



NATIONAL RESEARCH
FOUNDATION SOUTH AFRICA

Atmospheric Research in Southern Africa and Indian Ocean (GDRI ARSAIO)

Progress Report 2011

Introduction

Scientific activities of the GDRI ARSAIO started in 2010 at the 26th Annual conference of the South African Society for Atmospheric Sciences (SASA 2010) held at Gariep Dam (Orange Free State) from 20 to 22 September 2010. Thirteen talks and two posters were presented by GDRI Partners within 4 different sessions of the conference. These presentations, focused on research activities conducted in the Southern Africa, south western Indian ocean regions, were a good opportunity to see results of previous program conducted by GDRI ARSAIO partners.

On Thursday 23 September, after the conference, a specific meeting of the GDRI-ARSAIO partners was held at the same place to reconsider objectives that were listed in the project document and to plan future actions. Participants to this meeting were the following: Sivakumar Venkataraman, Robert Delmas, Paul Beukes, Miki Josipovic, Caradee Wright, Cathy Liousse, Corinne Galy-Lacaux, Philippe Keckhut, Hassan Bencherif, Jean Luc Baray, Yann Courcoux, Valentin Dufлот, Paola Formenti, Jean Marie Flaud (CNRS representative). It was decided to focus on a few actions that are listed below.

- 1- Impact of anthropogenic pollution in Southern Africa on Climate Change and Health. (C. Liousse and P. Beukes et al)
- 2- Aerosol characterization and transport
 - 2.1- Transport and deposition of mineral dust in western southern Africa: P. Formenti and K. Desboeufs (LISA) , S.J. Piketh (CRG)
 - 2.2- Tropospheric aerosol study over South Africa and Reunion Island (J.L. Baray, P. Beukes et al.)
- 3- Water vapor transport and cloud formation in the vicinity of the tropopause using lidar observations (P. Keckhut, V. Sivakumar et al.)
- 4- Stratospheric trends and dynamics (H. Bencherif and V. Sivakumar et al)
- 5- Solar UV radiation and human health effects research in La Reunion and South Africa (C. Wright et al.)

All the five action started in 2011 in spite of an important delay in funding from the French side, CNRS financial support was made available in May. The activities carried out in 2011 are reported in the following action progress reports. A video conference between South African and French laboratories was organized on April 8 to plan the work program for 2011. A second video-conference was organized on November 28 to finalize the present 2011 progress report and to start planning future actions for 2012.

Action 1- Impact of anthropogenic pollution in Southern Africa on Climate Change and Health.

South Africa Theme Co-Ordinator	K. Pienaar (North-West University Potchefstroom)
French Theme Co-Ordinator	C. Liousse (Laboratoire d'Aérodologie, Toulouse)
Theme	Impact of anthropogenic pollution in Southern Africa on Climate Change and Health.
1. Objectives of the theme	
<p>Our main aim is to study the seasonal and annual trends of atmospheric chemistry and pollution at the Southern Africa scale and its impact on regional climate and health. With this goal, on-going experimental and modelling activities have been carried out through the IDAF-DEBITS (IGAC DEBITS Africa, DEBITS: Deposition of Biogeochemical Important Trace Species) programme and the SACCLAP PICS Project (Air Pollution and Climate Change in South Africa).</p> <p>The GDRI activities will be oriented towards:</p> <ul style="list-style-type: none"> • A better characterization of industrialized, domestic and biomass burning sources through specific measurement campaigns and fuel update with new satellite data for example : the aim is to improve south african emission inventories for present day and also to build future projection and scenarii with mitigation options to reduce regional air pollution. • A better characterisation of regional aerosol and gases concentrations emitted in southern Africa, with a focus on long term measurements in the industrialized area. Long range transport studies will be associated by including IDAF site measurements and modeling. • The study of regional aerosol radiative forcing and regional climatic impact for present day conditions and future climate. • The study of long term chemical deposition of species impacting terrestrial and marine ecosystems. • The study of the atmospheric pollution impact on health for present and future 	
2. Specify any changes to the objectives	
N/A	
3. Progress and outputs (highlight special achievements of research (max 300 words)	
<p>Emissions :</p> <ul style="list-style-type: none"> - Determination of <u>African Biomass burning emission inventory</u> from MODIS satellite burnt area data for the year 2009. Comparison with existing inventories (AMMABB and GFED) : Visit of Nelson Begue, LACy (october 2011) - <u>Domestic fires</u> : Campaign of <u>emission factor measurements</u> in a township in South Africa : experiment was conducted by Seneca Naidoo in the frame of her PhD (PI S. Picket). Collaboration with LA was on 	

carbonaceous aerosols. Analyses are on going.

