WEATHERSMART News

Scientific meteorological and climatological news from the South African Weather Service

February 2017

In this Issue

- Understanding Clouds
- Tornadoes
- Lightning
- Initiatives of the South African Weather Service towards sustainable development
- From global warming to climate change
- Tropical Cyclone Dineo and the development of a tropical temperate trough directly after the demise of the cyclone

South African Weather Service

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TABLE OF CONTENTS

Foreword by CEO 2

Editorial 3

Understanding Clouds 4

Understanding clouds this World Meteorological Day 2017 12

Tornadoes in Souh Africa 14

Lightning in Souh Africa 18

Initiatives of the South African Weather Service towards sustainable development 20

From global warming to climate change 22

TropicaL Cyclone Dineo and the development of a tropical temperate trough directly after the demise of the cyclone 26

Meet the authors 33

FOREWORD BY THE INTERIM CEO

As the South African Weather Service (SAWS) proudly presents the third edition of its first scientific external newsletter, we glimmer with pride when showcasing the excellent work done by the organisation. This edition is filled with exceptional articles related to weather and climate, such as tornados and lightning in South Africa, sustainable development, from global warming to climate change and tropical cyclone Dineo.

As a proud member of the World Meteorological Organization (WMO), we look forward to celebrating the upcoming World Meteorological Day on 23 March. A day which marks the establishment of the WMO, a United Nations (UN) specialised agency on meteorology.

This year's WMO theme, 'Understanding Clouds' celebrates the new International Cloud Atlas, which has its roots in the 19th century and was last updated in 1975. An International Task Team was assembled to update the existing cloud atlas which consisted of members from China, Switzerland, Australia, Argentina, United States of America, United Kingdom, Barbados and South Africa's representative was SAWS' very own Ms Colleen Rae, a Qualification Manager from SAWS' Regional Training Centre.

The updated atlas includes new cloud descriptions that have been added, a new based format, which will include time-lapse videos that will illustrate the evolution of cloud types, how cloud types can vary by season as well as radar images, thermodynamic profiles and a revamped, user-friendly flow chart which will assist observers in identifying clouds.

The recent adverse weather conditions experienced, such as the influx of tropical moisture and Tropical Cyclone Dineo, have had a significant impact on South Africa. Tropical Cyclone Dineo, which made landfall on the southern Mozambique coast, north of Inhambane, near Massinga on 15 February 2017, presented a formidable storm and winds ranging from 118-165km/h, which caused significant damage to coastal and inland infrastructure. The communities in southern Mozambique were greatly affected by torrential rain, which resulted in widespread flooding. The cyclone's impact was not only restricted to Mozambique but had far-reaching impacts on neighbouring countries such as South Africa, Botswana and Zimbabwe. The system caused widespread rain showers and thunderstorms over eastern Mpumalanga and Limpopo, leading to localised flooding. During this period, it was imperative that the organisation continuously issue weather warnings and safety precautions in efforts for the nation to be safe.

With these recent occurrences the need has become increasingly apparent that the South African Weather Service has to forge ahead in creating a WeatherSMART nation, which is firmly entrenched in being **S**afe, **M**ore informed, **A**lert, **R**esilient and **T**imeous in their reaction to adverse weather conditions.

This year's World Meteorological Day will enable the South African Weather Service to officially present the 'Creating a WeatherSMART nation' campaign. This entails the regular provision and greater societal awareness of quality weather services to the public in response to the risk of climate variability and climate change. The public needs to become more resilient, more prepared, more informed of severe weather and climate episodes, which we have become accustomed to recently in our country and the rest of the world.

Mmapula Kgari
Interim Chief Executive Officer:
South African Weather Service

EDITORIAL

The third edition of the South African Weather Service's (SAWS) external publication brings to the fore the ground breaking work being done by the organisation. The organisation continues pushing the boundaries in the provision of weather and climate products, services and research in South Africa and the African continent. These feats are accomplished through a dedicated workforce that is driven by creating a WeatherSMART nation, whose guiding principles are based on a Safe, More informed, Alert, Resilient and Timeous nation.

With this newsletter we aim to shine the light on some of the scientific work conducted by the organisation as well as its implications, influence and impact on the public and the scientific community at large.

Since the beginning of civilisation, humankind has used various forms of energy for different types of work. Renewable and non-renewable energies have become an integral part of our lives. SAWS has established several initiatives which will contribute towards sustainable development. These include collaborations with national and international organisations, solar energy research activities and the re-establishment of the new radiometric network of thirteen stations covering the length and breadth of the country which will measure global, direct and diffuse solar radiation along meteorological parameters.

The theme "From global warming to climate change" has been a topic of fierce debate in various scientific spheres. As early as 1869, global warming has been identified as posing a risk to global society. A closer look is provided into the reasons why the term global warming has changed to the more popular term climate change and its influence on lives, societal assets and infrastructure.

Mark Majodina
Acting General Manager:
Corporate Affairs

Since 2013 an international World Meteorological Organization (WMO) Task Team has been tasked with updating the existing cloud atlas which was last revised in 1975. This publication provides a preview of the new edition of the Cloud Atlas, which is set to be published in March 2017 coinciding with this year's World Meteorological Day (23 March 2017) theme 'Understanding Clouds'. The cloud atlas will include a web-based version with more imagery and a number of new cloud descriptions that have been added.

With the rise of previously unseen or scarce weather phenomena such as the tornado which hit the township of Tembisa, situated in the East Rand, Gauteng, it was imperative that SAWS brings the occurrences, ideal conditions and other topical issues related to tornados in South Africa to the forefront.

With an estimated death rate of around 1.5 million people in urban areas and 8.8 million people in rural areas each year, lightning has become a key topic in weather education and precautions. Lightning occurs with every thunderstorm and in South Africa lightning-producing storms are most prevalent over the eastern half of the country, especially the high-lying areas. With this in mind, SAWS is propelled further to create a WeatherSMART nation which will be well-equipped with knowledge and safety precautions during unfavourable weather conditions.

We also include a very relevant report about the cyclone which struck southern Africa in February 2017. While large scale events are always of interest to the meteorologists, their impact can be devastating. By ensuring that the community is aware and alert, much of the adverse effects of such severe weather can be mitigated.

I trust the readers will find the content riveting and valuable in enhancing their understanding and appreciation of weather and climate issues and their influence on lives, communities and the nation.

UNDERSTANDING CLOUDS

– by Colleen Rae, Qualification Manager: Meteorological Technicians, Regional Training Centre

Since 2013, an International World Meteorological Organization Task Team has been tasked to update the existing cloud atlas, which was last revised in 1975. In this new edition, which is planned for release in March 2017, the atlas is being updated to a web-based version with a lot more imagery as compared to the previous edition. In addition, there also are a number of new cloud descriptions that have been added.

Principles of cloud classification

Clouds continuously evolve and appear in an infinite variety of forms. However, a limited number of characteristic forms are frequently observed all over the world. These are broadly grouped in a classification scheme. The scheme uses genera, species and varieties. This is similar to the systems used in the classification of plants or animals, and similarly uses Latin names.

Genera

The classification of clouds has ten main groups, called genera and is **based on the height at which it develops**. Each observed cloud is a member of one, and only one, genus.

No new Cloud Genera have been added.

Speci

Most of the genera are subdivided into species, **based on the shape** of the clouds **or their internal structure**.

A cloud, identified as a specific genus, may bear the name of only one species. One new cloud Speci has been added to the existing 14 cloud species in the new International Cloud Atlas.

(a) Volutus

Varieties

Varieties are different arrangements of the visible elements of clouds and varying degrees of transparency.

A variety may be common to several genera, and a cloud may show characteristics of more than one variety and in this case, all the observed varieties are included in the name of the cloud. Nine Cloud Varieties exist. No new Cloud Varieties have been added.

Supplementary features Accessory clouds

A cloud may show supplementary features attached to it, or may be accompanied by accessory clouds, sometimes partly merged with its main body. They may occur at any level of the cloud, or above or below it.

One or more supplementary features or accessory clouds may be observed simultaneously with the same cloud.

Five supplementary features exist, while five new supplementary features have been added.

(a) Asperitas

(b) Fluctus

(c) Cavum

(d) Murus

(e) Cauda

Three Accessory clouds exist while one new Accessory cloud has been added.

(a) Flumen

Mother-clouds

Clouds may also form or grow from other clouds, called "mother-clouds". A part of a cloud may develop with pronounced extensions. These extensions, whether attached to the mother-cloud or not, may become clouds of a genus that is different from that of the mother-cloud. They are then given the name of the appropriate genus, followed by the name of the genus of the mother-cloud with the addition of the suffix "genitus".

OR – the whole or a large part of a cloud may undergo complete internal transformation, thus changing from one genus into another. The new cloud is given the name of the appropriate genus, followed by the name of the genus of the mother-cloud with the addition of the suffix "mutatus".

Two additional cloud classifications: Special Clouds and Upper Atmospheric Clouds tend to be rarely or occasionally observed and, in some cases, only in certain parts of the world.

Special clouds

In addition, there are special cases where clouds may develop as a consequence of certain, often localised factors - either natural, or as a result of human activity. Six new Special clouds have been added.

(a)"Flammagenitus": Clouds may develop as a consequence of convection initiated by heat from forest fires, wildfires or volcanic eruption activity.

The cloud is named by its genus, then, if appropriate, by the species, variety, any supplementary features, and finally by the special cloud name "flammagenitus". (Note: Cumulus flammagenitus is also known by the unofficial, common name "pyrocumulus").

(b)"Homogenitus": Clouds may develop as a consequence of human activity, such as aircraft condensation trails (contrails), or clouds resulting from industrial processes. The cloud is named by its genus, then, if appropriate, by the species, variety, any supplementary features, and finally by the special cloud name "homogenitus".

(c) **Aircraft condensation trails** (contrails) that have persisted for at least 10 minutes will be given the name of the genus, Cirrus, followed only by the special cloud name "homogenitus".

(d)**"Homomutatus"**: Persistent contrails may be observed (Cirrus homogenitus) over a period of time and under the influence of strong upper winds, to grow and spread out over a larger portion of sky, and undergo internal transformation. The cloud is named by its genus, then, if appropriate, by the species, variety, any supplementary features, and finally by the special cloud name "homomutatus".

(e)**"Cataractagenitus"**: Clouds may develop locally in the vicinity of large waterfalls as a consequence of water broken up into spray by the falls. The cloud is named by its genus, then, if appropriate, by the species, variety, any supplementary features, and finally by the special cloud name "cataractagenitus".

(f)**"Silvagenitus"**: Clouds may develop locally over forests as a result of increased humidity due to evaporation and evapotranspiration from the tree canopy. The cloud is named by its genus, then, if appropriate, by the species, variety, any supplementary features, and finally by the special cloud name "silvagenitus".

Cloud genera are generally encountered over a range of altitudes, varying from sea level to the level of the tropopause, which varies depending on where one is in the world:

- 18 kilometers in the Tropics
- 13 kilometers in Middle Latitudes
- 8 kilometers in Polar Regions

As the classification of clouds is based on the height at which the clouds develop, low level Stratus, Stratocumulus, Cumulus and Cumulonimbus cloud occur between the surface and 2km, middle level Altocumulus, Altostratus and Nimbostratus clouds between 2 and 6km, and high level Cirrus, Cirrocumulus and Cirrostratus clouds between 6 and 15km.

Low level cloud genera

Stratus

A grey cloud layer with a fairly uniform base, which may give drizzle or snow grains. When the sun is visible through the cloud, its outline is clearly seen. Stratus can sometimes appear in the form of ragged patches. It does not show halo phenomena.

Stratocumulus

A grey or whitish, or both grey and whitish, patch, sheet or layer of cloud which almost always has dark parts, an arrangement of shapes closely fitted together in a repeated pattern without gaps or overlapping, rounded masses, rolls, etc.

Cumulus

Detached clouds, generally thick with sharp outlines, developing vertically in the form of rising mounds, domes or towers, of which the bulging upper part often resembles a cauliflower. The sunlit parts of these clouds are mostly brilliant white; their base is relatively dark and nearly horizontal.

Cumulonimbus

A heavy, dense cloud, with extensive vertical extent, in the form of a huge tower. Its upper portion is usually smooth and nearly always flattened; often spreading out in the shape of an anvil or vast plume. Under the base of this cloud which is often very dark, with frequently low ragged clouds either merged with it or not.

Middle level cloud genera

Altocumulus

A white or grey, or both white and grey, patch, sheet or layer of cloud, generally with shading, composed of a layer or layers, rounded masses, rolls, etc.

Altostratus

A greyish or bluish cloud sheet or layer of cloud, with grooves or channels arranged parallel to the flow of the air, or uniform appearance, totally or partly covering the sky, and having parts thin enough to reveal the sun. It does not show halo phenomena.

Nimbostratus

A grey cloud layer, often dark, which is made less discernable by falling rain or snow. It is thick enough throughout to blot out the sun. Low, ragged clouds frequently occur below the layer, with which they may or may not merge.

High level cloud genera

Cirrus

Detached clouds in the form of white, delicate filaments or white or mostly white patches or narrow bands. These clouds have a hair-like appearance, or a silky sheen, or both.

Cirrocumulus

A thin, white patch, sheet or layer of cloud without shading, composed of very small elements in the form of grains, ripples, etc.

Cirrostratus

A transparent, whitish cloud veil of hair-like or smooth appearance, totally or partly covering the sky, and generally producing halo phenomena.

