WEATHERSMART

Scientific meteorological and climatological news from the South African Weather Service **News**

August 2016

Lessons learnt from the 2015-16 drought in South Africa

Identifying strong wind hazards in South Africa

Cut-off lows in the upper atmosphere

South African Weather Service

ISO 9001 Certified Organisation

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EDITORIAL

The second WeatherSMART newsletter is once again a reflection on the excellent work being done by the South African Weather Service. Our feature article provides an in-depth discussion of the lessons learnt during the drought of 2015/16, the preceding factors as well as the impact on the country. This reflection not only captures the severe conditions and hardship experienced during the past El Niño event, but will also assist future decision makers to learn from lessons experienced during this episode.

An interesting article on interference with weather radars leads us to understand in depth how weather radars add to South Africans becoming WeatherSMART, as the information provided by this technology has become indispensable in our daily lives. As weather radars are powerful instruments in early warning technology, the interference by wind farms and WIFI technology is a reason for concern, but SAWS is cooperating with authorities to address this matter and looks forward to excellent solutions in this regard.

One of our young and upcoming female researchers provides an insight into the validation of various Numerical Weather Prediction (NWP) models and satellite quantitative precipitation estimation algorithms based on daily rainfall totals over South Africa, which once again demonstrates the South African progress with regard to using satellite information effectively along with other technology. In South Africa, rainfall is always important (too much or too little) and good measurements are required to ensure that our early warnings are efficient and effective.

Air pollution is a challenge in South Africa and the role of the South African Weather Service is reflected in two articles. One of the unintended consequences of air pollution is the effect on health, as discussed by Mr Lotta Mayana, while air quality modelling, discussed by Dr Melaku Esfaye, is crucial in protecting the public.

With summer on the way, we provide an in-depth discussion about cut-off lows - what they are, how they are formed and their impact. These systems produce a lot of rain, but as always, the public needs to be alert to mitigate effects such as flash flooding.

Dr Ziyanda Majokweni
General Manager: Corporate Affairs

What does it mean to become a WeatherSMART nation?

The South African Weather Service has a very important role to play to ensure that the public is informed about severe weather conditions and also react appropriately to those conditions.

As part of our drive to build a WeatherSMART nation, we regard the engaging of vulnerable communities in matters relating to severe weather as extremely important. As we live in a country with abundant sunshine, we often forget about the severe weather events that can cause havoc in our lives – often not only damaging our property, but also creating life-threatening and even fatal situations.

The world we are living in is changing. Climate change is a reality. While research shows that the climate is changing, countries around the world also start to experience severe weather more frequently. In South Africa, we have experienced first-hand the extremely hot and dry spells caused by the recent El Niño event, which was one of the strongest events in modern history, and apart from this, the records of the South African Weather Service show that in 2015 South Africa has experienced its driest year since 1904. This means it was the driest overall in 112 years!

Drought is not the only type of severe weather that is experienced in South Africa. As the weather becomes more variable, storms become more severe, which can lead to flooding, hail, the sweeping away of cars, damage to dwellings, crops and the loss of human and animal lives. If one lives at the coast, sea level rise and dangerously high waves, which can erode the beach front and habitable coastal land, are becoming increasingly important challenges.

In order to create a nation that is WeatherSMART, we have adopted the guiding principle of a WeatherSMART South Africa. A WeatherSMART nation is **S**afe, **M**ore informed, **A**lert, **R**esilient, and has **T**imeous access to relevant information and services. This means that the South African Weather Service wants you first of all to be Safe wherever you are – be it when driving in the rain, when lightning strikes, when you fly or when you hike in the mountains or attend an outdoor sports event. In order to be safe, you need to be More informed. You need to know the expected weather conditions, but you also need to know about the dangers of the weather and how to take appropriate care not to be caught in those conditions. If you approach a river in flood, you need to know that you should not cross the river – neither by foot, nor with any type of vehicle. And you need to spread this knowledge to the people you have daily contact with – be it your children, friends, parents, the elderly or general community.

Linked to the knowledge and awareness about weather conditions, the lurking dangers and the precautionary actions, the public needs to become more Resilient. You'll know what to do when faced with danger, and should disaster inevitably strike, you'll be able to recuperate sooner. Of course, all of this will be achieved when you have Timeous access to information – be it on your cell phone, the radio, television, social media or even word of mouth via friends.

Therefore, in order to be create a WeatherSMART nation, the role of the South African Weather Service is to ensure that you receive timeous information, understand its implications and take the necessary steps to mitigate and reduce the negative impacts.

For the South African Weather Service to provide the public with timeous weather information, we operate a sophisticated observations network. We have 23 weather offices around the country, where some offices do weather and other specialised observations and other offices (our regional offices) also do daily weather forecasting. Our technological network includes weather radars, daily upper-air soundings, a lightning detection system, weather satellite observations as well as one of the most powerful super computers in South Africa, which hosts our numerical weather predictions and other data used to do, amongst others, the daily weather forecast. While we ensure that we stay technologically updated, our biggest asset is our dedicated staff who operate and maintain this network and also ensure that data reaches our information dissemination network for distribution to the public, the media, stakeholders and clients. For this reason, we employ weather technicians, meteorologists, forecasters, researchers and support staff to ensure that our nation becomes WeatherSMART.

Dr Linda Makuleni
Chief Executive Officer

LESSONS LEARNT
from the 2015-16 drought in SA

– a co-authored article between Dr Joel Botai, Prof Hannes Rautenbach,
Dr Andries Kruger, Dr Asmerom Beraki and Ms Elsa de Jager

The South African Weather Service (SAWS) strives to be the foremost provider of relevant services in respect of weather, climate and related products, which contribute to sustainable development in South Africa and the African continent. SAWS is therefore regarded as an authority for weather and climate forecasting in South Africa.

The performance and relevance of its monitoring and forecasting capabilities were especially assessed during the 2015/16 drought, which was identified to be one of the most extreme droughts ever recorded in history in some parts of South Africa. In addition, lessons learnt from the 2015/16 drought provided an excellent opportunity for developing and introducing new ideas aimed at improving monitoring and forecasting services for implementation to address extreme future weather events.

With its outstanding research track record, SAWS had contributed considerably to innovative practices and products over the past decades. SAWS has recently been declared as a national Research Institution for the purpose of receiving direct funding from the National Research Foundation (NRF), which will strengthen its capability towards advanced research substantially. The Research unit at SAWS consists of specialized sections in (1) Now-casting and very short range forecasting, (2) Short and medium-range forecasting, (3) Long-range forecasting, (4) Global Atmospheric Watch (GAW), ozone and radiation and (5) Climate change and variability, (6) Air quality and (7) Applications research with an emphasis on water resources: agriculture, health and energy. These sections are well placed to address various challenges related to the impact of extreme weather and climate events on society in both South Africa and the region. SAWS also has an exceptional international footprint with a strong relationship with the World Meteorology Organization (WMO) and the Intergovernmental Panel for Climate Change (IPCC). SAWS is also looking at ways in which it can further extend its scientific endeavours with the Food and Agriculture Organization (FAO) of the United Nations.

Run up to the 2015/16 drought

January 2014 to December 2014

The 2015/16 drought was preceded by the 2014/15 season with low rainfall that covered the KwaZulu-Natal, Free State, Mpumalanga and the North West provinces.

These low rainfall conditions were already captured before the 2015/16 season by the SAWS Department: Climate Service that monitors rainfall and temperature extremes and trends on an ongoing basis, using an extended SAWS network of monitoring stations. Due to below-normal rainfall conditions during the 2014/15 summer rainfall season, the northern and north-eastern parts of South Africa were already classified as dry to very dry for 2014, as presented by the 12-month Standard Precipitation Index (SPI) analysis for 2014 (January 2014 to December 2014) that is depicted in Figure 1.

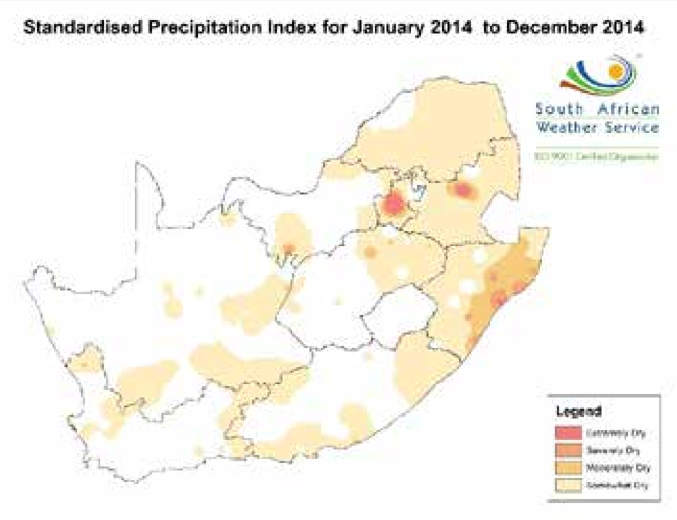


FIGURE 1: The 12-month Standard Precipitation Index (SPI) for between January 2014 and December 2014, as provided before the 2015/16 dry summer season by the South African Weather Service (SAWS) Department: Climate Service.

July 2014 to June 2015

The July 2014 to June 2015 period was identified to be, on average, the driest season for South Africa since 1991/92, and the third driest since 1932/33. This is confirmed by Figure 2, which illustrates the 12-month SPI analysis as well as the percentage of normal rainfall map for the July 2014 to June 2015 season.

January 2015 to December 2015

January 2015 was characterized by further below-normal rainfall, exacerbating the drought in the western and north-western interior, which received very little rain. By February 2015, some agricultural organisations already wanted the North West Province to be declared drought-stricken, and in the

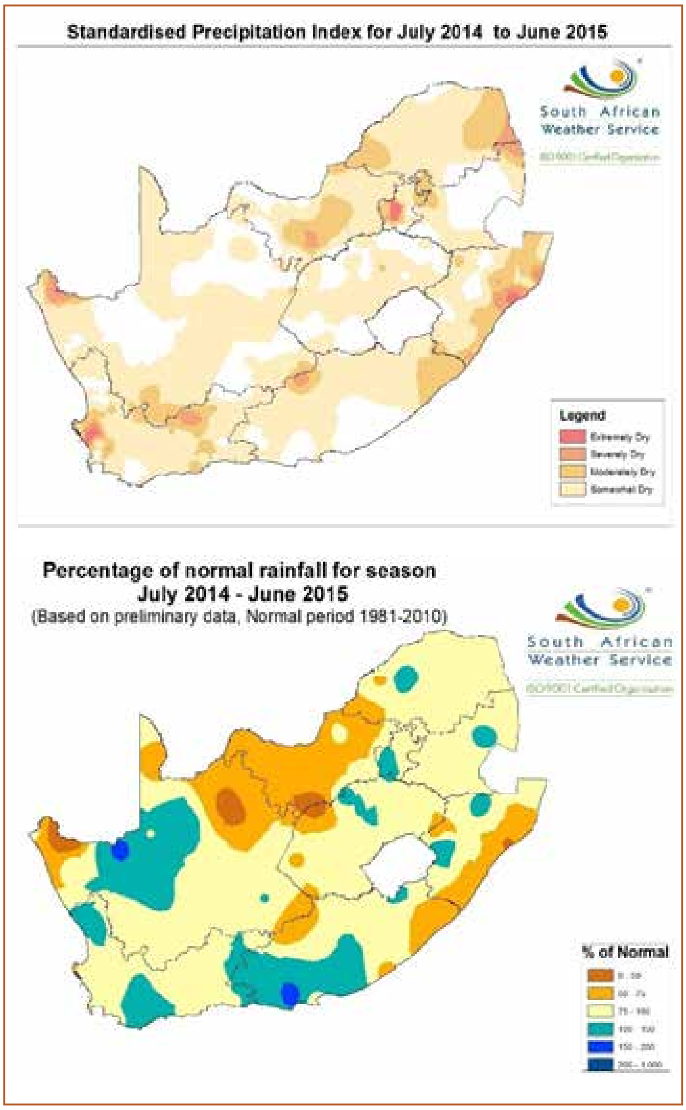


FIGURE 2: The 12-month Standard Precipitation Index (SPI) (left) and percentage of normal rainfall (right) maps for the July 2014 to June 2015 season, as provided by the South African Weather Service (SAWS) Department: Climate Service.

KwaZulu-Natal province a substantial loss in the sugarcane yield was expected, while water restrictions were in place over a substantial part of the province. By March 2015, other provinces also considered applying to be declared drought-stricken areas, including the Western Cape, Free State, Limpopo, and Northern Cape provinces. By the end of the 2014/15 summer season, the prolonged drought conditions already severely affected maize, sugar cane, and sorghum harvests. In June and July 2015, the western half of the country as well as some parts in the east, got temporary relief from the dry conditions, with most places receiving more than double the expected rainfall for the month. In September 2015 the rainfall season in the summer-rainfall areas commenced well, with comparatively high rainfall totals reported in the northern interior. However, spring and the beginning of summer of 2015 experienced very dry conditions accompanied by recurring heat waves in many places. Due to the persistent dry conditions, the North West, KwaZulu-Natal, Mpumalanga, Limpopo, and the Free State provinces were declared drought disaster areas in November

2015. The pre-2015/16 dry conditions are confirmed by Figure 3, which depicts the twelve-month SPI between January 2015 and December 2015. Most of the central interior and some parts of the Western Cape province experienced extremely dry conditions. Almost the whole of South Africa experienced what can be described as a moderate drought or worse, with the exception of the south coast and southern parts of the south-east coast and adjacent interior.

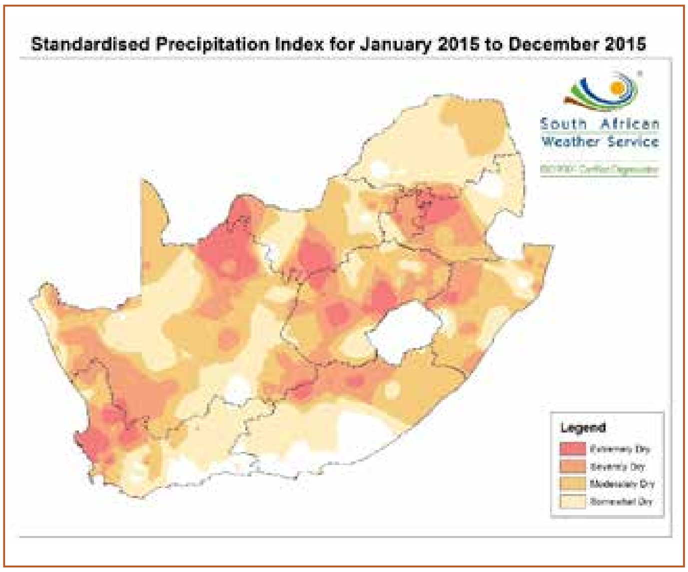


FIGURE 3: The 12-month Standard Precipitation Index (SPI) for between January 2015 and December 2015, as provided during the 2015-16 dry summer season by the South African Weather Service (SAWS) Department: Climate Service.

An analysis of the district rainfall for South Africa (Figure 4) revealed that 2015 was the driest year on record in some areas of South Africa since 1921. These areas include the KwaZulu-Natal province and adjacent regions, the eastern and south-eastern parts of the Free State Province, the southern parts of the Mpumalanga province (extending into the Gauteng province), some parts of the North West province as well as the south-western parts of the Western Cape province.

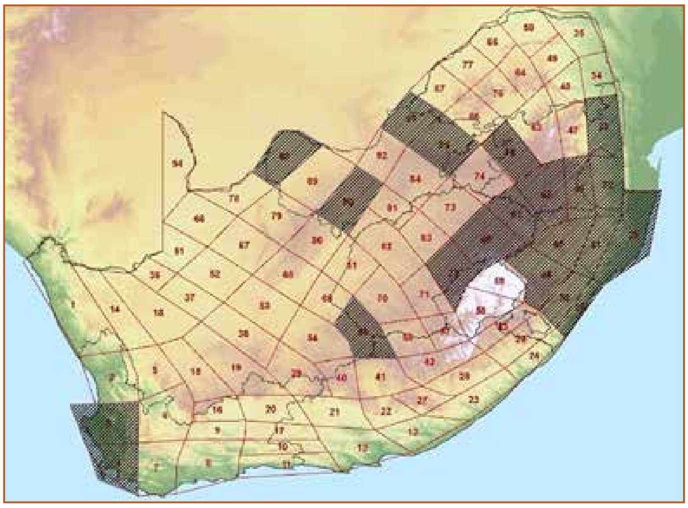


FIGURE 4: The district rainfall areas of South Africa. Shaded are districts that were identified in 2015 (January 2015 to December 2015) as the driest districts since 1921, Source: SAWS Department: Climate Service.

January 2016 to March 2016

Following the extremely dry conditions which prevailed in 2014 and 2015, the three-month SPI analysis for January 2016 to March 2016 (Figure 5) indicates that about half of South Africa was described as dry. Notable is the lack of rainfall in the northern KwaZulu-Natal and southern Mpumalanga provinces, as well as isolated areas in the North West province.

