SOUTH AFRICA

INTRODUCTION

The depletion of the stratospheric ozone layer, increases in tropospheric 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.

Worldwide it is proven that sustained systematic observation only survives under the auspices and responsibility of a Government. More and more of these specialized environmental monitoring activities are shifted towards the responsibilities of National Meteorological Services. This is undoubtedly a core service resulting from international agreements undertaken by government of the Republic of South Africa.

Since the establishment of the Montreal Protocol, South Africa has succeeded in implementing the protocol and has achieved the following with voluntarily co-operation mainly from industry. South Africa is in the fortunate position that it is well ahead of the normal phase out of ozone depletion substances schedules for developing countries due to its initial classification as a developed country. However, it does not rest on its laurels since there are still many ozone-depleting substances that must be phased out. A study has shown that about 75% of methyl bromide is used for soil fumigation, 11% for fumigation of structures, and the remaining is used for durable products such as beans and nuts as well as for quarantine and pre-shipment treatment. South Africa has almost completely phased out the use of ozone-depleting substances such as CFCs and carbon tetrachloride, and it stopped using ozone-depleting CFCs in aerosol spray-can propellants as far back as July 1992. However, a small amount of legal CFCs are imported and exported to fill asthma inhalers as well as air conditioners and refrigerators manufactured before 1996. The CFC methyl bromide (used as a pesticide in the agricultural sector) is still being imported and used. Although methyl bromide is a versatile, cost effective with many applications particularly in the field of agriculture, however like all other signatories to the Protocol South Africa will have to phase out methyl bromide by 2015.

South Africa is responding to its air pollution challenges in various ways. These include legislative reform, revision of ambient air quality limits, proactive planning by local authorities, and sector-specific controls. On 24 February 2005, President Thabo Mbeki assented to the National Environmental Management: Air Quality Act (No. 39 of 2004) (NEMAQA).

Use of Ozone Depleting Substances in South Africa Since ratification of the Montreal Protocol

Substance	Usage	Montreal Protocol status	Amount used 1998
CFCs 11,12, 113, 114 and 115	CFC: chloroflurocarbons. CFC-11: $CFCl_3$ or equivalently CCl_3F. CFCs were used in fridges, plastics industry and spray cans.	Phased out 1995. Domestically used aerosols in South Africa stopped using CFCs as propellants in July 1992 (AMA news)	Not applicable
HCFC-22	HCFC: hydrochlorofluorocarbons. A temporary replacement for CFCs, will eventually be replaced by hydrofluorocarbons. HCFC-22: chlorodifluoromethane (CF_2HCL)	To be phased out by 2030	1574 tons
CH_3Br	CH_3Br : Methylbromide is used as a soil sterilant in agriculture.	To be phased out by 2010	Not available
1,1,1-trichloroethane	CCl_4 : Carbon tetrachloride was used in dry cleaning	Phased out 1995	Not applicable
CCl_4	Trichloroethane is used for adhesives, solvents and as a degreasing agent	Phased out 1995	Not applicable
Halons	Halons were used for firefighting	Phased out 1993	Not applicable

Source: A-GAS 1998.

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 centers as universities.

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

Column measurements of ozone and other atmospheric variables

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. Dobson #035 on permanent loan from the UK Met Office still needs to meet the required operational specifications and will operate soon from Cape Town (34.1S 18.2E).

A WMO/GAW International Comparison of Dobson Spectrophotometers (SAWB2000IC) was organized by the World Meteorological Organization and the South African Weather Service in close cooperation with the USA National Oceanic and Atmosphere Administration's Climate monitoring and Diagnostics Laboratory (NOAA/CMDL). This first Africa, WMO Region-I Inter-comparison event was conducted in Pretoria from 18 March – 10 April 2000. In addition the Czech Republic Hydro-meteorological institute continued to provide expert assistance to southern African training of Dobson operators. A training visit also was conducted in July 2004 at the Irene station. The second all African Dobson Inter-comparison was hosted by the Egyptian Meteorological authority and participation occurred in 2004 in Dahab. The next is to occur in 2008, South Africa.

Since November 1998, the S A Weather Service has been fortunate to reinstate its ECC RSG80-15GE Ozonesonde sounding programme, which operated during the period 1990 until 1993. Weekly ozonesonde soundings are conducted. This data is shared with the **S**outhern **H**emisphere **Ad**ditional **OZ**onesondes (**SHADOZ** - http://croc.gsfc.nasa.gov/shadoz/) programme from NASA, USA, which also is submitted to WOUDC. Since 2000, the Irene ozonesonde station was officially accepted into the SHADOZ network. The Irene Ozone Launching programme now also formed part of the AURA validation of OMI/TES and data after each launch is submitted in near real time. In spite of some technical upper air sounding equipment difficulties during 2007, the Weather Services is still able and committed to continue with a programme of two ozone ascents per month for the foreseeable future. Some **preliminary** long-term data results from our ozone network are revealed below.

