in km². (c): Fire lifetime in days. (d): Fire spread rate in km/day, i.e. fire size / lifetime. (e): Ignition date as Day-of-Season. (f): Fire size (indicated by symbol size), ignition time (colors) and location of ignition (symbol centroid) for all individual fires in the marked subset, i.e. the blue box in (a-e).
Hence, the approach allows to reconstruct when and where a fire started, and in which direction and how fast it moved. After it has ceased, the total size is also estimated.

By following this process, we extracted fire spread related information for every single fire over sub-equatorial Africa between 2000 and 2014.


Figure 2. Ignition points, L1-segmentation and burn dates for a large fire in season 6. The approximate burning trajectories are visualized with arrows that have their origin in the detected ignition points; trajectories are drawn manually for illustration purposes only.

Task 196: Multiple hazard maps and geological-geophysical works for risk assessment at medium and large scale

Task 196 aims to contribute towards an updated multiple hazard map and geological-geophysical knowledge for risk assessment at medium and large scale.

Specific aims include the production of updated diagnostic maps (land use, lithological, topographic, tectonics, hydrological, and hydro-geological). The envisaged objectives include, amongst others, research in “Urban Geology” and “Geological Environment” applied, in particular, in the city and surrounding area covering part of the province of Luanda.

by Gabriela Pires
Universidade Agostinho Neto de Luanda (UAN)

In the last two quarters, Task 196 has made significant progress. An updated Land Use and Slope Map of Luanda Province have been produced.

The land use map presents the different locations and the land use activities in Luanda, of which vegetation and exposed soils are the most predominant spaces. The permeable area represents 72 % of Luanda and the impermeable area corresponds to 27 % of Luanda’s land surface. Based on that, the report concludes that the main cause of the existent risks (Natural and Geological) in Luanda is derived from poor use and occupation of the physical space.

In regard to the slope map, the report states that the slope of Luanda predominantly varies between 0% and 5%, which corresponds to a plain or smooth slope (Silva, 2000). Based on that, the report concluded that Luanda is suitable for urban use and intensive development and habitation. However, any development should always be guided by integrated urban planning due to the fact that there are zones with high slope which vary between 15% and 40%. These zones pose a risk of mass movement and flooding in the low-lying plains.
While paying attention to shifts in research focuses, Gobabeb continues to learn more about the functioning of the and, coastal Namib from the level of microbes to the larger fauna and flora, the climate and geomorphology, the human occupants - and all in between. One current project receiving much attention is an attempt to understand the management of domestic livestock in the naturally fluctuating arid environment. Another major focus is encapsulated under the title of NERMU – Namib Ecological Restoration and Management Unit – focusing on the extensive mining activities taking place in the area.

A number of studies are addressing directly climate change. These range from FogLife which augments the SASSCAL-funded FogNet following the climate and particularly the fog across the central Namib. FogLife also monitors the flora, fauna and microbes of the Namib dunes supporting the management of the Namib Sand Sea, World Heritage Site. With the bordering Benguela Current slowly warming, fog decreasing and rainfall becoming more erratic, the fauna and flora of the Namib are responding in unpredictable ways. As just one example, fog harvesting members of the well known beetle fauna are changing their distribution patterns, some moving coastward to access the shifting presence of fog.

The Gobabeb Research and Training Centre is a unique construction as a Joint Venture Agreement between the Ministry of Environment and Tourism and the Desert Research Foundation of Namibia. As far as could be established it is the only NGO/government Joint Venture operating in Africa. Currently it is under the directorship of Dr Gillian Maggs-Köl ling, a botanist by training.

For more information:
www.gobabebtrc.org

Related information:
The Desert Research Foundation of Namibia is a founding party of the Gobabeb Training and Research Centre’s joint venture agreement: drfn.org.na

Gobabeb is located in the Namib desert and nestled in the meeting point of three ecosystems: the ephemeral Kuiseb River, the Namib desert sand dunes and the gravel plains. Gobabeb was formerly a Topnaar community called Nomatabeb, which means “place of the Figtree”.