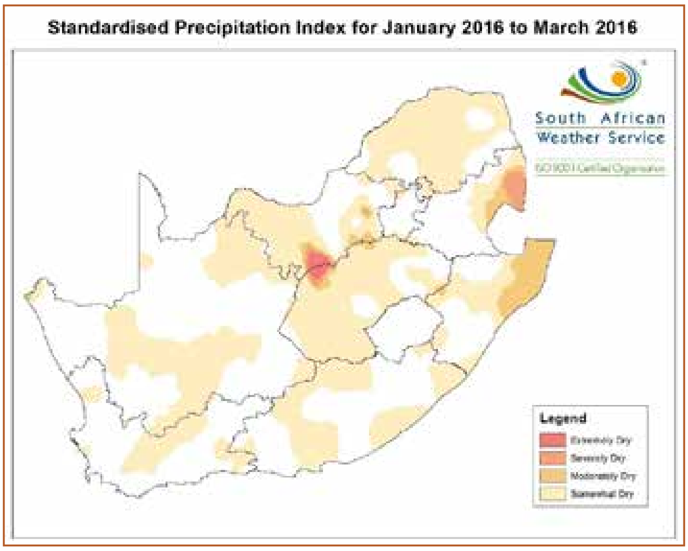


FIGURE 5: The 3-month Standard Precipitation Index (SPI) for between January 2016 and March 2016, as provided by the South African Weather Service (SAWS) Department: Climate Service.

Near-surface temperature trends and 2016 extremes

The 2015/16 drought was accompanied by extremely high near-surface temperatures across South Africa. The annual mean temperature anomalies for the period January 2015 to December 2015, as recorded by 26 climate stations, was on average 0.86°C above the reference period (1981–2010), making 2015 the warmest year on record since 1951 (Figure 6). The year 2015 was also the warmest year in a general warming trend observed in South Africa of about 0.14°C per decade. This trend agrees well with the latest global warming trends provided by the NOAA National Climate Data Centre (Figure 7), meaning that the trend could be attributed to global warming. It is interesting to note that the temperature trend in South Africa is moderate compared to other continental areas on the globe, especially continents in the Northern Hemisphere.

In some parts in the interior, the mean maximum temperature deviations for January 2015 were more than 3°C above the normal. By March 2015, the Western Cape, Free State, Limpopo and Northern Cape provinces experienced maximum temperature deviations that were in excess of 2° to 3°C above normal. In spring 2015, record high temperatures were exceeded on a regular basis, with Vredendal the highest recorded global temperature on 27 October 2015 at 48.4°C. The previous highest maximum temperature for this station was 42.5°C, recorded on 30 October 1999. Extremely high maximum temperatures

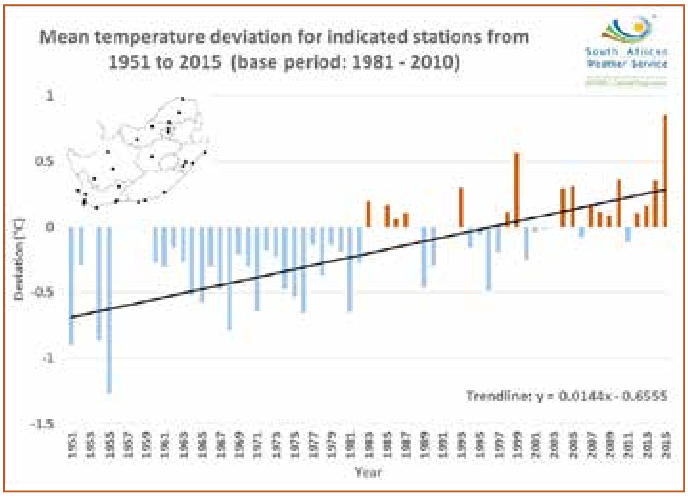


FIGURE 6: 1951 to 2015 annual mean near-surface temperature anomalies (°C), as calculated from the base period 1981–2010 and as recorded at 26 climate stations across South Africa (black dots on the map). The trend line indicates a warming of 0.14°C per decade. Source: South African Weather Service (SAWS) Department: Climate Service.

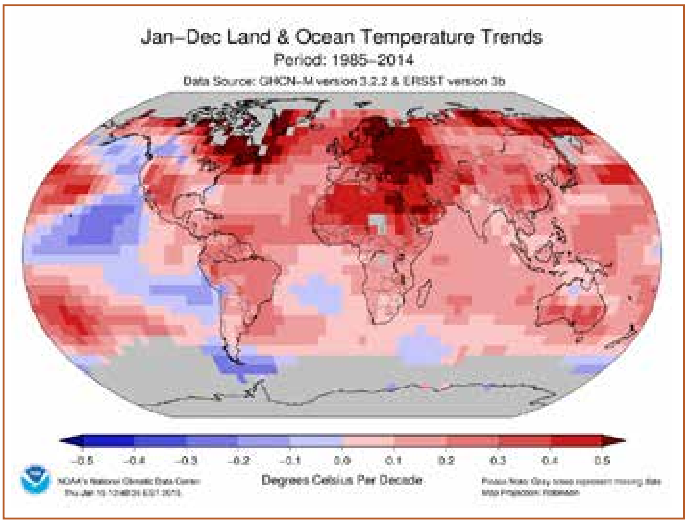


FIGURE 7: 1985 to 2014 global near-surface temperature trends (°C per decade). Source: NOAA's National Climate Data Centre.

also occurred in Gauteng from 4 October 2015, and resulted in prolonged heatwave conditions for nine consecutive days in Pretoria and eight consecutive days in Johannesburg. Lephalale in the Limpopo Province also experienced heat wave conditions for 6 consecutive days. Heat wave conditions also occurred in November 2015, starting on 7 November 2015 and prevailing across four provinces (Gauteng, Mpumalanga, Limpopo and North West provinces).

Figure 8 denotes the number of new records at individual stations during 2015, indicating the large number of highest maximum and minimum temperature records broken during spring and early summer in 2015.

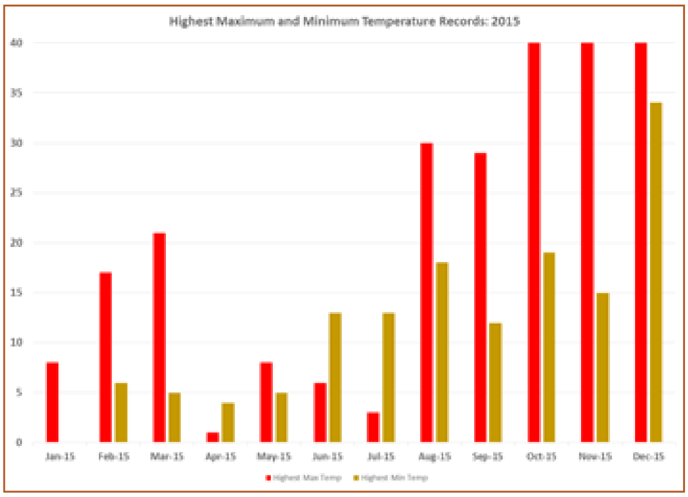


FIGURE 8: Number of highest maximum and minimum temperatures broken at individual stations during different months in 2015. Source: South African Weather Service (SAWS) Department: Climate Service.

In summary, 2015 was the hottest year globally, and most probably also in South Africa, since the instrumental period (1800s). The record warming globally continued into 2016, with January and February 2016 globally the hottest months on record by a relatively large margin.

Forecasts and Predictions

Short-term forecasts and the National Joint Drought Coordinating Committee (NJDCC)

At the beginning of the 2015/16 season, SAWS was invited to make key contributions to the newly established National Joint Drought Coordinating Committee (NJDCC). The NJDCC was established by the South African Government in 2015 to monitor the evolution and to respond to the risks posed by the 2015/16 drought to various national sectors (e.g. water and agriculture). The NJDCC is hosted by the National Disaster Management Centre (NDMC) in the Department of Cooperative Governance. In the NJDCC, SAWS is regarded as a national authority to provide input on seasonal predictions and shorter term forecasts of weather extremes.

The progression of the 2015/16 drought, especially with respect to extremely dry and warm conditions (e.g. heat waves), were monitored by the SAWS Short-Range Forecasting section using the operational Unified Numerical Weather Prediction (NWP) model from the UK Met Office (Figure 9).

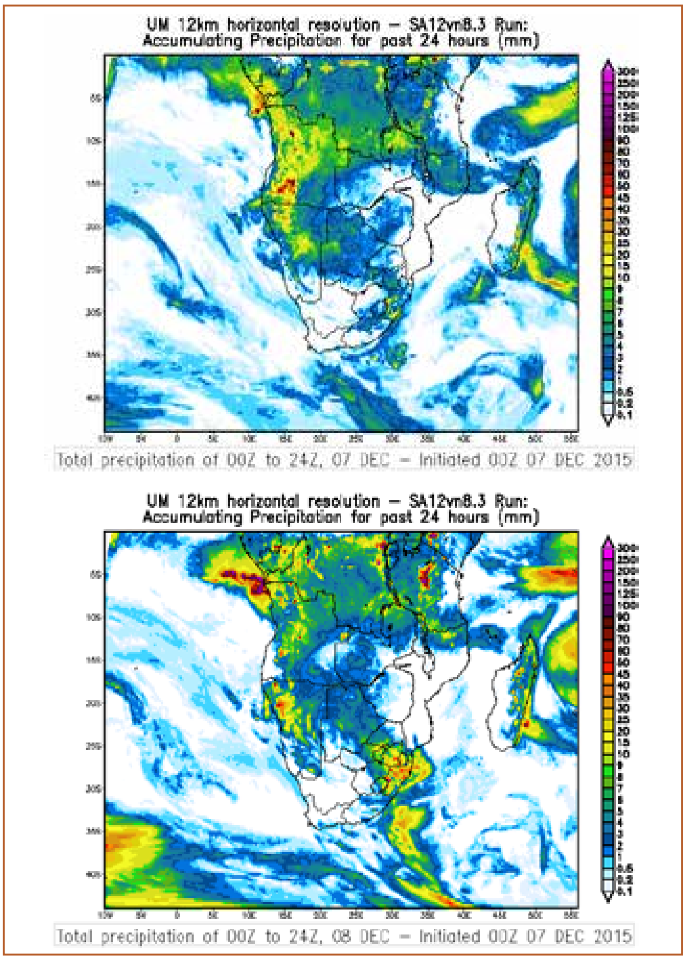


FIGURE 9: Typical short-range forecasting products generated by the operational Unified Numerical Weather Prediction (NWP) model from the UK Met Office, and used to inform the National Joint Drought Coordinating Committee (NJDCC) and public about the progression of the 2015/16 drought, especially with respect to heat waves. Source: South African Weather Service (SAWS) Short Range Forecasting Section.

ENSO Predictions

At the seasonal timescale, the predictability of atmospheric circulation and rainfall mainly arises from slowly evolving boundary forcing which include, inter alia, global Sea Surface Temperatures (SSTs), sea ice, snow cover and land surface conditions. The El Niño Southern Oscillation (ENSO) is regarded as one of the most dominant universal modes of climate variability which significantly influences climate variability in southern Africa. About 50% to 60% of droughts in southern Africa could be associate with El Niño episodes (Figure 10). The interaction of ENSO with other modes of climate variability, such as Indian Ocean Dipole (IOD) and Southern Annular Mode (SAM), might also play an important contributing role.

In collaboration with the Centre for High Performance Computing (CHPC) and other international partners, SAWS has introduced an operational Ensemble Prediction System (EPS) to generate sub-seasonal to seasonal predictions. The EPS successfully predicted the development and maturity of the 2015/16 El Niño in advance, which substantially contributed to early warnings of a possible advancing drought (Figures 11 and 12).

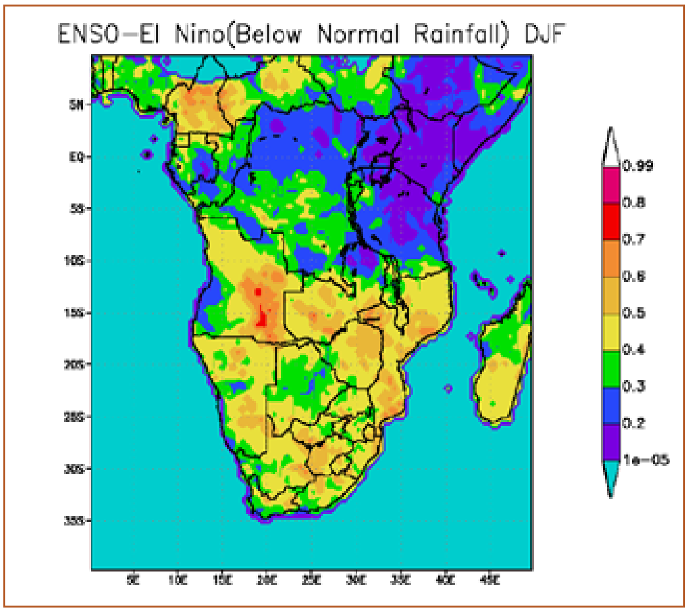


FIGURE 10: Between 50% and 60% of the time below-normal rainfall across southern Africa is associated with El Niño or positive ENSO events. Source: South African Weather Service (SAWS) Long-Range Forecasting Section.

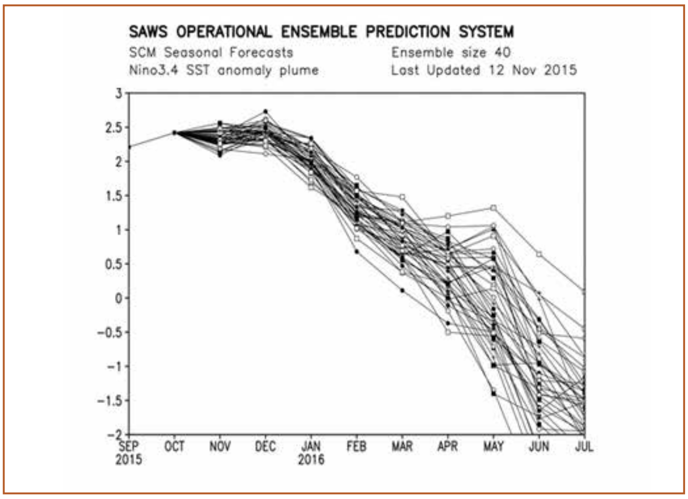


FIGURE 11: The SAWS ENSO predictions released in November 2015 successfully indicated in advance how the 2015/16 El Niño had evolved, and might weaken towards the second half of 2016. Source: South African Weather Service (SAWS) Long-Range Forecasting Unit.

MMS seasonal predictions

On a monthly basis, SAWS coordinates a Seasonal Climate Watch Forum (SCWF) with the objective of creating the space and opportunity for all seasonal prediction role players in South Africa (including indigenous knowledge outlooks) to contribute to a national seasonal climate prediction consensus, and to collectively devise a mechanism for stimulating end-user uptake and feedback. It is worth mentioning that SAWS has made a noticeable contribution to inform users timeously about the risk of a drought in the 2015/16 season. For example, guided by its Multi-Model System (MMS), the SAWS had made a recommendation in its advisory monthly bulletin issued in August 2015 that the likelihood of a drier and warmer 2015/16 season is high (Figure 13). The SAWS Seasonal Climate Watch bulletin, which is produced every month, is disseminated through various channels.

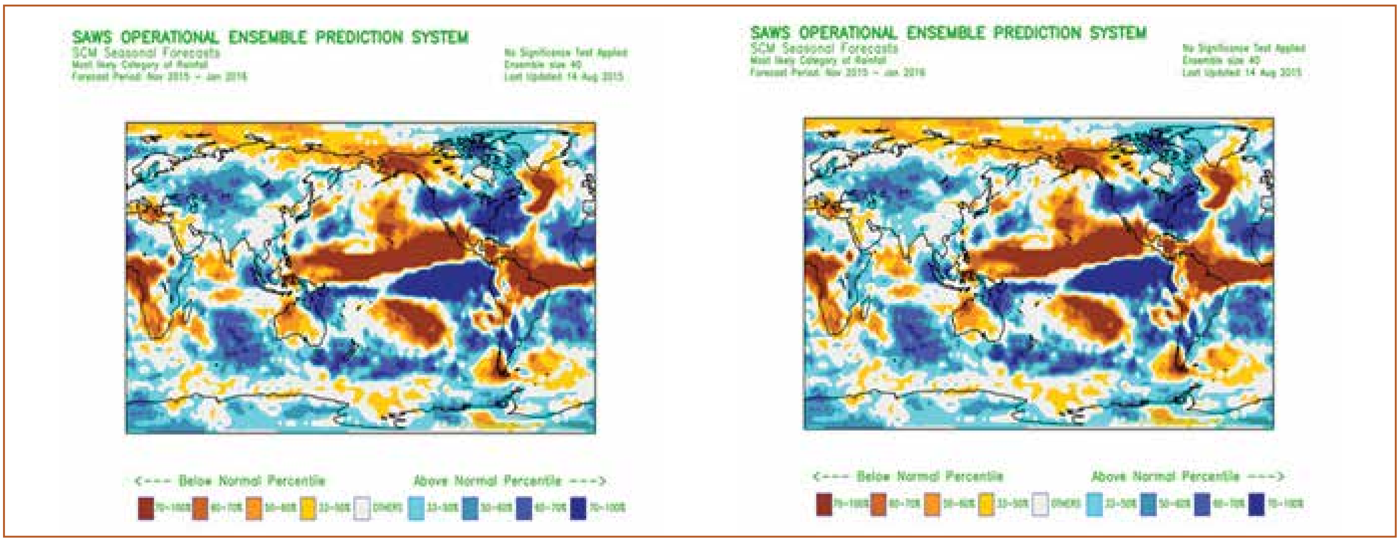


FIGURE 12: The SAWS ENSO predictions released in November 2015 successfully indicated in advance how Global Sea Surface Temperatures (SSTs) might evolve in the 2015/16 season. Source: South African Weather Service (SAWS) Long-Range Forecasting Unit.

