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PSG PROGRAMME (NCQF LEVEL 5)

MODULE 5.

WEATHER AND CLIMATE.

OBJECTIVES (5.1)

- **On completion of this module you will:**
  - Have an understanding and know the difference between weather and climate.
  - Understand the process of cloud formation.
  - Know the different types and names of clouds.
  - Know what weather conditions are associated with the different cloud types and how this my affect the guiding experience.
  - Know the different types of local wind conditions that may apply to the area of operation.
  - Be able to describe the four major influences on the Southern African climate.
  - Understand the general summer and winter conditions of Southern Africa.

THE PRINCIPALS AND PRACTICES OF WEATHER & CLIMATE (5.1.1)

- General Meteorology: Nothing in our environment exists in isolation. Our weather systems affect practically everything around us, - the clothes we wear, our culture, our food, our building styles, our transport system, plants, soils and animals etc. It is therefore essential for field's guides to have a basic understanding of how our weather systems operate.

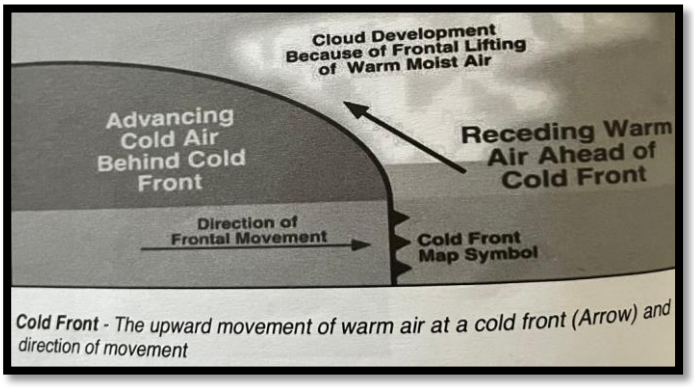
- **Weather systems are primarily created by the interaction of three elements:**
  1. Heat (generated by the sun).
  2. Movement of air.
  3. Moisture.
- The weight of an air column could also vary according to the temperature of the column of air. Warm air is less dense than cold air, and would therefore be lighter. Think about the concept of hot air balloon, air is warmed up, becomes lighter and rises and in the process the balloon is lifted. So we have established two important principles:
  1. Warm air is lighter than cold air.
  2. Warm air rises, while cold air sinks.

DISTINGUISH BETWEEN THE TERMS WEATHER AND CLIMATE (5.1.2)

- **Weather:** is the climatic or atmospheric conditions at the moment; for example, a twenty-four hour period.
- **Climate:** is the seasonal changes in weather! In other words, it is the average weather conditions over a period of time that will change seasonally with movement of time.

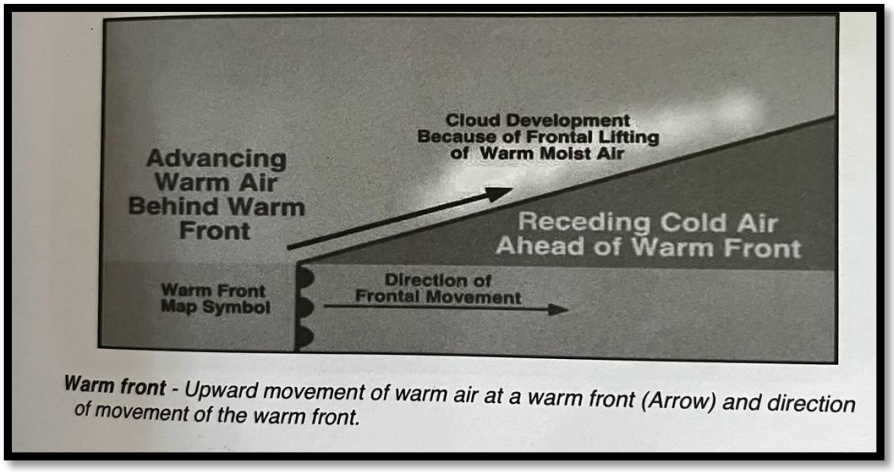
- **The Main Causes of Weather.**

  - **A Cold Front:** a cold front has a wedge of cold air forcing warm air upward. As it rises it cools and the water vapor becomes visible. The temperature drops quite rapidly and reaches a low with passage, after which it must rise again. The dew point drops because cold air holds less water than warm air; - visibility decreases and even more so in the rain. Because of the speed of movement of the cold front the conditions improve rapidly after the cold front has passed through. The air pressure then drops as the cold front approaches and once the front has passed will remain steady or rise slowly. Clouds tend to be of a cumuliform nature. The warm air that is lifted often breaks out in violent thunderstorms. These may also occur along a line well in in advance of the cold front; a squall line (a group of storms arranged in a line, often accompanied by "squalls" of high wind and heavy rain). See diagram below:



Cold Front - The upward movement of warm air at a cold front (Arrow) and direction of movement

- **A Warm Front:** the movement of the warm air over the cooler air leads to the formation of considerable cloud and usually rain ahead of the front. After having passed there is generally either slight rain or drizzle or no rain at all.
- The movement of a warm front through the area normally leads to a rise in temperature, a decrease in or no rain and wind. Warm fronts are commonly associated with stable atmospheric conditions. However, if the warm air is unstable, it will develop convection cells and there will be heavy showers and thunderstorms. See diagram below:

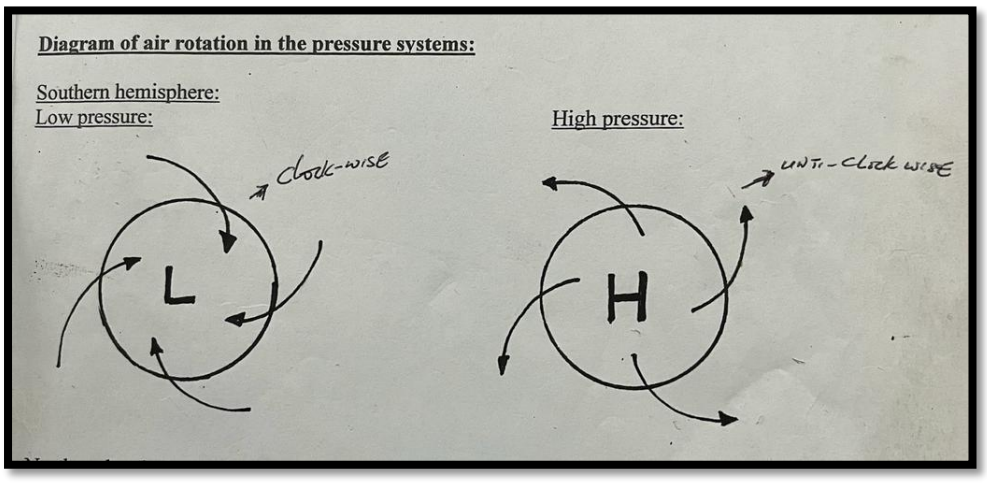


Warm front *- Upward movement of warm air at a warm front (Arrow) and direction of movement of the warm front.*

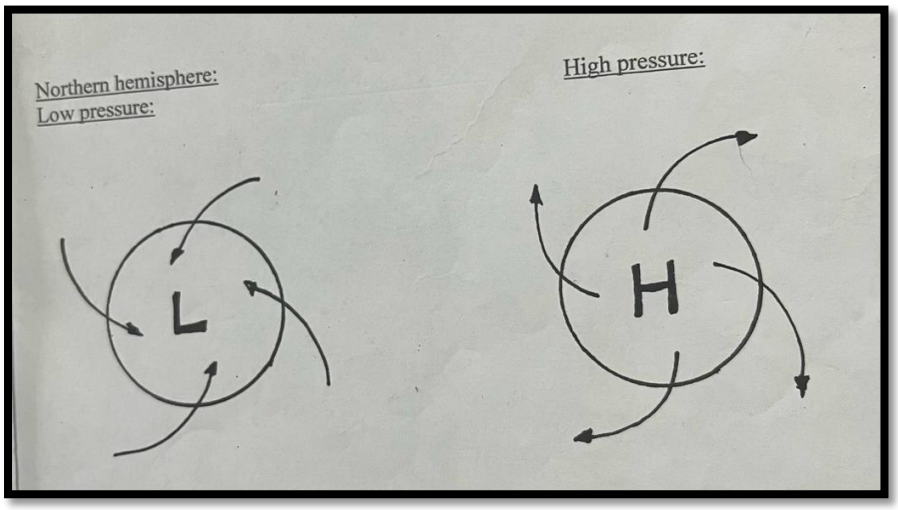
AIR PRESSURE CELLS (5.1.3).

