

Creating weather awareness amongst communities



South African
Weather Service

ISO 9001 Certified Organisation

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What are thunderstorms and how do they work?

Thunderstorms are local atmospheric disturbances, produced by cumulonimbus clouds (cauliflower shaped clouds of great vertical extent), accompanied by lightning, thunder, heavy rain and often strong winds.

Thunderstorms are among the most spectacular weather phenomena in the atmosphere, particularly inland. These storms develop from convective clouds in an atmosphere that is unstable. An unstable atmosphere is a condition that develops in the atmosphere when the rising air is warmer and less dense than the surrounding air and keeps rising. The rising air, however, also cools down, but as long as the atmosphere remains unstable, this air package will be warmer than the surrounding air and will therefore keep rising.

As a result of the rising air cooling down, the air will later be saturated and then condensation will take place. This is the process by which invisible water vapour changes in the atmosphere to visible drops of water and that we then observe as the formation of a cloud.

There are mainly three trigger actions that initiate the vertical movement of the atmosphere that can cause the development of clouds and thunderstorms. Firstly, there is the intense heating up of the earth's surface during the hottest time of the day during the hottest months of the year. The air at the earth's surface becomes very hot and because it is less dense, it is lighter and will therefore start rising into the atmosphere.

The uplift can also be caused by enforced rising when an air mass blows against a mountain or mountain range and is forced to rise. This is known as an orographic thunderstorm. The third way in which thunderclouds can start developing is when the fast movement of a cold air mass behind a cold front moves underneath warm air and forces the warm air to rise. If there is sufficient moisture in the warm air, clouds will form in the warm air. This type of thunderstorm is called a frontal thunderstorm.

The speed with which the warm air rises vertically into the atmosphere is normally more than 10 m/s, but it can even be more than 30 m/s. This results in thunderclouds easily developing up to heights of 12 km. In South Africa the troposphere occurs on average at that height and prevents any further development of clouds. The clouds therefore spread horizontally to form the well-known anvil.

The different stages of the life cycle of a thunderstorm

During the life cycle of a thunderstorm three different phases can be identified. The average life-span of a thunder cloud is less than an hour, but not all thunder clouds develop through all three phases of the life cycle.

During the first phase, known as the cumulus or development phase, there are normally mainly rising air currents in the cloud that are strong enough to hold all the already-formed cloud drops and rain drops in a floating state in the cloud. The drops grow through various processes and become bigger and heavier until the rising air currents can no longer hold them in the thundercloud. In that section of the cloud where the rain drops become too big and too heavy, the rising movement changes to a downwards movement and rain starts falling.

Note: Cloud drops are so small that it takes a million of them to form an average rain drop with a diameter of 2 mm.

A thunder cloud reaches the beginning of the second phase when there are still rising currents in one section of the cloud that cause the cloud to develop further, while in another section of the cloud there are already air currents moving downwards as result of the drops becoming too heavy and falling as rain.

At the end of the second phase, known as the mature phase, the thunderstorm is usually at its worst with intense lightning and thunder and also hail if it developed within the cloud. Gradually the downwards movement will spread throughout the cloud until the third and last phase of the life cycle is reached, namely the dying phase when there are only downwards-moving air currents in the cloud and rain falls. Because there are no longer rising air currents in the cloud, the cloud does not develop further and when all the large rain drops have fallen from the cloud, the cloud disappears and before long the sun will be shining again.

A thunderstorm can consist of one single convective cloud or cell, but the most common thunderstorms in South Africa consist of groups of cells that develop one after the other with each lasting around 30 to 40 minutes. However, some thunderstorms cover a much larger area and also last much longer. They are referred to as “super cell” thunderstorms. This type of thunderstorm lasts much longer and has stronger and longer-lasting rising and falling currents in the clouds. It normally forms part of a storm squall line – a line of thunderstorms that move together.

General precautions during a thunderstorm

- If outdoors DO NOT seek shelter under trees.
- Listen to the radio or TV for warnings.
- If possible stay indoors well clear of windows.
- Shelter pets and cover vehicles.
- Disconnect all electrical appliances.
- Do not take a shower or bath or use the telephone.
- If driving, STOP and park well off the road clear of trees, power lines and streams.