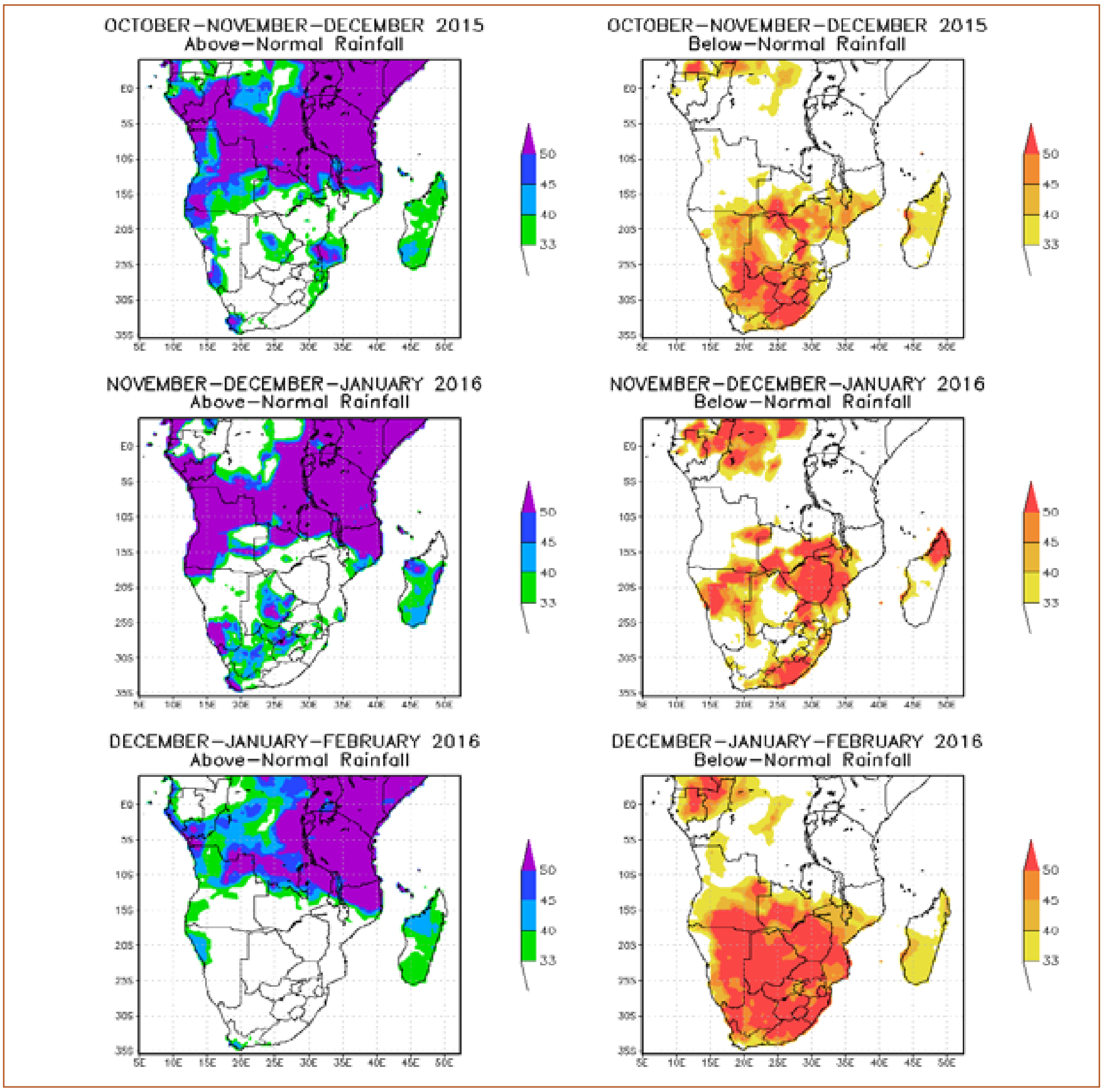


FIGURE 13: The SAWS Multi-Model System (MMS) predictions released in September 2015 captured the anticipated 2015/16 drought. High maximum and minimum temperatures were also predicted. Predictions towards dry and warm conditions persisted throughout the 2015/16 season.

It is available via the SAWS website (www.weathersa.co.za), disseminated through an email distribution list and is presented at governmental committee meetings, most notably the National Agro-Meteorological Committee (NAC) which meets quarterly.

Climate change projections

Since global warming poses a risk to society in terms of possible changes in climate (e.g. the frequency of droughts and floods), SAWS is hosting a climate change and variability section which focuses on the "weather of climate change" and its sector based impacts. Research is conducted using global model results as well as results from dynamical and statistical downscaling methods (Figure 14).

Future Planning

SAWS' response to the National Drought Monitoring plan

During early 2016, SAWS had positioned itself to contribute to the National Drought Monitoring plan through the provision of information and services based on observations and weather forecasting, categorized according to the following different timescales:

- *Now-casting and very short-range forecasting:*

  Forecasting of weather phenomena from 0 - 12 hours. Real-time observation platforms such as satellite, weather radar, and real-time reporting surface observations are used.

- *Short and medium-range forecasting:*

  Forecasting the weather for periods of 1 - 3 days (short range forecasting) and day 4 - 10 days (medium range forecasting). NWP models are used.

- *Long-range forecasting*

  Forecasting weather and climate ranging from 1 - 6 months. Global Atmospheric Circulation (GCM) models coupled with ocean and land models are utilized to predict seasonal phenomena such as the El Niño and La Niña phenomena.

In addition, SAWS is also committed to contribute to the development of human capital by addressing the identified shortage of skills in weather, climate and air quality sciences in South Africa, and will serve as a key point from where weather and climate data and information is distributed to various sectors and users.

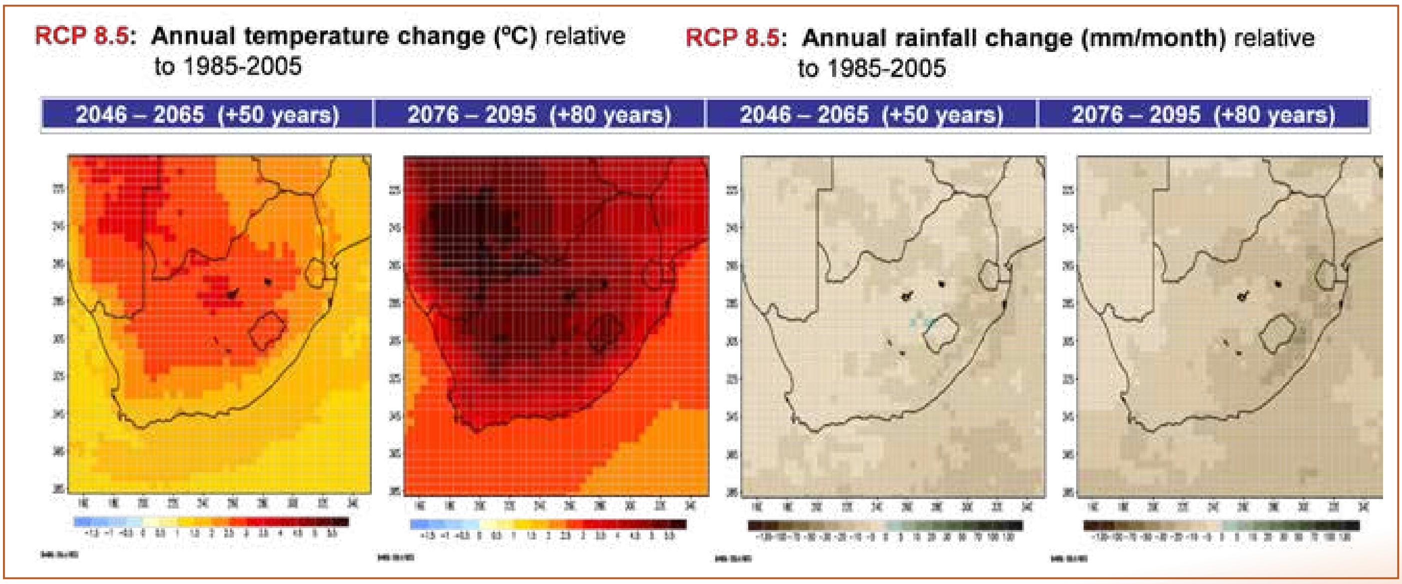


FIGURE 14: An example of SAWS climate change projections of near-surface temperature and rainfall, generated from an ensemble of regional model projections under different Representative Concentration Pathways (RCPs). Source: The SAWS Climate Change and Variability section.

National Framework for Climate Services (NFCS)

With the Department of Environmental Affairs (DEA), SAWS is actively involved in the development of a National Framework for Climate Services (NFCSs). Climate services aim at providing climate information in a way that assists decision making by individuals and organisations. Such services require appropriate engagement along with an effective access mechanism and must respond to user needs. It involves high-quality data from national and international databases on temperature, rainfall, wind, soil moisture and ocean conditions as well as maps, risk and vulnerability analyses, assessments and long-term projections.

Sector specific preparedness applications and benefits

The Research unit at SAWS has an application section with the responsibility to develop scientific application products covering hydrometeorology, agro-meteorology, health and energy. The research team in this section contributes towards innovative sector-specific products that address user needs. In particular, the hydrometeorology research team works towards providing new information, forecasts and knowledge of water resources in South Africa, covering different spatial and temporal scales and a broad range of users. The information is used in decision support for a safe and sustainable society, water management, environmental protection, and building of infrastructure. The agro-meteorology research team contributes towards the development of different products (weather and climate) which are designed to provide the best possible decision-making information for farmers. The health research section contributes towards the development of health monitoring indicators, modelling the interaction of environmental factors and population health, development of early warning systems (e.g. malaria, heat and health). The energy research section focuses on renewable energy research with particular emphasis on solar energy potential. Additionally, the energy section conducts research in wind energy through the development of a wind atlas: a mapping of the wind, (i.e., the wind's speed and direction is estimated using the statistical information available) is done. In this regard, "wind virtual masts" are conceptualized based on meteorological data from SAWS' data archive and wind model resulting in a quick first "screening" of the wind conditions in a specific location.

Conclusions

With its vision that states "A WeatherSMART nation", SAWS is putting emphasis on achieving an end-state where citizens, communities and business sectors are weather resilient because they are able to use the information, products and services provided by SAWS optimally. This will be achieved through:

- Thought leadership in meteorological, climatological and other related sciences;
- The development of relevant and innovative applications and products utilising cutting edge technology; and
- Establishing and leveraging collaborative partnerships.

The extreme 2015/16 drought episode, which already commenced in the second part of 2014 and lasted until 2016, has demonstrated and challenged SAWSs scientific and operational capabilities as the relevant authorities were warned about the pending drought. As a matter of fact, SAWS received much more exposure compared to previous years, with a specific drive towards the need for tailor-made impact-based data and information. With the newly established NJDCC, many drought preparation and response needs associated with end-user vulnerability were identified and will be addressed by the creation of relevant applications to create a more resilient society in similar future droughts. Important factors to take into consideration are the expansion and quality of the observational network as well as the improvement of skill in short, medium and long-rangeforecasting capacity.

Application of radar data at the South Africa Weather Service

– by Mr Erik Becker, Scientist: Nowcasting and Very Short-Range Forecasting

Weather Radar is one of the most powerful real-time weather observation tools in a meteorologist's arsenal. It is an active sensor that generates and transmits an electromagnetic signal at a defined frequency. It is capable of operating day and night giving a three-dimensional "picture" of the atmosphere at high temporal and spatial resolution. It is capable of covering a large domain typically at a radius of between 200 and 300km from the radar and completes a scan every 5-10 minutes.

Weather radar systems operate at three main frequencies designated as the S-, C- and X-band frequencies (±2.8, ±5.6 and ±9.4 GHz, respectively). Smaller frequency radars are much bigger and more expensive than their higher frequency counterparts, but the advantages in terms of quality of data is well worth the extra investment. The most common radar parameter measured, known as reflectivity, gives the user information about the concentration and size of particles present in the atmosphere. Capabilities such as Doppler detection and Dual-Polarization provide additional information on particle motion, phase and shape can also be collected. All these measurement allow meteorologists to observe and track the movement of thunderstorms, identify severe (damaging) thunderstorms, quantify rain rate and identify whether regions in the thunderstorm consist of hail, ice, snow, rain, etc. Various wind-related phenomena such as turbulence, wind shear, mesocyclones and microburst can also be identified using measurements from radar systems.

Over the past few years SAWS has invested a lot of time and money into the improvement of radar-based applications. During 2010 – 2012, the SAWS radar network was upgraded with 10 Gematronik Meteor 600S S-band radar systems. Eight of the older C-band frequency systems were replaced, which means that the network now consists of 14 radar systems. There are a number of advantages for selecting the S-band frequency over the C-band. The first reason is that the radar, due to the physical properties of the electromagnetic radiation, experiences much less attenuation (the loss of power due to the radiation travel through a medium, such as precipitation). Thus, if there is a region of precipitation behind a thunderstorm (relative to the position of the radar) the measurements will be much more accurate. Another major driving force for migrating the frequency from C-band to S-band was due to interference detected from wireless radio transmitters such as Wi-Fi. These transmitters frequently operate close to or within the frequency of the C-band radar systems. The resulting interference is difficult to correct and renders the data useless for quantitative purposes. The only drawback from operating in the S-band frequency is that the radars are expensive to construct and maintain. As a result it is a major challenge for the SAWS technical team to keep the instruments operating at all times.

The new network opened the doors for various collaborations with international partners, which significantly improved how radar data can be used within SAWS. The first project, Rain for Africa (R4A), is funded by the Dutch government and aims to reach small-scale farmers in rural Africa to provide them with the necessary information to improve their crop yield. The second project is the World Meteorological Organization's (WMO) Aviation Research and Development Project (AvRDP), which was initiated in an effort to improve nowcasting for aviation applications. Oliver Tambo International Airport (ORTIA) in Johannesburg, South Africa, was selected as one of the participating airports in this project.

One of the deliverables of the R4A project is to establish a high quality Quantitative Precipitation Estimation (QPE) product using radar data. Collaboration with the Dutch Weather Service (Koninklijk Nederlands Meteorologisch Instituut: KNMI) has resulted in the implementation of calibration monitoring software to monitor antenna alignment and radar performance operationally (i.e. without interrupting the radars scanning process). Exact calibration is essential for good quality measurements and accurate precipitation estimates from the radar. The project also allowed access to SCOUT radar processing software (developed by Hydro & Meteo in Germany). The software is primarily used to handle quality control processes on the raw radar data. Errors in the measurements due to non-meteorological targets such as ground clutter, ships, aircraft, beam blockages due to topography, etc. need to be corrected. Each radar is unique and needs special attention to remove and correct all possible sources of errors. Figure 1 is a precipitation accumulation from 1 December 2014 to 31 December 2014 at the Durban radar that illustrates the data measurements before and after quality control.

The existing QPE algorithm at SAWS was updated to include precipitation classification into stratiform and convective precipitation regions. The use of dual Z-R relationships to convert the reflectivity values to precipitation estimate takes into consideration the different microphysical processes with these two different types of precipitation and subsequently more accurate precipitation estimates are produced. There are also temporal biases within the precipitation due to the temporal resolution of the radar. The use of optical flow vectors to track to motion of each individual pixel measurement and integrating the precipitation with the tracked motion has resulted in the reduction of these temporal biases within accumulations.

The AvRDP project will investigate improvements of convective rainfall nowcasting cases over the OR Tambo International Airport. With the help of the Hong Kong Observatory, the community version of Short-range Warning of Intense Rainstorms in Localized Systems (SWIRLS), or com-SWIRLS, is being tested over the South African domain. Com-SWIRLS use state-of-the-art techniques for analysis and prediction of precipitation and convective weather phenomena for the next few hours. The extrapolated forecast shows good skill within a lead time forecast of 2 hours. To further increase the skill of the forecast, future plans include assimilating radar observations into a numerical weather prediction model running at high temporal and spatial resolution. Blending the extrapolated forecast with the assimilated model data will increase the skill of the forecast with a lead time of up to 6 hours.

To be useful for all purposes, radar data needs to be available at all times and be of high quality. Resent advances in technology, such as the use of wireless internet devices and the popularity of wind farms cause severe concern for radar data users. Both can lead to significant interference in weather radar data. However, SAWS is cooperating with various entities to ensure the radar network produces accurate and high quality measurements.