Regional pollution characterization :

Aerosol measurement in Vaal triangle IDAF industrial site : Visit of Petra Maritz (May 2011) at LA, Toulouse. Carbonaceous aerosol were analysed on filters weekly sampled in different sites in South Africa during one year.

Atmospheric pollution and Climatic impact :

Presentation of GDRI works on aerosol climatic impact in South Africa by Fiona Tummon at the C4-SAR (Changing Chemistry in a Changing Climate: Human and Natural Impacts over Southern Africa) workshop organized in Johannesburg in June 2011.

Atmospheric Pollution and Health :

Visit of Kobus Pienaar (May 2011) at LA, Toulouse : organization of the work on pollution and health in South Africa. We decided to focus on respiratory problems of children of a school in a township linked to atmospheric pollution of Vaal triangle industries.

Measurements will involve : Characterization of related sources (industries, domestic fires), Characterization of atmospheric pollution in this selected site associated to health measurements (in vitro experiments to determine inflammatory biomarkers, pro-oxidant aerosol capacities).

Beginning of measurements will take place in 2012.

Discussion will be organized with Caradee Wright to organize a cohort of children for the follow up of diseases.

4. Students trained in programme

Petra Maritz (PhD)

Fiona Tummon (PhD)

Nelson Begue (PhD)

5. Staff and student exchange

Name	Place visited	Period of stay
Kobus Pienaar (Pr)	LA, Toulouse	May 2011
Petra Maritz (PhD)	LA, Toulouse	May 2011
Nelson Begue (PhD)	LA, Toulouse	October 2011
Fiona Tummon (PhD)	Johannesbourg, South Africa	May-June 2011

Cathy Léal-Liousse	Johannesbourg, South Africa	February 2012
Corinne Galy-Lacaux	Johannesbourg, South Africa	February 2012

6. Results

Emissions : Determination of African Biomass burning emission inventory from MODIS satellite burnt area data for the year 2009.

Regional pollution characterization : analyses are on going.

Atmospheric pollution and Climatic impact : a first paper has been accepted (see below). A second paper dealing with trends is in preparation (Tummon et al., 2011).

Atmospheric Pollution and Health : measurements will start at the beginning of 2012.

Articles in referee-based scientific journals

Tummon, F., F. Solmon, C. Liousse, and M. Tadross (2010), Simulation of the direct and semidirect aerosol effects on the southern Africa regional climate during the biomass burning season, *J. Geophys. Res.*, 115, D19206, doi:10.1029/2009JD013738.

Articles in other scientific journals and anthologies

N/A

Other reports, papers and presentations from scientific meetings

Tummon F., F. Solmon, C. Liousse and M. Tadross, oral presentation at the C4-SAR workshop, Johannesburg, June 2011.

Action 2- Aerosol characterization and transport

South Africa Theme Co-Ordinator	S. Piketh (CRG, University of the Witswatersrand, Johannesburg)
French Theme Co-Ordinator	P. Formenti (Laboratoire Interuniversitaire des Systèmes Atmosphériques, Créteil)
Theme	Transport and deposition of mineral dust in western southern Africa
1. Objectives of the theme	
<p>The aim of this work is to look at the concentrations, physico-chemical and optical properties of mineral dust exported from the south-west African sub-continent.</p> <p>The science questions addressed in this work are</p> <ol style="list-style-type: none">1) how much mineral dust is exported towards the Atlantic ocean?2) which is the seasonal cycle of dust export?3) which sources are contributing to dust export?4) which are the physico-chemical, optical and solubility properties of exported dust?5) how do they relate to the soil properties in the major source regions of south-west Africa?5) is the exported dust modified by mixing and heterogeneous reaction? How does that alter the properties of mineral dust?6) which is the impact of exported mineral dust to the local radiative budget?	
2. Specify any changes to the objectives	
N/A	
3. Progress and outputs (highlight special achievements of research (max 300 words))	
<p>The collaboration is established and benefit from the visit of Prof S. Piketh to LISA in late november. The sampling site of Hentjes bay (Lat= -22.095 Long= 14.260, 70.0 km from Swakopmund) is being set up. A CIMEL sunphotometer attached to the AERONET network is operational late november.</p> <p>The installation of the in situ measurements is planned for the beginning of 2012 during a visit of P. Formenti and K. Desboeufs to Namibia.</p>	

