WEATHERSMART

NEWS

Scientific meteorological and climatological news from the South African Weather Service

FEBRUARY 2018

South African Weather Service

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FOREWORD BY
MR JERRY LENGOASA: CHIEF EXECUTIVE OFFICER

This edition of WeatherSMART News marks the second anniversary of a publication that has rightfully become a source of pride at the South African Weather Service. The appeal of the newsletter lies in how it bridges the gap between news that is in the public domain and the SAWS research. In essence, it provides an opportunity to "tell the story behind the stories".

In this issue you will find interesting snippets such as how, based only on monthly rainfall totals, the Standardised Precipitation Index (SPI) can used be used to determine the impact of drought on water storage facilities. One of the articles also gives the reader a fascinating glimpse into the atmospheric conditions that can lead to an aircraft crash such as the one in the Tsitsikamma-Karreedouw Mountains on 16 December 2015.

The importance of finding alternative energy sources such as solar power is a topic of great interest to South Africans. Using the Direct Normal Irradiance (NDI) Index, SAWS scientists have assessed the viability of locations for the installation of Concentrating Solar Power (CPS) technologies. This is an excellent example of how the work of the organisation can help decision-makers avoid costly mistakes in an economically constrained environment.

The drought that continues to cripple the southern and western regions of the country is never far from our minds and it features in two of the articles in this issue of WeatherSMART News. One provides an analytical overview of the atmospheric conditions associated with the drought while the other reveals how droughts are classified and how one type transitions into another. Both these areas of study hold promise for a forward thinking approach in coping with and mitigating the effects of extreme weather events.

I trust that you will find this newsletter as interesting and informative as I did.

SUMMARY OF 2017 CLIMATE AND SIGNIFICANT WEATHER EVENTS

By Andries Kruger, Kevin Rae and Charlotte McBride

Surface temperature

Annual mean temperatures for 2017, as collected from 26 climate stations in South Africa, were on average +0,48° C higher the 1981-2010 mean, making 2017 the fourth warmest year on record since 1951 (Figure 1). A warming trend of +0,16° C per decade is also observed, statistically significant at the 5% level. While 2017 was somewhat of a relief after 2015 and 2016, years regarded as the hottest years globally but which coincided with El Niño conditions. 2017 is regarded as the second hottest year globally.

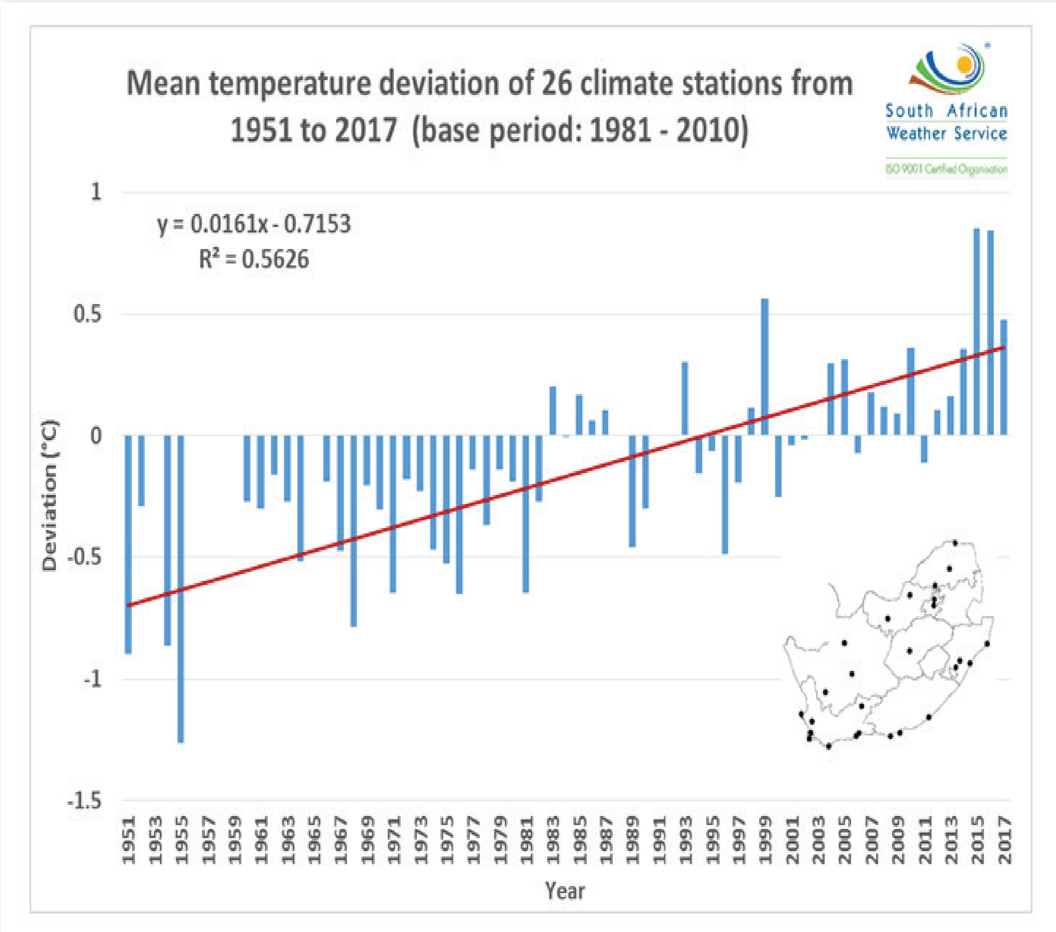

Figure 1: Annual mean temperature anomalies at 26 climate stations in South Africa for the period 1951-2017 (base period 1981-2010). The linear trend is indicated by a red line (Source: South African Weather Service).

Rainfall

During 2016 very dry conditions were experienced in some regions of the country, with parts of the Western Cape and KwaZulu-Natal provinces experiencing their driest years on record. While there was some improvement in KwaZulu-Natal during 2017, the situation in the Western Cape deteriorated further, resulting in strict water usage restrictions being imposed.

As shown in Figure 2, the most significant feature of the rainfall during 2017 was that most of the country received close to average rainfall but the majority of the Western Cape and the western parts of the Northern Cape received less than 75% of the annual mean rainfall. The Northern Cape was particularly dry, with rainfall less than 50% of the average for the period 1981-2010.

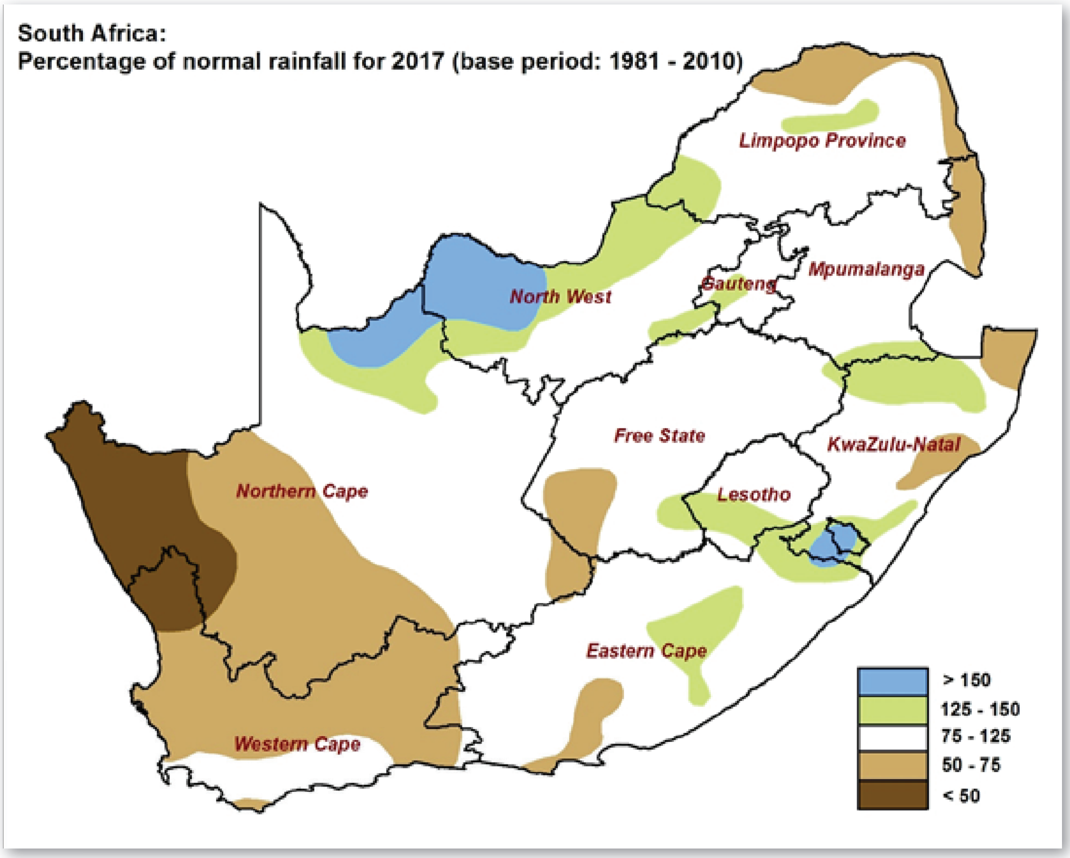

Figure 2: Rainfall anomalies in South Africa during 2017 (expressed as a percentage of the 1981-2010 average). (Source: South African Weather Service).

Apart from the extreme western and southwestern parts, most of the country received above average rainfall during January and February. March was again extremely dry over most of the country, particularly in the western and central regions where almost no rainfall was recorded. April saw an increase in rainfall with the northern and north-eastern parts of the country receiving above normal rainfall. The eastern and south-eastern regions continued to experience good rains in May. June marks the onset of the winter rainfall season and while rainfall in this month was generally low, some parts of the Western Cape had good rains accompanied by exceptionally stormy weather conditions. The rest of the winter rainfall season (July to August 2017) produced little rain in the Western Cape and these dry conditions persisted into spring. In comparison to the 543 mm average annual rainfall for Cape Town over the period 1981-2010, only 285 mm was recorded in 2017.

It is worth noting that the dry conditions experienced in the Western Cape were exacerbated by the three consecutive years of well below average rainfall before 2017. As a result, 2017 was identified as Cape Town's driest year since 1951 (Figure 3) and 2015-2017 as the driest three year period since 1951-1953 (Figure 4). However, despite this, no statistically significant long term drying trend is discernible from the rainfall records.

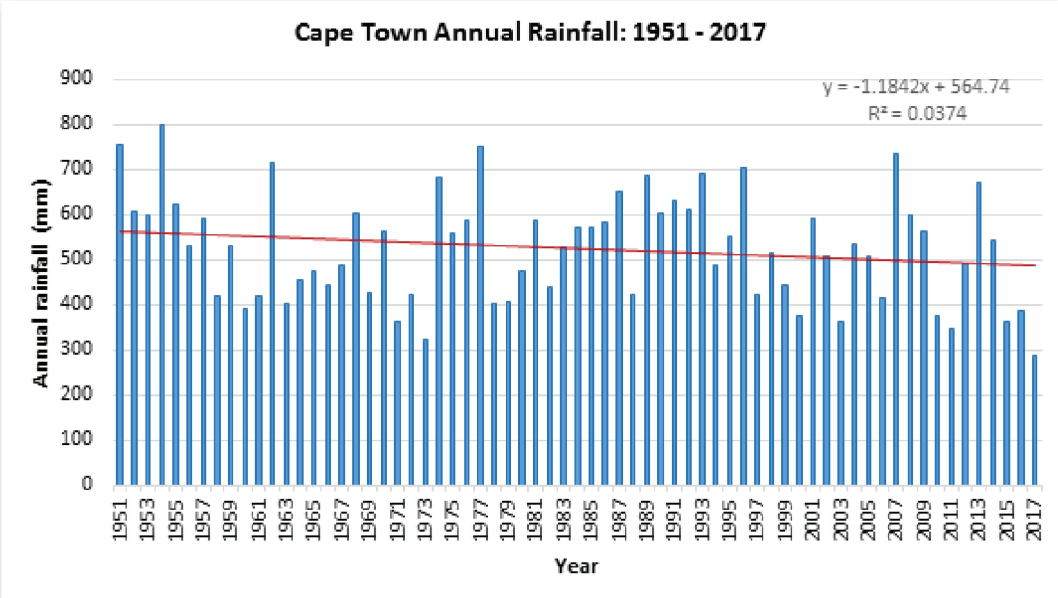

Figure 3: Annual rainfall for Cape Town from 1951 to 2017 (mm). The red line indicates the linear rainfall trend.