2. Weather Phenomena Associated with Thunderstorms

Any thunderstorm can produce lightning, flash flooding, very strong winds, hail and in severe cases tornadoes.

a. LIGHTNING

When thunder roars, go indoors!

Lightning occurs with every thunderstorm and must be expected as soon as thunderstorms form.

What is lightning?

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.

The eastern parts of the country, especially the Eastern Cape and KwaZulu-Natal, have the highest incidence of lightning related deaths in South Africa. Thus take extra special care when in these areas.

Lightning facts

- There are three types of lightning
 - cloud-to-ground
 - ground-to-cloud
 - cloud-to-cloud
- Lightning strikes the earth around 100 times every second.
- About 20% of people that get struck by lightning die.
- “Lightning never strikes twice” unfortunately is a myth. Lightning can strike the same location many times.
- Most strikes occur at the beginning and at the end of a storm.
- About 85% of strike victims are children and young men between 18-35 years of age because they are caught in the storm while playing or working outside.
- The energy contained in a single lightning strike can power a 100 watt light bulb for 90 days.
- The chance to be killed by lightning is 1 in 2,000,000.

Lightning precautions

- If you are outdoors when you see or hear a thunderstorm coming seek safe shelter **immediately!**
- If your hair stands on end, leave the area as fast as possible, as lightning will almost certainly strike that spot shortly.
- When you see the lightning FLASH count the seconds to where you hear the BANG. At 30 seconds - suspend all outdoor activities and seek safe shelter as lightning strikes are close. If you count 15 seconds or less, a lightning strike could occur where you are.
- Unsafe areas during an electric storm are:
 - Tall structures such as trees, telephone and power lines
 - Hilltops
 - Isolated sheds
 - Open water
 - Unprotected gazebos or picnic shelters
- Avoid being near or touching:
 - Metal objects such as fences, golf carts, bicycles, and motorcycles, telephone or power lines and steel structures such as pylons and windmills.
- If indoors, during a storm stay well clear of windows. Do not:
 - Hold any metal object
 - Use any electrical appliance
 - Use the telephone,
 - Take a bath or shower
- If you are travelling, stay in the vehicle.
- Do not swim during a thunderstorm.
- Do not play sport during thunderstorms. Golfers and fisherman are at high risk.

Tornado precautions

- In the event of seeing a tornado, move to a pre-designated building or else move into the centre of your house and get under a strong piece of furniture, such as a table.
- Get out of vehicles, caravans and mobile homes, as they can be moved, overturned and even destroyed by the strong winds and flying debris.
- Stay away from windows, as flying glass and debris cause the most deaths.
- Do not attempt to outrun a tornado in your vehicle. Leave it immediately and seek shelter.
- If caught outside in the open, lie flat in a ditch or depression but beware of flooding if there is heavy rain.

b. TORNADOES

A tornado is a violently rotating storm of small diameter and is the most ferocious of all weather events. It is a weather phenomenon that develops from thunderstorms, particularly those that are associated with hail.

There are still different opinions among experts on how exactly a tornado develops, but many agree that it has to do with vertical rotation movements that already exist in the cloud and that are just intensified. A tornado, therefore, develops within a cloud and moves as a visible funnel-like phenomenon from the cloud to the earth.

It can assume different forms and at times looks like a thin and narrow funnel, or like a cylinder and at times even like a piece of rope hanging from the base of the cloud to the earth. The visible funnel consists mainly of drops of water that formed in the funnel as result of condensation. Close to the ground where dust, leaves and other debris is blown up, there is normally a strong whirlwind.

The diameter of the funnel is on average less than a few hundred metres, but some tornados are bigger with a diameter of more than 1 km. The movement of air in a tornado is usually cyclonic, in other words, in the Southern Hemisphere, the winds blow clockwise around it. Normally the tip of the funnel touches the surface of the earth for only a few seconds, but there have been cases observed where it has remained on the surface for longer than an hour.

The maximum wind speed in a tornado is usually between around 120 and 360 km/h, but can even be stronger than 432 km/h. The pressure in the funnel is considerably lower than the surrounding atmospheric pressure.