4. Students trained in programme

Nicola Walton (PhD)

5. Staff and student exchange

Name	Place visited	Period of stay
Stuart Piketh (Pr)	LISA, Créteil	18 November - 8 December 2011
Nicola Walton (PhD)	LISA, Créteil	18 November - 8 December 2011

6. Results

Measurements will start at the beginning of 2012.

Articles in referee-based scientific journals

N/A

Articles in other scientific journals and anthologies

N/A

Other reports, papers and presentations from scientific meetings

N/A

Action 3- Water vapor transport and cloud formation in the vicinity of the tropopause using lidar observations

South Africa Theme Co-Ordinator	Sivakumar Venkataraman (CSIR)
French Theme Co-Ordinator	Philippe Keckhut (Latmos)
Theme	Water vapor transport and cloud formation in the vicinity of the tropopause using lidar observations
1. Objectives of the theme	
<p>The objectives of this theme consist in improving our knowledge about cirrus clouds formation and persistence and more generally the transport of water vapour on a long distance in conjunction of the subtropical jet. It consists in comparing cirrus clouds climatology over 3 sites including La Réunion, Durban and Brazil (Sao Paulo or Bauru).</p> <p>The second phase consists in performing analyses of data obtained over the 3 sites on similar trajectories. It is proposed to perform such investigations using existing data from 1999 to 2002. It is also proposed to perform coordinated campaigns in which the forward trajectory of air mass already sounded with lidar will be sounded on alert if and when the air is predicted to pass over the two other locations.</p>	
2. Specify any changes to the objectives	
<p>The campaign depending of the ability to perform observations with the South Africa lidar that is at that time out of order. The university of Durban has not positively respond to this inquiry last year. The coming year, it seems that South Africa lidar team is rebuilt and ready to reactivate such measurements, after an analysis.</p> <ul style="list-style-type: none"> - A meeting teleconference meeting is planned to discuss the analyse of the South African lidar team about the possibility, capabilities and needs for the reactivation of the lidar in Durban and the plans to analyse existing data. - A meeting in Paris is plan in June 2012 to discuss the trajectory analyses and the inclusion of the micro-physic code. 	
3. Progress and outputs (highlight special achievements of research (max 300 words))	
<p>Existing cirrus clouds lidar data from Sao Paulo (Brazil) and from La Réunion were analyzed to improve the lidar data analyses and to perform first climatologies. South Africa lidar team has also started analyzing cirrus lidar data from the CSIR mobile instrument and will be applied on the existing Durban lidar. Clustering analyses applied on the both other sites has revealed that cloud layering over Brazil are mainly due to the mixing of wet air coming from equator and along the subtropical jet while La Réunion seems to be influence by mid-latitude air or tropical depressions or cyclones.</p> <p>Water vapor measurements were analyzed over La Réunion and the new instrument was mounted in Guyancourt (France) and will be implemented in the new Maïdo observatory not before April 2012.</p>	
4. Students trained in programme	

Christophe Hoareau PhD Guyancourt (UVSQ, France)

Eliane Gonçalves Larroza PhD Sao Paulo (IPEN, Brazil)

Nkanyiso Mbatha Post Doctorant, (UKZN & SANSA, South Africa)

5. Staff and student exchange

Name	Place visited	Period of stay
Jean-Luc Baray (LACy)	LATMOS, Paris	June 18-22, 2012
Sivakumar Venkataraman (CSIR)	LACy Réunion	April 2011
Nkanyiso Mbatha (UKZN & SANSA)	LaCy Réunion	November 2011
Eliane Gonçalves Larroza (IPEN, Brazil)		

6. Results

Articles in referee-based scientific journals

Hoareau, C. et al., A Raman lidar at la Reunion (20.8°S, 55.5°E) for monitoring water vapor and cirrus distributions in the subtropical upper troposphere: preliminary analyses and description of a future system, submitted in AMTD, 2011

Gonçalves Larroza, E. et al., Robust retrieval of microphysic and macrophysic lidar cirrus cloud parameters for long-term monitoring, in preparation.