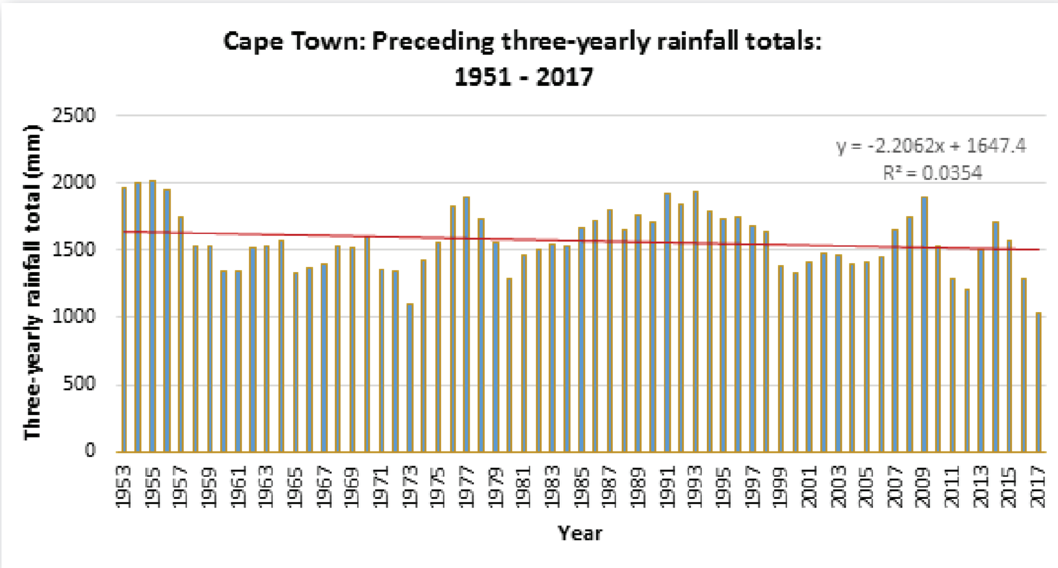

Figure 4: Three-yearly rainfall totals for Cape Town in the period 1951-1953 to 2015-2017 (mm). The red line indicates the linear rainfall trend.

The Standardised Precipitation Index (SPI)

The Standardised Precipitation Index (SPI) is one of the most widely used indicators of drought severity and has been used operationally by the South African Weather Service for at least a decade (http://www.weathersa.co.za/climate). Advantages of the SPI are that the only input needed is monthly rainfall totals and that the index can be calculated over various periods (e.g. preceding month, 3 months, 6 months, 12 months, 24 months etc.) to indicate the variable potential impact of a prevailing drought. For example, soil moisture levels usually respond quickly to dry conditions while a decline in groundwater and reservoir levels are indicative of longer term drought conditions. Index values for a period of twelve months or longer might be used to determine the impact of a drought on water storage facilities.

Figure 5 presents 12-, 24- and 36-month SPI values for Cape Town for the period 1951-2017. SPI values in the region of -2 indicate extremely dry conditions with a historical probability of about 2,28% or a return period of about 44 years. A value of -3 indicates low rainfall conditions with a probability of about 0,14% or a 700 year return period. The only other comparable dry period in Cape Town was 1973-1974. It is obvious that the 2015-2017 Cape Town drought can be considered the worst on record since at least 1951.

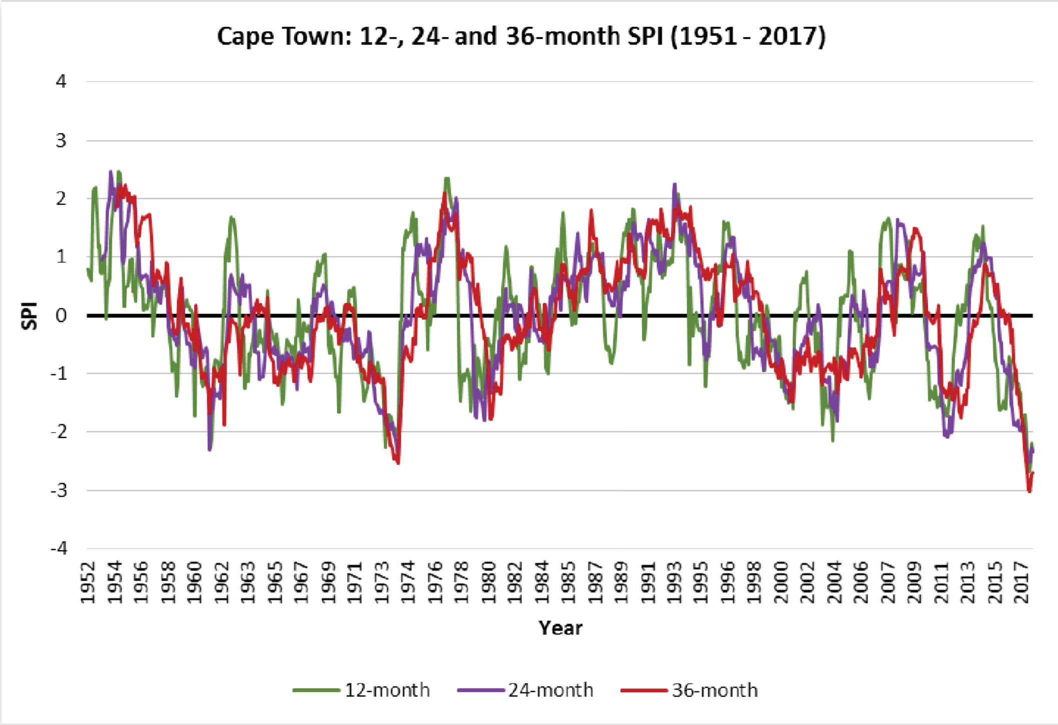

Figure 5: The Standardized Precipitation Index (SPI) over 12, 24 and 36 months for Cape Town in the period 1951-2017.

It is clear from the 2016-2017 24-month SPI shown in Figure 6 that the majority of the Western Cape Province and adjacent areas of the Northern and Eastern Cape Provinces experienced conditions that could be described as moderately to extremely dry over an extended period of time.

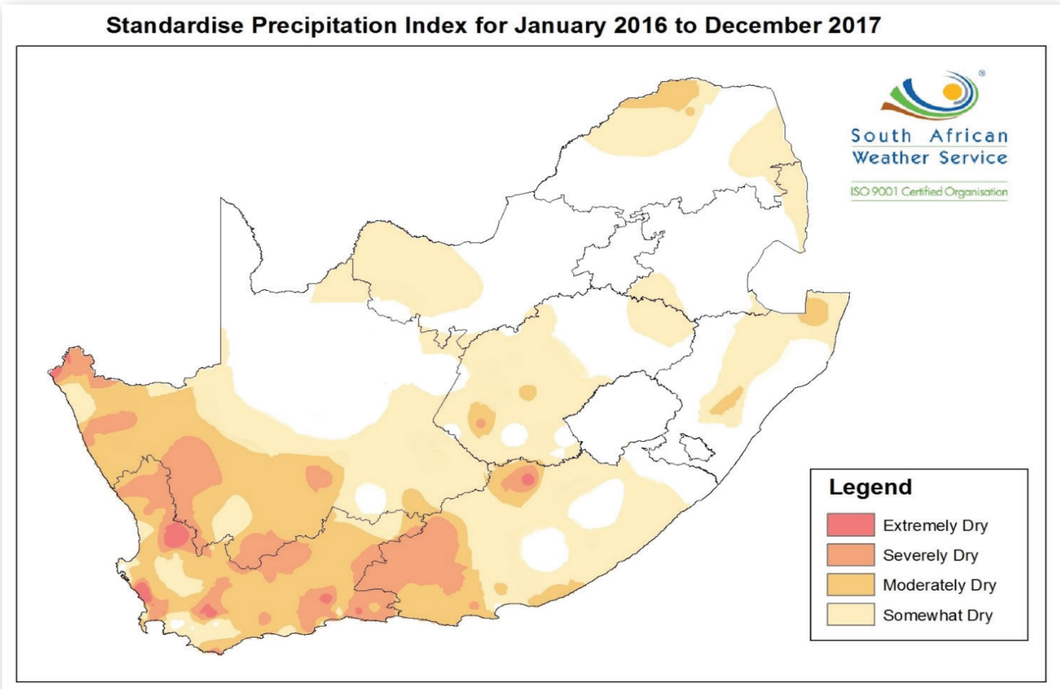

Figure 6: The 24-month Standardised Precipitation Index (SPI) for the period 2016-2017.

Noteworthy weather events during 2017

Southern Africa experienced a number of severe and/or extreme weather events during 2017, including tropical cyclone Dineo in February 2017 and the intense winter weather accompanied by widespread fires in the Western and Eastern Cape in June 2017. South Africa's summer rainfall area also experienced numerous severe thunderstorms during the later months of the year.

Tropical cyclone Dineo

In contrast with previous tropical cyclones which often displayed highly erratic tracks and variations in intensity, the South African Weather Service was able to forecast tropical cyclone Dineo quite adequately. Both the location and timing of landfall (near Inhambane in southern Mozambique early in the evening of Thursday 16 February 2017) were anticipated with the result that early warnings could be issued. On Friday 17 February 2017 the cyclone moved overland across southern Mozambique where heavy rainfall was recorded. In the 48 hour period between Friday 18 February 2017 and Saturday 19 February 2017, the Limpopo and Mpumalanga Provinces also experienced heavy rains, with 356 mm recorded at Graskop between 16 and 19 February 2017 and 101 mm at Kruger Mpumalanga International Airport. Tzaneen and Woodbush recorded 152 mm and 433 mm respectively during the tropical cyclone event.

Dineo started to dissipate over the extreme north west region of Namibia after following track across Zimbabwe and Botswana. The follow-up impact of the tropical cyclone manifested between 19 and 22 February 2017 in the form of a Tropical Temperate Trough (TTT) system with unstable moist tropical air moving towards the central provinces of South Africa. During this period, rainfall stations in the Free State, North West, Gauteng, Mpumalanga and KwaZulu-Natal reported accumulated rainfall of more than 100 mm. In North West Province, 168 mm and 175 mm fell at Ottosdal and Klipfontein respectively, while 183 mm and 184 mm were recorded at the Royal Natal National Park and Richards Bay in KwaZulu-Natal.

The South African National Disaster Management Centre reported a total of 11 deaths during the tropical cyclone event and subsequent TTT system, with river drowning being the most common cause of death.

The Cape Storm

From the evening of 6 June 2017 through to 8 June 2017 an intense winter cold front accompanied by a deep upper-air trough crossed the Western and Eastern Cape Provinces. This system (dubbed "The Cape Storm") resulted in gale force winds of between 70 and 90 km.h^{-1} and 6 to 9 m high seas with peaks of approximately 13 m. The exceptionally strong winds downed numerous trees, damaged power lines and ripped roofs off buildings, including schools. There were also disruptive snowfalls on the mountains in the Western and Eastern Cape. The Western Cape Provincial Government closed all schools and universities on Wednesday 7 June 2017 which was when the South African Weather Service forecast that the storm would be at its zenith.

The Cape Storm was followed by the outbreak of a number of fires in the George, Knysna and Wilderness regions along the Garden Route between 8 and 12 June 2017, prompting public evacuations as the fires raged out of control. Due in part to the difficult terrain but also limited resources, firefighting teams battled to cope as strong winds spread the fires further along the coast towards Plettenberg Bay. For a significant period helicopters were unable to take off safely, with persistent winds exceeding 30 kts (approximately 60 km.h^{-1}). The fires were eventually brought under control but not before eight people had lost their lives and some settlements had been completely devastated. It is estimated that 870 structures were destroyed and approximately 2,500 persons were displaced.

