South African

A report for the 8th WMO/UNEP Ozone Research Managers Meeting, WMO, Geneva, Switzerland, May 2011

Introduction

The depletion of the stratospheric ozone layer, increases in troposphere ozone, higher levels of acidity in rain, rising carbon dioxide and methane concentrations, and changes in the radiative balance of the earth-atmosphere energy system - all reflects the increasing influence of human activity on the global atmosphere, the life-support system of planet Earth. Environmental issues and policy matters have to play a pivotal role in meeting the developing needs and challenges of the people in a new democratic South African Society. Clauses in protecting and respecting the environment in a sustainable context, is embedded in the South African Constitution.

To underline these facts: - An excerpt by the Minister of Water and Environmental Affairs Me. Bee Molewa, on Wednesday 20 April 2011, in the National Assembly, Parliament.

> "We *rank among the world's top 20 greenhouse gas emitting countries. As a country, we must strive to maintain a balance between development and environmental conservation. Like many other countries of the world, the number one threat to our long term sustainable development, economic growth and quality of life are related to the impacts of climate change.*
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> *Climate change is already a reality! Its early impacts can be seen on declining agricultural production, higher food prices and food insecurity; which are most severely felt in developing countries like ours. Working together we must ensure that our response to climate change seizes the new growth opportunities presented by the global effort to address climate change.*
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> *President Jacob Zuma announced prior to the Copenhagen United Nations Climate Change Conference in December 2009 that South Africa will implement nationally appropriate mitigation actions which will result in the reduction of our carbon emissions by 34 % by 2020 and by 42 % in 2025, dependant on availability of finance and technology.*
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> *As a department working together with the people of South Africa, we are ready to give practical meaning to this commitment. Consequently, our Climate Change Response Policy is nearing completion and we will present the Climate Change White Paper for Cabinet approval, later this year. This evolving policy outlines our vision for an effective climate change response and our transition to a climate resilient and low-carbon economy and society.*
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> *From the 28th of November to the 9th of December this year 2011, our country will host the United Nations Climate Change Conferences in Durban (COP17).* "

In light of the above stated commitment the activities following describes the ongoing systematic monitoring efforts in South Africa.

1. OZONE OBSERVATIONAL ACTIVITIES

The South African Weather Service (SAWS), an agency of the Government Department of Environmental Affairs and Tourism (DEAT), is the focal point of ozone monitoring and research activities in South Africa. These activities are enhanced by collaboration with a few national research centers and universities.

The ozone monitoring and research activities are conducted within the context of the World Meteorological Organizations (WMO) Global Atmosphere Watch (GAW) program. The Cape Point Global Atmosphere Watch (GAW) station undertakes a regional network of observations.

1.1 Atmospheric Ozone Monitoring

The first South African column ozone measurements were made during 1964 until 1972 with Dobson #089 operating from Pretoria. Reinstating South Africa's commitment to the Vienna Convention, the Weather Service now operates two Dobson ozone spectrophotometers, #089 at Irene near Pretoria (25.9 S, 28.2 E) since 1989, and #132 at Springbok (29.7 S, 17.9 E) since 1995. Both these instruments have been regularly calibrated with reference to the world standard. Our participation at the recent UNEP/WMO Dobson Data Workshop held in Hradec Kralove, Czech Republic re-affirmed good quality data sets.

During 2009, the 3rd African UNEP/WMO International Comparison of Dobson Spectrophotometers was organized by the World Meteorological Organization and the South African Weather Service in close cooperation with the World Calibrations centre at NOAA and the European calibrations centre hosted by DWD, Germany. This event was conducted during October 2009 at the Irene Weather Service Technical Centre, just south of Pretoria.

After a three year break the Weather Service has been fortunate to reinstate its ECC RSG92-15GE Ozonesonde sounding program, which operated during the period 1990's until early 2007. Regular ozonesonde soundings are once again scheduled for 2011. This data is shared with the **S**outhern **H**emisphere **Ad**ditional **OZ**onesondes (SHADOZ-http://croc.gsfc.nasa.gov/shadoz/) program from NASA, USA, which also is submitted to WOUDC.

