LESSON 3: AFRICA’S CLIMATE REGIONS

Key Concepts

You must know, or be able to do the following:

- Name, understand the characteristics and position of Africa’s major climate regions
- Be able to link the African Continent circulation to Global Tri-cellular circulation with particular reference to areas of uplift (rain) and subsidence (dry)
- Identify the major ocean currents around Africa and the influence on climate control over Africa
- Fully understand the processes of El Nino and La Nina and their effects on African climate
- Be able to interpret synoptic charts of South Africa with special reference to air movements, interpretation of station models and the dominant pattern of High Pressures that affect the climate. Much of this is a recap from Grade 10.

X-PLANATION

Characteristics and Position of Africa’s Major Climate Regions

Africa’s position is relatively unique in the sense that it almost has a mirror image of climate zones to the north and South of the Equator with regard to latitude. The six main climate zones of Africa are found to the north and south of the equator, namely, Equatorial, Humid Tropical, Tropical, Semi-desert (Sahalian), Mediterranean and Desert.

A climate region is an area with similar temperature and rainfall.

In Grade 10, you learnt about several factors that influence the climate of different places in the world. These are:

- Latitudinal position
- Altitude
- Distance from the sea
- Prevalent pressure belts
- Ocean currents.

Considering this, Africa has a large variety of different climates.
## Map of Africa Climate Zones

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Characteristics</th>
</tr>
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| Desert             | - 18° - 36° N & S of the Equator  
- Sub-tropical HP zone  
- West coast and Continental effect  
- Cold Canary Current and Cold Benguela Current |
| Equatorial         | - 10° N & S of the Equator  
- ITCZ  
- Continental mainly with west coast warm current |
| Tropical (Savannah) | - 15° to 20° N & S of the Equator  
- Sub-tropical HP over region in winter  
- Summer rainfall region prone to droughts and tornadoes  
- Large temperature ranges |
| Mediterranean      | - 30° - 40° N & S of the Equator  
- Situated on the furthest north and south west margins of the African continent  
- Winter rainfall brought on by temperate cyclones (cold fronts)  
- Maritime |
| Sahelian (semi-desert) | - 20° N of Equator  
- Transition between Monsoon and desert zones  
- ITCZ moves N -summer rainfall  
- Mainly Continental effect |
| Humid Tropical     | - Transition between Equatorial and Tropical (Savannah)  
- Rainfall throughout the year – more in summer  
- Small variations in temperature  
- 20° - 25° C  
- High temperatures due to tropical location |

![Map of Africa Climate Zones](http://sageography.myschoolstuff.co.za/wp-content/uploads/sites/2/2012/11/AfClimate.gif)

*Figure 1* Map of Africa showing the various Climatic regions

Adapted
Subsidence and Convergence in Africa

Africa straddles the Equator from 37° N to 34° S. Africa has two Sub-tropical belts with the ITCZ somewhat equidistant from the two high pressure zones.

The ITCZ (also known as the heat Equator) moves between the Tropics of Cancer and Capricorn depending on the season. This is the area of massive uplift over Africa and very high rainfall figures are measured.

The sub-tropical High Pressure Belt also migrates with the seasonal movement of the overhead sun. Areas in Africa have their rainfall season when the heat Equator moves into its respective hemisphere. Figure 2 is more simplified. It shows conditions for an Equinox with the overhead sun over the Equator.

Figure 2  Subsidence and convergence (link to rainfall) in Africa
http://www.theodora.com/maps/new6/african_color.gif Adapted

The Role of Oceans in Climatic Control in Africa

The ocean covers more than 70 % of the Earth’s surface. The ocean plays a major role in regulating the weather and climate of the planet.

Oceans in general have a great influence on rainfall on a continental basis and an influence on temperatures along coastal margins.

Figure 3 is an isotherm map that shows ocean temperatures around Africa. If the ocean currents are superimposed on this map, there will be a striking correlation between the cold ocean currents and colder waters and warm ocean currents and warm waters.
Isotherm: Line joining places of the same temperatures

Temperature

- The effect of the ocean with regard to temperature is Maritime in effect.
- Generally, when looking at temperature of oceans and currents around the coast of Africa, there is a dominance of warm water around the continent.
- The exceptions are the North West and the South West coastlines, (Cold Canary and the Cold Benguela currents, respectively).
- Both Mediterranean areas are cooler than expected due to cloud cover in winter as cold fronts move through and lessen insolation. These areas are marked on Figures 3 & 4.
- Since South Africa is surrounded by water masses, all coastline temperatures are moderated and have small temperature ranges.


Rainfall

- The map of average rainfall over Africa annually shows a similarity to the maps that show climatic regions.
- The effect of ocean temperatures and currents has a maritime and continental effect. This together with the migration of the “heat Equator” presents a rainfall pattern of considerably more rainfall over Sub-Saharan Africa.