Stormy weather during early summer

The early summer of 2017 was characterised by stormy weather. In October 2017 a cut-off low system that moved south eastwards from the north west region of the country resulted in the development of large thunderstorms over the western parts of Gauteng as well as several tornado sightings. A subsequent media statement by the South African Weather Service reported severe thunderstorms with heavy downpours, strong damaging winds and large hail in parts of North West Province, Gauteng, Free State, KwaZulu-Natal, Mpumalanga and Limpopo between 9 and 10 October 2017. Areas that were most affected were Mogale City and the Johannesburg as well as towns and cities in the Ekurhuleni area. On 9 October 2017 there were reports of tornadoes at Ruimsig (adjacent to Roodepoort and Krugersdorp) and at Eloff near Delmas which caused extensive damage to property. On the same day a tornado was reported near Bethulie in the Free State and hail with stones the size of golf and tennis balls was reported near Krugersdorp.

The cut-off low system migrated rapidly eastwards towards Durban where heavy rain on Tuesday 10

October 2017 resulted in severe urban flooding and, combined with high winds, loss of life. Durban recorded 108 mm of rain in a 24 hour period, with 65 mm recorded in less than an hour between 09:00 and 10:00. Similarly, Virginia Airport in KwaZulu-Natal received 142 mm of rain, with 89 mm occurring between 11:00 and 12:00. Maximum sustained wind speeds of 75 and 78 km/h were reported in Durban and at King Shaka International Airport respectively.

December 2017 also saw the occurrence of severe thunderstorms. Two supercell storms spawned damaging tornadoes in parts of Gauteng on 11 and 30 December 2017. The latter event occurred in the late afternoon and affected Westonaria, Soweto and other suburbs to the south west of Johannesburg. Figure 7 illustrates the extent of damage to property as roofs were blown off. Numerous informal dwellings were also destroyed.

Figure 7: One of the houses in Protea Glen, Soweto, that was severely damaged by the tornado that occurred on 30 December 2017. Photo: © P. Mofokeng, 2017.

Importantly, SAWS forecasters issued a severe storm warning SMS specifically mentioning the possibility of a tornado. This represented a first for the organisation in terms of successfully ensuring early awareness of impeding severe weather.

The radar scan for 16:34 on 30 December 2017, as captured by the South African Weather Service radar at Irene (Figure 8), shows a well-defined “hook echo” – a feature commonly associated with supercell storms. Apart from large hail and damaging winds, some supercells also spawn one or more tornadoes. These storms are often characterised by a large rotating updraft, termed a mesocyclone, which contributes to the generally long-lived nature of supercell storms which can persist for several hours.

Similarly, the tornado that occurred on 11 December 2017 developed from a long-lived supercell lasting approximately 6 hours and traversed the Free State, Gauteng and Mpumalanga Provinces. As the storm moved over Midvaal Local Municipality it caused widespread damage to a number of dwellings at the Vaal Marina (Figure 9).

Tornadoes in South Africa probably occur more frequently than many people might think. Research suggests that tornadoes are most prevalent over the eastern provinces, especially KwaZulu-Natal and the Eastern Cape, while Free State, Gauteng and Mpumalanga are also prone to incidents.

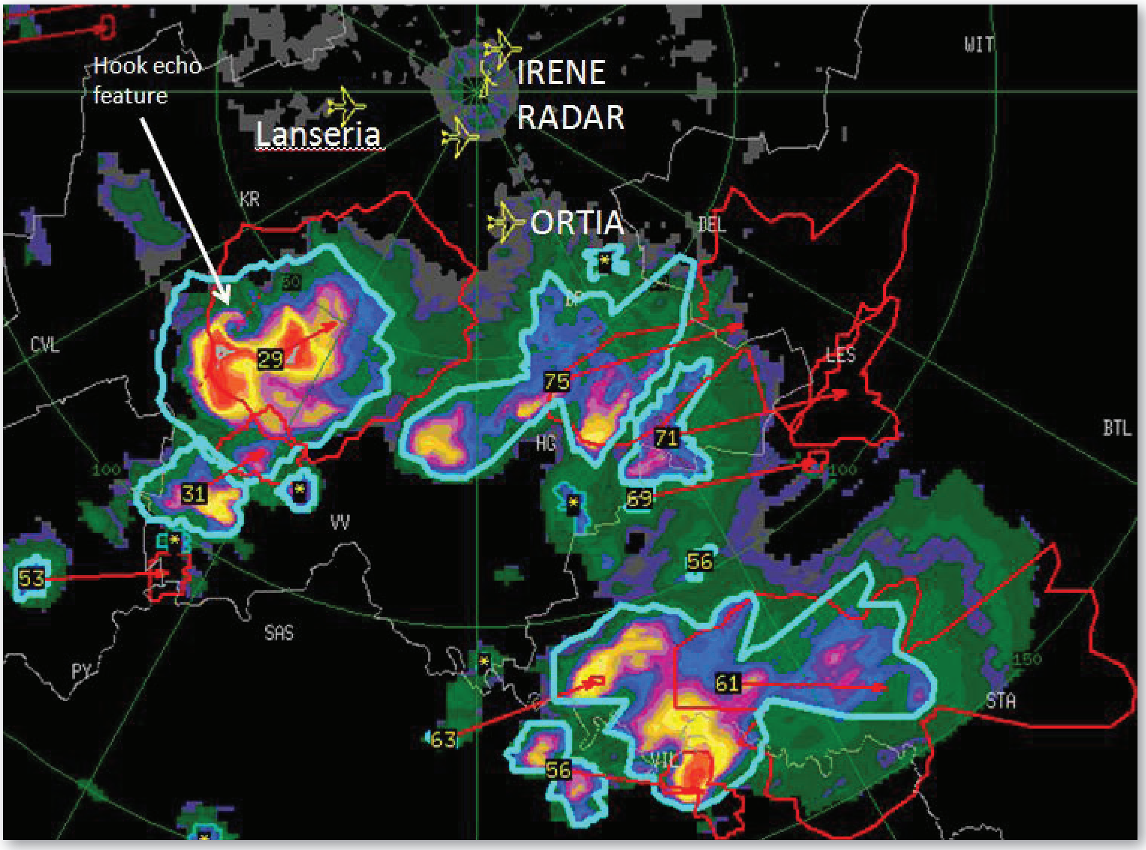

Figure 8: SAWS Irene radar site low-level 3 km radar reflectivity scan at 16:34 on 30 December 2017, with the hook echo feature indicated by a white arrow. The storm was located approximately 65 km south west of the Irene radar site. Red/orange storm regions are indicative of more active storms registering a higher reflectivity (dBz) value. (Source: South African Weather Service)

Figure 9: Aerial photo of storm damage to property at Vaal Marina following the 11 December 2017 tornado. Photo: © Brett Powell, 2017.

TURBULENT TURMOIL: MOUNTAIN WAVES, GAP FLOW AND BLOCKING FORCED BY COMPLEX SOUTH COAST TERRAIN

By Markus Geldenhuys

Introduction

On 16 December 2015 a light aircraft crashed en route from Graaff-Reinet to Plettenberg Bay, killing two passengers and injuring the pilot. The crash took place near Clarkson in the Tsitsikamma- Kareedouw Mountains in South Africa. The pilot reported severe turbulence which knocked him unconscious moments before the crash. His report elicited a study of the weather conditions that led to the crash, which were found to be turbulence related. During the investigation three turbulence producing systems were identified, namely (1) blocking, (2) gap flow and (3) mountain waves.

Turbulence is driven by kinetic energy (energy of moving air particles) and is handed down from larger to smaller masses until finally being converted into heat. It is a normal, frequent and sometimes threatening phenomenon produced by horizontal or vertical variations in the wind field. $100 million is spent annually on turbulence-related injuries by the worldwide aviation industry.

Background

Visualising the atmosphere as a fluid such as water allows us to understand the properties of turbulence. For example, to understand blocking, visualise water running diagonally towards a wall. Upon hitting the wall the water will be deflected, forming localised higher pressure as the water piles up. Since flow responds to an increase in pressure, there is a resulting increase in flow speed. In the case of the South Coast accident, one can exchange water for cold stable air and the wall for the Tsitsikamma and Kareedouw mountain ranges. The cold stable air originating from the ocean (frequently south westerly winds behind a cold front) is "heavy" air and therefore resists flowing over the mountains (Figure 1). The flow is instead deflected to a westerly wind which builds speed as the pressure increases with more wind piling up south of the mountain. This in turn increases the pressure gradient which accelerates the wind even further.

Gap flow can be pictured as water running towards a gap between two walls. The water will hit the walls and look for an opening through which to escape. The flow again builds pressure and converges into the gap with a resulting increase in speed. This is referred to as the Venturi-Bernoulli effect. If the water is exchanged for south westerly winds and the gap for the Kareedouw Pass (Figure 1) or any saddle between two adjacent peaks, gap flow develops. As the airflow is initially blocked and channelled by the barrier, some of the flow forces a rapid escape to the northern side of the mountain (the Langkloof Valley). As air is forced to converge into the gap, high wind speeds are achieved. Gap flow winds in the Olympic Mountains in the United States of America (USA) have measured up to 50 (180 km.h^{-1}). These strong wind speeds coupled with a 90° change in wind direction (from the blocking regime) can be exceptionally hazardous.

Mountain waves are the most complex form of turbulence to visualise (Figure 1). Water approaching a wall with sufficient speed and momentum will hit and leapfrog over the wall, producing wavelike qualities over and downstream of the wall. In hydrology this is referred to as a hydraulic jump and, with some exceptions, can be applied to the atmosphere. For example, the wave can be extended to greater heights (tens of kilometres in the vertical) and multiple downstream waves can be allowed to form a wave train extending for hundreds of kilometres downwind.

Generally, atmospheric waves take a shape similar to swell in the ocean but can be more erratic at times. Mountain waves take form as visible waves (in beautiful cloud formations as shown in Figure 2), invisible waves, standing waves, moving waves (into the wind or with the wind), breaking waves or rotors under the waves (narrow rotating winds – Figure 1). The latter can pose a significant threat to aviation activities as they are frequently not visible, erratic in nature and unpredictable in their location. In the most severe case, a pilot flying at 15,000 feet and 200 km from the closest mountain can experience sudden and severe turbulence which may result in loss of control of the aircraft.