(Picture courtesy of Erik Voges)
Flying for Climate Change
The NASA ORACLES project

From the 26th August to the 29th September 2016 the SE Atlantic, off the Western shores of Africa (from 0-20’S) became the focus area of a large scale airborne laboratory. The field campaign was conducted to carry out the science questions asked by the NASA ORACLES (ObseRvations of Aerosols above CLOuds and their InterActionS) project team. The overarching research topic of the ORACLES project is to determine how aerosols, generated by burning biomass (i.e. vegetation fires), that takes place over much of Africa between August – October every year, are interacting and impacting on the permanent strato-cumulus (SC) cloud deck situated over the SE Atlantic ocean (figure 1).

by Dr. Nicky Knox
Namibia University of Science and Technology (NUST)

Figure 1: A modelled example of the month of September where the burning biomass aerosols, which form a plume of aerosols, generated over the African continent are moved by upper air currents from the continent over the SE Atlantic. In the SE Atlantic the question to be investigated is how do these aerosols interact, with the variable sized strato-cumulus deck? And what will the result of this interaction be on the cloud properties and thus on the meteorology of the region?

Biomass Burning (BB) Plume and Permanent Strato-cumulus (SC) Interaction

To take a step back and get everyone on the same page, the SC cloud deck referred to above is an extensive low level cloud (generally this type of cloud forms in the lowest 2km of the atmosphere) that is permanently located over the SE Atlantic (the extent of this cloud will vary seasonally). Similar cloud decks are also found off the West coast of both S. America and N. America. This extensive cloud deck plays an important role in the climatology we experience over Africa and the SE Atlantic.

Annually from June to Oct/Nov southern Africa produces approximately 30% of the earth’s biomass burning (BB) particles, the peak of this production is between August and October. The dominant winds during this time of the year are easterly winds which transport these particles as a plume from the continent over into the SE Atlantic ocean (known as the Biomass Burning plume). Currently there is a lack of understanding about how this BB plume interacts with this SC cloud deck. As a feedback from this uncertainty is an uncertainty in how the aerosols impact on the climatology of the region.

Particle interactions with clouds have the ability to result in cooling or heating, depending on resulting radiative forcing that happens when the particles interact (or don’t interact) with clouds. By radiative forcing we refer to the amount of incoming solar energy that is absorbed by the earth vs. reflected back into the atmosphere.

continued on next page...

Figure 2: Different climate models and their predictions for temperature change based on aerosol direct effect from data obtained from Aug-Sept. As can be seen the various model outcomes differ substantially.
The dominant effect changing these radiative forcing values is the properties of clouds and atmospheric gases. Understanding the changes to the radiative forcing values will therefore play a crucial in not only improving current global and regional climatological models, but will also be important input to fine tune climate change models. There are numerous global and regional climate change models that have been developed. Figure 2 provides an overview of how a number of different climate models produce different predictions of future temperature changes for the region based on direct effects produced in the August-September climatology. The uncertainty that is displayed in these models is primarily linked to the lack of understanding about the behavior of the interaction taking place between the BB aerosols and the SC cloud deck.

**NASA ORACLES**

How then does NASA ORACLES plan to investigate these questions? The ORACLES project is a complex science project that brings together atmospheric scientists, remote sensing scientists, and modelers. This team of researchers each has their specific area of interest and questions they wish to investigate, and individual expertise in terms of understanding atmospheric properties. But together when their findings are combined they have the potential to provide the answers sought by the overarching ORACLES objective of understanding the interaction of BB aerosols on the SC cloud deck and how this impacts climatology regionally and globally. The way that ORACLES is approaching this problem is through conducting, over a three year period, three 1 month airborne field campaigns during different months of the annual peak BB seasons (2016-Sept, 2017-Aug, 2018-Oct).