Figure 1: Dobson #132 Total Ozone Column for Springbok

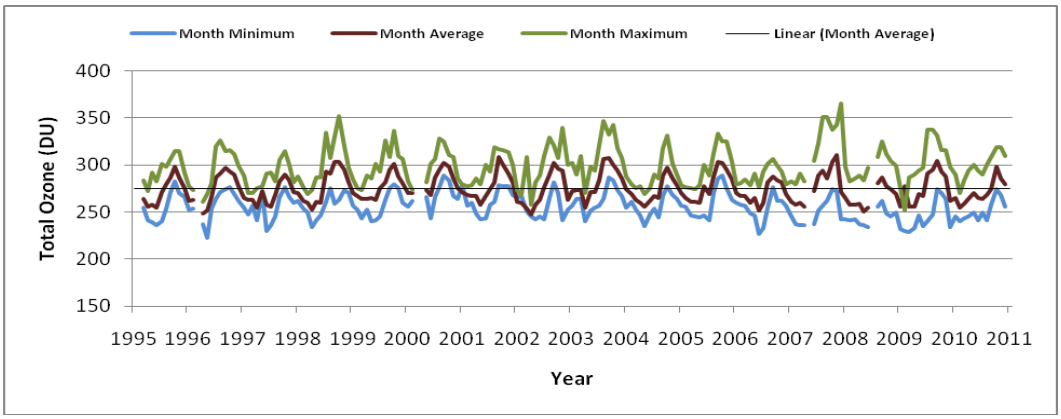
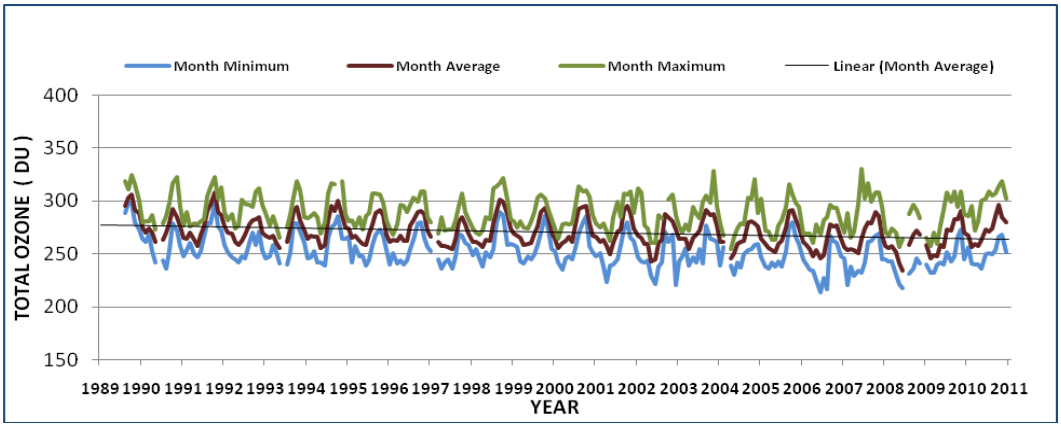


Figure 2: Dobson #89 Total Ozone Column for Irene



Surface ozone measurements are continuously undertaken at Cape Point since 1982. Our program has also extended surface ozone measurements to the South African National Antarctic Expedition Base (SANAE IV) in Antarctica since December 2003. Surface ozone monitoring is to be extended to the two Dobson stations, Irene and Springbok during 2011.

1.2 Other relevant Trace Gases and profile measurements

The pristine location of the Cape Point Global Atmosphere Watch GAW station (34.3S, 18.5E) enables measurements to be made in air that has passed over the vast clean Southern Ocean. Such long-term observations are representative of background conditions, making it possible to detect changes in the atmosphere's composition. The Cape Point GAW Laboratory is also scientifically twinned with a research partner, namely the Fraunhofer Institute for Atmospheric Environmental Research (IFU) in Garmisch, Germany, now IMK-IFU (Forschungszentrum Karlsruhe).

Measurements include a wide range of parameters namely: - surface O_3, gases which lead to stratospheric ozone depletion such as: $CFCl_3$, CCI_2F_2, $CCI_2F\text{-}CClF_2$, CH_3CCl_3, CCl_4 and N_2O greenhouse gases in the troposphere such as CO_2 and CH_4 and reactive gases such as CO.