- The earth and the atmosphere tend to gain and loose heat (from the sun) faster than the oceans. Although the atmosphere stores very little heat, the wind in the atmosphere can move around the planet fairly quickly. Due to the rotation of the earth the air masses are deflected into ribbons that spiral around the planet forming what are known as the north east and south east trade winds on either side of the equator and the westerly`s near the north and south poles.
- Everything is driven by wind in turn driven by pressure changes that are the result of temperature differences. Air pressure at a point is a measure of how much the weighs above that point. Where there are high temperatures, the ground gets heated up and air rises, reducing the effective weight of the air and a **low pressure** is the result. When conditions are cooler, the air will sink, effectively increasing the weight and a **high pressure** is the result. Because nature will always try to equalize pressure, air from high pressure areas will want to flow to the low pressure areas, creating wind (wind is moving air). Because the earth is turning, an effect called **Corioli`s Force** comes into play which causes winds to be deflected as follows: See diagrams below:

  - Southern Hemisphere –

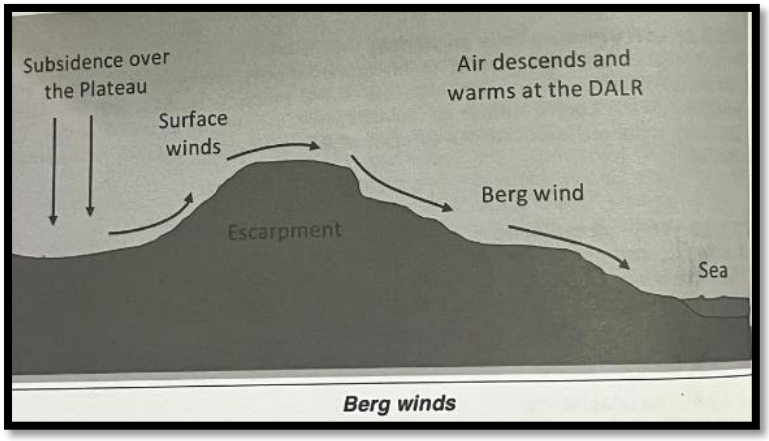


- Northern Hemisphere –



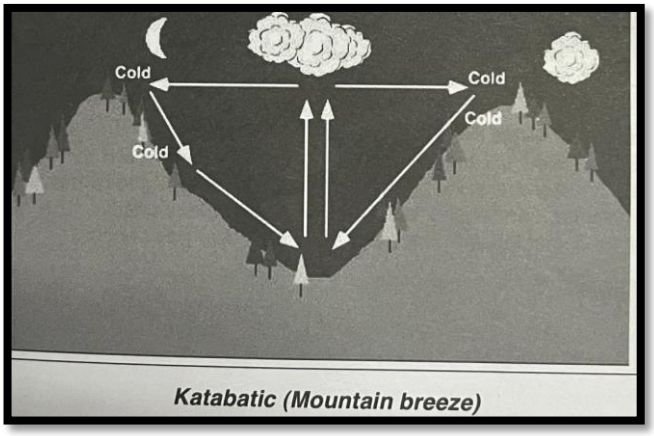
1. **High Pressure Cells (anticyclones) –** the high-pressure cells consist of a downward sinking mass of air rotating anti-clockwise under the influence of pressure gradient and earth`s rotation. High pressure cells are associated with clear skies and settled weather.
2. **Low Pressure Cells (cyclones) –** the low pressure cells consist of an upward-moving mass of air, rotating in a clock-wise direction under the influence of pressure gradient and the earth`s rotation. At the earth`s surface air moves inward towards the center of the cell. Low pressure cells are associated with uplift of air, condensation, cloud formation and rainfall.
3. **Tropical Cyclones –** a small intense cell (often less than 100km in diameter) occurs occasionally along the Mozambique coast. It is associated with stormy weather conditions, extremely strong winds and heavy rainfall. Since this type of low-pressure cell occurs most frequently in the tropics, it is known as a **tropical cyclone.**
4. **The Coastal Low –** a small weekly developed low pressure cell frequently occurs along the coast line of Southern Africa. It is often associated with a cold front, and frequently develops along the west coast from where it travels around the coastline.