In September 2016, the field campaign involved bringing 2 instrumented planes to Namibia accompanied by the respective instrument scientists. The incoming team, which included scientists from not only NASA, but also 8 other US universities, totaled approximately 100 scientists, pilots and operational staff. The field campaign was broken down into collecting data at 3 different levels: the ground component; the in-cloud, below cloud, above cloud and plume measurements; and high altitude measurements taken from above the cloud and plume deck. The ground component was composed of in-situ measurements, modelling, instrument monitoring and flight planning. Flight planning was based upon information generated through daily weather prediction modelling (twice daily), and science discussions used to help focus the science plans for each flight. The weather briefings looked at the modelled distribution of the SC cloud and the probable location of the BB plume. The afternoon weather briefings were used to design the plan for the following few days of flight plans (e.g. to make routine flights or flights of opportunity), and the morning weather briefing were used to decide if the planned science flight would or wouldn’t go ahead (predicted windspeed and presence of high level cirrus cloud were factors here). The in-situ measurements derived from the regional network of sun photometers, which contribute to the global AERONET network, were used to derive an interpolation of how the aerosol optical depth varied across the region (Figure 3).

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Figure 4: (a) The P3 plane at the Walvis Bay Airport, (b) and one of the instruments on the plane. Note that most instruments included a console which enable immediate review of the acquired data as it was measured and it enables check-ups on the health of the instruments.
Most of these planning meetings took place in a conference room at the Swakopmund hotel. This room became the ground base for science operations. Scientists that weren’t on the flights of that day would gather in this room and would monitor their instruments (the instruments on the plane were linked to a central wireless and could be monitored from the ground), and start with basic data processing. The progress of the science flights could also be followed and if any information needed to be relayed to the scientists on the plane this could be done through a communal chat. At the end of each day and particularly on the soft down days (the days when there were no flights, but scientists where still working on instruments and data) there would be a science tag up meeting which would give everyone a chance to share either findings or ideas on what had been observed during flights. These science tag up meetings became progressively more in-depth as the campaign progressed because the instrument scientists had had a chance to start analyzing their data and could present their preliminary findings.

The in-cloud, below cloud and in BB plume measurements were made using an instrumented P3 Orion plane (Figure 4a). The P3 was really the workhorse plane that carried the bulk of the science instrumentation. The plane can take a total of 23 passengers including the 1 pilot. This is no commercial com-

fort plane, it is a plane designed to carry out science. This year the plane was kitted out with 10 different measurement instruments, next year this will increase to include 15 different instruments (Figure 4b). During each flight, each instrument may have one or two operators that operate it during the flight. They are able to see data directly as it is acquired and link this directly to what is being observed outside. The particular instruments on board measure different aerosol properties, e.g. solar spectral irradiance or AOD (SSFR or 4STAR instrument), condensation nuclei or particle sizer (HiGEAR). During the campaign 15 science flights were made with this plane, and a total of 115 hours of measurement were taken.

continued on next page...

Figure 5: The ER2 plane together with the ground crew that are preparing the plane for a science flight.

Figure 6: One of the 5 instruments on board the ER2 is located within the nose of the plane. The AirMISR instrument simulates the MISR satellite instrument.

Figure 7: The different science flight paths taken by the ER2 and P3 planes during the 2016 ORACLES field campaign.
Different flight plans involved the plane flying at different altitudes either above, below, or in the clouds or BB plume. It is planned that this plane will be used in Namibia for all three of the flight campaigns.

The second plane that joined for this campaign was the ER2 (Figure 5). This is a high altitude plane which flies at approximately 20km altitude (this puts 95% of the earth’s atmosphere below the plane). It is operated by a single pilot whom has to don a space suite and breathe pure oxygen for the duration of the flight. On board this plane were 5 instruments (Figure 6), the pilot during the flights receives instructions as to when and where these instruments should be turned on and off. These instruments are either simulators of satellite instruments, or instruments being developed for future satellite missions. The measurements taken on the P3 provide the scientists with physical measurements of the cloud properties, the ER2 instruments collect remote sensing data at high resolution which can be used to develop models over larger areas (compared to the in-situ measurements being taken on the P3). Data acquired on the P3 can be used to calibrate and validate these upscaled models. These models can then be used to validate satellite measurements. In particular the measurements made by the ER2 could be used for calibration of measurements taken on the CALIPSO satellite. In order to facilitate this validation some of the flights of the ER2 were synchronized with the CALIPSO satellite overpasses. In total the ER2 had 12 flights and flew for a total of 97.3 hours. Of these 12 flights, 7 were coordinated flights between the ER2 and P3 aircrafts. Because the planes fly at different speeds, they are unable to coordinate during the entire flight. They therefore coordinate where the two planes should meet and perform joint measurements.