The damage to property is normally caused by the very strong winds, particularly when they blow stronger than 144 km/h. Pressure differences between the inside and outside of the tornado are also partially responsible for damage, particularly to buildings of which the windows and doors are closed.

When a tornado moves across such a building, the pressure within the building is considerably higher than the pressure on the outside. A difference of 69 hPa causes a pressure on a ceiling of 3 by 3 metre that is equivalent to the weight of a mass of more than 6 000 kg. Such a weight can cause extensive damage and in certain cases the whole roof of the building can be lifted or the walls pushed outwards.

An interesting aspect of tornados is the loud distinctive noise that they make. People who have heard it have described it as the sound of "a thousand trains", "the buzz of millions of bees" or "the rumble of jet planes".

3. Tropical Cyclones

Besides the tornado, there is another devastating weather phenomenon that occurs in the atmosphere and is known by different names in different countries. We refer here to the tropical storm that is known in Southern Africa as a tropical cyclone. In America it is called a hurricane and in Asia, a typhoon.

The tropical cyclones that influence South Africa's weather, normally originate in the late summer, close to the equator, over the Indian Ocean and roughly between 5°S and 10°S. Initially the cyclone moves slowly in a south-westerly direction away from the equator, but later turns and moves faster in a south-easterly direction under the influence of stronger westerly winds. The warm tropical sea water causes the moist air above it to have a temperature of at least 27°C. The unstable conditions in the atmosphere cause the warm moist air to rise vertically and this leads to the development of a low-pressure system with large-scale condensation and cloud formation above the area. An enormous amount of heat energy, known as latent heat, is released during the condensation process and serves mainly as the energy source for such a tropical cyclone.

In the Southern Hemisphere the air circulation around a cyclone is clockwise and the clouds develop in characteristic spiral bands that move clockwise with the wind into the cyclone. These spiral cloud bands consist mainly of Cumulus and Cumulonimbus clouds that can reach up to a height of 12 km and can cover a horizontal distance of up to 700 km. The average life-span of a tropical cyclone is around 9 days, but in extreme cases it can last for 3 to 4 weeks.

Tropical cyclones also have other characteristic features. In the centre of the cyclone the air is dry and descends from above to the earth's surface. This results in an area where there are no clouds and where the winds are very calm. This area is called the eye and is approximately 30 to 50 km wide. While the eye is calm, the area around the eye is certainly not. Here storm winds blow at speeds of between 120 and 200 km/h.

A tropical cyclone is further characterised by high rainfall that can result in floods. The storm winds also give rise to high waves and swells of up to 12 metres that can cause severe damage to coastal towns.

As soon as a tropical cyclone moves in over land, it is cut off from its source of energy and the greater friction that the air movement experiences results in the intensity of the cyclone decreasing until after a while it fades away totally. Every year a list of names in alphabetical order is drawn up from which cyclones are named as they appear. Initially only women's names were used, but these days men's names are also used. A tropical cyclone that caused havoc in especially KwaZulu-Natal, was cyclone Domoina that caused widespread damage in January 1984.

4. Flooding

Flooding occurs when water overflows its normal channels such as streams and storm water drains. It can occur with prolonged periods of rain, with continuous heavy falls or in the form of flash floods which are usually associated with severe thunderstorms. Just six inches of fast-moving flood water can knock you off your feet, and a depth of two feet will float your car! NEVER try to walk, swim or drive through such swift water. STOP! Turn around and go another way.

Flooding precautions

- o If at all possible stay indoors and off the roads.
- o Listen to the special warnings on the radio and TV.
- o Avoid crossing rivers and swollen streams where water is above your ankles.
- o Move to higher ground when flooding is possible.
- o If trapped in flooding in a vehicle, abandon it and climb to higher ground.
- o In buildings, move valuables to a safe place above the expected flood level.
- o Switch off electricity at the supply point to the building.
- o In rural areas protect/relocate animals to a safe place on higher ground.
- o Abandon your home immediately if evacuation is recommended, before access is cut off by flood water.
- o NEVER drive into water covering the road. You do not know how deep it is or if the road is washed out.
- o If the vehicle stalls, leave it immediately and seek higher ground.
- o Be especially cautious at night when it's harder to recognize flood dangers.