SPECIES

Observed peculiarities in the shape of clouds and differences in their internal structure have led to the subdivision of most of the cloud genera into species. A cloud observed in the sky, belonging to a certain genus, may bear the name of one species only; this means that the species are mutually exclusive. On the other hand, certain species may be common to several genera. The fact that several species may be distinguished in a given genus, does not imply that a specific cloud must necessarily receive the name of one of those species. When, for a cloud of a given genus, none of the definitions of the species relevant to the genus is applicable, no species is indicated.

Fibratus
Detached clouds or a thin cloud veil, consisting of nearly straight or more or less irregularly curved filaments which do not terminate in hooks or tufts.
This term applies mainly to Cirrus and Cirrostratus.

Uncinus
Cirrus often shaped like a comma, starting with a hook at the upper end of the filament, or in a tuft, the upper part of which is not in the form of a rounded protuberance.

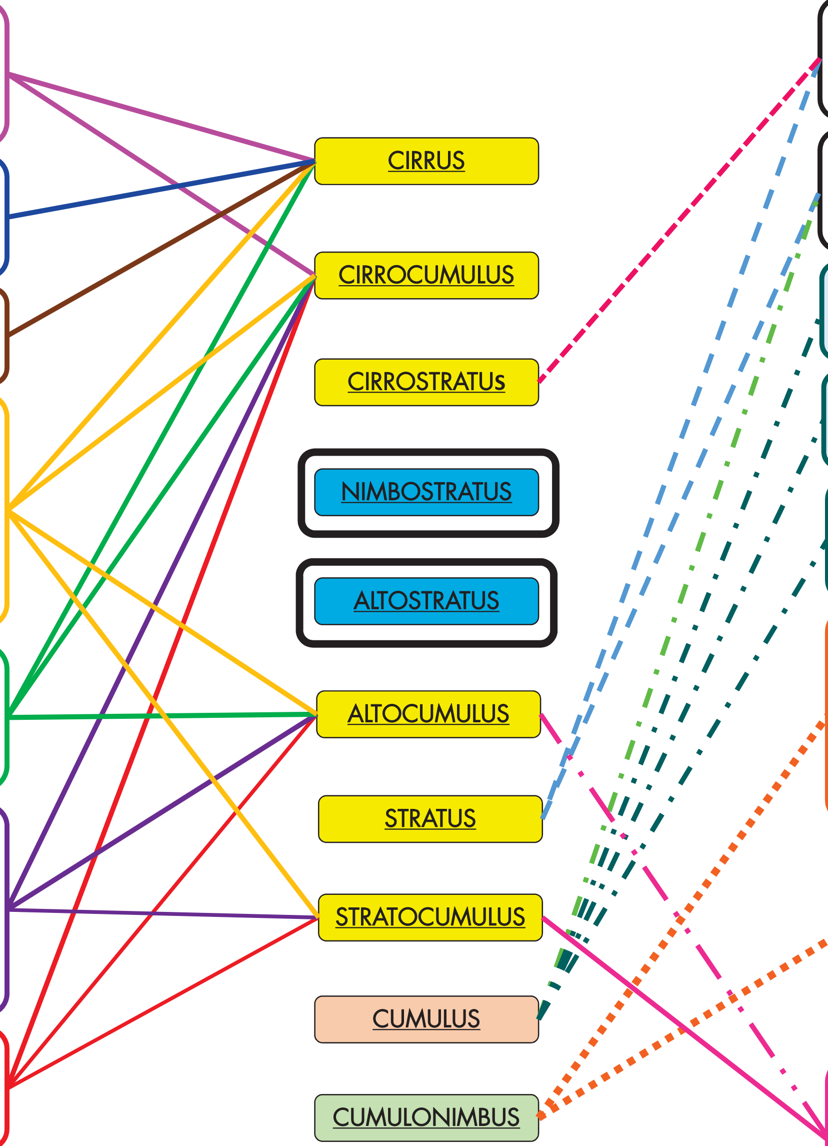
Spissatus
Cirrus of sufficient optical thickness to appear greyish when viewed towards the sun.

Castellanus
Clouds which present, in at least some portion of their upper part, cumuliform protuberances in the form of turrets or towers . some of which are taller than they are wide, and are connected by a common base and seem to be arranged in lines. The castellanus character is especially evident when the clouds are seen from the side.
This term applies to Cirrus, Cirrocumulus, Altocumulus and Stratocumulus.

Floccus
A species in which each cloud unit is a small tuft with a cumuliform appearance, the lower part of which is more or less ragged and often accompanied by virga.
This term applies to Cirrus, Cirrocumulus and Altocumulus.

Lenticularis
Clouds having the shape of lenses or almonds, often very elongated and usually with well defined outlines; they occasionally show irisation. Such clouds appear most often in cloud formations of orographic origin, but may also occur in regions without marked orography.
This term applies mainly to Cirrocumulus, Altocumulus and Stratocumulus.

Stratiformis
Clouds spread out in an extensive horizontal sheet or layer.
This term applies to Altocumulus, Stratocumulus and, occasionally, to Cirrocumulus.



Nebulosus
A cloud like a nebulous or ill-defined veil or layer of clouds showing no distinct details. This term applies mainly to Cirrostratus and Stratus.

Fractus
Clouds in the form of irregular shreds, which have a clearly ragged appearance. This term applies only to Stratus and Cumulus.

Humilis
Cumulus clouds of only a slight vertical extent; they generally appear flattened.

Mediocris
Cumulus clouds of moderate vertical extent, the tops of which show fairly small protuberances.

Congestus
Cumulus clouds which are markedly sprouting and are often of great vertical extent; their bulging upper part frequently resembles a cauliflower.

Calvus
Cumulonimbus in which at least some protuberances of the upper part are beginning to lose their cumuliform outlines but in which no cirriform parts can be distinguished.
Protuberances and sproutings tend to form a whitish mass, with more or less vertical striations (Grooves or channels in cloud formations, arranged parallel to the flow of air and therefore depicting the airflow).

Capillatus
Cumulonimbus characterized by the presence, mostly in its upper portion, of distinct cirriform parts of clearly fibrous or striated structure, frequently having the form of an anvil, a plume or a vast, more or less disorderly mass of hair.
Cumulonimbus capillatus is usually accompanied by a shower or by a thunderstorm, often with squalls and sometimes with hail; it frequently produces very well-defined virga.

Volutus
A long, typically low, horizontal, detached, tube-shaped cloud mass, often appearing to roll slowly about a horizontal axis. The roll cloud, volutus, is a soliton, not attached to other clouds and is an example of an undular bore. This species applies mostly to Stratocumulus and rarely Altocumulus

VARIETIES

Various arrangements of the macroscopic elements and the greater or lesser degree of transparency have led to the introduction of the concept of varieties. A given cloud may bear the names of different varieties, which means that varieties are not mutually exclusive. An exception to this are the varieties translucidus and opacus both of which are mutually exclusive.
On the other hand, certain varieties may be present in several genera. The fact that a number of varieties has been established does not imply that a specific cloud must necessarily receive the name of one or more of those varieties.

Intortus

Cirrus, the filaments of which are very irregularly curved and often seemingly entangled in an erratic and unpredictable manner.

Vertebratus

Clouds, the elements of which are arranged in a manner suggestive of vertebrae, ribs, or a fish skeleton.
This term applies mainly to Cirrus.

Undulatus

Clouds in patches, sheets or layers, showing undulations. These undulations may be observed in fairly uniform cloud layers or in clouds composed of elements, separate or merged. Sometimes a double system of undulations is in evidence. This term applies mainly to Cirrocumulus, Cirrostratus, Altocumulus, Altostratus, Stratocumulus and Stratus.

Radiatus

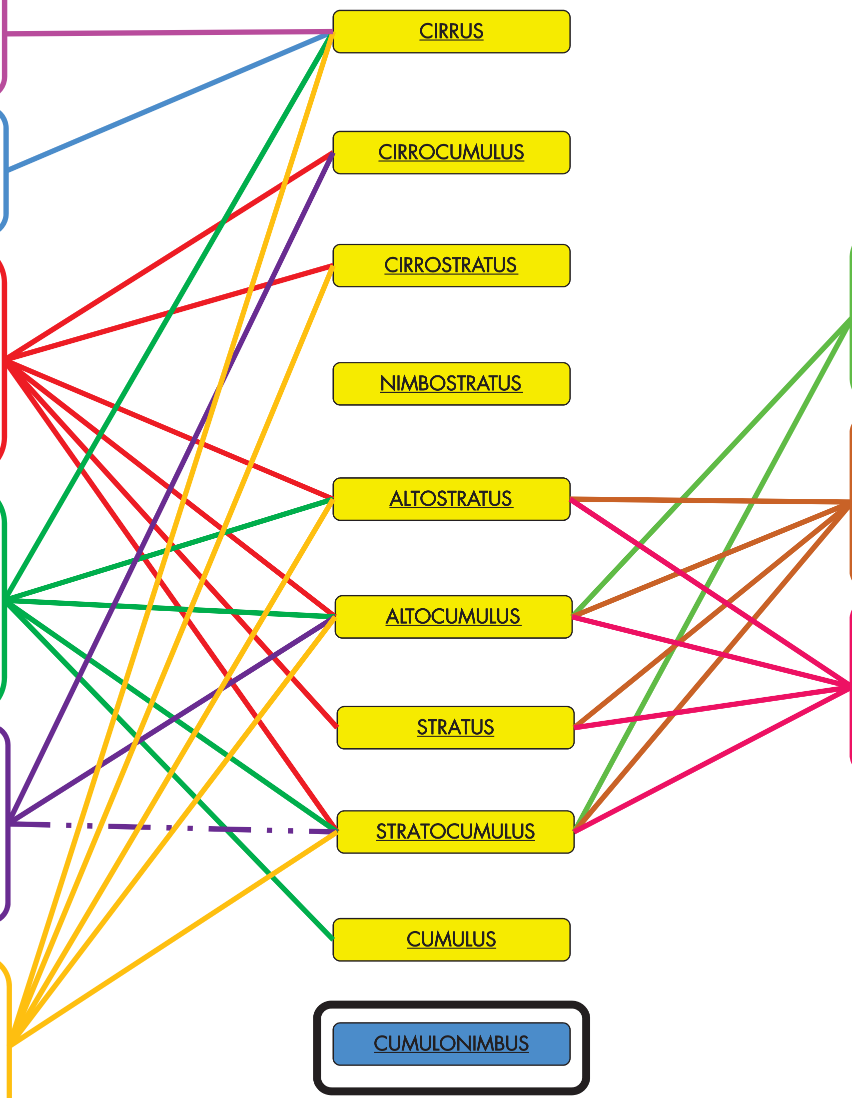
Clouds showing broad parallel bands or arranged in parallel bands, which, owing to the effect of perspective, seem to converge towards a point on the horizon or, when the bands cross the whole sky, towards two opposite points on the horizon, called "radiation point(s)".
This term applies mainly to Cirrus, Altocumulus, Altostratus, Stratocumulus and Cumulus.

Lacunosus

Cloud patches, sheets or layers, usually rather thin, marked by more or less regularly distributed round holes, many of them with fringed edges. Cloud elements and clear spaces are often arranged in a manner suggesting a net or a honeycomb.
This term applies mainly to Cirrocumulus and Altocumulus; it may also apply, though very rarely, to Stratocumulus.

Duplicatus

Superposed cloud patches, sheets or layers, at slightly different levels in two or more layers, sometimes partly merged.
This term applies mainly to Cirrus, Cirrostratus, Altocumulus, Altostratus and Stratocumulus.



Perlucidus

An extensive cloud patch, sheet or layer, with distinct but sometimes very small spaces be tween the elements. The spaces allow the sun, the moon, the blue of the sky or overlying clouds to be seen.
This term applies to Altocumulus and Stratocumulus.

Translucidus

Clouds in an extensive patch, sheet or layer, the greater part of which is sufficiently translucent to reveal the position of the sun or moon.
This term applies to Altocumulus, Altostratus, Stratocumulus and Stratus.

Opacus

An extensive cloud patch, sheet or layer, the greater part of which is sufficiently opaque to mask completely the sun or moon.
This term applies to Altocumulus, Altostratus, Stratocumulus and Stratus.

SUPPLEMENTARY FEATURES AND ACCESSORY CLOUDS

Clouds sometimes have supplementary features attached to them or may be accompanied by other usually smaller clouds, known as accessory clouds which are separate from their main body or partly merged with it. A given cloud may present simultaneously one or more supplementary features or accessory clouds, which means that supplementary features and accessory clouds are not mutually exclusive.

SUPPLEMENTARY FEATURES

Mamma
Hanging protuberances, like udders, on the under surface of a cloud.
Occurs mostly with Cirrus, Cirrocumulus, Altocumulus, Altostratus, Stratocumulus and Cumulonimbus.

Virga
Vertical or inclined trails of precipitation (fallstreaks) attached to the under surface of a cloud, which do not reach the Earth's surface.
Occurs mostly with Cirrocumulus, Altocumulus, Altostratus, Nimbostratus, Stratocumulus, Cumulus and Cumulonimbus.

