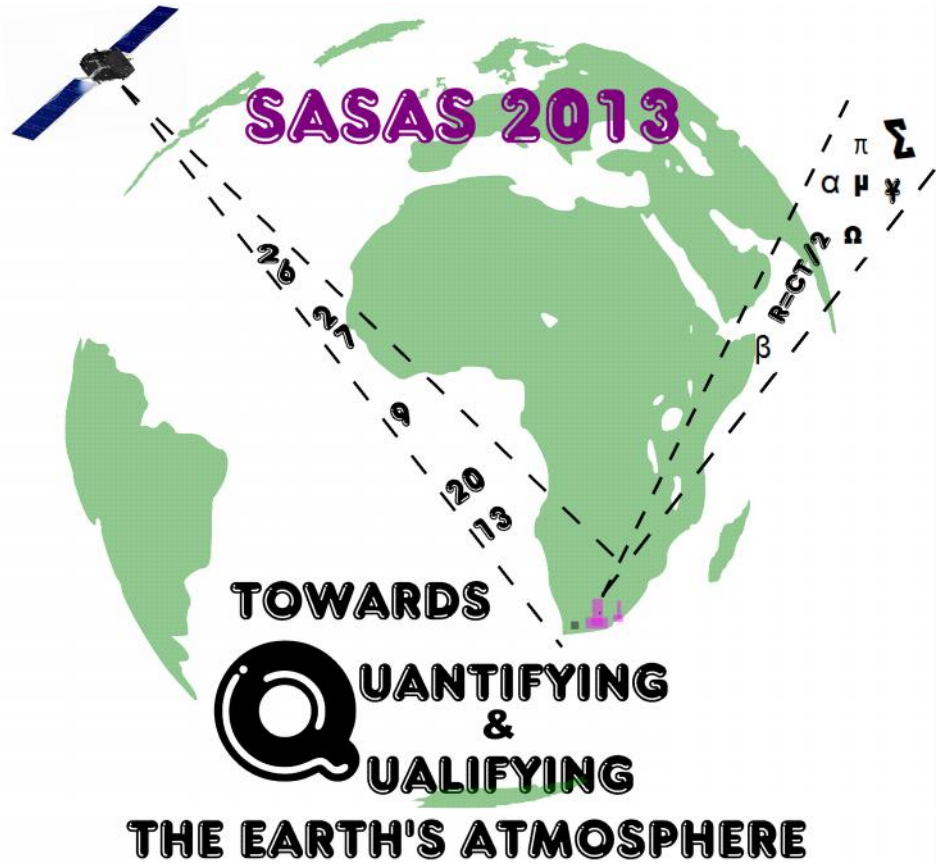
29th Annual Conference of

SOUTH AFRICAN SOCIETY FOR ATMOSPHERIC SCIENCES



26 - 27 SEPTEMBER 2013

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PREFACE

The 29th annual conference of South African Society for Atmospheric Sciences has been hosted in DURBAN. The theme for the conference was decided through organizing committee by the beginning of 2013 and was decided as "**Towards Quantifying and Qualifying the Earth's Atmosphere**. It is always a challenging task to know how to quantify and qualify the results, thus in the atmosphere. The major aim of the conference is to discuss and understand what are the shortfalls in quantifying (accurate) and qualifying (better result) while addressing the earth's atmosphere. In general, the atmosphere studies are governed by various in-situ/ground-based, space borne measurements, models and simulations, and their dependence with Land and Ocean.

We have introduced on-line version of communication processes, which includes a dedicated web-page for the conference and it has been hosted through University of KwaZulu Natal (UKZN) server. We believe that most number of participants have benefited the online registration (expression of interest), short abstract submission and access to most useful information. Based on various demanding request to improve further on conference proceeding, we have provided an option to author's for submitting their research contribution into maximum of 4 pages. We were quite successful to receive more than 95 % of the contributions into 4 pages. The proceedings review processes were led by one of the conference organizing committee members, **Dr. Raghavendra Kumar Kanike** (University of KwaZulu Natal). He has made a challenging job and ensured all the conference proceedings quality has been improved through peer review process. In total, 50 conference proceedings were peer reviewed and published with ISBN. The conference proceeding shall be available for download through SASAS and SASAS 2013 web-page.

Besides the conference, we have introduced a student training workshop on 25th September 2013 and the course is focused on "Atmospheric Remote Sensing and Training". There were about 45 students participated and motivated on atmospheric studies. The workshop was sponsored through a National Research Foundation (**NRF**) and has allowed us to waive the registration fee for all the South Africa University students.

On behalf of the SASAS 2013 organizing committee, we would like to thank everyone who are enthusiastic and contributed for the 29th Annual conference of SASAS, as a successful one. SASAS 2013 organizing committee, thank all our learned referees for their kind cooperation and support in reviewing the extended abstracts and made us possible to bring this peer-reviewed conference proceeding.

We have also received gratitude sponsors from University of KwaZulu Natal (**UKZN**), South African National Space Agency (**SANSA**), Wirsam Scientific and National Research Foundation (**NRF**). It is our duty to acknowledge their contributions and their support always appreciable.

Prof. Sivakumar Venkataraman and
Dr. Nkanyiso Bongumusa Mbatha
Conference Chair

MESSAGE FROM THE PRESIDENT

Dear Delegates

I welcome you to the 29th South African Society for Atmospheric Sciences Conference. After the successful 28th Conference held in Cape Town last year and organized by ETV it is a great pleasure to be in Durban hosted by UKZN under the leadership of our vice-president Prof. Sivakumar Venkataraman**.** SASAS aim is to stimulate interest and support for all branches of atmospheric sciences, to encourage research and education in the atmospheric sciences and to promote collaboration between organizations and institutions interested in atmospheric science in Southern Africa. This includes meteorology, agro-meteorology, climatology, air quality, ocean-atmosphere interaction, troposphere-stratosphere interaction, physical oceanography, hydroclimatology, numerical modelling, and instrumentation. On top of organising an annual conference since 1989, where the general assembly is also held, SASAS annually awards a prize worth R3000 for the best peer-reviewed paper published two years before the conference is held, the Stanley Jackson Award. Best presentation, best student presentation and best poster are also rewarded at the SASAS conference. Proceedings of the conference are peer reviewed and former conference papers and abstract are available on the SASAS web site. A newsletter is also produced by its members. SASAS has a web site http://www.sasas.org.za. At the end of the day, we compete for grants, for discoveries, for papers, for awards; and we agree or disagree on how to run things but SASAS unites everybody and the conference is one of the longest running annual conferences in Africa. I encourage everybody to fill in the membership form that you will find in your bag and hand it to any of the council member before the assembly and prize giving which I also encourage you to attend. We need to grow the society and therefore welcome any suggestions to improve the society. I also remind you that we do have a constitution that can be amended by a vote by the council. This year we are going to discuss the possibility of awarding a prize every year for achievement in SASAS related field. Next year, we will have some election for a new council and a new president. Here is your chance to change things and help the society to progress.

Dr Mathieu Rouault

President of SASAS

COMMITTEES

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Dr. Natalie Burls (Yale University, USA)
Dr. Neil Hart (University of Reading, U.K)
Prof. Hassan Bencherif (UR – Reunion, France)

PROGRAMME 26 September 2013

PLENERY SESSION -1 : REGISTRATION & OPENING: - VENUE : ROYAL PALM Chaired by : Dr. Mathieu Roault		
08:30-09:00	Registration	Royal Palm
09:00-09:40	Sivakumar Venkataraman	Welcome
	Jane Olwoch Directorate - SANSA	Opening
09:40-10:30	Thierry Lebel	Keynote address: "The West African Monsoon: Contribution of the AMMA multidisciplinary programme to the study of a regional climate system"
10:30-10:50	**TEA BREAK**	

PARALLEL SESSION 1A (ROYAL PALM) : ATMOSPHERIC MEASUREMENTS Chaired by: Prof. R. R. Reddy			Pg.	PARALLEL SESSION 1B (SAILS): METEOROLOGY Chaired by: Dr. J.L. McGregor		Pg.
10:50-11:10	M. J. SAVAGE	AIR TEMPERATURE MEASUREMENT ERRORS	24	M.M.BOPAPE	SIMULATING SUPPRESSED AND ACTIVE CONVECTION PERIODS DURING TOGA COARE	12
11:10-11:30	K. RAGHAVENDRA KUMAR	LONG-TERM VARIATIONS IN MODIS DERIVED AEROSOL OPTICAL DEPTH AND FINE MODE FRACTION AT THREE DIFFERENT ENVIRONMENTS IN SOUTH AFRICA	23	J. STANDER	STEP-WISE SNOW FORECASTING DECISION TREE	25
11:30-11:50	A. JOSEPH ADESINA	AEROSOL OPTICAL PROPERTIES OVER PRETORIA, SOUTH AFRICA DURING SPRING TIME MEASURED FROM CIMEL SUNPHOTOMETER	17	M. GELDENHUYS	ESTIMATING FOG WATER YIELD POTENTIAL ON THE SOUTHERN CAPE MOUNTAINS OF SOUTH AFRICA	15
11:50-12:10	LAVRIC JOST	CONTINUOUS ATMOSPHERIC MEASUREMENTS IN SOUTHERN AFRICA – OPPORTUNITIES FOR NETWORKING AND COLLABORATION	33	L. SIMPSON	INVESTIGATING THE OCCURRENCE AND POSITIONING OF POSITIVELY CHARGED LIGHTNING WITHIN CUMULONIMBUS CLOUDS	24
12:10-12:30	T. GUMEDE	TRENDS IN ATMOSPHERIC CONDITIONS ASSOCIATED WITH SEVERE STORMS OVER GAUTENG	16	B. MASEKO	PRELIMINARY RESULTS OF THE RAPIDLY DEVELOPING THUNDERSTORM PRODUCT IN SOUTH AFRICA	21
12:30-12:50	E. MORGAN	CONTINUOUS MEASUREMENTS OF GREENHOUSE GASES AND RELATED TRACERS IN THE NAMIB DESERT	39	S. LANDMAN	EVALUATION OF SEVERE WEATHER GUIDANCE MAPS ISSUED BY THE SOUTH AFRICAN WEATHER SERVICE	19
12:50-14:00	**LUNCH**					

PARALLEL SESSION 2A (ROYAL PALM) : CLIMATE MODELS Chaired by: Prof. James McKenzie			Pg.	PARALLEL SESSION 2B: (SAILS) CLIMATE-RAINFALL Chaired by : Dr. Thierry Lebel		Pg.
14:00-14:20	J.L. McGREGOR	AN UPDATE ON CCAM MODELLING ACTIVITIES AT CSIRO	21	J. MALHERBE	DECADAL-SCALE RAINFALL VARIABILITY AND THE SOUTHERN ANNULAR MODE	36
14:20-14:40	F. ENGELBRECHT	THE FUTURE IS UNCERTAIN, BUT NOT IN A RANDOM WAY	15	L. DYSON	CLIMATOLOGY OF HEAVY RAINFALL SOUNDINGS AT IRENE BY USING SELF-ORGANIZING MAPS	15
14:40-15:00	M. GIJBEN	VERIFICATION OF A UNIFIED MODEL BASED LIGHTNING RISK INDICATOR FOR SOUTHERN AFRICA	16	X. JELE	SIMULATING HOURLY RAINFALL OVER SOUTH AFRICA USING THE CCAM	17
15:00-15:20	I. PINTO	CLIMATE EXTREMES INDICES IN THE CORDEX MULTIMODEL ENSEMBLE: FUTURE CLIMATE PROJECTIONS	22	C. ENGELBRECHT	THE RELATIVE CONTRIBUTION OF SYNOPTIC TYPES TO RAINFALL OVER THE CAPE SOUTH COAST REGION	13
15:20-15:40	ROELOF BURGER	RE-EVALUATING THE CONCEPTUAL MODEL DESCRIBING THE THERMODYNAMIC STRUCTURE OF THE TROPOSPHERE IN THE MID-LATITUDES	12	B. DIEPPOIS	OBSERVED DECADAL VARIABILITY IN WEST-AFRICAN SAHEL RAINFALL AND THEIR ASSOCIATED MONSOON ANOMALIES	11
15:40-16:00			**TEA BREAK**			

PARALLEL SESSION 3A (ROYAL PALM): CLIMATE - AIR QUALITY Chaired by: Dr. Liesl Dyson			Pg.	PARALLEL SESSION 3B (SAILS) : CLIMATE - OCEAN INTERACTION Chaired by: Dr. Mathieu Roault		Pg.
16:00-16:20	U. EVA LILIANE	AN EVALUATION OF HOW WELL RCMS CORDEX AND GCMS MODELS SIMULATES SOUTHERN AFRICAN DROUGHTS PATTERNS	44	B. BACKEBERG	A REGIONAL SIMULATION OF THE GREATER AGULHAS CURRENT SYSTEM WITH DATA ASSIMILATION	29
16:20-16:40	M.MOKHELE	ENTERIC METHANE EMISSIONS ESTIMATES FOR SOUTH AFRICA	11	PETER JOHNSTON	OCEAN-CLIMATE TELECONNECTIONS, DROUGHT AND WHEAT YIELD VARIATION IN SOUTH AFRICA	32
16:40-17:00	A. BERAKI	THE ROLE OF THE SOUTHERN ANNULAR MODE IN A DYNAMICAL GLOBAL COUPLED MODEL	11	L. GUASTELLA	EFFECT OF WIND ON NEAR-SURFACE CURRENTS WITHIN THE DURBAN EDDY	31

17:00-18:30	**Poster Session - Tea/Coffee/Juice and eats**	**19:00**	**Dinner - Conference Room - MARLIN**

PROGRAMME 27 September

PLENERY SESSION -2 : ROYAL PALM Chaired by : Prof. Piketh Stuart		
08:30-09:00	Prof. Hassan Bencherif	Ground and Satellite based remote sensing
09:00-09:30	Prof. R. R. Reddy	Spatial heterogeneity in Aerosols
09:30-10:00	Mr. Raven Jimmy	NRF Funding opportunities for Researcher and Students
10:00-10:30	Prof. P. B. Rao	High power VHF radar studies of atmosphere
10:30-10:50	**TEA BREAK**	

PARALLEL SESSION 4A (ROYAL PALM) : ATMOSPHERIC MEASUREMENTS Chaired by: Prof. Hassan Bencherif			Pg.	PARALLEL SESSION 4B (SAILS) : CLIMATE MODELS AND METEOROLOGY Chaired by: Dr. Francois ENGELBRECHT		Pg.
10:50-11:10	C.Y.WRIEGHT	SOLAR ULTRAVIOLET RADIATION MEASUREMENTS AT SOUTH AFRICAN AND REUNION ISLAND COASTAL SITES: AN INDICATOR OF PUBLIC SUN PROTECTION	13	J.C.J.CRONJE	INVESTIGATING LIMITING CONDITIONS IN MOUNTAIN WAVE ROTOR FORMATION: AN EXPERIMENTAL APPROACH APPLIED TO THE OUTENIQUA MOUNTAINS IN THE GEORGE REGION	14
11:10-11:30	J.R.COETZEE	THE VALUE OF HIGH RESOLUTION BALLOON OZONE SOUNDINGS FROM THE IRENE WEATHER OFFICE IN AIR-POLLUTION STUDIES OVER THE JOHANNESBURG-PRETORIA MEGACITY	31	W.S. CONRADIE	DEFINING THE NONLINEAR, CHAOTIC CLIMATE SYSTEM: IMPLICATIONS FOR MEASUREMENT AND EXPERIMENTS IN A TRANSIENT PERIOD	25
11:30-11:50	E. BECKER	EXPERIMENTING WITH THE RAINBOW BRIGHT-BAND CORRECTION ALGORITHM	38	I. PRETORIUS	A CFD MODEL OF FLOW OVER THE COMPLEX TERRAIN OF MARIEPSKOP, SOUTH AFRICA	22
11:50-12:10	JM. JOSIPOVIC	ATMOSPHERIC BOUNDARY LAYER REDUCTION ENABLED COMPARISON OF REMOTELY SENSED AND SURFACE MEASURED TRACE GAS CONCENTRATIONS OVER SOUTH AFRICA	18	S.STRYDOM	A NEAR REAL-TIME FIRE DANGER INDEX MEASUREMENT SYSTEM	26
12:10-12:30	C. LABUSCHAGNE	CARBON DIOXIDE MEASUREMENTS AT CAPE POINT: RECENT REVALATIONS	30	R. MAISHA	EVALUATION OF WRF AS A METEOROLOGICAL FORECASTING TOOL OVER THE COMPLEX TERRAIN OF SOUTH AFRICA	20
12:30-12:50	T.MOHAMMED	A DUAL LIDAR DEVELOPMENT FOR ENVIRONMENTAL STUDIES IN ALGERIA	26	HERSEY SCOTT	CLOUD CONDENSATION NUCLEI IN THE ARABIAN PENINSULA	16
12:50-14:00	**LUNCH BREAK**					