In Figure 7 the flight paths of the two planes are shown. At this stage no results have yet been produced from the campaign. The scientists are however delighted with the data they have obtained, and I’m certain we can expect some very exciting scientific findings coming from this and the future campaigns. To keep abreast with the output it is worth keeping an eye on the ORACLES website (espo.nasa.gov/home/oracles).

**Capacity Development Component**

While the focus of the campaign was on conducting the science and collecting data, the scientists also took a lot of time to assist in the development of local and regional science in a multi-faceted capacity development program. Through a jointly funded project of the US Embassy and NUST, 7 students (Masters and PhD level) from the region (5 students from the two Namibian Universities, and 2 from South African universities) joined on a 3 week shadowing program (Figure 8). These students had the opportunity to work together with the scientists and find out more about the campaign, different instruments and further develop their skills in atmospheric sciences. A couple of scientists also joined a local team from Namibia University of Science and Technology and the Gobabeb Research and Training Centre to the Science Fair in Ongwediva to help stimulate science in school learners. And some of the scientists delivered talks at the Scientific Society in Swakopmund and in Windhoek at that Windhoek Show, and an Open Day was held at the Walvis Bay airport to introduce both government and some of the local schools in the area to the project. It is planned that in the future field campaigns these different capacity building initiatives will be expanded to maximize exposure to both scholars, students and researchers.

*Figure 8: One of the ER2 pilots kitted out in his flight suit, together with the 7 NASA ORACLES Shadowers from Namibian and SA universities whom joined the field campaign and “shadowed” the different scientists for 3 weeks.*
The Indigenous Knowledge Research Cluster from NUST (Namibia University of Science and Technology) was representing their research findings and experiences at the Biennial Participatory Design Conference in Aarhus, Denmark in August 2016 (pdc2016.org).

As part of the conference proceedings, the group hosted a one day open workshop titled “Formulating the Obvious as a Task Request to the Crowd: An Interactive Design Experience Across Cultural and Geographical Boundaries.”

The workshop aimed at demonstrating a typical co-designing session as it occurs in-situ with Namibian communities, as well as exposing the challenges that arise during these, due to language barriers and apparent differences in culture between researchers and knowledge holders.

In addition to that, the installation showcased the various technologies that the group has co-designed and developed using this approach with Namibian rural communities.

Apart from this workshop, the group also had the opportunity to participate in other workshops offered at the Conference. Topics ranged from Art to Design to Industry cases. A few of the organisations exhibiting their designs, products and technologies were Intel and Lego, that have co-designed solutions and products using the Participatory Design Approach.

The June-July SASSCAL Newsletter already had a feature on the “Preserving Indigenous Knowledge with mobile technology” project of NUST (www.indiknowtech.org). The project is part of an initiative to preserve and catalogue Namibian Indigenous Knowledge (IK), by co-designing and developing digital tools that can be used by indigenous knowledge holders to capture, store and curate their own IK.

by Michael Chamunorwa
NUST & SASSCAL Namibia
The National Commission on Research, Science and Technology (NCRST) in Namibia recently celebrated their Month of Science with a Science, Technology and Innovation Festival. In this context, the Ongwediva Trade Fair took place in September.

by José Júnior
NUST & SASSCAL Namibia

The Namibia University of Science and Technology (NUST) together with representatives from the National Aeronautics and Space Administration (NASA) and Gobabeb Research and Training Center (GRTC) took part in the National Science, Technology and Innovation Festival in Ongwediva.