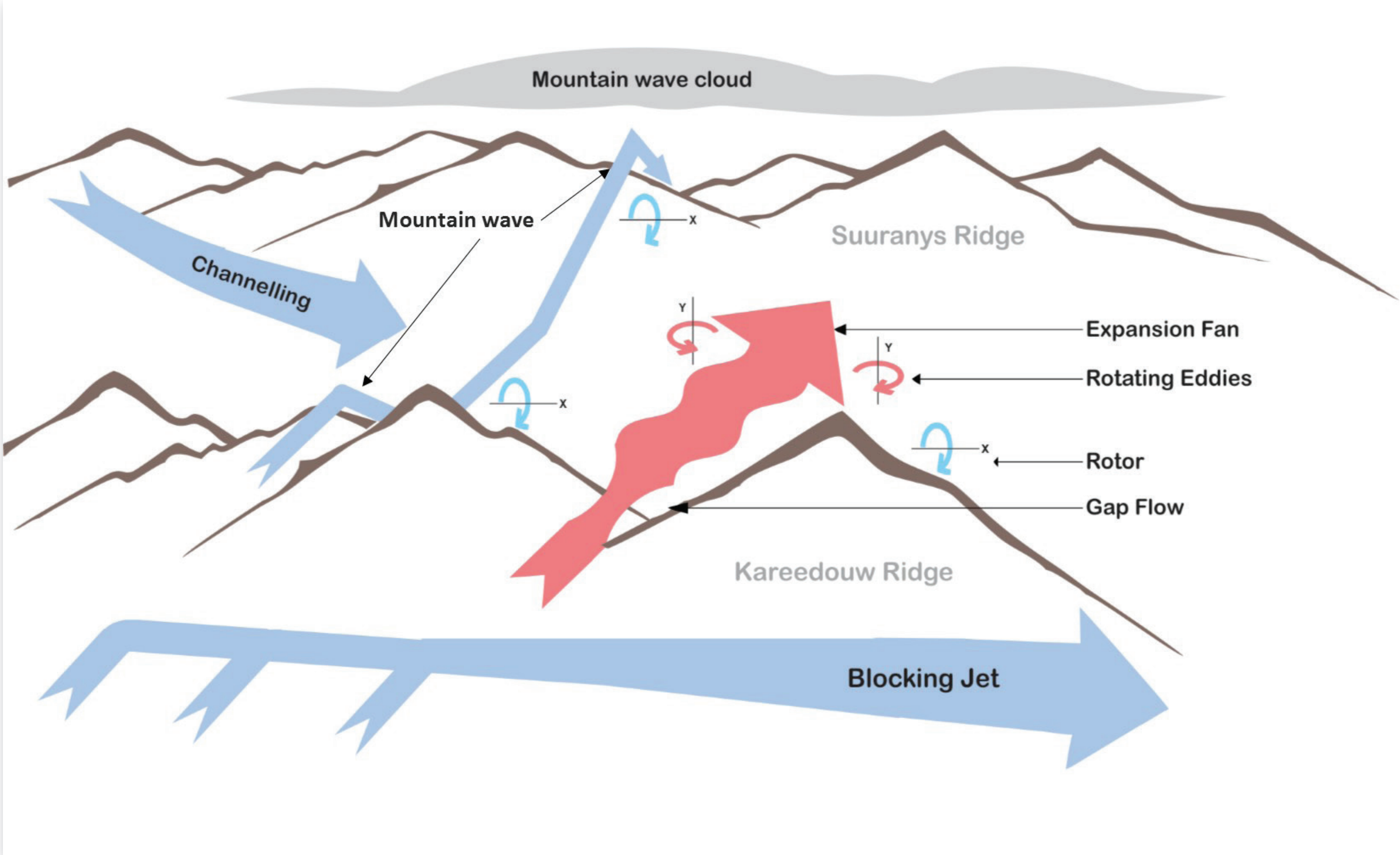

Figure 1: Depiction of wind flow at the foot of the Tsitsikamma/Kareedouw ridge along the South Coast. (Image credit: Janique Savy)

Study details

The observational part of the study consisted of surface point measurements blended with area and upper-air observations. Four Automatic Weather Stations (AWSs) were placed in the field to supplement an existing network of four permanent stations. Surface observations were combined with radiosondes (disposable specialised weather stations linking to satellites) attached to a weather balloon. The 19 radiosondes released relayed data to satellites which in turn sent them to field antennae. Area observations included satellite imagery every 15 minutes combined with satellite altimetry (satellite-measured winds) twice daily.

In addition to the above conventional observations, other experiments were conducted. Experiments included tethersondes (weather balloons floating 1 km above the surface, fixed by a fishing line) and dropsondes (radiosondes attached to a parachute dropped off the mountain). Experiments with dronesondes (a weather station attached to a drone) were started but downscaling at the drone company supporting the study resulted in its withdrawal. Lastly, smoke grenades and homemade smoke bombs were triggered both on the surface and while attached to weather balloons. The smoke was found to be very helpful in visualising wind flow and turbulence.

Figure 2: Lenticular cloud forming in a mountain wave (left). Field assistants Jerome Putter (from the local gliding club – top left) and Deon van der Mescht (from SAWS – top right), with myself (Markus Geldenhuys) and children from the local Zuuranys Primary School (right).

Findings

Excessive winds were measured during the study. Blocking was observed in radiosonde and satellite altimetry data. The strongest blocking wind measured 26 (95 km.h^{-1}). The depth of the blocking jet always reached mountaintop height. Gap flow measured wind speeds of 17 (62 km.h^{-1}) using radiosondes and 31 (112 km.h^{-1}) at surface stations. Another significant observation was a 45 (162 km.h^{-1}) wind on Africa Peak, a peak bordering the study gap at 819 m above mean sea level.

Vertical air motions of up to 7 were measured from mountain waves and, interestingly, in the gap flow exit region. To provide a frame of reference, a light aircraft similar to the crashed aircraft has the capability of comfortably cruising at 267 km.h^{-1} with a stall speed of 103 km.h^{-1} and a maximum rate of climb of 5.1 . The measured wind motions far exceeded the capabilities of such an aircraft. A downdraft of 7 will cause a plane to lose altitude at 2 even if the pilot manages to recover from the initial turbulence and maximises the aircraft's rate of climb.

Another scenario is an aircraft flying down the Langkloof Valley to pass through a gap in order to reach a destination south of the mountains. Flying upwind into moderate wind and suddenly being overrun by a localised strong wind region in the gap followed by an even greater wind can be fatal; not to mention the increase and decrease in headwind and tailwind as the pilot manoeuvres the aircraft. If the pilot manages to handle the downdrafts littered with updrafts in the approach to the gap, a sudden lull or the strong converging winds and direction change in the gap may throw the aircraft off course. This can later be fatal when the already unstable aircraft proceeds into an enormous blocking jet with a 90° direction change. A slightly tilted wing or one incorrect adjustment canthrow the aircraft out of control and cause it to crash.

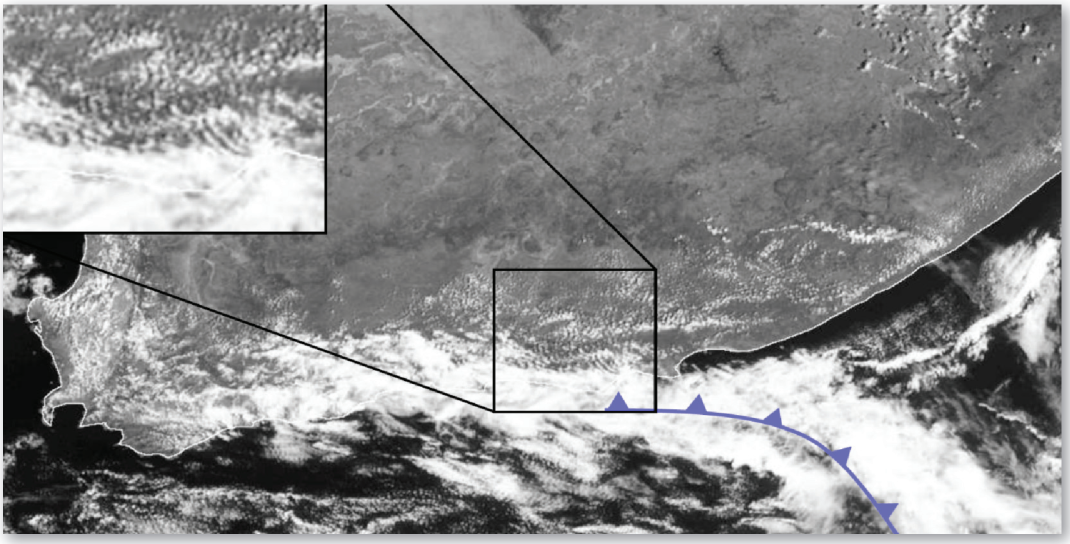

Figure 3: Eumetsat high-resolution visible satellite image at 11:00 South African Standard Time (SAST) on 16 December 2015, indicating the position of the cold front (blue line). The enlarged image indicates mountain waves (lines of clouds) over the crash area.

DIRECT NORMAL IRRADIANCE MONITORING INDEX IN SOUTH AFRICA

By Dr Joel Botai, Brighton Mabasa, Nosipho Zwane

The energy sector plays an important role in society and the economy. Solar energy is one of the most promising inexhaustible and renewable resources for power generation. South Africa is among the top three countries in the world with 2,500 hours of sunshine per year and direct solar radiation of between 4.5 and 6.5 kWh.m^{-2} per day. The Department of Energy (DoE) has prioritised a number of renewable energy technologies, including Concentrating Solar Power (CSP), Solar Photovoltaics (SPV), biomass and onshore wind technologies with the goal of achieving 17,800 MW of renewable energy by 2030 and reducing South Africa's significant reliance on conventional fossil fuels.

CSP systems are based on the conventional principle of driving turbines and generators for electricity generation. The first successful CSP plant was installed in California in the mid-1980s. In South Africa it is a new and developing technology. Seven CSP plants have been or are being built, of which only three are already connected to the national grid. At this stage, all the plants are in the Northern Cape where the annual average Direct Normal Irradiance (DNI) is 2,816 kWh.m^{-2}.

Surface solar radiation in South Africa is variable. It is therefore vital to assess the potential of installed CSP technologies before going ahead. The Energy Section in SAWS' Applications Department has initiated a project aimed at computing the Direct Normal Irradiance Index (DNII) as a measure of the potential of CSP technologies at different locations in South Africa.

The data used were obtained from 12 SAWS solar radiometric stations distributed across the country, as illustrated in Figure 1 and Table 1**.** One minute data from each station were converted to hourly data by taking the median value over 60 minutes. Data were further converted from hourly to daily through integrating the DNI values between sunrise and sunset. Finally, the data was converted from daily to monthly by taking the average of all the daily totals in the month. The seasons defined for Year 1 were March-May 2015; June-August 2015; September-November 2015; and December 2015-February 2016. Similarly, for Year 2 the seasons were classified as March-May 2016; June-August 2016; September-November 2016; and December 2016-February 2017.

CSP technologies require large amounts of DNI (>5 kWh/m^{2}/day) in order to be functional and economically viable. The threshold for classifying the potential of CSP in a specific location is based on the average DNI per month, as shown Table *2*.

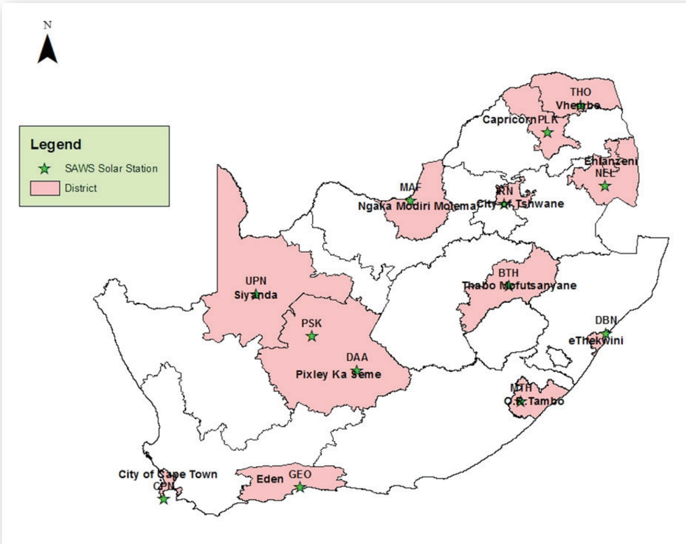

Figure 1: Map depicting the location of the SAWS network of radiometric stations (green stars)

Table 1: Description of the SAWS radiometric stations

Station	Abbreviation	District Municipality	Latitude	Longitude	Altitude (m above mean sea level)
DE AAR	DAA	Pixley ka Seme	-30.6652	23.9927	1284
UPINGTON	UPN	ZF Mgcawu/ Siyanda	-28.4794	21.1163	848
IRENE	IRN	City of Tshwane	-25.9105	28.2106	1524
NELSPRUIT	NEL	Enhlanzeni	-25.3878	31.1001	870
BETHLEHEM	BTH	Thabo Mofutsanyana	-28.248	28.3349	1688
MAFIKENG	MAF	Ngadi Modiri Molema	-25.8055	25.5403	1289
MTHATHA	MTH	OR Tambo	-31.5486	28.6746	744
GEORGE	GEO	Eden	-34.008	22.3817	192
DURBAN	DBN	eThekwini	-29.6074	31.1122	91
CAPE POINT	CPN	City of Cape Town	-34.35	18.48	86
POLOKWANE	PLK	Capricorn	-23.8591	29.4502	1233
THOHOYANDOU	THO	Vhembe	-23.0796	30.3848	619

Table 2: Thresholds from previous studies

Reference (study)	Threshold
IRENA (2015)	CSP technologies require large amounts of DNI (>5 kWh/m²/day) in order to function and be economically viable.
Balghouthi *et al.*, (2016)	DNI threshold value of 2000 kWh/m²/year for solar thermal power generation.
Bandyopadhyay *et al.*, (2008)	Factors in determining the most suitable site for a solar CSP installation include DNI greater than 5 kWh/m²/day (208 W/m²).
Pidaparthi *et al.*, (2016)	Criterion for suitable sites for CSP plants: Solar irradiation DNI > 2500 kWh/m²/year.
Enjavi-Arsanjani *et al.*, (2015)	CSP systems are only economical in locations with direct normal irradiation (DNI) above 1800 kWh/m²/year (about 5 kWh/m²/day).
5 kWh/m²/day= 5 kWh/m²/day *365.25 =1826.25 kWh/m²/year (*approximation*)	

The results for the 2015/16 period show that DAA (Pixley ka Seme District Municipality) and UPN (ZF Mgcawu/ Siyanda District Municipality) are best suited to the installation of CSP as they receive DNI of more than 6 kW/m² (average DNI per season) which is regarded as high. As indicated in Table 3, MAF (Ngadi Modiri Molema District Municipality), BTH (Thabo Mofutsanyana District Municipality) and IRN stations (City of Tshwane District Municipality) recorded DNI of more than 5 kW/m² in summer, making the summer installation of CSP technologies most suitable. The NEL (Enhlanzeni District Municipality), GEO (Eden District Municipality) and MTH (OR Tambo District Municipality) were found to be unsuitable for the installation of CSP because of the low DNI (less than 5kW/m²) recorded per season.