PARALLEL SESSION 5A (ROYAL PALM): REMOTE SENSING and METEOROLOGY Chaired by : Prof. P. B. Rao			Pg.	PARALLEL SESSION 5B (SAILS) : CLIMATE and RAINFALL Chaired by: Dr. M. M. Bobabe		Pg.
14:00-14:20	G.N.LONGANDJO	HOW DOES AEROSOL VARIABILITY OVER CENTRAL AFRICA IMPACT TROPICAL ATLANTIC CONVECTION AND RAINFALL?	34	J.M.ATANASIO	ATMOSPHERIC AND OCEAN PATTERNS RESPONSIBLE FOR THE EXTREME RAINS AND FLOODS IN SOUTHERN AFRICA IN JANUARY 2013	29
14:20-14:40	S. LAWAL	ASSESSMENTS OF THE CARBON STORAGE POTENTIAL OF FORESTATION IN SOUTHERN AFRICA	34	T.MUKUNGA	LEARNING TOOLS TO TRY AND ANSWER QUESTIONS: ASSESSING THE ABILITY OF THE GFS FORECASTS TO PREDICT HOURLY SURFACE TEMPERATURE AND RAINFALL AT 5 WEATHER STATIONS IN THE WESTERN CAPE	40
14:40-15:00	C. POWELL	CHARACTERISTICS OF HAILSTORMS OVER THE HIGHVELD OF SOUTH AFRICA	22	C. OLIVER	RIVER-FLOW PRIDICTIONS FOR THE SOUTH AFRICAN MID-SUMMER USING A COUPLED GENERAL CIRCULATION MODEL	21
15:00-15:20	C.M.NZOTUNGICIMPAYE	REGIONAL TRANSPORT OF TROPOSPHERIC OZONE FROM TO CAPE TOWN	42	B.VAN DEN BERG	PRECIPITATION CHARACTERISTICS OF THE SOUTH ATLANTIC	27
15:20-15:40	W.SIVLA/Olakunle	THE MID-LATITUDES UPPER THERMOSPHERE DURING THE RECENT SOLAR MINIMUM	25	C. PRINGLE	A CASE OF HEAVY RAINFALL – VALIDATION OF DIFFERENT RAINFALL ESTIMATION TECHNIQUES	23
15:40-16:00	**TEA BREAK**					

Wrap Up (ROYAL PALM)	
16:00-16:30	**SASAS AGM**
16:30-16:45	**Prize Distribution**
16:45-17:00	**Thanks** (Dr. Nkanyiso Bongumusa Mbatha) **and Farewell**

POSTER PRESENTATION : Conference Room - ROYAL PALM

First Author Name		Paper Title	Number
ABBA OMAR	SABINA	ABILITY OF CORDEX MODELS TO SIMULATE EXTREME RAINFALL EVENTS OVER SOUTHERN AFRICA	P01
CARADEE	Y. WRIGHT	CHANGES IN GROUND-BASED SOLAR ULTRAVIOLET RADIATION DURING FIRE EPISODES: A CASE STUDY	P02
DEDEKIND	ZANE	MODELLING THE ATTRIBUTES OF RAINFALL OVER THE EASTERN ESCARPMENT OF SOUTH AFRICA	P03
LANDMAN	STEPHANIE	TOWARDS A MEDIUM-RANGE COASTAL STATION FOG FORECASTING SYSTEM	P04
LANDMAN	WILLEM	STATISTICAL DOWNSCALING OF MULTI-DECADAL CLIMATE CHANGE PROJECTIONS: BRIDGING THE GAP BETWEEN CLIMATE MODELS AND THE END-USER	P05
LENNARD	CHRIS	A DIAGNOSTIC EVALUATION OF PRECIPITATION IN CORDEX MODELS OVER SOUTHERN AFRICA	P06
LERATO	SHIKWAMBANA	ESTIMATES OF THE AEROSOL OPTICAL DEPTH OVER PRETORIA USING THE CSIR MOBILE LIDAR	P07
LUCKY	COLANE DLAMINI	ANALYSIS OF BIOMASS BURNING AND THE RELATIVE CAUSE TO VEGETATION BASED ON REMOTE SENSING DATA	P08
MASUPHA	TEBOHO	ASSESSMENT OF CHILL ACCUMULATION FOR SWEET CHERRIES AT THE MAIN PRODUCTION SITES IN SOUTH AFRICA	P09
PRETORIUS	ILZE	A CFD MODEL OF FLOW OVER THE COMPLEX TERRAIN OF MARIEPSKOP, SOUTH AFRICA	P10
RAGHAVENDRA	K. KUMAR	AEROSOL-CLOUD INTERACTIONS AS INFERRED FROM MODIS OVER AN URBAN COASTAL SITE, DURBAN – A PRELIMINARY STUDY	P11
SIVLA	W. TAFON	ZONAL WINDS IN THE WEST AFRICAN REGION UPPER THERMOSPHERE DURING LOW SOLAR ACTIVITY PERIOD	P12
BUBELE	BULO	EVALUATION STUDY OF UNIFIED MODELS(UMS) ON TROPICAL CYCLONE "FELLENG" THAT HIT MAGASCAR IN JANUARY 2013	P13
KENT	MICHAEL	RANKING AOGCMS BY MODES OF VARIABILITY IDENTIFIED USING INDEPENDENT COMPONENT ANALYSIS	P14

Continued to page-2

POSTER PRESENTATION : Conference Room - SAILS

First Author Name		Paper Title	Number
MAHLOBO	DD	TEMPERATURE VERIFICATION OF THREE CONFIGURATIONS OF THE UNIFIED MODEL OVER SOUTH AFRICA	P15
MATABANE	MORWAKOMA	ATMOSPHERIC TURBULENCE FORECASTS IN THE SOUTHERN AFRICAN REGION: THE MOISTURE ASPECT	P16
MCKENZIE	JF	ROSSBY WAVES IN WINDS	P17
MIRZA	ABDUL	QUANTUM KEY DISTRIBUTION IN FREE SPACE	P18
MOLEKWA	SAMUEL	ATTRIBUTES OF CUT-OFF LOW INDUCED RAINFALL OVER THE EASTERN CAPE PROVINCE OF SOUTH AFRICA	P19
MOUSSA	MOUNKAILA	THE CAPABILITY OF CORDEX MODELS IN SIMULATING ONSET OF RAINFALL IN WEST AFRICA	P20
NCIPHA	XOLILE	CARBON DIOXIDE SPATIAL DISTRIBUTION OVER SOUTH AFRICA	P21
NELVIA	PHALA	SEASONAL DRY DEPOSITION OF SO2 AND NOX WITHIN THE FOOTPRINT OF MATIMBA POWER STATION, MARAPONG AND SURROUNDING COAL MINES, DURING THE PERIOD 2007-2012	P22
NXUMALO	MP	TREND ANALYSIS OF HEAT-WAVES RELATED TO BIRD SPECIES IN NORTH-WESTERN SOUTH AFRICA	P23
PADAYACHI	YERDASHIIN	PROFILING POLLUTION EVENTS IN SOUTH AFRICA: A CASE STUDY OF PARTICULATE MATTER IN DURBAN	P24
REBECCA	GARLAND	INVESTIGATING DRIVERS OF PARTICULATE MATTER POLLUTION IN URBAN AREAS IN SOUTH AFRICA	P25
T.E.	MAKGOALE	HEAT WAVES ALONG SOUTH WESTERN COAST OF SOUTH AFRICA	P26
A. M.	TOIHIR	COMPARISON OF OZONE TOTAL COLUMN FROM OMI/AURA AND GROUND BASED (DOBSON AND SAOZ) INSTRUMENTS IN THE SOUTHERN HEMISPHERE	P27
AUBREY	KEKANA	IMPACTS OF PM10 ATMOSPHERIC FLOWS ON CLIMATE, CITY OF CAPE TOWN (CoCT)	P28
JEAN-PIERRE	MULUMBA	ANALYSIS OF TROPOSPHERIC OZONE CLIMATOLGY IN CENTRAL AFRICA	P29
MMATHAPELO	THAPI MAKGABUTLANE	THE INFLUENCE OF METEOROLOGICAL FACTORS ON SOLAR ULTRAVIOLET RADIATION OVER PRETORIA, SOUTH AFRICA FOR THE YEAR 2012	P30

KEYNOTE **ABSTRACT**

The West African monsoon: Contribution of the AMMA multidisciplinary programme to the study of a regional climate system

Thierry Lebel
LTHE – IRD, BP 53, 38041 Grenoble cedex 9, France

The AMMA international project aims at improving our knowledge and understanding of the West African monsoon and its variability with an emphasis on daily-to-interannual timescales. AMMA is motivated by an interest in fundamental scientific issues and by the societal need for improved prediction of the WAM and its impacts on water resources, health and food security for West African nations.

The West African monsoon (WAM) has a distinctive annual cycle in rainfall that remains a challenge to understand and predict. The location of peak rainfall, which resides in the Northern Hemisphere throughout the year, moves from the ocean to the land in boreal spring. Around the end of June there is a rapid shift in the location of peak rainfall between the coast and around 10°N where it remains until about the end of August. In September the peak rainfall returns equatorward at a relatively steady pace and is located over the ocean again by November. The fact that the peak rainfall migrates irregularly compared to the peak solar heating is due to the interactions that occur between the land, the atmosphere and the ocean.

To gain a better understanding of this complex climate system, a large international research programme was launched in 2002, the biggest of its kind into environment and climate ever attempted in Africa. AMMA has involved a comprehensive field experiment bringing together ocean, land and atmospheric measurements, on timescales ranging from hourly and daily variability up to the changes in seasonal activity over a number of years.

This presentation will provide an overview of the scientific objectives of AMMA-Phase 1, describe the field programme and its accomplishments, and finally address some key questions that have been recently identified to form the core of AMMA-Phase 2.

Short CV of Dr. Theirry Lebel

Dr. Thierry F. Lebel, is director of Laboratoire d'étude des Transferts en Hydrologie et Environement (CNRS, IRD, Université Jospeh Fourier). He obtained his doctoral degree in 1984 from Institut National Polytechnique de Grenoble and has been honored by outstanding awards from CNRS and the French National Scientific Academy. He has published more than 80 articles in peer reviewed journals and his research focii are in the field of Hydrometerology, Climatology, Stochastic Modelling, Water Cycle and Climate Change. He has made significant research contributions on tropical regions, more specifically on West Africa. He has been a steering committee member of several national and international programmes, more specifically, HAPEX-Sahel: Hydrological and Atmospheric Pilot Experiment in the Sahel, CLIVAR : Climate Variability and predictability, and most recently, AMMA as the head of the *International Coordination and Implementation Group of the intensive field campaigns (2005-2007). He is currently member of the Independent scientific panel of* CCAFS : Climate Change, Agriculture and Food Securit), a CGIAR-ESSP Mega program.

Abstracts from Peer-reviewed conference Proceedings

OBSERVED DECADAL VARIABILITY IN WEST-AFRICAN SAHEL RAINFALL AND THEIR ASSOCIATED MONSOON ANOMALIES

Bastien Dieppois[1], Arona Diedhiou[2], Bernard Fontaine[3], Alain Durand[1], Mathieu Fournier[1], Yongkang Xue[4]

[1] Laboratoire Morphodynamique Continentale et Côtière (M2C), Université de Rouen, CNRS, Mont-Saint-Aignan, France. bastien.dieppois@gmail.com
[2] Laboratoire d'étude des Transferts en Hydrologie et Environnement (LTHE), Université de Grenoble, IRD, Grenoble, France.
[3] Centre de Recherche Climatologie (CRC), Université de Bourgogne, CNRS, Dijon, France.
[4] Department of Geography, University of California, Los Angeles, California, USA.

ABSTRACT

West-African Sahel rainfall shows a large decadal signal, transitioning from wet conditions in the 1950s to dry conditions in the 1970s/80s. Only the quasi-decadal time-scale is significantly detected in the Sahel rainfall index during the 1970s and 1980s. This time-scale of rainfall variability appears to be related to two periods of dry conditions and one of relatively wet conditions in the mid-70s. The dominant quasi-decadal anomalies of West-African Monsoon have been reconstructed using Fourier transform for the 70s–80s, and subsequently assessed by the differences in wet and dry states. A strengthening of cross-equatorial Atlantic SST and pressure gradients can be related to an enhancement of monsoon flow and the northward shift of the ITCZ.

EXPERIMENTING WITH THE RAINBOW BRIGHT-BAND CORRECTION ALGORITHM

Erik Becker

South African Weather Service, Private Bag X097, Pretoria, 0001, South Africa

ABSTRACT

The bright-band is a significant source of errors when considering radar Quantitative Precipitation Estimation (QPE). The increase in reflectivity due to ice falling through the melting layer can results in a significant over-estimation when radar precipitation measurements are compared to rain gauge data. The following study attempts to utilize the bright-band filter available within the Rainbow® meteorological software. The goal is to minimize the errors caused by bright-band interference. Five selected case days that had significant bright-band interference within the radar precipitation field were selected and compared against rain gauges. Results showed improved QPE measurements at both hourly and twenty-four hourly temporal scales.

THE ROLE OF THE SOUTHERN ANNULAR MODE IN A DYNAMICAL GLOBAL COUPLED MODEL

Asmerom F. Beraki[1,2] and Willem A. Landman[2,3]

[1]South African Weather Service Pretoria, South Africa, asmerom.beraki@weathersa.co.za
[2]Departement of Geography, Geoinformatics and Meteorology, University of Pretoria
[3]Council for Scientific and Industrial Research, Natural Resources and Environment Pretoria, South Africa

ABSTRACT

The interannual and decadal variability of the Southern Annual Mode (SAM) was examined in the ECHAM 4.5-MOM3-SA ocean-atmosphere coupled general circulation model (OAGCM). The analysis placed emphasis on the behavior of the SAM when its variability and impact becomes

noticeable in the extra-tropical subcontinent. Further, the coupling interaction of the SAM with vertically intergraded moisture flux, rainfall and sea surface temperature (SST) was also investigated and compared with observations. The result revealed that the model was successful in capturing observed features of the oscillation. Nevertheless, the model SAM was found to exert more influence on the underlying atmosphere. The analysis unfolded that the low-frequency signal (11years cycle) was more likely explained by natural variability. Further, the model has shown potential in predicting the austral winter slowly evolving climate signal when the temporal vacillation of the SAM is adjusted.

SIMULATING SUPPRESSED AND ACTIVE CONVECTION PERIODS DURING TOGA COARE

Mary-Jane Morongwa Bopape[1,2], Francois Alwyn Engelbrecht[1,3], David A Randall[4] and Willem Adolf Landman[1,2]

[1] Council for Scientific and Industrial Research, Pretoria, South Africa
[2] University of Pretoria, Pretoria, South Africa
[3] University of the Witwatersrand, Johannesburg, South Africa
[4] Colorado State University, Fort Collins, Colorado, United States

ABSTRACT

The two-dimensional Non-hydrostatic σ-coordinate Model (NSM) is used to simulate two twelve day periods and an eight day period observed during the Tropical Oceans Global Atmosphere Coupled Ocean-Atmosphere Response Experiment (TOGA COARE). The response of the NSM to the large-scale forcing which occurred over the three periods, and which included both suppressed and active convection, is examined. The NSM is shown to be able to capture the differences in the three experiments and responds correctly to the large-scale forcing (i.e. it is able to distinguish between suppressed and active regimes). However, the model is cooler and drier than the observations.

RE-EVALUATING THE CONCEPTUAL MODEL DESCRIBING THE THERMODYNAMIC STRUCTURE OF THE TROPOSPHERE IN THE MID-LATITUDES

Roelof P. Burger* and Stuart J. Piketh

Unit for Environmental Management and Sciences, North-West University, Potchefstroom

ABSTRACT

The vertical structure of the troposphere explains important mixing, transport and stability characteristic. This paper describes the typical discontinuities in the troposphere using radiosonde and aircraft based in-situ observations. Simultaneous measurements of the thermodynamic profile, humidity and other tracers, like particulates and trace gases, confirms the importance of stable discontinuities to vertical and horizontal transport. Only soundings with more than 60 reported levels should be used to describe the thermodynamic structure of the troposphere. Including the standard reporting levels also bias ed the characterization. These considerations challenge the current conceptual model describing the vertical structure of the troposphere in the mid-latitudes.

SOLAR ULTRAVIOLET RADIATION MEASUREMENTS AT SOUTH AFRICAN AND REUNION ISLAND COASTAL SITES: AN INDICATOR OF PUBLIC SUN PROTECTION

Caradee Y. Wright[a]*, Colette Brogniez[b], Katlego P. Ncongwane[c,d], Venkataraman Sivakumar[d], Gerrie Coetzee[c], Jean-Marc Metzger[c], FrédériqueAuriol[b], Christine Deroo[b], and Béatrice Sauvage[b]

[a]Council for Scientific and Industrial Research. [b]Université Lille. [c]South African Weather Service.
[d]University of KwaZulu-Natal. [e]Université de La Reunion.

ABSTRACT

Solar ultraviolet radiation (UVR) has the potential to cause biological harm to humans. Intensity of solar UVR at the Earth's surface depends on several factors, such as total column ozone and cloud cover, and temporal trends are usually dependent on season and time of day. Understanding such patterns helps inform the development of sun protection awareness information for the public. Here, solar erythemal (sunburning) UVR levels were analysed for three populated coastal sites in South Africa and Reunion Island to determine seasonal and diurnal trends. These trends were then discussed in light of tailoring appropriate public health messages.

CHANGES IN GROUND-BASED SOLAR ULTRAVIOLET RADIATION DURING FIRE EPISODES: A CASE STUDY

Caradee Y. Wright[a*], Sally Archibald[b], Rebecca M Garland[a], Mogesh Naidoo[a], Phillip Frost[c] and Nelvia Phala[a]

[a]CSIR Climate Studies, Modelling and Environmental Health, Pretoria, South Africa. * cwright@csir.co.za
[b]CSIR, Natural Resources and the Environment, Pretoria, South Africa.
[c]CSIR Meraka Institute, Pretoria, South Africa.

ABSTRACT

Solar ultraviolet radiation (UVR) levels are affected by airborne aerosols, such as particles and gases released during biomass burning events. Two large-scale fires in South Africa were identified and selected based on their proximity to solar UVR measurement sites and the prevailing wind direction at the time of the fires. Solar UVR levels were then scrutinized to qualitatively assess whether it could be seen if the fires impacted upon solar UVR levels. It was difficult to make definitive conclusions about the relationship between fires and solar UVR without local high-quality column or ground-based ambient air pollution (particulate matter in particular) data; however, the threat to public health from fires was acknowledged.

THE RELATIVE CONTRIBUTION OF SYNOPTIC TYPES TO RAINFALL OVER THE CAPE SOUTH COAST REGION

Christien J Engelbrecht,[1,2] Willem A Landman[2,3] and Francois A Engelbrecht[3]

[1]Agricultural Research Council, Institute for Soil, Climate and Water, Pretoria, South Africa
[2]Department of Geography, Geo-informatics and Meteorology, University of Pretoria, Pretoria, South Africa
[3]Council for Scientific and Industrial Research, Climate Studies, Modelling and Environmental Health, Pretoria, South Africa

ABSTRACT

A synoptic decomposition of rainfall over the Cape south coast region for the period 1979-2011 is presented. This is achieved by considering the average daily low-level circulation to develop a

synoptic climatology. Daily area average rainfall derived from weather station rainfall data is related to the identified synoptic types. It is shown that ridging high pressure systems are responsible for about 41% of the annual rainfall over the Cape south coast region, followed by tropical-temperature troughs (24%), cut-off lows (COLs) (13%), frontal troughs (12%), continental trough – ocean ridge combinations (8%) and weak synoptic flow (2%).

INVESTIGATING LIMITING CONDITIONS IN MOUNTAIN WAVE ROTOR FORMATION: AN EXPERIMENTAL APPROACH APPLIED TO THE OUTENIQUA MOUNTAINS IN THE GEORGE REGION OF SOUTH AFRICA

J.C.J. Cronjé[1], D. Van der Mescht[2]

[1]Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria 0001, South Africa
[2]South African Weather Service, Private Bag 5991, Walmer 6065, South Africa

ABSTRACT

Stably-stratified airflow across a topographic barrier may lead to the generation of gravity waves known as mountain waves, where buoyancy acts as the restoring force. Turbulent eddy structures known as mountain wave rotors (MWRs) may result in the lee of the topographic barrier, and pose a serious hazard to aviation activities. Concomitant occurrence of mountain waves and MWRs is predicated on both established and theorised upwind -and lee-side conditions being met. Historical experiments in the United States, Europe and North Africa, as well as more recent investigations in South Africa, have investigated MWR formation with varying degrees of success. The investigation focusses on the potential establishment of definitive limiting conditions in MWR formation, both upwind and on the lee-side of topographic barriers. Three sets of balloon soundings were conducted in pre-frontal synoptic conditions in the George Area of South Africa, which were deemed similar to prevailing conditions during previous successful MWR detection experiments. Scorer parameter, Froude number, potential temperature, wind speed and direction in relation to topographic azimuth angle were used as indicative upwind parameters. Wind speed, ascent rate and displacement with time served as lee-side indicators. Upwind data revealed non-ideal conditions for MWR formation in all upwind ascents. The ideal indicator of a looped perturbation in vertical displacement with time is not present in lee side data. Possible evidence of MWR occurrence is present in lee side data as ascent rate - wind speed relationships, as well as the occurrence of reversed flow below summit level.

MODELLING THE ATTRIBUTES OF RAINFALL OVER THE EASTERN ESCARPMENT OF SOUTH AFRICA

Zane Dedekind[1], Francois A. Engelbrecht[1], Roelof P. Burger[2] and Stuart Piketh[2]

[1]CSIR Natural Resources and the Environment – Climate Studies, Modelling and Environmental Health, Pretoria, 0001, South Africa
[2] North-West University, Potchefstroom, South Africa

ABSTRACT

Rainfall simulations for 1979-2004 by the Conformal-Cubic Atmospheric Model (CCAM) are presented with particular emphasis on timing and spatial attributes over southern Africa. Global Circulation Models (GCMs) and Regional Climate Models (RCMs) generally fall short in simulating rainfall over the eastern escarpment by over estimating rainfall south east of Lesotho. December is shown to be the wettest as observed datasets indicated that the CCAM is too early with its maximum rainfall simulations by a month. The diurnal cycle resembles a more realistic outcome as convective rainfall mostly occurs between 12h and 18h in the form of high-veld heat storms.

CLIMATOLOGY OF HEAVY RAINFALL SOUNDINGS AT IRENE BY USING SELF-ORGANIZING MAPS

Liesl L Dyson[1], Christien E Engelbrecht[2] and Johan van Heerden[1]

[1] Department of Geography, Geo-informatics and Meteorology, University of Pretoria, Pretoria, South Africa
[2]Agricultural Research Council, Institute for Soil, Climate & Water

ABSTRACT

A sounding climatology was created for heavy rainfall at Irene in the austral summer by using self-organizing maps (SOMs). South African Weather Service Irene sounding data were utilised and the temperature, dew point temperature and wind direction and speed at 12 pressure levels were extracted and 12 sounding derived parameters calculated. These variables were used to train the SOM. The SOM was capable to distinguishing atmospheric conditions favourable for heavy rainfall in early summer from those in late summer. It combines information about the vertical profile of the atmosphere with sounding parameters and detailed information on critical values for heavy rainfall is available.

THE FUTURE IS UNCERTAIN, BUT NOT IN A RANDOM WAY

Francois A. Engelbrecht

Climate Studies, Modelling and Environmental Health
CSIR Natural Resources and the Environment

ABSTRACT

Projections of future climate change are subject to uncertainties around the future rate of greenhouse gas emissions, systematic errors in climate models and natural climate variability. Chaos theory provides perspective for projecting the evolution of the climate system against the background of enhanced anthropogenic forcing, within the context of model uncertainties. If it is assumed that the climate system lies on a strange attractor (that is, it is chaotic, or non-periodic), one may deduce that the structural evolution of the system is predictable, despite quantitative projections for any point in time being uncertain. Applying these ideas at the regional scale, it is shown that the regional climate futures of the southwestern Cape and Limpopo in South Africa are projected to have a very well-defined structural evolution, drifting towards future temperature states that have never been observed within the context of present-day climate. It is also plausible for both regions to become drier, in response to defensible projected hemispheric-scale changes in circulation. It is concluded that, at least for certain regions, the projected structural evolution of the climate systems under enhanced anthropogenic forcing is sufficiently defensible for the projections of changes in near-surface variables to be actionable.

ESTIMATING FOG WATER YIELD POTENTIAL ON THE SOUTHERN CAPE MOUNTAINS OF SOUTH AFRICA

M. Geldenhuys, J. Van Heerden

Department of Geography, Geo-informatics and Meteorology, University of Pretoria, Pretoria 2000, South Africa

ABSTRACT

In some rural communities access to potable water can be an everyday struggle. Furthermore South Africa is an arid country with a luring water problem. It's been known for centuries that numerous plants, insects and animals, across the world, use fog water for survival. In South Africa fog water

harvesting is making a contribution to the water resources of isolated mountain communities. This research describes the meteorological characteristics of fog and fog events that occurred, during 2012, on the Zondachsberg, Tsitsikamma and Outeniqua Mountains of the Southern Cape of South Africa. Results indicate that the South Cape Mountain fog characteristics differ from that found over the Western Cape West Coast regions. December, January and February months had the highest incident of fog. Surprisingly maximum fog water yield occurred, early evening during the hours 17:00-22:00 SAST. Most fog events, in the region, are caused by southerly winds advecting moist maritime air up the southern mountain slopes in the late afternoon.

VERIFICATION OF A UNIFIED MODEL BASED LIGHTNING RISK INDICATOR FOR SOUTHERN AFRICA

Morné Gijben

South African Weather Service, Private Bag X097, Pretoria, 0001, South Africa

ABSTRACT

A lightning threat index using Unified Model fields was developed for the South African region. The Lightning Threat Index calculates the possible risk for lightning. For the case of 25 March 2012, various skill scores indicates the capability of the index to forecast the lightning threat, while some scores suggests that the index overestimates the threat area. The percentage of the total amount of lightning strokes inside each risk category show that the risk categories evaluate well, while the scores which show what percentage of the risk category area contained lightning confirmed that the lightning threat area was over forecasted.

TRENDS IN ATMOSPHERIC CONDITIONS ASSOCIATED WITH SEVERE STORMS OVER GAUTENG

Thandiwe Gumede and Liesl Dyson

Department of Geography, Geo-informatics and Meteorology, University Of Pretoria, Pretoria 0001, South Africa

ABSTRACT

Sounding parameters have been used extensively to determine atmospheric conditions that are conducive to severe convective storms. This paper uses upper air soundings for 1200Z at Irene, South africa to determine trends in atmospheric conditions associated with severe storms through the use of sounding-derived parameters. Data are analysed for September-November from 1976 to 2012. Nine parameters were extracted and monthly mean values were calculated as well as frequency of exceedance of critical values associated with severe storms. The mean layer dew point temperature has a significant downward trend as does the convective cloud base pressure. Surface temperatures and 500 hPa temperatures increase but these trends are not significant.

CLOUD CONDENSATION NUCLEI IN THE ARABIAN PENINSULA

[1]Scott P. Hersey, [1]Stuart J. Piketh, [1]Roelof P. Burger, [1]Jared Lodder, [2]Duncan Axisa

[1]North-West University, Unit for Environmental Sciences and Management,
11 Hoffman Street, Potchefstroom, 2520, South Africa
[2]UCAR, Boulder, Colorado, USA

ABSTRACT

Aerosol particles have a significant impact on climate by directly interacting with solar radiation and indirectly by influencing cloud microphysics. The degree to which aerosol particles, or condensation nu- clei (CN), activate when exposed to RH >100% and become cloud condensation nuclei (CCN)

determines their indirect effect. These CCN characteristics are particularly important in areas with high aerosol loading like the Middle East and Sub-Saharan Africa. This paper presents satellite, ground, and aircraft-based measurements of aerosol composition and CCN concentrations that were made between 2006 and 2008 during field campaigns in Saudi Arabia. Results indicate that a common particle type is sulfate-coated dust, which is efficient in acting as CCN. Sea breeze and moist air intrusions enhance CCN concentrations signifi- cantly, coincident with elevated numbers of accumulation mode aerosol. Correlations between CCN con- centrations and satellite measurements of aerosol optical thickness (AOT) and Ängstrom exponent are explored.

SIMULATING HOURLY RAINFALL OVER SOUTH AFRICA USING THE CCAM

X.F Jele[1], M .M Bopape[2], F.A Engelbrecht[2]

[1]University of Pretoria, Private Bag X20, Hatfield, Pretoria, 0028
[2]Council for Scientific and Industrial Research, P O Box 395, Pretoria, 0001

ABSTRACT

The diurnal cycle of rainfall over four cities (i.e. Cape Town, Pretoria, Kimberly and Umtata) in South Africa as simulated by the Conformal Cubic Atmospheric Model (CCAM) is investigated in this study. Hourly CCAM simulations made for the period 1989 to 2008, are compared with the South African Weather Service (SAWS) observations. An afternoon peak is observed and simulated over Kimberly and Umtata. Over Pretoria there is a midnight and afternoon peak in both the observations and simulations. The simulated rainfall peak occurs earlier than observed in Kimberly, Pretoria and Umtata. The diurnal cycle is weaker over Cape Town and most of the rainfall is simulated and observed in the morning. The simulated rainfall intensity is lower than the observed rainfall intensity in all the cities because simulated rainfall reflects rainfall averaged over a grid box while the observations reflect values at a single point.

AEROSOL OPTICAL PROPERTIES OVER PRETORIA, SOUTH AFRICA DURING SPRING TIME MEASURED FROM CIMEL SUNPHOTOMETER

A. Joseph Adesina*, K. Raghavendra Kumar, V. Sivakumar

Discipline of Physics, School of Chemistry and Physics, College of Agriculture, Engineering and Science, University of KwaZulu – Natal, Westville Campus, Durban 4000, South Africa

ABSTRACT

The present study investigates the optical properties of aerosol measured with the ground based Sunphotometer over Pretoria for the springtime of 2012. AOD (Aerosol Optical Depth) showed strong wavelength dependence with lower wavelength corresponding to higher AOD and vice-versa. The seasonal AOD_{500} average was found to be 0.21±0.12, CWV (Columnar Water Vapor) is 1.39±0.50 and $\alpha_{440\text{-}870}$ (Angstrom Exponent) average was 1.52±0.22 with fine aerosol dominance throughout the season.

ATMOSPHERIC BOUNDARY LAYER REDUCTION ENABLED COMPARISON OF REMOTELY SENSED AND SURFACE MEASURED TRACE GAS CONCENTRATIONS OVER SOUTH AFRICA

M. Josipovic[1], R.P. Burger[2], H.J. Annegarn[3], J.J. Pienaar[1], S.J. Piketh[2], M.A. Kneen[4]

[1]School of Physical and Chemical Sciences, Faculty of Natural Sciences, North-West University, Potchefstroom
[2]School of Geo and Spatial Sciences, Faculty of Natural Sciences, North-West University, Potchefstroom Campus, Potchefstroom
[3]Department of Geography, Environmental Management and Energy Studies, Faculty of Science, University of Johannesburg, Johannesburg
[4]Department of Geosciences, the University of Texas at Dallas, Richardson, USA

ABSTRACT

A database of ground-level trace gas concentrations of sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and ozone (O_3), measured by gaseous passive diffusive sampling, was used to compare remote sensing (RS) retrievals (SCIAMACHY and MLS/OMI) of these pollutants. The ground-based network comprised 37 passive sampling sites, covering the north-eastern interior of South Africa, while avoiding sources of local pollution. The network operated between August 2005 and September 2007. A method to compare surface-level passive sampling concentrations to remote sensing vertical column densities was developed, based on assumptions of well-mixed boundary layer and on partitioning of the trace gases between layers of the atmosphere. The boundary layer reduction was used for the conversion of the RS retrievals into molar ratios and split of boundary columns from tropospheric columns. Results test if the method could constitute a useful supplementary approach to monitoring regional-scale air pollutants for regions lacking ground or air-borne monitoring capabilities.

TOWARDS A MEDIUM-RANGE COASTAL STATION FOG FORECASTING SYSTEM

Stephanie Landman[1*], Estelle Marx[1], Willem A. Landman[2], Simon J. Mason[3]

[1] South African Weather Service, Pretoria, South Africa
[2] Natural Resources and the Environment, Council for Scientific and Industrial Research, Pretoria, South Africa
[3] International Research Institute for Climate and Society, New York, United Stated of America

ABSTRACT

An empirical downscaling technique to predict daily fog occurrence at Cape Town International Airport from low-level atmospheric circulation is developed by using the Principal Component Regression option of the Climate Predictability Tool. NCEP 12UTC sea-level pressure data fields are the predictors in the empirical model and the occurrence of fog the next day the predictand. Probabilistic fog predictions are tested over an independent 365 day period and the skill is represented by the ability of the model to discriminate fog days from non-fog days and also to test the reliability of the forecasts.

EVALUATION OF SEVERE WEATHER GUIDANCE MAPS ISSUED BY THE SOUTH AFRICAN WEATHER SERVICE

Stephanie Landman*[1], Estelle Marx[1], Njabulo Mchunu[2]

[1] South African Weather Service, Pretoria, South Africa
[2] University of Pretoria, Pretoria, South Africa

ABSTRACT

Daily subjective guidance maps of severe weather are issued by the South African Weather Service for the southern African region. In this study, the skill of the guidance for rainfall exceeding 25 and 50 mm/day for the period of October 2012 to March 2013 is determined using the Hydro-Estimator as well TRMM rainfall estimation fields. Similar results are found with both rainfall estimation fields, however the statistics tends to give higher scores when applying the 25 mm/day threshold and using the Hydro-Estimator as observations. It is also found that with both the Hydro-Estimator and the TRMM data, the guidance maps have the best skill and overall performance during January and February when most of the extreme events occur.

STATISTICAL DOWNSCALING OF MULTI-DECADAL CLIMATE CHANGE PROJECTIONS: BRIDGING THE GAP BETWEEN CLIMATE MODELS AND THE END-USER

Willem A. Landman,[1,2] Francois A. Engelbrecht,[1] Johan Malherbe[3] and Jacobus van der Merwe[1]

[1]Council for Scientific and Industrial Research, Climate Studies, Modelling and Environmental Health, Pretoria, South Africa
[2]Department of Geography, Geo-informatics and Meteorology, University of Pretoria, Pretoria, South Africa
[3]Agricultural Research Council, Institute for Soil, Climate and Water, Pretoria, South Africa

ABSTRACT

Multi-decadal regional climate projections are assimilated into a statistical model in order to produce an ensemble of mid-summer maximum temperature for southern Africa. The statistical model uses atmospheric thickness fields (geopotential height differences between the 500 and 850 hPa levels) from high-resolution reanalysis data as predictors in a perfect prognosis approach in order to develop linear equations which represent the relationship between atmospheric thickness fields and gridded maximum temperatures across the region. The statistical model is found to be able to replicate the increasing maximum temperature trends of the driving regional climate model. Since dry-land crops are not explicitly produced by climate models but are sensitive to temperature extremes, the effect of these projected maximum temperature trends is assesses on dry-land crops over multiple decades by employing a statistical approach similar to the one introduced for maximum temperatures.

A DIAGNOSTIC EVALUATION OF PRECIPITATION IN CORDEX MODELS OVER SOUTHERN AFRICA

Chris Lennard[1]*, Liana Kalagnoumou[1], Mxolisi Shongwe[2]

[1]Climate System Analysis Group, University of Cape Town; [2]South African Weather Service, Pretoria

ABSTRACT

We evaluate the ability of ten regional climate models (RCMs) to simulate precipitation over southern Africa. In general, the spatial and temporal nature of rainfall over the region is captured although models generally produce lower seasonal rainfall. Model biases are related to model setup, simulated circulation fields and moisture transport. The ensemble mean generally out-performs individual

models, with bias magnitudes similar to differences across the observational data sets. In places the ensemble mean improves the precipitation climate compared to that of the ERA-Interim reanalysis. The models generally capture the dry (wet) precipitation anomaly associated with El Niño (La Niña) events.

ESTIMATES OF THE AEROSOL OPTICAL DEPTH OVER PRETORIA USING THE CSIR MOBILE LIDAR

Lerato Shikwambana[1,2*], Venkataraman Sivakumar[2]

[1]Council for Scientific and Industrial Research, National Laser Centre, Pretoria, South Africa
[2]School of Chemistry and Physics, University of KwaZulu-Natal, Durban, South Africa

ABSTRACT

The LIDAR measurements taken at Pretoria (25° 53′ 7″S, 27° 42′ 28″E) were validated against the Level-3 MODIS aerosol optical depth (AOD) data. The AOD retrieved from the LIDAR data was very comparable to that of the MODIS data.

EVALUATION OF WRF AS A METEOROLOGICAL FORECASTING TOOL OVER THE COMPLEX TERRAIN OF SOUTH AFRICA

Robert Maisha[1] G. Djolov[1], T.Ndarana[2]

[1] Department of Geography, Geo-Informatics and Meteorology, University of Pretoria, Pretoria, South Africa,
[2]South African Weather Service, Pretoria, South Africa

ABSTRACT

Weather Research and Forecasting model was applied over South African during depression Dando and heat wave with three cumulus parameterization schemes. The model was setup at a horizontal resolution of 9km with two 3km nests. Flooding over north-eastern parts of South Africa was caused by an intense low over Mozambique Channel. Moisture was transported from the tropics and Mozambique Channel into the east coast of South Africa and rise against steep topography resulting in enhanced rainfall. WRF schemes captured the spatial distribution of rainfall, but under-predicted the event. The heat wave was caused by subsidence of air and eventual surface divergence due to a high at 700 hPa over the Cape region. The model captured the spatial distribution, but under-predicted its intensity.

THE INFLUENCE OF METEOROLOGICAL FACTORS ON SOLAR ULTRAVIOLET RADIATION OVER PRETORIA, SOUTH AFRICA FOR THE YEAR 2012

M. Makgabutlane[a], C.Y. Wright[b]

[a]Department of Geography Geo-informatics and Meteorology, University of Pretoria
[b]Council for Scientific and Industrial Research

ABSTRACT

Pretoria receives a fair amount of solar ultraviolet radiation (UVR). Certain meteorological factors affect the amount of solar UVR that reaches the ground. The most dominant influencing meteorological factors are stratospheric ozone, cloud cover and solar zenith angle. In this paper the

following relationships were investigated: solar UVR and cloud cover, solar UVR and solar zenith angle and solar UVR and total column ozone over Pretoria for 2012. The difference between the satellite-based and ground-based solar UVR values was also considered. This study provided insight into the intensity of solar UVR and various influencing factors at various times of the year.

PRELIMINARY RESULTS OF THE RAPIDLY DEVELOPING THUNDERSTORM PRODUCT IN SOUTH AFRICA

Bathobile Maseko, Cassandra Pringle, Mornè Gijben

South African Weather Service, Private Bag X097, Pretoria, 0001, South Africa

ABSTRACT

The Rapidly Developing Thunderstorm (RDT) product was developed in Europe to use Meteosat geostationary satellite data to identify, classify and track thunderstorms. It is currently being implemented at the South African Weather Service to assist forecasters in identifying potentially hazardous convective cells, particularly for use in data sparse areas. It uses geostationary satellite Brightness Temperature thresholds along with Numerical Weather Prediction (NWP). It can display past, growing, mature and decaying storms using cooling rates to determine which phase the storms are in. The RDT will be verified for a severe storm case day of 6 September 2012.

AN UPDATE ON CCAM MODELLING ACTIVITIES AT CSIRO

John McGregor, Jack Katzfey, Marcus Thatcher, Peter Hoffmann, Kim Nguyen

CSIRO/Centre for Australian Weather and Climate Research, Aspendale, Australia John.McGregor@csiro.au

ABSTRACT

This paper describes the dynamical formulation of CCAM, its physical parameterizations, and its downscaling methodology. Recent developments in the physical parameterizations are shown. Results are then presented for ensembles of 50 km resolution downscaled global simulations, performed for CORDEX. Finally, plans and developments for CCAM are described.

RIVER-FLOW PRIDICTIONS FOR THE SOUTH AFRICAN MID-SUMMER USING A COUPLED GENERAL CIRCULATION MODEL

C Olivier[1], WA Landman[2], AF Beraki[1]

South African Weather Service, Pretoria, 0181, South Africa[1]
Council for Scientific and Industrial Research, Pretoria, 0184, South Africa[2]

ABSTRACT

There are limited sources of streamflow data available in South Africa. These include simulated streamflow for catchments across South Africa and measured river-flow at specific rivers around the country. Given that a number of studies has been done on the prediction of simulated streamflow, and only one recent study on a limited number of measured river-flow stations, there is a need for a national measured river-flow dataset that previous results of streamflow prediction can be compared against. This study demonstrates the seasonal-to-interannual predictability of river-flow over the summer rainfall areas of South Africa by using various fields from a coupled general circulation model as predictors in statistical post-processing system.

CLIMATE EXTREMES INDICES IN THE CORDEX MULTIMODEL ENSEMBLE: FUTURE CLIMATE PROJECTIONS

Izidine Pinto*, Chris Lennard, Mark Tadross and Bruce Hewitson

Climate System Analysis Group, University of Cape Town, Cape Town, South Africa

ABSTRACT

The study analyses the CORDEX ensemble simulations with respect to changes in extreme events characteristics at the end of 21st century compared to present day conditions. A regional climate model (RCM) from the CORDEX project is analyzed to assess projected changes in 21st century extreme precipitation events over southern Africa. The Rossby Center Regional Climate Model (RCA4) with horizontal grid spacing of 50 km is considered, which is driven by 8 GCMs under an RCP4.5 emission scenario.

CHARACTERISTICS OF HAILSTORMS OVER THE HIGHVELD OF SOUTH AFRICA

Craig L Powell[1]

[1]South African Weather Service, Private Bag X097, Pretoria, 0001, South Africa

ABSTRACT

The interior and eastern escarpment of South Africa frequently experience thunderstorms during the summer rainfall period. While most of these are not severe, thunderstorms have to potential to inflict serious damage to property and result in the loss of life. Large hail is of particular importance in South Africa. The identification of storms which produce this phenomenon is therefore crucial. An investigation of hailstorm properties is presented here to aid the identification process. Hail Mass Aloft was used to discriminate between non-hailstorms and hailstorms. A combination of the storm properties; VIL, ETH and Direction prove to be good hailstorm identifiers.

A CFD MODEL OF FLOW OVER THE COMPLEX TERRAIN OF MARIEPSKOP, SOUTH AFRICA

Ilze, I. Pretorius[1,2] and Hannes, C.J. DeW. Rautenbach[1]

[1]Department for geography, Geoinformatics and Meteorology, University of Pretoria
[2]School of Geo- and Spatial Science, Unit for Env. Sc. and Management, North-West University

ABSTRACT

Locations where large altitudinal gradients exist have been shown to be a good early indicator of climate change. Mariepskop is a high mountain peak situated in the Mpumalanga province of South Africa. It is partly isolated from the rest of the Drakensberg mountain range, making it ideal to study the effects of flow dynamics and climate over the mountain without interference in the flow from adjacent topography. The flow dynamics of Mariepskop was studied by forcing averaged, long term synoptic observations at Mariepskop across the lateral boundaries of a Computational Fluid Dynamics (CFD) model. Although CFD models have traditionally been used for engineering applications, CFD models have been used more commonly in the meteorological realm over the last few years. Model results were verified by weather station observations and aerial photographs of the mountain. The model was able to simulate wind speed, wind direction and high rainfall areas relatively accurately.

A CASE OF HEAVY RAINFALL – VALIDATION OF DIFFERENT RAINFALL ESTIMATION TECHNIQUES

Cassandra Pringle

South African Weather Service, Private Bag X097, Pretoria, 0001, South Africa

ABSTRACT

The International Precipitation Working Group (IPWG) has a standardised format to validate global precipitation products. South Africa has a number of these validated products available daily on a webpage. A case study using a heavy rainfall event was used to gauge the performance of available products such that users can determine which products perform the best in South Africa. Various statistical scores and visual verifications were conducted using the IPWG standardised formats.

LONG-TERM VARIATIONS IN MODIS DERIVED AEROSOL OPTICAL DEPTH AND FINE MODE FRACTION AT THREE DIFFERENT ENVIRONMENTS IN SOUTH AFRICA

K. Raghavendra Kumar*, V. Sivakumar, A. Joseph Adesina

Discipline of Physics, School of Chemistry and Physics, College of Agriculture, Engineering and Science, University of KwaZulu – Natal, Westville Campus, Durban 4000, South Africa

ABSTRACT

Intra-annual variations in aerosol optical depth (AOD), Ångström exponent (α) and fine mode fraction (FMF) from MODerate resolution Imaging Spectroradiometer (MODIS) during 2005-2009 over three different environments (Pretoria, Bloemfontein and Cape Town) of South Africa are investigated. MODIS derived AODs at 500 nm are higher than 0.15 over Pretoria and show prominent seasonal variations of spring/summer high and winter low. The high value in spring in all three stations is due to enhanced biomass burning anthropogenic activities. The strong convection and deeper boundary layer and increase in water vapor results in growth of fine mode water soluble aerosol results in higher AODs during summer season. FMF values are noticed to be high over Cape Town (0.56) during summer indicates dominance of fine mode aerosols due to abundance of cloud condensation nuclei (CCN) aerosols transported from oceanic region. Ångström exponent showed similar trend as FMF. Thus it is clear that aerosol vary regionally with different geographical circumstances, and also seasonally.

AEROSOL-CLOUD INTERACTIONS AS INFERRED FROM MODIS OVER AN URBAN COASTAL SITE, DURBAN – A PRELIMINARY STUDY

K. Raghavendra Kumar*, V. Sivakumar and A. Joseph Adesina

Discipline of Physics, School of Chemistry and Physics, College of Agriculture, Engineering and Science, University of KwaZulu – Natal, Westville Campus, Durban 4000, South Africa

ABSTRACT

Aerosols are known to impact the formation and the life cycle of clouds. The present study focused on the variations in aerosol mass loading over an urban coastal site, Durban, and the impact of these particles on cloud formation and how they change the microphysical properties of clouds, using Moderate Resolution Imaging Spectroradiometer (MODIS) data from the Terra satellite. The seasonal variations in aerosol optical depth (AOD) at 550 nm and cloud parameters over Durban are reported for the year 2012. We have studied the impact of increase in aerosol loading on rainfall for the present

study period. We have then documented the correlation between AOD and various cloud parameters for better understanding of aerosol-cloud interactions.

AIR TEMPERATURE MEASUREMENT ERRORS

Michael J. Savage[1]

School of Agricultural, Earth and Environmental Sciences, Agrometeorology Discipline, Soil-Plant-Atmosphere Continuum Research Unit, University of KwaZulu-Natal, Pietermaritzburg, South Africa

ABSTRACT

Accurate air temperature measurements are required for many different purposes, including global warming impacts. Temperature methods used in this study included: Stevenson screen, 6-plate Gill shield, radiation-shielded and aspirated systems, and unshielded and naturally ventilated 25- and 75- m fir -wire thermocouples. The 25-µm unshielded thermocouple measurements were most accurate. A web-based near real-time data and information teaching, learning and research system was used to display measurements (http://agromet.ukzn.ac.za:5355/?command=RTMC&screen=Tair%20 comparison). This assisted in establishing the relative magnitude of the air temperature differences between the different systems. Stevenson screen properties are poorly characterised under conditions of varying solar irradiance and low wind speeds.

INVESTIGATING THE OCCURRENCE AND POSITIONING OF POSITIVELY CHARGED LIGHTNING WITHIN CUMULONIMBUS CLOUDS

*** Lee-ann Simpson [1,2], Hannes Rautenbach [2]**

[1]South African Weather Service, Private Bag X097, Pretoria, 0001, South Africa
[2]Department of Geography. Geo-informatics and Meteorology, University of Pretoria, 0002

ABSTRACT

Positive lightning flashes are known to be more intense and cause more damage than negative flashes, although positive flashes only occur about 10% of the time. This study illustrates the8 cloud microphysical aspects of thunderstorms and investigates the occurrence, timing and location of ice particles within thunderstorms and correlates this to the occurrence of positive cloud-to-ground lightning events.

ZONAL WINDS IN THE WEST AFRICAN REGION UPPER THERMOSPHERE DURING LOW SOLAR ACTIVITY PERIOD

Sivla W. Tafon[1] and Ogunjobi Olakunle[2]

[1]Department of Physics, Kogi State University, Anyigba, 1008, Nigeria
[2]School of Chemistry and Physics, University of KwaZulu-Natal, Durban, 4000, South Africa.

ABSTRACT

Using 3 years (2006 – 2008) of zonal wind data from the accelerometer on board the CHAMP satellite an attempt has been made for the first time to present the climatology of the West African region upper thermosphere. The diurnal variation of the zonal wind speeds reveals significant differences in wind speeds during the sunrise hours. June solstice winds are observed to be relatively stronger during the sunrise hours with maximum speeds going above 150 m/s. The wind behaviour presented in this study is longitudinally averaged and may differ from measurements at a certain

longitude. So, there is need for ground observatories which can generate data to be used for comparison.

THE MID-LATITUDES UPPER THERMOSPHERE DURING THE RECENT SOLAR MINIMUM

Sivla W. Tafon[1] and Ogunjobi Olakunle[2]

[1]Department of Physics, Kogi State University, Anyigba, 1008, Nigeria
[2]School of Chemistry and Physics, University of KwaZulu-Natal, Durban 4000, South Africa.

ABSTRACT

The diurnal variations of mid-latitude upper thermosphere zonal winds during extreme low solar activity period from 2006 to 2008 have been presented. This period is characterized by low magnetic activity and low solar flux levels. No significant differences are observed between north and south mid-latitude wind variations during the equinox seasons. The switch from westward to eastward direction is observed at about 1400 MLT for all the seasons. Large zonal wind speeds are observed at and after dawn in both hemispheres. The significant difference observed in morning winds at the two mid-latitude bands during the solstices may be attributed to the differences in the solar irradiation.

STEP-WISE SNOW FORECASTING DECISION TREE

Jannie Stander* and Liesl Dyson**

*South African Weather Service, Private Bag X097, Pretoria, 0001, South Africa
**Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, 0001, South Africa

ABSTRACT

South Africa is located in the sub tropics with an elevated plateau which is located approximately 1500 m above mean sea level. It is therefore prone to extra tropical weather systems in winter that can result in snowfall. Research into the forecasting of snowfall has largely been neglected in South Africa. When snowfall descends to lower elevations it affects the livelihood of people as was the case in August 2012 when snow fell in Gauteng without warning. A step-wise snow forecasting decision tree is presented which combines synoptic surface and upper air circulation patterns with cloud microphysical properties during snowfall.

DEFINING THE NONLINEAR, CHAOTIC CLIMATE SYSTEM: IMPLICATIONS FOR MEASUREMENT AND EXPERIMENTS IN A TRANSIENT PERIOD

Stefaan Conradie, J.D. Daron and B.J. Abiodun

Climate Systems Analysis Group, Department of Environmental and Geographical Science, University of Cape Town

ABSTRACT

In this study we aim to explore fundamental questions arising from inconsistent and often imprecise formulations of the definition of climate, particularly by analysing the predictability of the climate system from a non-linear dynamical systems perspective, examining also the impact of trend in external forcing. Methodological details of proposed large initial condition (IC) ensemble simulations of the Community Earth System Model (CESM) will be presented, together with the

results of a related preliminary study using the Community Atmosphere Model version 5.1 (CAM5.1 the atmosphere-only component of the above-mentioned fully-coupled model).

A NEAR REAL-TIME FIRE DANGER INDEX MEASUREMENT SYSTEM

Sheldon Strydom and Michael J. Savage[1]

School of Agricultural, Earth and Environmental Sciences, Agrometeorology Discipline, Soil-Plant-Atmosphere Continuum Research Unit, University of KwaZulu-Natal, Pietermaritzburg, South Africa

ABSTRACT

The objectives of this research included the development of a system for improved monitoring of meteorological conditions conducive to fire. The nomogram and lookup table lowveld fire danger index (FDI) system was replaced by mathematical functions programmed into a datalogger. Near real-time results of FDI were displayed in a web-based teaching, learning and research system (http://agromet.ukzn.ac.za:5355/?command=RTMC&screen=Fire%20danger%20index). Historic automatic weather station data were used together with a fuzzy logic system for determining Berg wind conditions. This involved use of wind direction and diurnal sinusoidal functions for solar irradiance, air temperature, relative humidity and wind speed, for various locations.

COMPARISON OF TOTAL COLUMN OZONE MEASUREMENTS FROM OMI/AURA SATELLITE AND GROUND BASED INSTRUMENTS IN THE SOUTHERN

A. M. Toihir [1], V. Sivakumar [2] and H. Bencherif [1]

[1]Laboratoire de l'Atmosphère et des Cyclones, UMR 8105, Université de la Réunion, Saint-Denis, Réunion, France

[2]School of chemistry and physics, Discipline of Physics, University of KwaZulu Natal, Durban, South Africa

ABSTRACT

In this paper , the monthly average of total column ozone measured by ground based instruments (Dobson and SAOZ) is compared with that from OMI/Aura satellite for 8 years (2005-2012) in 8 southern hemisphere stations. A good agreement is found between the two instruments (less than 5%) especially in the Indian Ocean and the mid-latitude zone where a correlation coefficient of 0.98 is observed between OMI and ground based.

A DUAL LIDAR DEVELOPMENT FOR ENVIRONMENTAL STUDIES IN ALGERIA

Mohammed TRAÏCHE and Abdelkrim KEDADRA

Centre de Développement des Technologies Avancées (CDTA)
Po Box 17, Cité 20 Août 1956, Baba Hassen, Algiers, Algeria

ABSTRACT

In this manuscript, we motivate for an efficient use of LiDAR system components towards environment studies. A dual LiDAR is being developed consisting of a novel design of two LiDARs which share some components. Thus, the whole cost would be reduced by a factor of 30 % or more as well as more than one application may be ensured at once.

PRECIPITATION CHARACTERISTICS OF THE SOUTH ATLANTIC

B. van den Berg[1], S. Piketh[1], R. Burger[1], S. Broccardo[1], P. Kucera[2]

[1]School of Environmental Sciences and Development, North-West University, Potchefstroom Campus, Private Bag X6001, Potchefstroom, 2520
[2]Research Applications Laboratory, National Center for Atmospheric Research, Boulder, CO 80307-3000, USA

ABSTRACT

The aim of this project is to test the utility of a Parsivel distrometer on ships for the purpose of characterizing precipitation on the South Atlantic. An OTT Parsivel is the gauge that was implemented on the Aghulas ll to measure hydrometeor sizes and determine intensity, speed and velocity of precipitation types. The credibility of the instrument was tested by comparing different datasets; data acquired from a stationary environment and data from an itinerant ship. Data differences can be ascribed to climate variations. There is concluded that a Parsivel could effectively define precipitation on the South Atlantic. This article will provide details of the Parsivel performance and give explanations of findings.

Analysis of biomass burning based on remote sensing data

Lucky Colane Dlamini[1], V. Sivakumar[2, 3] and Joel Botai[2]

[1] South African weather service, Private BagX097, Pretoria, 0001

[2] Department of Geography, Geo-informatics and Meteorology, University of Pretoria, 0002
[3]School of Chemistry and Physics, University of KwaZulu Natal, Durban 4000, South Africa

ABSTRACT

South Africa experiences strong seasonal variations of fire that impact the environment as well as social-economic activities in the country. In this paper, we use active fire detection data from Moderate Resolution Imaging Spectroradiometer (MISR). Active fire data used to calculate the seasonal climatology for the period 2000 to 2010 of active fire places. The data was gridded to a 0.5^0 grid resolution. The results show that the northern and southern part of KwaZulu Natal, the western and northern part of the western province and the borders of the Mpumalanga province show high and moderate fire intensity. The central Free State, the northern cape, the central and western part of the north west province, the northern part of the Limpopo province have low and very low fire.

Short abstracts

ATMOSPHERIC AND OCEAN PATTERNS RESPONSIBLE FOR THE EXTREME RAINS AND FLOODS IN SOUTHERN AFRICA IN JANUARY 2013

Atanasio J. Manhique[1], C. J. C. Reason[3], B. Silinto, J. Zucula, I. Raiva, F. Congolo, A. F. Mavume[2]
[1]Mozambique Institute of Meteorology, Maputo Mozambique
[2]University Eduardo Mondlane
[3]University of Cape Town.

ABSTRACT

The atmospheric systems associated with the extreme rains that affected Southern Africa in January 2013, particularly south and central Mozambique, with devastating impacts (more than 100 people killed and about 200000 displaced) are analysed and the underlying forcing atmospheric and oceanic mechanisms diagnosed. An active South Indian Convergence Zone (SICZ), in January, was responsible for the extreme rains. The SICZ was sustained by a low level trough, linked to a Southern Hemisphere planetary Wave (wavenumber – 4) and an upper level ridge over the southeast southern Africa. The low level trough and upper level ridge contributed to the convergence of moisture, particularly from the Atlantic (Benguela Niño region), which in turn contributed for the prolonged life span of the system. Positive SST anomalies (around 1 degree Celsius) in the Benguela Niño region may explain the significant contribution in moisture fluxes from the Atlantic Ocean.

A REGIONAL SIMULATION OF THE GREATER AGULHAS CURRENT SYSTEM WITH DATA ASSIMILATION

Bjorn Backeberg[1,2,3], François Counillon[3], Johnny Johannessen[3,4]
[1]Nansen-Tutu Centre for Marine Environmental Research, Cape Town, South Africa
[2]University of Cape Town, South Africa
[3]Nansen Environmental and Remote Sensing Center, Bergen, Norway
[4]Geophysical Institute, University of Bergen, Norway

ABSTRACT

The greater Agulhas Current is one of the most energetic current systems in the global ocean. It plays a fundamental role in determining the mean state and variability of the regional marine environment, affecting its resources and ecosystem, the regional weather and the global climate on a broad range of temporal and spatial scales. In the absence of a coherent in-situ and satellite based observing system in the region, modeling and data assimilation techniques play a crucial role in both furthering the quantitative understanding and providing reliable forecasts of this complicated western boundary current system. In this study we use a regional implementation of the Hybrid Coordinate Ocean Model and assimilate along-track satellite sea level anomaly (SLA) data using the Ensemble Optimal Interpolation (EnOI) data assimilation scheme. Compared to a free model run over a two-year period, data assimilation reduces the error compared to SLA observations that have not yet been assimilated. Mesoscale features are placed in more consistent agreement with drifter trajectories, and the error calculated from independent drifter measurements for eddy kinetic energy and surface velocities is reduced. However, the assimilation introduces a sea surface temperature bias in the Agulhas Return Current, which is associated with the correction of a sea surface height bias in the historical ensemble of the EnOI. Overall however, the data assimilation system produces a more realistic representation of the mesoscale dynamics in the greater Agulhas region.

CARBON DIOXIDE MEASUREMENTS AT CAPE POINT: RECENT REVALATIONS

E-G. Brunke[1], C. Labuschagne[1], T. Mkololo[1] and A.D. Venter[2]
[1]South African Weather Service, P O Box 320, Stellenbosch, 7599, South Africa
[2]North-West University, Private Bag X6001, Potchefstroom, 2520, South Africa

ABSTRACT

Long-term CO_2 measurements in addition to other trace gases have been made at the South African Global Atmosphere Watch (GAW) station Cape Point (34 °S, 18 °E) since 1993. The time series (1993-2012) as derived from data filtered with respect to background conditions currently reflects a growth rate of 2.2 ppm yr^{-1} with average seasonal amplitude of 0.75 ppm. The average annual ambient mole fraction for 2012 (filtered data) amounted to 390.33 ± 1.1 ppm. These results are in good agreement with measurements made at other southern hemispheric baseline stations. The Cape Point CO_2 half-hourly mole fractions ("all data" which were de-trended and normalized) have been analyzed in terms of their annual frequency distributions, which primarily display bimodal behavior. An investigation of the relationship between CO_2 bins (0.8 ppm size fractions; ranging from -3.4 to 5.4 ppm) and ^{222}Rn (an atmospheric tracer) reveals three air mass types. CO_2 mole fractions between -1.0 and 1.4 ppm reflect maritime background conditions associated with $^{222}Rn < 500$ mBq m^{-3}, while CO_2 bins > 2.2 ppm are indicative of local and regional anthropogenic pollution and are characterized by $^{222}Rn > 1\,400$ mBq m^{-3}. The strongly negative CO_2 bins (< -1.8 ppm) comprising the lower peak of the bimodal distribution are associated with rather high ^{222}Rn levels (up to 2 000 mBq m^{-3}) which are attributed to the continental biosphere. A special case of these "below background continental CO_2 levels" are Draw-Down Events (DDEs), which can amount to several ppms. However, these DDEs constitute only 1.2 to 2.4% of the total measurements and occur mainly during the winter months (June till September). The frequency of these DDEs correlate well ($R^2 = 0.6$) with the percentage of Easterly winds which moves air across the primary wheat growing region of the SW Cape to the measuring station. Air transport over this wheat- growing fetch region en route to Cape Point is also confirmed by isentropic back-trajectories. Hence the occurrence of DDEs during the Cape winter period strongly suggests that CO_2 is being taken up by the grain fields in the SW Cape during that time of the year. Further work is, however, required to characterize and quantify the strength of this regional carbon uptake process.

EVALUATION STUDY OF UNIFIED MODELS (UMS) ON TROPICAL CYCLONE "FELLENG" THAT HIT MAGASCAR IN JANUARY 2013

Bubele B. Bulo
South African Weather Service Forecasting ,P.O. Box 44287, Theresa Park Gauteng South Africa

ABSTRACT

Tropical Cyclone "felleng", the strongest cyclone since December 2012 gathered strength east of Madagascar. The powerful storm was forecast to be significant indirect impact to both Madagascar and the Macarene Islands during the course of the week. moreover, as of Tuesday it was too early to rule out a direct landfall, either in eastern Madagascar , or in the Mascarene Island of La Reunion. Forecasters of Tropical Cyclone Center of La Reunion were calling for a southward turn east of Madagascar through Wednesday, thereby implying a skirt of the coast. Strongest indirect impact to Madagascar were likely to include localised torrential rain and high east coast surf. Official forecasters as well as numerical forecast models were predicting that Felleng would sweep southwards to open Southern Ocean by start of the week.

THE VALUE OF HIGH RESOLUTION BALLOON OZONE SOUNDINGS FROM THE IRENE WEATHER OFFICE IN AIR-POLLUTION STUDIES OVER THE JOHANNESBURG-PRETORIA MEGACITY

Gerrie Coetzee and Katlego Ncongwane
South African Weather Service, Pretoria, Private Bag X097, Pretoria , 0001 South Africa

ABSTRACT

The aim is to present scarce and valuable high resolution (2-second vertical sampling) data from balloon ozone soundings. This study will focus on the concentrations, characteristics and variability of tropospheric ozone as air quality in the megacity region of Johannesburg-Pretoria, South Africa is one of major concern. Ozone concentrations of this secondary pollutant, is expected to rise even further due to an abundance of sunshine and ever increasing vehicle/industrial pollution, especially during the winter months of this high altitude region. The earlier concerns of stratospheric ozone decline (now possible recovery) have been overtaken by tropospheric and near-surface ozone concerns regarding the greenhouse warming potential of the troposphere and its effect on air quality. It was the stratospheric ozone concerns which led the South African Weather Service to start regular ozone soundings (once per week) since the very early 1990's. During these times the Irene Weather Office (16km south of Pretoria) was very much in-between urban encroachment by the now megacity. A weekly balloon ozonesonde sounding program was initiated and operated until 2007 using the ECC RSG92-15GE instrumentation. In spite to have some data gaps, Irene is again part of the international collaborative measurement program known as the Southern Hemisphere Additional OZonesondes (SHADOZ-http://croc.gsfc.nasa.gov/shadoz/) since 2012. The sustainment of these balloon soundings (which is rather expensive) and monitoring of ozone as one of the major factors controlling air quality in this megacity region could be invaluable in future to have air-quality forecasting systems contributing to health warnings, besides just keeping check on the stratospheric ozone layer. The ozonesonde information obtained, combined with the alternative air quality surface monitoring networks and modeling studies could serve as an important tool to mitigate adverse effects and impacts of air pollution.

EFFECT OF WIND ON NEAR-SURFACE CURRENTS WITHIN THE DURBAN EDDY

Lisa Guastella, Mike Roberts
UCT Oceanography Private Bag X3 Rondebosch Western Cape South Africa
Bayworld Centre for Research & Education (BCRE)

ABSTRACT

The Durban Eddy is a lee-trapped, semi-permanent, cold core cyclonic eddy circulation that occurs off the east coast of South Africa between Durban in the north and approximately Sezela in the south. The eddy is a mesoscale oceanographic feature, extending approximately 60-90 km alongshore and 30-50 km offshore and is driven mainly by the strong Agulhas Current moving offshore of the regressing shelf edge near Durban. Acoustic Doppler Current Profilers (ADCP's) deployed offshore of Durban during the ACEPII KZN Bight research programme from March 2009 to September 2010 indicate consistently strong south-westward flow associated with the Agulhas Current 40 km offshore of Durban, while the inshore regions are characterized by frequent current reversals associated with transient eddies – when the eddy is present inshore currents are north-eastward. A series of satellite-tracked drifters were deployed into the eddy to trace the near-surface current flow and determine the residence time of water within the eddy. The drifters showed that near-surface eddy water can re-circulate in the eddy itself, whilst inshore eddy water can penetrate northward along the inshore regions of the KZN Bight as far north as the Thukela (Tugela) River and beyond, assisted by one or a combination of inshore north-setting currents, south-westerly winds associated with coastal lows or

cold fronts, southerly swells and longshore drift. Eddy waters are also transported downstream into the Agulhas Current by getting taken up into the offshore Agulhas Current itself as water circulates southward on the outer arm of the eddy, sometimes assisted by north-easterly winds associated with the South Indian Ocean anticyclone, or through downstream propagation of the eddy itself. If north-easterly winds were above a certain threshold, the drifters were ejected out of the eddy south-westwards to be taken up in the Agulhas Current, however if wind speeds were lower, the drifter was able to recirculate within the eddy and proceed north-eastward along the inshore margin.

OCEAN-CLIMATE TELECONNECTIONS, DROUGHT AND WHEAT YIELD VARIATION IN SOUTH AFRICA

Peter Johnston, Pierre Kloppers
Env And Geographical Science , University Of Cape Town Private Bag x7, Rondebosch Cape Town WC SA

ABSTRACT

The winter rainfall region of South Africa is characterized by its interannual variability. Over the past decade there have been numerous studies attempting to determine the mechanisms which can be associated with this interannual variability (Reason et al. 2002; Reason & Jagadheesha 2005; Reason & Rouault 2005; Blamey and Reason 2007; Philippon et al. 2011). Such variability, coupled with the deregulating of production and market systems in the agricultural sector in the 1990s, has led to a significant decrease in the economic viability of low-value, high volume produce, such as wheat production. As a result the total number of farmers has decreased while the average farm size has increased in an effort to sustain economic viability (Hardy 1998; WWF 2010). Wheat production in the Western Cape (35-45% of the country's total crop) is heavy dependent on winter rainfall as wheat is not irrigated. Irregular deviations in the winter rainfall can, therefore, greatly affect the yields and quality of wheat production, making the crop especially vulnerable to abnormally drier years. The planting period for winter wheat in the SWC ranges from late April to early June while the wheat is harvested from late October to early December. Wheat farmers in the Swartland region have had to adapt to the changing environment by shifting from high input cost farming, e.g. wheat monocropping, to more sustainable farm management systems, such as crop rotation (Hardy 1998).. Producers need relevant information to identify ways to improve profitability and seasonal forecasting has had the potential to provide wheat producers in the Swartland region of the W Cape with invaluable information regarding the climatic conditions of the approaching growing season, theoretically enabling them to make sound economic decisions. Regrettably, due to the complex nature of the atmospheric dynamics associated with winter rainfall in South Africa, seasonal forecasting models have been found to have variable skill in predicting the variability of winter rainfall (Johnston, 2011). This paper investigates the potential predictability of wheat-specific climate impact indices and wheat yields in the Swartland. The study identifies wheat specific climate impact indices for the spring wheat crop in the Swartland region, their inter-annual variability and associated mesoscale atmospheric dynamics, including the occurrence of drought, as defined.

RANKING AOGCMS BY MODES OF VARIABILITY IDENTIFIED USING INDEPENDENT COMPONENT ANALYSIS

Michael Kent, Bruce Hewitson, Chris Jack
Climate System Analysis Group Environmental and Geographical Science (CSAG), University of Cape Town, Private Bag X3, Rondebosch Cape Town Western Cape South Africa

ABSTRACT

One of the current challenges in the multi-model simulation of the climate system, is determining which global climate models are best. Models may be simulating the present day climate correctly but for the wrong reasons (Tebaldi and Knutti, 2007). For example, a poor performing model can be

corrected by tuning it, rather than by correcting its simulation of modes of variability (MOVs) such as ENSO. Its ability to correctly simulate the future climate is therefore less clear, and so a method for evaluating models in terms of their MOVs is needed. As Principal Component Analysis has been shown to mix multiple MOVs in a single representation (Dommenget and Latif, 2002), we try and avoid this problem by using Independent Component Analysis (ICA). This technique separates patterns, termed signals, from mixtures of them. The signals are designed to be as unlike Gaussian noise as possible and they can be associates to MOVs. The contribution of models to the signals is then used to rank them. To demonstrate the methodology, a reanalysis (truth) dataset, four CMIP5 ensemble members, and a Gaussian (noise) dataset of geopotential height (700mb) are used. Initial results indicate that when the the signals from the members are compared to those from the reanalysis dataset, then the second signal (identified as the AMO) is generally poorly represented. The Gaussian dataset produces negligible contributions as expected.

CONTINUOUS ATMOSPHERIC MEASUREMENTS IN SOUTHERN AFRICA – OPPORTUNITIES FOR NETWORKING AND COLLABORATION

Jošt V. Lavrič[1], Ernst-Günther Brunke[2], Martin Heimann[1], Casper Labuschagne[2]
Gillian Maggs-Kölling[3], Eric J. Morgan[1], and Theo Wassenaar[3]
[1] Max Planck Institute for Biogeochemistry, P.O. Box 10 01 64, 07701 Jena, Germany
[2] South African Weather Service, CSIR PO Box 320, Stellenbosch, Cape Province 7599, South Africa
[3] Gobabeb Research and Training Centre, P.O. Box 953, Walvis Bay, Namibia"

ABSTRACT

The Namib Desert Atmospheric Observatory (NDAO), located about 50 km inland from the southern African Atlantic coast at the Gobabeb Research and Training Centre, is positioned well to study the air-sea gas fluxes of the nearby Benguela Current system, and the natural and anthropogenic greenhouse and other gas fluxes on the southern subtropical African continent. Here, since 2012 the Max Planck Institute for Biogeochemistry continuously measures the atmospheric O2/N2 ratio and biogeochemical trace gas concentrations (CO2, CH4, N2O, CO). The observatory is an addition to the still relatively sparse atmospheric measurement network in this region. In order to enhance the mutual benefits of this new station, collaboration was initiated with the global GAW station at Cape Point, South Africa. We aim for a partnership on both technical and scientific level that includes know-how and measurement-related exchange as well as cooperative scientific exploitation of our joint data pool. First results of this collaboration will be presented. In the future, our objective is to extend this collaborative approach in the southern African region.

ON THE RELATIONSHIP BETWEEN SOUTH AFRICAN SEASONAL CLIMATE PREDICTABILITY MEASURES AND CLIMATE INDICES

Kamoru A. Lawal[1], Daithi A. Stone[2], Babatunde J. Abiodun[1], Cameron Rye[3], Tolu Aina[4].
[1]Climate System Analysis Group, Dept. of Env. and Geo. Sciences, University of Cape Town, South Africa
[2]Lawrence Berkeley National Laboratory, Berkeley, California, U. S. A.
[3]Atmospheric, Oceanic and Planetary Physics, University of Oxford, Oxford, U. K.
[4]Oxford e-Research Centre, University of Oxford, Oxford, U. K.

ABSTRACT

This study investigates the relative role of sea surface temperature (SST) indices as driving forces behind the inter-annual variability in the ensemble spreads of austral seasonal precipitation and near surface air temperature over South African provinces. It analyzed the co-variability between seasonal climate predictability and seasonal anomalies in the SST. Seasonal measures of predictability are quantified by ensemble spreads which are in turn measured with the de-trended anomalies of standard

deviation and the distance between the 90th and 10th percentiles of the simulations. Precipitation results revealed that both measures of spread exhibit moderate-to-strong direct linear relationships with the ensembles mean throughout the austral seasons except over the inland provinces in summer. Contrary to these, temperature analysis show that there exist a no-linear-relationship between the measures of spread and the ensembles mean over the coastal provinces throughout the four austral seasons. There however exists a moderate-to-strong direct relationship over the inland provinces in summer and autumn. Investigations also indicate that the driving factors of these measures of predictability may both be locally or remotely based. However, there are certainties that the co-variability between these measures and the predictors are weak and therefore not significant. The study however indicates that there may be limits to the extent of which year-to-year variations in the predictability of seasonal climate forecasts over South Africa might be understood.

ASSESSMENTS OF THE CARBON STORAGE POTENTIAL OF FORESTATION IN SOUTHERN AFRICA

Shakirudeen Lawal and Babatunde Abiodun
[1]Climate System Analysis Group, Department of Environmental and Geographical Science,
University of Cape Town, Cape Town, 7700, South Africa

ABSTRACT

Forestation, which can be afforestation or reforestation, is recognized as a potential climate change mitigation option because of the forests' capacity in capturing and storing atmospheric carbon. Hence, there are global efforts to engage the developing countries in Climate Change mitigation using forestation. One of such efforts is carbon credit and trading through the Carbon Development Mechanism (CDM). Among the world's forest, tropical forests in developing countries like Southern Africa have been identified to have the greatest potential for carbon sequestration, but the carbon potential and cost-benefits of such forestation in South Africa remain unknown for various tree species. The present study uses IPCC Tier 1, 2, and 3 (CO2FIX v3.1 model) in assessing the carbon sequestration capacity of most tree species that grown in Southern Africa under various feasible scenarios. Our preliminary results show that Acacia spp, Portulacaria afra (Spekboom) and Faidherbia albida (Anaboom) are among the species with greatest economic potential for carbon storage. Results of this study will help in the long term mitigation scenarios in Southern Africa and will contribute to the third national communication in some Southern African countries.

HOW DOES AEROSOL VARIABILITY OVER CENTRAL AFRICA IMPACT TROPICAL ATLANTIC CONVECTION AND RAINFALL?

Georges Noel T. Longandjo[1,2] and Mathieu Rouault[1,3]
[1]Department of Oceanography, Mare-Institute, University of Cape Town, Cape Town 7701, South Africa
[2]Department of Meteorology, Institut Supérieur des Techniques Appliquées, Kinshasa,
Dem. Rep. of Congo
[3]Nansen-Tutu Center for Marine Environmental Research, R.W. James Building, University of Cape Town,
Cape Town 7701, South Africa

ABSTRACT

Central Africa (CA: 08° – 32°E, 14°S – 7°N) with its forest ecosystem well known as Congo basin (CB) rainforest plays not only an important role in regulating Earth climate system through the carbon sequestration, the water and momentum exchange between the biosphere and the atmosphere, but also in sustaining domestic consumption and agriculture activities which could represent an important economic role in this region. But previous studies have found that CA has been one of the areas of the world with high concentration of biomass burning aerosols particles associated mainly on agriculture clearing practices and/or on deforestation and degradation of forests. Also the tropical

convective clouds seem to play an important role in the tropical climate and it is well known that aerosols modulate the radiation budget and the hydrological cycle both directly and indirectly, thus have the potential to play an important role in weather and climate variability. But over CA, to the best of our knowledge, the spatial and temporal patterns of aerosol variability and its connections to the convection and rainfall have not been yet investigated nor well documented comprehensively. Therefore, the majors aims of our study are: (i) to analyze and to document the spatio- temporal variability of aerosol over CA, (ii) to investigate the connections or relationships between CA aerosols and convection and rainfall over tropical Atlantic (60°W – 40°E, 20°S –20°N), and (iii) how does aerosol variability interact with tropical Atlantic convection and rainfall? In order to achieve the goals of this research, we have used monthly satellite data: MODIS aerosol optical depth at 550nm, NOAA outgoing longwave radiation as proxy of convection and for rainfall, the TRMM 3B43 v6 products.

TEMPERATURE VERIFICATION OF THREE CONFIGURATIONS OF THE UNIFIED MODEL OVER SOUTH AFRICA

Dawn Mahlobo
South African Weather Service Climate Information Private Bag X097 Pretoria Gauteng RSA

ABSTRACT

In 2006 a Numerical Weather Prediction (NWP) model known as the Unified Model (UM) from the United Kingdom Meteorological Office (UK Met Office) was installed at the South African Weather Service (SAWS). Since then it has been used operationally at SAWS, replacing the Eta model that was previously used. The verification of the UM is imperative for SAWS and essential for the model's continuous improvement. Verification of rainfall for three different model configurations of the UM is done. The model simulations are compared with each other and observations. It was shown that the sole additional information produced by Data Assimilation (DA), has a beneficial impact in simulating temperature over South Africa, thus increasing the reliability as well as accuracy of the 12 km UM simulation with DA over the 12 km and 15 km simulations without DA.

HEAT WAVES ALONG SOUTH WESTERN COAST OF SOUTH AFRICA

Thabo Elias Makgoale

ABSTRACT

The Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report shows that global climate is changing in respond to the rise in global temperatures from late 20th century till to date. In the climate that undergone alteration due to warming it is of great importance to recognize the likely future changes of seasonal events and those extreme events that pose risk in human health. The understanding of future climate change can be achieved through knowledge of the past and the present climate. We study heat waves along South African western coast using gridded data; much attention is on historical changes in extreme temperature events and categorizing extreme temperatures that lead to heat waves. The study also investigates the climate overview and synoptic circulation that leads to heat waves. The tentative results shows that the warmest days as regards heat waves persistence in time and severity occurred within the periods 1997-1998, 1999-2000 and 2002-2004. The time series plot of maximum temperatures exhibit the increase in frequency of heat waves occurrence. Evidence of extending heat waves frequency is observed during trend analysis. The blocking high which go with shallow surface trough drift southward away from Namibian coast causing zonal pressure gradient that drives dry air down the mountains. The driven air warms adiabatically and this produces berg winds which are thought to results in extreme high temperatures along south west coast

of South Africa. As temperature increases to above unfavorable conditions damages crop development stages because metabolism in plant is controlled by temperature. High temperature limit photosynthesis rate and increases drought, this causes the low production of key crops (particularly rice, maize, wheat and soybean). The observed increase in extreme temperature episodes put agricultural production under a thread and this highlight the need to develop agricultural policies and adaptation strategies to mitigate heat stress impact on food supply.

DECADAL-SCALE RAINFALL VARIABILITY AND THE SOUTHERN ANNULAR MODE

J. Malherbe[1, 2], WA. Landman[2,3] and FA. Engelbrecht[3]
[1] Agricultural Research Council - Institute for Soil, Climate and Water, Pretoria, South Africa
[2]Department of Geography, Geoinformatics and Meteorology, University of Pretoria
[3]Natural Resources and the Environment: Climate Studies, Modelling and Environmental Health, Pretoria, South Africa

ABSTRACT

The ~18-year Dyer-Tyson rainfall cycle has been present in rainfall over large parts of the southern African summer rainfall region for centuries. Rainfall contributed by tropical cyclones and depressions over the Limpopo River Basin has varied with this cycle since 1948, the period of synoptic data availability. This association is explored towards understanding decadal-scale variability in the region. A modulation of middle-to-high latitude hemispheric pressure patterns at the ~18-year time scale during the January-March period is identified. This is reflected in a low frequency oscillation in the Southern Annular Mode (SAM). In the Southwest Indian Ocean, the anomalously anticyclonic circulation throughout the troposphere associated with the positive phase of the SAM causes stronger subtropical easterlies over the Southwest Indian Ocean and into southern Africa. The stronger easterlies enhance moisture advection whilst also steering tropical cyclones and depressions further west into the subcontinent, increasing their impact. Low level convergence and vorticity patterns toward the north of the easterly flow further contributes to above-normal rainfall over much of the region. The ~18-year oscillation in these anomalies therefore causes relatively wet multiyear periods with a larger impact by tropical cyclones resulting in major flood events over the Limpopo River Basin alternating with drier multiyear periods and a smaller impact by these systems. The circulation pattern towards the east and southeast of southern Africa is an important area for carrying the ENSO signal to southern African summer rainfall. The low frequency variation in this region of the Indian Ocean therefore implies an altered regional response/resilience to ENSO, causing both warm and cold events to be wetter (drier) during the wet (dry) part of the ~18-year oscillation.

ATMOSPHERIC TURBULENCE FORECASTS IN THE SOUTHERN AFRICAN REGION: THE MOISTURE ASPECT

Morwakoma M Matabane
South African Weather Service

ABSTRACT

Currently the South African Weather Service uses the dry gradient Richardson Number and the Elrod TI1 Index to forecast the atmospheric turbulence at 925hPa and 250hPa levels over a two day period. Recently the moisture aspect of the gradient Richardson Number (Ri_{moist}) has been added as another forecasting tool; the Ri_{moist} formulation is based on the moist Brunt-Vaisala frequency computed from algorithms that include Fraser et al. (1973) and Dudis (1972). The Ri_{moist} is computed at 850hPa and 500hPa levels using fourth-order centered differencing applied to the Center for the Ocean-Land-Atmosphere Studies (COLA) GrADS Data Server (GDS) 5D Ensemble Forecast data

(e.g. temperature). Overall on a larger domain (i.e. southern Africa and surrounding oceans), Ri_{moist} appears as an improvement to the dry gradient Richardson Number at higher altitudes.

ROSSBY WAVES IN WINDS

J F McKenzie[1] C T Duba[1] and T B Doyle[2,3]
[1]Department of Mathematics Statistics and Physics, Durban University of Technology, Durban, South Africa
[2]Themba Laboratory for Accelerator Based Sciences, Somerset West, 7129, South Africa
[3]School of Chemistry and Physics, University of KwaZulu-Natal, Durban, 4001, South Africa

ABSTRACT

The propagation properties of Rossby waves in zonal and meridional winds are analyzed using the local dispersion relation in its wave normal form, the geometry of which plays a crucial role in illuminating radiation patterns and ray trajectories. In the presence of a wind/current the classical Rossby wave normal (offset) circle is distorted by the Doppler shift in frequency and a new branch, consisting of a plane with an eastward facing bump, arises from waves convected with or against the flow. The radiation patterns generated by a time harmonic compact source in the laboratory frame are calculated using the method of stationary phase and are illustrated through a series of figures given by the reciprocal polars to the various types of wave normal curves. Some of these patterns are reminiscent of a "reversed" ship wave pattern in which cusps (caustics) arise from the points of inflection of the wave normal curves; whilst others bear a resemblance to the parabolic like curves characteristic of the capillary ship wave pattern. The "critical" level acts as an absorber, but also, under certain conditions as an emitter. The geometry of the wave normal surfaces at various latitudes is used to construct the various types of ray trajectories in zonal jets.

QUANTUM KEY DISTRIBUTION IN FREE SPACE

Abdul Mirza[1], Marco Mariola[1], Yaseera Ismail[1], Sharmini Pillay[1], Francesco Petruccione[1,2]
[1]University of KwaZulu-Natal
[2]National Institute of Theoretical Physics

ABSTRACT

Quantum Key Distribution (QKD) is a symmetric key sharing protocol. The theoretical process exploits the principles of quantum physics to underpin a physical security against any form of eavesdropping. QKD not only ensures an information theoretically secure key exchange but also provides an active real-time means of intrusion detection at a physical level. There are, however, many challenges that must be overcome in order to optimise this technology. One of the main bottlenecks in quantum communication is the short transmission distances that single photons are confined to, specifically in a fibre network. A free-space channel can provide a longer transmission distance for the quantum signal. We consider a polarisation encoded QKD system utilising a free space channel. Before the key distribution process begins, the detectors of the receiver must be aligned with the transmitter. To align the system, a laser beacon is used. In mobile systems such as an aircraft, satellite or boat, the relative orientation of the polarization between the source and detector may vary due to the motion of the vehicle. It is necessary to build the appropriate detectors and actuators able to resolve the relative motion and orientation of the system. Initially the problem can be resolved using classical analogical circuits and we compare the solution using an open source programmable logic unit. The open source electronics provides a powerful method to design a QKD system at low cost. Another factor that must be considered for free space QKD is the effect of turbulence on the quantum channel. Both the quantum signal and laser beacon undergo beam wandering, scintillation and beam divergence and these effects must be minimised in order to preserve

the integrity of the signal. Using a design comparative to the 'plug and play' scheme, the proposed system will utilise the bright laser beacon, transmitted from Bob, as a means to characterise the atmospheric channel. The bright signal will then be attenuated, encoded and transmitted from Alice as the quantum signal. Since the optics required for the Alice's unit is much smaller and cheaper than the receiver's unit, the free space 'plug and play' scheme is ideal for connecting multiple end users to form a star topology network. QKD systems, although capable of producing provably secure keys, must in itself be trusted. Entanglement provides this additional layer of security. To obtain entanglement, photons must undergo a second-order nonlinear process which is referred to as Spontaneous Parametric Down Conversion. Entanglement can be verified by means of proving the violation of the CHSH (Clauser, Horne, Shirmony and Holt) inequality which states that in local realistic theories the absolute value of a particular combination of correlations between two particles is bound by 2. The purity of the states generated can also be measured by performing a state tomography and hence constructing of the two-photon density matrix to determine the fidelity of the system. The principles of an entanglement-based QKD system can be applied to a free space network in order to create trusted nodes within a network, thereby increasing the distance of transmission between Alice and Bob.

APPLICATION OF ARCGIS AND MAPINFO IN LIGHTNING ANALYSIS

M. Mkhwanazi
South African Weather Service, Pretoria, South Africa

ABSTRACT

South African Weather Service (SAWS) receives several enquiries on lightning activities mostly during thunderstorm season. It is this demand that SAWS has invested in programs like ArcGIS and MapInfo. These programs are being utilized to analyze and display lightning events in a more meaningful way. The presentation will demonstrate the use of ArcGIS and MapInfo in lightning events analysis. Lightning analysis are event-by-event correlation of fault with lightning activity. ArcGIS and MapInfo are similar but MapInfo is applied more in lightning event analysis because of its powerful tool called Fault Analysis and Lightning Location Systems (FALLS). FALLS tool have different types of analysis namely; Regional Analysis (RA), Small Area Exposure Analysis (SAEA) and Reliability Analysis (RA) these analysis will be demonstrated using a specific case study.

ENTERIC METHANE EMISSIONS ESTIMATES FOR SOUTH AFRICA

Moeletsi M E[1], Otter L[2], Nape M[1], Malaka S[1]
[1]ARC-Institute for Soil, Climate and Water, Private Bag X79, Pretoria 0001, South Africa
[2]Climatology Research Group, University of the Witwatersrand, Private Bag 3. WITS 2050, Johannesburg. South Africa

ABSTRACT

Methane emissions form enteric fermentation is one of the main sources of methane in South Africa. Reasonable estimates in this category would be helpful for climate change mitigation decision making and policy making. Livestock population data and activity data to be utilized in estimating emissions factors for cattle were collected as per the 2006 IPCC guidelines. Due to lack of data and significance of other animals (sheep, goats, pigs, donkeys and horses) a low level methodology (Tier 1) was employed. There is no significant difference between the results obtained in 2004 as compared to other years (1990, 1994 and 2000) even though different methodologies were used. The results show total enteric methane emissions exceeding 1000Gg with over 50% being from cattle farming. Due to nature of their digestive system other animals's contribution is minimal with pigs and donkeys being the least contributors (< 5Gg). Careful consideration of feeding methods and promotion of alternative meat in South Africa forms part of the issues that can be addressed by policy makers. The country

specific emissions factors for cattle were significantly high than that of the default values. This might be due to vast differences in farming methods in South Africa as compared to most of the least developing countries in Africa.

ATTRIBUTES OF CUT-OFF LOW INDUCED RAINFALL OVER THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

S Molekwa[1], C J Engelbrecht[2], C J de W Rautenbach[1]
[1]Department of Geography, GeoInformatics and Meteorology Faculty of Natural and Agricultural Sciences University of Pretoria, Pretoria South Africa
[2]Agricultural Research Council – Institute for Soil, Climate and Water Pretoria South Africa

ABSTRACT

Cut-off low (COL) weather systems that are associated with rainfall over the Eastern Cape are considered in this study. COLs are objectively identified and tracked over a 31-year period. Daily rainfall data of 22 evenly distributed stations over the Eastern Cape are utilized. Only COLs with a minimum spatial distribution, defined as more than a third of the rainfall stations that need to report rainfall on at least one day of a COL event, are considered for analysis of rainfall attributes. These attributes include the occurrence of COL rain days of different magnitudes, the distribution of the depth and temperature of the COL centres for the rain days of different magnitudes, the associated spatial distribution of rainfall as well as the associated atmospheric circulation. The frequency of COLs over the Eastern Cape has a winter maximum and a summer minimum. COL rain days of small, medium and large magnitudes occur most frequently during the winter, while small and medium magnitude COL rain days experience peaks in autumn and spring respectively. The low-level flow, and in particular the position of the low/trough, seems to be the determinant factor in the occurrence, magnitude and spatial extent of COL induced rainfall.

CONTINUOUS MEASUREMENTS OF GREENHOUSE GASES AND RELATED TRACERS IN THE NAMIB DESERT

Eric J. Morgan, Jošt V. Lavrič and Martin Heimann
Max Planck Institute for Biogeochemistry, Jena, Germany"

ABSTRACT

Comparatively few continuous, ground-based observations of greenhouse gases (GHGs) are made in southern Africa. In order to better constrain surface fluxes and fill a gap in the global station network for GHGs, a new observatory has been created in coastal Namibia, the Namib Desert Atmospheric Observatory (NDAO). The station is located at Gobabeb Research and Training Centre at the northern edge of the Namib Sand Sea, approximately 50 km from the coast. A semi-autonomous measurement system has been created with the aim of producing long-term time series of GHGs. Air is sampled for carbon dioxide, methane, nitrous oxide, carbon monoxide, atmospheric oxygen and basic meteorology at a height of 21m. The site is characterized by low seasonality and unusually high diurnal variability, relative to the intraseasonal variability, both in meteorology and trace gas composition. Diurnal variability is a result of the pronounced local wind system which is driven by regional topography and the temperature gradient between the cold waters of the Benguela current and the hot continental interior. A strong sea breeze typically creates an inverted diurnal cycle in carbon dioxide and atmospheric oxygen, implying that the marine background is enriched in carbon dioxide and depleted in oxygen relative to the coastal background. Synoptic events characterized by high temperatures appear to increase this effect.

THE CAPABILITY OF CORDEX MODELS IN SIMULATING ONSET OF RAINFALL IN WEST AFRICA

Mounkaila S. Moussa[1,2], Babatunde J. Abiodun[1], and J. 'Bayo J. Omotosho[2]
1Climate Systems Analysis Group, Department of Environmental and Geographical Science, University of Cape Town, South Africa
2West African Climate Service Center, Federal University of Technology Akure, Nigeria

ABSTRACT

Reliable forecasts of rainfall onset dates (ROD) are important for agricultural planning and food security in West Africa. This study investigates the ability of CORDEX regional climate models (RCMs) to simulate ROD in West Africa using observed data (GPCP and TRMM) as a reference for the model validation. The evaluation focuses on how well the RCMs simulate the mean, standard deviation and interannual variability of RODs in 1998-2008. Four definitions based on rainfall threshold are used to compute ROD. In agreement with previous studies, GPCP and TRMM show that the mean ROD in West Africa has a zonal distribution with a northward (inland) increase in ROD from the coast. The highest interannual variability in ROD occurs over Guinea zone. However, while Sahel zone shows the highest spread in ROD, Savannah zone shows the lowest spread in ROD. ERA-Interim reanalysis fails to reproduce the mean distribution of ROD as in observed data. The performance of some RCMs in simulating the RODs depends on the ROD definition used. For instance, ARPEGE, RACMO, PRECIS, and CCLM produce a better ROD distribution than that of ERAIN when three of the ROD definitions are used, but give a worse ROD distribution than that of ERAIN when the fourth definition is used. However, regardless of definition used, CCRM5, RCA35, REMO, RegCM3 and WRF show a remarkably improvement over ERAIN. The study shows that the ability of a RCM in simulating ROD over West Africa depends on the model capability in reproducing the northward movement of monsoon systems, and the associated features. This study shows how RCM can improve the forecast of ROD and enhance food security in the region in West Africa.

TEMPERATURE AND RAINFALL AT 5 WEATHER STATIONS IN THE WESTERN CAPE

T. Mukunga
Climate Systems Analysis Group, University of Cape Town, Private Bag Rondebosch 7700, South Africa

ABSTRACT

The objective of this study is to improve the Global Forecasting System (GFS) model forecasts for the Western Cape, primarily looking at rainfall and temperature measurements at De Poort, Waterval Tulbagh, Zuurvlakte, Fizantakraal and Dwarsberg weather stations. Data from both the climate model and weather stations were compared to attempt to detect trends and determine whether the climate model was capturing the observed conditions. Due to data shortages, only the month of March was analysed for all 5 stations. Results show the climate model successfully capturing observed trends in temperature at Dwarsberg, Waterval Tulbagh and Fizantakraal, with the remaining stations reflecting inconsistencies in the two sets of data. Rainfall data was incomplete to draw any conclusions, since precipitation events were few and far apart. Further work in this study will focus on using numerical methods to determine the differences between the two data sets in order to improve the overall performance of the model in at these weather stations.

CARBON DIOXIDE SPATIAL DISTRIBUTION OVER SOUTH AFRICA

Xolile Ncipha[1,2], Venkataraman Sivakumar[2], Nkanyiso Mbatha[2]
[1]442 Rigel Avenue South, Erasmusrand, Pretoria, Gauteng, 0001, South Africa, South African Weather Service, Private Bag X097, Pretoria, South Africa, 0001
[2] University of Kwa-Zulu Natal, Department of Chemistry and Physics, Westville Campus, Durban, South Africa.

ABSTRACT

Atmospheric carbon dioxide (CO_2) is a long-lived greenhouse gas (LLGHG), with an atmospheric lifetime of 50 to 200 years. Its contribution to radiative forcing is greater than the contribution of the other LLGHGs combined. Since the beginning of industrialization the average atmospheric mixing ratio of CO_2 increased globally by about 100 ppm (36%), from a range of 275 to 285 ppm in the pre-industrial era (AD 1000-1750) to 379 ppm in 2005. Among the LLGHGs CO_2 increases have caused the largest sustained radiative forcing over this period. Emissions of CO_2 from human activities are considered the single largest anthropogenic factor contributing to climate change. The African continent plays a big and growing role in the carbon global cycle, with potentially important climate change implications. However the current knowledge about Africa's role in the global carbon cycle remains limited because of sparse observation network in and around the African continent. South Africa an industrial country has few CO_2 monitoring sites which are sparsely distributed and most of them don't have long-term data records. In this study the Total CO_2 Column (TCC) distribution in space over South Africa is determined, and CO_2 hotspots over the country are identified using data from the Tropospheric Emission Spectrometer (TES) instrument mounted on the Aura Satellite. The seasonal changes in atmospheric loading of CO_2 are also determined.

SEASONAL DRY DEPOSITION OF SO2 AND NOX WITHIN THE FOOTPRINT OF MATIMBA POWER STATION, MARAPONG AND SURROUNDING COAL MINES, DURING THE PERIOD 2007-2012.

Nelvia Phala
Wits university APES Private Bag 3 Wits 2050 Johannesburg Gauteng South Africa

ABSTRACT

Lephalale is located in the Waterberg District Municipality in Limpopo Province. Currently, within the footprint of Matimba power station, Marapong and surrounding coal mines there are mining, electricity generation, and agricultural activities in operation. However, this is expected to grow as more industrial activities are being planned. Considering the planned industrial activities that may impact on the area's future air quality, it is critical to look at these existing data and determine the status of NOx and SO2 to inform air quality managers and relevant stakeholders about potential threats and impacts of future development. The aim of this paper is to estimate seasonal dry deposition of SO2 and NOx dry deposition within the footprint of Matimba power station, Marapong and surrounding coal mines, during the period 2007-2012. This study uses inferential modeling to estimate dry deposition of NOx and SO2 using hourly ambient concentrations micrometeorology and plant characteristics and physiology.

TREND ANALYSIS OF HEAT-WAVES RELATED TO BIRD SPECIES IN NORTH-WESTERN SOUTH AFRICA

M. P. Nxumalo[1], S. J. Cunningham[2], A. C. Kruger[1] and P. A. R. Hockey[2]
[1]Climate Service, South Africa Weather Service, Pretoria 0002, South Africa
[2]Percy FitzPatrick Institute, DST.NRF Centre of Excellence, University of Cape Town, Private Bag X3, Rodenbosch 7701, South Africa

ABSTRACT

Heat-waves are generally described as anomalously hot weather that is usually accompanied by high humidity and last for several days. On the other hand, they are specifically referred to as periods of at least three days with a temperature-humidity index of 32° C or higher. The latter are classified as part of climate extremes and can have severe effects, which can include negative consequences on ecosystems and biodiversity. For this reason and others, heat-waves and their consequences require thorough understanding and constant monitoring. This could place one in a better position to predict the future frequencies of heat-waves. Intense heat-waves have led to breeding failures and mortalities of birds, and due to climate, are likely to continue affecting various species of bird populations. This study investigates the trends in frequencies of pre-defined heat-waves over north-western South Africa for the period 1961-2010. The heat-waves are defined according to two threshold temperatures, T_{crit} = 35.5° C and T_{crit} = 33° C, which affect aspects of the fitness of two focal southern African bird species: the southern pied babbler *Turdiodes bicolor* and the common fiscal *Lanius collaris* respectively. Trends in the frequency, duration and intensity of heat-waves of relevant T_{crit}s as well as the annual number of hot days (maximum air temperature > T_{crit}) were analysed. Results from this analysis showed that while all trends in heat-wave indices increased, most rapid trend increases for both temperature thresholds were observed in the annual number of days exceeding T_{crit} as well as in the maximum intensity of heat-waves. Expansions of this study can provide an objective impression of the effects of historical climate trends on South Africa's biodiversity.

REGIONAL TRANSPORT OF TROPOSPHERIC OZONE FROM TO CAPE TOWN

Claude-Michel Nzotungicimpaye, Babatunde J. Abiodun
Climate System Analysis Group, Department of Environmental and Geographical Science, University of Cape Town, South Africa

ABSTRACT

As part of efforts to understand the sources of air pollution in Cape Town, this study investigates the regional transport of tropospheric ozone to Cape Town. The study used data from air quality stations in the Greater Cape Town area, atmospheric-chemistry simulations over southern Africa, and Lagrangian trajectories for the period 2001-2004. Measurements of O_3 from three sites (rural, sub-urban and urban) in the Greater Cape Town area show that, in all seasons, the highest O_3 levels are observed at the rural site (Cape Point), while lowest O_3 levels are observed at the sub-urban site (Goodwood) mainly due to the presence of chemical sinks such as NOx in the suburb. Wind measurements do not suggest any substantial input of air pollution from the city to Cape Point. The atmospheric simulations show that extreme O_3 levels over Cape Town may be caused by transports of pollutants within the lowest atmospheric layers (below 800 hPa) from the industrial Highveld of South Africa to Cape Town. Lagrangian trajectories of pollutants released from the industrial Highveld suggest four paths by which O_3 can be transported to Cape Town: a direct north-easterly path (the most frequent path), a tropical deviation path, a deviation along the south coast of the country and, an oceanic deviation path (the least frequent path). The study recommends a consideration of regional scale emissions and long-range transport in managing air quality in Cape Town, especially between March and September. The principal remote source identified

is the industrial Highveld of South Africa and the two major advection paths are the direct north-easterly route and the path along the south coast of the country.

ABILITY OF CORDEX MODELS TO SIMULATE EXTREME RAINFALL EVENTS OVER SOUTHERN AFRICA

Sabina Abba Omar, Babatunde J. Abiodun
Climate System Analysis Group, Department of Geographical and Environmental Science University of Cape Town, South Africa

ABSTRACT

This study assesses the ability of 7 regional climate models (RCMs) to simulate extreme rainfall events and the synoptic features that produce the events over southern Africa. The simulations of 7 CORDEX RCMs were analyzed for the study. Using the 95th percentile of daily rainfall as a threshold for extreme rainfall events, the study obtained the spatial distribution of extreme rainfall events over Southern Africa for 12 years (1996-2008) from simulations, and compared the results with those from observation (TRMM) and reanalysis (ERAIM) data. In addition, the study used RCA4, forced with different global climate models (GCMs), to study the role of lateral boundary forcing in simulating extreme rainfall events over southern Africa. The RCMs reproduce well the spatial pattern of the extreme rainfall events, but five of the models overestimate the extreme threshold values, especially over the topography of the east coast of South Africa. ERA-Interim data shows that extreme rainfall events over the east coast are usually induced by 3 synoptic features: tropical temperate troughs cut off lows and cold fronts. The ERA-Interim extreme rainfall days over the east coast also show that ridging anticyclones act as a moisture feed for the region. Looking at the specific humidity divergence of the region we shall quantify whether the ridging anticyclone is acting as important moisture feed to the region. We shall also look at the convective nature of the day of, before and after an ERA-Interim extreme rainfall event by looking at the CAPE and the height of the level of free convection. When comparing the extreme rainfall of the region for TRMM and ERA-Interim it was found that ERA-Interim showed more extreme days than TRMM. Thus the above analysis could help explain why this is the case. RCA4 simulations faithfully link the extreme rainfall events to the 3 features mentioned above when forced with ERAIM and with different GCMs, except with the MPI-ESM simulation. When forced with MPI-ESM, RCA4 links the extreme rainfall events with a low that resembles a cut-off low or a tropical cyclone. Hence different forcings simulate different extreme rainfall event inducing synoptic conditions over southern Africa. Results of this study could provide valuable insights into the ability of CORDEX RCMs to simulate extreme rainfall events and to downscale impacts of global warming on extreme rainfall events in southern Africa.

PROFILING POLLUTION EVENTS IN SOUTH AFRICA: A CASE STUDY OF PARTICULATE MATTER IN DURBAN

Padayachi, Yerdashin[*,1], Thambiran, T.[1], Garland, R.M.[1], Naidoo, M.[1]. and Phala, N.[1]
[1]CSIR, Natural Resources and the Environment Unit, Climate Studies, Modelling and Environmental Health Research Group South Africa, KwaZulu-Natal, Durban, P.O. Box 17001, Congella, 4013.

ABSTRACT

Since the inception of the National Environmental Management: Air Quality Act (Act No.39 of 2004) (the AQA) in South Africa there has been a greater emphasis on the need for appropriate data to support the implementation of the AQA. As such there has been an increase in the number of air quality and meteorological monitoring around the country, with the data freely available for research purposes from the South African Air Quality Information System (SAAQIS). In this study, particulate matter (PM) monitoring data for the Durban were obtained from the SAAQIS. In this paper, the data

cleaning procedure used to create usable datasets of PM for the period of 2004-2009 will be presented, highlighting the key methodological procedures used. A key objective of this study was to use this dataset to identify episodes of elevated PM. Thus after applying the data cleaning procedure, the percentile approach was used to identify episodes of elevated pollution concentrations. Dry season occurrences of elevated PM concentrations were excluded, as these were extensively researched in previous campaigns such as SAFARI 1992 and 2000. It was therefore of interest to identify the meteorological drivers of wet seasonal elevated PM concentrations for Durban. The results of this case study are used to provide recommendations for air pollution abatement.

INVESTIGATING DRIVERS OF PARTICULATE MATTER POLLUTION IN URBAN AREAS IN SOUTH AFRICA

Rebecca M Garland[1], Tirusha Thambiran[2], Nelvia Phala[1], Mogesh Naidoo[1] , Yerdashin Padayachi[1]
[1]Climate Studies, Modelling and Environmental Health Research Group, Natural Resources and the Environment Unit, Council for Scientific and Industrial Research, Pretoria, South Africa
[2]Climate Studies, Modelling and Environmental Health Research Group, Natural Resources and the Environment Unit, Council for Scientific and Industrial Research, Durban, South Africa

ABSTRACT

Monitored particulate matter (PM) mass concentrations in ambient air in urban areas of South Africa are often in exceedance of the current national standard. These exceedances have the potential for large negative health impacts, and are also concerning as the national standards for PM10 will become more stringent in 2015. While in some areas of South Africa there is a strong understanding of the drivers of air pollution on seasonal scale, little is known about the drivers of air pollution in urban areas on smaller timescales (e.g., timescales similar to those in the national standards). This project investigates the drivers of local pollution events across urban areas in South Africa, with a focus on particulate matter in eThekwini, Tshwane and Johannesburg. Investigating drivers of particulate matter pollution in urban areas in South Africa.

AN EVALUATION OF HOW WELL RCMS CORDEX AND GCMS MODELS SIMULATES SOUTHERN AFRICAN DROUGHTS PATTERNS

Eva Liliane Ujeneza , Dr Babatunde J. Abiodun
Climate Systems Analysis Group, Department of Environmental and Geographical Science, University of Cape Town, South Africa

ABSTRACT

Drought is one of the most devastating natural disasters worldwide and for Sub-Saharan Africa in particular, as it is a region where a large number of the population's economy is based on agriculture. It is likely that in future climate the region will experience worse droughts due to global increase of temperature. Such a threat and the high variety of sectors spanned by droughts impacts over Sub-Saharan Africa, make crucial the assessment of drought in present and future days. Therefore, there is a need for reliable drought projections over the region. In this presentation, we discuss the potential ability of eight CORDEX models and nine GCMs to reproduce past Sub-Saharan African drought characteristics. The standardized precipitation evapo-transpiration index, a newly defined drought index sensitive to temperature, is computed at 3 and 12-months scale from monthly simulated precipitation and temperature, over the period 1989-2009. We used various techniques including principal component analysis, fast fourier analysis and temporal correlations to determine processes that govern droughts, identify their oscillation period and to associate them with atmospheric-oceanic teleconnections. Characteristics of simulated SPEI, like intensity, leading processes and frequency, have been compared with those of observed SPEI, computed from precipitation and temperature data from CRU and ERA-Interim. Preliminary results show that though RCMs poorly reproduce geographical pattern of the most important droughts processes found in the region, they capture quite

well their seasonal variations. On the other hand, GCMs performed good simulations of the geographical pattern of droughts processes but failed to capture their seasonal variations.

IMPACT OF CLIMATE CHANGE ON SMALLHOLDER FOOD CROP PRODUCTION IN SOUTHERN AFRICA

Nkulumo Zinyengere[1], Olivier Crespo[1], Mark Tadross[2], Sepo Hachigonta[3]
[1]Climate Systems Analysis Group (CSAG), Department of Geography and Environmental Science, University of Cape Town, South Africa
[2]United Nations Development Programme
GEF- Green-Low Emission Climate Resilient Development Strategies.
[3]Food Agriculture and Natural Resources Policy Analysis Network (FANRPAN), Pretoria, South Africa

ABSTRACT

Climate change impact studies in southern Africa (SA) are mostly performed at large spatial scales. Such scales are not the most appropriate in assessing climate change impacts on localised small scale crop production. This study sought to carry out an assessment of climate change on crop production at such a scale. To achieve this a crop model (DSSAT) was first evaluated in terms of its ability to simulate the production of major food crops under smallholder conditions in selected districts in SA; Mohale's Hoek- Lesotho (maize and sorghum), Lilongwe- Malawi (Maize and ground nuts) and Big Bend- Swaziland (maize and sorghum). DSSAT was then driven by downscaled climate projections to simulate crop yield changes between a baseline (1961-2000) and a future (2046-2065) period by 9 GCMs under assumed A2 and B1 emission scenarios. DSSAT performance in simulating crop yields was judged satisfactory across all sites; the percentage relative differences between simulated and observed crop yields for the 3 districts were within ±15 %. Simulations of yield changes showed that climate change will have significant impacts on crops in SA and that the impacts vary between locations and among the different mixes of crops. Maize (-11.3 % to 2.9 %) and groundnut yields (-21% to -51%) in Lilongwe-Malawi and maize (-6 % to -43.8 %) and sorghum yields (-40 % to 7 %) in Swaziland are mostly projected to decrease. There are indications that while climate change may negatively affect maize yields in Mohale's Hoek-Lesotho (-60.4 % to 120 %), benefits could accrue from a warmer climate, more so for sorghum, where mean yields are projected to increase by up to 3 times the baseline yields. The study helps to improve our understanding of how climate change can impact smallholder crop production in SA and will be used in the design of robust adaptation studies at such scales.

IMPACTS OF PM10 ATMOSPHERIC FLOWS ON CLIMATE, CITY OF CAPE TOWN (CoCT)

M.A.Kekana, B.J.Abiodun
EGS Department, University of Cape Town, Cape Town, South Africa

ABSTRACT

The study highlights some of the PM10 atmospheric flows impacts on the climate, in the City of Cape Town (CoCT). PM10 refer to suspended atmospheric aerosols or particulate matters with diameter less than 10 microns – which are also known as "inhalable particulate matters. The focus is only on PM10 episodes or days with average PM10 concentration above 50µg/m3 (UK Air Quality Standards, applied by CoCT). Data used is from 2001-2013 (i.e. 12.5 period length) and it was obtained from the City's 11 Air Monitoring Stations daily reports – available on the website. Data analyses are as follow. Firstly, Principal Component Analysis (PCA) is done; to find correlation(s) between the 11 stations. The results indicate that there exist two clusters or groups with strong correlations. One

group constitutes the 7 stations on the western side of the City, and the other group, the 4 stations on the eastern side of the City – and the groups correspond to PC1 and PC2, respectively. PC scores above 1 are considered; only PC2 is found significant (for this study), is thus, neglecting PC1 (with 40 episodes counts) in the next analyses. Furthermore, about 90% episodes dates of PC1 do not relate to those of PC2. Secondly, Self-Organizing Map analysis is done only for PC2 – to reveal the corresponding synoptic (climate) conditions and their degree of occurrence. Finally, (regional) climate model is used to simulate the above climate conditions and future projections are made – thus, highlights impacts of PM10 on climate.