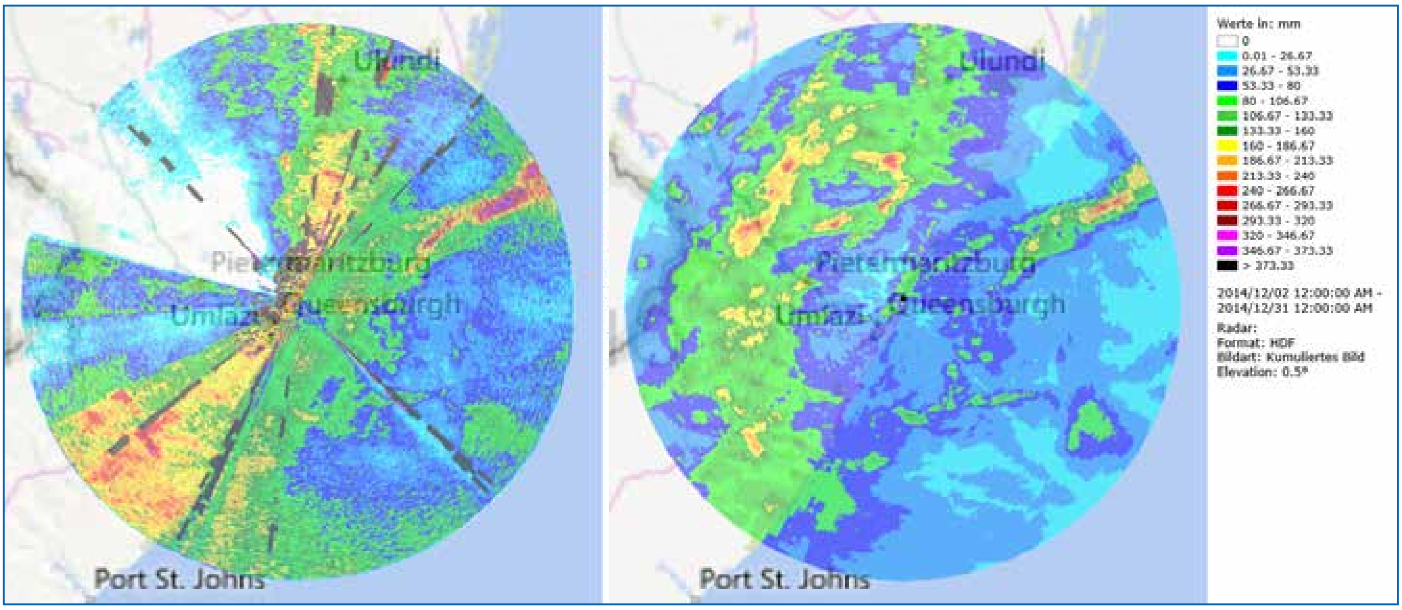
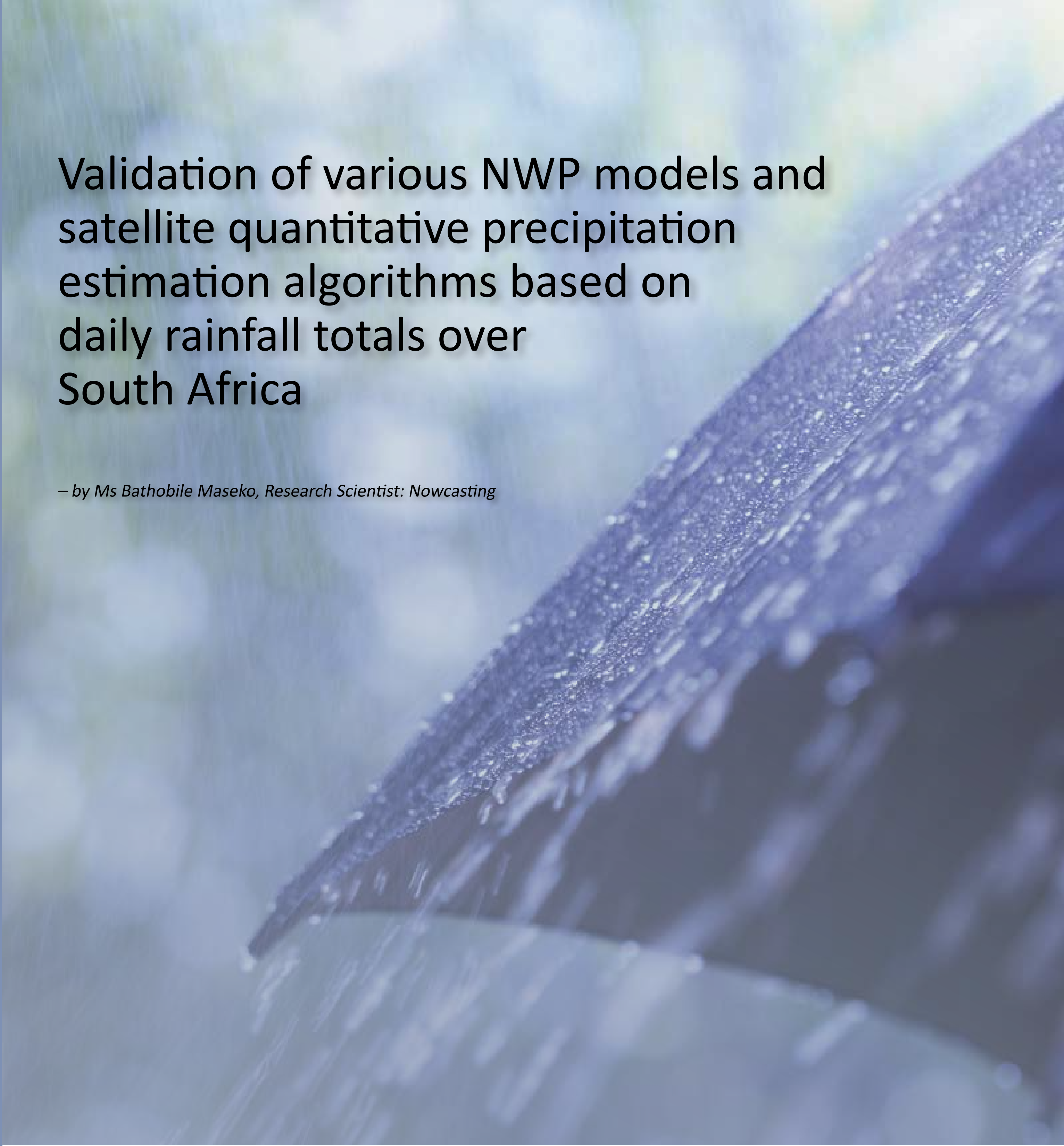


FIGURE 1: A precipitation accumulation from 1 December 2014 to 31 December 2014 at the Durban radar that illustrates the data measurements before (left) and after (right) quality control.



Validation of various NWP models and satellite quantitative precipitation estimation algorithms based on daily rainfall totals over South Africa

– by Ms Bathobile Maseko, Research Scientist: Nowcasting

Rainfall plays an important role in the global water cycle as well as for evaluating changes and trends in climate. South Africa is often influenced by floods and therefore good quality precipitation measurements are needed to assist in the forecasting of floods and other natural hazards. Precise measurements of precipitation are essential to weather forecasters and climate scientists, as well as hydrologists, agriculturists, emergency managers, and industrialists.

Rainfall estimates can be derived from Numerical Weather Prediction (NWP) models, radar systems as well as satellites. Satellite rainfall can be derived from Low Earth Orbiting (LEO) and/or geostationary (GEO) satellites. The LEO satellites have better spatial resolution than the GEO satellites, but cannot be used for operational forecasting purposes because of low temporal resolution. The GEO satellites have a lower spatial resolution than LEO, but they have a higher temporal resolution, which is useful for real-time products such as rainfall estimation. Data from the Meteosat Second Generation (MSG) GEO satellite, is available every 15 minutes, which makes the GEO satellites useful for nowcasting and forecasting purposes in operational weather services.

The International Precipitation Working Group (IPWG) is a forum where operational and research users of satellite precipitation measurements exchange information on precipitation measuring methods. The focus is on the development of improved precipitation products as well as the validation and verification of these products. The validation of all products is performed against rain gauges and radar rainfall measurements, where possible. On the IPWG website (http://www.isac.cnr.it/~ipwg/validation.html), NWP and satellite precipitation estimation algorithms are visually compared to daily rain gauge measurements on a 0.25˚ X 0.25˚ grid resolution for different regions in the world. The displays include daily rainfall total images as well as validation by means of scatterplots and various statistics. South Africa is participating in the IPWG validation forum by comparing different NWP modelling products and satellite precipitation estimation techniques to SAWS' rain gauge data on a daily basis.

A comparison of the different NWP model and satellite rainfall estimation algorithms has been done using South African rain gauge data since March 2013. The satellite algorithms include: a) methods combining microwave sensors and GEO satellite inputs, as well as b) methods using only GEO input. In South Africa a local version of the Hydro Estimator (HE) has been operational since 2007 and the Convection Rainfall Rate (CRR) was implemented operationally in October 2014. The NWP model used is the local version of the Unified Model (UM) developed by the UK Met Office and the Weather Research and Forecasting (WRF) model.

Data and methods

SAWS operates a rain gauge network, which consists of 1500 rain gauges. Measurements of daily rainfall from rain gauges are used to evaluate the NWP models and satellite-based precipitation products for the purpose of the IPWG. Figure 1 shows the location of the rain gauges used for daily rainfall total over South Africa. Measurements are made over a 24-hour period from 06:00 to 06:00 UTC. To assess the rainfall estimation products quantitatively, continuous (Bias ratio, Root Mean Square Error (RMSE), Correlation Coefficient (CC) and categorical (Bias, Probability of Detection, False Alarm Ratio, Heidke Skill Score) verification statistics are used (http://www.cawcr.gov.au/projects/verification).

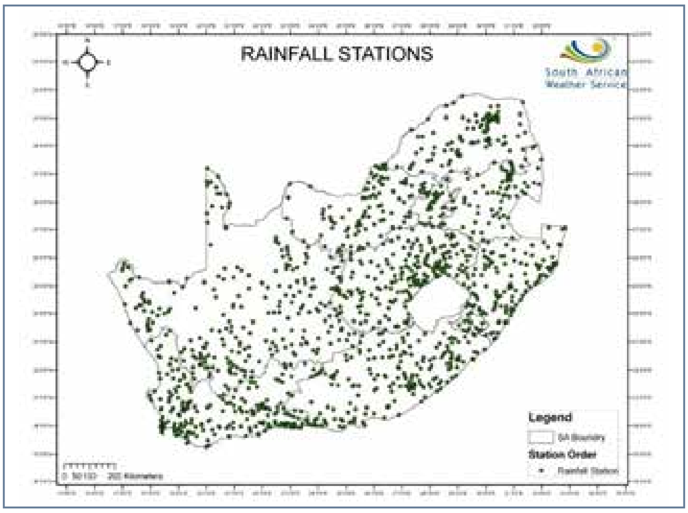


FIGURE 1: Rainfall stations operated by SAWS.

Results

Figures 2 and 3 show the monthly statistical averages of all satellite and NWP model rainfall estimation products which are validated over South Africa.

In general, the satellite estimation techniques perform better in the summer months (September-February), than in winter months (March-August) (Figure 2a). The highest false alarm ratios are observed during winter months (Figure 2b). In winter months South Africa receives stratiform rainfall from passing cold frontal systems as well as high pressure systems ridging on the coastlines. This type of rainfall is not well captured by satellite estimation techniques. CMORPH has the highest probability of detections in all months, followed by that of the CPCMMW, GSMaP, 3B42RT and CRR. The HE had lowest POD and FAR scores throughout. Figure 2c shows that the correlation is higher in summer months than the winter months. Figure 2d indicates that all the algorithms have some skill, more so during summer months than in winter months, with CMORPH preforming best.

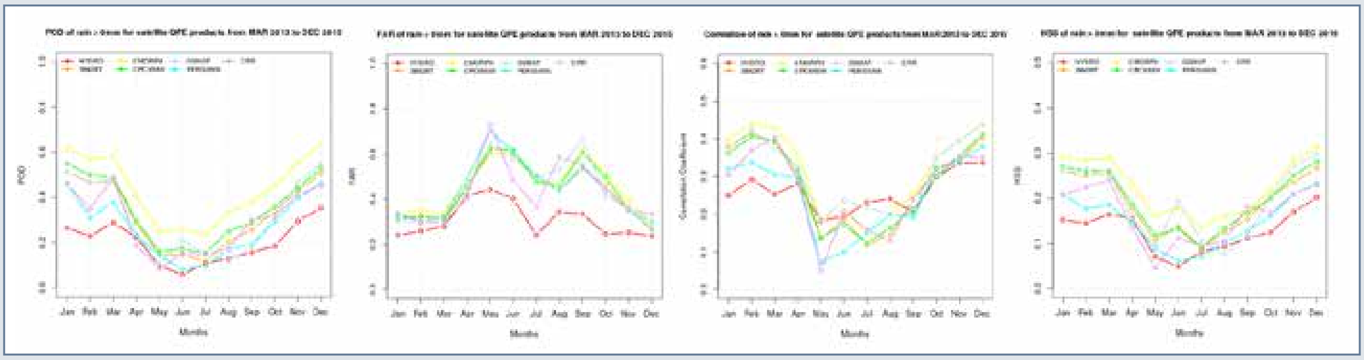


FIGURE 2: a) POD, b) FAR, c) CC and d) HSS monthly average of rain > 0mm for satellite-based precipitation products (HE-red, 3B42RT-orange, CMORPH-yellow, CPCMMW-green, GSMAP-light blue, PERSIANN-cyan, CRR-violet) from March 2013 to April 2016.

Figure 3a shows that the NWP products generally display higher probability of detection in summer months than the winter months. ECMWF has the highest POD followed by JMA and the UM. The FARs of the NWP model rainfall products are slightly less in summer than in winter months (Figure 3b), with the WRF model showing the lowest false alarm rates followed by the Unified Model (UM). ECMWF depicts a slightly higher correlation throughout, followed by the UM (Figure 3c),while WRF has the lowest correlation. There is not an obvious trend of the correlation since it is more or less the same throughout the summer and winter. The UM is showing more skill (Figure 3d) followed by ECMWF, with JMA showing the least skill. The UM skill is higher in winter months than in summer months.

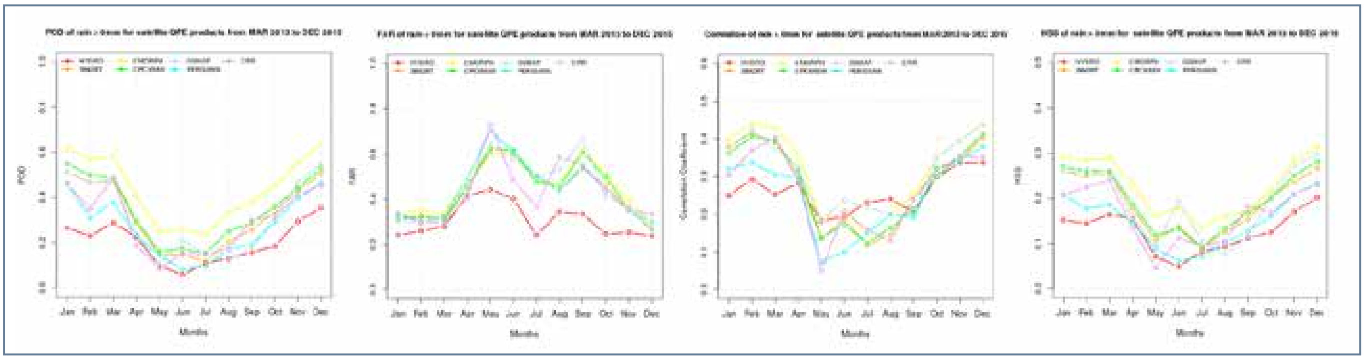


FIGURE 3: a) POD, b) FAR, c) CC and d) HSS monthly average of rain > 0mm NWP precipitation products (WRF-red, ECMWF-orange, JMA-blue, UM-violet) from March 2013 to April 2016.

Summary and conclusion

Satellite and NWP rainfall estimation techniques are far from being perfect when compared to daily rainfall totals measured by rain gauges. Satellite algorithms all have better scores during summer months than winter months due to the influence of stratiform rainfall, which is not always well captured by the satellite techniques. The better performing satellite algorithms use microwave sensors in combination with the GEO data. CRR is performing well compared to the algorithms from LEO satellite, and also performs better than the HE. Therefore, for operational forecasting purpose at SAWS, CRR was found to be the best satellite algorithm to use.

The NWP model rainfall estimation techniques all seem to have better scores in winter months when compared to the satellite techniques. A possible explanation for this is that winter time is associated with stratiform rainfall, which is easier to estimate for NWP models than convective rainfall. The satellite algorithms are best suited for convective type of rainfall, while NWP models are best suited for the stratiform type of rainfall. Both the NWP model products and satellite algorithms are not without fault, but both add value to rainfall estimation. Thus, understanding their strengths and limitations assist in knowing when and how to use them effectively.

WeatherSmart APP for Androids

With today's mobile technology at the forefront of assisting companies to reach their target markets through delivering products and services instantly, efficiently and in an effective manner, the South African Weather Service together with mobile technology provider Afrigis have teamed up to develop the Mobile App called WeatherSmart.

The WeatherSmart app is location based, meaning that a user who has downloaded the app to his android handset will automatically receive weather forecast-related information based on his or her current location. The app will provide any form of weather condition updates such as rain forecasting, temperatures, storm alert, and other severe weather alerts.
The WeatherSmart App is positioned as public good with free download, but it will have other special paid-up features enabling the user to customise his or her location to receive early warning alerts such as storm alerts or forecasts for lightning as part of a feature called" bufferzones".