Table 3: Potential areas suitable for the introduction of CSP technology

Suitability	2015/6	2016/7
Excellent	DAA, UPN and MAF	DAA and UPN
Good	BTH, IRN, THO, PLK and CPT	BTH, IRN and MAF
Not Suitable	NEL and GEO	NEL, GEO, and MTH

The results of the study indicate that there are district municipalities outside the Northern Cape region that are also suitable for the installation of CSP technologies. These were identified as (1) Thabo Mofutsanyana in Free State, (2) Vhembe in Limpopo, (3)City of Tshwane in Gauteng, (4) City of Cape Town in the Western Cape and (5) Ngadi Modiri Molema in North West Province.

The installation of CSP technologies in more regions in South Africa will contribute not only to climate change mitigation but to job creation and economic growth.

SHORT COURSES

Regional Training Centre PRETORIA

http://rtc.weathersa.co.za/

General public and Meteorologists

Understanding Clouds
This course empowers anyone to get a fuller understanding of cloud names, how clouds form and the associated forms of precipitation.
TBA

Basic Meteoroligical Understanding Course
This course is designed to empower those doing Aviation Forecasting and deals with the theory behind the Aviation
TBA

Satellite Meteorology
- This course is designed to shed light on the interpretation of satellite imagery for weather enthusiasts and deals with how Meteosat Second Generation satellite imagery can be used within Public, Marine and Aviation weather.
5-9 March 2018

Aviation and specialized courses

Aviation Meteorological Observer
This course is based on the ICAO AMO competency criteria standards
Sept - Nov

RADAR Meteorology
This course is designed to empower those doing Weather Forecasting providing an understanding of the practical interpretation of weather RADAR.
9-13 April 2018

Aviation Meteorology for Forecasters
This course is designed to empower those doing Aviation Forecasting and deals with the theory behind the Aviation Meteorological Forecaster Competencies of WMO. It lays the foundation to complete the practical aviation meteorological forecast competencies.
7-11 May 2018

Real time Data
This course is designed for forecasters on the decoding of real time land, ship and buoy synoptic messages and aviation based weather reports (METAR/SPECI) according to International Civil Aviation Organization (ICAO) Formats.
5-9 Feb 2018

Marine Theory
This course is designed to provide a theoretical background and understanding for Marine Forecasting and marine related activities
14-18 May 2018

Aerological Diagrams
Using both Tephigrams and Skew T grams, this course is designed to empower those using Aerological Diagrams as a tool for weather forecasting within Public, Marine and Aviation
19-23 Feb 2018

Numerical Weather Prediction for Forecasting
This course is designed to teach how to interpret, evaluate and apply Numerical Weather Prediction output products to weather forecasting.
3-6 April 2018 (Theory)
17-19 April 2018 (Prac)

The Flash Flood Guidance system
This course is designed to provide a theoretical and practical understanding of the Flash Flood Guidance system (FFGS), available to operational forecasters, which will assist them in forecasting flash floods.
TBA

Introduction to Coastal Meteorology
This course is designed to empower those tasked with management and policy-making opportunities of the environment
TBA

ANALYSIS OF ATMOSPHERIC CONDITIONS BETWEEN 2014 AND 2017 FOR THE WINTER RAINFALL SEASON

By Stephanie Landman – Lead Scientist: Numerical Weather Prediction Modelling and Forecasting

Cobus Olivier – Scientist: Long-range Forecasting

All observations over the past three years are indicative of the development of a severe drought in South Africa's winter rainfall region. The winter rainfall region, which is located in the south-western parts and southern coastal areas of the country, receives its rainfall primarily between May and August. Rainfall in this region (Figure 1 – right) is primarily due to the continental passage of cold fronts which form part of mid-latitude low pressure systems that develop to the south of the continent (Figure 1 - left).

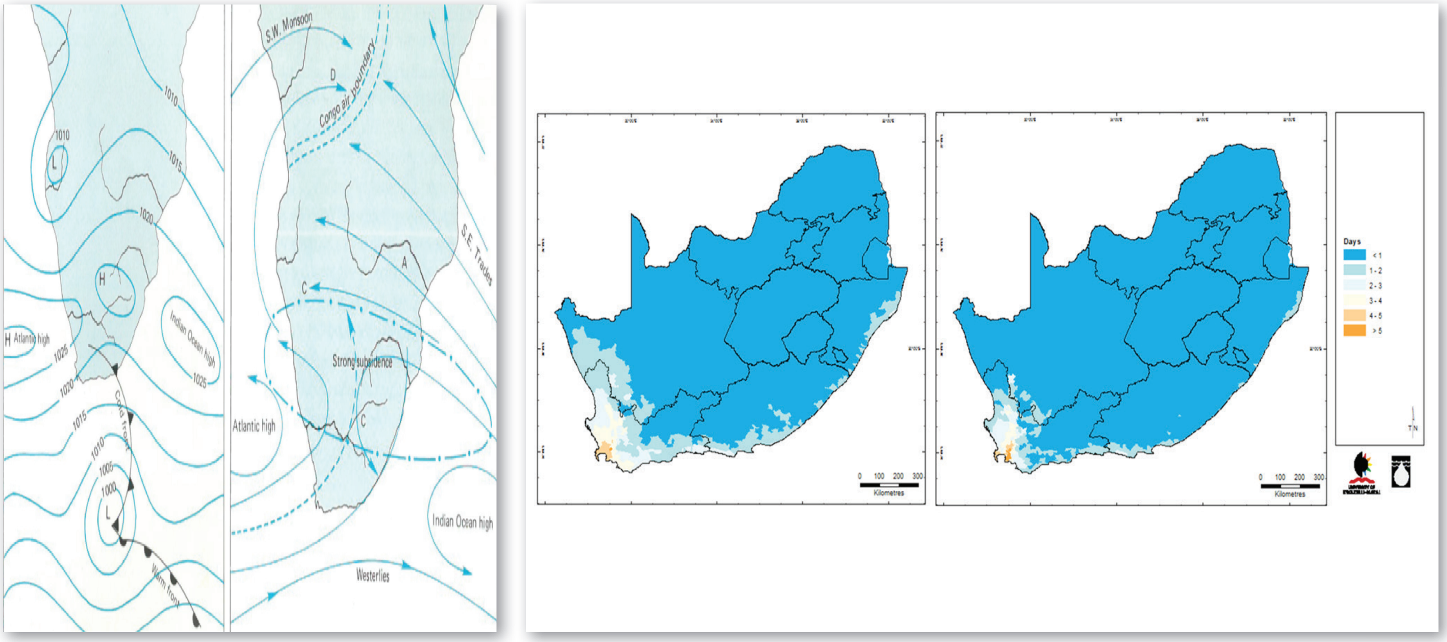

Figure 1: General synoptic systems during austral winter months (left) and the associated number of days with rain (right).

According to data collected at three rainfall stations in the vicinity of Cape Town and its major river catchments (known as the Western Cape Water Supply System), there has been a decrease in average annual rainfall since 2014 (Figure 2). The question is not one of the severity of the current drought in the winter rainfall region but of examining the possible changes in the driving dynamical and synoptic processes that have contributed to the decrease in rainfall observed over the past three years.
In order to identify the characteristics of historical synoptic patterns and their associated rainfall, Self-Organising Maps (SOMs) were used to classify daily synoptic patterns that occurred over the period 1 January 1983 to 31 October 2017. For synoptic patterns, data on the height of the 850 hPa pressure level at 12:00 UTC every day were obtained from the ERA-Interim reanalysis data archive. In addition, African Rainfall Climatology, based on satellite estimated and observed station rainfall, served as rainfall observations.

The SOM analysis was used to determine the 850 hPa circulation or synoptic patterns associated with daily rainfall totals in the winter rainfall region. Of the resulting 35 SOM nodes, six were identified and classified as being

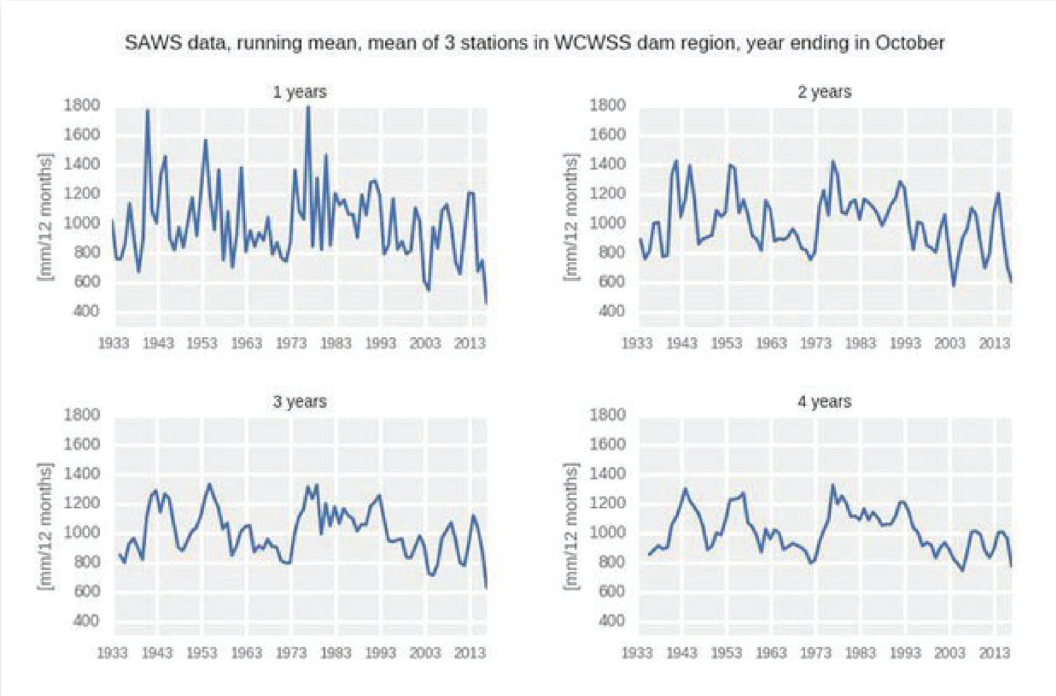

Figure 2: The running annual mean total rainfall (mm) as recorded at three SAWS rainfall stations in the Western Cape Water Supply System (WCWSS).

synoptic conditions primarily associated with South Africa's winter rainfall seasons (Figure 3). As expected, these synoptic patterns are largely associated with the west to east passage of cold fronts in mid-latitude systems as well as onshore cold air flow from the south (SOM node 14).

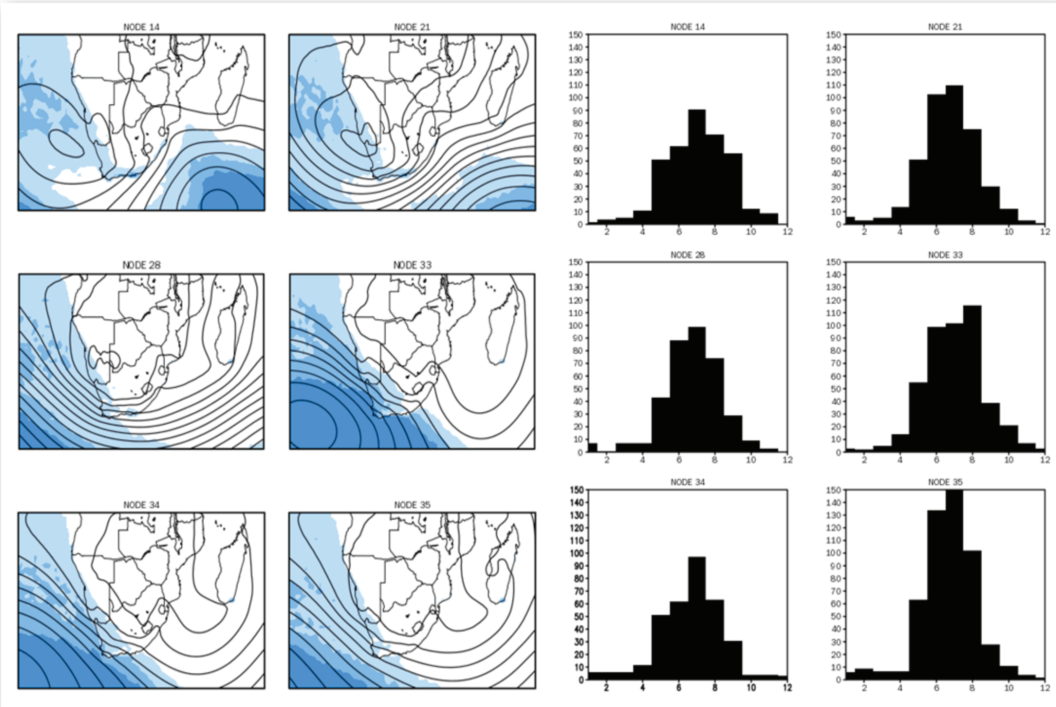

Figure 3: The six SOM nodes, calculated from daily data over a period 1983 to 2010, indicating the 850 hPa pressure level circulation (contours left) and associated surface rainfall pattern (shaded areas left), and the corresponding nodes indicating the annual distribution of the frequency of occurrence of the six patterns (right, with months on the x-axis).

The average monthly occurrence of each node (calculated from daily data) for the months May to September over the period 1983 to 2010 was calculated to obtain the long-term average and the monthly occurrences in the following seven years (2011 to 2017) were compared with the long-term average (Figure 4). From the node distributions in Figure 3 (right) and the corresponding node data in Figure 4, it can be seen that nodes 14, 21 and 28, which appear to block the continental passage of cold fronts and result in less winter rain, occur less often and have a weaker winter distribution than nodes 33 to 35. Node 28 however consistently occurred more frequently during June. On the contrary, in the period July 2014 to 2017, most of the nodes occurred more often (with the exception of nodes 33 and 34). If one focuses only on the three years associated with the drought (2015 to 2017), the June and July synoptic patterns almost seem to be exchanged. Overall, what is of concern is that in some years there were no occurrences of certain nodes during June and July, e.g. node 35 in June 2017 and node 34 in June 2015. The non-occurrence of certain historically prominent synoptic rainfall pattern nodes during the 2015 to 2017 drought period means that some important rain producing systems simply did not occur and this had a significant impact on the winter rain received in the Western Cape over these three years.

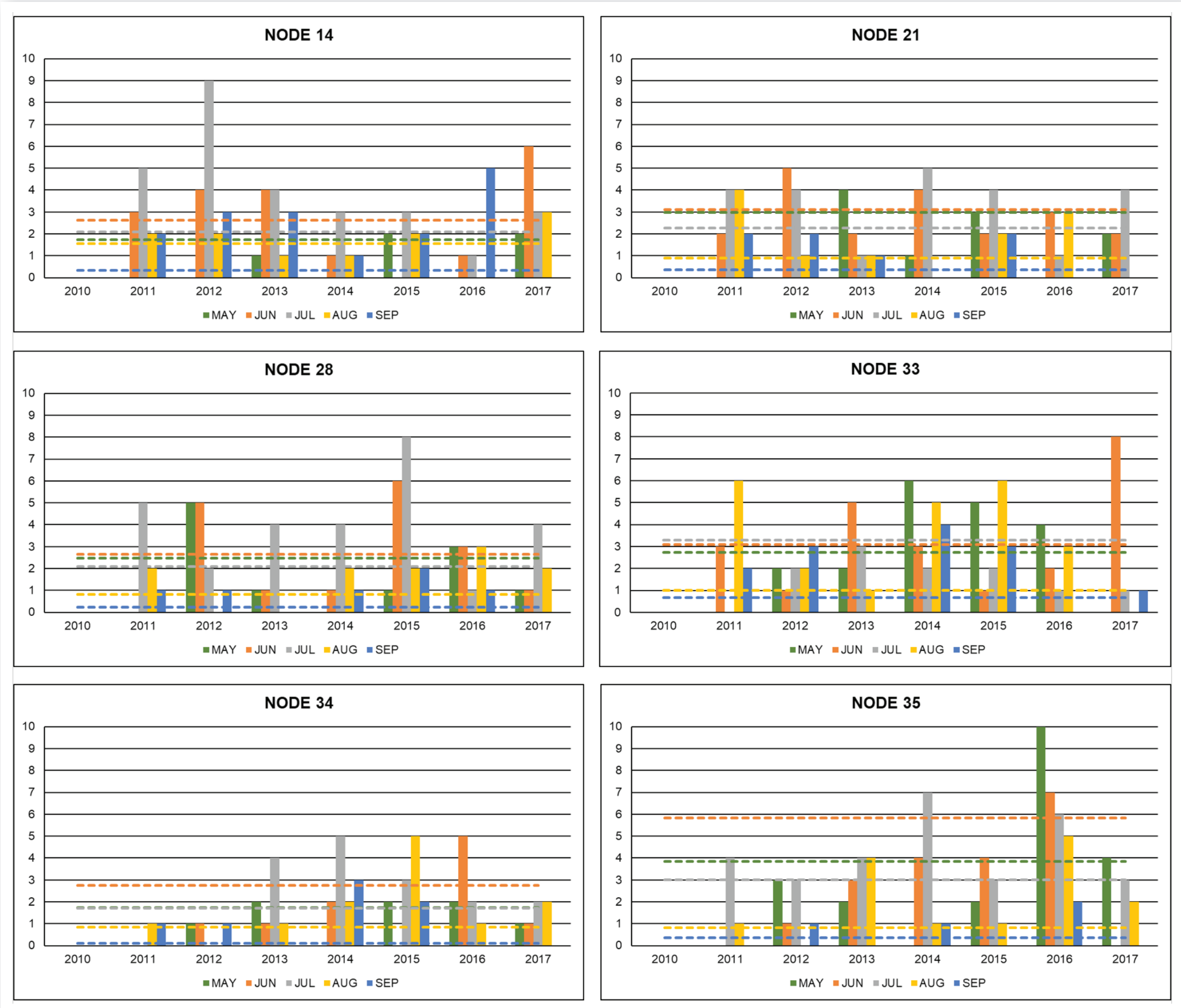

Figure 4: Monthly frequency of occurrence calculated over the period 2010 to 2017 (histograms) and long-term mean calculated over the period 1983 to 2010 (dashed lines) for the winter rainfall months May to September for SOM nodes 14, 21, 28, 33, 34 and 35.

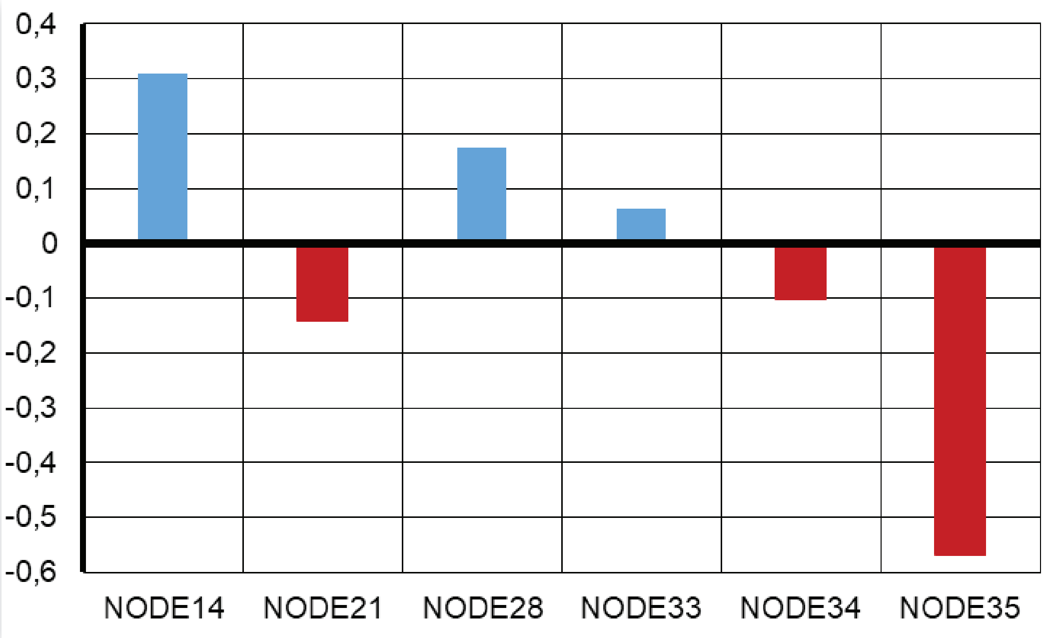

Figure 5: Changes in the frequency of occurrence of nodes 14, 21, 28, 33, 34 and 35 in the past seven years (2010 to 2017) as compared to the period 1983 to 2010.

The increased occurrence of node 14 (Figure 5) which is associated with the ridging of anti-cyclones to the south of South Africa (a synoptic system responsible for the predominantly summer season onshore south-easterly winds) might have contributed to the decline in winter rainfall. The decrease in node 35 events could be attributable to the increase in node 28 events which are also associated with the anti-cyclonic blocking that prevents cold fronts from passing across the southern continent by pushing them southwards.

The Antarctic Oscillation (AAO), which is defined as a low frequency mode of atmospheric circulation variability in the Southern Hemisphere, might be indicative of the development of mid-latitude cyclonic systems (associated with the appearance of cold fronts) in the Southern Ocean. Figure 6 shows that the AAO was mostly positive during the winter months in the period 2015 to 2017. This may have contributed to the prevention of frequent cold front continental passages.

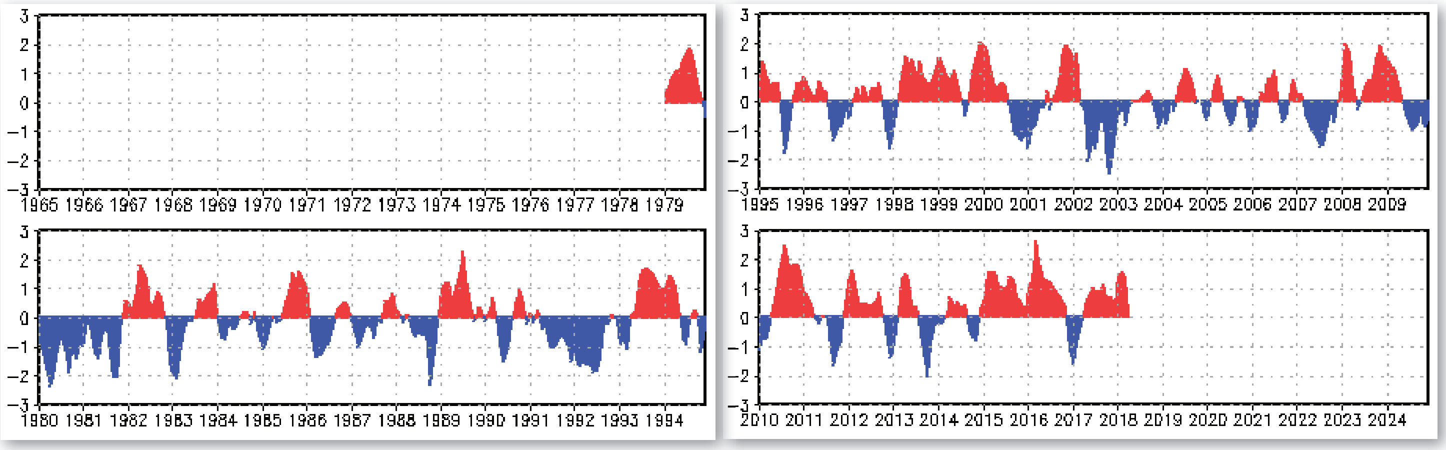

Figure 6: Standardised three-month running mean of the Antarctic Oscillation Index (AAO) from January 2010 to January 2018.

