Chapter 7

Mountain Weather

Mountain weather is both unpredictable and liable to sudden and dramatic change. The experienced hiker or climber has a healthy respect for its changing moods: he knows that a sunny and pleasant mountain scene can quickly be transformed into a death-trap for an ill-equipped or inexperienced party, and he is therefore always prepared for the worst possible conditions he might encounter. Be aware of the state of the weather, try to anticipate changes in the weather, and plan in advance your response to worsening conditions.

Experience is a valuable though not infallible guide to the vagaries of mountain weather. To supplement your practical experience, you require:

- A basic understanding of meteorology.
- Knowledge of local weather conditions and the effect of altitude in the area where you intend to hike or climb.
- Knowledge of how to obtain and interpret weather information.

Mountain Weather

Climate refers to the predominant type of weather which is experienced in a region, as determined over a number of years, while **weather** is defined as short-term or day-to-day fluctuations in atmospheric conditions.

South Africa is blessed with a sunny climate, and in most places in our country even the winters are moderate by European standards. It is, however, important to realise that at all times of the year mountains can have a profound effect on the weather, both in their immediate vicinity and much further away. Big mountains have a microclimate of their own which often seems to bear little resemblance to that of the surrounding countryside. For example, the distance between the Elsen-burg forestry station and the Jonkershoek forestry station in the Cape Province is only 13 km. However, while the average annual rainfall at Elsenburg was 594 mm in 1987 and it experienced 21 days on which rainfall of 10 mm or more was measured, Jonkershoek had an average rainfall of 1 065 mm and experienced rainfall in excess of 10 mm on 37 days in the year (1987 figures, supplied by the Weather Bureau, Pretoria).

The main reason for the virtual doubling in the rainfall figure lies in the difference in elevation: Elsenburg is 162 m above sea level, while Jonkershoek is 244 m above sea level. (Jonkershoek also holds the record for the highest recorded rainfall in South Africa over a period of 12 calendar.months — 3 784 mm (153 inches), recorded in 1950.) These facts bear out the contention that it rains much more frequently and much more heavily in the mountains than elsewhere.

Moving from low-lying regions higher into the mountains, one -can, within the space of a few kilometres, go from warm, windless conditions to icy-cold, windy and rainy conditions with an accompanying lethal wind-chill factor and near-zero visibility.

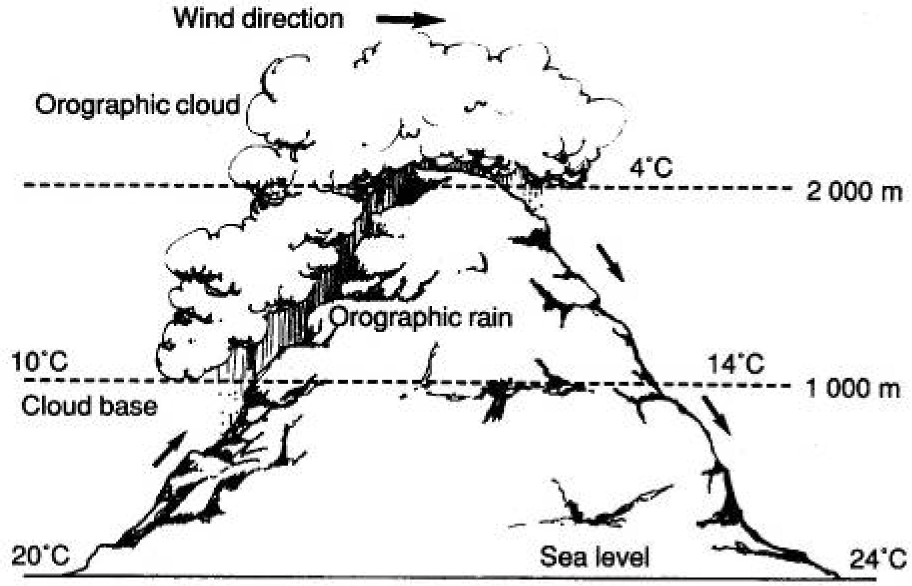
The main cause of the rapid weather changes usually experienced in mountainous regions is the undulating terrain itself. Mountain slopes force the air to move either upwards or downwards: when air moves upward against a slope, air pressure decreases and the temperature drops. On the other hand, the air pressure of air which moves down a slope increases, causing the temperature of the air to rise.