Furthermore, UV-A, UV-B and global radiation (total and diffuse) are also measured as well as the normal surface meteorological parameters. Radon measurements to assist with the classification of air masses arriving at Cape Point have been successfully established over the last five years. Regular scientific audits from EMPA, Switzerland for surface O_3, CO and CH_4 have been successfully conducted over the past seven years. In 2003 the WCC-N_2O (Forschungszentrum Karlsruhe IMK-IFU and Umweltbundesamt) conducted an audit for N_2O at Cape Point. During 2006 with German collaborations (GKSS Research Centre Geestacht) the Cape Point gashouse mercury measurement program was also revived.

Since 2005 a project was undertake for the continuous measurements of aerosols. This is now a well established program at the Cape Point GAW station and includes physical, chemistry and optical properties being measured. This milestone was reached with start-up funding support from WMO, scientific partnering with NOAA ESRL scientists (who designed and constructed the aerosol system) and local SAWS station scientist running and maintaining the system. The latest addition was the establishment of Aerosol Optical Depth (AOD) measurement relevant to global climate change in accordance to detailed guidelines set out in GAW Precision Filter Radiometer Network (GAWNET) *http://www.pmodwrc.ch/worcc* and Global Atmosphere Watch Program of the World Meteorological Organization (GAW) *http://gaw.tropos.de*

1.3 Ultraviolet-B measurements

Since January 1994 the Weather Service has maintained a routine program for monitoring erythemally weighted UV-B radiation at Cape Town (34.0S, 18.6E), Durban (30.0S, 31.0E) and Pretoria (25.7S, 28.2E), De Aar (30.7S, 24.0E) and Port Elizabeth (33.9S, 25.5E). The equipment used in this network is the Solar Light Model 501 Robertson-Berger UV-Biometer. The program was motivated by and in collaboration with the School of Pharmacy at the Medical University of Southern Africa (MEDUNSA), near Pretoria.

Since December 2001, the UV-Biometers are directly linked on the Services wide area network, and available in real-time on the SAWS WWW-site http://www.weathersa.co.za/ . UV-B forecasts are also issued for the Cape Town, Durban and Pretoria-Johannesburg metropolitan areas since 1 December 1997. The main purpose of the UV-Biometer network is to make the public aware of the hazards of excessive exposure to biologically active UV-B radiation, and it contributes to the schools' awareness programs for education. Regular enquiries from scholars are dealt with to satisfy their need to acquire more ozone and ultraviolet radiation knowledge. Celebrations around 16 September, each year, usually focuses

to create public awareness. Once a year on this day it is also dedicated to the hard working ozone observers and technicians gathering the measurements.

Renewed UV research is being undertaken by the Council for Scientific and Industry Research (CSIR). Their research unit for health is conducting research towards UVB exposure amongst scholars.

2. Other Observation/Monitoring Networks

2.1 Research Aircraft

The South African Weather Service's two research aircraft Aerocommanders are used as Air-borne monitoring platforms. Site sampling is conducted at a speed of 100 ms^{-1} , at low atmospheric levels (500 – 3000m above ground level) and the range of the aircraft is around 3.5 hours, over predetermined pollution hotspot areas over the country.

In addition to standard meteorological parameters, instruments mounted in and on the aircraft measure the following trace gases and aerosols:

- Carbon dioxide, Carbon monoxide, Sulphur dioxide, Hydrogen sulphide, Oxides of nitrogen, Ozone, Volatile organic compounds, and the concentration of aerosols between.

There has been a shift in air quality management in South Africa from source control to pollution prevention by focussing on ambient air quality is intended to ensure improved air quality for future generations. The aircraft monitoring capabilities complements other ground-based research and monitoring processes to ensure that information and data associated with air pollution are of the highest quality and are accessible to all South Africans.

The primary airborne monitoring project objectives are:

- To determine the spatial and temporal characteristics of air quality over South Africa through the use of ground-based, airborne and satellite measurements;
- To validate the various measurements and integrate them into a holistic picture of the South African air quality situation with the context of the region;
- To build capacity in the fields of air quality and atmospheric chemistry through hands-on training.

The Aircraft research and monitoring facilities are jointly managed by the South African Weather Service and the Climatology Research Group of the Witwatersrand University (Wits) in Johannesburg. These aircrafts and logistical staff have taken part in field experiments conducted in Australia and India during the last three years.