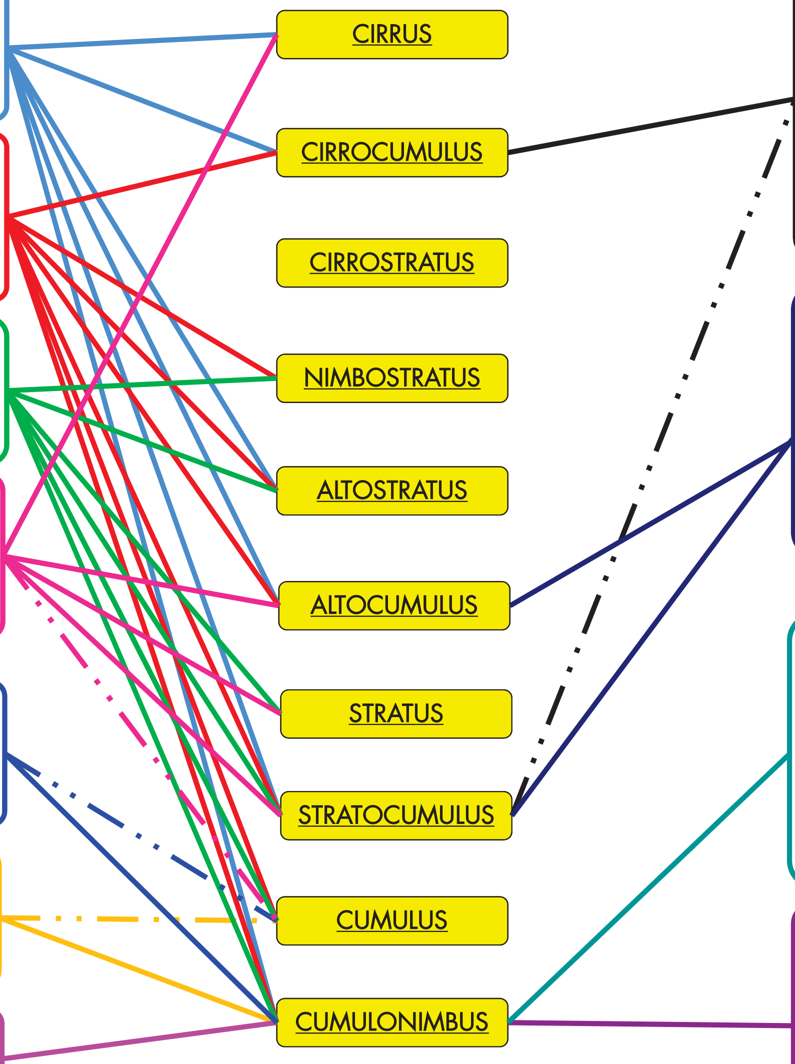
Praecipitatio
Precipitation (rain, drizzle, snow, ice pellets, hail, etc.) falling from a cloud and reaching the Earth's surface.
Mostly encountered with Altostratus, Nimbostratus, Stratocumulus, Stratus, Cumulus and Cumulonimbus.

Fluctus
A relatively short-lived wave formation, usually on the top surface of the cloud, in the form of curls or breaking waves (Kelvin Helmholtz waves). Occurs mostly with Cirrus, Altocumulus, Stratocumulus, Stratus and occasionally Cumulus.

Arcus
A dense, horizontal roll with more or less tattered edges, situated on the lower front part of certain clouds and having, when extensive, the appearance of a dark, menacing arch. Occurs with Cumulonimbus and, less often, with Cumulus.

Tuba
Cloud column or inverted cloud cone, protruding from a cloud base; it constitutes the cloudy manifestation of a more or less intense vortex.
Occurs with Cumulonimbus and, less often, with Cumulus.

Incus
The upper portion of a Cumulonimbus spread out in the shape of an anvil with a smooth, fibrous or striated appearance.



Cavum
A well-defined generally circular (sometimes linear) hole in a thin layer of supercooled water droplet cloud. Virga or wisps of Cirrus typically fall from the central part of the hole, which generally grows larger with time. Cavum is typically a circular feature when viewed rom directly beneath, but may appear oval shaped when viewed from a distance. When resulting directly from the interaction of an aircraft with the cloud, it is generally linear (in the form of a dissipation trail). Virga typically falls from the progressively widening dissipation trail. Occurs in Altocumulus and Cirrocumulus, and rarely in Stratocumulus.

Asperitas
Well-defined, wave-like structures in the underside of the cloud; more chaotic and with less horizontal organization than the variety undulatus. Asperitas is characterized by localized waves in the cloud base, either smooth or dappled with smaller features, sometimes descending into sharp points, as if viewing a roughened sea surface from below. Varying levels of illumination and thickness of the cloud can lead to dramatic visual effects. Occurs mostly with Stratocumulus and Altocumulus.

Cauda
A horizontal, tail-shaped cloud (not a funnel) at low levels extending from the main precipitation region of a supercell Cumulonimbus to the murus (wall cloud). It is typically attached to the wall cloud, and the bases of both are typically at the same height. Cloud motion is away from the precipitation area and towards the murus, with rapid upward motion often observed near the junction of the tail and wall clouds. Commonly known as a „tail cloud‰.

Murus
A localized, persistent and often abrupt lowering of cloud from the base of a Cumulonimbus from which tuba (spouts) sometimes form. Usually associated with a supercell or severe multicell storm; typically develop in the rain-free portion of a Cumulonimbus and indicate an area of strong updraft. Murus showing significant rotation and vertical motion may result in the formation of tuba (spouts). Commonly known as a „wall cloud‰.

SUPPLEMENTARY FEATURES AND ACCESSORY CLOUDS

Clouds sometimes have supplementary features attached to them or may be accompanied by other usually smaller clouds, known as accessory clouds which are separate from their main body or partly merged with it. A given cloud may present simultaneously one or more supplementary features or accessory clouds, which means that supplementary features and accessory clouds are not mutually exclusive.

ACCESSORY CLOUDS

CIRRUS

CIRROCUMULUS

CIRROSTRATUS

NIMBOSTRATUS

ALTOSTRATUS

ALTOCUMULUS

STRATUS

STRATOCUMULUS

CUMULUS

CUMULONIMBUS

Flumen

Bands of low clouds associated with a supercell severe convective storm (Cumulonimbus), arranged parallel to the low-level winds and moving into or towards the supercell. These accessory clouds form on an inflow band into a supercell storm along the pseudo-warm front. The cloud elements move towards the updraft into the supercell, the base being at about the same height as the updraft base. Note that flumen are not attached to the murus wall cloud, and the cloud base is higher than the wall cloud. One particular type of inflow band cloud is the so-called „BeaverÊs tail‰. This is distin guished by a relatively broad, flat appearance suggestive of a beaverÊs tail.

Pannus

Ragged shreds sometimes constituting a continuous layer, situated below another cloud and sometimes attached to it. This accessory cloud occurs mostly with Altostratus, Nimbostratus, Cumulus and Cumulonimbus.

Pileus

An accessory cloud of small horizontal extent, in the form of a cap or hood above the top or attached to the upper part of a cumuliform cloud which often penetrates it. Several pileus may fairly often be observed in superposition. Occurs principally with Cumulus and Cumulonimbus.

Velum

An accessory cloud veil of great horizontal extent, close above or attached to the upper part of one or several cumuliform clouds which often pierce it. Velum occurs principally with Cumulus and Cumulonimbus.

Understanding clouds this World Meteorological Day 2017

– by Musiiwa Denga, Communications Officer

On 23 March, the global meteorological community celebrates World Meteorological Day, which began in 1951 to mark the establishment of a United Nations (UN) body specialising exclusively in meteorology. As a member of the World Meteorological Organization (WMO), the South African Weather Service (SAWS) has taken pride in these celebrations by ensuring that the importance of meteorology and the role that it plays in our lives is recognised.

Understanding Clouds is the theme of World Meteorological Day 2017. This theme highlights the enormous importance of clouds for weather, climate and water. Clouds are central to weather observations and forecasts. Clouds are one of the key uncertainties in the study of climate change: we need to better understand how clouds affect the climate and how a changing climate will affect clouds. Clouds play a critical role in the water cycle and shaping of global distribution of water resources.

World Meteorological Day marks the launch of a new edition of the International Cloud Atlas, after the most thorough and far-reaching revision in its long and distinguished history. The new WMO Atlas is a treasure trove of hundreds of images of clouds, including a few newly classified cloud types. It also features other meteorological phenomena such as rainbows, halos, snow devils and hailstones.

For the first time ever, the Atlas has been produced in a digital format and is accessible via both computers and mobile devices.

The International Cloud Atlas is the single authoritative and most comprehensive reference for identifying clouds. It is an essential training tool for professionals in the meteorological community and those working in aviation and shipping. Its reputation is legendary among cloud enthusiasts.

The International Cloud Atlas has its roots in the late 19th century. It was revised on several occasions in the 20th century, most recently in 1987, as a hard copy book, before the advent of the Internet.

Advances in science, technology and photography prompted WMO to undertake the ambitious and exhaustive task of revising and updating the Atlas with images contributed by meteorologists, cloud watchers and photographers from around the world.

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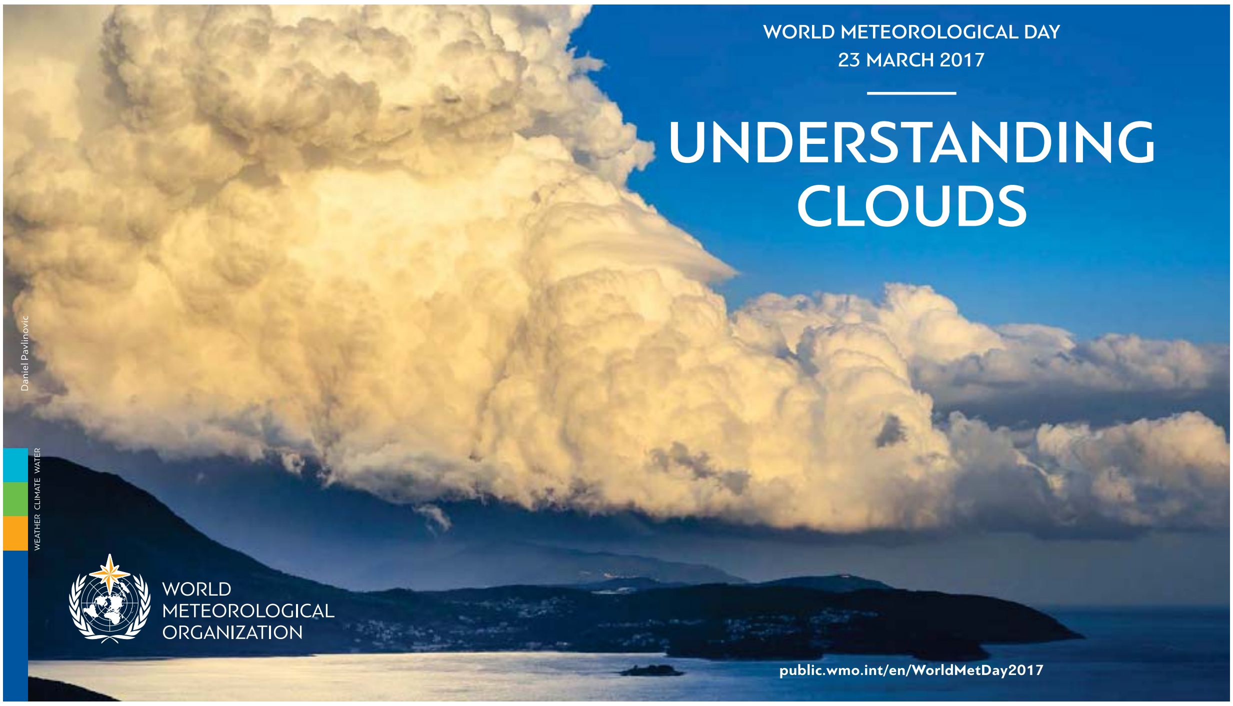
https://public.wmo.int/en/WorldMetDay2017



PRODUCT NEWS

SOUTH AFRICAN WEATHER SERVICE COMMUNITY RAINFALL STATION

South African Weather Service
ISO 9001 Certified Organisation

OVERVIEW

The Community Rainfall Station (CRS) is an affordable rainfall monitoring system that can be deployed easily in smaller communities.

The CRS is an ideal solution for automated real-time rainfall monitoring in communities to support communication activities of local disaster management centers during potential flooding situation.

BENEFITS

- Real time monitoring during persisting and heavy rainfall events.
- Real time communication to both disaster management officers and community leaders
- Prevention of disasters linked to extreme rainfall events

Typical Usage

Local Disaster Management
- Send Warning to local residence

Community Leader
- Alert Local Disaster Management
- Alert surrounding members

Weather Forecaster
- Confirm Storm
- Alert Community Leader and Local Disaster Management

SMS Configuration

- Rainfall thresholds
- Add/Delete Cellphone
- General Settings

Features

- Real-time rain measurements using a tipping bucket
- 3 rainfall levels threshold can be set for potential flood disaster.
- Compact
- 10W solar panel
- Backup battery
- Up to 5 days standby
- 24hr rain data for historical comparison

For more information contact: South African Weather Service Commercial Department
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TORNADOES IN SOUTH AFRICA

– Interview with Prof Hannes Rautenbach, Chief Scientist

1) Are there in fact more tornadoes that recently appeared in South Africa, or is it just that we are more informed about their appearance because of social media?

There is the perception that tornado appearance is not that common in South Africa, but in reality, although still rare, the development of tornadoes is not exceptional. It is, however, still dificult to quantify the annual occurance of tornadoes since tornadoes are mostly not being recorded by weather instrumentation, but are rather reported through human observation. That means that we will simply not know about tornadoes that have not been observed or that occurred in sparsly populated areas. Advanced social media, and especially the fact that most of us now have continuous access to at least camera and video recording facilities, contribute considerably to awareness and the visual observation of tornadoes. However, there is not yet any evidence that tornadoes are increasing in frequency.

2) Does South Africa have ideal weather conditions for tornadoes?