![](http://www.mapsnworld.com/africa/annual-rainfall-monsoon-africa.jpg)
Processes of El Nino and La Nina and their effects on African climate

The effects of La Nina and El Nino are part of what is called the Southern Oscillation. In Africa, there are two main areas affected where dry areas receive more rainfall, while, the wet areas receive less rainfall. The two areas are shown on Figure 6 & 7.

The Southern Oscillation originates over the Pacific Ocean. This changes the normal pressure patterns over the entire Earth’s surface. With changing pressure, winds are affected. Simply, this means that areas that would normally be moist are dry and visa-versa.

Normal Pacific Ocean Circulation

![Normal Pacific Ocean Circulation](http://kids.mtpe.hq.nasa.gov/archive/nino/elnino.html) Adapted

El Nino

![El Nino](http://kids.mtpe.hq.nasa.gov/archive/nino/elnino.html) Adapted

El Nino can have impacts on weather at various locations around the globe. Off the east coast of southern Africa, drought conditions often occur. In countries such as Zimbabwe, the effects of drought can be devastating.
The effects of the Southern Oscillation are graphically represented in Figure 8 where distinct times of below average and above average rainfall are noticeable.

![Rainfall fluctuations in Africa 1900–2000](http://www.unep.org/dewa/africa/publications/aeo-1/fig2a2.htm)

### Interpretation of synoptic charts of South Africa with special reference to air movements and interpretation of station models

**Synoptic Charts**

Synoptic charts are drawn 4 times a day at Greenwich Mean Time. We are 2 hours ahead in South Africa. Hence we create synoptic maps at 02:00, 08:00, 14:00 and 20:00. This allows for weather stations throughout the world to collect weather data at exactly the same time. Climatologists are then able to create a global weather picture.

Climate data is collected by land based weather stations, islands (Marion and Gough) and ships. We are then able to plot the weather conditions to the west, south and east of South Africa.

The major information that can be used from a synoptic chart is:

- Isobars that determine wind direction and wind speeds, subsidence and uplift
- Station models that measure present weather conditions
- Lines of latitude and longitude to show the position of weather phenomena
- Observe approaching cold fronts (warm fronts seldom reach South Africa)

### Air Movements

- The TWO main surface circulation patterns of winds are those of High Pressures (Anticyclones) and Low Pressures (cyclones), shown by Figure 9
- These must be understood as to where winds come from and their nature. This allows for the understanding of weather that will result from these wind patterns.
- In lesson 2 Pressure gradient, pressure gradient force and Coriolis force were covered with their impact on wind speeds and wind direction
- The two forces mentioned, determine the circular flow around High and Low pressure systems (Figure 9)
- Isobar spacing determines wind speed.
- Closely spaced isobars indicate a strong wind, while isobars spaced further apart indicate gentle winds.
- Air moves from a high pressure to a low pressure.

**Circulation of air around pressure cells**

![Diagram of air circulation around pressure cells](image)

**Figure 9**

**Source: Author**

**Station Models**

- It is important to know that a full station model is drawn with the weather observations in specific positions around the circle.
- Station models on synoptic charts are too small to show all the weather observations.
- On Figure 10, the usual station model symbols have been circled.
- Clearly, one cannot just place the 6 circled observations anywhere around the circle. The one exception is the wind (which is changeable).
- Common symbols used on station models are in the table (Figure 11).

![Symbols and sample plotted report](image)

**Figure 10 Full station model**

*Source: Strahler Physical Geography*
Fronts

- Fronts commonly affect South Africa in winter and are present on South African synoptic charts in summer further to the south.
- Warm fronts seldom pass over South Africa.
- Cold fronts pass over South Africa leaving very cold sunny days behind in the interior.
- The fronts approach the country from the west and are responsible for the winter rainfall at the Cape.

Notice the triangle features on the Earth’s Surface (used on a synoptic chart to show the position of where the front is positioned on the surface.)
Annotated Synoptic Chart

Lines of latitude and longitude – to show position of weather systems

A station model (in this case a ship) showing the weather conditions

A Low Pressure system

A High Pressure system

Isobars – lines joining places of the same air pressure

Date & Time
**X-AMPLE QUESTIONS**

**Question 1**

Refer to the map below (Figure 1 A) showing Africas climate regions and the climate graphs that match many of the climatic regions (Figures B – K). Answer the questions that follow:

| Desert          | • 18° - 36° N & S of the Equator  
|                 | • Sub-tropical HP zone             
|                 | • West coast and Continental effect 
|                 | • Cold Canary Current and Cold Benguela Current |
| Equatorial      | • 10° N & S of the Equator         
|                 | • ITCZ                             
|                 | • Continental mainly with west coast warm current |
| Tropical (Savannah) | • 15° to 20° N & S of the Equator 
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|                 | • Large temperature ranges         |
| Mediterranean   | • 30° - 40° N & S of the Equator   
|                 | • Situated on the furthest north and south west margins of the African continent 
|                 | • Winter rainfall brought on by temperate cyclones (cold fronts) 
|                 | • Maritime                         |
| Sahelian (semi-desert) | • 20° N of Equator     
|                 | • Transition between Monsoon and desert zones 
|                 | • ITCZ moves N -summer rainfall   
|                 | • Mainly Continental effect        |
| Humid Tropical  | • Transition between Equatorial and Tropical (Savannah) 
|                 | • Rainfall throughout the year – more in summer 
|                 | • Small variations in temperature  
|                 | • 20° - 25° C                      
|                 | • High temperatures due to tropical location |

