WEATHERSMART NEWS

Scientific meteorological and climatological news from the South Africa Weather Service

MARCH 2026

South African Weather Service

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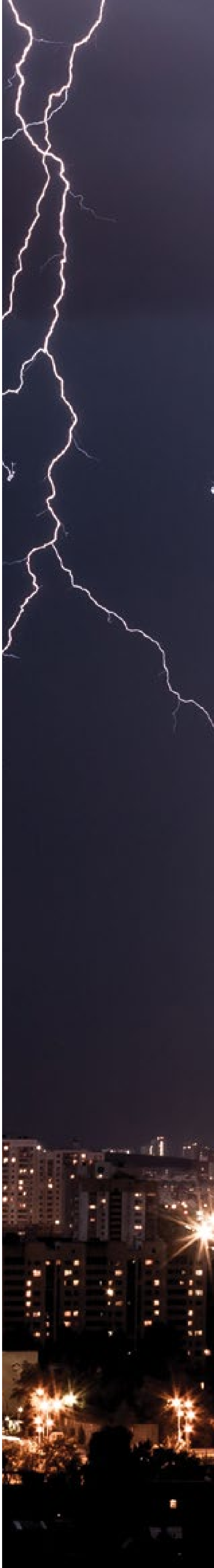
South African Weather Service



WEATHERSMART
March 2026

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FOREWORD

Chief Executive Officer

Welcome to the March 2026 edition of the WeatherSMART Newsletter. This issue examines South Africa's recent climate conditions, focusing on the key events and trends that shaped 2025 and the current summer season of 2025 – 2026.

Over the past year, South Africa has experienced high weather variability, including above-average temperatures, heavy rainfall, and catastrophic weather events like flooding and drought. These changes show how important accurate forecasting, climate monitoring, and effective weather-related communication are becoming.

We include an expert analysis from the South African Weather Service on seasonal forecasts, key climatic influences, including La Niña, and unexpected weather phenomena. In addition to advancing our knowledge of atmospheric processes, the articles demonstrate the critical role meteorologists play in safeguarding people's lives, property and means of subsistence.

South African scientists report on the State of South Africa's climate in 2025, examining temperature and rainfall patterns and highlighting significant weather and climate events observed during the year. Similar trends were noted worldwide, with the 2025 State of the Climate Report confirming that the world is experiencing a climate emergency, marked by record breaking temperatures, rising greenhouse gas concentrations and unprecedented ocean warming.

The South African Weather Service (SAWS) issues monthly seasonal forecasts covering five months ahead, using staggered three month periods. These probabilistic forecasts provide rainfall and temperature forecasts for the period. Interest in the 2025/26 summer forecast was heightened due to the development of a La Niña event, prompting a media briefing in September 2025 to warn of potential impacts. Our article reports on observed rainfall and temperature conditions experienced during the 2025/26 summer up to the end of February 2026.

We include an article on unusually warm, summer like daytime temperatures that were recorded over the Namakwa District and parts of the Western Cape on 29 July 2025, an atypical occurrence for winter. Temperatures peaked earlier than normal, before midday, and then cooled in the afternoon rather than steadily increasing toward a mid-afternoon maximum — the meteorological reasons for these conditions are discussed in our fourth article.

Our last article reflects on the importance of early warning systems for reducing the impacts of hazardous weather by providing timely, actionable information to disaster management authorities and the public. The article explores the value of early warnings for disaster management decision-making using a case study of cold fronts affecting western South Africa from 3 to 6 July 2025. These cold fronts brought very cold, wet and windy conditions, with risks of flooding, strong coastal winds, rough seas and snowfall over mountain peaks, posing significant threats to vulnerable communities, small stock farmers, infrastructure and transport systems.

I hope you will enjoy the content of this newsletter and be informed, engaged and more knowledgeable about the dynamic and shifting climate in South Africa as well as the very interesting landscape of meteorology and climatology.

Ishaam Abader
Chief Executive Officer
March 2006

State of the Climate 2025: South Africa

A. C. Kruger and C. McBride
– Climate Service, South African Weather Service, Pretoria, South Africa

Introduction

The 2025 State of the Climate Report has confirmed that Earth is in a climate emergency, with record heat, greenhouse gas levels and ocean warming among the trends of concern. This article examines the South African State of the Climate for 2025, with a specific focus on temperature, precipitation, and other noteworthy weather and climate events.

Temperature, precipitation and other noteworthy events

Temperature

South Africa experienced a warm year, among the top 10 warmest since 1951, based on data from 26 climate stations. The temperature was on average about 0,4°C above the reference period average (1991 – 2020) (see **Figure 1**). A warming trend of approximately 0,17°C per decade is indicated for the country, over the period 1951 – 2024, statistically significant at the 5% level.

Precipitation

The most significant feature of the rainfall in 2025, as shown in **Figure 2**, is the above-normal amounts received over most of South Africa. The major exception is the Western Cape, extending into the southern interior of the Northern Cape. Especially the South Coast and parts of the Northern Cape received well below-normal rainfall, with some places experiencing extremely dry conditions.

Noteworthy climate and weather events

In South Africa, the year started with above-normal temperatures over most of the interior, except for the west and the extreme north, and in isolated parts of the east, where relatively wet conditions were experienced. Tropical moisture led to Level 6 – 8 rain warnings with high risk of localised flooding, especially along the KwaZulu-Natal coast and Midlands. Motorists and residents were urged to exercise caution due to flooding threats. Between mid and late February 2025, intense above-normal rainfall triggered widespread flooding and landslides in eastern South Africa, particularly in KwaZulu-Natal. Multiple warnings were issued by SAWS for heavy rain and localised flooding across the province (and adjacent provinces). Specific impacts reported in February include fatalities and casualties as floodwaters surged in towns and low-lying areas, landslides in residential areas such as KwaMakhutha and Folweni. Other infrastructure damage included destroyed roads, bridges, and homes, with thousands displaced and relocated to shelters. An estimated billions in damages (e.g., R3.1 billion in KZN alone) were incurred.

These wetter-than-normal conditions continued in the east and extended westwards, covering most of the country by March and April. Widespread disruptive rainfall and thunderstorms were reported across many provinces in early to mid-March 2025, as the above-normal rain extended westwards beyond the east into the interior, including KwaZulu-Natal, Eastern Cape, Free State, Mpumalanga, Gauteng, Limpopo, North West and the Northern Cape. SAWS issued multiple impact-based warnings for severe thunderstorms and disruptive rain, localised flooding of roads and settlements, strong winds, lightning and hail. These warnings repeatedly covered a broad swath of the country around 12 – 16 March 2025, reflecting persistent wet patterns.

In May 2025, only the extreme western parts of the country received significant rainfall, while the remainder of South Africa was unseasonably dry and cold. Parts of Cape Town experienced localised flooding in May, when rainfall overwhelmed stormwater systems in some urban areas. Heavy downpours in Cape Town led to water buildup on roadways and localised flooding of streets and low-lying urban areas. City disaster management teams responded to service calls regarding flooding in the suburbs. The SA Weather Service issued a Yellow Level 2 warning for disruptive rainfall and damaging winds during these episodes. However, no major deaths or large-scale disasters were reported during this event, but it did cause travel disruption, traffic issues, and minor street flooding. Winter temperatures in June and July were mostly below normal and wetter than usual in the extreme south-west and east. Dry conditions persisted over the south coast and southern interior of the Northern Cape.

In August and September, temperatures were above normal across most areas, and extremely dry conditions persisted in the south, spreading eastwards. However, by the end of 2025, dry conditions were well-established across the whole south-west of South Africa. Severe drought conditions have developed in the Western Cape due to below-normal rainfall since August 2025, especially during the winter rainfall season, when this region normally receives the bulk of its precipitation. Patches of extreme drought were experienced in parts of the Boland and adjoining areas, with agricultural impacts such as poor winter crop prospects and low soil moisture. Drought stress, specifically, threatened winter crops such as wheat in these areas by late 2025 due to the lack of typical winter rains. The Western Cape and the Boland emerged as among the most drought-stressed parts of the country by year-end.

By the end of 2025, the south-western coastal areas around the Garden Route in the Western Cape were among the most drought-affected localities in that broader region, despite occasional rainfall earlier in the year. The below-normal rain had important impacts on both water supply and local conditions: The Garden Route Dam in George, a key resource for the town, declined steadily through 2025, dropping to below 50% capacity by December, prompting stricter municipal water-use restrictions. Commentary from local officials pointed to uneven and inadequate rainfall in key catchments, meaning even when storms occurred nearby, much of that rain didn’t fall where the dam could capture it. Currently, these dry conditions have also spread eastwards.

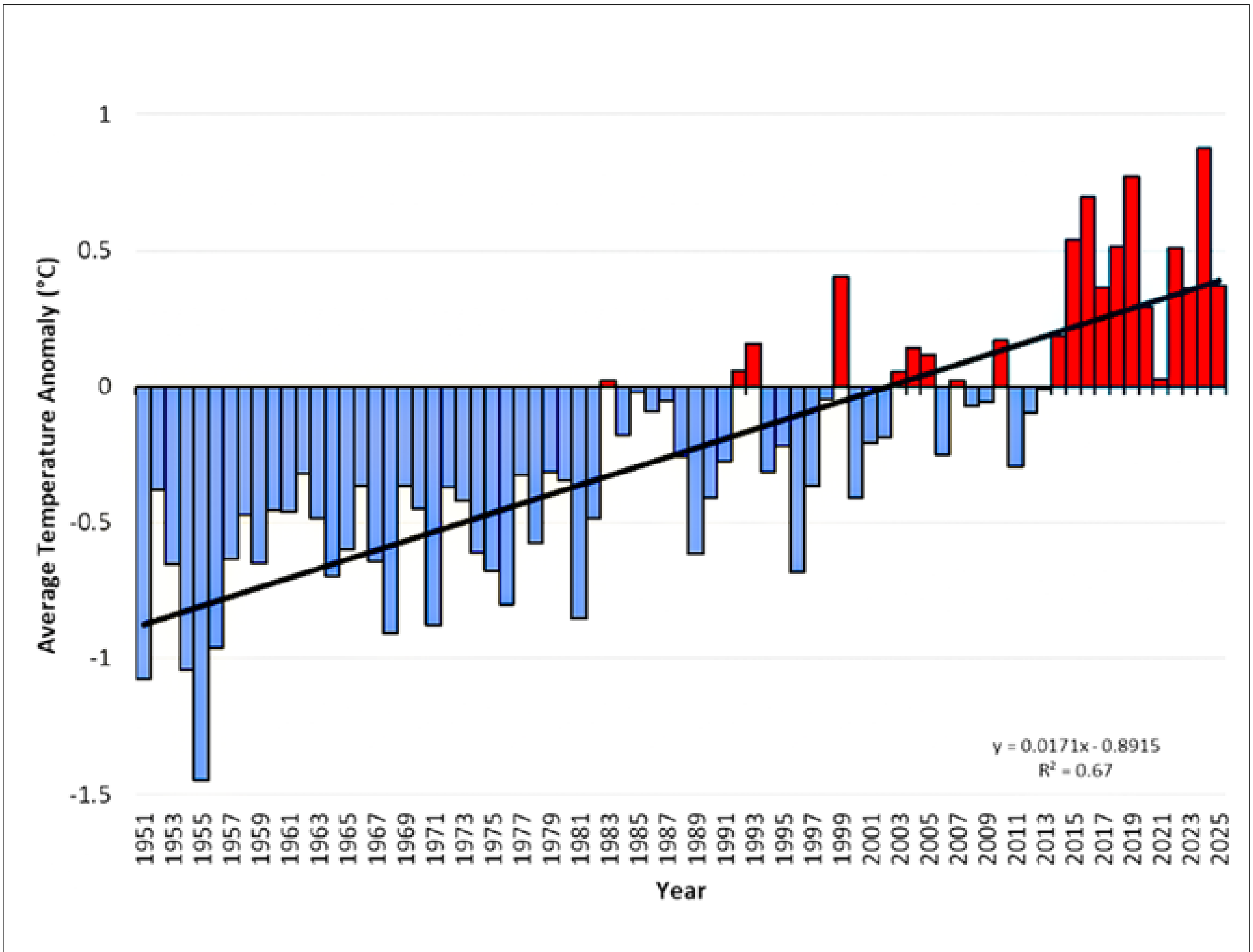

Figure 1: Average surface temperature deviation over South Africa based on 26 climate stations: 1951 – 2023 (base period: 1991 – 2020). The linear trend is indicated (Source: South African Weather Service).