2.2 LIDAR

During the past three years, the Council for Scientific and Industrial Research - CSIR has developed a new mobile LIDAR. The Light Detection and Ranging (LIDAR) has become an excellent tool for monitoring the atmosphere in a relatively short period of time (within a few seconds to minutes). Currently, LIDAR systems are used for studying the atmospheric structure and dynamics, trace constituents, aerosols, clouds, boundary and mixed layers and other meteorological applications [1]. Although ground based LIDAR systems are deployed for atmosphere studies in many developed countries, it is still a very novel technique for South Africa and African countries. There are currently two different LIDARs available in South Africa, located in Pretoria and Durban respectively. The Durban LIDAR is operated at University of KwaZulu-Natal as part of cooperation between the Reunion University and the Service d'Aéronomie (CNRS, IPSL, and Paris) for climate research studies. It allows for studying the stratosphere-mesosphere (30-80 km) thermal structure and troposphere-stratosphere aerosol

(8-40 km). Future plans include field campaign measurements in and around South Africa, for qualitative industrial pollutant measurements and higher atmosphere characteristic changes in ozone, aerosol and other parameters.

3 CALIBRATION ACTIVITIES AND DATA SUBMISSIONS

All primary GAW data (ozone and trace gas data) are submitted regularly to WMO recognised World Data centers. Dobson column ozone is submitted to WOUDC, Toronto, Canada. Since the inception of the Dobson programs these instruments have been internationally calibrated through inter-comparison campaigns as supported by UNEP and WMO. Various regular international scientific audits remain in place for the Cape Point GAW station.

4. COLLABORATION - NATIONAL AND INTERNATIONAL

Ozone and related research are conducted sporadically within the country, mostly at a few academic institutions such as the CSIR, University of Kwazulu Natal in Durban, the University of Cape Town, and the University of the Witwatersrand in Johannesburg. Typical GAW type of collaborations is ongoing with the University of North West, School of Chemistry in Potchefstroom.

South Africa must also acknowledge its many international collaborators with specific references to international programs and institutions such as:

- The World Meteorological Organization (WMO) and many other NHMS in our region
- SHADOZ/Penn State University
- USA NOAA ESRL, Boulder
- WOUDC and ARQP, Toronto, Canada
- Training assistance from GAWTEC http://www.schneefernerhaus.de/e-gawtec.htm, Germany also DWD (European Dobson Calibration facility)
- EMPA http://www.empa.ch/plugin/template/empa/704/
- GAWSIS http://www.empa.ch/gaw/gawsis/ and IMK-IFU Garmisch, Germany
- GAWNET http://www.pmodwrc.ch/worcc/pmod.php
- LSCE, CNRS and DEBITS, Paris and Toulouse, and La Reunion Island - France. (Flask sampling , the SASRIO project and GDRI offices)
- The CZECH SOO-HK, in Hradec Kralove

5. FUTURE PLANS AND RECOMMENDATIONS

Priority research work at the South African continues to include a service rendering UVB Forecast, especially during summer months. South Africa has some of the world's highest UVB levels. There still remains the need to establish long term continued high-resolution spectro-radiometer UV observations at some suitable sites in southern Africa.

To maintain and enhance our data quality and to gain near real-time access of the data from the monitoring processes to various user-communities.

The SAOZ ozone monitoring instrument from SANAE, Antarctica has been brought back to South Africa and needs to be refurbished before resuming its monitoring capabilities.

The South African Weather Service is now well settled in it role of the custodian of the South African Air Quality Information System (SAAQIS) which has been developed and launched during 2010. The SAAQIS is a web-based interactive air quality information system which seeks to provide state of the air quality information to citizens and it is a research portal for strengthening policy development related to air quality issues. This has a profound advantage in that the country we can begin to assess whether air quality is improving and also identify areas where potential air pollution problems exists.

Various national air-quality monitor stations is linked in real time gathering vital atmospheric data for decision making for improving ambient air quality in especially our industrial areas. Technical staff off the Weather Service is tasked to calibrate and maintain these monitoring stations as part of the normal weather observational system across the country. http://www.saaqis.org.za/ .

To continue building our scientific capacity – ozone, atmospheric research and monitoring in general, and related Climate Change Activities). The South African "ozone" community is very small and published peer reviewed articles of research findings remain admittedly very scarce.

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