With so many weather apps in the market, this app will stand out as a unique innovation when it comes to reliability and accuracy. This tool is a must have for any person who is travelling from one region to the other, farmers who need to protect their livestock from extreme weather conditions, sports persons or event organisers responsible for outdoor activities, or the individual who needs to prepare for any changing weather conditions.

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South African
Weather Service
ISO 9001 Certified Organisation

The unintended consequences of GLOBALISATION AND HEALTH ENCUMBRANCE

– by MrLotta Mayana, Chief Technician: Air Quality Information

Source: http://www.greentimes.co.za

It is said that a healthy human being can last less than eight minutes without air and three weeks without food. It is this science which led to the Bill of Rights and Section 24 of the Constitution of the Republic of South Africa, which gives every citizen the right to live in an environment that is not harmful to his/her health or well-being and to protect the environment for the benefit of future generations. There is empirical evidence which shows that poor air quality is affecting health and everyday quality of life.

Air is constantly moving, crossing vast areas of land and ocean, so are the many substances floating in the atmosphere. The air contains various chemical components, some of which are pollutants and when concentrated in the air, they present a threat to the environment and human health.

Most of the harmful air pollution comes from human activities, which result in harmful substances in the air which enter the respiratory system when inhaled, thereby irritating the nose, throat and the lungs. This in turn may cause inflammation, resulting in breathing problems. Some elements of pollution are so small, they not only penetrate deep into the lungs but also pass into the bloodstream just like oxygen. This can affect the central nervous system, causing headaches and anxiety problems. Breathing polluted air can also cause damage to blood cells, the liver and spleen. Long-term exposure to these pollutants can lead to cardiovascular diseases and cancer.

People are affected by air pollution in different ways. Some are more sensitive to toxins than others. Young children and the elderly often suffer more from the effects of air pollution as do people with health problems such as asthma, heart and lung disease. The extent to which an individual is harmed by air pollution usually depends on the total exposure to the damaging chemicals.

The World Health Organization (WHO) in its recent study has found that outdoor air pollution has grown by 8% globally in the past five years, with billions of people around the world now exposed to dangerous air, according to new data from more than 3,000 cities.

In order to protect human health and the environment, the management of air quality is a major global challenge. As a global fraternity we need to understand and manage air quality on a global, regional and local scale. National and local authorities in South Africa recognise the need to improve and maintain the quality of air to protect human health as well as the environment.

The economic benefits of rapid urbanisation and industrial development are always accompanied by an environmental cost that is related to air and water pollution. This pollution manifests in the contamination of our fresh water resources and the air we breathe. The impact of poor air quality on the health and well-being of our citizens is becoming more apparent.

As we continue to pursue and appetise the market for economic freedom, we have to ensure that we reduce negative environmental impact by employing technologies and behavioural practices that conserve water; use energy efficiently; minimise and manage waste and pollution; use resources sustainably; conserve biological diversity; and prevent resource loss and degradation before they occur.

Many of these efforts have enjoyed success, however, in the developing world, a lack of financial resources and suitably skilled personnel remain our greatest challenge.

To overcome these challenges, we need to harness the strength of limited resources by coordinating our efforts and sharing our knowledge, wealth and information.

If such an approach to our planning efforts is leveraged effectively, it will ensure the realisation of environmental co-benefits. Figure 1 illustrates sources of air pollution and potential health effects which are a result of continued exposure.

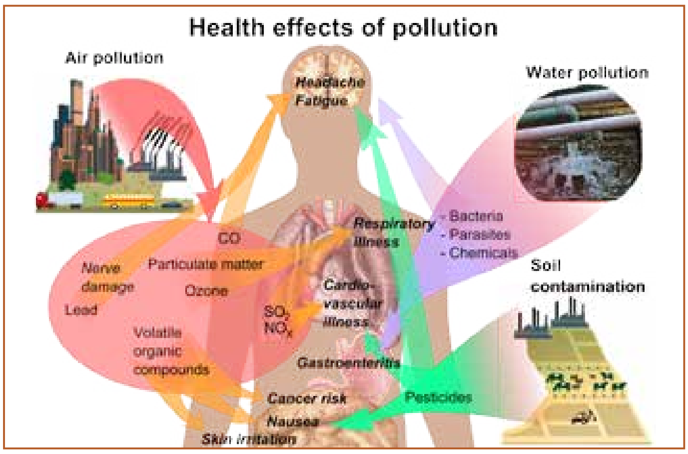


FIGURE 1: Sources of air pollution and potential health effects which are a result of continued exposure. Source: http://www.consorzioproambiente.it/eco/images/151230_pollution_effects.png/

It is clear that poor air quality is costing societies significant amounts in terms of the value of lives lost and ill health, with healthcare costs, loss of productivity in the workplace and human welfare impacts that cost billions of Rands annually. Furthermore, medical conditions arising from air pollution can be very expensive.

According to the United Nations Environment Programme (UNEP) seven million people die as a result of indoor and outdoor air pollution annually, while many more suffer illnesses that damage their health, happiness and productivity. In the European region alone, the cost of 600,000 premature deaths and air pollution-related diseases was R25-trillion in 2010, according to the World Health Organization (WHO). Air pollution has now become the biggest environmental cause of premature death, overtaking poor sanitation and a lack of clean drinking water. In most Organisation for Economic Co-operation and Development (OECD) countries, the death toll from heart and lung diseases caused by air pollution is much higher than that from traffic accidents.

Although this stems from the political agenda of the most influential states, addressing this environmental issue will bring obvious health and economic benefits. In line with the Constitution, we should all attempt to preserve the environment for the benefit of future generations.

In the South African context, the Department of Environmental Affairs reported that healthcare costs associated with the burning of fossil fuels amounted to R4-billion per annum in 2009. Despite this, South Africans are generally breathing good air, but there are hotspots that are a cause for concern as was reflected in the 2014 State of the Air Report.

This is due to the fact that most municipalities in South Africa have an Air Quality Management Plan which aims to improve air quality for the benefit of the environment and human health. Government has invested significantly in Air Quality Monitoring Networks to the tune of R100-million purchasing over hundred ambient air quality stations and continues to spend a further R18-million per annum for operation and maintenance of these stations across the country. These mobile stations are used as resources and tools to assess the quality of air on a continuous basis to compare pollution to national and international standards which were set using epidemiological studies on impact of human health from air pollution. In line with the recent developments in legislation, these tools are used to inform stringent policy direction.

There is potential for the stations to support policies related to emerging pollutants and pollutant sources, including, but not limited to, shale gas fracking, carbon capture and storage.

Due to economic growth developments, urbanisation, globalisation and industrialisation, areas that were previously not hotspots may become hotspots, hence there is a great need to establish baselines that will comprise historical datasets and future projections.

Through this comparison we are able to gauge and estimate communities' exposure to air pollution. Collecting and reporting on air quality data remains a mandate of SAWS through data collection and maintenance of the National Ambient Air Quality Network.

This information has been critical for the compilation of an Air Quality Management Plan, atmospheric impact report which investigates the current status and projected effects to avoid long-term negative health impacts and remains a critical tool to inform spatial development planning.

In the past, this area was based largely on ad hoc air quality information, often with no historical data to understand air quality trends and impacts. However, with the existence of an Air Quality Information System such as the SAAQIS, policy making will, for the first time, be driven by air quality information which will make it possible for air pollution trends to be determined for each area being monitored. This is in line with the National Environmental Management Air Quality Act, 2004 (No. 32 of 2004 as amended) which adopted the air quality governance cycle that emphasises air quality information as a start and end point of air quality management in South Africa. Each organ of state has a constitutional responsibility in respect of the environment, it needs to maintain a fine balance between economic growth, socio-economic challenges and sustainable use of our natural resources. Municipalities and other spheres of government are required, in terms of Section 8 of the above act, to monitor ambient air quality within their jurisdictions with a view of ensuring that government meets its mandate as enshrined in Section 24 of the Constitution.

It is our role as SAWS to provide the most accurate and reliable scientific data to inform policy and spatial planning as well as the industrial development to realise a better socio-economic development.

SAWS requires a huge investment in technology to be able to conduct real-time air quality modelling to project air quality forecasts, for future levels of air pollution-based on anticipated changes in emissions.

This will be more beneficial as it can be used for regulatory purposes as well as for information dissemination to the public. This will lead to a quantifiable measure in the policies interventions and the effectiveness of mitigation measures.

The 'true value' of the air quality will remain underestimated in the absence of high performance technology, which can disseminate the information published on pollution to all affected groups across the demographics. Investments in technology may increase the range of potential users.

There is potential to add substantial value to the current infrastructure investment through enhanced coordination of ambient monitoring activities between public, private, academic, as well as the research councils who may fund short-term research activities at our existing sites.

Through this cooperation, an indirect benefit may be realised and in efforts to fully exploit data, it must be freely available and well organised.

The Government ambient monitoring initiatives are not only for compliance but also to support a range of science and policy needs.

Government has a comprehensive air pollution network across South Africa, which covers the national hotspots. The network is configured to cover a wider geographical footprint, particularly in areas where the risk of air pollution exceeding the threshold coincides with the greatest population. The network is continuously maintained to ensure it continues to evolve dynamically in line with the changes in legislation and technology.

Ambient air quality is such an important resource – if not preserved it may pose serious impacts. This has been proven in studies focusing on the economic cost of air quality. For instance, tourism is a booming industry worldwide and in China this industry has been adversely affected due to poor air quality.

Poor air quality does not only affect tourism, it also affects infrastructure and development planning. This includes residential, commercial and industrial developments. Therefore, it is important to ensure that SAWS provides a platform to access high quality data for the purposes of valuable support to economic developments.

Economic growth development is an important driver for any economy and this can take place effortlessly if we rethink the way we do business and re-design current businesses to create ambient space for more business. There are businesses which have pollution occupying large spaces and do not leave any room for other industries. This means that we have to explore ways within or towards a green economy.

According to the UNEP's scoping study in Egypt, it has been found that opportunities for a shift towards a green economy would result in annual savings of over R20-billion in the agriculture sector, and R17-billion in the water sector, as well as a 13% reduction in CO_2 emissions and a 40 % reduction in water consumption. This will further assist to slow down the effects of climate change by safeguarding food security and by reducing ultraviolet damage to crops and marine ecosystems.

UNEP's ProEcoServ project, which aims to integrate the economic value of ecosystems into government policies, identified almost R10-billion of annual benefits in four countries, namely Trinidad and Tobago, South Africa, Vietnam and Chile - including soil retention services worth R8-billion in Trinidad and Tobago and R2-billion in savings through ecosystem-based disaster risk reduction in South Africa. Governments are now including the value of ecosystems in national planning, protecting livelihoods and ensuring sustainable growth.

As international communities make use of SAWS' ambient air quality data for different analysis, SAWS has embarked in a process of accreditation to ensure data integrity.

As much as the data is made available to different institutions, one needs to know that what is made available is indeed a true reflection. It is for this reason that SAWS has achieved an ISO/IEC 17025 accredited testing and calibration facility which is based in Irene, Pretoria. This facility will service primarily government-owned networks.

Accreditation is an essential requirement for testing laboratories as it serves as recognition of the technical competence of the laboratory and provides confirmation that the measurement and testing procedures are in accordance with internationally accepted standards such as ISO/IEC 17025 and that the measurements are directly traceable to the National Institute of Standards and Technology (NIST). The accreditation confers confidence to the reported results, which in turn can be used to assist government to protect public health, welfare of consumers and the environment.

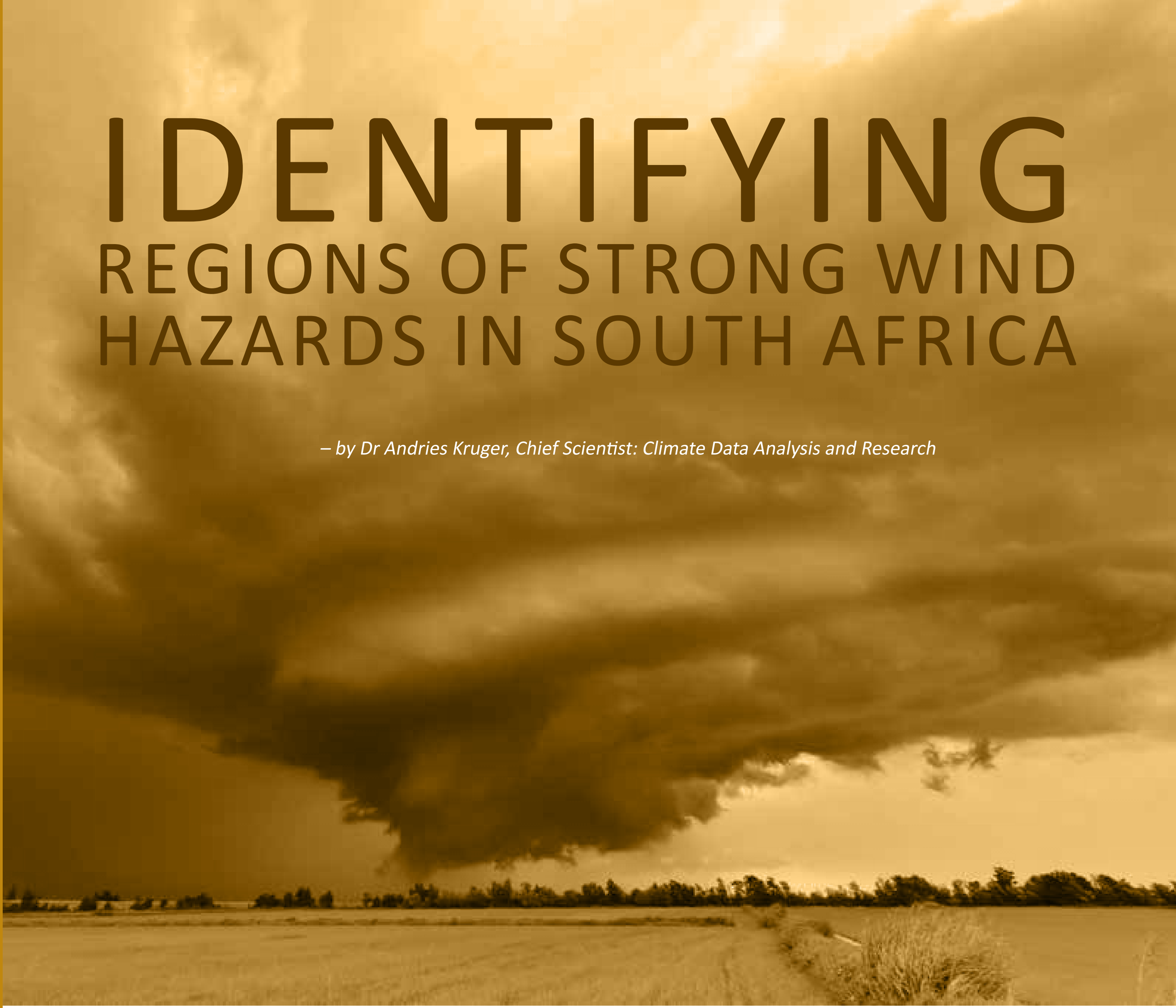
This particular standard was chosen because it is widely accepted and is regarded as the best in the industry. South African government bodies and regulators are often challenged to make decisions. In order to ensure that informed decisions are made, the decision making processes need to consult accurate, reliable and impartial data which has a certain level of confidence. This exercise brings the following benefits to a government institution:

- Increase in confidence in data that is used to establish baselines for key decisions;
- Reduces uncertainty associated with decisions that affect the protection of human health and the environment; and
- Increase in public confidence, owing to the accreditation which is a recognisable approval mark which eliminates further redundant reviews and improving the efficiency of the assessment process.

FIGURE 2: The effects and transmissions of air toxins. Source: http://www.ourair.org/air-toxics-infographic

IDENTIFYING REGIONS OF STRONG WIND HAZARDS IN SOUTH AFRICA

– by Dr Andries Kruger, Chief Scientist: Climate Data Analysis and Research



Recently, SAWS collaborated with the National Disaster Management Centre (NDMC) to develop an indicative profile for strong wind hazards for South Africa. The results of the research were duly published in the South African Journal of Science in the January/February issue of 2016, from which more details and additional results are available.

In South Africa, most of the damages inflicted on the built environment are strong wind-related, particularly exceptionally strong wind gusts that usually last for only a very short period of time. Various extreme wind studies have been done for South Africa, mostly for the purpose of, amongst others, the developing of strong wind statistics, disaster models for the built environment and estimations of tornado risk. However, a general analysis of the strong wind hazard in South Africa according to the requirements of the NDMC was needed.

The NDMC is mandated to oversee the implementation of the Disaster Management Act, 2002 (Act 57 of 2002) and the National Disaster Management Framework 2005 (Government Notice 654 of April 2005) with the objective of inter alia: Preventing or reducing the risk of disasters, emergency preparedness, rapid and effective response to disasters and post disaster recovery. The identification of risk related to various hazards provides the foundation for Disaster Risk Reduction (DRR) activities aimed at both the prevention and mitigation of disasters and the loss of human lives.

SAWS was approached to assist in the quantification of a relative wind storm hazard component, which is one of three components (vulnerability and capacity are the other two) that would comprise the National Indicative Risk and Vulnerability Profile for Wind Storms in South Africa, in compliance with legislative requirements relating to generating indicative risk and vulnerability profiles.