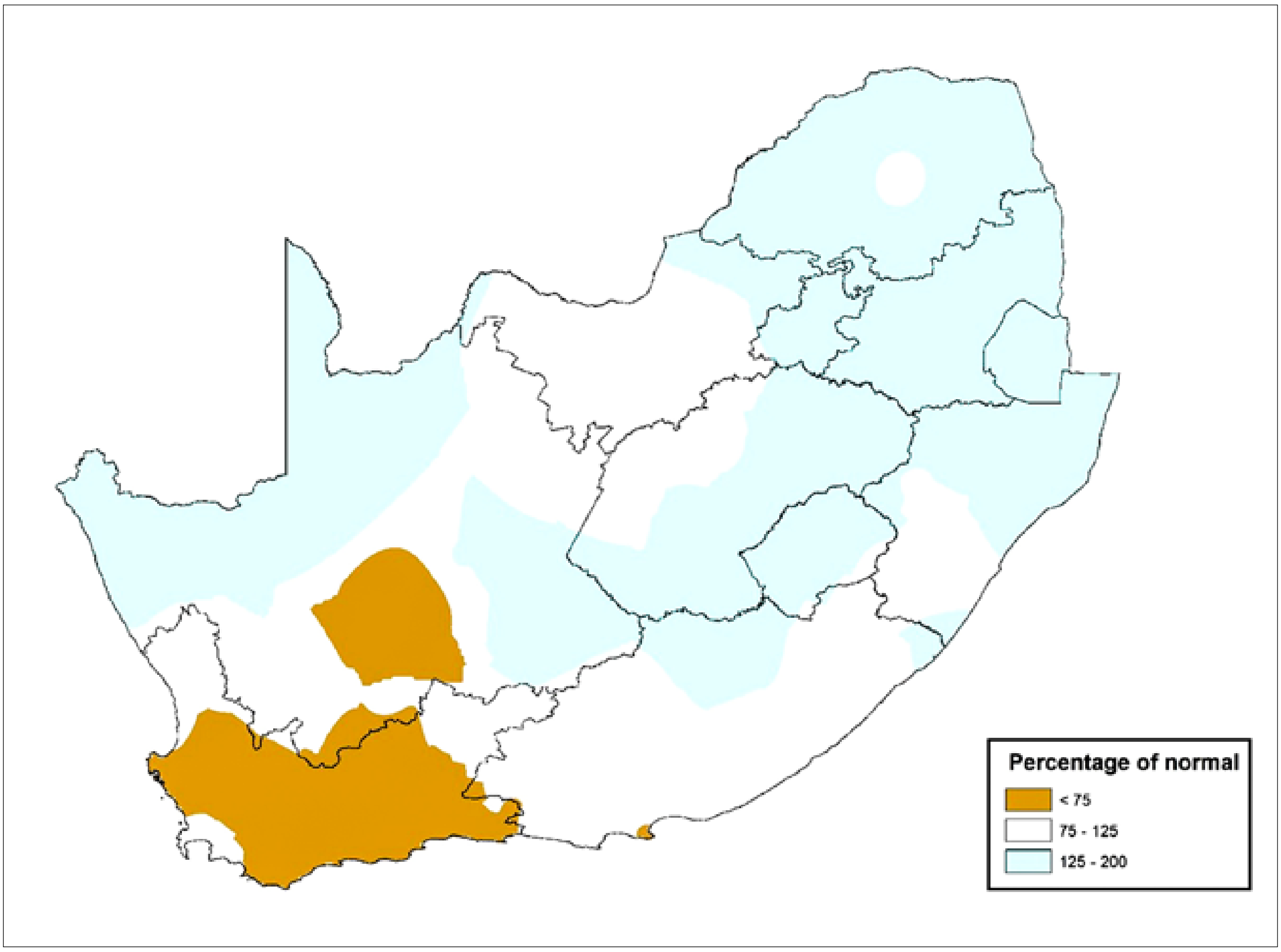

Figure 2: Rainfall anomalies (expressed as percentage of 1991 – 2020 annual average) for South Africa for 2025 (Source: South African Weather Service).

A Reflection of the 2025/26 Summer Season

Kelebogile Mathole, Cobus Olivier, Steven Phakula, Christien Engelbrecht

February 2026

Introduction

Seasonal rainfall and temperature predictions at the South African Weather Service (SAWS) are issued every month for a five-month forecast period. These months are grouped into staggered three-month seasons. The predictions for these three-month seasons are probabilistic and indicate which of the below-normal or above-normal categories of the average conditions for a particular three-month season are most likely. The SAWS multi-model seasonal prediction system is based on two seasonal prediction models. Seasonal forecasts are derived from the individual models before combining the forecasts of the contributing models into a multi-model ensemble forecast.

There was increased interest in the summer seasonal predictions for the 2025/26 summer rainfall season due to the evolution of a La Niña event in the El Niño Southern Oscillation (ENSO) phenomenon over the equatorial Pacific Ocean. A media briefing was given in September 2025 to inform and warn the country of the potential effects of this La Niña event.

Here, we present the observed rainfall and temperature conditions experienced so far (up to the end of February 2026) during the summer of 2025/26.

Rainfall and temperature evolution from late spring 2025 to mid-summer 2025/26

South Africa's summer rainfall season usually begins to take shape in October. Storm activity increases during November and becomes firmly established by December and January. Climatologically, the northeastern provinces, including Limpopo, Mpumalanga and parts of KwaZulu-Natal, tend to receive their peak rainfall during mid-summer from December to February. This is the time of year when tropical moisture moves further south, regional low-pressure systems become more active and tropical-temperate troughs (TTT) occur more frequently (*e.g. Mason and Jury, 1997; Todd and Washington, 1999*).

With this typical seasonal pattern in mind, the observed rainfall as measured by weather stations and averaged provincially from October-November-December (OND) 2025 to November-December-January (NDJ) 2025/26 has revealed a noticeable shift in how rainfall was distributed across the country (**Figure 1**). At the time of writing, the station rainfall data were available up to the end of January 2026.

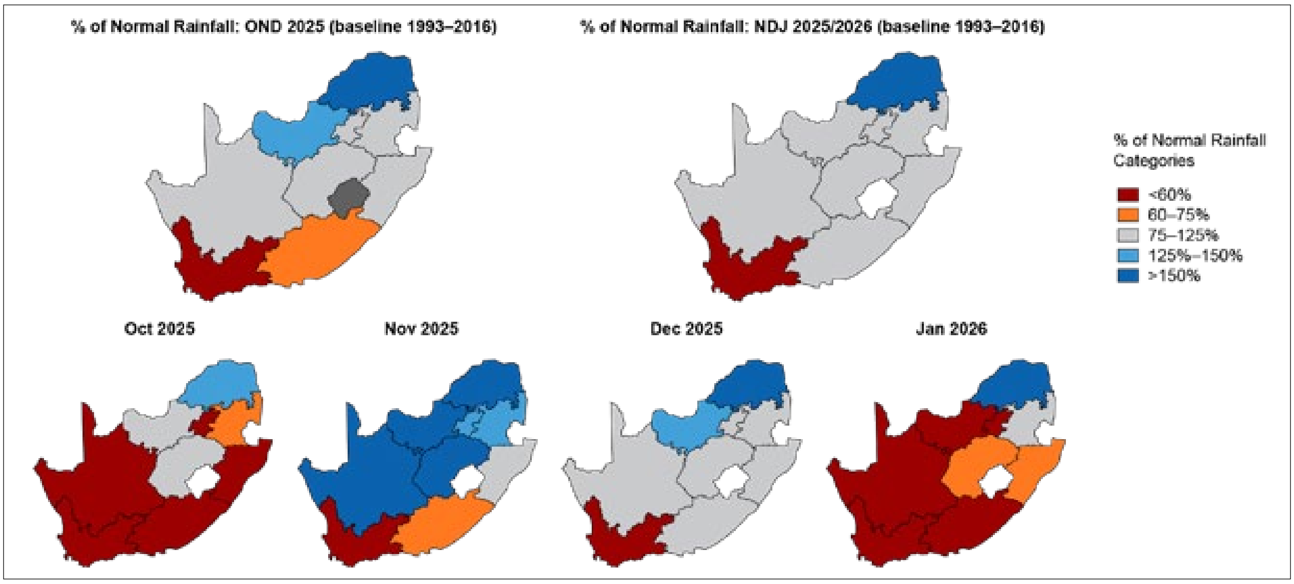

Figure 1: Percentage of normal rainfall across South Africa for OND 2025 and NDJ 2025/26 (baseline 1993 – 2016), with corresponding monthly breakdown (October 2025 – January 2026).

During OND 2025, much of the country received near-normal rainfall. Limpopo stood out as wetter than normal, and North West also recorded above-normal rainfall. Most of the central interior was neither particularly wet nor dry at this stage.

When moving into NDJ 2025/26, the overall picture does not change dramatically. We see that large parts of the country remained in the near-normal category. The most noticeable adjustment is in North West, which shifted from above normal in OND back to near-normal conditions in NDJ. Limpopo also remained relatively wet through both seasons and strengthened further in NDJ. This was largely due to the heavy rainfall recorded in January, when a persistent low-pressure system over southern Mozambique produced sustained rainfall across the northeastern interior. Rainfall data for February 2026 became available on 2 March 2026 from the United States' Climate Prediction Centre (CPC). The percentage of normal rainfall derived from the CPC data for the DJF season is shown in **Figure 2**. For consistency, the OND 2025 and NDJ 2025/26 percentage-of-normal-rainfall maps are also included and convey the same message as the provincially averaged percentage-of-normal-rainfall shown in **Figure 1**. During DJF, rainfall occurred over parts of the Western Cape, Eastern Cape and Northern Cape. This rainfall occurred in February (*Figure 3*), associated with a cut-off low, and brought relief to areas that at the time experienced very dry and hot conditions.

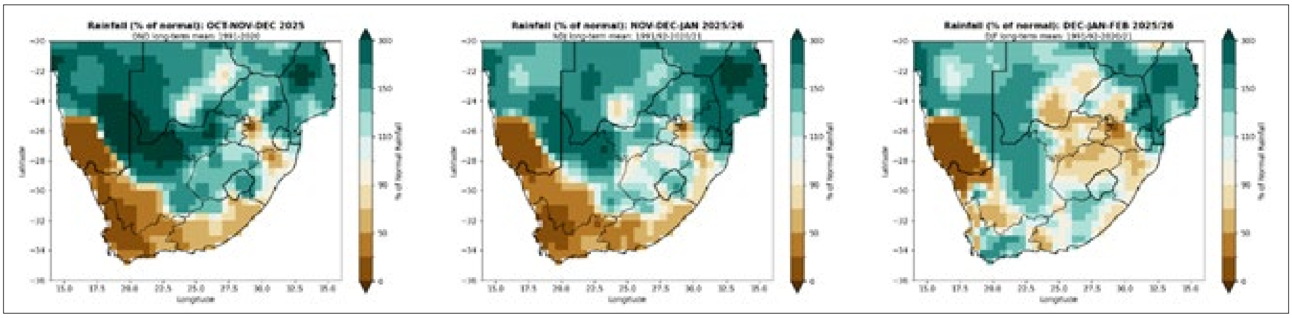

Figure 2: Percentage of normal rainfall based on the CPC rainfall data across South Africa for OND 2025, NDJ 2025/26 and DJF 2025/26.