Orographic clouds

Rising air (moving up a slope) cools down at approximately -10°C for every 1 000 m of altitude (the dry adiabatic lapse rate). When the air is dry the lapse rate is greatest, while it is at least when the air is saturated, i.e. cloudy. Irrespective of the weather, however, it will always be colder at the top of a mountain than at its base, a fact which the mountaineer must bear in mind.

The air continues to cool down until it reaches its dew point, when water vapour in the air condenses into droplets to form a cloud. The air is now saturated with water vapour. Should it rise further, its temperature will drop at a slower rate of approximately 6°C (wet adiabatic lapse rate). This cloud causes rain to fall as it moves over the mountain, and the air loses some of its moisture.

When the air begins to flow down the other side of the mountain, its temperature rises at a rate of 6°C while it is still a cloud. Once the dew point temperature is reached — which is now considerably lower, since the air has lost much of its moisture in the form of rain — its temperature will begin to rise at approximately 10°C for every 1 000 m in altitude lost. Since the air on the leeward side of the mountain will be heated over a longer period at 1°C for every 100 m lost in height, the air will be drier and warmer at the foot of the mountain on this side. Clouds that form in this way against mountain slopes as a result of adiabatic cooling (without transference of heat) are called orographic clouds. The best-known orographic cloud in South Africa is Table Mountain's familiar misty white 'cloak'.



The formation of an orographic cloud

When air moves from the inland plateau to the coast it is also heated adiabatically and many of South Africa's coastal regions are therefore affected by warm mountain winds at certain times of the year. Mountain climbers know that winds that originate in this way (also referred to as a Fohn in Germany or a Chinook in North America) usually spell the onset of hazardous climbing conditions.

Mountaineers usually find themselves high up in the mountains, and therefore inside any orographic cloud or mist. These cloudy, rainy, snowy or misty conditions can last for several days and they constitute a serious hazard to an inadequately prepared party. Emergency food supplies, windproof and waterproof clothing, and tents carried by the party must be up to the task of ensuring the party's survival for as long as the bad weather lasts. (See also Chapter 8, Mountain Hazards, on how to deal with bad weather.)

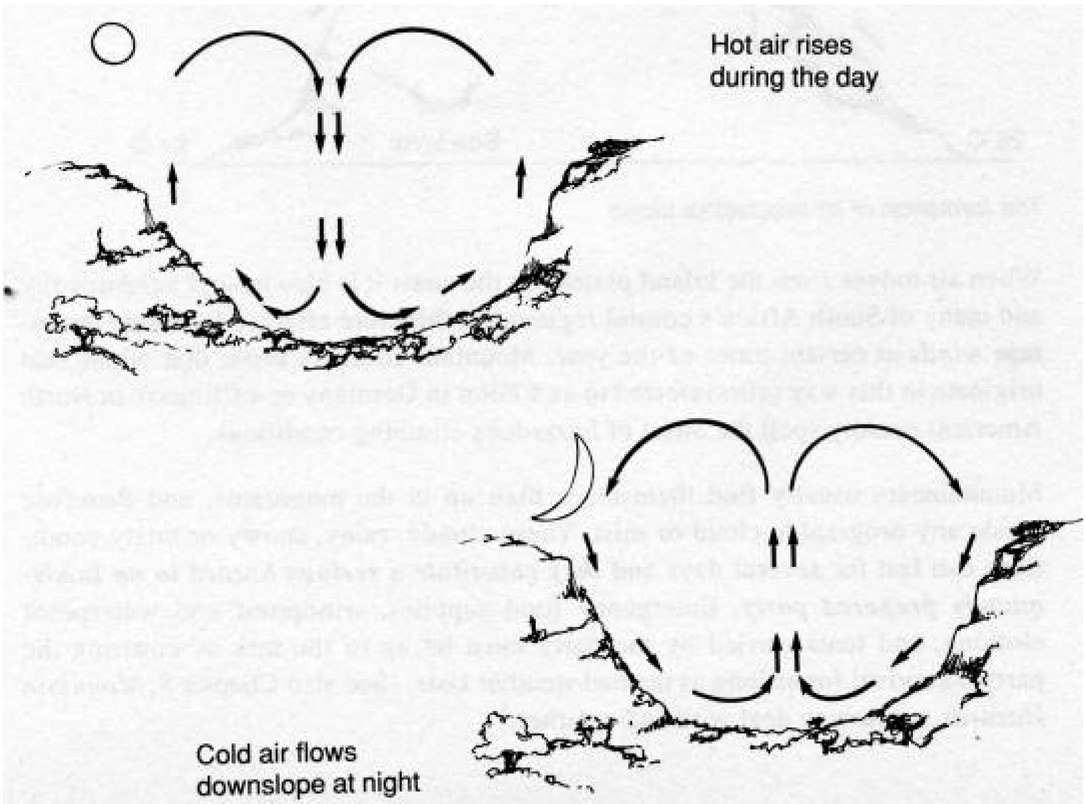
If you know the mountain well and decide to move lower, out of the cloud mass, you should remember that the cloud base on the leeward side of the mountain should be higher, particularly if it is raining.

Anabatic and katabatic breezes

On a hot day, from about three hours after sunrise until about sunset, the sun heats up the slopes of the mountain, which in turn heats up the air above the slopes, causing it to rise and move up the sides of a mountain from the valleys. This gentle breeze is called an anabatic (upward-moving) wind.

During the night, mountain slopes cool down again. The air above the slopes also cools down and begins to flow downslope towards the valleys from about midnight to sunrise. These katabatic (downward-moving) winds are of greater significance to the mountaineer. They are usually not very strong (seldom stronger than 4-5 m/s), but they cause cold air to collect at the bottom of valleys.

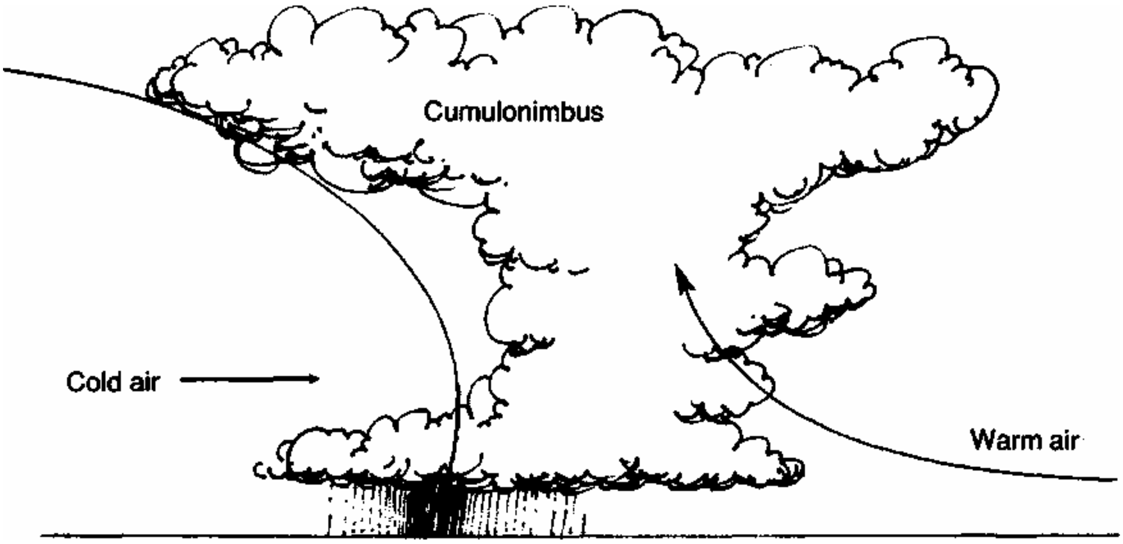
This means that the best place to camp is usually half-way up the mountain slope, out of the strongest gusts experienced on the top of the mountain, and away from the cold air at the bottom of the valley. There is also no danger of being surprised by a flash flood.



Weather phenomena of concern to hikers

Cold fronts

Adjacent air columns with a different temperature and pressure do not mix easily and are separated instead by, boundary zones called fronts. A cold front is a mass of cold air that moves in under a region of warm air, with the cold air gradually displacing the warm air as it moves forward and wedges in under the warm air. The 'front' is actually the dividing line where the two columns of air meet, and across this boundary there exists a sharp contrast of temperature and humidity.



A typical cold front

The front separating the warm and cold air masses always slopes upward over the cold air, because the cold air is denser. The slope of fronts varies, but the slope of a cold front usually ranges from 1 : 50 to 1 : 100. The width of the front is usually about 50-100 km.

A cold front is always associated with a low pressure cell, which is usually found at its centre. In the southern hemisphere the cyclonic movement of the winds associated with such a low pressure area is always clockwise, round the centre of the low pressure area. At the same time, warm air is drawn upwards into the system at low levels and spread out at high levels. The third kind of motion involved is that of the system as a whole, which moves at a speed which varies between 20 km and 80 km per hour, generally from west to east in South Africa.

Weather changes associated with a cold front

The following changes in weather can be experienced on the ground when a cold front moves in:

- The temperature will drop as the the cold air displaces the warm air.
- The wind direction will change, usually from a warm north-westerly or a westerly wind to a cold south-westerly or southerly wind.
- A fast-moving cold front overtaking warm air that is unstable and moist will cause cumulonimbus clouds to form, with the associated danger of thunder, lightning, hail and turbulence. There will be a relatively narrow zone in which heavy showers or snow could fall.

In the interior of the country a cold front is usually preceded by fairly strong westerly winds, followed by cold southerly winds. A cold front in the mountains is often preceded by strong winds or gusts and it usually brings extreme cold and snow which may prove dangerous or fatal to an ill-equipped br unprepared party. It can cause snow to fall at any time of the year in the Drakensberg and the Cape mountains.

Thunderstorms

Thunderstorms usually occur during the summer over most parts of the interior of South Africa. In mountainous areas they can occur at any time of the year, at any time of the day or night. (Chapter 8 discusses thunderstorms and lightning as mountain hazards.)

A thunderstorm usually develops in the following way: Moist, unstable air is displaced in a vertical direction. The air cools down and forms a cloud. In the cloud itself air continues to rise, cooling down further and forming rain droplets and hail. When the upward air streams are no longer strong enough to keep the condensed water suspended, the water mass is discharged as rain and hail, and this process is usually accompanied by great air turbulence and lightning.

Types of thunderstorm

The type of thunderstorm depends on the manner in which the vertical displacement of the air occurs. This can happen in a number of ways:

- ***Heat-induced thunderstorms***, in which air, heated by the ground, begins to rise.
- ***Frontal thunderstorms***, in which the air is forced upwards by colder air wedging in underneath it.
- ***Orographic thunderstorms***. This is the type of thunderstorm most commonly encountered by mountaineers. Moist, unstable air is forced upwards by a mountain. Because the air is unstable, once it has begun to rise it will continue to rise, causing a thunderstorm. This type of thunderstorm can take place at any time of the day or night and can last for as long as the air continues to move up against the mountain.
- ***Thunderstorms due to convergence***. Low-level convergence of air currents causes rising air currents; given adequate moisture and unstable conditions, thunderstorms may be triggered at any time of day or night.

Weather changes associated with a thunderstorm

One is usually warned of an impending thunderstorm by a light wind blowing in the direction of the thunderstorm cell. This air is, however, suddenly displaced by a cold wind blowing from the approaching storm. The cold wind is caused by downdraughts blowing away from the storm.

Gusts, reaching speeds of 40 to 50 knots, and sometimes as much as 60 to 90 knots, immediately precede the rain front. The gusts are followed by rain and also possibly hail. The intensity of the gusts decreases once the storm front has passed, and wind strength returns to what it was before the storm.

Hail always occurs during a thunderstorm. However, it can never be stated with qertainty whether it will reach the ground or not, because most of the time it melts before it can reach the ground.

In addition to the lightning and hail risk associated with thunderstorms, what makes them particularly dangerous is their power to change a little stream into a raging torrent within minutes. You should therefore know what precautions to take to reduce the chances of being struck by lightning (see Chapter 8), and you should not camp in or near river beds.

The light wind preceding the storm is a warning sign: it can soon change into a strong wind and rain that could make it very difficult to pitch a tent. Find a suitable camp site in good time and erect tents with their openings facing away from the approaching storm.

Weather forecasting

Although meteorology has developed into a sophisticated tool for weather prediction, it is still impossible to predict with any degree of accuracy the weather more than three days in advance. Each of the many sources of weather information also has limitations which you should be aware of.

Mountain weather presents a further problem, owing to its inherently changeable nature. While it is a good idea to obtain beforehand a weather prediction for the area where you plan to hike, it is therefore not advisable to depend completely on a favourable weather forecast.

How our weather forecasts are made

The weather forecasts which we hear every day on the radio, read in the newspaper or see on television originate from the same source, namely the South African Weather Bureau. The Central Forecasting Office in Pretoria continually issues short- and long-term forecasts and warnings to the news media, the general public and to a variety of special users, such as airports, harbours, and off-shore oil-drilling operations. This office is assisted by the regional forecasting offices in Cape Town, Durban, Port Elizabeth, Bloemfontein, East London and at the Johannesburg Airport. Metereological data are also exchanged world-wide with other weather offices which belong to the World Metereological Organisation.

Daily, at times which have been fixed internationally, observers throughout the world take readings on land or from ships at sea of the temperature, humidity, atmospheric pressure, wind direction and speed and the amount of rain which has fallen. Visual observations are made of the types and height of clouds, horizontal visibility and the prevailing weather (e.g. fog, drizzle, rain, lightning, thunder, hail, etc.)

From these observations the weather report is compiled and a coded message is then sent to the nearest regional weather office. Regional offices collect their reports from the various stations in their area and send them to the head office of the country concerned, where they are stored in computers and then distributed worldwide on the Global Telecommunications System (GTS).

Approximately 2 000 surface reports from drifting weather buoys are also disseminated on the GTS. Increasing use is also being made of automatic weather stations to supplement the surface observations.

Balloon ascents which provide data from higher levels in the atmosphere are carried out twice a day at more than 2 400 stations all over the world, while temperature and wind data for the upper air are also reported from aircraft in flight.

Weather satellites are used to make the picture of existing weather conditions more complete. By means of radiation observations from polar-orbiting satellites it has become possible to determine the vertical temperature structure of the atmosphere reasonably accurately. Approximately 12 000 of these temperature profiles are used in forecasts daily. It is expected that technological development will accelerate in the nineties and even more accurate observations of vertical profiles of wind, temperature and humidity are envisaged with the aid of lasers in weather satellites.

The Weather Bureau in Pretoria employs telecommunication computers to receive, process and disseminate these large quantitities of data to other metereologi-cal centres and regional offices. These data are also transferred to mainframe computers and subjected to further analysis and processing. The analysed data fields serve as input data for the highly complex computer forecasting programs which are used to produce our daily weather forecasts.

Sources of weather information

Daily forecasts can be obtained from:

- The press — not really suitable, and fairly out of date.
- The radio — regular and reasonably up to date.
- Television — detailed and reasonably up to date.
- Regional meteorological offices of the Weather Bureau — the most accurate tad up-to-date source of weather information.

When you phone a meteorological office you should remember that there are very few reporting stations in mountainous areas. It is therefore often difficult for the forecaster to give you an accurate report of the weather prevailing in the area where you intend to hike, let alone give you a detailed forecast for the area.

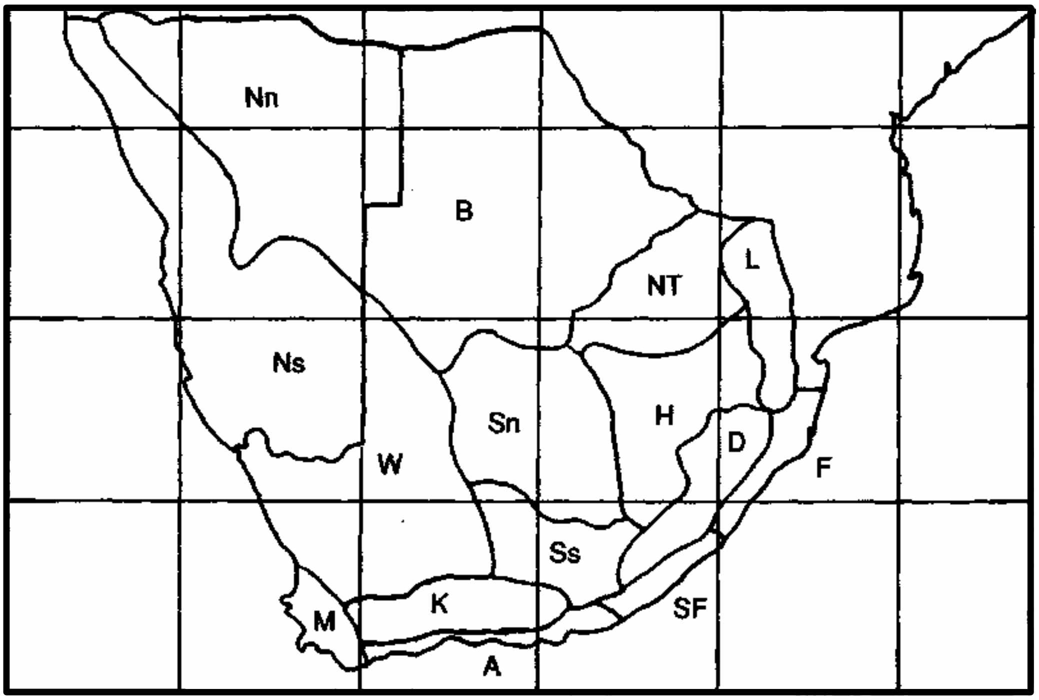
The numbers of the various regional offices of the Weather Bureau are:

Pretoria	(012) 290-3000
Bloemfontein	(051) 33-1472
Cape Town	(021) 934-0450/58
Durban	(031) 42-4225
Johannesburg Airport	(011)975-5671/2/3
Pietersburg	(01521) 93-0505
Port Elizabeth	(041) 51-1476
East London	(0431)46-1300

(These telephone numbers correct as at 28.03.91.)

Climatic zones

In addition to official weather predictions we have at our disposal a second important aid: knowledge regarding the various climatic zones of South Africa. Since we know that climate varies from region to region, by looking at a map of the various climate zones we can decide which time of the year is likely to be the most suitable time for visiting a particular area. The map below shows the climatic zones into which South Africa is divided.

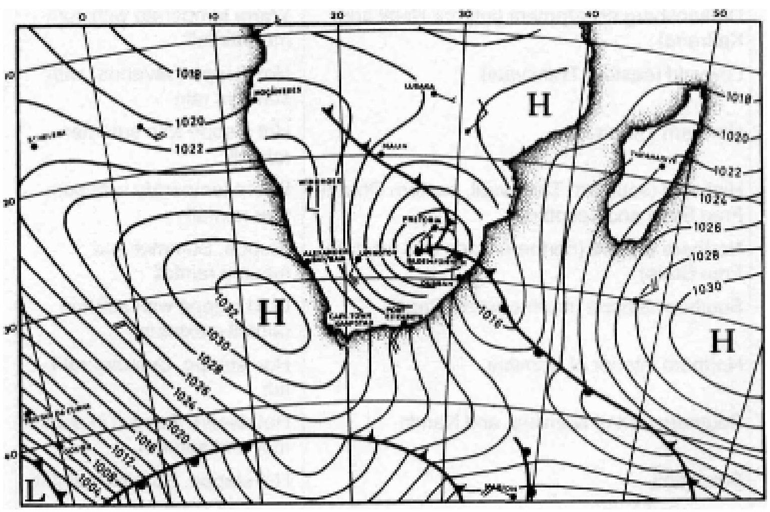


Zone	Region	Type of climate
W	Namaqualand & the North Western Cape	Desert climate
M	South Western cape winter rainfall region	Mediterranean climate
K	Karoo	Mainly desert climate
A	South Cape Costal Belt	Rain during all seasons
SF	South Eastern coastal region	Warm temperature with summer rainfall
F	Eastern coastal belt and Zululand	Subtropical with summer rains
D	Drakensberg escarpment	Warm temperate with summer rainfall
L	Lowveld	Hot steppe (savanna) with summer rainfall
NT	Northern Transvaal	Hot steppe with summer rainfall
H	Highveld	Warm temperate with summer rainfall
Sn	Northern Steppe	Cold steppe. Summer & autumn rainfall
Ss	Southern steppe	Cold steppe with autumn rainfall maximum
Nn	Northern interior of Namibia	Hot steppe. Summer rainfall
Ns	Southern part of Namibia & Namib	Hot desert. Rainfall in summer and autumn
B	Botwsana	Hot steppe. Summer rainfall

Synoptic weather maps

A synoptic weather map shows the weather and the various pressure systems prevailing in a particular area at a particular time. It supplies information regarding cold fronts, temperature, cloud cover, wind strength and direction, rain, mist, and so on.