Tornadoes in South Africa are usually not as intense as those that form in the United States, but can develop at any location where thunderstorms develop. The likelihood of tornado development is higher during summer months in the eastern summer rainfall parts of South Africa. Tornado development is mostly confined to the mid-summer months (November to January), although they might also occur during autumn (February to May) and spring (September to October). Most tornadoes are being observed in the late afternoon (16:00 to 19:00), which falls within the time frame of maximum diurnal atmospheric heating feedback that manifests in the form of atmospheric instability and late afternoon thunderstorm development. Most tornadoes are being observed in the Gauteng, Free State, KwaZulu-Natal and Eastern Cape Provinces.

3) What conditions gave rise to the many tornadoes observed since July 2016?

South Africa recently came out of the dry 2015-16 summer season that was characterised by extreme (often the highest on record) temperatures. Whether these extreme temperatures were driven by an exceptionally strong El Niño episode, in conjunction with the global warming signal, is still an open question, but also a reality that can not be ignored. With the outlook of good (above-normal) rain during the 2016-17 summer season, and with large quantities of heat that are stored in the Earth's upper surface layers and that are being emitted to the atmosphere, conditions for deep convective cloud development are becomming more favourable. These conditions could easily result in the development of strong local thunderstorms, and under the right conditions, to the development of tornadoes.

Future projections indicate that global warming might lead to an increase in the frequency of more extreme weather conditions, and while South Africa is heating up, more intense thunderstorms might be expected. Such conditions might result in an increase in the frequency of tornado events.

4) What is a tornado, and how are tornadoes classified?

Tornadoes in South Africa can develop as a result of two types of weather conditions:

Firstly, tornadoes often form in cloud sytems known as super cells. A super cell forms when there is a substantial vertical change in wind speed and direction (also known as vertical wind shear). A supercell can be seen as a major or impressive rotating cloud system, associated with strong convection. Ideal conditions for vertical wind shear is when near-surface cold air advetion from the south (usually as a result of a eastward ridging high pressure system along the southern coastline) coincides with warmer high altitude air flow from the tropics in the form of an upper-air trough.

Secondly, tornadoes can also develop in areas where two airmasses with different thermal properties meet. For example, when cold air masses from the south intersect with warmer air masses from the north.

In such conditions vorticities (air with rotational properties) might develop, which in turn could give rise to tornado-like vortex develpment.

Tornadoes can be classified into five categories, namely:

F0: Wind speed = 105 – 137 km per hour / Light damage

F1: Wind speed = 138 – 177 km per hour / Moderate damage

F2: Wind speed = 178 – 217 km per hour / Considerable damage

F3: Wind speed = 218 – 266 km per hour / Severe damage

F4: Wind speed = 267 – 322 km per hour / Devastating damage

F5: Wind speed = > 322 km per hour / Violent damage

Approximately 65% of tornadoes in South Africa are classified as F0 to F1 tornadoes (light to moderate damage), while 90% of tornadoes are clasified as F1 to F2 tornadoes (considerable and lower damage).

5) Must we be alert for the possibility of more tornadoes in 2017?

As in the past, tornadoes will still occur in the future. With our growing population and infrastructure developments, more demographic and industrial space is being occupied, which makes us more vulnerable to the damage that is caused by tornadoes.

6) What must we do when we are in the vicinity of an approaching tornado, or even in such a tornado?

One of the most important precautions to take when a tornado is approaching is to be in a position as close as possible to the ground, or even to get yourself below ground level. If in an open space, lie down with your hands covering your head. It is also important to stay away from glass or windows or any loose objects in order to avoid being injured by flying material. The best room to take cover in is the bathroom, especially if you could lie in the bath tub while covering yourself with a blanket. Remember that most injuries during tornadoes are caused by flying objects. Rather use a vehicle to get away from a tornado instead of using it as shelter.

LIGHTNING IN SOUTH AFRICA

LIGHTNING IN SOUTH AFRICA

– Morné Gijben, Research Scientist

Lightning is a flow of energy through the air. Positive and negatively charged particles gather together on the bottom and the top of a cloud. When the forces of attraction between them become too strong, energy is released. This energy is seen as a great flash of light across the sky.

Lightning occurs with every thunderstorm and must be expected as soon as thunderstorms form. It results from the build-up and discharge of electrical energy between positively and negatively charged areas in the atmosphere and clouds. The most lightning occurs between clouds but it is the ground strikes that are dangerous. A person's chances of being struck by lightning are estimated to be 1 in 350,000 but this risk could be significantly reduced if lightning safety rules are followed.

In South Africa, lightning-producing storms are most prevalent over the eastern half of the country, especially the high-lying areas. This is illustrated in figures 1 and 2 below.

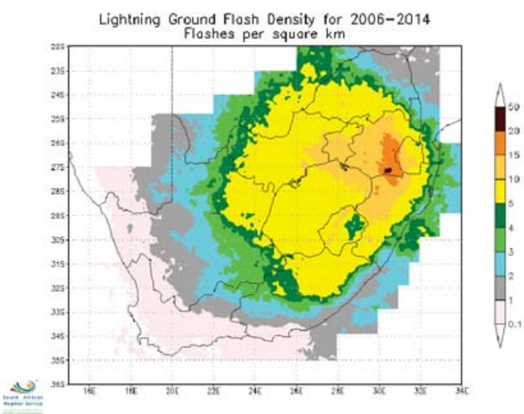


Figure 1. Lightning Ground Flash Density for 2006-2014

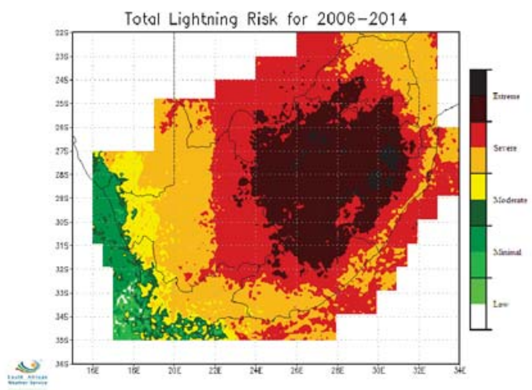


Figure 2. Total Lightning Risk for 2006-2014

The highest flash densities of more than 15/km^2 are found along the windward slope of the Northern Drakensberg Mountains, extending from the northernmost parts of KwaZulu-Natal into the Mpumalanga Lowveld. Flash densities of between 10/km^2 and 15/km^2 are seen from the western to north-western parts of KwaZulu-Natal, extending into the Mpumalanga Lowveld, the southern parts of Gauteng as well as the northern and north-eastern Free State. Small areas over the western parts of the North-West Province and Lesotho also have flash densities of between 10/km^2 and 15/km^2. Most of the central interior of the country receives between 5 and 10 flashes/km^2, from where it decreases towards the west of the country. Flash densities also decrease towards the northern to northeastern parts of the country, as well as towards the coast.

People are at risk from lightning over the entire country, however, areas over the central interior are at a higher risk than areas over the Western Cape for example.

People living in rural areas are often affected more by lightning than those in urban areas due to the fact that they spend most of their time outdoors and have insufficient shelter to protect them from lightning. Informal settlements are particularly vulnerable to lightning, since the houses and structures provide little protection against lightning. Lightning victims in urban areas are often outdoors at the time of the lightning strikes, without an opportunity to seek shelter in a fully enclosed building.

It is also estimated that annually, between 500 and 700 people will survive a lightning strike in South Africa. Survivors of lightning strikes tend to have neurological complications. Some survivors might be unable to walk or talk, develop deafness or even develop cataracts in their eyes.

Unfortunately there are no countrywide statistics on lightning deaths, but it is estimated that the death rate due to lightning in South Africa varies between 1.5 and 8.8 per million of the population each year (1.5 for urban areas and 8.8 for rural areas). Based on information from newspapers, online newspapers and websites, and data reported by some mortuaries, between 80 and 100 people lose their lives annually in South Africa due to lightning. This number is likely an underestimate since lightning deaths might not be reported by the media, some mortuaries might not report the data, and some deaths (especially in rural areas) may not get investigated where a person is buried without an autopsy to establish that lightning was the culprit.

Lightning deaths are tragic, but can be prevented. Unfortunately, informal settlements, whether in urban or rural areas, remain a huge challenge. A significant effort is required to improve physical lightning protection in South Africa through an engineering approach. Priorities in this regard should be aimed at community facilities, schools and looking at effective ways of retrofitting cost effective lightning protection to rural dwellings.

LIGHTNING PRECAUTIONS

In order to ensure that people do not become victims of lightning strikes, education on lightning safety guidelines are very important. The following guidelines should be followed when a thunderstorm moves over an area:

DO NOT shelter close to the trunk of a tree, or any isolated pole, as these attract lightning. On the other hand, they will protect you if you sit down at a distance away from them or not more than about half their height. This is what is known as being safe within the so-called 45-degree cone of protection of the pole or tree.

DO NOT ride horses, motorcycles, tractors, or bicycles, or even walk, when a thunderstorm is approaching, unless you can reach a place of safety within minutes. If not, rather dismount and sit down keeping a low profile until the storm is over. You are also in danger sitting on wagons or carts that have no metal protection for you on them.

DO NOT touch metal fences or gates for more than the time you need to pass through them. On the other hand, you will be protected sitting directly underneath the overhead wires of an electric power line.

DO NOT swim when lightning threatens, and if you are in an open boat without its own lightning protection, make for dry land if this is possible within minutes, otherwise, sit or lie down in your boat until the storm is over.

DO NOT carry golf clubs, garden implements or firearms at shoulder height, or hoist an umbrella, while seeking shelter from an approaching thunderstorm.

DO NOT believe that some persons (Sangomas) can make lightning hit where they want it. When a down coming lightning leader approaches the ground, it causes electric streamers to start flowing upwards from protruding objects like trees, poles or bushes, or even stone boulders including people, and if one of these streamers reaches the lightning leader, before it reaches the ground, it will deviate and strike that particular object.

DO find a safe place immediately if lightning and thunder comes near. If you count less than 10 seconds between seeing a lightning flash and hearing the thunder, it is already very dangerous to remain exposed to it outside. You are safe inside a motorcar, or a house or building, but not in huts, tents or shelters, unless they are provided with metal protection recommended in published codes for protection against lightning.

DO make sure that your houses or huts with thatched or non-metallic roofs are properly protected from lightning according to the lightning protection codes of practice published by the South African Bureau of Standards or other national bodies. Lightning has killed many people in them either directly or by setting them on fire.

DO call for medical help immediately, if any of your companions are struck by lightning and are unconscious, and then try to revive them by all means possible. You should learn how to do this if you ever intend to go camping in the thunderstorm season, as you could thus save lives.

GUIDELINES

- It is advised that all building structures (especially thatch structures) have a lightning conductor near to but not touching the building.
- The use of corded phones is not advised, however cellphones, Ipods and cordless phones are safe to use.
- Taking a bath is considered marginally safer than taking a shower during a thunderstorm.
- Unsafe areas during an electric storm are:
  - Tall structures such as lone trees, telephone and power lines
  - Hilltops
  - Isolated sheds
  - Open water
  - Unprotected gazebos or picnic shelters

For more information please visit the following website: http://www.lightningsa.org.za/

INITIATIVES OF THE SOUTH AFRICAN WEATHER SERVICE TOWARDS THE SUSTAINABLE DEVELOPMENT

– By Dr Jyotsna Singh, Senior Scientist, Renewable Energy Research and Application

Since the birth of human civilisation, we are using different forms of energy for various types of work. Energy is an integral part of our life. In our daily activities, we can't imagine our life without energy. Energy resources are mainly of two types - renewable and non-renewable resources of energy. Non-renewable resources of energy are fossil fuels (coal, petroleum and natural gas). For many decades non-renewable resource of energy is the primary source for energy-related activities. Non-renewables became important for the industrial revolution and our development. However, we know there are always pros and cons associated with anything, and non-renewables are not an exception to it. The burning of fossil fuels not only generates a large amount of energy but it is also responsible for the emission of harmful gases and particulate matter. These emissions are causing problems in our environment and affect human health.

The primary objectives of development are to satisfy human needs and aspirations. Energy is a significant factor for the economic development of any country. We have to use available energy resources in such a way that it should meet the needs of the present without compromising future generations' needs. It is our moral obligations to think about other living beings and future generations'. This type of development is known as sustainable development. The non-renewables are depleting at a faster rate and developing sustainably would not be possible without using renewables. Extensive research in the field of renewable energy would open new ways to use the available renewable energy resources in an effective way. In some parts of the world, renewable energy resources have become the primary source of energy supply. The demand for renewable energy is growing very fast that has led to the demand for research in the field of renewables.

The South African Weather Service (SAWS) is a national meteorological organisation where scientists are working towards excellence in providing to give the accurate weather forecasts. In this organisation, we are taking initiatives to tackle the challenges of society related to weather. We are involved in using valuable weather data to do high-quality research in the area of renewable energy. Scientists can play a significant role in the sustainable development of South Africa by doing good research in the field of renewable energy. Research and development in the field of renewable energy in collaboration with the national and international organisations will help us identify the problems in this area and find the possible solutions to those problems. We have collaborated with the UK Meteorological Office (UKMO) and European Commission's Joint Research Centre (EC-JRC) to develop products and services in the field of renewable energy. The collaboration is bringing new technologies, skills and most importantly, presenting SAWS as a brand name in renewable energy research in South Africa. We are planning some important solar energy research activities which would be carried out in partnership with French institution, Laboratory of Energy, Electronic and Process (LE2P), and the University of the Reunion Island.

In collaboration with the UKMO, we are planning to use the technology that will enable the forecasting of solar and wind energy parameters of any site. SAWS operationally runs the Unified Model (UM) Numerical Weather Prediction (NWP) model over limited area domains of southern Africa at 4 km and South Africa at 1.5 km horizontal resolutions respectively. Both domains are initialised four times a day with three different lead times. The 4 km Southern Africa forecasts initialised at 0000 UTC, and 1200 UTC have a lead time of 72-hours and for 0600 UTC and 1800UTC a 48-hour lead time. The South African domain at 1.5 km has a lead time of 36-hours for all four initialisations. The vertical resolution of the limited domains is 70 levels (to ~40 km above the surface), with 17 levels within the first 1 km of the atmosphere. The forecast of solar radiation from NWP would be helpful in different sectors like tourism, transportation and constructions. In collaboration with UKMO, we are in the process of using the Site Specific Processing System (SSPS). It is a system which reads the NWP gridded forecast. Then SSPS performs either horizontal interpolation or a selection of nearest grid-point data. SSPS uses different correction algorithm (orographic, coastal, land use and convective diagnosis procedures) to produce site specific forecasts. This system can be used to forecast weather parameters for any place using the gridded NWP forecast. The present system could be effectively utilised for the forecasting the incoming solar radiation. In this system recently we have installed a solar power module which will also forecast the solar photovoltaic (PV) power output. We only need to feed PV panels information in SSPS like-azimuth panel, the tilt of panel, nominal operating cell temperature, temperature coefficient of the PV module and albedo of the panel.

This module would be useful for power generator companies like Eskom and Independent Power Producers (IPPs). Eskom is responsible for over 90% South Africa's electricity, and the rest is being generated by municipalities and IPPs. Globally there is a demand for integration of renewable energy to the power grids. Solar power plants are dependent on variable (daily, seasonal and annual) solar radiation over the Earth's surface. SSPS would be helpful in power plant operations (photovoltaic plants) and balancing the power supply network.

SAWS has reestablished the new radiometric network of thirteen stations since 2013, covering the length and breadth of the country, where we measure global, direct and diffuse solar radiation along with the meteorological parameters. We also calibrate our radiometric instruments at the proper interval to ensure the quality of data. These radiometric instruments are expensive, so it limits us to make radiometric network very dense. However, we have a dense network of sunshine duration stations in South Africa with a long history. The instrument for measuring the sunshine duration is simple and less expensive. It is the reason for better spatial coverage of sunshine duration stations over South Africa. Data of sunshine duration can be used in many research areas like environmental pollution and energy. We are currently analysing the long-term trend of sunshine duration. It would help us to understand the behaviour of sunshine duration in the past decades. Currently, we are focusing on another venture-solar resource assessment, which is the analysis of solar energy potential of any site for any solar energy applications. It will help the small and big investors to select their site for the solar power projects.

At SAWS we keep ourselves abreast with the latest technologies. In recent decades, remote sensing and Geographic Information Systems have advanced rapidly. We use geo-spatial techniques to analyse in situ and satellite data. We are also looking forward to using meteorological data in the development of products and services for wind, hydro-and bioenergy.

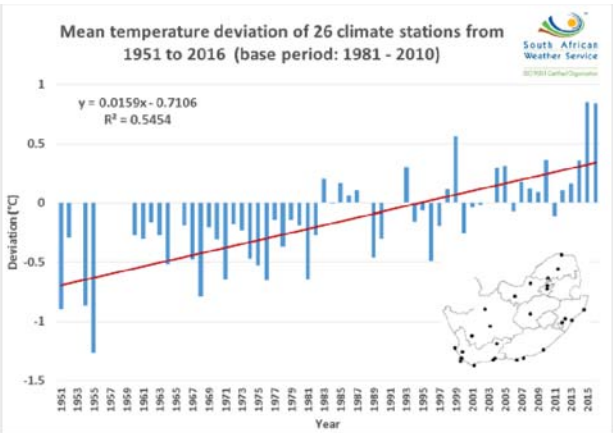
As a national meteorological organisation, we are watching the weather for the safety and well-being of the South African society. We understand our responsibility towards sustainable development. We want to work hand in hand with the national and international organisations to achieve this goal and make this world sustainably viable for our present and future generations.

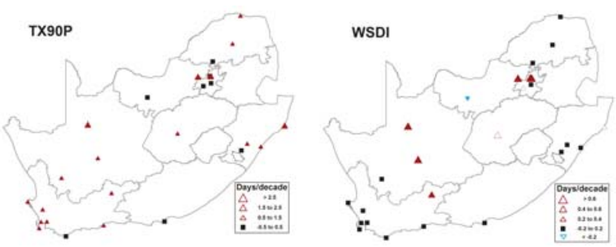
FROM GLOBAL WARMING TO CLIMATE CHANGE

– Hannes Rautenbach, Andries Kruger, Mthobisi Nxumalo, Thabo Makgoale & Nosipho Zwane

As early as 1896, global warming has been identified by the Swedish scientist Svante Arrhenius as posing a risk to global society. It was then suggested that increased concentrations of Greenhouse gases in the atmosphere, like carbon dioxide (CO_2) and water vapour, could result in more heat being retained in the lower atmosphere of the earth, meaning that the rate of outgoing radiation to space could gradually decrease. Note that near-surface atmospheric heat comes from outgoing surface radiation, which originates from solar radiation that is absorbed by the Earth's crust. In short, more trapped heat in the lower atmosphere could disturb the Earth's radiation balance in such a way that near-surface temperatures will start to rise.

With the observed increase in global near-surface temperatures since the industrial revolution, associated with a rise in the concentration of CO_2 in the atmosphere, it is now widely accepted that the Earth is warming up and that this warming is predominantly driven by the human demand for fossil fuels. For example, in South Africa it was found that near-surface temperatures increased at a rate of 0.16 °C per decade during the period 1951 to 2016, for a set of 26 reliable long-term weather stations. The term global warming is therefore scientifically proven and established.





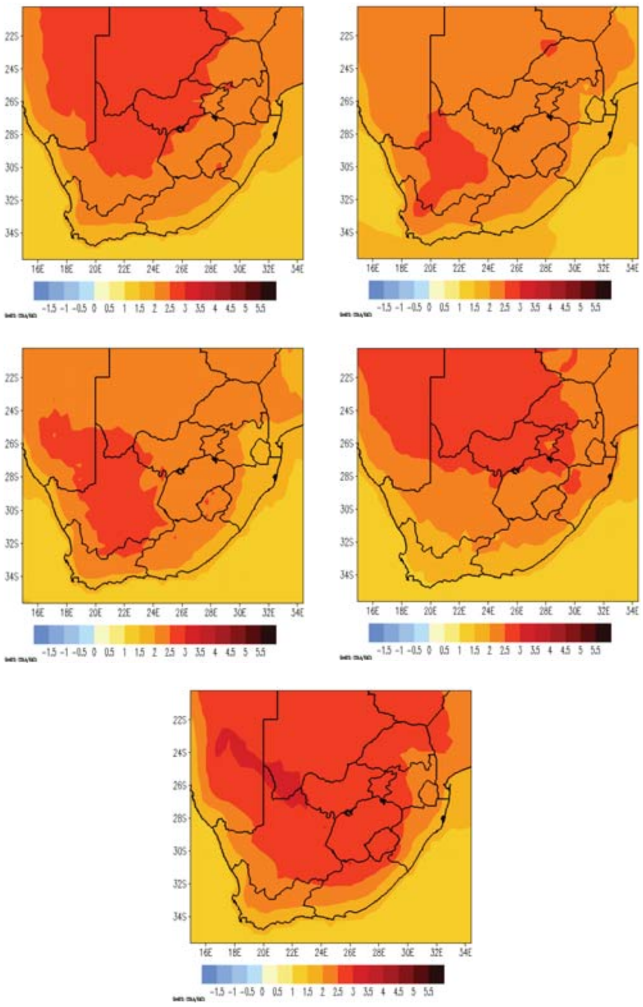
Associated with the increase in the average temperatures (top figure), increases in high temperature extremes and warm spells also became evident. In the figure at the bottom left the decadal trends in the annual number of hot days (TX90P) are shown and in the figure at the bottom right the trends in the annual maximum lengths in warm spells (WSDI) are shown for the period 1931-2015, both in days per decade. Filled symbols indicate significance of trend at the 95% confidence level (Kruger and Nxumalo, 2016, International Journal of Climatology).

Since heat is directly proportional to energy, more heat in the lower atmosphere will also result in more energy being available in the lower parts of the atmosphere. Subsequently, one may argue that it is the heat or energy emitted from the earth's surface that drives our weather systems and climate. This is why the term global warming in recent years has changed to the more popular term climate change. This change in thinking indicates that it is currently assumed that global warming eventually leads to a change in weather systems and consequently climate, and therefore to climate change.

Although one can theoretically argue that a gradual change in temperature could be described as a change in climate, temperature represents only an aspect of the total climate system, meaning that the term "climate change" is a much more comprehensive concept compared to global warming. Despite the common use of the term climate change, we are not yet sure about how global warming might influence our weather and climate systems. For this, longer-term observations are required. What we know is that global warming is a reality, implying that the increase in atmospheric heat results in higher atmospheric temperatures. How such warming will affect the total climate system is still a topic of debate and further research. The question is whether it is scientifically correct to assume that, apart from the observed increases in temperature, other aspects of the climate system will necessarily change significantly.

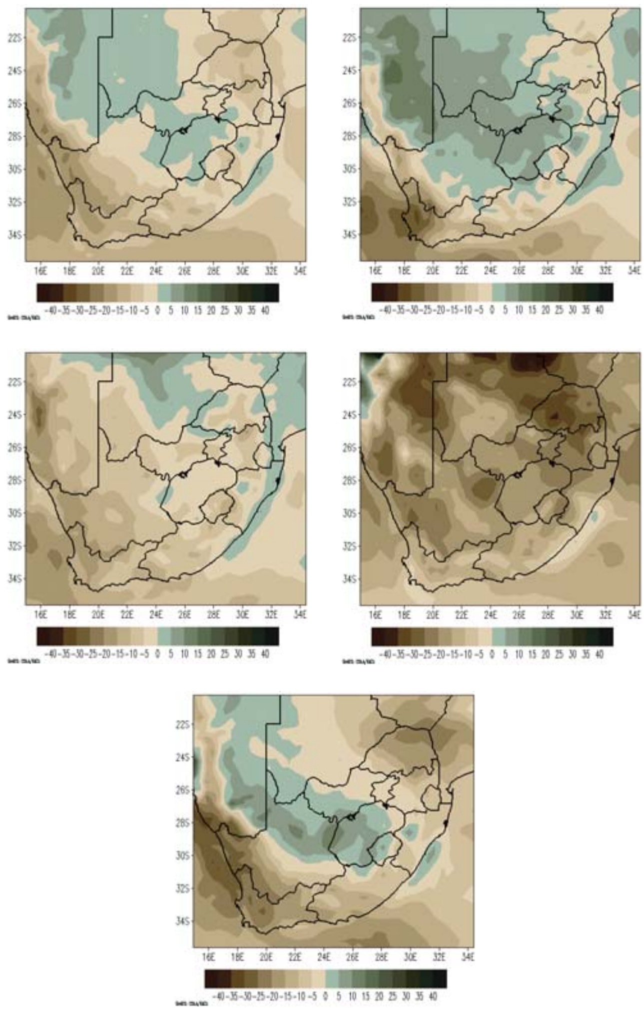
The same argument applies for South Africa. We already know that temperatures in South Africa have shown a recent increase in the region of 0.16 °C per decade, but whether these temperature increases are influencing our weather systems in general is still to be confirmed. As a matter of fact, many of the extreme weather events that we have experienced over the past few seasons are not unusual and have occurred in history. It is still too early to say with certainty whether the frequency of these weather events are already on the increase.

Future climate change, or more correctly, future global warming projections generated by atmospheric models are indicating that with temperatures on the increase (±3 °C in the 2050s and ±5 °C in the 2100s higher than the 1976–2005 average), extreme rainfall events might also increase. This makes sense since more heat energy might lead to higher temperatures and more extreme weather events. Although not yet being scientifically proven, the extreme temperatures recorded over the past few years might just as well have contributed to the extreme thunderstorms that were experienced over the same period. These postulations create a vast opportunity for exciting new research in our South African atmospheric laboratory.



Ensemble average of annual (top left) and seasonal (December-January February: DJF, March-April-May: MAM, June-July-August: JJA and September-October-November: SON: bottom from left to right) near-surface temperature change projections (°C) for 2036 to 2065 (centred at 2050), relative to 1976 to 2005, under conditions of the Representative Concentration Pathway (RCP) 8.5 (business as usual) and as simulated by the RCA4 Regional climate model forced by nine global models. Since observed temperatures are already on the rise due to global warming, one can suggest with greater confidence that temperatures might continue to rise in future.

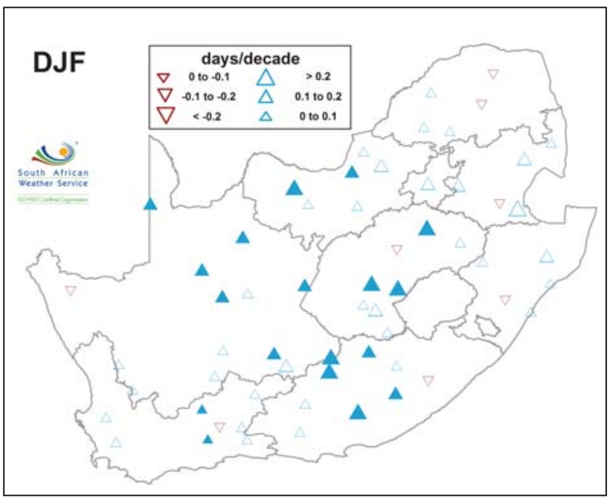
If we assume that climate change is happening because of global warming, especially through the extreme weather we have experienced over the past seasons, how prepared is the South African Weather Service (SAWS) to deliver on its mandate to issue early warnings of said events? It is possible, with our most advanced weather prediction models, to forecast the possibility of extreme thunderstorms to develop over larger areas up to about 5 days in advance (e.g. on the provincial scale), but at the same time, it is not possible to forecast the exact location of such storms, as we know that extreme thunderstorms can develop rapidly (within a few hours). In this regard we can note that over the past few years SAWS had great success in providing short-term early warnings of the percentage probability of extreme weather events to develop over a larger area. In order to address early warnings on the precise location of such storms, the only option is still to carefully monitor cloud development, and to report on any risk of the development of an extreme thunderstorm. Of great aid is the national weather radar network that SAWS has deployed, since radar images can provide real-time 3D images of atmospheric water/ice content. Unfortunately, such thunderstorm developments can only be forecast in the range of an hour in advance, meaning that there is very limited time for response.



Ensemble average of annual (top left) and seasonal (December-January-February: DJF, March-April-May: MAM, June-July-August: JJA and September-October-November: SON: bottom from left to right) rainfall change projections (% of average) for 2036 to 2065 (centred at 2050), relative to 1976 to 2005, under conditions of the Representative Concentration Pathway (RCP) 8.5 (business as usual) and as simulated by the RCA4 Regional climate model forced by nine global models. Although associated with greater uncertainty, model generated projections could assist us in defining climate change in response to global warming.

This brings us to the very interesting concept of "the weather of climate change". It is indeed through detecting changes in weather events that we will be able to detect changes in our climate system. The link between global warming and climate change therefore runs through the weather, which not only creates challenging research opportunities, but also a greater responsibility for SAWS to ensure that useful, or even sector-specific, tailor-made early warnings are issued in order to strengthen disaster risk reduction.

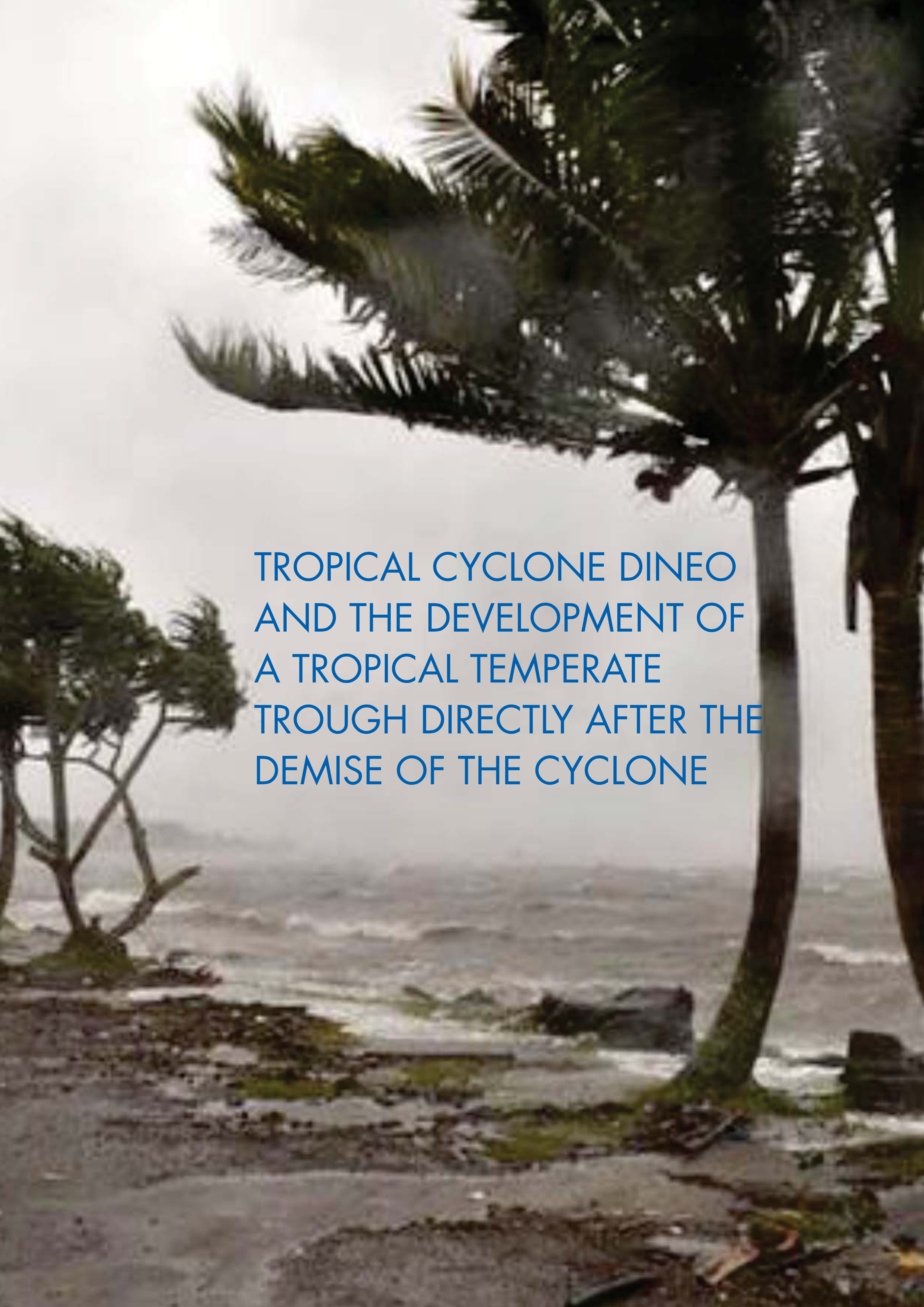
Some good news is that model-generated climate change projections are not pointing towards a considerable change in the large-scale weather systems that modulate our annual and even seasonal climate cycles, but rather a change in the frequency of weather events – this is in addition to the expected rise in temperature as a result of global warming, which is linked to a greater degree of confidence. One can therefore project with more confidence that temperatures will rise in future, which is also associated with a higher frequency of heat waves and fewer cold spells. Societies could suffer in many ways from rising temperatures. It might, for example, influence public health (e.g. heat strokes and even malaria distribution), water availability and supply networks (through higher evaporation rates) or even agriculture (more heat units and soil evaporation). Although future climate change projections do not indicate a significant change in our annual rainfall totals (at most 10 – 15% in some regions), the character of rainfall events might change. This might logically lead to more extreme rainfall events over shorter periods with longer dry periods in-between. Historically it is evident that some regions in the interior have observed increases in days with substantial rainfall, particularly in summer.



Seasonal trends in the annual count of days when precipitation ≥20 mm, for the period 1921-2015 for December to February summer rainfall (shaded symbols indicate significant trends at the 5% significance level) (Kruger and Nxumalo, Water SA (in press).

Such changes might have an influence by damaging societal assets and infrastructure, which can be avoided through early risk reduction planning and adaptation. It is also important to take note that in some cases, global warming can even lead to more favourable conditions, for example, higher atmospheric concentrations of CO_2 could lead to enhanced plant growth and agricultural cultivars that are more heat tolerant, which could thrive in future.

South Africa is in a good position as the Department of Environmental Affairs (DEA), with SAWS, is taking the risks posed by both global warming and climate change seriously. Apart from mitigation interventions aimed at reducing greenhouse gas emissions (for example through the Air Quality Act), DEA is currently in a process of implementing a National Framework for Climate Services (NFCS) which will facilitate improved communication between climatologists and society. In addition, DEA is also advancing in introducing a comprehensive sector-based Climate Change Adaptation Strategy. With these initiatives in place, society is urged to collaborate with the South African government and to respond to early warnings in creating an environment where we can all became more resilient to the risks posed by global warming, and eventually by climate change.



TROPICAL CYCLONE DINEO AND THE DEVELOPMENT OF A TROPICAL TEMPERATE TROUGH DIRECTLY AFTER THE DEMISE OF THE CYCLONE

TROPICAL CYCLONE DINEO AND THE DEVELOPMENT OF A TROPICAL TEMPERATE TROUGH DIRECTLY AFTER THE DEMISE OF THE CYCLONE – FEBRUARY 2017

– by Kevin Rae, Ezekiel Sebego, Elsa de Jager

The purpose of this article is to discuss the meteorological sequence of events during Tropical Cyclone Dineo, as well as the widespread heavy rain and flooding episode over South Africa, which closely followed the demise of the Tropical Cyclone.

Tropical Cyclones in the south-west Indian Ocean

The south-west Indian Ocean region experiences, on average, about nine significant tropical systems annually, with many of these systems being 'named' tropical cyclones. The official alphabetical list for 2016/2017 appears below in Table 1.

TC Name	Nominated by (RA 1 Country)	TC Name	Nominated by (RA 1 Country)
Abela	Tanzania	Nousra	Comoros
Bransby	South Africa	Olivier	Mauritius
Carlos	Mauritius	Pokera	Malawi
Dineo	Botswana	Quincy	Seychelles
Enawo	Malawi	Rebaone	Botswana
Fernando	Mozambique	Salama	Comoros
Gabekile	Swaziland	Tristan	France
Herold	Seychelles	Ursula	Kenya
Irondro	Madagascar	Violet	South Africa
Jeruto	Kenya	Wilson	Mozambique
Kundai	Zimbabwe	Xila	Madagascar
Lisebo	Lesotho	Yekela	Swaziland
Michel	France	Zaina	Tanzania

Table 1. The list of Tropical Cyclone names for the south-west Indian Ocean basin, valid for the 2016/2017 season. The list is compiled annually by WMO Regional Area 1 (RA 1) member countries, which includes South Africa. The system that followed "Dineo" was named "Enawo".

It will be recalled that in other parts of the world, tropical cyclones are termed hurricanes (United States and Caribbean) or typhoons (Asian countries and the Pacific). The relative intensity of a tropical cyclone is rated according to the estimated range of maximum wind strength expected to be associated with the system. Moreover, the appropriate name associated with the classification of the system is also directly related to the storm's expected intensity (refer to Figure 1).

Southwest Indian Ocean
Tropical Cyclone Intensity Scale

Category	Sustained winds
Very Intense Tropical Cyclone	>115 kt >212 km/h
Intense Tropical Cyclone	90–115 kt 166–212 km/h
Tropical Cyclone	64–89 kt 118–165 km/h
Severe Tropical Storm	48–63 kt 89–117 km/h
Moderate Tropical Storm	34–47 kt 63–88 km/h
Tropical Depression	28–33 kt 51–62 km/h
Tropical Disturbance	<28 kt <50 km/h

Figure 1. The categorical scale used by MeteoFrance's La Reunion office to describe tropical weather systems of varying intensity, within the SW Indian Ocean basin, from the East African coast, up to 090 E longitude. Note that this scale relies on the plain language name descriptor to convey information regarding storm intensity. By contrast, the Saffir-Simpson numeric scale (1-5) in use by the USA assigns a NUMBER to convey intensity information, with 1 being the most intense. In the above table, 1 knot is equivalent to 1.852km/h.

For clarity, it should be mentioned that in the south-west Indian Ocean region, the established regional practice is to use the plain text name (i.e. tropical disturbance, tropical depression) to convey information regarding the intensity of the system. This regional practice tends to vary significantly in different parts of the world. For instance, the USA favours a numeric categorisation, from 1 to 5, with the most intense systems being "1" and the weakest being "5" (also known as the Saffir-Simpson scale).

South Africa, being part of WMO Regional Area 1 (RA 1) is obliged to follow established regional practices as adopted by RSMC La Reunion. There is even much regional variation within the Indian Ocean, with tropical cyclones intensity in the northern Indian Ocean following a markedly different naming convention than the south-west Indian Ocean. This theme is mentioned particularly to alert readers to these regional variations, especially when sourcing internet-based information.

In the south-west Indian Ocean region, bordered by southern Africa on its western periphery, regional responsibility for identifying, tracking and warning for such systems lies with the WMO-designated Regional Specialised Meteorological Centre (RSMC), based at La Reunion. Whilst the South African Weather Service (SAWS) is indeed also a WMO-designated RSMC for southern Africa, sharing African responsibility with RSMC Nairobi, Kenya; the La Reunion office is specifically tasked with monitoring and tracking marine tropical systems and tropical cyclones in particular.

Climatologically, the majority of tropical cyclones in the south-western Indian Ocean (a) develop initially and (b) move or migrate within the equatorial and tropical region eastwards of Madagascar, bounded by the equator in the north and the Tropic of Capricorn (23.5 S latitude) in the south. Any tropical system ultimately moving beyond the Tropic is therefore termed extra-tropical. The months of January to April are particularly favoured for tropical cyclone development, when sea surface temperatures (SST) in the region are hotter than 27 °C. Furthermore, embryonic tropical cyclones are very sensitive to strong winds in their early, developmental stages and require very light winds in the lower to middle troposphere, combined with stronger winds and wind shear on their periphery in order to grow successfully. It is in this early developmental stage that many tropical systems fail to deepen, due to one or more such ingredients not being ideal or optimum, hence meteorologists are wary not to issue alerts too early, in case of premature demise of the system.

In the case of tropical disturbances developing in the Mozambique Channel, west of Madagascar, this favourable synoptic and mesoscale setup is encountered far less frequently than in the former (east of Madagascar) cases. On average, the literature suggests only a small fraction of such south-western Indian Ocean systems form in the Mozambique Channel. Sufficiently high SST values can often be a limiting factor in this regard. In the case of TC Dineo, SST values reported by the US Navy Joint Typhoon Warning Centre (JTWC) were at least 30 °C over the eastern and northern parts of the Mozambique Channel during the week of 13 to 17 February 2017 when Dineo formed and intensified.

Whilst tropical cyclone formation in the Mozambique Channel is relatively uncommon, this fact reinforces the need for meteorologists (including SAWS personnel) to be especially vigilant and mindful of the potential impacts of such systems. In particular, this is important as the public may well underestimate the level of personal risk posed by such systems (such as one or more of wind damage, heavy rain, storm surge and flooding) if they have not previously (or recently) encountered such an event. In the historic record, at least 14 such systems (including Dineo) have directly or indirectly affected parts of South Africa in the period from 1958 onwards. In Table 2, the tropical systems associated with significant (or more severe) impact are listed.

It will be recalled that Tropical Cyclone Domoina (January 1984) was the last landfalling Tropical Cyclone system to directly impact severely on KwaZulu-Natal. It can also be noted that the literature (Brundrit et al., 1990) suggests that, in sympathy with global warming (and attendant SST increase), tropical cyclone frequency in the south-western Indian Ocean is likely to show an increasing trend in the years ahead. Before the development of Tropical Cyclone Dineo, only five significant historic tropical systems had affected South Africa in the preceding (approximately) 60 year period - further underscoring the relative rarity of such events.

Tropical Cyclone Name	Year	Comments
Astrid	January 1958	Destroyed Wylliespoort pass, Louis Trichardt, Limpopo
Claude	January 1966	
Caroline	14 February 1972	
Eugenie	21-22 February 1972	
Danae	27-31 January 1976	Southern Zimbabwe
Emilie	6-8 February 1977	Landfall near Beira and into SE Zimbabwe. Heavy rainfall over eastern SA provinces and bridges damaged/destroyed
Kolia	March 1980	
Justine	March 1982	
Domoina	29-31 January 1984	Landfall N KZN coast. Numerous coastal bridges destroyed, >600mm in 3 days
Imboa	February 1984	Close pass off KZN coast
Eline	9-22 February 2000	Extensive flooding and river flooding in Kruger Park and Lowveld, numerous bridges destroyed
Dando	16 January 2012	Landfall near Xai-Xai, dissipated over SA lowveld where localised flooding and fiver flooding occurred
Funso	end January 2012	N/S close pass along southern Mozambican coast
Irina	Early March 2012	close marine bypass: Maputo and Richards Bay
Dineo	mid February 2017	Extreme north-eastern Limpopo

Table 2. Chronological list (from 1958 onwards) of significant tropical systems which affected South Africa either directly or indirectly.

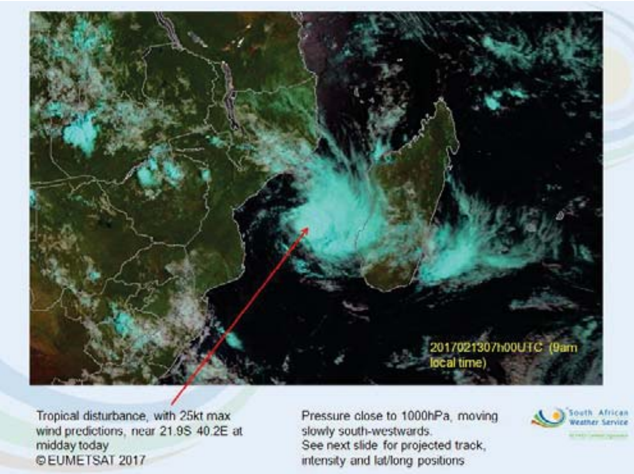


Figure 2. On Monday morning, 13 February 2017, Dineo had not yet intensified and was only a weak system (Tropical Disturbance, with winds 25kts or less). However, the potential for a significant tropical system to develop was emphasized.

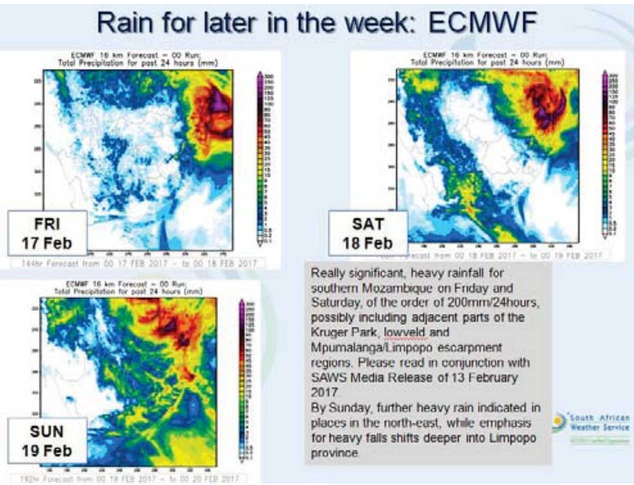
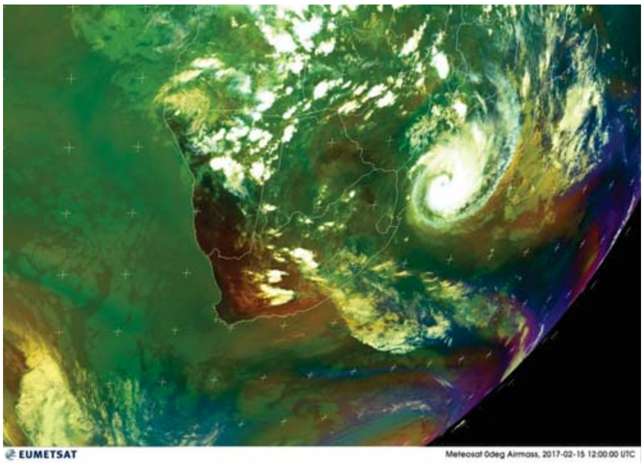


Figure 3. On Monday 13 February 2017, possible heavy rain related impacts were suggested, should Dineo intensify and move overland over the north-eastern extremity of South Africa. As such, this was an early alert, at a 5 day lead-time, that the provinces of Limpopo and Mpumalanga were likely to be affected later in the week. Note in particular the content of the grey text box.



Sequence of events – Tropical Cyclone Dineo

The weak embryonic beginnings of the system were first identified and discussed at the South African Weather Service during the period 8 to 10 February 2017. While it was strongly suspected that the system had the potential to deepen, this was tempered with a concern that alerts issued at too early a time, might prove to be unwarranted and had the potential to erode the good reputation of the organisation. On Monday, 13 February 2017, the system was still classified as a Tropical Disturbance and only associated with wind speeds of about 25knots, 50km/h (not damaging at all). Table 3 below shows the development of the system as from Monday, 13 February 2017.

Day	Date	Time(SAST)	Latitude	Longitude	Classification (refer Figure 2)
Monday	13	2pm	-21.9 S	040.2 E	Tropical Disturbance
Tuesday	14	8am	-22.3 S	038.8 E	Severe Tropical Storm
Wednesday	15	2am	-22.7 S	037.8 E	Severe Tropical Storm
Thursday	16	2pm	-23.3 S	032.7 E	Tropical Cyclone (landfall near Inhambane, South Mozambique approx 8pm SAST)
Friday	17	2am	-22.7 S	030.7 E	Overland; Ex-tropical cyclone
Friday	17	2pm	-22.2 S	027.6 E	Overland; Ex-tropical cyclone
Saturday	18	2am	-22.6 S	024.4 E	Overland; Ex-tropical cyclone
Saturday	18	2pm	-23.8 S	020.2 E	Overland; Ex-tropical cyclone

Table 3: Logframe of latitude/longitude positions of Dineo during the lifetime of the system.

From Monday, 13 February 2017 onwards, regular media and disaster management briefings were done as the system gradually intensified. In contrast with other historic tropical systems, which often display highly erratic tracks as well as variation in intensity, this particular system was generally well-forecast by deterministic and ensemble Numerical Weather Prediction systems.

The location and timing of landfall near Inhambane, southern Mozambique in the early evening of Thursday, 16 February, was well-anticipated and publicised. During Friday the 17th, Dineo was overland over southern Mozambique, where much heavy rain fell, but with limited impacts on South Africa.

In the 48-hour period between Friday and Saturday, some notable, very heavy falls occurred over Limpopo and Mpumalanga (see accumulative rainfall data, Table 4 below). In particular, Graskop in Mpumalanga registered 356 mm in the period between 16 -19 February, while the Kruger Mpumalanga International Airport registered 101.6 mm. In the Limpopo Province, Tzaneen and Woodbush (152.4 mm and 433 mm respectively) registered the highest amounts, no doubt assisted by orographic uplift against the topography of the escarpment. In general, while a few very heavy falls occurred, these falls were mostly isolated and thankfully not widespread over the region, despite the vortex of Dineo bypassing close to (or over) the extreme north-eastern tip of the Limpopo Province. During Friday and Saturday, heavy falls of rain were recorded over southern Zimbabwe and northern Botswana and by Sunday, heavy falls were restricted to northern Namibia, when the last remnants of the cyclonic circulation associated with Dineo began dissipating over extreme north-western Namibia, west of Ondangwa.

Table 4: Accumulative rainfall (50 mm or more):
16 -19 February 2017

StationName	Latitude	Longitude	Province	Total
BARBERTON PRISON ARS	-25.7833	31.05	MPUMALANGA	83.2
ERMELO WO	-26.4977	29.9838	MPUMALANGA	62.1
GRASKOP AWS	-24.9351	30.8391	MPUMALANGA	356.0
KRUGER MPUMALANGA INT. AIR.	-25.3877	31.0995	MPUMALANGA	101.6
NELSPRUIT	-25.5031	30.9116	MPUMALANGA	69.0
LEVUBU	-23.0943	30.2863	LIMPOPO PROVINCE	54.4
PUNDA MARIA	-22.692	31.015	LIMPOPO PROVINCE	56.3
ROODEWAL BOS ARS	-23.0112	30.0129	LIMPOPO PROVINCE	55.4
THOHOYANDOU WO	-23.0797	30.3838	LIMPOPO PROVINCE	50.0
TZANEEN-WESTFALIA ESTATE	-23.73 67	30.1127	LIMPOPO PROVINCE	152.4
WOODBUSH	-23.804	29.9698	LIMPOPO PROVINCE	433.0
KLIPFONTEIN ARS	-25.7042	27.3656	NORTH-WEST	75.2
LEEUKOP ARS	-27.0136	26.1536	NORTH-WEST	59.6
SWARTRUGGENS - POL	-25.6491	26.689	NORTH-WEST	80.3
BETHLEHEM WO	-28.2496	28.3343	FREE STATE	54.0
BLOEMFONTEIN - STAD	-29.1204	26.1874	FREE STATE	55.6
LILLYDALE ARS	-30.0141	25.9579	FREE STATE	50.8
BARKLY WEST - TNK	-28.5372	24.52	NORTHERN CAPE	53.0
HOPETOWN - TNK	-29.622	24.0887	NORTHERN CAPE	54.5
KAGISHO POLICE	-28.7114	24.7197	NORTHERN CAPE	56.0
MARYDALE - POL	-29.4064	22.1061	NORTHERN CAPE	171.0
VAN ZYLSRUS	-26.8774	22.0499	NORTHERN CAPE	139.8
WILLOWMORE	-33.3003	23.4839	EASTERN CAPE	82.2
MAKATINI RESEARCH CENTRE	-27.3941	32.1769	KWAZULU-NATAL	51.4
PONGOLA	-27.4139	31.5906	KWAZULU-NATAL	64.0
RIVERVIEW	-28.444	32.1821	KWAZULU-NATAL	65.8
ROYAL NATIONAL PARK	-28.68 58	28.9542	KWAZULU-NATAL	94.0

Development of a Tropical Temperate Trough (TTT)

A very interesting and noteworthy development, both from a meteorological point of view as well as potential weather-related impacts, was the development of a Tropical Temperate Trough (TTT) system very soon after the demise of ex-Tropical Cyclone Dineo.

TTT systems form as a result of the interaction of two particular weather elements, each originating in different latitudinal zones. The first requirement is an upper-air trough, originating in the temperate mid-latitudes. In the case of southern Africa, such a trough typically drifts over the country, from the southern Atlantic Ocean, moving progressively eastwards. Such troughs are a fairly common feature on southern African weather maps, occurring year round. The second TTT ingredient, namely a spatially extensive, tropically-sourced airmass over southern Africa is also relatively common. However, it is the interaction of these two systems which produces the so-called TTT system. Tropical and temperate airmasses, interacting in close proximity to one another, do not occur that frequently, however when they do, there is invariably significant capacity for the combined system to be a significant rain producer. Why should this be the case? The answer lies in the general nature of tropically-sourced air, which is generally fairly warm and very moist throughout much of the troposphere. Such an airmass also has (a) a great capacity to transport moisture over great distances, from the equatorial and tropical regions, into sub-tropical southern Africa. In addition, such an airmass also has (b) significant potential to deliver large amounts of rainfall. Such an airmasss is inherently unstable and requires only slight vertical uplift for the column to reach saturation and to deliver rainfall. Furthermore, under such conditions, the airmass is also fairly uniform over an extensive spatial area, thus further enhancing the potential for widespread rainfall. In a TTT system, the mid-latitude upper-trough provides marked, sustained uplift and undercuts the tropical air, resulting in widespread, often heavy rain. In the particular case of the recent TTT system, the circulation over southern Africa was greatly modified during the dying stages of ex-tropical cyclone Dineo. While a large part of the central interior of southern Africa was relatively dry and stable as Dineo made landfall over Mozambique, this all changed rapidly once Dineo made its way to northern Botswana (and latterly northern Namibia) between Saturday and Sunday.