When inspecting monthly maps (**Figure 1**), we can see that November 2025 was clearly a wet and cool month (**Figure 4**) over much of the interior, especially in the central to northeast regions, and this strongly supported the OND seasonal outcome. In contrast, January 2026 was drier across parts of the central and western interior and relatively warmer than normal (**Figure 4**). That reduced the NDJ totals in those areas even though the overall seasonal category remained near normal in many provinces. January 2026 saw record rainfall and floods over the far north-eastern escarpment areas of the country due to the low-pressure system that moved in from southern Mozambique and stalled just east of the northeastern escarpment for days. Those northeastern areas experienced cooler-than-normal conditions during January 2026, associated with rainfall.

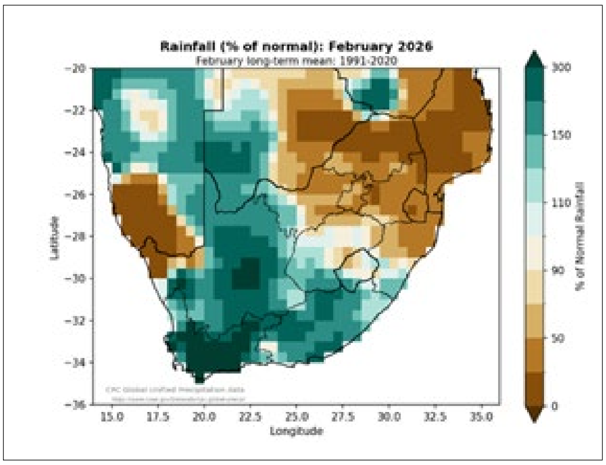

Figure 3: Percentage of normal rainfall based on the CPC rainfall data across South Africa for February 2026.

The focus of rainfall over South Africa during February 2026 shifted to the western and southern parts of the country, driven by a cut-off low weather system.

The 2025/26 fire season over the southwestern parts of the country was very active and extended spatially further eastwards along the Cape south coast. Devastating fires occurred. **Figure 4** shows that warmer-than-normal conditions occurred over those areas for most of the summer, particularly in November and December 2025, leading to further vegetation drying. Widespread rainfall brought relief in February.

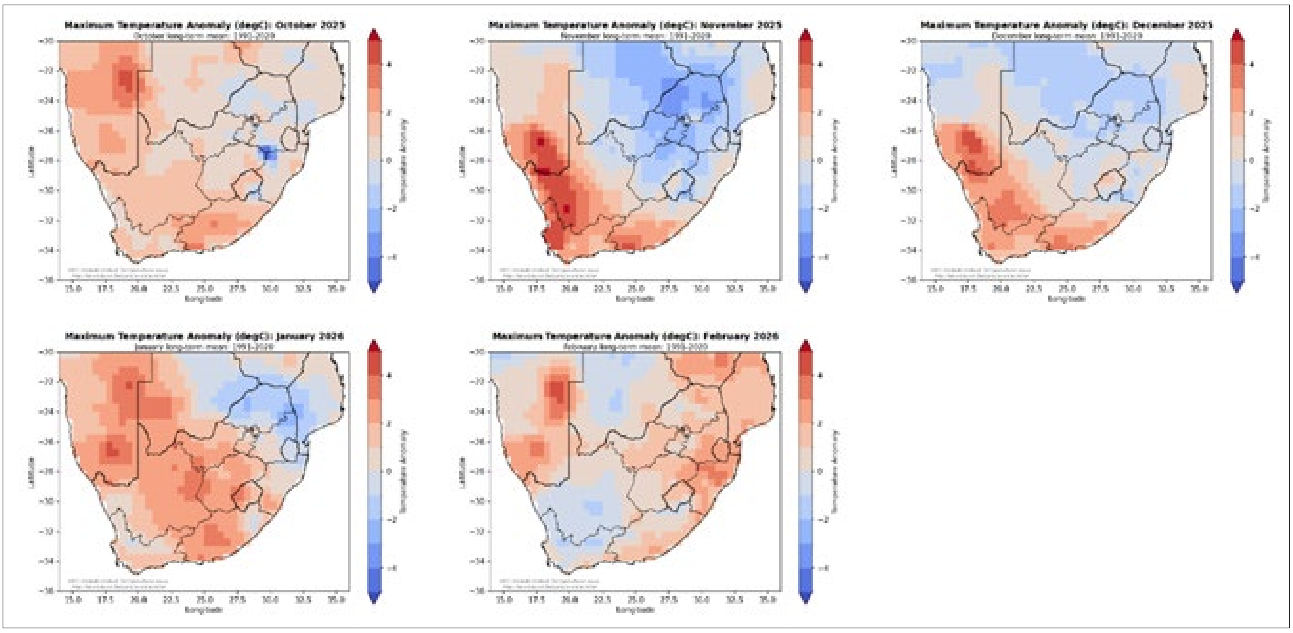

Figure 4: Maximum temperature anomalies based on the CPC temperature data across South Africa for October 2025, November 2025, December 2025, January 2026 and February 2026.

Provincial rainfall shift from October-November-December (OND) 2025 to November-December-January (NDJ) 2025/26

We also quantified the provincial change in the percentage of normal rainfall between OND 2025 and NDJ 2025/26, as shown in **Figure 5**. Limpopo recorded the largest positive shift (+38 percentage points), reflecting the strong contribution of January rainfall described earlier. Provinces such as the North West (-32), the Northern Cape (-31) and the Free State (-21) showed the largest declines. Moreover, Gauteng and the Northern Cape (marked with stars in **Figure 2**) crossed the 100% (normal) threshold between the two seasons. This indicates a shift across the normal rainfall benchmark, rather than simply a small fluctuation within the same rainfall category. The star, therefore, highlights a structural change relative to the climatological norm.

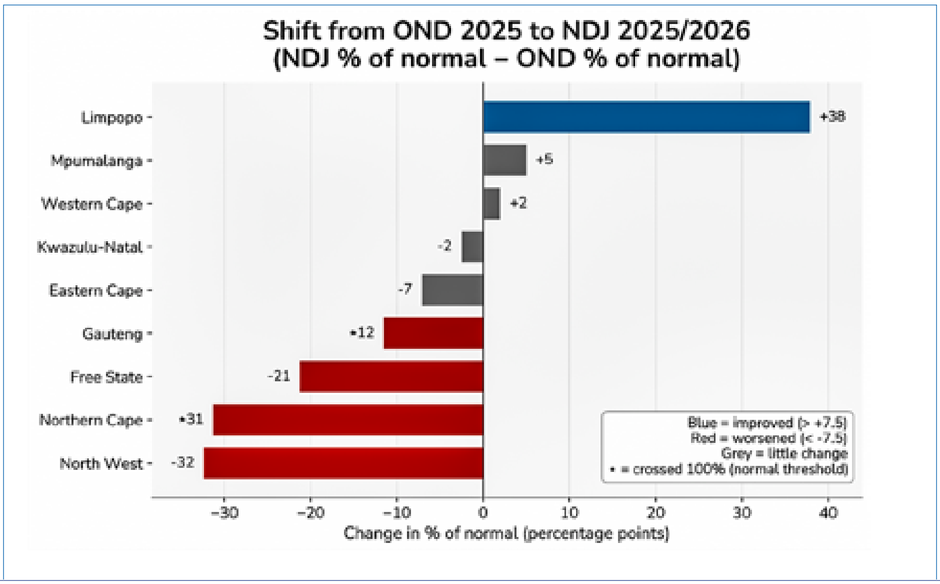

Figure 5: Provincial change in percentage of normal rainfall from OND 2025 to NDJ 2025/26 (NDJ minus OND), showing improvements (blue), declines (red) and provinces crossing the 100% normal threshold (★).

Large-scale ocean background

Given that the seasonal differences between OND and NDJ were largely driven by changes in monthly rainfall contributions, particularly the strong signals in November and January, it is also useful to examine the broader ocean state during this period (**Figure 6**).

ENSO

Sea surface temperatures in the Niño3.4 region remained weakly negative in both OND (-0.61 °C) and NDJ (-0.57 °C), indicating a persistent but weak La Niña-like state. The limited change between seasons suggests that ENSO provided a generally favourable background for summer rainfall over parts of South Africa, particularly the eastern interior, but did not directly drive the transition from OND to NDJ. So, in other words, ENSO conditions were relatively stable.

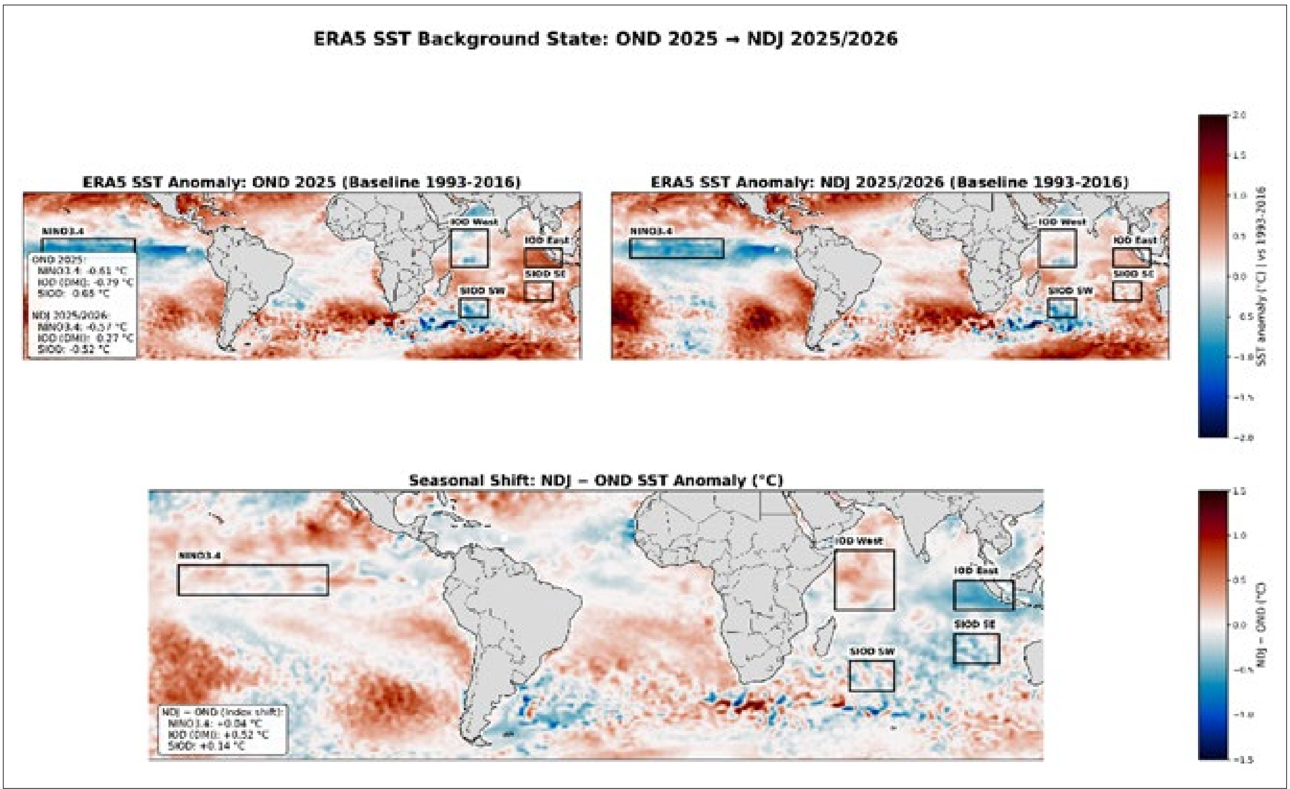

Figure 6: ERA5 SST anomaly patterns for OND 2025 and NDJ 2025/26 relative to 1993-2016, with the corresponding seasonal difference (NDJ - OND). Boxes indicate the Niño3.4, IOD and SIOD index regions.