Isobars (lines that join all places with the same air pressure) are used to indicate air pressure gradients and distribution, while symbols are used to depict other weather features. The isobars are arranged round centres of high and low pressure (marked H and L on the maps). Triangles and semi-circles are used to mark cold and warm fronts respectively. The wind is represented by an arrow flying with the wind while the number of feathers on the arrow indicates the wind speed (1 feather is 10 knots, that is approximately 5 m/s or 18 km/h). The total amount of cloud is represented by the amount of black in the station circle. On a detailed weather map the air temperature is plotted at the top left of the station and the dew-point temperature at the lower left. Between these two figures is the symbol for present weather.



A simplified weather map

The simplified weather map shown above describes the weather over the subcontinent on 18 June 1964, i.e in mid-winter. In this case, severely cold weather occurred over most of the country. With the invasion of cold air a low was cut off over the eastern parts of South Africa. The north-north-westerly air stream established over these regions for a few days brought in moister air from the north and convergence in the lower layers caused heavy rain in places over the eastern and south-eastern Cape Province. The weather was, however, unsettled over a great deal of southern Africa, and rain was fairly general with snow in many places. Light snow occurred as far north as Pretoria.

Clouds

At a given temperature air can only hold a limited quantity of water vapour, with the capacity of warm air being greater than that of cold air. When air that contains the maximum amount of water vapour (saturated air) cools down, the water vapour condenses and clouds form.

Condensation occurs readily only when suitable particles of microscopic size are present in the atmosphere. These particles are called condensation nuclei. They are normally and naturally present in the air, and there may be a million or more in a cubic centimetre. The nuclei originate from sources such as veld and bush fires, industrial processes, duststorms, volcanic eruptions, and from sea spray and foam.

Air normally cools down as a result of being forced upwards, to higher, colder levels. This can happen in one of four ways:

- Convection currents (vertical air currents) can carry moist air upwards into the upper atmosphere.
- The relief of the landscape, e.g. a mountain range, can force air to rise.
- Heavy, cold air can wedge in under a mass of warm air, forcing it to rise.
- There can be a convergence of air in the lower regions of the atmosphere.

Cloud types

A basic knowledge of the various types of cloud often allows us to make inferences regarding the weather. Clouds are classified on the basis of their shape and altitude. The four basic cloud types are:

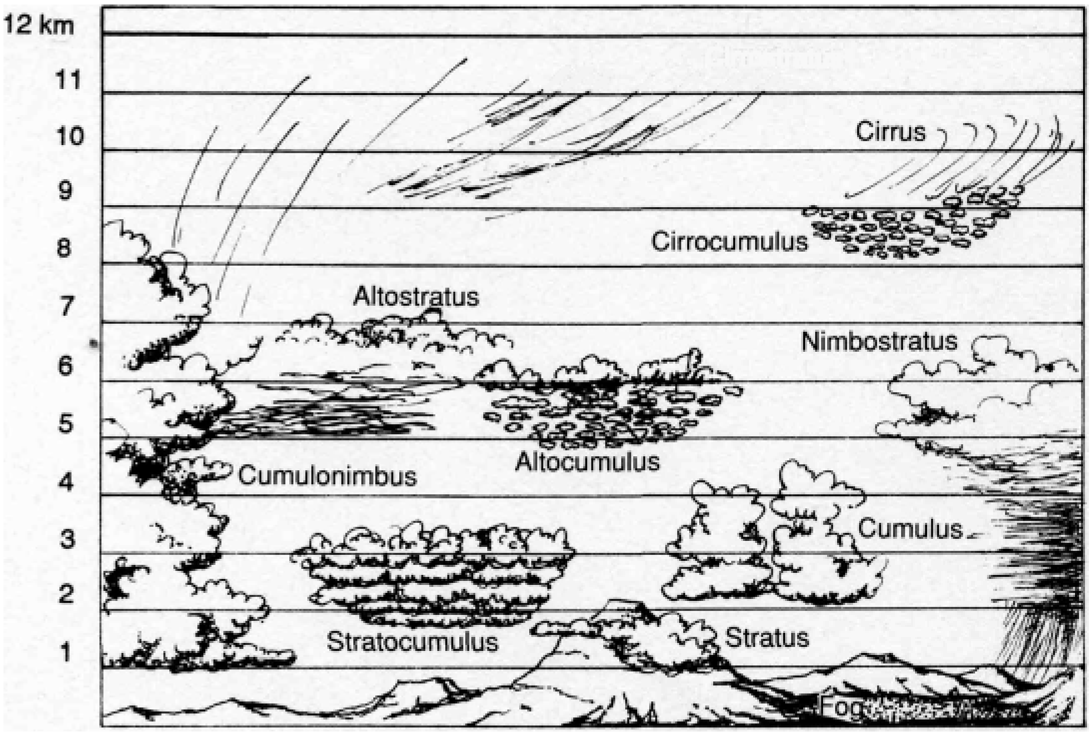
- Cirrus (fleecy, white — high altitude).
- Cumulus (big and billowy — low and medium altitudes).
- Stratus (grayish, fairly dense, uniform shape — low, medium and high altitudes).
- Clouds with vertical development (develop vertically as a result of rising air currents, e.g. cumulonimbus).