5. Severe Winds

Gale force winds often occur along coastal regions, but they also often occur during thunderstorm activity in various forms. These winds are sudden and can cause much damage, especially if they are as a result of a tornado.

Exotic trees are easily uprooted by strong winds, especially after prolonged periods of rain. Plant indigenous trees in your region.

Severe wind precautions

- Stay indoors where possible, away from the windows that open towards the severe winds.
- Listen to the radio or TV for warnings.
- If travelling in a vehicle, be aware of sudden cross winds, especially between buildings.
- Be aware of the possibility of fallen trees or power lines and flying debris.
- Small boats must stay away from the sea and seek the shelter of a harbour, river estuary or protected bay.

6. Cold and snow

High wind chill, snowfall, freezing rain, and cold temperatures all pose hazards to those travelling or venturing outside and one should dress to suit the weather.

Cold & Snow Precautions

- Stay indoors where possible.
- Listen to the radio or TV for warnings.
- If venturing outdoors dress warmly.
- If it is extremely cold, cover your mouth to protect your lungs from the cold air.
- Don't drink alcohol, consume caffeinated drinks or smoke when out in the extreme cold. All of these activities encourage hypothermia and frostbite.
- Protect small stock from the cold in sheds.

Driving in icy conditions

The best advice for driving in bad winter weather is not to drive at all - if you can avoid it - and allow yourself extra time to reach your destination. Numerous vehicles are regularly stuck in mountain passes because they don't heed weather warnings that are broadcast on radio and TV.

Driving Precautions

- Stay off roads if possible.
- Listen to the radio or TV for warnings.
- When driving in fog, reduce your speed and turn on your headlights. NOT on bright.
- Make sure that you can be seen.
- Don't stop in the middle of a roadway.
- Use the left edge of the road as a guide rather than the center line, to avoid running into oncoming traffic or becoming distracted by their headlights.
- Always use your defroster and windscreen wipers in foggy conditions to keep the windows clear.
- Keep an eye on your speedometer and maintain a slow, constant speed.
- Remember that other drivers have a limited sight distance and that fog can leave roadways slick.
- Signal early, and when you use your brakes, don't stomp on them.

7. Thick/Dense fog

Thick or dense fog can reduce the visibility to such a great extent resulting in disruptions to traffic and accidents.

Fog and lights can cause optical illusions which can cause accidents. Studies show that people are attracted to flashing lights which can lead to accidents. So avoid using emergency flashers unless completely necessary.

Thick and Dense Fog Precautions

- Decrease your speed and leave yourself plenty of room to stop. You should allow at least three times more space than usual between you and the car in front of you.
- Brake gently to avoid skidding. If your wheels start to lock up, ease off the brake.
- Turn on your lights to increase your visibility to other motorists.
- Keep your lights and windshield clean.
- Use low gears to keep traction, especially on hills.
- Be especially careful on bridges, overpasses and infrequently traveled roads, which will freeze first. Even at temperatures above freezing, if the conditions are wet, you might encounter ice in shady areas or on exposed roadways like bridges.
- Don't assume your vehicle can handle all conditions. Even four-wheel and front-wheel drive vehicles can encounter trouble on icy roads.

8. High discomfort and heat waves

Discomfort Index: When temperature and humidity are high at the same time, humans' ability to cool their bodies through sweating is reduced. This can be a real threat.

The temperature in a motor-car can be more than 10 degrees higher than outside. Do not leave pets or children in motor-cars, especially in hot conditions.

High discomfort and heat waves precautions

- Stay indoors in a cool room near a fan if possible.
- The old and infirm must take extra care.
- Listen to the radio or TV for warnings.
- Cease strenuous outdoor activity if advised.
- Avoid playing sport.
- Dress in light weight clothes.
- Drink plenty of liquids, but NOT alcohol, as alcohol further dehydrates the body.

Runaway fire precautions

- Listen to the radio or TV for warnings.
- Don't make fires in the open.
- Don't throw cigarette butts out of cars or in open veldt.
- Don't throw bottles in the veldt as they can start fires.
- Report any fires immediately.

9. Conditions favourable for the spread of runaway fires

Whenever there are prolonged periods of little and no rain, coupled with warm dry winds, veldt fires can easily be sparked and will spread rapidly. Veldt fires occur more often in winter over our interior. Winds are the fuel for veldt fires.

When a warning is issued by the South African Weather Service, it is illegal to make outdoor fires.

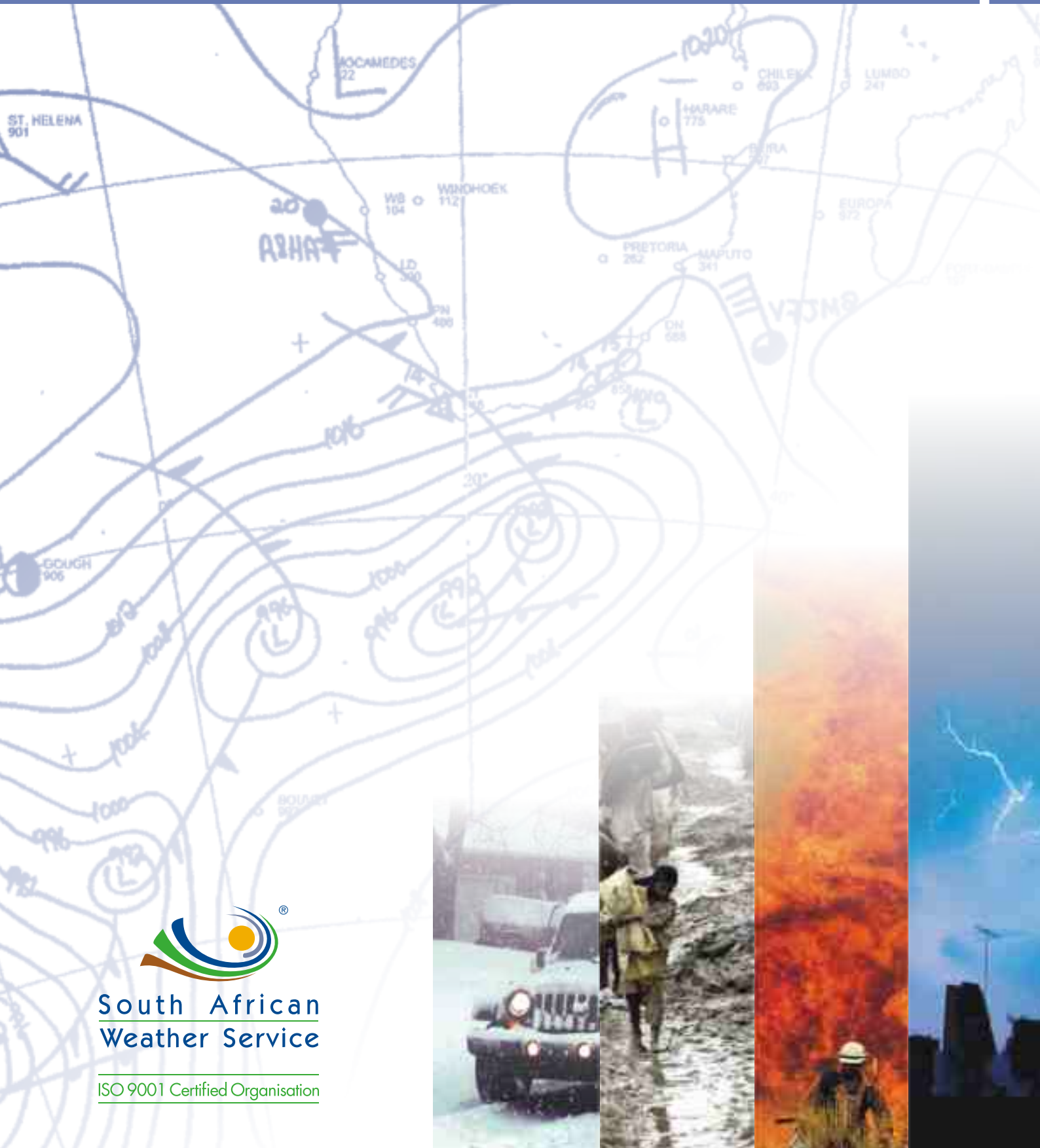
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