Gonçalves Larroza, E. et al., Investigations of cirrus clouds layering in the vicinity of the subtropical jet of the southern hemisphere, in preparation.

Articles in other scientific journals and anthologies

Sivakumar V. et al., CSIR-NLC lidar observations of tropical cirrus clouds, *Proc. of 27th Annual conference of South African society for atmosphere science, ISBN 978-0-620-50849-0, 22-23 September 2011, Hartbeespoort, (South Africa), Pg, 71-72.*

Other reports, papers and presentations from scientific meetings

C. Hoareau, PhD Thesis, Nov 2011.

E. Gonçalves Larroza, PhD thesis, Nov 2011.

P. Keckhut et al., Cirrus investigations with lidar above south of France (44°N) and at La Réunion (21°S), WAVAC meeting, September 26-28, Paris

Action 4- Stratospheric trends and dynamics

South Africa Theme Co-Ordinator	Pr. Venkataraman Sivakumar (CSIR Pretoria)
French Theme Co-Ordinator	Pr. Hassan Bencherif (LACy, Réunion)
Theme	Stratospheric variability, trends and dynamics
1. Objectives of the theme	
<p>This research project focuses on stratospheric changes and variability. It is divided in two research actions, one based on LIDAR observations, while the other is expected to focus mainly on the use of radiosonde datasets (with and without ozone) at different locations:</p> <p><i>a.</i> Lidar studies of middle atmosphere thermal structures and dynamics</p> <p><i>b.</i> Examination of Troposphere – Stratosphere Interactions : variations of surface parameters (Rainfall and Temperature) and effects on the tropical tropopause – lower stratosphere</p>	
2. Specify any changes to the objectives	
N/A	
3. Progress and outputs (highlight special achievements of research (max 300 words))	
<p>In the framework of the ARSAOI/GDRI bilateral project, during the 2011 year, we conducted studies on <i>climatology, trend and dynamics</i> in the southern middle atmosphere.</p> <p>We actually developed the ongoing research activities (initiated in the SAFIR/Protea project) in form of research publications. Indeed, 3 papers have been published or are about to appear.</p> <p>Most of research activity developed in the present topic is undertaken within the PhD of M. Nkanyiso MBATHA (co-supervised by V. Sivakumar and H. Bencherif). This PhD aims to address “Middle Atmosphere Dynamics and stratosphere-mesosphere interactions in the southern hemisphere”, which has been rarely studied by research community. It has been investigated in the framework of a bilateral research program (French-SA) and also within the South Africa National Antarctic programme. It can be recalled that a research article on “impact of the 2002 major sudden stratosphere warming” was published last year (2010) by Mbatha et al. in the ACP journal:</p> <p>In the framework of Nkanyiso’s PhD a large amount of data of different kind has been extensively used: wind data from SuperDARN HF radar, temperature profiles from satellite observations (HALOE, TIDE, SABER and COSMIC) and from LiDAR records (Durban LiDAR archives), SANA E Imaging Riometer and meteorological fields from global models.</p> <p>As it can be seen from the publication-list above, we also focused on the use of trend analyses derived by the use of the Trend-Run model, a linear multi-regression model (Bencherif et al., 2006, Bègue et al., 2010). The model has been applied to temperature profiles radiosonde in order to study “Tropopause characteristics and variability from 11 yr of SHADOZ observations”</p>	

Furthermore, we recently initiated a study on the study of self-similarity in Precipitable Water Vapour (PWV) by the use of NCEP and ERA-40 reanalysis datasets. The preliminary results suggest that the self-similar behaviour of non-detrended PWV is significantly different from that of the detrended PWV derived from both reanalysis datasets. In addition, PWV does not exhibit a uniform power-law scaling, rather, the power-law exponents have spatial dependence.

4. Students trained in programme

M. Nkanyiso MBATHA (co-supervised by V. Sivakumar and H. Bencherif)

5. Staff and student exchange

Name	Place visited	Period of stay
▪ Venkataraman Sivakumar, CSIR, UKNZ,	LACy	April 2011 (UR invitation)
▪ Hassan Bencherif, LACy, UR,	CSIR Prétoria	May 2011 (SAFIR/Protea)
▪ Joel Botai, University of Pretoria,	LACy	June 2011 (ARSAIO/GDRI)
▪ Venkataraman Sivakumar, CSIR, UKNZ,	LACy	October 2011 (UR invitation)
▪ Nkanyiso MBATHA	NDACC Conference (Réunion)	November 2011 (GDRI ARSAIO)

6. Results

Articles in referee-based scientific journals

- Sivakumar V, Bencherif H, Begue N and Thompson A.M., Tropopause characteristics and variability from 11-year SHADOZ observations in the southern tropics and sub-tropics, *Journal of Applied Meteorology and Climatology*, doi:10.1175/2011JAMC2453.1, 50, 7, 1403-1416, 2011
- N. Mbatha, V. Sivakumar, H. Bencherif, S.B. Malinga and S. R. Pillay, Analyses of the Middle atmosphere thermal structure over Durban using a ground-base Rayleigh LIDAR system and satellite experiments (HALOE and SABER), *South African Journal of Sciences*, 2011 (under press)
- Sivakumar, V., Vishnu Prasanth, P., Kishore, P., Bencherif H., and Keckhut. P., Rayleigh LIDAR and satellite (HALOE, SABER, GPS-CHAMP and COSMIC) measurements of Stratosphere-Mesosphere temperature over a southern sub-tropical site, Reunion (20.8°S; 55.5°E): Climatology and comparison study, *Annales Geophysicae*, 29, 649-662, 2011
- Mbatha N, Sivakumar V, Malinga S.B., Bencherif H. and Pillay S.R., Study on the impact of sudden stratosphere warming in the upper meosphere-lower thermosphere region using satellite and HF radar measurements, *Atmospheric Chemistry and Physics*, 10, 3397–3404, 2010

Articles in other scientific journals and anthologie

Other reports, papers and presentations from scientific meetings

5- Solar UV radiation and human health effects research in La Reunion and South Africa

South Africa Theme Co-Ordinator	Dr. Caradee Wright (CSIR)
French Theme Co-Ordinator	Colette Brogniez
Theme	Solar UV radiation and human health effects research in La Reunion and South Africa

1. Objectives of the theme

The primary objective of this action plan is to co-ordinate and work together for investigating and gaining a better understanding of the solar ultraviolet (UV) radiation environment in Southern Africa and the Indian Ocean by using in-situ and modelling techniques, as well as human health risk assessment frameworks. The work focuses on two key themes:

- Ambient solar ultraviolet radiation levels in South Africa and La Reunion, analysis and interpretation;
- Determining the possible human health risks (under-exposure, excess exposure, seasonal differences etc) as defined by the United Nations Environment Programme report on the effects of solar UV-B radiation soon to be published in 2011.

Participants

South Africa

Dr Caradee Wright (CSIR)

Mr Gerrie Coetzee and Mrs Katlego Ncongwane (Masters student) (South African Weather Service)

Dr Beverly Summers (MEDUNSA)

France

Prof Robert Delmas (LACy, Université de la Reunion)

Dr Jean-Luc Baray (LACy, Université de la Reunion)

Colette Brogniez (LOA, Université de Lille)

Research questions

Two specific objectives have been identified:

- 1) To analyse past and present ambient solar UV radiation and associated factors in South Africa and La Reunion, and future levels in South Africa through developing a forecasting model, and considering its applicability to La Reunion.
- 2) To identify possible human health risks, beyond UV-B and sunburn, to also consider new and emerging

risks in relation to UV-A, such as immune suppression.

Requirements

- Solar UV radiation data for South Africa (South African Weather Service) and La Reunion (Université de la Reunion)
- Researcher and student exchange between the two research groups

Outputs

- At least 2 peer-reviewed journal articles in international journals
- At least 1 conference paper per year

2. Specify any changes to the objectives

None.

3. Progress and outputs (highlight special achievements of research (max 300 words))

Caradee Wright visited the University of La Reunion from the 24-30 April 2011 and spent time with Dr Jean-Luc Baray learning about the instruments and data. She also made a presentation about the 'photobiological human health risk assessment using measured ambient solar ultraviolet radiation and typical lifestyle scenarios: a South African – Reunion Island comparison'.

During 2011, Caradee Wright obtained solar UV radiation data from South African Weather Service and prepared the data for analysis. The data were applied in two series of analyses for publication in two scientific journals, one pertaining to child health risks and the second, outdoor worker health risks.

Data were obtained in August 2011 from France for solar UV radiation levels at La Reunion Island. There had been some difficulties in preparing the data hence the delay in the final data set being provided. The data has now been sorted and the two lines of data from each file (one file per hour per day for all of 2009) have been collected. The analysis on the La Reunion solar UV radiation data will begin this month (November 2011). A highlight has been a successful application to the Cancer Association of South Africa (CANSAs) to pursue additional solar UV radiation and human health exposure risks analyses in 2012, using output produced during this project as motivation for the need for future research.

4. Students trained in programme

Patricia Albers (Masters in Community Health, UP) contributed to the South African solar UV radiation analyses and write-up.

5. Staff and student exchange

Name	Place visited	Period of stay
Caradee Wright	University of La Reunion	24 April – 30 April 2011

6. Results

Articles in referee-based scientific journals

Wright, C., Coetzee, G and Ncongwane, K. (2011) Ambient solar UV radiation and potential sunburn risk among schoolchildren at six sites in South Africa. *South African Journal of Child Health*. South African Journal of Child Health 5(2): 33-38.

Wright, C., Coetzee, G and Ncongwane, K. (2011) Seasonal trends in potential sunburn risk among outdoor workers in South Africa using monitored ambient solar UV radiation levels. *South African Journal of Occupational Health*. In press.

Wright, C., Norval, M., Summers, B., Davids, L., Coetzee, G. and Oriowo, M . The impact of solar UV radiation on human health in sub-Saharan Africa. Very near to submission.

Articles in other scientific journals and anthologies

None

Other reports, papers and presentations from scientific meetings

Wright, C. and Albers, P. (2011) Sun-related knowledge, attitudes and behaviours among South Africans: pilot study results. *SASAS 22-23 September 2011 Conference Proceedings* – ISBN 978-0-620-50849-0.

Wright, C. (2011) Solar UV radiation and human health impacts in South Africa and La Reunion. Presentation at the University of La Reunion, 24 April 2011, St Denis.

Wright, C. (2010) Potential Solar UVR health risks in South Africa. Paper presented at the annual South African Society for Atmospheric Sciences Conference, 21-22 September 2010, Gariep Dam, Free State.

Wright, C. (2010) The Solar UVR Exposure Research Environment in South Africa: Past, Present and Future. CSIR Biennial Conference, August-September, Pretoria.

Any Additional Relevant outputs

- Annexure-1: Dr. Joel Botai (Recently completed Ph.D Student from University of Pretoria) – Report on his visit to Universite de la Reunion
- Annexure-2 : Mr. Nkanyiso Mbatha, (Ph.D Student from University of KwaZulu Natal, Durban)- Report on his participation to NDACC symposium at Reunion
- Annexure-3 : Report from Remote Sensing students, University of Pretoria – On the participation of outreach programme for Exploring the atmosphere remote sensing instruments.
- Annexure-4 : Report on LIDAR measurements and exploration to students and public – outreach programme.
- Student discussion forum has been conducted two times, at Pretoria, CSIR for discussion and interaction with local students at U.P (4 Master and 4 Ph.D). The first forum was a generic on “Let’s Interact with each other” and the second forum was to discuss on “How to write a journal article”.

Conclusion

This report gives a brief summary of actions undertaken in 2011. Most of them are just starting; scientific results are expected to appear by the end of 2012. A workshop is being planned at the end of November or beginning of December 2012 in La Réunion to allow direct scientific exchanges between GDRI Partners and also to discover the new Maïdo Atmospheric Observatory which should be opened in April 2011 and fully operational in October 2012. This new facility will enhance opportunities of collaborations between France and South Africa for next few years.