- **Types of Wind:** The types of wind that you as a nature guide should be aware of are:
    1. Berg winds – Berg winds are usually associated with coastal and lowveld areas. They are hot, dry winds that blow from the land in a seaward direction. The onset of a berg wind raise the temperature by as much as 10 degrees, and thus are not usually very popular. During the winter months there is frequently a strong high pressure system over Southern Africa. Along the escarpment the wind generally blows outwards towards the sea. As the air moves over the escarpment it descends down the leeward side. The air heats up at the dry adiabatic lapse rate of roughly 1 degrees for every 100 metres of descent. The air reaches the lowveld and coastal areas as hot, dry wind. (See diagram below).

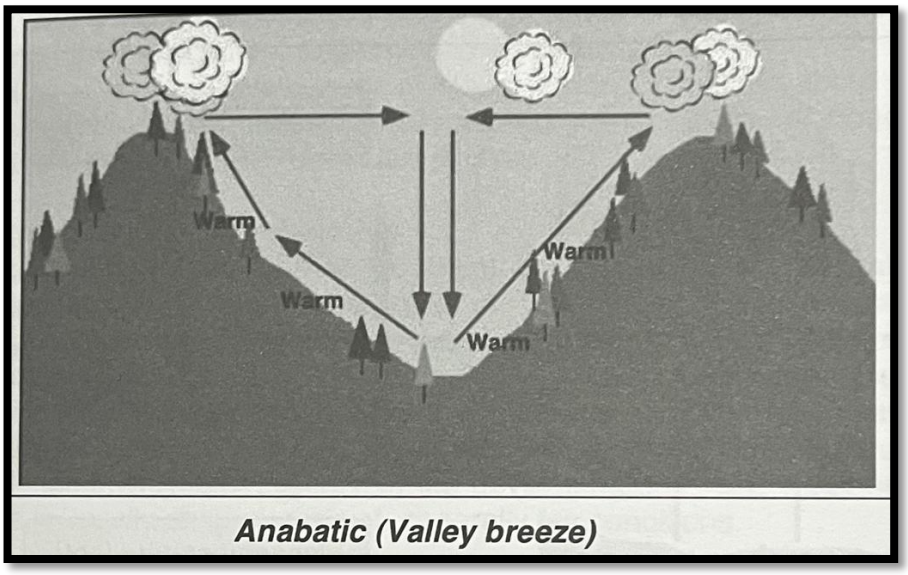


2. Mountain and Valley Breezes:

- **Katabatic Winds –** these winds are a result of rapid cooling of air on higher ground due to radiation. The cooler air begins to move down the slope and as it descends lower its speed increases; this increase in speed may often result in gusts of wind. This winds usually occur at night as the temperature drops. See diagram below:



- **Anabatic Winds –** early in the morning the air that is in contact with the hillsides or mountain slopes is warmed up quicker than the air in the low lying plains. The rays of the sun strike the eastern slopes at a greater angle of incidence; this rising air is known as Anabatic wind and is often evident in the form of rising fog out of the valleys up the mountain slopes. See diagram below:



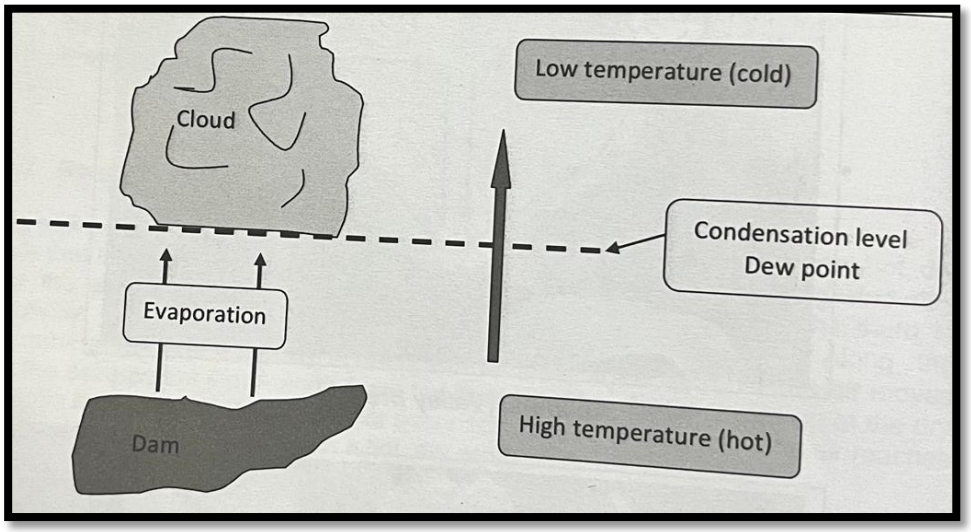
- **Humidity:** Water vapor is a gas, - the only gas that can change from a gaseous state to a liquid state under ordinary atmospheric conditions, and this has some remarkable effects.
- There is a limit to the amount of water vapor that air can hold. The higher the temperature of the air, the greater the amount of water vapor that it can carry before it becomes saturated. When saturation point of air is exceeded, the excess water vapor changes into the liquid state and then becomes visible cloud or fog. This means that when warm moist air is cooled down, cloud will form. The opposite is also true, when cold air containing cloud or fog is heated up, the cloud will evaporate into invisible water vapor.
- An important concept that goes hand in hand with this process, is the term **dew point** t**emperature**. Dew point temperature is that temperature at which the air would become saturated with water vapor. What does this mean in practice? Let us say you are guiding in a mountainous area, the temperature is

15 degrees Celsius, and dew point is 14 degrees Celsius; - if the temperature drops one degree, you will find yourself in fog. This will obviously have important consequences for the safety of your guests.

- When air rises, it cools down at approximately 2 degrees per 1000ft. If partially saturated air thus rises, it will cool down and reach dew point temperature at some stage, at which point cloud will form.
- Air masses can be lifted by a variety of forces; that is:
  1. Moving air mass forced by a barrier such as a mountain.
  2. Frontal lift, - cold air wedging in under the warm air.
  3. Turbulence caused by strong winds and uneven ground surface.
  4. Convection, - warm air rising.

EXPLORE THE PROCESS OF CLOUD FORMATION (5.1.4)

- Water molecules are constantly escaping from dams, ponds, swamps and rain into the atmosphere. The process is known as **evaporation.** The water molecules in the air are known as water vapor and the higher the temperature the more evaporation takes place. As the water molecules rise higher and higher into the air, the temperature will decrease. When air is cooled its ability to hold water vapor is reduced. Once a temperature is reached at which the air cannot hold the water vapor any more, it will condense back into water. The temperature at which condensation takes place is known as **Dew Point.**
- In the atmosphere water condenses onto tiny specks of material suspended in the air (salt particles, dust or soot). These particles are then known as condensation nuclei. As condensation continues, microscopic droplets of water form around each nucleus and these droplets combine to form visible cloud and eventually provide the water for rain. See diagram below:

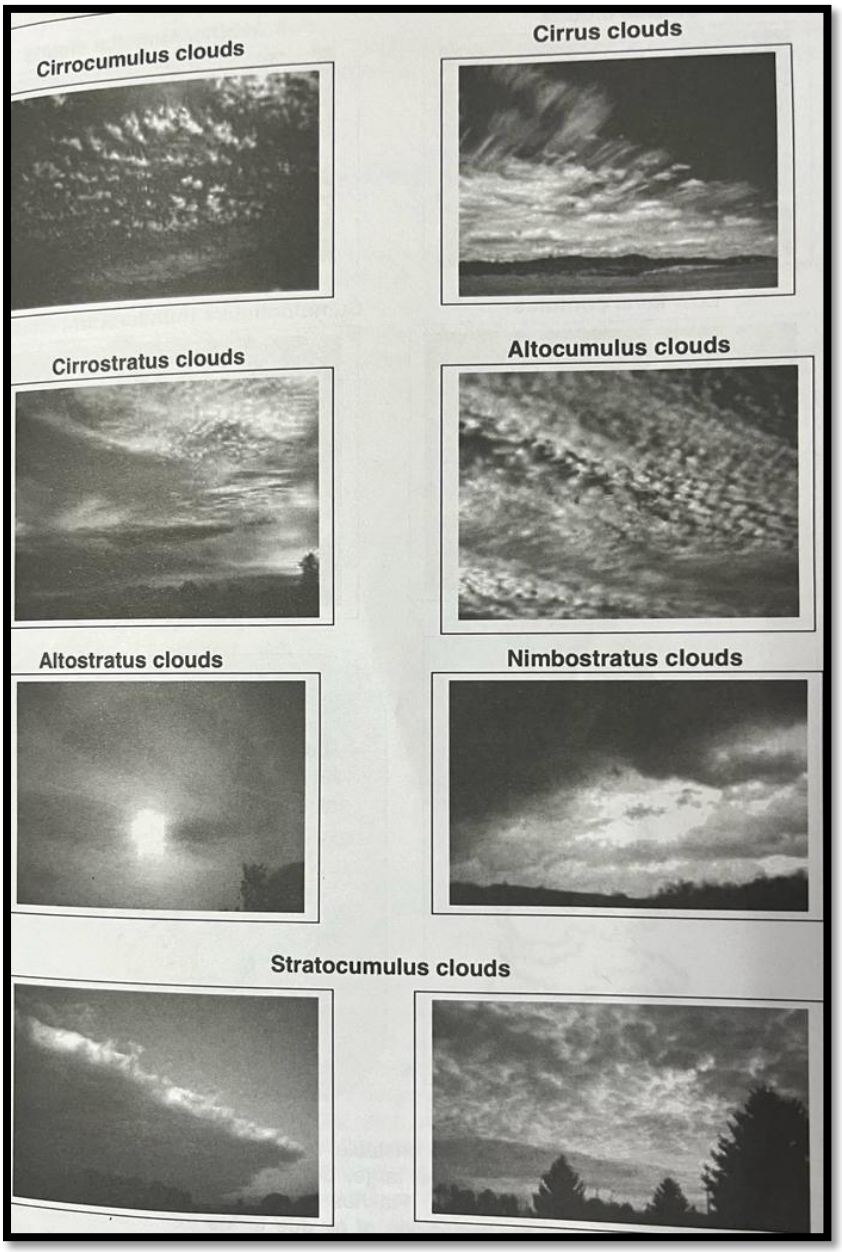


EXPLAIN THE NAMES AS WELL AS DIFFERENT TYPES OF CLOUDS (5.1.5).

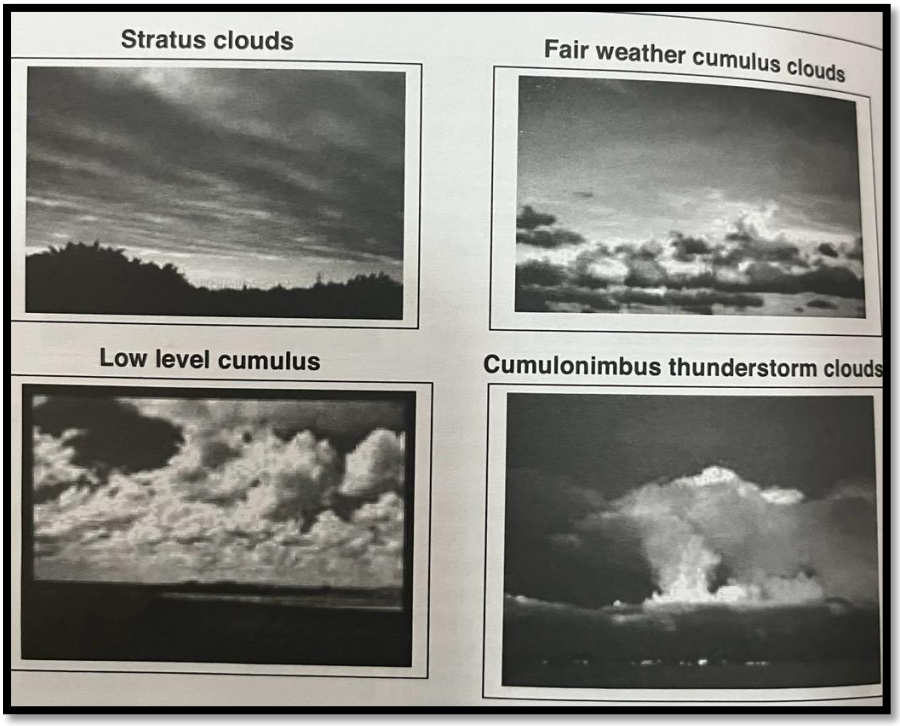
- Cloud types are often named after shapes. Most cloud names are of Latin origin. The best known of these are Cirrus clouds, which comes from Latin word for “Curly”, Cumulus clouds come from Latin word for “Wedge-shaped”, Stratus clouds from the Latin word for “Spread-out”, and Nimbus which is taken from the Latin word for “Cloud”. Cloud types may be classified on the basis of their general form and altitude (height). On the basis of form there are two major groups; - Stratiform or Layered types, and Cumuliform or Massive Globular types. Cloud types and interpretation below:

- **Stratiform Clouds** – Stratiform clouds are blanket-like, often covering vast areas, but are fairly thin in comparison to horizontal dimensions. Stratiform clouds are subdivided according to the level of elevation (height) at which they lie.

- **Cirrostratus and Cirrocumulus (**6000 – 12000m) – The highest type is the cirrus and its related forms, cirrostratus and cirrocumulus. Cirrus is a delicate wispy cloud, often forming streaks across the sky. It does interfere with the passage of sunlight or moonlight and appears to the ground observer to be moving very slowly, if at all. Cirrostratus is a more complete layer of cloud, producing a halo about the sun or moon. Where the layer consists of closely packed globular pieces of clouds, arranged in groups or lines, - the name cirrocumulus is given.
- **Altostratus and Altocumulus (**2000 – 6000m) – At intermediate height range are the altostratus and altocumulus clouds. Altostratus is a blanket layer, often smoothly distributed over the entire sky. It is greyish in appearance, usually has a smooth underside, and will often show the sun as a bright spot in the cloud. Altocumulus is a layer of individual cloud masses, fitted closely together in geometric pattern. The masses appear white or somewhat grey on the shaded sides, and blue sky is seen between individual patches or rows. Altostratus is commonly associated with the development of bad weather, whereas, Altocumulus is usually characteristic of generally fair conditions.
- **Stratus, Nimbostratus and Stratocumulus (**from ground level to 2000m) – In the low cloud group are stratus, nimbostratus and stratocumulus clouds. Stratus is a dense, low-lying cloud layer consisting of distinct greyish mass of cloud between which is open sky. The individual masses often take on the form of long rolls of cloud, orientated at right angles to the direction of wind and cloud motion. Stratocumulus clouds are generally associated with fair or clearing weather, but sometimes rain falls from individual cloud masses. See diagram of cloud types below:



- **Cumuliform Clouds –** The cumuliform clouds tend to display a height as great as, or greater than their horizontal dimension. Cumulus is a white, woolpack cloud mass, often showing a flat base and a bumpy upper surface somewhat resembling a head of a cauliflower. These clouds look pure white on the side illuminated by the sun, but may be grey or black on the shaded or underneath side. Small cumulus clouds are associated with fair weather. Under different conditions, individual masses grow into cumulonimbus, the thunderstorm cloud mass of enormous size that brings heavy rainfall, thunder and lightning and strong winds. A large cumulonimbus cloud may extend from 300m to 12000m (1000 to 40 000ft). See diagram of low level clouds below:



- **Interpretation of Cloud Formation –** Clouds are usually good indicators of atmospheric conditions. Cirrus and cirrostratus clouds invading the sky (usually from the west) are often the first indicators of an approaching warm front. Nimbostratus clouds are usually associated with the passage of a low-pressure system (these clouds usually bring widespread rains), while the presence of small cumulus clouds usually indicates convectional uplift with moderately dry, stable air. If the air is moist and unstable cumulonimbus clouds will develop.

WEATHER PATTERNS OVER SOUTHERN AFRICA (5.1.6)