Indian Ocean Dipole (IOD)

Also notable was the evolution in the tropical Indian Ocean. The Indian Ocean Dipole (IOD) weakened from -0.79 °C in OND to -0.27 °C in NDJ, a substantial +0.52°C shift toward neutral conditions. The Indian Ocean Dipole is characterised by anomalous zonal SST gradients across the equatorial Indian Ocean (*Saji et al., 1999*). Variations in this gradient can influence tropical convection and circulation patterns, which in turn may modulate moisture transport toward southern Africa. The Dipole Mode Index weakened substantially from OND to NDJ, indicating a relaxation of the negative phase. While ENSO conditions remained relatively stable, this Indian Ocean adjustment might have coincided with enhanced January rainfall over the northeastern interior, perhaps suggesting that the evolving ocean conditions may have supported mid-summer moisture availability.

Subtropical Indian Ocean Dipole (SIOD)

The Subtropical Indian Ocean Dipole remained negative in both seasons (-0.65 °C in OND and -0.52 °C in NDJ), with only modest changes between them. The SIOD represents variability in sea surface temperatures across the southern Indian Ocean subtropical region (*Behera & Yamagata, 2001*) and has been linked to southern African summer rainfall through its influence on the subtropical circulation and low-level moisture transport (*Reason, 2001*). In this case, the seasonal adjustment in the SIOD was relatively small compared to the change observed in the tropical IOD, suggesting that it likely contributed to the broader background oceanic state rather than driving the whole observed rainfall evolution.

Seasonal forecast

Here, the predictions made for the summer rainfall season are presented, starting from the predictions made in September 2025.

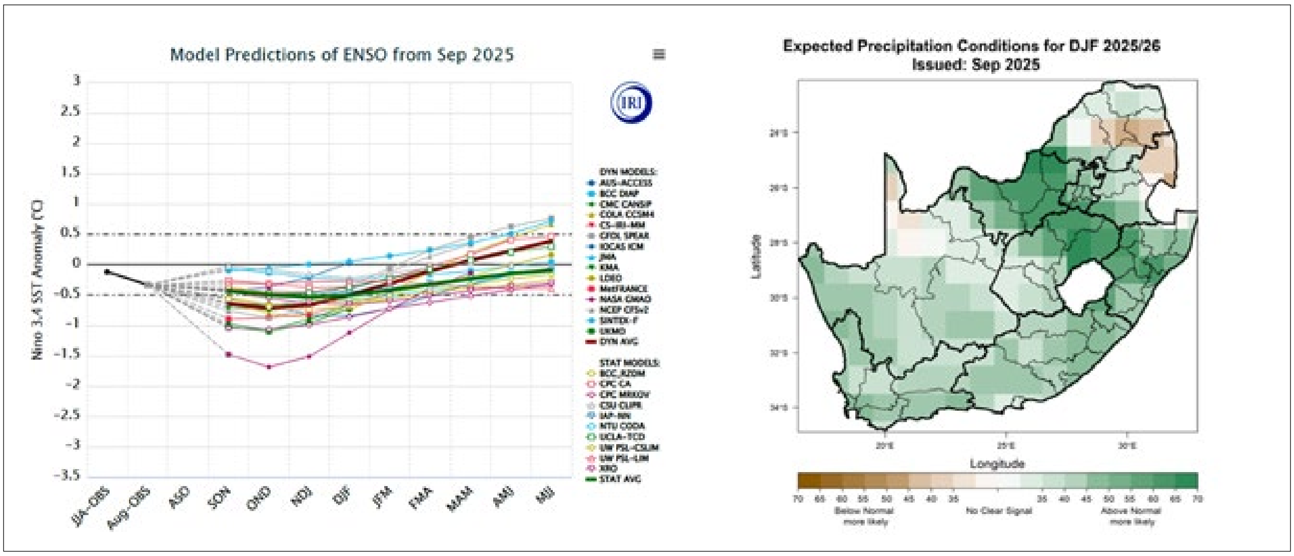

Figure 7: Model Predictions for the ENSO state (left, IRI) and the Dec-Jan-Feb 2025/26 season (right) made in September 2025.

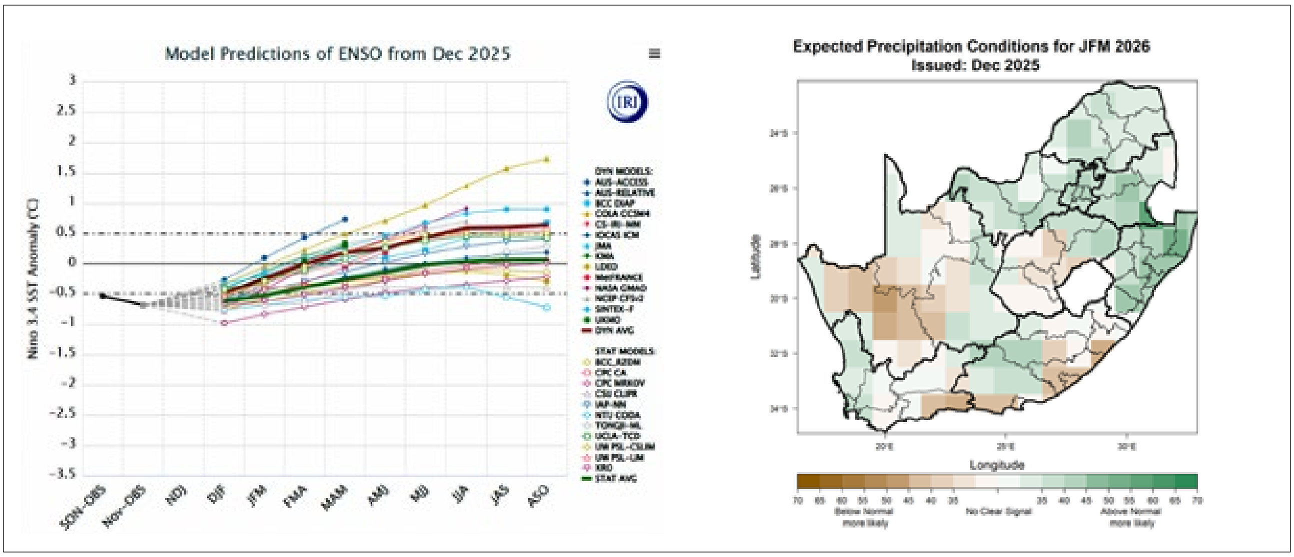

Figure 8: Model Predictions for the ENSO state (left, IRI) and the Jan-Feb-Mar 2026 season (right) made in December 2025.

In September 2025, the predictions indicated that the La Niña event would occur in early summer (**Figure 7**); however, there is usually a month-long lag in the effects of ENSO events in South Africa. Thus, we highlighted the DJF forecast in September (**Figure 7**). As the season progressed into December 2025 predictions (**Figure 8**), the effects of La Niña were delayed relative to those expected in September, and the JFM 2026 season (**Figure 8**) was indicated as the main season when La Niña would impact.

Summary

In summary, weak La Niña conditions were present for most of the 2025/26 summer season. As is typical during La Niña events, large parts of South Africa have received good rainfall so far (through February 2026 at the time of writing). November 2025 had very good rainfall over parts of the interior. In December 2025, rainfall was below average, and in January 2026, exceptional rainfall occurred over the far northeastern parts of the country, leading to floods, damage, and loss of life. Across the southwestern parts of the country, the summer has so far been mostly characterised by warmer-than-normal conditions, which have made conditions favourable for a very active fire season. Large parts of the southwestern and southern parts of the country continued to experience dry conditions, exacerbated by warmer-than-normal conditions. Relief came in February over those areas when cut-off low weather systems within a short span of time caused widespread rainfall. However, follow-up rains will be needed over those areas.

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Unseasonably Warm Daytime Temperatures Experienced Over the Western and Northern Cape During The 2025 Winter Season

Betty Makwakwa and Joew Malebane

Abstract: *Unseasonably warm conditions, mimicking typical summer daytime temperatures, were recorded over the Namakwa District and parts of the Western Cape on 29 July 2025. Temperatures peaked above normal before midday in some parts of the Namakwa district but cooled during the afternoon. This is an atypical pattern for winter, when daytime heating usually leads to a gradual rise towards a mid-afternoon maximum. On this day, the synoptic setup showed a surface trough along the west coast, which promoted offshore flow, contributing to adiabatic warming over Namakwa and the north-western Western Cape. At the same time, an inland surface high-pressure system advected warm tropical air across much of the Western Cape and the eastern parts of Namakwa, further enhancing the elevated temperatures. Later in the day, the approaching cold front from the south-west of the country brought northerly to north-westerly flow in the afternoon. As the front drew closer, cooling was observed over the western areas towards the afternoon.*

Introduction and background

The winter weather in the Western Cape and the Northern Cape is mainly influenced by cold fronts and ridging high pressure systems, where the maximum temperatures are generally cold to cool. Synoptic event analyses show that when a strong subtropical (Indian Ocean) high-pressure system is situated to the east or over the north-east of South Africa, it tends to favour warm air flow from the north-eastern tropical areas and eastern sector of the Indian Ocean, while suppressing moisture transport from the westerlies (*Mahlobo et al. 2023; Rouault et al. 2010; Miyamoto et al. 2022*).

In this case study, we aim to show that the central and western parts of South Africa may experience above-normal winter temperatures when tropical air is advected southwards from the tropics. This warm, subsident tropical air mass enhances surface heating (*Reason & Jagadheesha 2005; Hart et al. 2010*). The Western Cape typically remains dry during such episodes; therefore, persistent north-easterly flow can transport warm tropical air into the interior, producing warmer conditions inland (*Reason 2017*). Overall, strong tropical air intrusions tend to suppress cold-airmass circulation, reducing the likelihood of 'sharp' daytime cooling and leading to warm winter days (*Engelbrecht et al. 2015*).

29 Jul 2025		Forecast		Current parameters					Min Max		Flags
Current Synop	Day: 29 1300Z	Tn	Tx	T	Td	Wind		Gust	Tn	Tx	Tx
68403	Alexander Bay			17.5	10.9	310	19	27	17.5	22.3	5
68512	Springbok			20.3	7.8	030	23	31	19.5	21.5	1
68416	Pofadder			19.4	8.5	030	09	21	19.4	21.1	2
68516	Garies			30.3	8.4	010	13	25	30.1	30.6	0
68618	Calvinia			21.8	7.0	010	19	29	20.9	22.3	1
68722	Sutherland			16.8	6.1	330	14	27	15.7	17.1	0
68614	Vredendal			31.0	8.4	020	05	13	31.0	32.4	1
68711	Clanwilliam			29.8	9.1	020	04	13	29.6	30.5	1
68710	Redelinghuys			29.9	8.6	010	07	13	29.6	30.4	1
68714	Langebaanweg (Tn)			27.9	9.9	360	14	28	27.8	28.2	0
68811	Geelbek (Tx)			27.3	8.4	350	20	30	27.3	27.9	1
68715	Malmesbury			27.3	13.1	010	09	15	27.2	27.8	1
68809	Atlantis			28.1	10.6	340	07	18	27.8	28.3	0
68813	Robben Island			21.6	12.5	360	04	07	21.2	23.6	2
68819	Cape Town - City			27.9	9.9	360	05	10	27.6	28.6	1
68816	Cape Town International			27.9	12.8	010	12	X	X	X	
68912	Slangkop			20.0	11.8	340	14	18	19.7	24.8	5
68916	Cape Point			X	X	X	X	X	X	X	
68812	Kirstenbosch			25.0	12.4	070	04	16	24.7	25.3	0
68911	Strand			X	X	X	X	X	X	X	
68822	Stellenbosch			28.4	9.4	350	05	14	27.2	29.1	1
68713	Paarl			26.1	13.1	350	04	08	25.6	27.0	1
68925	Grabouw			26.9	7.6	330	07	15	26.8	28.3	1
68815	Ceres			28.3	10.7	000	00	02	26.2	29.0	1
68821	Worcester			28.1	9.1	260	03	06	27.9	28.8	1
68718	Robertson			25.9	5.2	340	06	10	25.8	26.5	1
68723	Laingsburg			X	X	X	X	X	X	X	
68727	Beaufort-West			22.5	5.1	350	24	37	22.4	23.3	1
68823	Prins Albert			26.6	7.8	330	06	14	25.1	26.6	0
68827	Oudtshoorn			27.7	6.7	340	09	17	27.2	27.8	0
68825	Ladismith			25.8	6.1	300	08	19	25.8	26.6	1
68918	Hermanus			29.6	8.9	020	05	12	29.6	30.3	1
68920	Cape Agulhas			28.0	11.8	080	03	07	28.0	29.0	1
68922	Swellendam			29.3	6.3	350	09	25	29.1	29.5	0
68926	Riversdale			28.9	8.8	350	08	17	28.1	30.0	1
68929	Mossel bay			29.5	7.1	360	10	19	29.4	29.9	0
68828	George			X	X	X	X	X	X	X	
68935	Knysna			X	X	X	X	X	X	X	
68931	Plettenberg Bay			X	X	X	X	X	X	X	

Figure 1: Daytime temperatures observed at 13:00Z on 29 July 2025.

Forecasting Parameters

Weather situation

On 28 July 2025, a cold front was approaching far west of the country, with clear conditions over the Northern and Western Cape, while some convective development occurred over the southern parts of Namibia, as shown in **Figure 2a**. The cold front was expected to move closer to the country the next day, 29 July, thereby affecting afternoon maximum temperatures, but for the most part, it would remain clear.

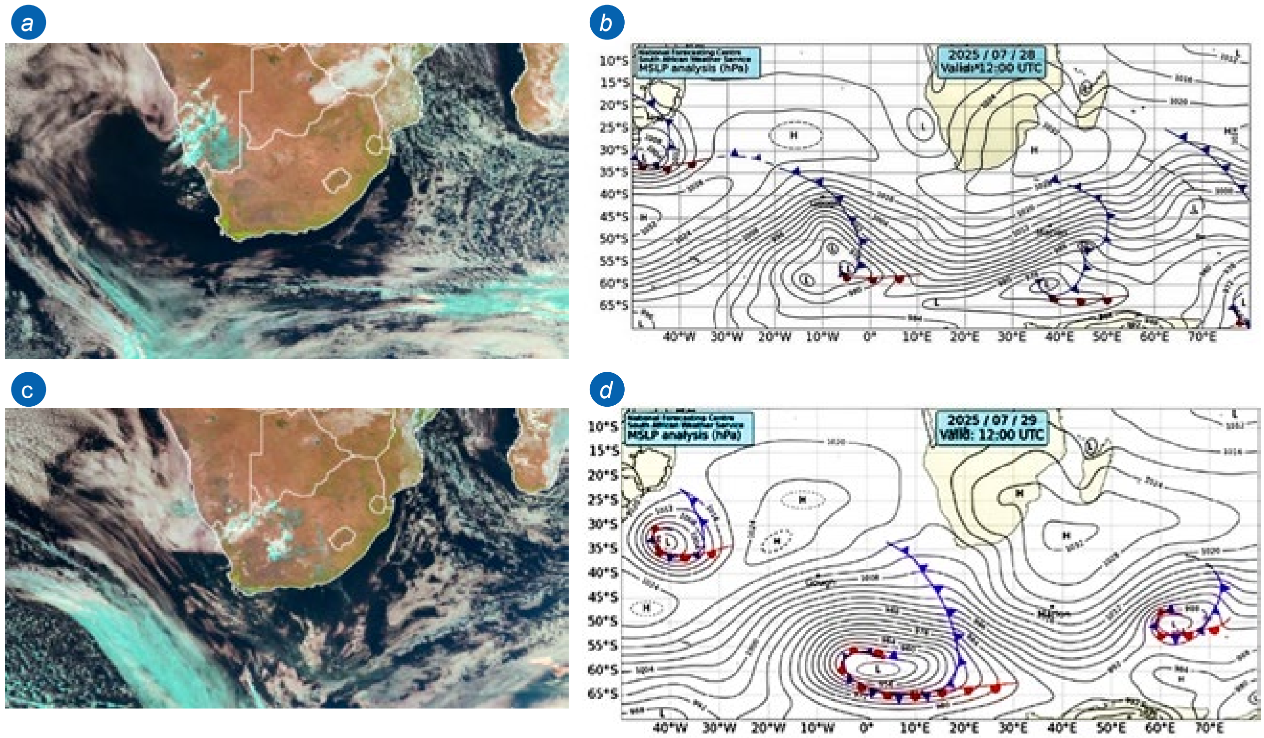


Figure 2: Satellite imagery (Natural-colour MSG-RGB, Eumetsat) for the (a) 28 July at 12h00Z, (c) for 29 July (12h00Z) with the observation synoptic chart indicating the dominating weather systems. A surface low-pressure system over the Namibian coastline and the inland high-pressure system over the interior of the country at 12h00Z on (b) 28 July and (d) 29 July 2025.

Synoptic Systems

When forecasting temperatures, several atmospheric parameters are taken into consideration, including prevailing synoptic weather systems. On this day, a high-pressure system dominated the country's interior. In contrast, a low-pressure system over the Namibian coast extended its trough southwards along the west coast of South Africa, as illustrated by **Figure 2b**. The interaction between these two systems influences local temperature patterns. The inland high-pressure system advected warm tropical air into the western regions of the country, including the Northern Cape and Western Cape. Simultaneously, the surface trough supports offshore flow along the coastal areas. The combined effects of these systems result in warm, dry, and clear conditions, consistent with the observations shown in **Figure 2a**.

Wind

Wind speed and direction play a critical role in temperature forecasting, as they can warm or cool the lower atmosphere depending on the flow regime and wind intensity.

Strong easterly to north-easterly winds were expected across the region, as illustrated in **Figure 3**. This wind flow is typically associated with the advection of warm-to-hot air, resulting in elevated temperatures even in the early morning hours. Consequently, maximum temperatures over the Namakwa District and the northern parts of the Western Cape were expected to be reached earlier than usual. This is attributable to the combination of above-average minimum temperatures and persistent, strong winds transporting warm tropical air into the region from 28 July (**Figure 3a, b**). In addition to their thermodynamic influence, these winds serve as indicators of the spatial extent of the synoptic systems discussed in Section 1.2. This is evident in the 12Z Unified Model (hereafter called UM) wind predictions shown in **Figure 3d**, which indicate the position of the approaching cold front.

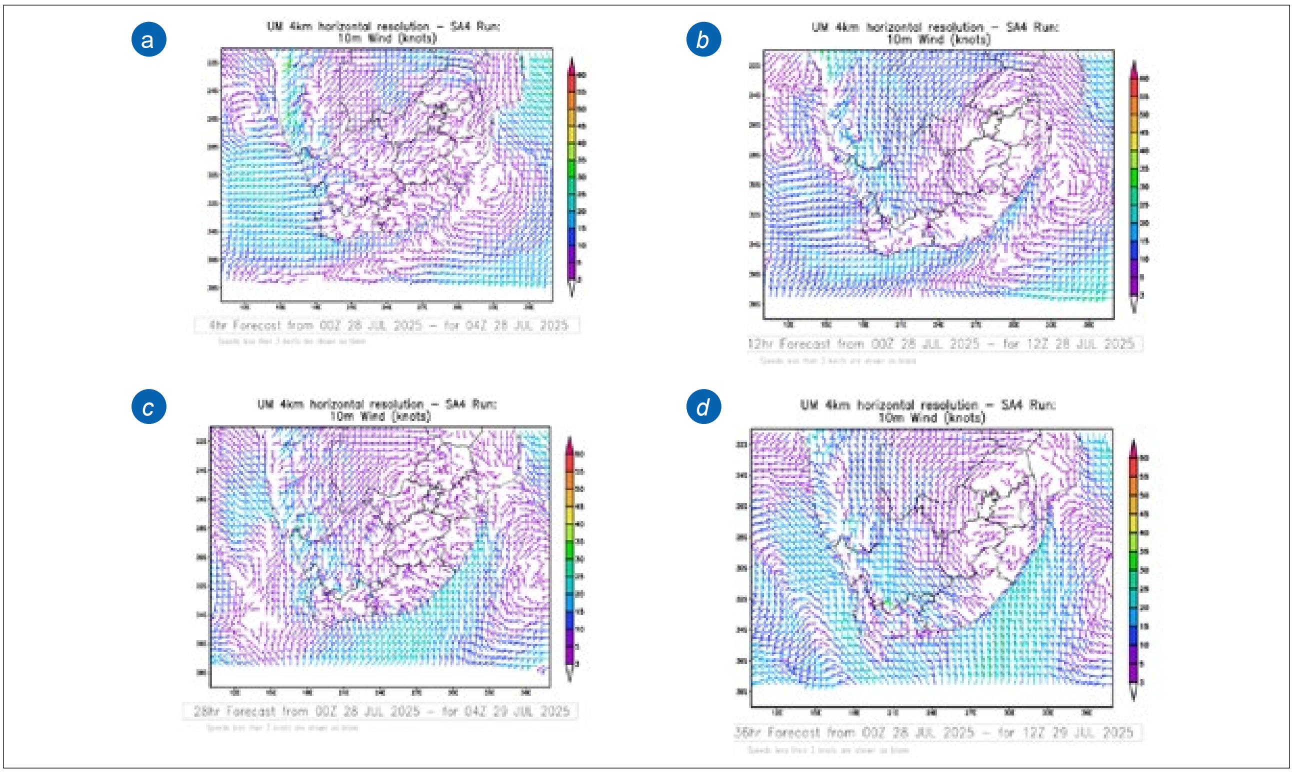
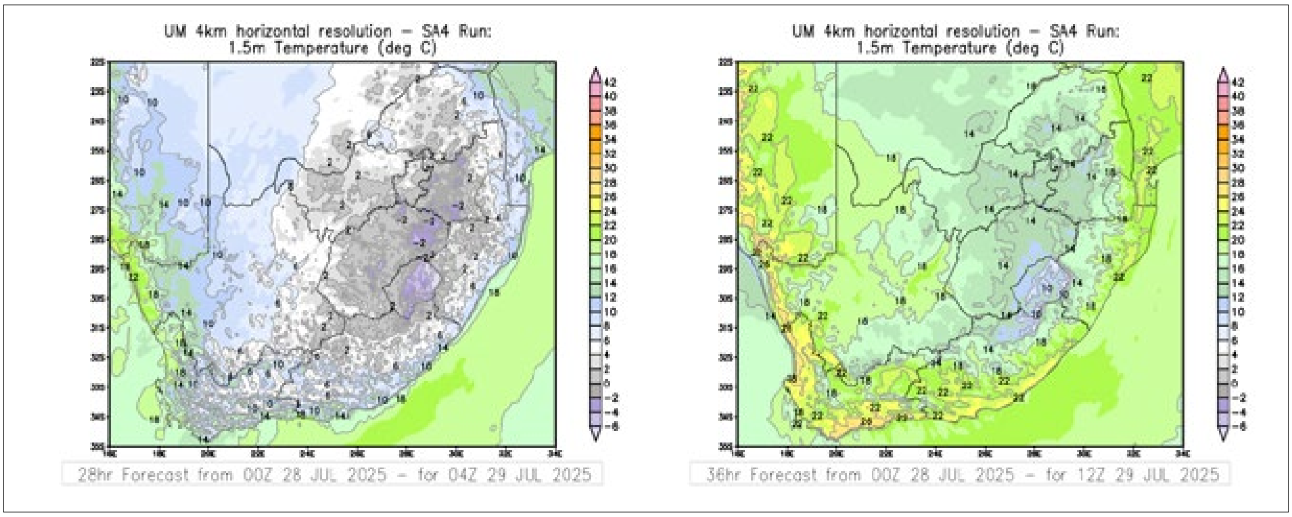


Figure 3: Unified Model (UM) 10 m winds indicating the strong north to north-easterly winds over the Northern Cape and Western Cape for the morning (a) of 28 and (c) and 29 July 2025, and the afternoon (b) of 28 and (d) 29 July 2025.

Predicted Model Temperatures

The Unified Model projected warmer minimum temperatures over the west coast but kept most minimums close to average over the south-west coast (see **Figure 4**). In contrast, maximum temperatures were predicted to reach around 26 to 28°C in the west, south-west and south coastal areas, which were warmer than the average maximum. This was to be expected with the weather systems in play.



Observation Analysis

The Alexander Bay station reached a maximum of 25°C at 03Z (around 05h00 SAST), with winds predominantly offshore (**Figure 5**). The METAR observations showed that a transition to onshore winds occurred between 05Z and 06Z, coinciding with a temperature drop from 22 to 17°C. In contrast, the Unified Model had anticipated this wind direction and the consequent cooling change to take place after 07Z (09h00 SAST).

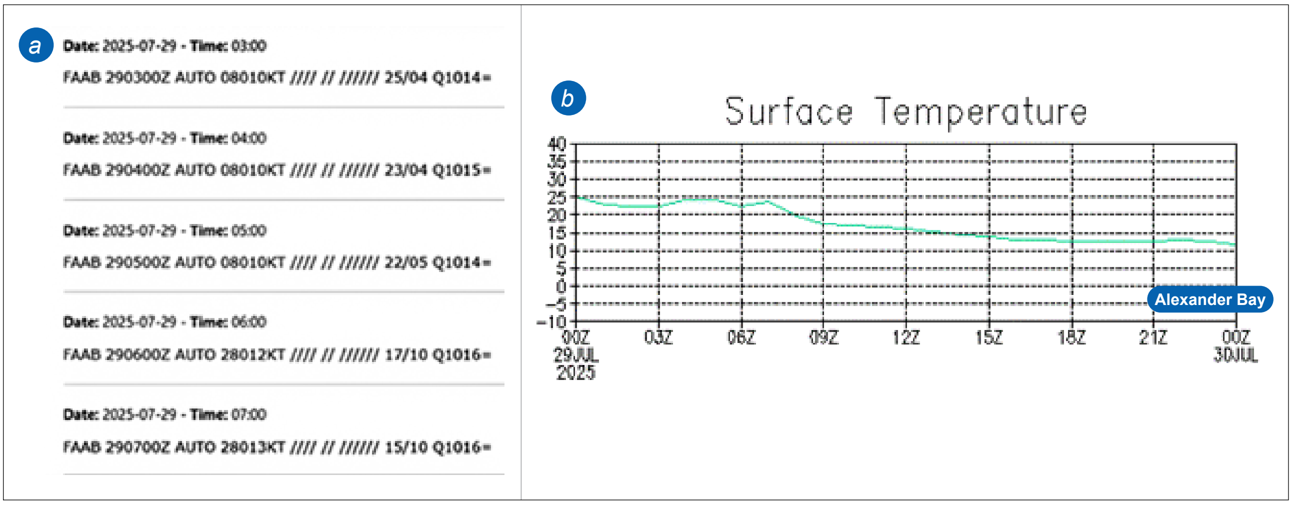


Figure 5: (a) METAR indicating the observed temperature and wind direction change over Alexander Bay in the morning, and (b) UM spot graph surface temperature forecast.

From *Figure 2c*, the cold front was observed near the western parts of the country, with low clouds due to onshore north-westerly winds over the extreme northern coastline of the Northern Cape. This occurred already at 12Z, resulting in cooling temperatures over Alexander Bay, which explains why the maximum temperatures reached 25°C in the early morning and then cooled significantly towards the afternoon, as observed in **Figure 5a**.

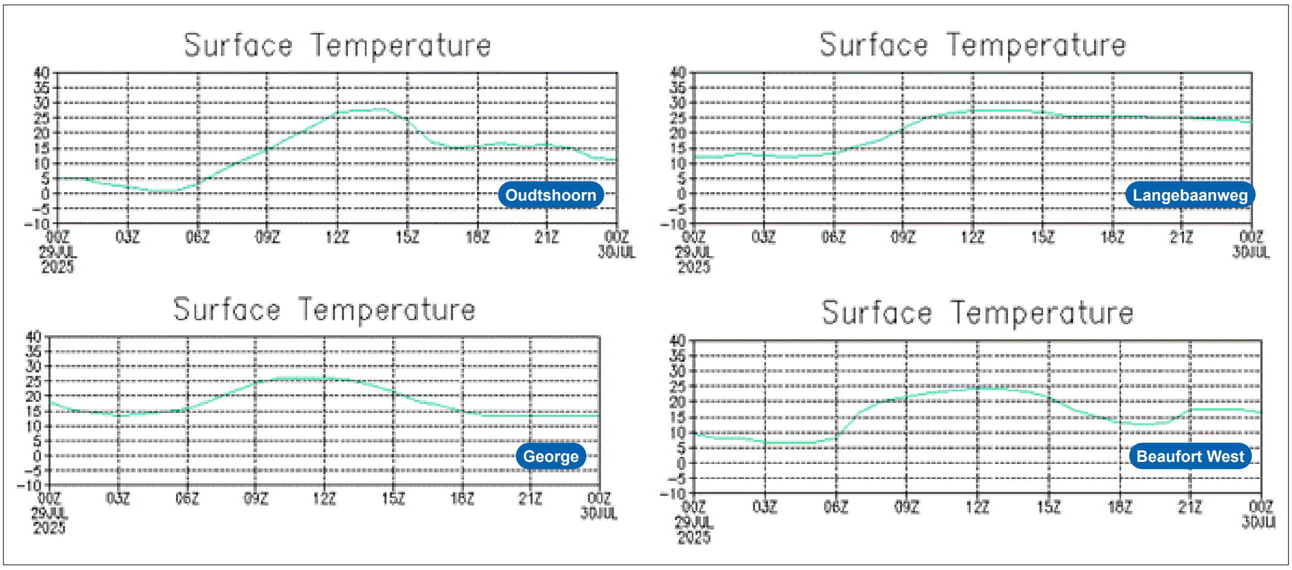


Figure 6: UM Spot graph surface temperature forecast for different stations projecting warm summer-like temperatures for 29 July 2025.

Most stations over the interior had summer-feel afternoon temperatures. Furthermore, other areas along the West Coast had unusual winter minimums and higher maximums. These areas included Vredendal, Clanwilliam, Redelinghuys, Langebaan, Malmesbury, Atlantis, and Oudtshoorn (**Figure 1**).

It is also important to note that the Unified Model indicated higher minimums and maximums (**Figure 6**) but missed some areas, such as the City of Cape Town, which recorded a warmer minimum temperature of 18°C with a north-easterly wind, and a maximum temperature of 28°C with a north-westerly wind. When the cold front moved through in the afternoon (**Figure 7**), these observed minimum and maximum temperatures are relatively rare for the winter months.

FACT 290300Z 02010KT CAVOK 18/03 Q1016 NOSIG=

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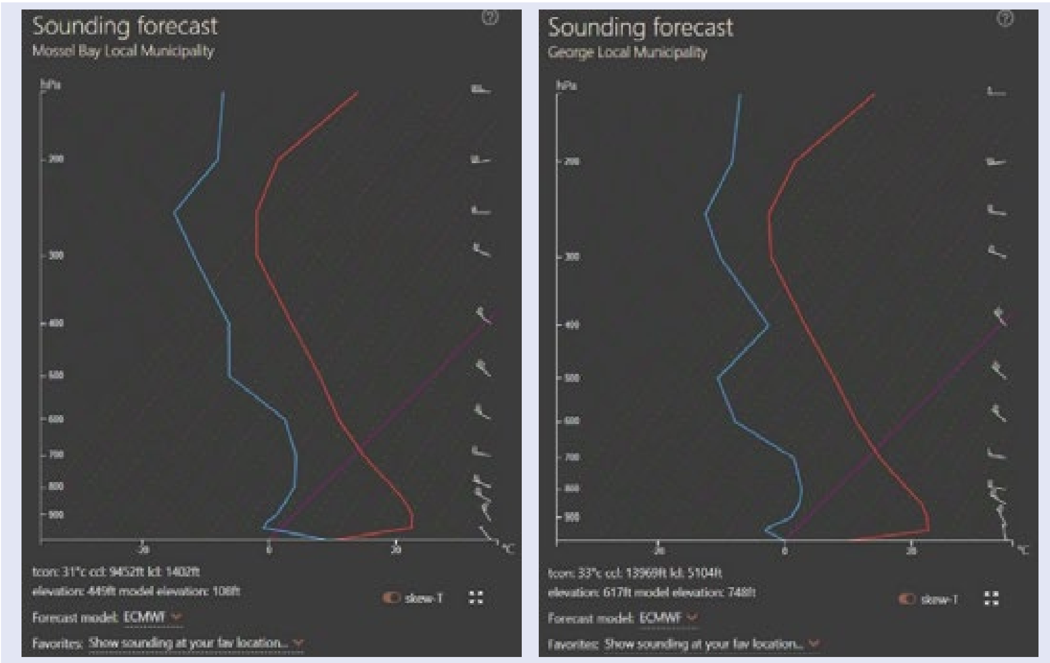
Figure 7: Cape Town METAR illustrating the observed winds and temperatures in the morning (top) and the afternoon (bottom).

The stations with warm temperatures had a surface inversion layer observed on the night of the 28th into the 29th of July 2025 (**Figure 8**). The low-level temperature inversion contributed to the unusually warm, summer-like daytime temperatures, as it was associated with a strong high-pressure system. At the same time, subsidence around the high-pressure suppressed cloud formation (**Figure 2c, d**), resulting in clear skies and consequently enhanced surface heating.



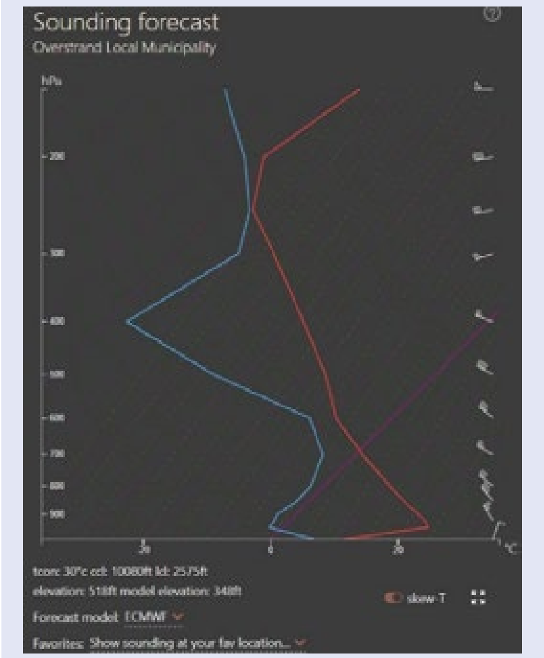


Figure 8: The ECMWF SkewT plots at different stations along the southern coast, showing a low-level inversion layer on 29 July 2025 at 00h00Z

Conclusion

On this day, the combination of a dominating inland high-pressure system and a coastal low-pressure trough created a warm winter scenario. These systems collectively enhanced the advection of warm tropical air into the western interior and coastal regions, leading to unusually warm, dry, and clear conditions. Strong easterly to north-easterly winds further amplified this warming by facilitating early temperature increases and illustrating the spatial extent of the synoptic systems.

The analysis of the above synoptic situation demonstrates how temperature forecasting relies on a detailed understanding of atmospheric dynamics, including synoptic systems, wind, and associated advective processes. Therefore, it highlights that forecasting temperatures requires significant expertise and remains inherently complex. Although the Unified Models performed well overall, some temperature deviations were not accurately captured (as seen on the Unified Model spot graphs). Such discrepancies emphasise the ongoing need for forecaster interpretation, as human expertise allows for the integration of nuanced atmospheric patterns and the filling of gaps that models may overlook.

Future Research and Recommendations

Many studies in southern Africa focus on summer rainfall and moisture fluxes due to their link with severe weather events, whereas winter processes, particularly temperature extremes and tropical air mass intrusions, remain less extensively studied (*Roffe, Lynch & Reason 2021; Camargo et al. 2022*). The analysis of this event could serve as a basis for conducting a climatological study of warm-to-hot temperature days occurring during the winter season, while examining a broader domain across southern Africa.

As the field advances into an era increasingly influenced by Artificial Intelligence, this example underscores that forecasters continue to play an indispensable role. Their ability to interpret and contextualise multiple atmospheric parameters ensures that temperature forecasts remain both accurate and operationally relevant, even during rare events such as this unusually warm winter day.