The main aim of this collaboration was to conduct a science education outreach focused on educating the Namibian youth on issues regarding atmospheric climate change, biodiversity and water sustainability. The outreach was performed by presenting various educational quizzes, videos and interactive talks from NASA representatives. These activities were presented not only to educate the youth, but also to inspire and lure them into becoming scientists.

Amongst the representatives from the NUST, was José Júnior, who is currently an intern at SASSCAL’s OADC in Namibia and, is enrolled for a MSc degree in spatial sciences at NUST.

During the science festival, he would spend time at the NUST/NASA/Gobabeb stall enlightening visitors on the NASA (ORACLES) project, that is currently taking place in Namibia. Furthermore, he represented the faculty of Spatial Science and Technology and showcased some of the courses offered. He also introduced some projects he worked on as a student at NUST that were relating to biodiversity and climate change. In the afternoons, José spent his time presenting educational videos and quizzes relating to climate change. Different quizzes were presented of which one of them was developed by José to allow learners to answer a series of multiple choice questions on the computer.
African Drought Conference
15 to 19 August 2016, Windhoek

“Towards a Strategic Framework for Enhancing Resilience to Drought at the African level that will contribute to poverty alleviation, economic development and enhance environmental and human well-being”

According to UNOCHA, the United Nations Office for the Coordination of Humanitarian Affairs, the El Niño climatic event has caused the worst drought in 35 years in Southern Africa, and according to The Guardian, 35 million people faced hunger as a consequence of the strong El Niño that produced record high temperatures.

Due to an ever-growing worldwide concern that the frequency and severity of droughts may be increasing in frequency and severity given the changing climatic conditions, the African Drought Conference was organised.

The organization of the Conference was coordinated through the Ministry of Environment and Tourism of Namibia in its role as UNCCD focal point, but in collaboration with a number of other domestic and international partners.

According to a press statement by the Honourable Pohamba Shifeta, Minister of Environment and Tourism, more than 400 delegates from international and local Governments, civil society organisations, UN agencies, academia and the private sector attended the Conference.

The four day conference consisted of a two-day technical segment and a two-day high level segment. The main focus of the event was to review, enhance and develop the White Paper Strategic Framework document for drought risk management and enhancing resilience in Africa and to develop the Windhoek Declaration for Enhancing Resilience to Drought. In order to ensure a continuous and interactive process, an open-ended working group has been established that involves delegates from all over Africa, that will further develop and enhance the strategic framework document.

The framework document is to serve as a guide to African countries, for the creation and successful implementation of national and sub-regional drought policies.

With the Windhoek Declaration, African countries have committed themselves to a number of activities in order to operationalise the Strategic Framework. A few examples are the adoption of the framework by relevant bodies such as the African Union and the development of a binding protocol under the framework of the UN Convention to Combat Desertification.

During the Conference, it was refreshing that in numerous discussions, African delegates pointed out that rather than keep reinventing new organisations or mechanisms, there should be a stronger focus on enhancing existing organisations and mechanisms in a tone of “if it does not work, first ask how we can make it work, before reinventing”.


by Sylvia Thompson

His Excellency Dr. Hage Geingob, President of the Republic of Namibia, giving his keynote address, Source: New Era
Photo Focus

The SASSCAL National Node of Zambia kick-starts and conceptualized this exciting new segment where we will be showcasing photos of events that do not appear as articles, but that capture the essence of the life, the vision and the mission of SASSCAL.

Please contribute to this segment by sending us your photos and including a short caption: communications@sasscal.org

Sheer beauty of the Zambezi sunset—KfW-Namibia representative Ms. Rosa-Stella Mbula during a meeting in Livingstone, Zambia

Left to right: Mrs. Petra Wolff (BMBF), Dr. Appollonia Okhimambe (WASCAL) Mrs. Gisela Heilig (BMBF) & Ms. Indie Dinala (SASSCAL) during a briefing of the BMBF officials over SASSCAL/WASCAL participation at the 2013 COP in Warsaw, Poland.