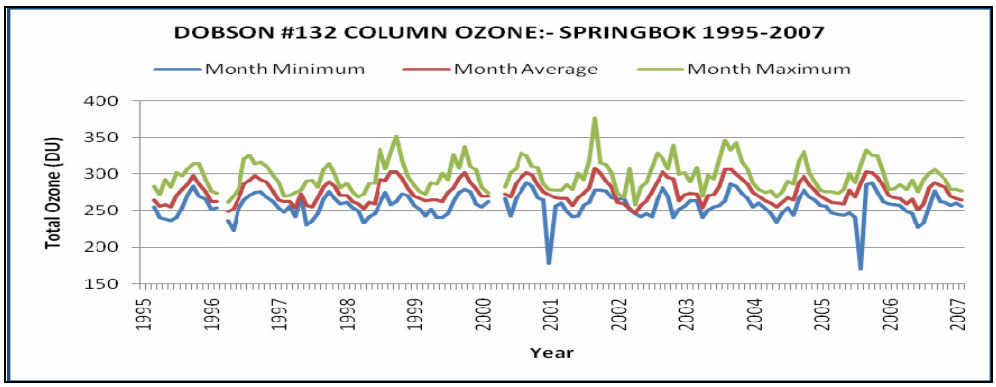

Figure 1: Dobson #132 Total Ozone Column for Springbok.

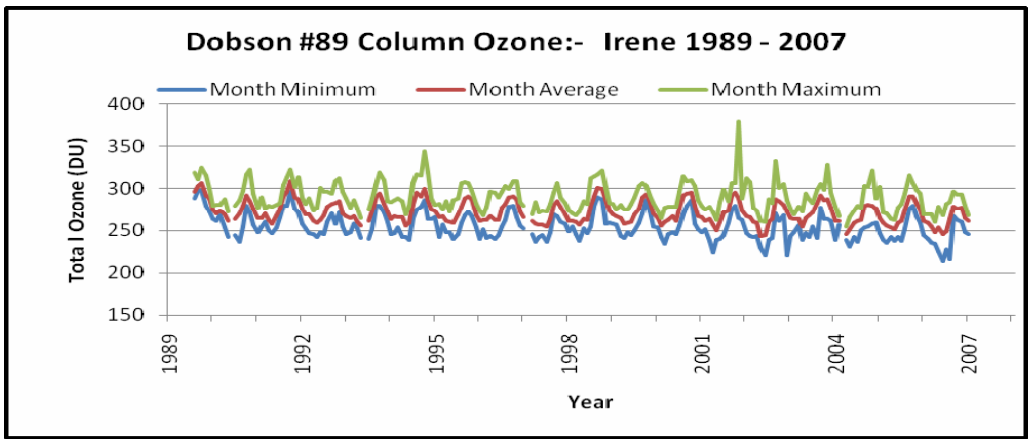

Figure 2: Dobson #89 Total Ozone Column for Irene.

Surface ozone measurements are continuously undertaken at Cape Point since 1982. Our programme has also extended surface ozone measurements to the South African National Antarctic Expedition Base (SANAE IV) in Antarctica since December 2003. This data will be included in research efforts relating to the current ongoing International Polar Year (IPY) activities. The SAOZ instrument which operated at SANAE during the early 1990's, has been refurbished at LSCE, CRNS, and France and was reinstated at the new SANAE IV base in December 2005.

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: $CFCl_3$, CCl_2F_2, $CCl_2F\text{-}CClF_2$, 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 Umweltbundesant) conducted an audit for N_2O at Cape Point. During 2006 with German collaborations (GKSS Research Centre Geestacht) the Cape Point gashouse mercury measurement programme was also revived.

Since 2005 a project was undertake for the continuous measurements of aerosols. This is now a well established programme 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 GAW 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 Programme of the World Meteorological Organization (GAW) *http://gaw.tropos.de*

Ultraviolet-B measurements
Since January 1994 the Weather Service has maintained a routine programme 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 programme 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 programmes for education. Regular enquiries from scholars are dealt with to satisfy their need to acquire more ozone and ultraviolet radiation knowledge. Two UV-B narrow-band (~306nm) Kipp&Zonen sensors are located at the two Dobson sites to investigate possible trend correlation between ultraviolet radiation and total ozone. Great strides have been made to develop our own numerical weather predictions outputs for UV indices. 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.