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The Role of Early Warnings in Supporting Disaster Management: A Case Study on a Series of Cold Fronts from 3 to 6 July 2025

Mahlako Makgata – Forecaster, and Lauren Smith – Senior Forecaster

Introduction

Early warning systems play a crucial role in reducing the impacts of hazardous weather events by providing timely and actionable information to disaster management authorities and the public. Through continuous monitoring of weather systems, forecasters can identify potential hazards, assess their likely impacts, and communicate early warnings that allow communities and response agencies to prepare themselves in advance.

This article examines the role of early warnings in supporting disaster management decision-making through a case study of a series of cold fronts that affected the western parts of South Africa between 3 and 6 July 2025. The event brought very cold, wet, and windy conditions, with the potential for flooding, strong coastal winds, rough seas, and snowfall over mountain peaks. These conditions posed risks to vulnerable communities, particularly small-stock farmers, as well as infrastructure and transportation networks.

Using this event as a case study, the article illustrates how the early warning process operates within the South African Weather Service (SAWS) and how collaboration with Disaster Management supports preparedness, mitigation planning, and response actions. This creates a better understanding of how early warning systems support disaster management operations. It is important first to consider the meteorological conditions associated with the July 2025 cold front event and the potential hazards it presented. The following section provides a brief overview of the synoptic setup and expected impacts of the series of cold fronts that affected the western parts of South Africa.

Background

Between 3 and 6 July 2025, a series of cold fronts moved across the western parts of South Africa, resulting in widespread winter weather conditions across the Western Cape and parts of the Namakwa District in the Northern Cape. These systems were associated with a surface trough over the western interior and an approaching upper-air trough that supported the development and intensification of the frontal systems.

As the cold fronts approached and made landfall, freezing levels were expected to decrease significantly. At the same time, a tightening pressure gradient over the western regions of the country led to stronger winds along the coast and in adjacent interior areas. The combined synoptic setup was forecast to produce scattered to widespread rainfall across the western parts of the Western Cape from late Wednesday through to Sunday evening. Over the four days, rainfall accumulation was expected to reach between 30 and 60 mm over the south-western parts of the province, while mountainous regions were expected to receive between 70 and 90 mm. The most significant rainfall was anticipated from Friday going into Saturday.

These weather conditions posed several potential risks. Very cold daytime temperatures were expected in the central and western interior of the Western Cape and the Namakwa District, with maximum temperatures remaining below 10 °C. Combined with rainfall and strong winds, these conditions presented risks to small-stock farmers and vulnerable members of the community, particularly the elderly and young children. In addition to the cold conditions, the forecast rainfall raised concerns about flooding in areas that had already experienced significant rainfall earlier in the month. Soil saturation and elevated dam and river levels increased the likelihood of rapid runoff and localised flooding. Snowfall was also expected over the mountain peaks as cold fronts moved across the western parts of the country.

Given the range of potential hazards associated with this cold front event, timely and well-coordinated early warnings were essential to reduce risks to vulnerable communities and infrastructure. Understanding how these warnings are developed and communicated is therefore central to appreciating the role of meteorological services in supporting disaster risk management.

The Role of Early Warning Systems

Early warning systems provide advanced communication regarding potentially hazardous weather conditions and their expected impacts. These systems combine meteorological forecasting with impact assessment to inform authorities and communities about potential risks. Within the forecasting environment, warnings are developed by assessing the likelihood of hazardous weather conditions and evaluating their potential impacts on society. The severity level of a warning is determined not only by the meteorological hazard itself, but also by the vulnerability of the affected region. Local vulnerability factors such as infrastructure, transportation routes, essential services, environmental conditions and regional activities are considered when determining the appropriate warning level. Regions may be particularly sensitive to certain weather hazards, including:

- rainfall accumulation
- snow accumulation
- strong winds over interior and coastal areas
- wave heights and swell periods
- severe thunderstorms

Clear and simple communication of these warnings is essential so that stakeholders and the public can understand the risks and take appropriate precautionary actions.

While the forecasting process provides the scientific basis for early warnings, their effectiveness ultimately depends on close collaboration between meteorological services and disaster management authorities. This partnership ensures that warnings are translated into practical preparedness and response actions at provincial and municipal levels. In the Western Cape region, forecasters at the Cape Town Weather Office play a central role in identifying potential hazards and issuing impact-based warnings. During forecasting shifts, dedicated time is allocated to discussing developing weather systems and assessing their potential impacts. These discussions focus on evaluating the severity of the weather event, determining appropriate warning levels, and identifying the areas and time periods likely to be affected. Once potential warnings are identified, the Provincial Disaster Management Centre (PDMC) is contacted to discuss the developing situation. This communication typically takes place via phone calls or WhatsApp messages, allowing both institutions to exchange information and assess the likelihood and severity of potential impacts.

After the SAWS and Disaster Management jointly agree on the warning levels, the warnings are compiled and disseminated to relevant stakeholders, such as municipal districts in the Western Cape and Namakwa region, via Impact-Based Forecasting (IBF) WhatsApp groups. They are also sent to the National Forecasting Centre for public dissemination. Over time, this collaboration has strengthened significantly, resulting in an efficient and well-coordinated warning dissemination process.

Within this collaborative framework, the forecasting process itself remains central to identifying potential hazards and determining appropriate warning levels. The following section describes how forecasters monitored the approaching weather systems and assessed their potential impacts during the July 2025 event.

The Early Warning Process During the Event

Numerical weather prediction (NWP) models form a critical component of the forecasting process when assessing approaching weather systems. Forecasters continuously monitor multiple NWP models to evaluate the expected development, timing and severity of weather events. These model outputs are interpreted considering the forecaster's experience and previous feedback from Disaster Management. This combination of scientific guidance and operational knowledge enables forecasters to make informed decisions regarding potential warning levels.

As these weather systems approached, forecast confidence increased, and the approaching cold fronts became more clearly defined in both model guidance and observational data. Consequently, warnings were continuously monitored and updated as new information became available. Forecasters were able to determine the appropriate impact-based warnings for the event, which formed the basis of early warning communication issued to Disaster Management. Once the system made landfall, forecasters closely monitored observed conditions such as rainfall accumulation, wind speeds and swell heights. Throughout the event, updated information on observed conditions and forecast developments was shared with Disaster Management to ensure that authorities remained informed and prepared.

On the day before the first event day, the forecasting team issued three Impact-Based Forecasting (IBF) warnings in response to the approaching cold fronts (**Figure 1**). Two Yellow Level 2 warnings were issued for damaging waves and winds along the south-western coastline. Strong to gale-force winds of 60–70 km/h with gusts reaching approximately 80 km/h were forecast along the coast. These winds were expected to be accompanied by significant wave heights between 3,5 and 4,5 m on 4 July 2025. Very rough sea conditions were also forecast along the south coast of the Western Cape from 5 to 7 July 2025, with wave heights expected to reach between 4,5 and 5,5 m together with strong winds. In addition, a Yellow Level 4 Impact-Based Forecasting warning for disruptive rainfall was issued for the western parts of the Western Cape from 3 to 6 July 2025.

The primary impacts highlighted in these warnings included flooding of roads and settlements, potential damage to infrastructure and property, and dangers associated with fast-flowing streams crossing low-lying bridges. Major traffic disruptions were also possible due to flooded or damaged roads, potentially increasing travel times across affected regions. Additional risks included mudslides and rockfalls in mountainous areas, disruptions to essential services such as water and electricity supply, and hazardous conditions for small vessels and personal watercraft along the coast. Localised disruptions to small harbours, ports and beachfront activities were also considered possible.

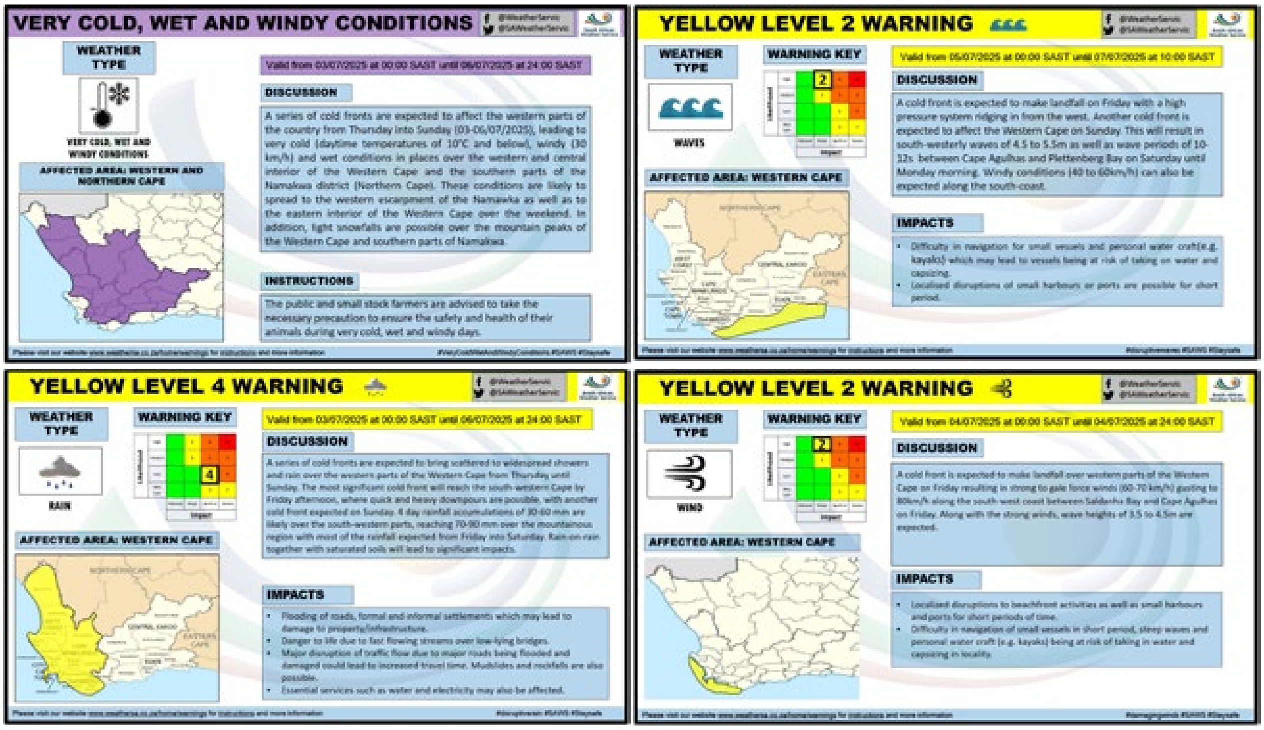


Figure 1: Weather advisory and IBF warnings issued for the event.

Once the warnings were issued, continued communication with Disaster Management remained essential to ensure that decision-makers fully understood the event's potential impacts. This led to the organisation of early warning briefings and operational coordination meetings as the event unfolded.

As the weather event developed, the Western Cape Disaster Management Centre requested an Impact-Based Forecasting Early Warning Weather Briefing for the Overberg District. At the time of the briefing, dam levels were steadily rising, and several rivers were already at bank-full capacity. The Hermanus and Betty's Bay areas, which had already experienced flooding following approximately 20 mm of rainfall during the first day of the event, were areas of concern. Forecast guidance indicated the possibility of an additional 80 mm of rainfall within a short period, significantly increasing the risk of further flooding in the region (**Figure 2**).

The early warning weather briefing was conducted on 3 July 2025 by a senior forecaster from the Cape Town office. The presentation focused on the issued warnings and weather advisories, with particular emphasis on observed rainfall amounts and the rainfall still expected in the coming days. On the following day, a Joint Operations Centre (JOC) meeting was convened. During this meeting, both the Western Cape Disaster Management Centre and the SAWS Chief Forecaster presented updated information, and mitigation and response plans were discussed and implemented. These engagements formed part of a broader communication process between the SAWS and Disaster Management authorities.

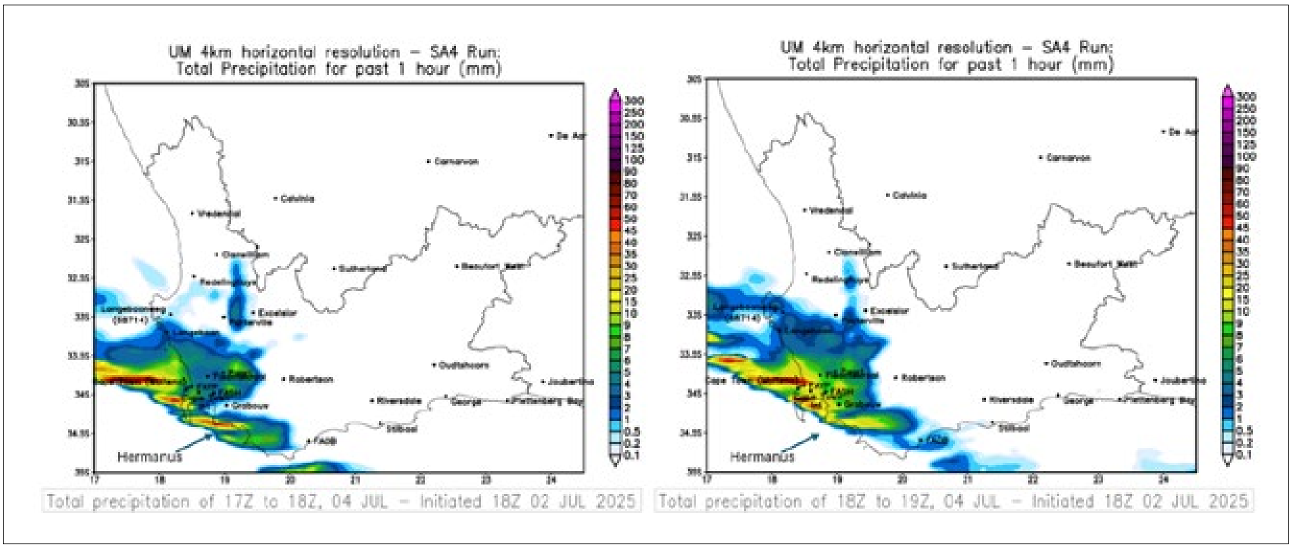


Figure 2: UM 4 km model precipitation forecast indicating approximately 55 mm within two hours for the Hermanus and Betty's Bay region.

Continuous information sharing through IBF warnings, early warning briefings and JOC engagements ensured that decision-makers received timely and clear guidance, ensuring a coordinated response. Regular updates on observed rainfall, wind speeds, swell heights and forecast developments strengthened confidence in the evolving forecast. This consistent engagement also demonstrated transparency in the forecasting process and reinforced trust between institutions. As a result, disaster management authorities were able to refine mitigation strategies and respond rapidly to changing weather conditions.

Beyond supporting real-time decision-making during the event, this collaborative communication process also contributes to learning and improvement within the early warning system. Feedback from stakeholders provides valuable insights into how warnings are interpreted and how their effectiveness can be enhanced in future events.

Outcomes and Feedback

Feedback from stakeholders is an essential component of the forecasting process. It allows forecasters to understand better which warnings are most relevant to specific regions and how different weather hazards affect local communities. Such feedback enables forecasters to refine future warnings so that they remain both scientifically accurate and operationally useful. The process also strengthens forecaster confidence and enhances trust between meteorological services and disaster management authorities. These reports provide important context for evaluating the effectiveness of the warnings issued. Therefore, producing reliable warnings that allow stakeholders to take preventive action, minimise damage, and allocate resources more effectively, with sufficient lead time to prepare.

Several Western Cape provincial departments reported incidents related to the severe weather conditions during the event (3 – 6 July 2025). The Department of Infrastructure reported temporary and full road closures due to flooding and traffic disruptions. The Department of Health and Wellness reported damage to roof tiles at a health centre, flooding in a hospital parking area and surrounding infrastructure, and the diversion of patients to alternative hospitals. The Department of Social Development reported flooding in both formal and informal settlements, as well as flooding in low-lying areas. Meanwhile, the Department of Water and Sanitation reported high river and dam levels, saturated soils and rapid surface runoff.

Response teams were deployed to assist affected communities and provided several forms of emergency support. These included the distribution of sandbags, blankets, beanies and hot meals, as well as plastic sheeting for temporary shelter support and bulk food supplies. Throughout the event, departments continued to monitor high-risk areas while assessing conditions in areas where weather impacts were beginning to improve.

The range of reported impacts underscores the importance of timely, well-coordinated early warnings in supporting preparedness and response efforts. The July 2025 event, therefore, provides a useful example of how collaboration between meteorological forecasting and disaster management can reduce risks and support vulnerable communities.

Conclusion

This case study demonstrates how a well-coordinated early warning system can directly support informed and timely decision-making during hazardous weather events. Through continuous evaluation of Numerical Weather Prediction models, synoptic analysis, and real-time observations, forecasters were able to assess the severity and potential impacts of the approaching cold fronts with greater confidence. The integration of scientific guidance, operational experience and structured feedback from Disaster Management ensured that warnings were both impact-focused and regionally relevant.

Teamwork within the forecasting office, together with the established collaboration between the SAWS and Disaster Management authorities, played a critical role in the response's effectiveness. Regular discussions during forecasting shifts, joint agreement on warning levels, early warning briefings and Joint Operations Centre meetings ensured alignment between meteorological information and operational planning. Feedback from districts and government departments further strengthened the warning process by supporting continuous improvement of impact-based forecasts.

Ultimately, early warnings are not only about forecasting hazardous weather; they are also about building partnerships, fostering trust and enabling coordinated action that protects lives, infrastructure and vulnerable communities.

Meet the Authors

Ms Kelebogile Mathole is a Senior Scientist in the Seasonal Prediction Group within the Research Department at the South African Weather Service (SAWS) where she contributes to seasonal forecasting, climate research, and related scientific projects. Her work includes the production and analysis of seasonal forecasts, running and interpreting climate models and supporting operational forecasting systems, with a focus on improving the understanding and application of seasonal climate predictions. She also contributes to regional climate activities, particularly in the South West Indian Ocean (SWIO) region which is aimed at strengthening regional seasonal forecasting capacity, collaboration and climate services for decision-making.

She is also currently pursuing a PhD at the University of Pretoria on Stratospheric Processes and their role in South African Climate and Predictability with a strong interest in advancing the understanding of the complex dynamical and statistical pathways through which large-scale climate drivers influence regional rainfall variability and predictability.

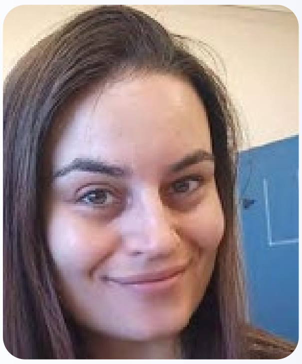
Mr Cobus Olivier has worked for the South African Weather Service and the Long Range Forecasting Group since 2008. He holds a BSc honours: Meteorology from the University of Pretoria. He specialises in Seasonal forecast production and seasonal forecast interpretation. Cobus regularly helps different South African sectors such as the Agriculture sector to interpret seasonal forecasts for the coming seasons to help in planning decisions.

Dr Steven Phakula is a Scientist with the Long-Range Forecasting (LRF) unit in Research and Development department of the South African Weather Service. His duties include both operational and research in seasonal and subseasonal-to-seasonal time scales. Dr Phakula has a PhD, MSc and Hons in Meteorology from the University of Pretoria, as well as BSc in Pure Mathematics and Statistics from the University of Limpopo. Other qualifications include Advanced Diploma in Geographic Information Systems, Diploma in Project Management, Diploma in Business Administration, and Diploma in Business Administration and Corporate Management. He has published few peer-reviewed journal papers in international journals.

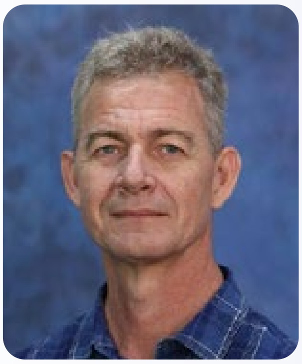
Dr Christien Engelbrecht started her career in July 1998 as a weather forecaster at the then South African Weather Bureau. She extended her experience to tropical Africa in 2003, when she forecasted for the United Nations operations in Kinshasa. Upon returning to South Africa in 2004, she commenced with an MSc (Meteorology) and graduated in 2007. She joined the Institute for Soil, Climate and Water of the Agricultural Research Council (ARC) in May 2006. As a researcher at the Agricultural Research Council, she graduated with a PhD (Meteorology) degree at the University in April 2016.

At the ARC, Christien applied her analytical skills to climate model simulations to improve understanding of how various climate attributes influence the agricultural sector in South Africa. This included investigating predictability attributes on agriculturally important time scales. In July 2019, she moved to the South African Weather Service's Long-Range Prediction Group from where she has been producing climate forecasts so serve various industries, but in particular the agricultural community of South Africa

Mr Mahlako Makgata is a forecaster at the Cape Town weather office. She has been with the SAWS since 2024. Mahlako holds a BSc degree in Geography and Agrometeorology and a BSc honours degree in Agrometeorology from University of the Free State. She specialises in aviation, public and marine weather. Mahlako aims to enhance the use of forecast information within communities and stakeholders



Ms Lauren Smith is a senior forecaster: marine, based at the Cape Town weather office. She began her career at the Aviation Weather Center, at OR Tambo international airport, where her passion for aviation ignited. Lauren has a love for severe weather forecasting and a special interest in aviation hazardous weather. She believes that teamwork makes the dream work. Lauren holds an MSc in Meteorology obtained at the University of Pretoria, 2022, focused on clear air turbulence forecasting over South Africa utilising the Convective Scale Ensemble Predication System.



Dr Andries Kruger is a Chief Scientist: Climate Data Analysis and Research in the Department: Climate Service of the South African Weather Service. His present and previous duties include the creation and writing of general climate publications, climate change variability research with historical data as input, ad hoc scientific projects, climate data and information requests, where advanced statistical analyses are required, drought monitoring, and assisting in the quality control of climate data. Dr Kruger has a PhD (Civil Engineering) degree (University of Stellenbosch) on the research topic "Wind Climatology and Statistics of South Africa relevant to the Design of the Built Environment".

Before that, he obtained and MSc (Environmental and Geographical Science) degree at the University of Cape Town. He has published papers both locally and internationally, and authored a SAWS series of publications on the general climate of South Africa. He is widely recognised, both nationally and internationally, for his research which involved advanced statistical analyses and interpretation of historical climate data.

Dr Charlotte McBride is a manager in the Climate Data Unit within the Climate Service Department. Her present duties include managing the quality of the climate data on the main climate database. She is passionate about data rescue activities, and her team is actively involved in manually capturing historical climate records to make them available electronically. She recently completed her PhD and thus also ventures into the world of academia from time to time. When not at work, she enjoys the outdoors and is probably in the Kruger National Park.

Ms Betty Makwakwa is a meteorologist and weather forecaster based at the Cape Town Weather Office. She joined the South African Weather Service in 2024 as a forecasting intern and underwent operational training. In 2025, she began working as a weather forecaster. Betty holds both a Bachelor of Science and a Bachelor of Science Honours degree in Meteorology from the University of Pretoria. She was drawn to meteorology out of a deep curiosity and a love for the ever-changing nature of weather.

Ms Joew Malebane is an ICAO- and WMO-accredited operational meteorologist with expertise in aviation, public, and marine weather forecasting. She holds a BSc (Hons) degree in Meteorology from the University of Pretoria and began her career at the South African Weather Service (SAWS) in 2023 as a forecasting intern, advancing to a full forecaster role at the Cape Town Regional Office in 2024. In this capacity, she delivers accurate services that support aviation safety, maritime operations, and impact-based weather services to support public awareness and safety. Recognised for her ability to translate complex atmospheric data into practical guidance, Joew is motivated by the challenge of producing forecasts that meet diverse stakeholder needs and embracing the dynamic nature of meteorology, where no two days are alike.

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