'Nimbus' means rain. Nimbostratus, which describes stratus clouds that bring rain, are low, thick clouds that bring soft, continuous rain that can last for days. This weather is typical of the Cape Province. Cumulonimbus, on the other hand, is usually associated with the heavy showers, lightning and high winds that characterise Transvaal thunderstorms.

Type	Height	Characteristics	Predict
Cirrus	The highest clouds, usually above 9 000 m.	White, composed of ice crystals. Thin, delicate lines, often twisted at one end like a 'mare's tail'.	If they are moving quickly and increasing in number they often indicate the approach of a cold front (it may be 24 hours away still).
Cirrostratus	Also very high, usually above 9 000 m.	Also composed of ice crystals. Form a thin, uniform layer. Often cause a 'halo' around the sun or moon.	Often indicate the approach of bad weather and rain.
Cirrocumulus	High, from 8 000 to 1 0 000 m.	Spread-out, fluffy cloud, sometimes referred to as 'mackerel sky'.	Usually indicates fine weather. The chances of sudden showers increase as the clouds get bigger.
Altostratus	From 3 000 to 9 000 m.	A uniform greyish or bluish layer which some-times gives the sun a 'watery' appearance.	If these clouds thicken and move lower, it is a sign of impending widespread rain.
Altocumulus	Average height, around 6 000 m.	Usually covers a large part of the sky but ap-pears billowy, with spaces between smaller patches.	If these clouds combine to form a flatter cloud layer, rain can be expected the same day.
Cumulus	Fairly low, 2 000 to 3 000 m.	Large, white clouds with 'bubbly' tops. Typical of hot summer's days in the interior of the country.	If the clouds remain spread out and independent, good weather may be expected.
Cumulonimbus	Low base, towering to a great height.	Formed by cumulus clouds that combine to form a huge cloud mass. The top often spreads out in a characteristic anvil shape.	'Nimbus' means rain; these clouds usually bring rain, lightning and strong winds, particularly on the highveld and the mountains of the interior
Stratus	Below 2000m	A low, dense, grey, uniform and featureless cloud base. Mist is stratus at ground level	Typical of costal regions and Boland mountains. Can be 3000m or more thick, and causes dense mist in the mountains
Nimbostratus	Low, 1200m or less	Stratus clouds that bring rain. Thick low clouds	Bring soft, continuous rain. Often found below a dense mass of cloud when a front is in the vicinity
Stratocumulus	Low, 4000m or less	Patches of blue sky are visible between the billowy clouds. These clouds sometimes appear as thick rolls that cover the entire sky	Cool, temperate conditions are normally associated with these clouds

Major cloud types and inferences which can be drawn from them

The sky will often contain a mixture of cloud types, and it is instructive to note whether any particular type is increasing, decreasing, or newly appearing.



The ten principal cloud types

During winter in the Natal Drakensberg only fair-weather cumulus normally forms. This dissipates on the Natal side. If the clouds maintain on the Natal side, snow often results. Rain is more frequent in summer, usually in the form of afternoon storms.

In the western Cape mountains winter weather is often characterised by a calm period, followed by low valley cloud. Mares' tails, cirrus and altostratus clouds accompanied by lenticular formations with freshening wind pre-indicate the arrival of a cold front and rain or snow. In summer, cold fronts occur far less frequently and are of lesser intensity.