RESEARCH AIRCRAFT AND OTHER OBSERVATION/MONITORING NETWORKS

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 (500m – 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 and 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.

Figure 3: SAWS research Aircraft and under-wing measurement pods.

CALIBRATION ACTIVITIES AND DATA SUBMISSIONS

All primary ozone and trace gas data are submitted regularly to WMO recognized World Data centers. Data for year 2007 is slightly delayed due to our 2nd level of quality assurance processes still needed to be finalized. Since the inception of the Dobson programmes these instruments have been internationally calibrated through inter-comparison campaigns as supported by WMO. The next all-African Dobson calibration is scheduled to take place in South Africa during 2008, currently recognized as a WMO Regional African Dobson Calibration Centre.

Regular scientific audits from EMPA, Switzerland for surface O_3, CO and CH_4 have been successfully conducted over the past years, the latest being in September 2006. We have also acquired a surface ozone calibrator. With EMPA references the Cape Point laboratory hope to act as a national calibrations facility, especially for the many air quality monitoring networks in operation.

COLLABORATION - NATIONAL AND INTERNATIONAL

Ozone and related research are conducted sporadically within the country, mostly at a few academic institutions such as the University of Kwazulu Natal in Durban, the University of Cape Town and the University of the Witwatersrand in Johannesburg. Research interest on the effects of ultraviolet radiation amongst the medical and environmental sectors has also become more pronounced but are still sporadic.

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

- The World Meteorological Organization (WMO) and many other NHMS in our region
- SHADOZ/NASA/GSFC/USA
- USA NOAA CMD
- WOUDC and ARQP, Toronto, Canada
- Training assistance from GAWTEC http://www.schneefernerhaus.de/e-gawtec.htm, Germany
- 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, France
- EML, New York, USA
- The CZECH NHMS

FUTURE PLANS AND RECOMMENDATIONS

In collaboration with various research institutes we still would like to improve the general circulation models for ozone and UV-B predictions. The SAWS currently runs the Unified model of the UK Met. Office as its operational forecasting model. Efforts in this regard and capacity building in extending the NWP capabilities to include future Air Quality Forecasting services as an operational task of the weather serves is ongoing.

Also to note is that the Department of Environmental Affairs and Tourism (DEAT) has prioritized environmental policies especially through the new Clean Air Act. The South African Air Quality Information System (SAAQIS) is being developed under the auspices of a task team comprising members from the National Department of Environmental Affairs and Tourism (DEAT) and the South African Weather Service. The broad purpose of SAAQIS is to provide all stakeholders with access to accurate, relevant, current and complete information pertaining to national air and atmospheric quality in order to facilitate informed decision-making with respect to South African ambient air quality objectives. http://www.saaqis.org.za/

Through various other DEAT initiatives and projects it is believed that many municipalities (level of local government) across South Africa who operates air quality monitoring networks will also contribute relevant information to the SAAQIS system. Some of these monitoring projects can be researched at http://www.deat.gov.za/

The International Polar Year (IPY) also provides ample opportunity for the extension of collaboration and monitoring networks in the southern Oceans and Antarctica. Plans are being developed to enhance RSA ozone and trace gas measurement activities, at the South African National Antarctic Base at SANAE. These could also include the enhancement at the monitoring stations at Gough (40S, 10W) and Marion (47S, 37E) islands where permanent South African weather stations are operating.

Enhancing ozone and trace gas activities on the African continent, remains a great need and a great challenge. Many countries have expressed their willingness to participate and to become more actively involved in sustaining measurement programme in some form. The challenge, we as the scientific community thus must encounter, is how to assist those who also needs further investment, capacity and encouragement to secure and enhance the global network.

South Africa remains committed to continue building its scientific capacity relating to – ozone, atmospheric research and monitoring in general, and the related integrated Climate Change activities. The South African “ozone” community is very small and published peer-reviewed articles of research findings are admittedly very scarce.

There is an ever increasing need to establish long term continued high-resolution spectro-radiometer UV observations at some suitable sites in southern Africa. The first most favorable site could be located at the Base-Line Surface Radiations Network (BSRN) station at the De Aar location.

Total Quality management is gaining momentum in SAWS and the implementation of ISO standards for data quality assurance is needed for all instruments and observation technologies used for monitoring of ozone and UV in the national networks. This includes manly definition and implementation of traceable calibration systems/chains, SOPs and maintenance of relevant metadata files.

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