![Map of Africa showing climate regions](image)
1.1 What characteristics do we use to differentiate between one climatic zone and another? (2)

1.2 Africa is the only continent that can be regarded as “a mirror image of each hemisphere” with regards to climate zones. Prove or disprove this statement. 2 x 2 (4)

1.3 Refer to the climatic graphs (Figures B to K). Match any SIX of the climate graphs to the correct climatic region. 6 x 2 (12)

1.4 Identify the 5 ocean currents that wash the shores of Africa. (5)

1.5 In which season does a Mediterranean climate zone receive its rainfall? 1 x 2 (2)
Question 2

Refer to Figure 2 A and 2 B that shows El Nino conditions and La Nina (also known as “normal”) conditions by some.

The oscillation between El Niño & La Niña conditions in the equatorial eastern Pacific Ocean is called ENSO (El Niño Southern Oscillation). after: www.bom.gov.au

2.1 Identify the surface pressures at A, B and C. In each case give a reason for your answer.  3 x 2 (6)

2.2 The movements of air at D and E have names. What are these?  2 x 2 (4)

2.3 Identify the areas that have drought conditions during an El Nino event by using Figure 2 A.  1 x 2 (2)

2.4 From your answer, explain the weather that would be experienced during the drought conditions brought about by El Nino.  2 x 2 (4)

2.5 Write a paragraph about the effect that an El Nino event would affect Southern Africa. In your answer, refer to economic, social and environmental effects.  6 x 2 (12)

2.6 Account for the desert labelled on Figure 2 A.  1 x 2 (2)

2.7 The rainfall indicated over Australia and surrounding islands (Figure 2 B) are Monsoons. Briefly explain the seasonal activity and movement of winds that would cause Monsoons in this area.  5 x 2 (10)
X-ERCISE QUESTIONS

Question 1

Refer to Figure 3 showing a synoptic chart for South Africa. Answer the questions.

**Figure 1**  Synoptic Chart of South Africa. South African weather services

1.1 Identify the isobar patterns illustrated by the letters on Figure 1. In your answer to this question, list the following letters and the isobar pattern next to each letter respectively. (R, S, W X AND Y).

5 x 2 (10)

1.2 Name the two fronts labelled P and Q. List the letters P and Q. Again, next to each, write down the appropriate answer.

2 x 2 (4)

1.3 Comment and explain how wind speeds would vary in the areas indicated by T and U.

4 x 2 (8)

1.4 Write down the direction of the wind found at V, and explain how this wind is generated.

5 x 2 (10)

1.5 The following readings were taken at one of our weather stations yesterday:

- Air Temperature: 26 °C
- Dew point temperature: 23 °C
- Wind speed: 15 knots
- Wind direction: WSW
- Cloud cover: ⅞
- Weather: showers

Draw a weather station model that reflects these conditions.

6 x 1 (6)

1.6 Refer to the synoptic chart showing the west coast of Namibia. M indicates a ship off the western coastline labelled M. Describe the weather conditions observed on the day in question.

6 x 1 (6)
1.7 What is the likely pressure of the dotted line (isobar) on the map?

**SOLUTIONS TO X-ERCISE QUESTIONS**

**Question 1**

1.1 R South Atlantic High (2)
   S Low pressure cell (tropical cyclone) (2)
   W Low pressure trough (2)
   X Low pressure cell (coastal low) (2)
   Y Kalahari High Pressure (2)

1.2 P Cold front
   Q Warm front (2)

1.3 T has a steep pressure gradient (2) indicated by close spacing of isobars (2). Winds will be very strong (2) (NB Friction is not a factor as both T and U are over the ocean).
   U has a gentle pressure gradient (2) indicated by spaced out isobars (2). Winds will be very gentle (2)

1.4 Wind at V moves anticlockwise (2) around a high pressure (2) in the southern hemisphere (2) and is indicated by the station model (2).

1.5

1.6

<table>
<thead>
<tr>
<th>Ship</th>
<th>Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud cover</td>
<td>¾ (1)</td>
</tr>
<tr>
<td>Present temperature</td>
<td>22º C (1)</td>
</tr>
<tr>
<td>Dew point temperature</td>
<td>18º C (!)</td>
</tr>
<tr>
<td>Wind speed</td>
<td>5 knots (1)</td>
</tr>
<tr>
<td>Wind direction</td>
<td>South (1)</td>
</tr>
<tr>
<td>Humidity</td>
<td>High (1)</td>
</tr>
</tbody>
</table>

1.7 1012 hPa (1)