The strong wind hazard was quantified on a local municipal scale resolution. There are in excess of 200 local municipalities, and a relative wind hazard quantity was allocated to each of these geographical areas. While the strong wind climate will exhibit significant variability at denser spatial scales than some local municipal areas, in most cases wind measurements, on which the analysis were based, is close to the most populated areas in most municipalities. Therefore, in most cases the strong wind hazards profile reflects the risk to the largest part of the population (i.e. in the more urbanised areas) residing in a particular local municipality.

It is possible to objectively define a wind hazard as a mean wind of strength of about 60 km.h^{-1} or a gust of stronger than about 90 km.h^{-1}, which, with current knowledge, can be assumed to be the lower bounds of wind speeds capable of inflicting damage to infrastructure. However, in many countries, particular in developing countries like South Africa, informal settlements are still significantly contributing to the provision of shelter. These structures are of varying integrity, with the effect that it will be difficult, if not impossible, to assign a threshold wind speed at which damage is likely. After consideration of various national warning thresholds, the most likely damage to occur at specific wind gust speeds, the lower threshold for a hazardous wind gust was considered to be in the region of 20 m.s^{-1} (or 72 km.h^{-1}).

The windstorm hazard was seasonally and annually quantified into five relative categories, in terms of their likelihood, frequency, magnitude and predictability. This classification showed clear seasonal variation in the wind storm hazard. Ultimately it could be shown that some regions in the country are in general more prone to wind hazards than others. Of particular interest is the predictability per season, defined as the estimated return period in years of a potentially damaging wind gust, shown in Figure 1. In summer, most of South Africa from Gauteng southwards can expect at least one potentially damaging wind gust. This situation also applies to spring, where it can be expected that many places north of Gauteng will experience strong wind gusts at least once per season. In the autumn and winter months, the expectations of strong wind gusts in the north-east diminish, with return periods of 2–3 years or longer expected for strong wind gusts to occur. However, in the south-western part of the Western Cape province there is a marked increase in expectation of strong wind gusts in winter, at least once per season, due to the frequency of strong cold fronts passing over the region. It should be noted however, that strong wind events with very low probability, e.g. tornadoes and tropical cyclones, were not considered, as it is impossible to consider these events in the forward planning to mitigate against strong wind disasters, due to the rarity of occurrence at specific point locations.

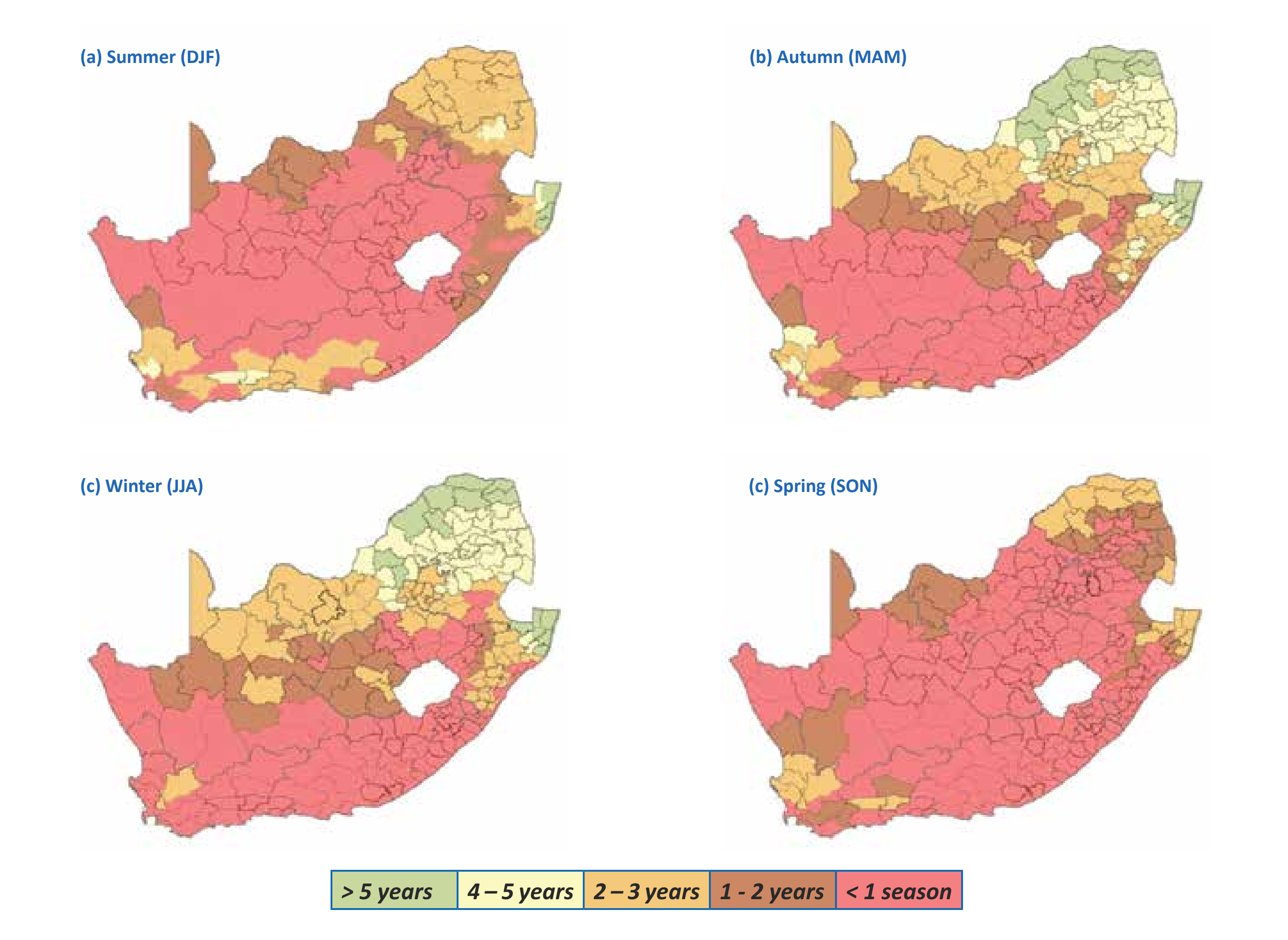


FIGURE 1: The estimated return period in years of a potentially damaging wind gust (20 m/s or higher).

The seasonal relative wind hazard is shown in Figure 2. A larger section of South Africa is subjected to very strong winds in summer and spring than during the other seasons of the year. In the south and south-east the higher hazard categories are, as expected, more prevalent during winter and spring. The central parts, e.g. central and southern Free State province and north-eastern Karoo experience high wind hazards during summer and spring, when strong north-easterly winds associated with troughs over the interior are prevalent, together with the increased likelihood of strong thunderstorms. The overall all-year relative wind hazard risk map is shown in Figure 3.

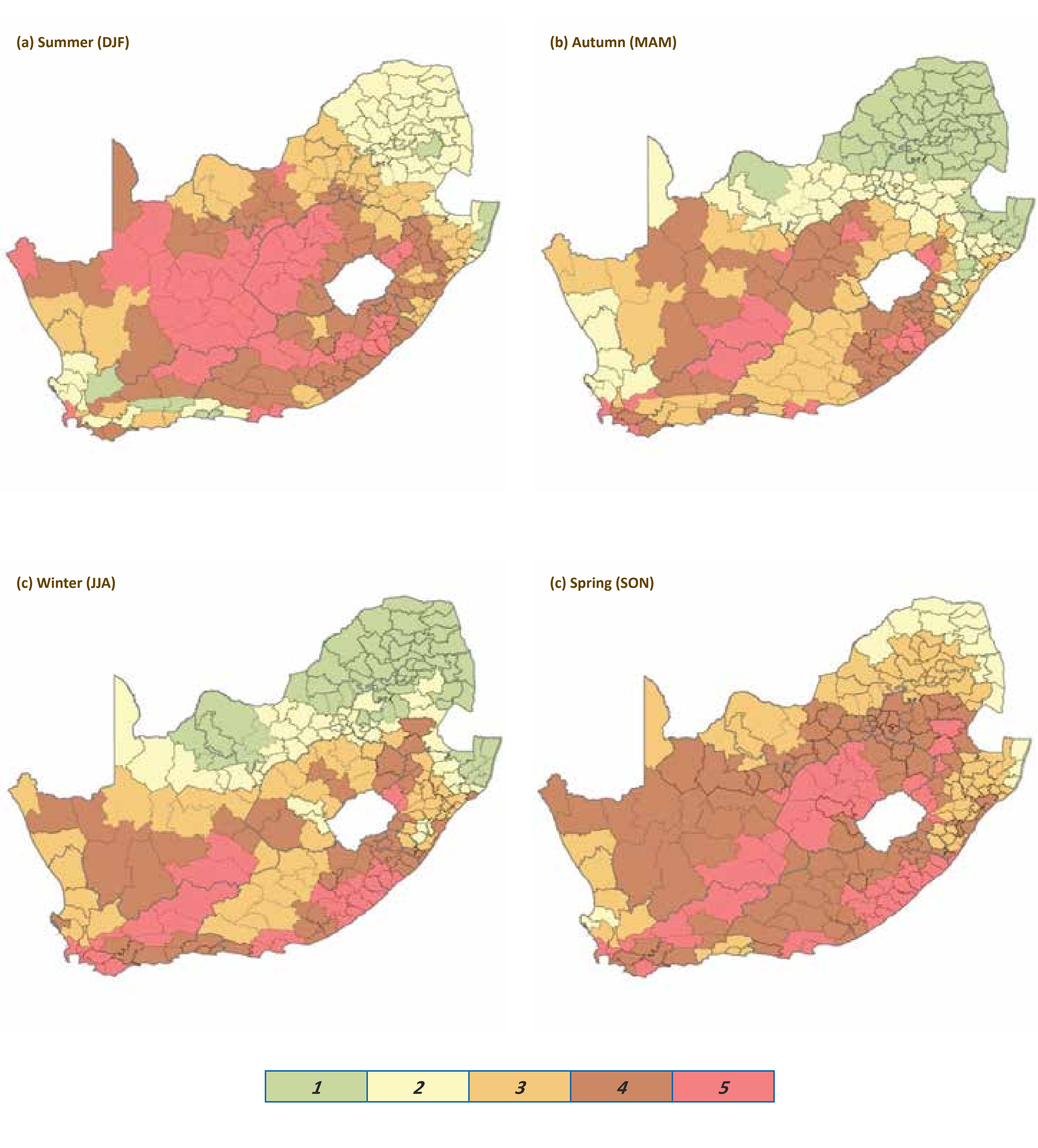


FIGURE 2: Seasonal relative wind hazard per local municipality (1: lowest to 5: highest)

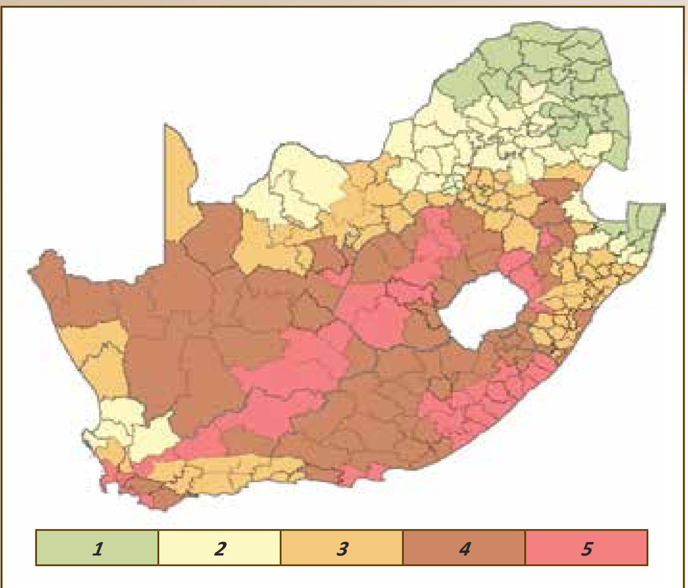


FIGURE 3: Relative wind hazard in South Africa per local municipality (1: lowest to 5: highest)

The highest wind hazard (and the reasons thereof) is in

- South-western parts of the Western Cape province, further north-eastwards from Worcester, Beaufort-West, De Aar, Kimberley/Bloemfontein and Welkom in the north (mainly due to synoptic systems in the south-western parts of the Western Cape province, i.e. cold fronts and ridging of the southern Atlantic Ocean high pressure system, and central interior, i.e. deep troughs, and thunderstorms in the north).
- Nelson Mandela metropole and surrounds (due to synoptic scale systems, i.e. cold fronts)
- Parts of the escarpment in the north-east, e.g. Van Reenen to Ladysmith, Bergville and Newcastle (synoptic-scale systems, i.e. cold fronts).
- Eastern half of the Eastern Cape province.

The outputs of the above research served as the essential input in the determination of wind hazard risk by the NDMC.

AIR QUALITY MODELLING

– by Dr Melaku Tesfaye Yigiletu, Senior Scientist: Air Quality Modelling

The Earth's climate system includes several components which are intricately coupled with each other. The major components of this system include the atmosphere, the hydrosphere/cryosphere, the lithosphere and the biosphere. The blanket of air which surrounds the planet earth is known as the Earth's atmosphere; it helps protect the Earth and allows life to exist. Though trace gases and atmospheric aerosols comprise a small proportion of the Earth's atmosphere mixture, they are primarily accountable for some of the most significant physico-chemical characteristics of the Earth's atmosphere; and in turn, play a substantial role in our climate system. However, the presence of aerosols and trace gases in the Earth's atmosphere with undesirable amounts is regarded as atmospheric pollution. As the amount of air pollutant concentration increases, the quality (cleanness) of the air we breathe will be degraded. This air quality deterioration has a direct and indirect multiphase and diversified impact on human health, the Earth-atmosphere system radiation budget, atmospheric chemical/photochemical processes, cloud microphysical properties and hydrological cycle, fauna and flora, vegetation, biogeochemical cycling, different sects of biocoenosis and natural balance of the ecosystem, the built environment, as well as human socio-economic and welfare consequences. Industrialization, urbanization, economic growth and an associated increase in energy demands have resulted in a profound deterioration of air quality and variation in physico-chemical characteristics of the climate system in many parts of the world. Hence, national meteorological services in different developed countries provide not only weather forecast and climate services, but in protecting public health they also offer air quality forecasts and conduct research on several implications of air pollution and scientific information and provide advice for government/environmental institutes and decision makers.

Africa has a significant amount of land mass in both the southern and northern hemispheres. Trace gas and aerosol emissions from this vast continent have important climatic and environmental implications. Geographically speaking, southern Africa is most

frequently described as the region south of approximately 10°S. Over this region, South Africa is one of the most industrialised countries, which has several anthropogenic sectors, biomass burning events and natural activities which almost emit all major types of atmospheric pollutants. Approximately 75% of the South African industrial infrastructure such as coal-fired power plants, manufacturing industries and mining activities is concentrated over the northern parts of the country. Hence, this part of the country is the major source area for anthropogenic activities induce air pollutants (see Figure 1).

Besides natural events that occur occasionally such as veld fires, anthropogenic activities are the main causes of biomass combustion in South Africa. As the dry season progresses, vegetation dries out, thus several agricultural burning activities occur for the preparation of the coming growing season; beside this, it is also a conventional practice to burn sugarcane fields prior to harvesting and for pre-industrial processing. These activities become the main sources of air pollutants that are induced from biomass burning over the eastern parts of the country (see Figure 2).

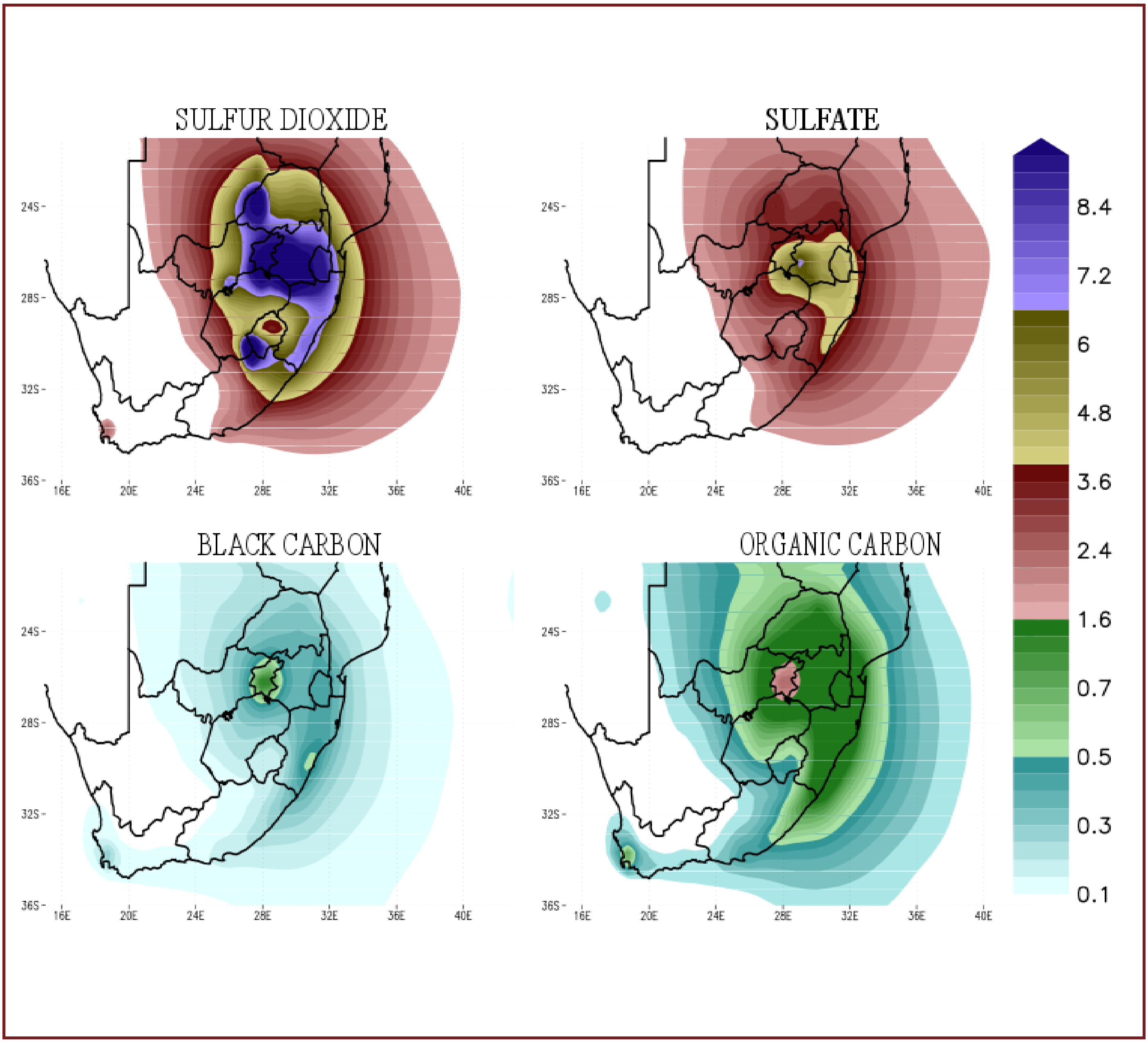


FIGURE 1: 12 years averaged (over 1998–2008) column burden of anthropogenic activities induced sulfur dioxide, sulfate, black carbon and organic carbon aerosols (shaded, unit: mg/m²). This figure is generated based on Tesfaye et al. 2015 – interactively coupled model simulation results which were published in International Journal of Climatology.

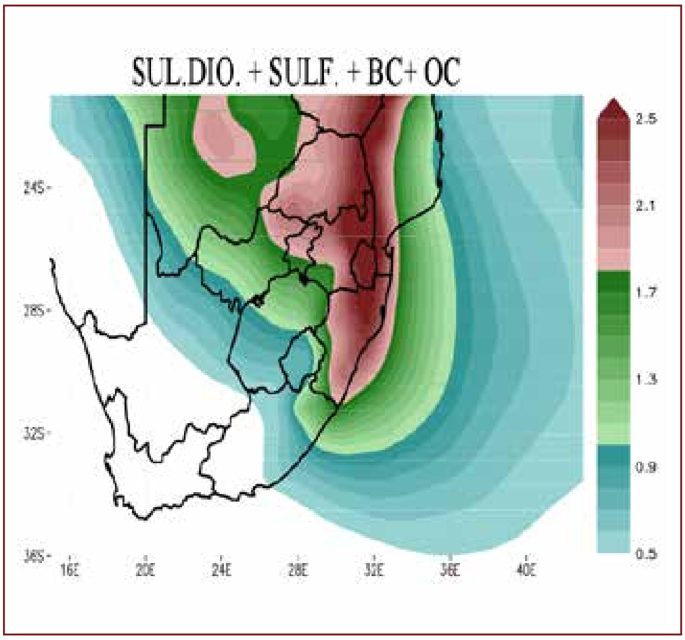


FIGURE 2: 12 years averaged (over 1998–2008, from July to October) column load of biomass burning activities induced sulfur dioxide + sulfate + black carbon + organic carbon aerosols (shaded, unit: mg/m2). This figure is generated based on Tesfaye et al. 2014 – interactively coupled model simulation results which were published in Journal of Meteorology and Atmospheric Physics.

The coastal areas of South Africa are loaded with marine aerosols which are emitted from the surrounding oceans. On the other hand, the Etosha Pans, Makgadikgadi, Namib and Kalahari desert areas are the most important sources of wind-blown desert dust particles in the southern parts of Africa. Although relatively small compared to their northern hemisphere counterparts, southern African dust sources are still significant in terms of the global budget and certainly play an important role in regional atmospheric processes and ecosystem functioning. The well-known southern African anticyclonic air circulation pattern which sweeps through these desert regions, is not only responsible for the emission of dust particles, but it is also accountable for the dispersion of these particles towards South Africa. Therefore, the western regions of South Africa are highly affected by desert dust particles (see Figure 3).

As evident in aforementioned studies as well as different scientific reports, South Africa is influenced by virtually all major types of atmospheric pollutants. As a result, the effect of the deterioration of the South African air quality on health, the environment, ecological resources and socio-economic activities has become one of the major concerns of the country. The South African Weather Service Amendment Act, Act No. 48 of 2013, expands the responsibilities of SAWS to include

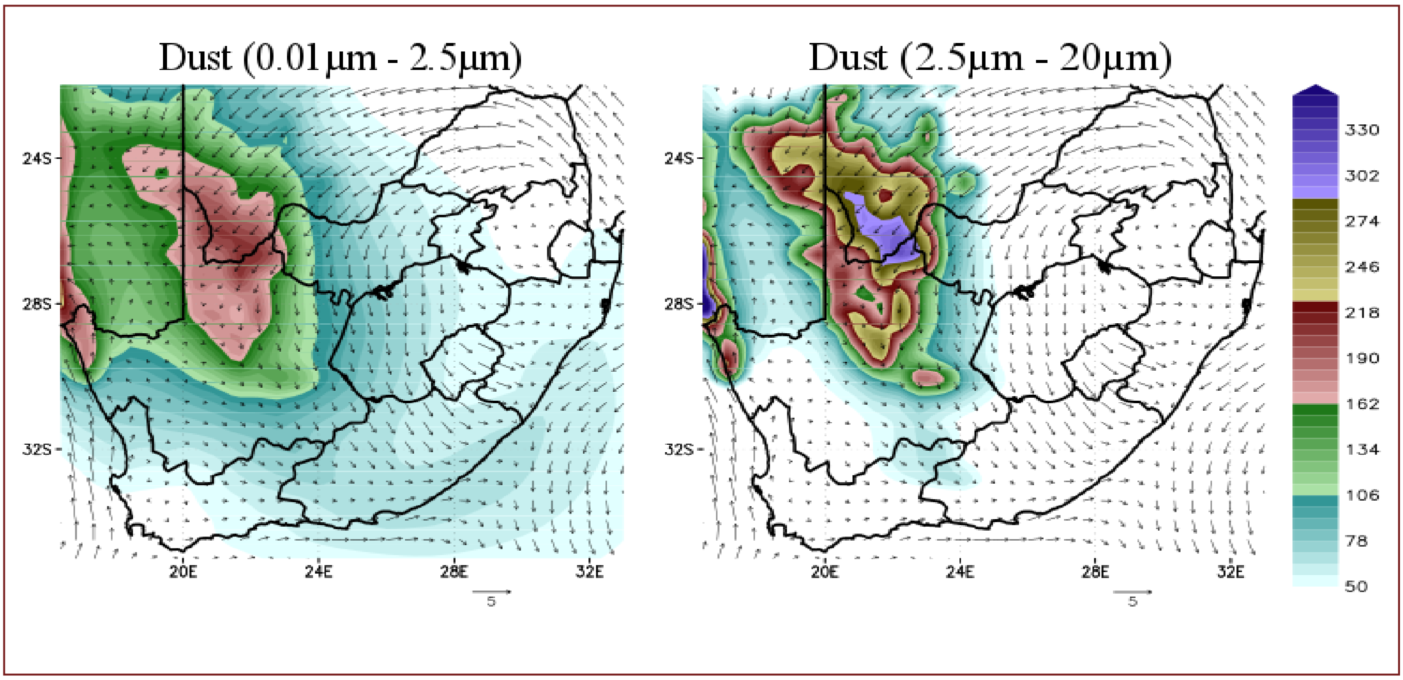


FIGURE 3: 12 years averaged (over 1998–2008) column load of wind eroded desert dust particles which are within the diameter range of 0.01µm to 2.5µm and 2.5µm to 20µm (shaded, unit: mg/m2), superposed with the 10 m wind field (vector; the scale is indicated by the arrow to the lower right; unit: m/s), in and around South Africa.. This figure is generated based on Tesfaye et al. 2015 – interactively coupled model simulation results which were published in Journal of Arid Environments.

services and products that are related to ambient air quality. As such, SAWS is required to provide ambient air quality forecasts and warnings as well as scientifically quantified information to decision makers and resource managers. Currently, the South African Weather Service Air Quality Modelling and Forecasting (SAWS-AQMF) group in collaboration with the SAWS air quality information group as well as other local and international institutions is working towards the establishment of regionally optimized interactively coupled climate–chemistry modelling system. This system will be deployed for a national scale operational air quality forecast as well as along with the air quality observations it will be used for near-real time Air Quality Health Index (AQHI) services. The near-real time AQHI will provide the public timely updated information about the air pollution levels posing health concerns in and around specific areas of the nation. The short range air quality forecast will provide the public and air quality management bodies with air quality forecast and alerts, one to three days in ahead. This is crucial in protecting public health, counselling vulnerable patients in order to reduce exposure and to take prior-informed action by air quality management bodies. Beside these benefits, both systems are also important for risk management, supporting a sustainable society, exposure reconstruction and applied epidemiology. Moreover, using a multi-model approach which integrates online coupled climate–chemistry models, various environmental modelling systems and observational analysis, SAWS-AQMF group in collaboration with different stakeholders, is conducting as well as establishing different research activities which are focused on multiphase and diversified impacts of air pollutants. These research activities, will, apart from enhancing our scientific understanding, also generate different applicable products which can serve the general public, as well as provide scientifically quantified information which can be used by environmental institutions and different sectors for resource management, policy and decision making.

USSD FOR ALL TYPES OF HANDSETS

USSD (Unstructured Supplementary Service Data) is widely used for services such as account balance, cell phone airtime recharge and other banking services. The South African Weather Service, in partnership with technology provider Afrigis, has developed a USSD weather forecasting service that delivers weather forecasting to the mobile handset regardless of the model. The service is location based, meaning that the service is able to pick up your current location and pushes the weather forecast instantly to your mobile handset. The service has three menus to choose from:

1. Area – a user can browse any area in South Africa which he or she wishes to get the weather forecasting from

2. Date – user may select a future date up to seven days ahead for any area for which a weather forecast is required

3. SMS - weather forecast is sent to the user handset by SMS

This service is easy to access, user simply dial *120*7297(SAWS)# and Dial button to view the weather forecast of the current location.

The associated cost is 20c per 20 second interval. The service is targeted at all users especially those with feature phones, commuters, farmers, a traveller, sport person for outdoor activity and mostly those who wishes to view occasional weather forecast.

simply dial

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CUT-OFF LOWS

IN THE UPPER ATMOSPHERE

– by Mr Kevin Rae, Mr Wayne Venter and Ms Elizabeth Webster, Central Forecasting Office

Cut-off low pressure systems are relatively large, persistent weather systems which are often associated with a range of severe weather, including strong surface winds, thunderstorms (often severe), snow as well as rain. It is particularly with respect to rain that these systems are notorious as they have a great capacity to produce heavy rain over vast areas, often resulting in flooding. Such systems typically affect a number of South African provinces simultaneously and are usually associated with a significant drop in air temperature.

While these systems can usually be beneficial for agriculture and water management, they can also be associated with extreme weather. Cut-off lows often result in episodes of widespread flooding, washaways as well as often causing structural damage to infrastructure such as bridges and roads. A combination of one or more of snow, thunderstorms and bitter cold often exacerbates the situation, elevating the overall risk to public safety, posed by such systems.

In South Africa, one of the most significant weather-related disasters attributed directly to a cut-off low was the Laingsburg flood, which occurred in January 1981, sadly resulting in 104 deaths, mostly by drowning. Heavy rainfall in the mountains surrounding Laingsburg resulted in much overland run-off into the river which runs directly through the town. The hard, predominantly rocky terrain in and around the Laingsburg area also contributed to this disaster, allowing extreme run-off of heavy rain, rather than soaking (infiltrating) into the ground. More recently, in November 2013, a cut-off low affected the country and resulted in flooding in many places over the Western Cape. Figure 1 (below) shows the aftermath of a mudslide on Chapman's Peak drive which was triggered by heavy rain and flooding.

How does a cut-off low develop?

A cut-off low begins its life-cycle as an ordinary trough, located in the upper reaches of the troposphere. The upper-trough fulfils the role of 'parent' in allowing the cut-off low to form as a secondary circulation system. The troposphere is the very lowest, relatively thin layer of air adjacent to the earth's surface where all earth's weather occurs. The troposphere is only about 40km thick (somewhat deeper at the equator, where the air is generally warmer, but thinner as one nears the polar regions where the atmosphere is colder and more dense). Within the troposphere, upper-air troughs usually occur in the region of about 6 to 8km above the earth's surface and are characterized as being significantly colder and more unstable than their surroundings.

FIGURE 1: Chapman's Peak, Cape Town, 16 November 2013.

Upper-air troughs drift from west to east, slowly migrating along in the mid-latitudes where westerly winds dominate. This westerly drift is true for the northern hemisphere as well as in the southern hemisphere. In the southern hemisphere, if one were to be directly over the south pole, viewing the earth from space, the general motion of upper- troughs would be in a clockwise fashion, circling the Antarctic. Upper-troughs forming in the southern Atlantic tend to drift towards southern Africa, then into the southern Indian Ocean and ultimately towards Australia and New Zealand.

An upper-air trough looks much like a sine wave on meteorological charts of equal pressure in the upper-air (500hPa for instance), with troughs and ridges alternating. Occasionally, a trough becomes distorted and stretched, elongating towards the equator, usually in a north-south orientation. Using the sine wave analogy, the amplitude of the trough therefore increases. If this amplitude becomes too great, the waveform is unable to maintain itself and the tip of the trough (on the equatorward side) breaks away from the parent trough. Bearing in mind that an upper-air trough is characterized by coldness and instability aloft (relative to the surrounding air), the result is that a cold core upper-air low is formed as the new system buds off from the parent trough. This new low becomes an independent system, characterized by a cold core, surrounded by airflow which circulates the core in a clockwise fashion (in the northern hemisphere the flow is anti-clockwise). This process therefore prompted the name "Cut-off" low, as the system is literally cut off, or disconnected from the upper-air trough which spawned it.

While cut-off lows occur both in the northern and southern hemispheres, it is quite interesting to note that while such systems are seasonally more prevalent during the northern hemisphere summer, the opposite is true for the southern hemisphere. In the southern hemisphere, while such systems may be encountered throughout the year, there is a definite bias towards more cut-off lows occurring in the winter months. Furthermore, given the dominance of ocean regions in the southern hemisphere, many Cut-off low systems exclusively affect the southern oceans. For those systems which do impact on the southern continents, research suggests that only 10% affect Africa, 48% affect Australia, while the remaining 42% are encountered over South America.