Flashback: Preparing for the SASSCAL/WASCAL side event at the 2013 Warsaw COP, Poland—Left: Dr. Appollonia Okhimambe (WASCAL), Centre: Ms. Indie Dinala (SASSCAL-Zambia) and Right: Prof. Nobert Jürgens (SASSCAL-University of Hamburg)

Indigenous mushrooms (edible) collected by local communities of Chingola, Copperbelt Province of Zambia

All pictures courtesy of Indie Dinala, National Director of SASSCAL Zambia

Websites or Data Portals

When this article was written, there were some 3 467 120 000 internet users in the world and the number was growing by the second. 2.5 Exabytes of data are put on the internet every day. Therefore, the quote by John Naisbitt is more relevant than ever:

“We are drowning in information but starved for knowledge”

If there are any websites or data portals that might be useful to other SASSCAL colleagues, please provide these to communications@sasscal.org.

nsa.org.na
Namibia Statistics Agency
Go here to read about Namibian legislation governing the creation, use and distribution of statistical and geographical data. Further find relevant and interesting reports, statistics and data.

sadc.africadata.org
Data Portal of SADC
Data portal to view statistics, maps and graphs of socio-economic data and agricultural figures by country.

schiub.copernicus.eu/dhus/#/home
Sentinels Scientific Data Hub
By selecting your area of interest, you can get a list of available Sentinel 1A, 1B and 2A products for that area. A normal registered user can download 2 images per day.

nature.com
Nature Website
For up-to-date articles on new research, exciting science and countless publications, subscribe on the Nature website. Whilst subscribing, you can determine your thematic or research interests.
Publications


Main, R., Mathieu, R., Kleyhans, W., Wessels, K., Naidoo, L., Asner, G.P., 2016. Hyper-temporal C-band SAR for baseline woody structural assessments in deciduous savannas. Remote Sensing, 8(8), 661; doi:10.3390/rs8080661


PhD theses


Master Theses


Schelstraete, M. 2016. Assessment of fire damage on the forest population near Hamoye, Kavango. Master thesis University of Gent, Belgium.
**Upcoming Events**

**5th International Conference on Climate Services in Cape Town**

The secretariat of the Climate Service Partnership (CSP), hosted by the Climate Service Center Germany (GERICS), is pleased to announce that the upcoming 5th International Conference on Climate Services (ICCS5) will be held from 27th February to 3rd March 2017 in Cape Town.

The conference theme will be on innovation and capacity building and will last three days, with an additional day either before or after scheduled for side meetings. More detailed information on the conference, such as registration and the agenda, will be issued in due course. Please also visit the conference website: [www.climate-services.org/iccs/iccs5](http://www.climate-services.org/iccs/iccs5)

**Pre-announcement for a training course on regional climate change assessment and uncertainty analyses**

In the framework of the SASSCAL Climate Task 006 (lead by the Climate Service Center Germany; GERICS) and Climate Task 203 (lead by CSIR), a training course on analyzing and interpreting climate model data is planned. The course will be conducted jointly. The training will take place in the first quarter of 2017 (end of February or at the beginning of March) most probably in Cape Town or Stellenbosch, South Africa.

The focus of this climate training course will be on regional climate change assessment and uncertainty analysis on the basis of an ensemble of regional climate model projections compiled within SASSCAL as well as within the CORDEX Africa initiative. The training is addressed to SASSCAL scientists who are working with climate model data needed for sector specific climate change assessments and climate impact assessments. In order to enable participants to use climate model data for their specific applications, emphasis will be given to practice relevant hands-on sessions.

More detailed information on the program, venue and logistics will follow at the end of the year. Main contact person for the workshop is Dr. Torsten Weber from GERICS ([torsten.weber@hzg.de](mailto:torsten.weber@hzg.de))

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<td>19 to 21 October 2016</td>
<td>Zambia Science Conference</td>
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<td>24 to 28 October 2016</td>
<td>Invitation to the 11th AARSE International Conference</td>
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<td>7-18 November 2016</td>
<td>22nd session of the Conference of the Parties (COP 22) to the UNFCCC</td>
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<td>04 to 17 December 2016</td>
<td>Thirteenth meeting of the Conference of the Parties to the Convention on Biological Diversity</td>
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