By Sunday morning, the 19th February 2017, the remnants of Dineo were finally dissipating over extreme north-western Namibia, no longer associated with much cloud cover and no longer associated with heavy rain. Dineo, however, had a much greater, albeit indirect impact on our weather from Sunday 19th, right through to Wednesday the 22nd February 2017. This indirect effect was manifested in terms of the development of a TTT system, with a moist, spatially extensive, unstable and tropically-sourced airmass moving into the central provinces of South Africa. What is also worth noting, in the context of this report, is that although much interest was focused on the progression of Dineo across the country, meteorologists were still able to correctly, and in a timely manner, identify the TTT setup as being a rain producer with the potential to exceed the rainfall (as well as weather-related impacts) delivered by Dineo over South Africa.

In particular, the Free State and North-West were identified as being at risk for prolonged heavy falls over a number of successive days.

Figure 4 below shows the expected sequence of heavy rainfall for the period 20 – 23 February 2017.

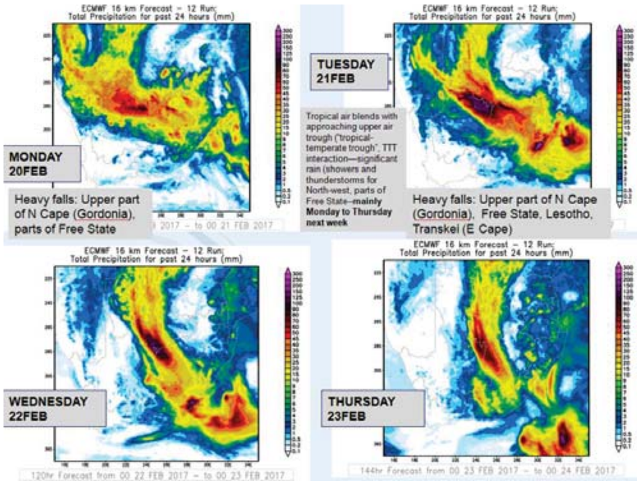


Figure 4: Saturday 18th February, indicating the expected sequence of heavy rainfall, especially highlighting which provinces were most expected to be affected on which date. The accumulative effect of the rainfall, over 4 to 5 days was also emphasised.

Table 5 below reveals that the Numerical Weather prediction system predicted the location and timing of (heavy) rainfall fairly well, with many stations reporting 100 mm or even well in excess of 100 mm in the period from 19 to 22 February 2017. Note that, due to the widespread nature and extent of the rainfall, Table 5 indicates ONLY the stations which registered 100 mm or more (many other stations, not listed, reported 50 - 99 mm).

JHB BOT TUINE	-26.1566	27.9991	GAUTENG	121.6
PRETORIA - PRESIDENCY ARS	-25.7394	28.2325	GAUTENG	143.6
PRETORIA UNISA	-25.7663	28.2005	GAUTENG	100.0
VEREENIGING	-26.5699	27.9582	GAUTENG	104.2
WONDERBOOM AIRPORT	-25.6631	28.2166	GAUTENG	125.6
ERMELO WO	-26.4977	29.9838	MPUMALANGA	134.0
GRASKOP AWS	-24.9351	30.8391	MPUMALANGA	219.6
MARKEN	-23.5948	28.3878	LIMPOPO PROVINCE	149.0
THABAZIMBI	-24.5799	27.4134	LIMPOPO PROVINCE	125.4
HARTEBEESPOORT DAM	-25.7486	27.8325	NORTH-WEST	136.4
KLERKSDORP	-26.8981	26.6209	NORTH-WEST	157.6
KLIPFONTEIN ARS	-25.7042	27.3656	NORTH-WEST	175.2
LELIEFONTEIN ARS	-27.0597	24.9906	NORTH-WEST	104.4
MARICO	-25.4718	26.3819	NORTH-WEST	120.0
OTTOSDAL	-26.8145	26.0107	NORTH-WEST	168.8
PHITSHANE ARS	-25.7487	25.0983	NORTH-WEST	128.4
PILANESBERG	-25.2573	27.2238	NORTH-WEST	125.6
POTCHEFSTROOM	-26.7359	27.0755	NORTH-WEST	130.0
BETHLEHEM WO	-28.2496	28.3343	FREE STATE	148.6
EDENVILLE MUNISIPALITEIT	-27.5544	27.6739	FREE STATE	132.0
FRANKFORT - TNK	-27.2672	28.4946	FREE STATE	157.8
HEILBRON PRISON	-27.2926	27.9667	FREE STATE	120.3
KROONSTAD	-27.6665	27.3136	FREE STATE	107.2
LILLYDALE ARS	-30.0141	25.9579	FREE STATE	130.8
LINDLEY - MUN	-27.8736	27.9223	FREE STATE	130.0
PETRUS STEYN - MUN	-27.6471	28.1291	FREE STATE	109.0
REITZ - SILO	-27.7962	28.4428	FREE STATE	107.0
VERKYKERSKOP - POL	-27.917	29.283	FREE STATE	110.0
VREDE	-27.4228	29.1695	FREE STATE	102.4
WARDEN - HERITAGE	-27.9611	29.0594	FREE STATE	119.6
WEPENER	-29.9157	26.847	FREE STATE	154.4
VAN ZYLSRUS	-26.8774	22.0499	NORTHERN CAPE	150.6
KING SHAKA AIRPORT (KSIA)	-29.6108	31.1239	KWAZULU-NATAL	118.8
MARGATE	-30.8588	30.3433	KWAZULU-NATAL	108.6
MTUNZINI	-28.9474	31.7079	KWAZULU-NATAL	160.6
PADDOCK	-30.7544	30.2577	KWAZULU-NATAL	109.6
RICHARDS BAY AIRPORT	-28.7378	32.0934	KWAZULU-NATAL	184.2
ROYAL NATIONAL PARK	-28.68 58	28.9542	KWAZULU-NATAL	183.2
VAN REENEN	-28.3789	29.3853	KWAZULU-NATAL	172.8

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

*120*7297(SAWS)#

South African Weather Service

ISO 9001 Certified Organisation

Solutions for a WeatherSmart South Africa

HydroNET

Reliable weather information at your fingertips because every raindrop counts

It is well documented that South Africa is a water scarce country, which is vulnerable to the impacts of climate change. Large parts of the country already have low and variable rainfall and a significant portion of our surface water resources are already fully allocated.

In addition, floods caused by excessive rainfall over a short period also cause hazardous conditions. Such hazards range from local, water-induced damage to large-scale devastation for whole communities.

South Africa is unlikely to get substantial rain in the months ahead, with local and international climate experts predicting one of the strongest El Niño weather events in more than half a century. In this situation, every drop of rainfall information counts.

To optimally benefit from the available rainfall, access to real-time weather information is essential. The South African Weather Service (SAWS) and Hydrologic, a Dutch based company, have joined forces to make, reliable historical, actual and forecasted rainfall information easily available.

On 17 November 2015, the South African Weather Service CEO, Dr Linda Makuleni, signed a cooperation agreement with Hydrologic, a Dutch-based company, to develop and implement an online rainfall management application. The signing ceremony took place in Newtown, Johannesburg in the presence of the Dutch Prime Minister Mark Rutte, who is on an official visit to South Africa.

HydroNET makes real-time monitoring and the prediction of rainfall as well as water availability easily accessible. The South African Weather Service and Hydrologic officially launched RainWatch, a set of web-applications empowering weather sensitive industries to make WeatherSmart decisions because every raindrop counts.

RainMap application

The RainMap application allows online access to historical and actual rainfall information from rain gauges, satellites and radars and automatically combines and calibrates the different sources and produces a composite via an interactive map.

Weather station

The Weather Station application allows users easy access to historical and actual rainfall time series from the SAWS automatic weather stations.

Forecast application

The Forecast application allows users to easily access the rainfall forecast from SAWS, incorporated into a geographical precipitation map.

* Users are able to personalise dashboards with relevant graphs, thematic maps, tables and model results, in order to make safe and reliable decisions at the right time.

MEET THE AUTHORS

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 people who qualified themselves as Meteorological Technicians. She still has a passion for transferring skills.

Ms Musiiwa Denga

Ms Musiiwa Denga is the Communications Officer at the South African Weather Service (SAWS). She holds a BA Communication Science and Strategic Marketing Management qualification from the University of South Africa (UNISA). She is currently studying towards her Honours qualification. Her duties include internal communication, social media, external events, brand awareness and media relations.

Mr Morné Gijben

Morné Gijben is a research scientist in the Nowcasting and Very Short-Range forecasting group at the South African Weather Service. He completed his BSc (Hons) degree (Meteorology) in 2010 and MSc degree (Meteorology) in 2016 on the development of a model based lightning threat index for South Africa. His fields of research include lightning, satellite, and thunderstorms in the 0 - 12 hour forecast scale. He has worked on topics like anticipating lightning activity from numerical model fields, creating a lightning climatology for South Africa with data from the South African Lightning Detection Network (SALDN), the Rapidly Developing Thunderstorm product, and various other topics related to lightning and satellite. Mr. Gijben has published several journal articles, presented papers at numerous national and international conferences, and has been involved in several externally funded projects.

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 Build Environment". Before that, he abtained an Msc (Environmental and Geographical Science) degree at the University of Cape Town. He published papers both locally and internationally, and authored a SAWS series 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.

Mr Thabo Makgoale

Mr Thabo Makgoale is a research scientist in the Climate Change and Variability research at SAWS since 2015. His career involves exploring the theory of climate change and then goes into the question of predictability, cross scale relationships and feedbacks in the climate system, the tools and techniques of prediction, and translation of predictions into the user community including impacts and vulnerability analyses. He has been involved in national research projects focusing on impact of climate change on extreme weather events and water resources and participated in national and international science conferences. He has background in Climate Modelling, Climate Change & Predictability, Ocean Modelling, Ocean & Atmosphere Dynamics, and Marine Systems. He graduated with a BSc degree in Ocean and Atmospheric Sciences in 2012 at University of Cape Town (UCT) and BSc (Hons) in Atmospheric Sciences in 2013 through Climate System Analysis Group – UCT. He is currently enrolled for MSc study at North West University.

Mr Mthobisi Nxumalo

Mr. Mthobisi Nxumalo is a Senior Scientist: Climate Information: Climate Service of the South African Weather Service. He joined SAWS in 2012 as an intern in the Climate Data: Climate Service Department and was employed as a scientist within the same unit in 2013. He joined the Climate Information unit in 2016 as a Senior Scientist. He completed his BSc Geography and Hydrology and pursued his Honours degree in Geography with the University of Zululand. He is currently completing his MSc degree on Agrometeorology with the University of Free State. His present duties include conducting climate research and scientific publications, developing climate products and servicing clients with climate data.

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 Service in 1981 as a meteorological technician and spend 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 qualification include an MSc in Meteorology (Univesity 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 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 scientist by the NRF.

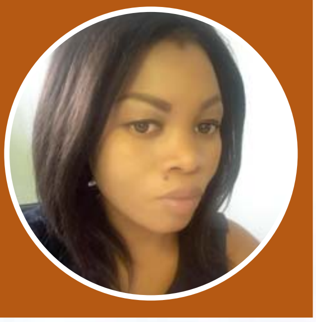
Dr Jyotsna Singh

Dr Jyotsna Singh joined SAWS in November 2015 as a senior scientist. She is leading the energy application research group. Prior to that she was working as an Assistant Professor of Environmental Science in Manipal University Jaipur, India, 2015. She did her PhD from Birla Institute of Technology, Mesra, Ranchi, India in Environmental Science and Meteorology in 2013. After submitting her PhD, she has gained research experience in the Department of Meteorology, Stockholm University, Sweden, 2013. For this research work, she was awarded first poster award by Committee on Space Research (COSPAR), France, at COSPAR 1st Symposium, Bangkok, Thailand, 2013. She has done postdoctoral research work at University of Kwa Zulu Natal, Durban, South Africa, 2014. In India, she was involved in many national level projects. She has developed a model to predict diffuse solar radiation fraction for India under Birla Institute of Technology, Mesra, Ranchi, India and Indian Space Research Organisation (ISRO) collaborative project. She has more than eight years of research experience and two years of teaching experience. She has also done Post-graduate Diploma in Remote Sensing and GIS from Indian Institute of Remote Sensing, Dehradun, India, 2013. To gain research experience she has visited many countries - Austria, Sweden, United Kingdom, Thailand, South Africa, Italy and Hong Kong. She has published her work in national and international journals, book and conferences. She is also the member of many national and international scientific societies like COSPAR, AARSE and SASAS. She is the reviewer of many national and international journals. She has been registered as a "Professional Natural Scientist" by SACNASP (South African Council for Natural Scientific Professions), 2017. Currently, she is contributing her renewable energy research experience in the SAWS-UK Newton fund project as a work package five leader. Her research interests are in the areas of renewable energy, remote sensing, and GIS.

Mr Ezekiel Sebego

Ezekiel Sebego is a Chief Forecaster in the South African Weather Service. He completed a National Higher Diploma in Meteorology (Specialising in Weather Forecasting) in 2001 from the then Pretoria Technikon (now Tshwane University of Technology). In 2002, Ezekiel joined the South African Weather Service as a forecaster at the headquarters of the South African Weather Service in Pretoria. He currently heads the National Forecasting Office in Pretoria.

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.

The South African Weather Service Logo

The South African Weather Service logo represents the movement of weather system and their interaction with the earth, sun and atmosphere. It also portrays a fresh and dynamic visual appearance that identifies the South African Weather Service as a proudly South African organisation.

- The light blue represents water which is our main source of life.
- The dark blue represents the atmosphere in which all weather occurs.
- The green symbolises sustainability and life
- The red-brown represents the earth from which all life originates.
- The yellow circle represents the African sun.

South African Weather Service

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