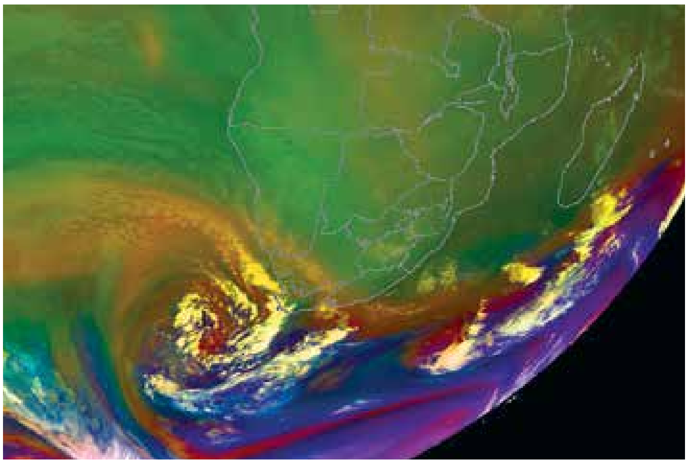
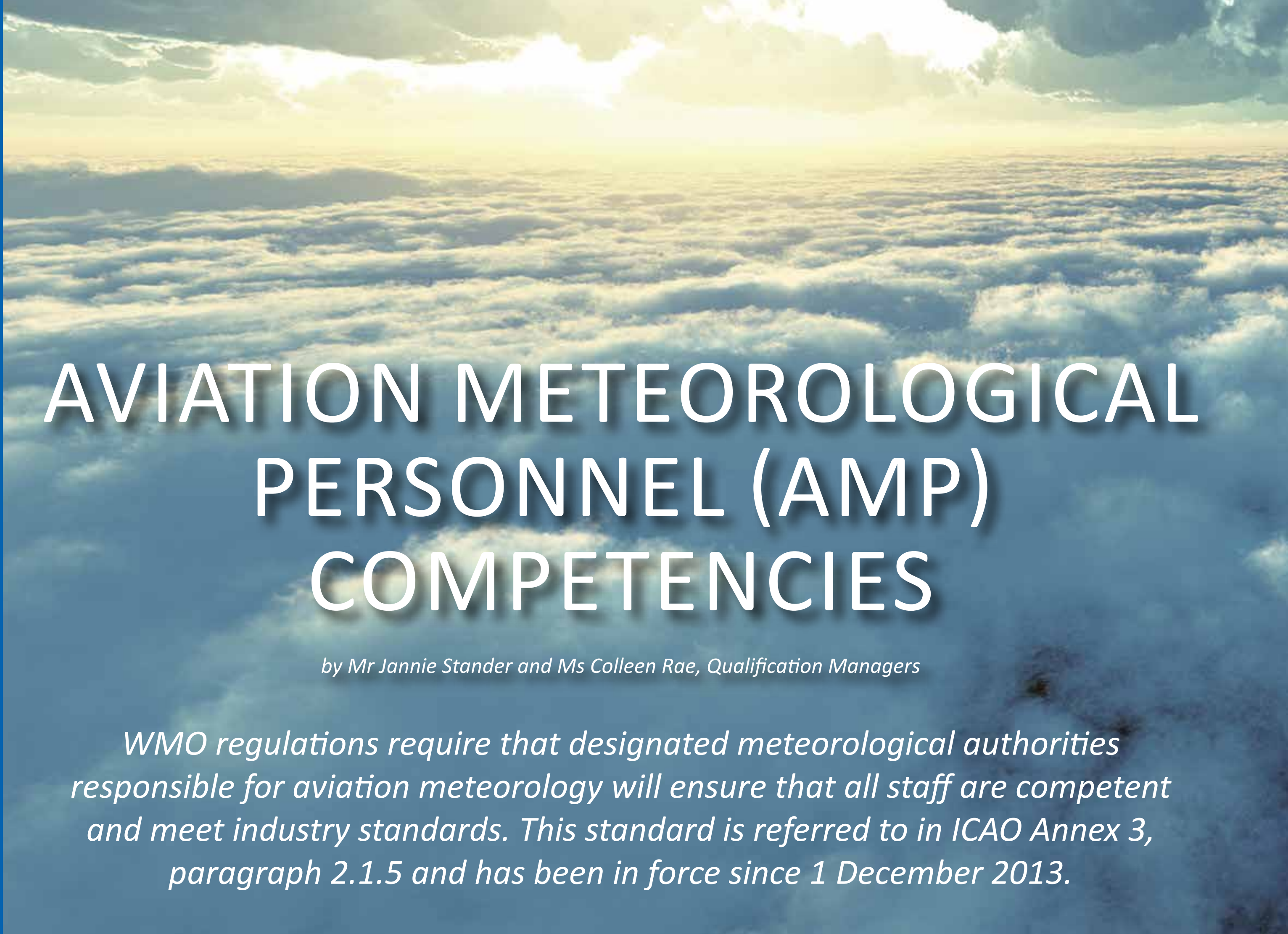


Figure 2: False colour METEOSAT satellite image indicating a Cut-off low positioned south-west of South Africa on 4 July 2008 at 0800 SAST. Winds circulate in a clockwise fashion around the cold core, labeled "L" in this image. Whilst the spiral banding in this image is superficially reminiscent of a tropical cyclone, it must be emphasised that a cut-off low is an extra-tropical system, occurring beyond tropical regions. Cut-off lows are weather systems which occur in the mid-latitudes. (Image source: courtesy of Eumetsat).

Roughly a dozen such systems affect southern Africa annually, with a minimum frequency (i.e. fewer systems) in the months of December-January-February (DJF) and a maximum frequency in the six month period spanning March to August. Furthermore it is mostly the land areas between 30S to 35S (roughly south of the Orange river) which are most often affected by cut-off lows. The overall effect that a cut-off low pressure can have on a region depends largely on the intensity as well as initial position of the system, relative to the landmass (be it South Africa, South America or Australia). If a cut-off low is situated to the south-west of South Africa and moves over the southern parts, it is the Cape provinces which will bear the brunt of the weather system. For the central provinces to be affected, a cut-off low would ideally need to be located somewhat to the west of South Africa, and to subsequently move over the central parts. The path of such systems is mostly linear, with movement of the cold core from west to east although a slightly parabolic path is also sometimes favoured. Cut-off lows are a significant contributor to annual rainfall in South Africa, with some studies suggesting that as much as 10% of our rainfall can be attributed to cut-off lows.



AVIATION METEOROLOGICAL PERSONNEL (AMP) COMPETENCIES

by Mr Jannie Stander and Ms Colleen Rae, Qualification Managers

WMO regulations require that designated meteorological authorities responsible for aviation meteorology will ensure that all staff are competent and meet industry standards. This standard is referred to in ICAO Annex 3, paragraph 2.1.5 and has been in force since 1 December 2013.

The WMO Cg-16 (2011) approved AMP Competency Standards for both Aviation Forecasters and Observers as indicated below:

An Aeronautical Meteorological Forecaster	An Aeronautical Meteorological Observer

A. For the area and airspace of responsibility,

B. In consideration of the impact of meteorological phenomena and parameters on aviation operations, and

C. In compliance with aviation user requirements, international regulations, local procedures and priorities

An Aeronautical Meteorological Forecaster

should[1], in taking into account conditions A to C, have successfully completed the BIP-M[2] and shall be able to:

1. Analyse and monitor continuously the weather situation;
2. Forecast aeronautical meteorological phenomena and parameters;
3. Warn of hazardous phenomena;
4. Ensure the quality of meteorological information and services; and
5. Communicate meteorological information to internal and external users.

An Aeronautical Meteorological Observer

shall, in taking into account conditions A to C be able to:

1. Monitor continuously the weather situation;
2. Observe and record aeronautical meteorological phenomena and parameters;
3. Ensure the quality of the performance of systems and of meteorological information; and
4. Communicate meteorological information to internal and external users.

[1] 'Should' to become 'shall' in a November 2016 amendment of WMO-No. 49 Volume I.

[2] As defined in the revised WMO-No. 49 Volume I.

If an aviation meteorological service provider (AMSP) is unable to prove that its personnel satisfy competency standards, the national regulator must be informed that the standard has not been achieved and, in addition, indicate when conformance will be achieved. A non-compliance issue is then registered with ICAO or the regulator, in exceptional cases, will seek an alternative service provider that satisfies the Standard.

Continued non-compliance (even when notified) will significantly weaken the AMSP's likelihood of continuing to retain aviation meteorological service provision designation.

Aviation Meteorological Forecaster academic qualifications requirement

An Aeronautical Meteorological Forecaster (AMF) must successfully complete the relevant parts of the Basic Instruction Package for Meteorologists (BIP-M). This includes the area and airspace of responsibility, the impact of meteorological phenomena and parameters on aviation operations and compliance with aviation user requirements, international regulations, local procedures and priorities.

From 1 December 2016 Aviation Meteorological Service Provider need to ensure that their Aeronautical Meteorological Forecasters have successfully completed the Basic Instruction Package for Meteorologists, as defined in Appendix D of WMO Technical Regulations Volume 1 (WMO-No.49).

It is the responsibility of each AMSP to consult with the national Meteorological Authority (MET Authority), national aviation regulator (in many countries the regulator also performs the Meteorological Authority role) and, where appropriate, other regional bodies to agree and assure that this requirement is being met.

Some AMSPs may decide, at an organisational level, to set a higher qualification level or a MET Authority may decide to impose a similarly higher qualification level. Only in instances where a WMO Meteorologist classification requirement is set or imposed should the relevant WMO Permanent Representative(s) also be consulted.

AMSPs have to demonstrate that competency standards have been adapted to local and national circumstances and that all personnel satisfy the relevant requirements of the competency standards.

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Meet the Authors

Mr Erik Becker

Mr Erik Becker is an expert in meteorology and atmospheric remote sensing utilising weather radars, specialising in Quantitative Precipitation Estimation (QPE) and Forecasting (QPF) techniques. He obtained a BSc (hons) degree in Dynamic Meteorology in 2008 at the University of Pretoria. An MSEN degree in the application of radar based precipitation estimation algorithms was obtained from the University of Kwa-Zulu Natal in 2014. He has been employed by the South African Weather Service since 2009 in the research department as a scientist in nowcasting and very short rage forecasting and has been involved in numerous national and international research projects, the development of various radar based applications and products as well as the verification and operational implementation of these products.

Dr Asmerom Beraki

Dr Asmerom Beraki a research scientist at the South African Weather Service and forms part of the Long-Range Forecasting (LRF) group. He is a counsel member of the South African Society for Atmospheric Society (SASAS) and a member of the Expert Team on Operational Predictions for Sub-seasonal to Long Time-Scales (ET-OPSLS) of the WMO (World Meteorological Organization). He has a background in soil science and meteorology with more than 13 year experience in climate modelling. He is a major contributor to the modelling work that led to the SAWS' acquisition of Global Producing Centre for Long-Range Forecasting status awarded by the WMO. He is the author and co-author of many peer reviewed journal articles, conference proceedings, newsletters and technical reports. His current research interests are zooming in on numerical and empirical modelling on a range of timescales and their applications.

Dr Joël Botai

Dr Joël Botai is a chief scientist in charge of a team of senior scientists conducting research and developing weather and climate information dissemination systems in support of four strategic application sectors i.e., Hydrometeorology, Agrometeorology, Health and Energy. Dr Botai has a multi-disciplinary academic background with a vast experience in cross-cutting research areas, including earth and atmosphere sciences. He has been involved in various national and international research projects focusing on geodynamic processes mimicking earth-atmosphere interactions and the resultant impacts to society and the environment. Dr Joël Botai has authored and co-authored more than twenty peer reviewed journal publications and presented at various national and international workshops and conferences. Dr Botai is currently an extra-ordinary staff member at the University of Pretoria and has been actively involved in capacity building, especially supervision of post graduate students (MSc and PhDs).

Ms Elsa de Jager

Ms Elsa de Jager heads SAWS' Climate Information section where the organisation interfaces with clients and supplies climate data. Her career at the organisation started on 2 January 1975. She is the first female in South Africa to have completed the BSc Meteorology degree offered at the University of Pretoria. One of the highlights of her career was to be the Training Officer responsible for transferring knowledge and skills to so many young people who qualified themselves as Meteorological Technicians. She still has a passion for transferring skills.

Dr Andries Kruger

Dr Andries Kruger is Chief Scientist: Climate Data Analysis and Research in the Department: Climate Service of the South African Weather Service. His present and previous duties include the creation and writing of general climate publications, climate change and variability research with historical data as input, ad hoc scientific projects of which the numbers have increased substantially in recent years, climate data and information requests, where advanced statistical analyses are required, drought monitoring, as well as assistance in the quality control of climate data. In 2011, Dr Kruger obtained a PhD (Civil Engineering) degree at the University of Stellenbosch, with research topic “Wind Climatology and Statistics of South Africa relevant to the Design of the Built Environment”. Before that, he obtained an MSc (Environmental and Geographical Science) degree at the University of Cape Town. He publishes scientific papers both locally and internationally, and authored a SAWS series of publications on the general climate of South Africa as well. He is widely recognized, both nationally and internationally, for his research, which mainly involves advanced statistical analyses and interpretation of historical climate data.

Ms Bathobile Maseko

Ms Bathobile Maseko is a research scientist in the Nowcasting and Very Short-Range forecasting group at SAWS since April 2011. She completed her BSc degree (Statistics and Geography) in 2008, and her BSc (Hons) in Meteorology in 2010 at the University of Pretoria. She is currently enrolled for MSc study at the North West University. Research in Nowcasting Forecasting includes working with radar, satellite, and lightning data and products, as well as computer programming. She has attended and presented at the South African Society of Atmospheric Sciences (SASAS) national conferences in 2012 and 2013 and submitted extended peer-reviewed abstracts for these conferences. She is the co-author in a paper published in the South African Journal of Science (SAJS) in February 2015 titled “Using satellite data to identify and track intense thunderstorms in South and southern Africa”.

Mr Lotta Mayana

Mr Lotta Mayana is one of the few chemists in the country who has commissioned, operated and accredited the biggest ambient air quality network in the SADC region close to 50 stations. He is a member of South African National Accreditation System (SANAS) specialist technical committee and a SANAS technical assessor. As a Quality Manager at SAWS within Air Quality Information, he is responsible for the development, maintenance and implementation of the ISO 17025 accreditation standard. Furthermore, he has achieved close to 20 distinctions throughout his academic life, ranging from engineering mathematics, chemistry to systems. He is a strategist, businesses developer, visionary, entrepreneur, futurist and a very decisive leader. Lotta Mayana is a former regional environmental manager for a multinational firm with 1 800 laboratories worldwide. In his capacity as a manager he was managing revenue in excess of 10 million. Lotta Mayana is an ambassador of SAWS representing air quality and related products.

Ms Colleen Rae

Ms Colleen Rae is the Qualification Manager: Meteorological Technicians within the SAWS Regional Training Centre, with 19 years’ experience within the training environment which includes eight years as an Accredited Assessor and Moderator. Other experiences include Observations since 1976 to 1981 and 1987 to 1991, Forecasting from 1992 to 1996, Meteorological Trainer from 1997 to 1998 and Forecaster Trainer from 1999 to 2000.

Mr Kevin Rae

Mr Kevin Rae is one of the Chief Forecasters in the Forecasting section at the South African Weather Service, a position he has held since 2008. Prior to his appointment as Chief Forecaster, Kevin spent 18 years ‘on the bench’ as an operational forecaster, based at the National Forecast Centre (NFC) in Pretoria. He first joined South African Weather Service in 1981 as a meteorological technician and spent a year on Gough Island as Senior Meteorologist in the early 80s. Subsequently, a number of annual takeover and buoy-deployment voyages soon followed, including visits to the SANAP bases at Marion Island and SANAE IV (Antarctica), South Thule, Bouvet Island and Tristan da Cunha. Kevin’s current duties include the development and implementation of short term forecasting-related indices, especially with respect to thunderstorm prediction. He is particularly passionate about striving to improve overall knowledge and understanding of the diverse ingredients which contribute to thunderstorm severity. His qualifications include an MSc in Meteorology (University of Pretoria) as well as a Higher Diploma in Meteorology.

Prof Hannes Rautenbach

Prof Hannes Rautenbach was appointed as Chief Scientist: Climate Change and Variability at SAWS in 2016. He graduated with a BSc degree in Meteorology in 1987 and obtained his PhD in Meteorology in 1999 at the University of Pretoria (UP). He served as coordinator of the Meteorology Group at the University of Pretoria from 2003 to 2015, and became head of the Department of Geography, Geoinformatics and Meteorology (GGM) in 2006, a position that he held until 2014. During this period he also served as Director: UP Water Institute between 2010 and 2014. Prof Rautenbach was also President of the South African Society for Atmospheric Sciences (SASAS) during 2005 to 2010, and still serves on the Board of the National Association of Clean Air (NACA). He served on various bodies that evaluate research and was leader of various research projects at, amongst others, the Water Research Commission (WRC) and the National Research Foundation (NRF). He has currently published more than 45 scientific papers in accredited science journals and presented more than 100 talks at national and international conferences. He is currently rated as a C2 scientists by the NRF.

Mr Jannie Stander

Mr Jannie Stander received his BSc Hons degree in Meteorology from the University of Pretoria, South Africa in 1998 and then went on to obtain his MSc degree in Meteorology in 2013 from the same University. He currently works at the SAWS Regional Training Centre as Qualification Manager: Forecaster Training. His area of specialty is Aviation, in which he has 17 years of experience.

Mr Wayne Venter

Mr Wayne Venter is a junior forecaster at the Pretoria Head Office where he started in January 2016. He did his honours degree in Meteorology at the University of Pretoria and he has a particular interest in severe weather and the impacts thereof.

Ms Elizabeth Webster

Ms Elizabeth Webster started working at the South African Weather Service in 2011, after completing her honours in Forecasting with a BSc in Meteorology at the University of Pretoria the year before. After a brief 3 month period forecasting in the Port Elizabeth Weather Office, she returned to Pretoria where she worked as an operational forecaster in the National Forecaster Centre. From 1 July 2016, she joined Dr Eugene Poolman in the Disaster Risk Reduction division in the South African Weather Service, developing an Impact-Based Severe Weather Warning System for South Africa. This is a completely new way in which warnings will be issued, not using meteorological thresholds anymore, rather forecasting warnings based on the impact they will have on communities.

Dr Melaku Tesfaye Yigiletu

Dr Melaku Tesfaye Yigiletu is a senior scientist in air quality modelling and forecasting at SAWS. He received his PhD in Meteorology from the University of Pretoria with Golden Academic Honorary Colours, and graduated his Master and Bachelor in physics with distinction. Dr Melaku has been involved in several research projects such as: Modification and implementation of online coupled regional climate-chemistry models; Large scale assessment of aerosol-radiation-climate interactions and feedbacks; Development of interactive schemes which link pollution dispersion models and geospatial information system; Instrumental construction and nonlinear mathematical inversion model development for atmospheric trace species retrievals from both ground-based passive and active remote sensing instruments; Aerosol studies based on satellite products and nonlinear mathematical characterization of aerosol optical property; and others. Dr Melaku has published a number of international research articles as well as received a number of fellowships and awards from different national and international institutions.

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