In conclusion, it was found that an analysis of daily synoptic patterns might shed significant light on the reasons for the recent drought in the Western Cape Province. The synoptic deviations across the South African domain were most probably influenced by larger scale circulations or climate drivers such as the AAO. A better understanding of how the integrated earth system might have contributed to the 2015 to 2017 drought will certainly allow for improved weather and climate forecasts and predictions and, with early warning systems in place, contribute to greater climate and weather resilience.

A THERMAL WATCH INDEX APPLICATION FOR GAUTENG

By Katlego Ncongwane and Dr Joël Botai

A 2013 report by the Intergovernmental Panel on Climate Change (IPCC) suggests that it is likely that global air temperatures will continue to rise in the 21st Century, particularly given the absence of much anticipated shifts in policy to limit greenhouse gas emissions.

An increase in temperatures means increased human exposure to severe heat, which can lead to discomfort and sometimes heat stress, especially during prolonged hot spells similar to those experienced in most parts of South Africa in December 2017 and early January 2018. Some places in the Gauteng, Limpopo and Mpumalanga Provinces endured three to five consecutive days of maximum temperatures in the mid to upper 30° C. In most instances these high temperatures were accompanied by high relative humidity which made the weather feel even hotter than it actually was. Eleven locations, nine of which were in the Western Cape, experienced record-setting temperatures of above 40° C. (Ladysmith recorded 40.4° C, Tygerhoek 43.2° C, Swellendam 43.5° C and Vredendal 45.5° C.) Unfortunately, scientific evidence indicates that the situation might get much worse due to global warming.

According to the *IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX*), in the future there might be more frequent, more intense and longer-lasting extreme heat events which will have negative implications for human health. The challenge we face is that the health risks and even mortalities associated with high temperatures are growing as the frequency of extreme heat events increases. Medical conditions resulting from prolonged exposure to heat can have varying degrees of severity, such as oedema, heat rash, cramps, heat exhaustion and heat stroke. Many prescribed medications can increase the risk of heat-related illness, particularly for athletes. Heat can also indirectly exacerbate pre-existing medical conditions such as asthma, lung and cardiovascular diseases, hypertensive diseases and chronic renal failure to name but a few. Those most at risk are members of the vulnerable segments of the population such as children, the elderly, the socially isolated and the homeless, as well as outdoor workers, marginalised communities, athletes and tourists who are unaware of the dangers of hot weather.

The Thermal Watch Index

While exposure to excessive heat and heat wave events can be life threatening, human health impacts can be mitigated to some extent through effective, practical interventions such as the availability of a heat or Thermal Watch Index (TWI) application. The TWI, developed by SAWS' Applications Department, is aimed at improving the preparedness of decision-makers and private individuals so that they are able to take appropriate action to protect against scorching heat and ensure optimal thermal comfort, performance and health. Planning and preparedness are without a doubt no longer a luxury but a necessity when it comes to saving lives.

The TWI monitoring tool is based on Apparent Temperature (AT) (°C), and estimates what the temperature will feel like on the next day based on relative humidity (%), wind speed (ms^{-2}) and water vapour in combination with air temperature. The TWI interactive map (Figure 1) serves as a warning/watch tool by providing the near real-time status of the day's thermal conditions per location (Gauteng in this example). The application will be expanded to the rest of the country over the next six months.

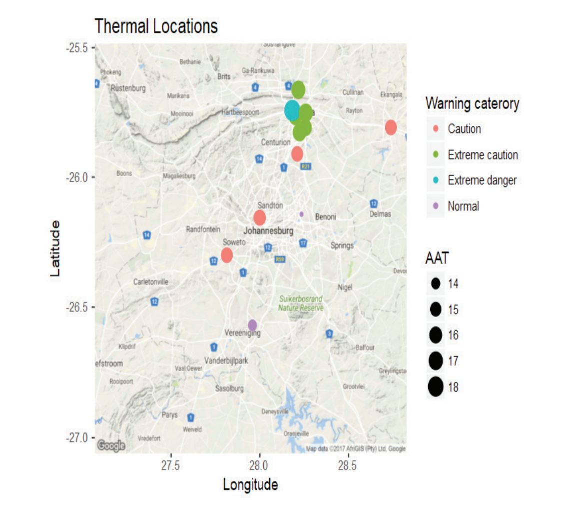

Figure 1: A screenshot of the TWI interactive map showing areas in Gauteng where potentially life threatening heat stress conditions are observed and actions are required to mitigate the effects of excessive heat and the increased threat of heat related illnesses.

The TWI values provided are accompanied by a four scale AT (°C) potential health impact chart (caution, extreme caution, danger and extreme danger) to communicate the associated risks.

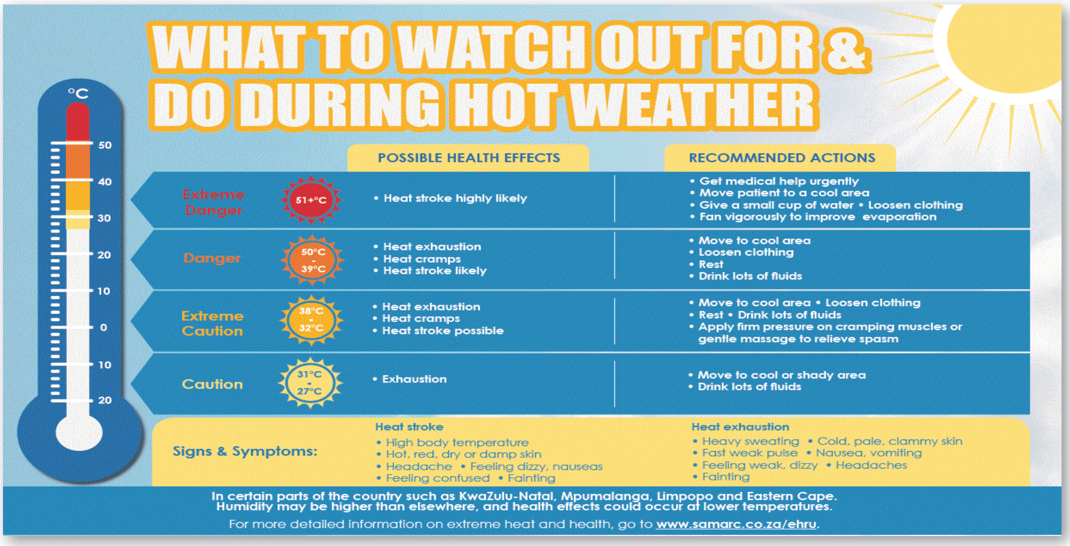

Figure 2: Apparent Temperature (AT) ***(°C) thresholds and*** their potential health impacts

As shown in Figure 2, there are no imminent health risks associated with an AT of >26° C. However, in the case of ATs between 27 and 51° C, heat-related illnesses may result and some actions are recommended. The risk category "caution" (27-31° C) is associated with heat exhaustion which is an acute heat-related illness characterised by fainting or dizziness, excessive sweating and pale and clammy skin. In this case, people are advised to move to a cooler or shady area and to drink lots of fluids, particularly water. Serious medical conditions can occur in the "extreme caution" category (32-38° C), including heat exhaustion, heat cramps and in some cases heat stroke which is the most severe and can result in shock, brain damage, internal organ failure and, in extreme cases, coma. When the AT rises to the "danger" risk category (39-50° C), the body overheats, causing severe heat illness which requires immediate medical intervention. In this category, people are advised to move to cooler areas, loosen their clothing, avoid strenuous physical activities and drink lots of fluids.

With the TWI, the South African Weather Service is able to issue advance warnings and watches for potentially dangerous AT values and advise on the most appropriate actions to take to mitigate the associated health effects. This is known as an impact based warning system aimed at providing more information to the public through various platforms to facilitate improved public response and decision making.

CHARACTERISTICS OF DROUGHT PROPAGATION IN THE HYDROLOGICAL CYCLE IN SOUTH AFRICA

By Dr Christina Botai, Dr Joël Botai, Jaco de Wit

Many sectors of South African society and the economy have been affected by periods of drought. A typical example is the current situation in the Western and Eastern Cape Provinces which has progressed to the point of a hydrological drought where most of the dams are running dry. Other provinces have also experienced various types of drought - meteorological, agricultural and hydrological.

It is acknowledged that a meteorological drought (a condition arising from deficient or delayed rainfall over an extended period) can be difficult to monitor or even foresee, particularly if the models are not sensitive enough for seasonal forecasts. On the other hand, the impact of agricultural and hydrological droughts can be mitigated through efficient Drought Early Warning Systems (DEWS) or the use of drought monitoring indices. The effectiveness of DEWS depends on a proper understanding of drought evolution over time. This implies that it is crucial to understand the exact timeframes in which a meteorological drought transits into an agricultural drought (a condition that affects all forms of farming due to soil moisture depletion) or a hydrological drought (a condition that drains water reservoirs).

The Hydrometeorology Group at the South African Weather Service (SAWS) has conducted a research study to track drought propagation in the hydrological cycle. This was done by using the Standardised Precipitation Index (SPI), a drought monitoring indicator highly recommended by the World Meteorological Organization (WMO), and the Standardised Streamflow Index (SSI). In calculating the SPI and SSI, six different probability distribution functions were fitted to the monthly precipitation and streamflow time series data. These probability distribution functions consisted of the two-parameter approach (i.e. Gamma, Log Normal and Gumbel) and the three-parameter approach (i.e. Generalised logistic, Pearson 3 and Tweedie). Furthermore, a cross-correlation analysis of SSI-1 (i.e. one month accumulation period) with SPI accumulation periods from one month to 24 months was completed. In this cross-correlation analysis, the SPI accumulation period with the largest correlation with the SSI-1, denoted SPI-*n*, was taken to be the time period in which a meteorological drought transits into a hydrological drought (referred to as the hydro-meteorological transition period).

Overall, the results showed that drought transition periods in South Africa range from one month to 24 months (Table 1 and Figure 1). For the period 1985 to 2016, the drought transition periods in South Africa can be grouped as follows: (1) shorter timescales of one to three months; (2) intermediate timescales of four to six months; (3) longer timescales of seven to 12 months; and (4) an extended timescale which goes beyond 12 months. As indicated in Figure 1, parts of the Western Cape, Eastern Cape, Free State and North West Provinces show short to intermediate drought propagation periods. According to the summary presented in Table 1, only 27% of the stations are characterised by short to medium drought propagation periods. All of these stations are located in the Western Cape, Eastern Cape, Free State and North West Provinces. The short to medium transition period implies that once there is deficient or delayed rainfall, water reservoirs in the region are likely to be affected within six months or less, notwithstanding other non-climate factors such as demographic patterns. Faster drought transition periods can also be attributed to aridity or higher temperatures in a region which lead to more rapid water moisture loss, either into the soil or through evapotranspiration. Approximately 15% of the analysed weather stations show longer transition periods, ranging from seven months to a year. On the other hand, the vast majority of South African regions (>60%) experience delayed drought propagation (from one year to up to two years). These regions are mostly located in the Limpopo, Mpumalanga and KwaZulu-Natal Provinces as well as parts of the Northern Cape and Western Cape Provinces. The existence of major dams and aquifers, which are often supplemented by groundwater and surface water, significantly contribute to delayed drought propagation in most regions. This implies that water reservoirs, coupled with other factors such as precipitation climate, catchment properties, aquifer depth, presence of lakes and wetlands, soil types, land cover/use and a climate change signal, play a vital role in drought propagation in the hydrological cycle.

Table 1: Hydrometeorological drought transition periods and a summary of some of the characteristics of Water Management Areas in South Africa. The altitude, soil bulk density and soil texture characteristics refer to buffer zone (10 km radius) area characteristics averaged across the selected rainfall and streamflow stations within the Water Management Areas.

WMA (Code, see Figure 1)	Mean Altitude [m]	Soil Bulk Density	Dominant Soil Texture	Median Transition Period [Months]
1	1021.31	1.38	Loam; Clay Loam; Sandy Clay Loam	21
2	1058.73	1.40	Sandy Clay Loam	24
3	1185.49	1.44	Clay Loam; Sandy Clay; Sandy Clay Loam	10
4	1337.20	1.35	Clay; Clay Loam; Sandy Loam; Sandy Clay Loam	21
5	1216.00	1.33	Clay; Sandy Loam; Sandy Clay; Sandy Clay Loam	24
6	876.34	1.39	Clay; Clay Loam; Sandy Loam; Sandy Clay Loam	23
7	1284.17	1.41	Sandy Clay Loam	16
8	1479.39	1.40	Clay, Sandy Clay Loam	19
9	1343.74	1.42	Clay Loam; Sandy Clay Loam	3
10	1169.25	1.34	Clay; Sandy Loam	10
11	925.72	1.41	Sandy Clay; Sandy Clay Loam	15
12	914.74	1.33	Clay; Clay Loam; Sandy Clay Loam	6
13	1236.87	1.34	Clay; Clay Loam	21
14	853.54	1.31	Clay Loam	13
15	640.04	1.33	Clay; Clay Loam	6
16	690.01	1.36	Clay Loam; Sandy Loam	23
17	282.48	1.35	Loam	1
18	859.42	1.32	Loam; Clay Loam	13
19	397.02	1.44	Clay Loam; Sandy Loam	1

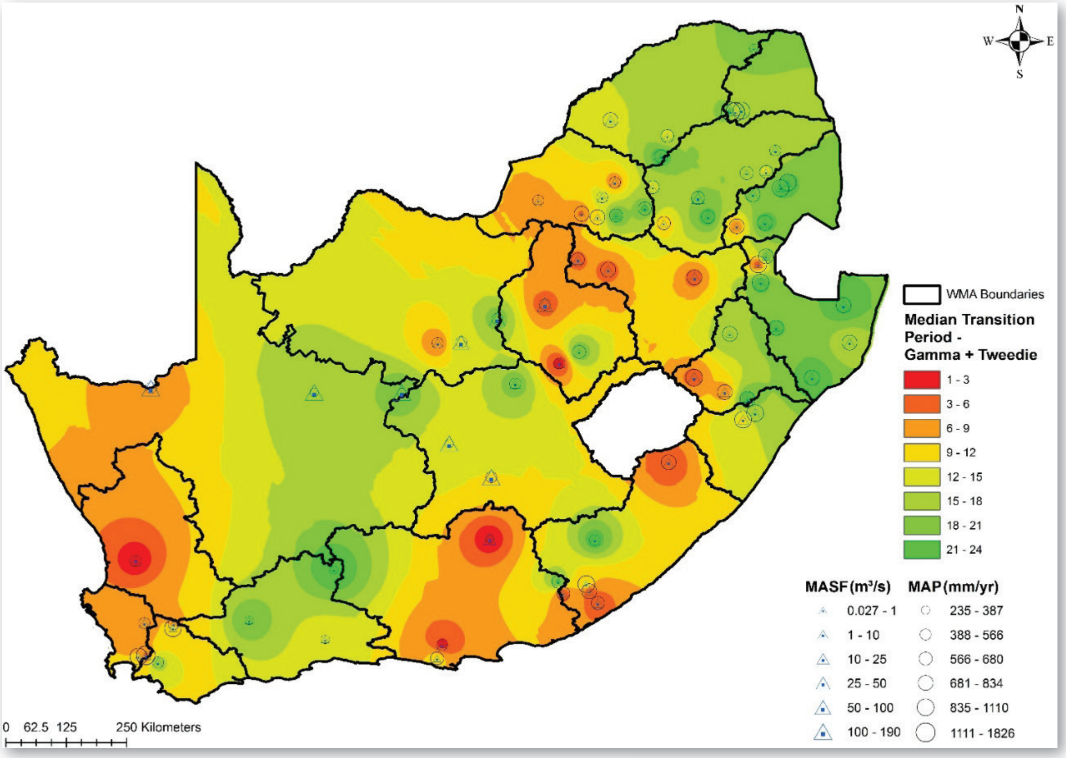

Figure 1:: Median transition periods derived from the Gamma and Tweedie probability distribution functions.

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

USSD FOR ALL TYPES OF HANDSETS

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 traveler, sport person for outdoor activity and mostly those who wishes to view occasional weather forecast.

simply dial
*120*7297(SAWS)#

MEET THE AUTHORS

Dr Christina Botai

Dr. Christina Botai is a Senior Scientist in Hydrometeorology applications at the South African Weather Service. She has a PhD in meteorology from the University of Pretoria, MSc. in Astrophysics and Space Science from North West University (Potch Campus), BSc. (Hons) in Astrophysics and Space Science from UCT and BSc from the University of Venda for Science and Technology. Dr Christina has more than 10 years of experience as a researcher specialising in satellite and hydrometeorology applications. She has authored and co-authored more than 10 peer reviewed journal publications and has presented at various national and international workshops and conferences. Dr Christina is leading the Hydrometeorology applications research group at SAWS, which is responsible for developing applications research products and services that address the impacts of weather and climate on water resources management in South Africa. Dr Christina Botai is currently affiliated with Tshwane University of Technology, offering guest lectures and also supervises BSc. (Hons) students at the University of Pretoria.

Dr Joël Botai

Dr Joel 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 multi-disciplinary academic background with a vast experience in cross-cutting research areas, including earth and atmosphere sciences. He has been involved in various and international research projects focusing on geodynamic processes mimicking earth-atmosphere interactions and the resultant impacts to society and the environment. Dr Joel 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).

Mr Jaco de Wit

Mr Jaco de Wit is a Research Scientist in the hydrometeorology field which forms part of the applications research group at the South African Weather Service. He started in 2016 as a research intern at the organisation and was absorbed into a permanent position in the research department in May 2017. He obtained a BSc (Meteorology) degree in 2014 and his BSc Honours (Meteorology) in 2015 from the University of Pretoria. Some of his duties include partaking in applications research dealing with hydrometeorology and water sector issues which arise from weather and climate sensitive variability and change and researching solutions to the various public and private issues regarding that. He is also in charge of the "State of Dams" database which is used to track current drought status and water availability throughout South Africa. He is planning on starting his MSc in 2018.

Markus Geldenhuys

Markus Geldenhuys has been a weather forecaster with SAWS from 2014. In 2013, he did research on fog nets and completed his honours degree in Meteorology with the University of Pretoria. He submitted his Master's degree in 2018, where he studied the unknown features of Blocking, Gap flow and Mountain waves in a small-scale coastal environment. Later in 2018 he will start his doctoral degree in Germany; whereby he will study oblique gravity waves, propagating to the stratosphere, over the southern Antarctic Peninsula and the South American Andes. Understanding this will impact our climate projections, weather forecast models, seasonal predictions and have the capacity to contribute to a seamless forecasting environment. He currently serves on a Water Research Council Reference group and also acts as a reviewer for their project proposals. Markus has a keen interest on the unknown, experimental design and fluid dynamics

Dr Andries Kruger

Dr Andries Kruger is a Chief Scientist: Climate Data Analysis and Research in the Department: Climate Service of the South African Weather Service. His present and previous duites include the creation and writimg 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 2001, Dr Kruger obtained a PhD (Civil Engineering) degree at the University of Stellenbosch, with research topic "Wind Climatology and Statitsics of South Africa relevant to the Design of the Build Environment". Before that, he obtained an MSc (Environmental and Geographical Science) degree at the University of Cape Town. He published papers both locally and internationally, and authored a SAWS sries of publications on the general climate of South Africa as well. He is widely recognised, both nationally and internationally, for his research, which mainly involves advanced statistical analyses and interpretation of historical climate data.

Ms Stephanie Landman

Stephanie Landman has been working as a Meteorologist for almost 15 years. She started her career as a weather observer at the Bethlehem Weather Office (METSYS) after which she joined the short-term insurance industry for a number of years. Returning to atmospheric sciences, she was a Scientific Consultant in Air Quality at Bohlweki Environmental before she re-joined the South African Weather Service in 2008 where she has since been appointed to Lead Scientist in Numerical Weather Prediction (NWP). She completed her MSc (Meteorology) degree at the University of Pretoria in 2012 with the research topic of determining the skill in multi-model short-range ensemble prediction systems over South Africa. Her main area of interest is in post-processing of NWP data, including the development and implementation of prediction systems for short-range forecasting. She also teaches on a part-time basis at the University of Pretoria a BSc (Honours) (Meteorology) course in applications of NWP, supervises BSc (Honours) students with their research projects on model evaluation issues as well as co-supervising MSc dissertations. At the Regional Training Centre (RTC) she teaches the forecast interns on the use of NWP for practical forecasting as well as applying model output statistics to forecasts. She is currently enrolled for her PhD at UKZN and will graduate in 2018.

Ms Charlotte McBride.

Charlotte McBride has worked for the South African Weather Service for the past 20 years. Her interests related to climate data, data quality control, quality management and education. She holds a master's degree in Science Education from the University of Pretoria and has held a number of different positions at SAWS. She is currently the Acting Senior Manager for Climate Service. She is also involved with work of the WMO Commission for Climatology as the Co-Chair of Focal Area on Capacity Development. When she is not at work she enjoys traveling and visiting far off places.

Ms Katlego Ncongwane

Ms Katlego Ncongwane is a Senior Scientist leading the Health Application Group within the Research Department of the South African Weather Service (SAWS) since 2016, responsible for developing products and services such as early warning systems for infectious diseases (including Malaria, Pneumonia, Dengue fever and Cholera) and heat-health in support of communities. Ms Katlego Ncongwane has research experience in ozone, shortwave (solar) and UV radiation research and has managed the scientific aspects of SAWS UV and solar radiation networks, responsible for the monitoring of stations in the two networks, data quality assurance and control as well as sensor calibration. Ms Katlego Ncongwane holds two Masters Degrees, an MSc in Physics from the University of Kwa-Zulu Natal (2015) and MPhil in Sustainable Development Planning and Management (2010) from the University of Stellenbosch. She is currently pursuing her PhD in Environmental Science with the University of Kwa-Zulu Natal.

Mr Cobus Olivier

After completing his BSc Honours in Meteorology at the University of Pretoria, Cobus started working at the South African Weather Service in 2008. He has been working with the Long-Range Forecasting Group for the duration, where they produce seasonal forecasts on a monthly basis. The group investigates important climate drivers, such as ENSO, to better understand the potential impact on the coming seasons weather conditions. The group is extensively involved with Agriculture, Water resource managers as well as the media to communicate and help interpret the expected weather conditions.

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 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 Meteorology in 1999 at the University of Pretoria (UP). He served as a coordinator of the Meteorology Group at the University of Pretoria from 2003-2015, 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 2010-2014. Prof Rautenbach was also President of the South African Society for Atmospheric Sciences (SASAS) during 2005-2010, 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 46 scientific papers in accredited science journals and presented more than 100 talks at national and international conferences. He is currently rated as a C2 scientist by the NRF.

Ms Nosipho Zwane

Ms Nosipho Zwane is a Research Scientist at the South African Weather Service since 2014. She began specialising in Climate Change and recently moved to Application Research under the Energy Unit. She completed her BSc degree with a double major in Environmental and Geographical Science and Ocean and Atmosphere Science in 2012 (University of Cape Town). In 2013 she completed her BSc Honours in Ocean and Atmosphere Science (University of Cape Town). She is currently enrolled for MSc Meteorology at the University of Pretoria.

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South African Weather Service

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WEATHERSMART NEWS Scientific meteorological and climatological news from the South African Weather Service

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