- **General Climate of Southern Africa:**
  - The climate can be described as sub-tropical with dry, stable conditions and a large amount of sunshine, falling within the sub-tropical belt of high pressure (either side of the 30 degrees latitude). The summer of South Africa and other parts of Southern Africa is from October to March, with the midday temperatures averaging between 15 degrees Celsius to 36 degrees Celsius. (In the lowveld of South Africa it may get up to around 46 degrees Celsius).
- **The Major Factors that Influence the Climate of Southern Africa are:**
  1. The Benguela current along the west coast moving from south to north and the warm Mozambique/Aghulhus current along the east coast moving north to south.
  2. The altitude of central plateau.
  3. Atmospheric circulation, that is, high pressure cells, coastal lows and cyclonic circulation.
- **The Effect of the Oceans:**
  - Both the atmosphere and the earth lose and gain heat faster than the oceans. Even though the atmosphere stores very little heat, the winds in the atmosphere can move heat around the earth very quickly. The earth`s rotation deflects air masses into ribbons that spiral around the globe forming the north east and south east trades on either side of the equator and the westerly`s near the poles. Heat also causes air to rise, creating convection currents and resulting in areas of low

pressure. Cool conditions resulting in dense air that sinks, creating areas of high pressure. Winds move from high to low pressure areas.

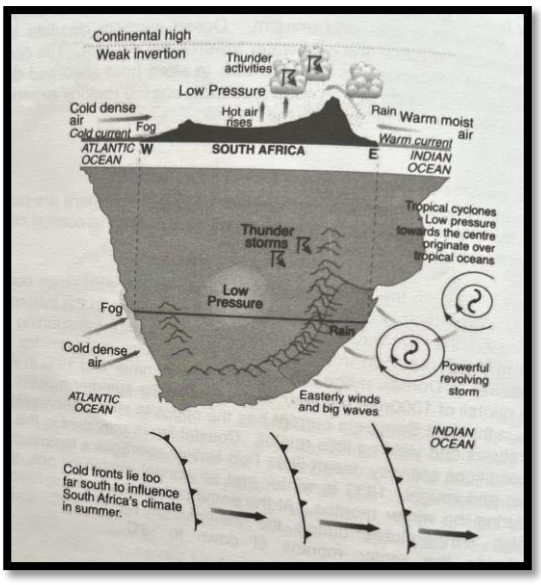
- The ocean play a moderating role as water stores a thousand times more solar heat than air and can slowly release this heat. The upper 2.5 meter layer of the oceans stores the same amount of heat as all the air in the atmosphere. It also takes about 3200 times more energy to heat a given volume of water than air. The huge capacity of water to store heat is fundamental to the role of the oceans in influencing the earth`s climate as it results in temperature that cause winds and rain.
- The sea is warmest near the equator due to the fact that solar heating in this area is strong, while the solar radiation at the poles is reduced which results in a cold environment. Ocean currents circulate warm equatorial water towards the poles and cold water towards the equator. The ocean also moderate seasonal differences as they are able to store heat absorbed during summer and then release it during winter. Consequently, coastal regions experience warmer winters and cooler summer than inland areas.

Seasonal Weather Systems:

- A major influence on the weather of Southern Africa is the fact that there are oceans on both sides of the continent. Maritime air movement moderates the coastal climate and influences weather over the countries. When you look at a typical synoptic chart of South Africa it depicts a low pressure (depression) system south of the country, with high pressure systems at around 30 degrees south. During the summer months the high pressure system is weak over the hot land but strong over the sea. During the winter periods, as the sun moves north, these high and low pressure system move roughly 6 degrees northwards. The central part of South Africa becomes cooler and the high pressure belt is strong over both the land and the sea. The low pressure system influence the Southern Cape primarily but also affects the weather patterns further north of Southern Africa.

Weather Patterns for Summer and Winter:

- **Summer –** the summer weather in Southern Africa is influenced by the southerly movement of the South Atlantic High Pressure Systems and the Southern Indian High Pressure System. The weather in summer is mainly influenced by the interaction of warm, moist air from the Indian Ocean and cool dry air from the Atlantic Ocean. Based on the position of this two high pressure, a thermal low pressure system develops in the interior of South Africa and warm moist air is fed into the interior and in the eastern parts of the country causing the development of thunderstorms. The south western parts of Southern Africa experience dry summer periods due to the fact that the air circulating over this areas does not contain enough moisture to provide rainfall. Summer weather pattern, see diagram below:



- **Winter –** in the winter off-show high-pressure systems move north with low-pressure systems; moving from the Polar Regions reaching Southern Africa. These low-pressure systems bring rainfall and cold conditions to the Western Cape. The weather in the interior of the country is influenced by subsiding stable dry air associated with high pressure systems. This usually results in sunny and dry conditions with cold night time temperature. Winter weather patterns, see diagram below:

