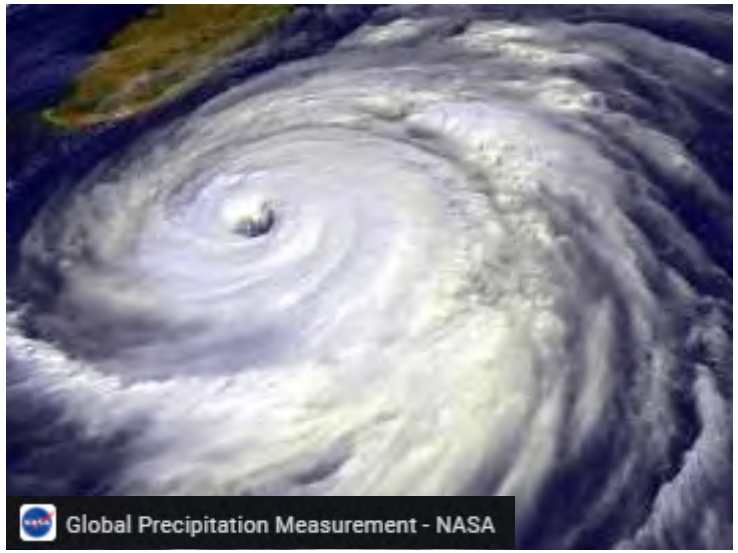
SUMMARIES - GRADE 12



CLIMATE AND WEATHER
AND
MAPWORK CALCULATIONS

RAJENDRA DAVECHAND

PAPER 1
3.1.1 Climate and Weather
Mid-latitude cyclones (frontal depressions, extra-tropical cyclones)
General characteristics
Areas of formation
Conditions necessary for formation
Stages in the formation
Associated weather patterns:
Cold front conditions
Warm front conditions
Occluded front conditions
Cross-section through a mid-latitude cyclone
Cyclone families
Impact on human activities (social and economic) and the environment
Possible pre-cautionary and management strategies
Identification on synoptic weather maps and satellite images:
Identification of stages of development on synoptic weather maps
Impact of South Indian High and South Atlantic High on movement of the cyclone
Reading and interpretation of weather symbols, predicted weather and impact

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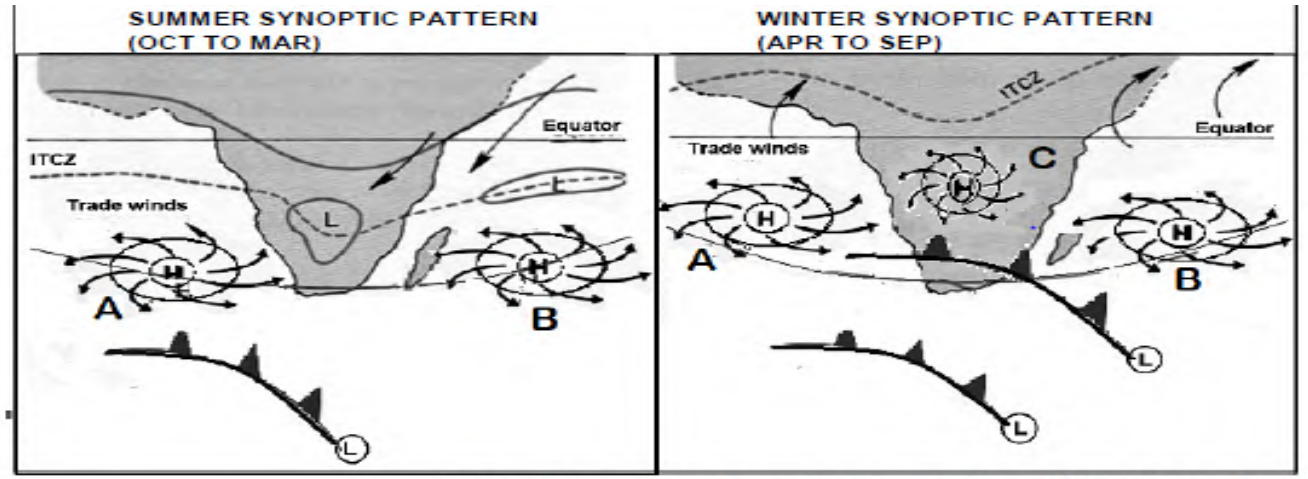
Mid-latitude cyclones

- Alternate names: temperate cyclones, extratropical cyclones. frontal depressions or wave cyclones
- Are low pressure weather systems that occur in the middle latitudes of the Earth, usually between 30° and 60° latitude north and south of the equator.
- This system is made up of a cold front and a warm front.
- The cold fronts reach and effect South Africa mostly in winter when the high pressure belts are in their northerly position.
- Cold fronts effect South Africa winter bringing rainfall (Western Cape receives winter rainfall).
- Moves from east to west.
- The warm front is bent southwards away from South Africa and does not effect South Africa.
- Three or more of them are known as a family of cyclones.
- Moves from west to east



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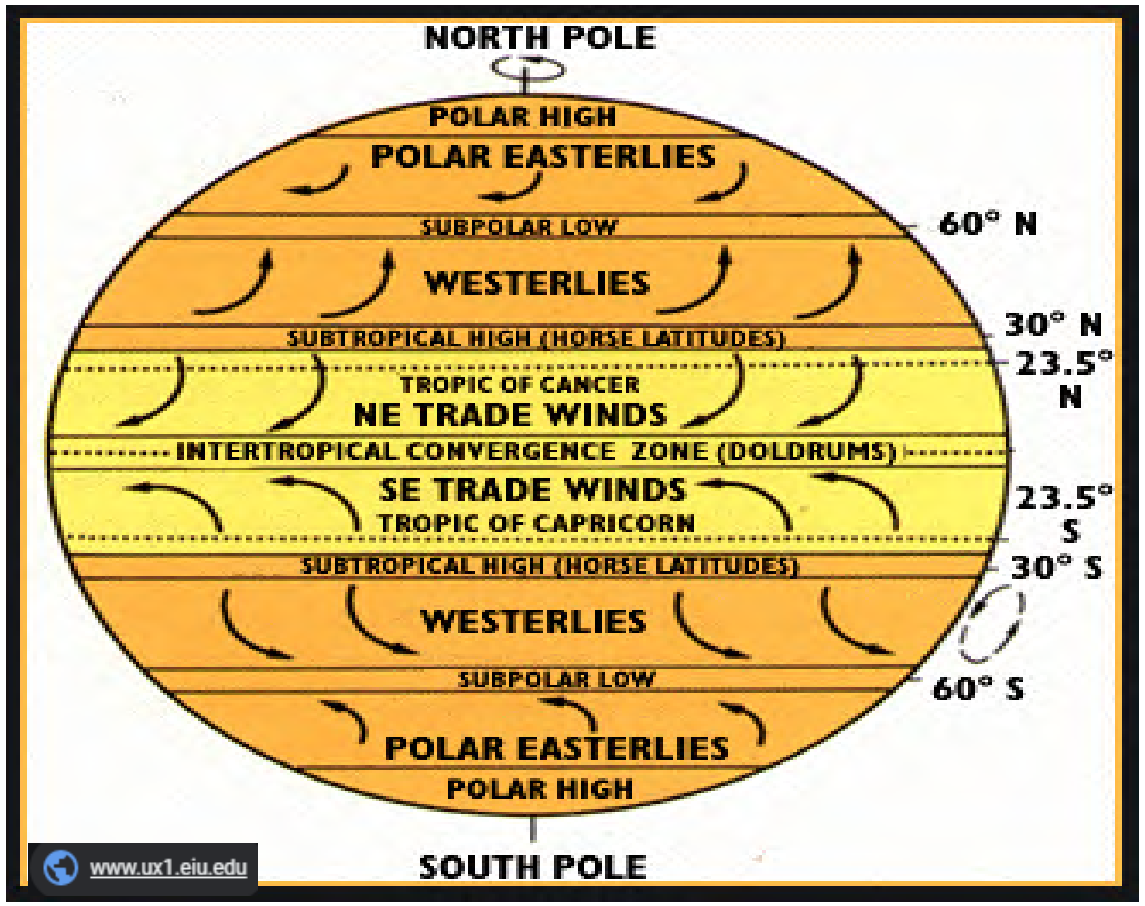

Conditions for formation

- Form at the polar front
- Warm moist air from the subtropical high pressure meets with cold dry air from the polar high pressure at the polar front.
- These air masses blow past each other in opposite directions.
- A disturbance along the polar front causes unstable air resulting in a low pressure.
- This results in the circulation of air.

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Conditions for formation

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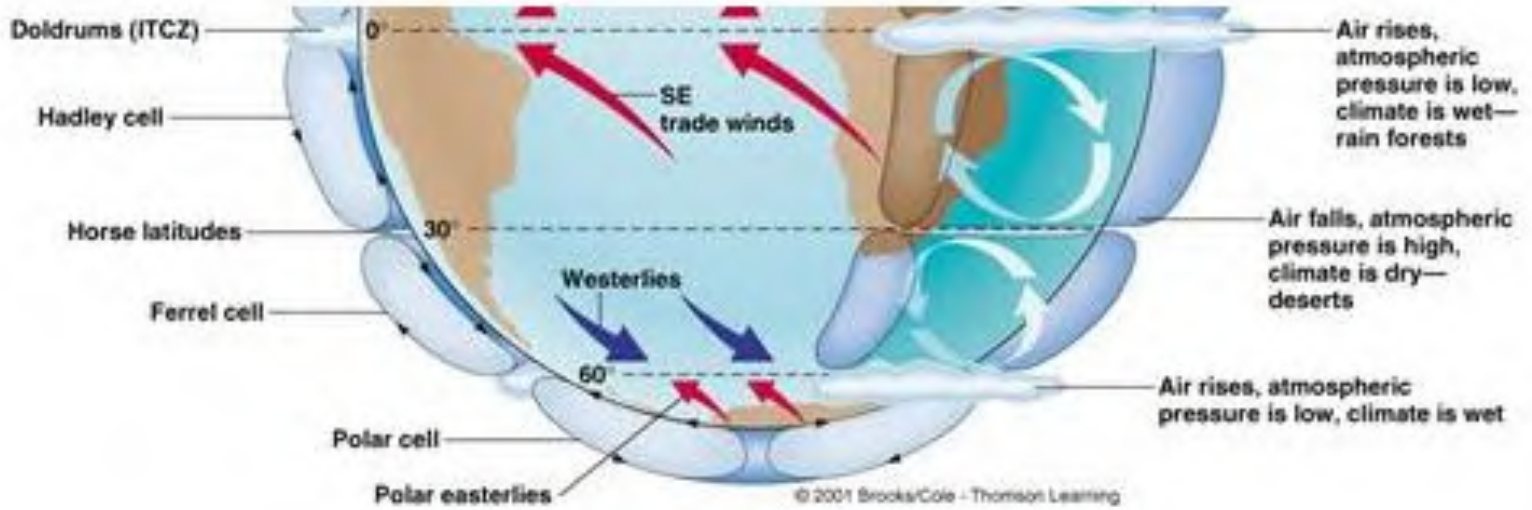

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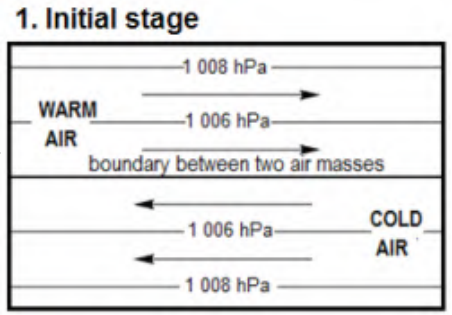
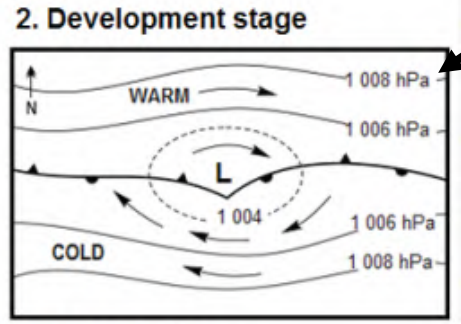
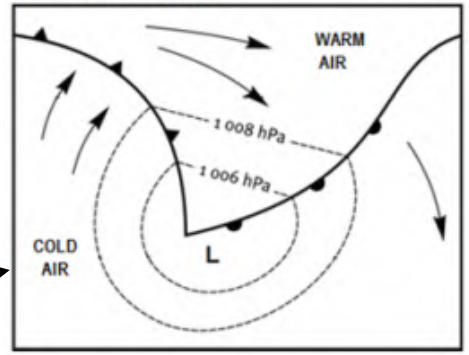
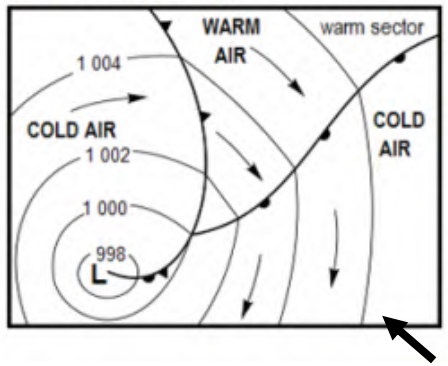
There is a boundary (polar front), separating warm air to the north from cold air to the south. The air masses do not mix and move parallel to each other in opposite directions. The polar front is often stationary. .





A wave forms on the polar front as an upper level disturbance embedded in the jet stream (**Jet streams are currents of air high above the Earth. They move eastward at altitudes of about 8 to 15 kilometers**) moves over the front. The front develops a curve where the wave is developing. Warm air is uplifted resulting in a low pressure due to decrease in pressure. In the southern hemisphere cold air mass moves northwards and warm air mass moves southwards (the opposite is true for the northern hemisphere) Precipitation starts to occur, heaviest along the frontal boundary





The cold air mass moves quickly northwards and the warm air mass moves gently southwards (the opposite is true for the northern hemisphere). There is a clearly defined cold front, warm front and warm sector. Rainfall occurs with the heaviest rainfall along the cold front due to the upliftment of warm air.

Dissipating stage: Here warm air is uplifted from the ground. Rainfall decreases or stops.

Cold front, moving faster than the warm front, "catches up" with the warm front. The cold front overtakes the warm front, an occluded front forms.

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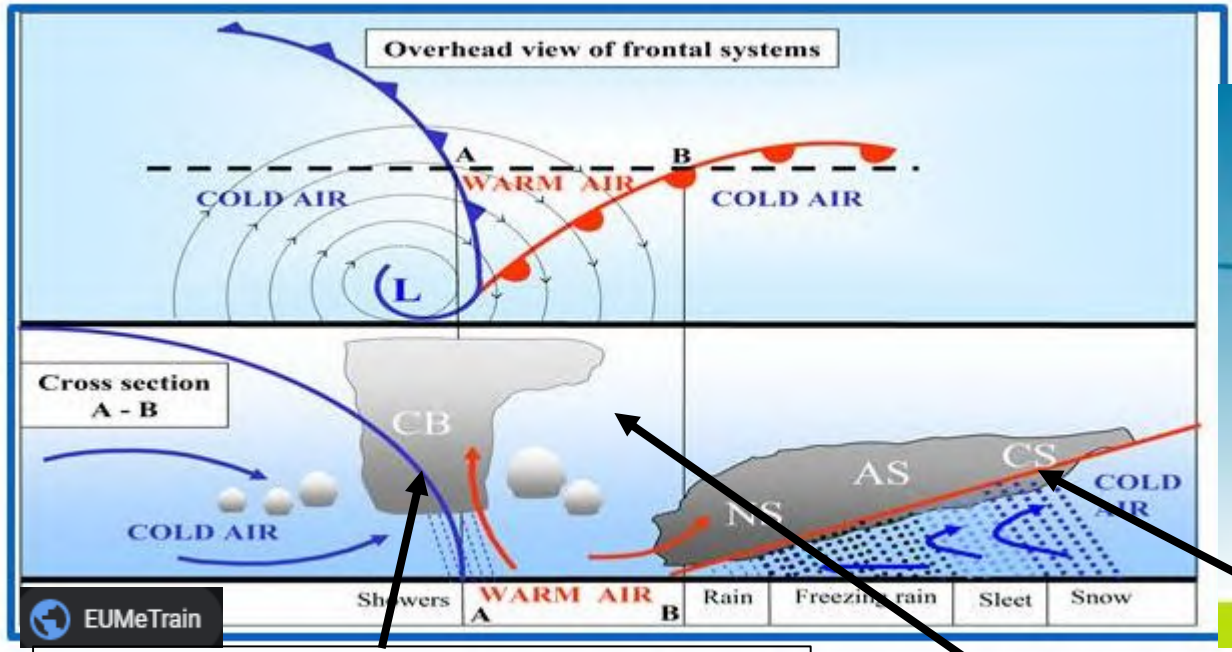

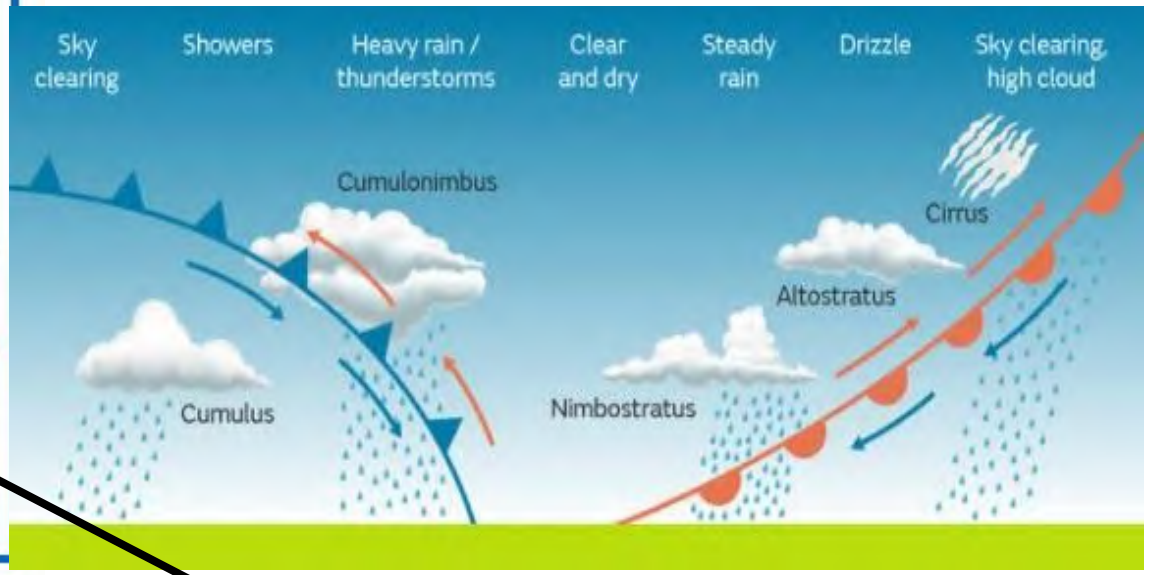

Cold front: Pressure gradient at cold front is steep resulting in rapid upliftment of warm air.
Temperature decreases
Pressure decreases but increases with cold sector
Humidity decreases
Cloud cover increases – cumulonimbus clouds
Chances of precipitation increases - heavy rain/snow
Due to veering and backing wind direction changes (Veering warm air advection, anticlockwise circulation in Southern Hemisphere. Backing cold air advection, clockwise circulation In Southern Hemisphere. Opposite for Northern Hemisphere)
Stronger winds

Warm sector: Decrease in wind speeds.
Warm conditions.
Calmer conditions
Possibility of drizzle or no rainfall.
Higher humidity

Warm front: Pressure gradient at warm front is gentle and air rises along this front. Temperature increases
Pressure decreases
Humidity increases
Cloud cover nimbostratus
Precipitation – soft soaking rainfalls

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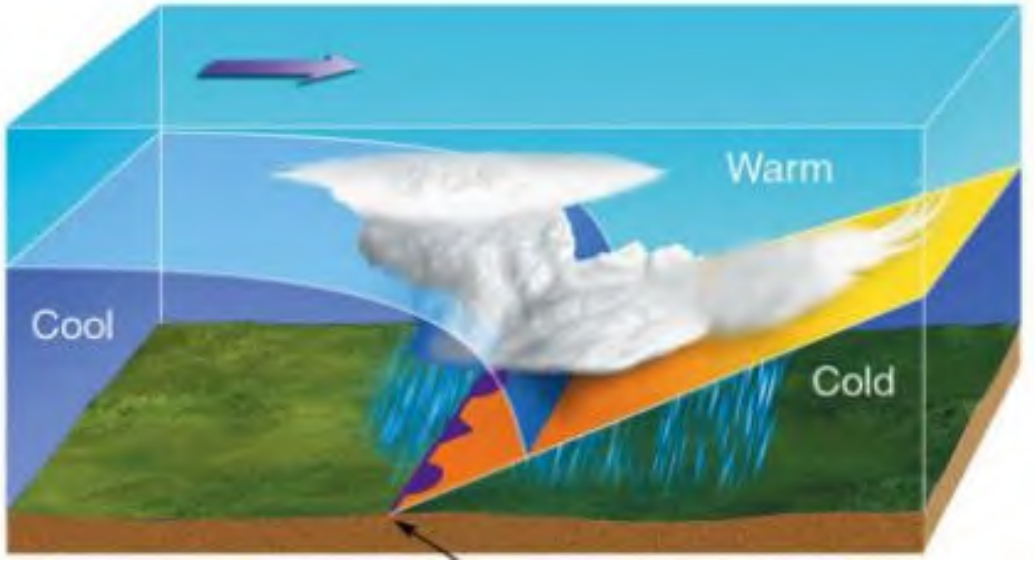
Note when an occlusion takes place the warm air is uplifted.

atmos.uw.edu

A cold front occlusion results when the statically more stable air is behind the cold front. The cold front undercuts the warm front.



A warm occlusion occurs when the cold air behind the occluded front is warmer than the air ahead of it. The warm occlusion acts in a similar way to a warm front. The cold air behind the front is less dense than the even colder air ahead of it, and so it passes over the top of the colder air.

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EXAMPLES OF SOCIAL IMPACTS

Positive

- Brings rainfall – increase in agricultural production – more employment
- Increase in agricultural production more food available
- Employment improves quality of life
- Increase in recreational facilities

Negative

- Results in floods – damage property
- Floods decrease accessibility to recreation facilities
- Floods could result in loss of lives
- Floods could damage crops/kill livestock – reduce amount of food available
- Floods decrease – decrease in production - decrease employment opportunities

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EXAMPLES OF ECONOMIC IMPACTS

Positive

- Brings rainfall – increase in agricultural production – more employment
- Increase in agricultural production – greater income to area
- Improves aesthetic appeal – vegetation grows due to rainfall – snowfall – tourist attractions
- Availability of water supply for secondary and tertiary economic sector

Negative

- Floods – decrease in agricultural production – increase unemployment
- Floods/strong winds damage infrastructure
- Floods restrict accessibility to tourist attractions – effecting tourism.
- Less production – less income to area

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Tropical cyclones

General characteristics
Areas of formation and associated terms in different parts of the world
Conditions necessary for formation
Stages in the formation
Associated weather patterns
Cross-section through a tropical cyclone
Impact on human activities (social and economic) and the environment (the impact of the weather associated with tropical cyclones)
Pre-cautionary and management strategies to manage the effects of tropical cyclones
Identification on synoptic weather maps and satellite images:
Identification of stages of development on synoptic weather maps
Reading and interpretation of weather symbols
Case study of ONE recent tropical cyclone in the southern hemisphere.

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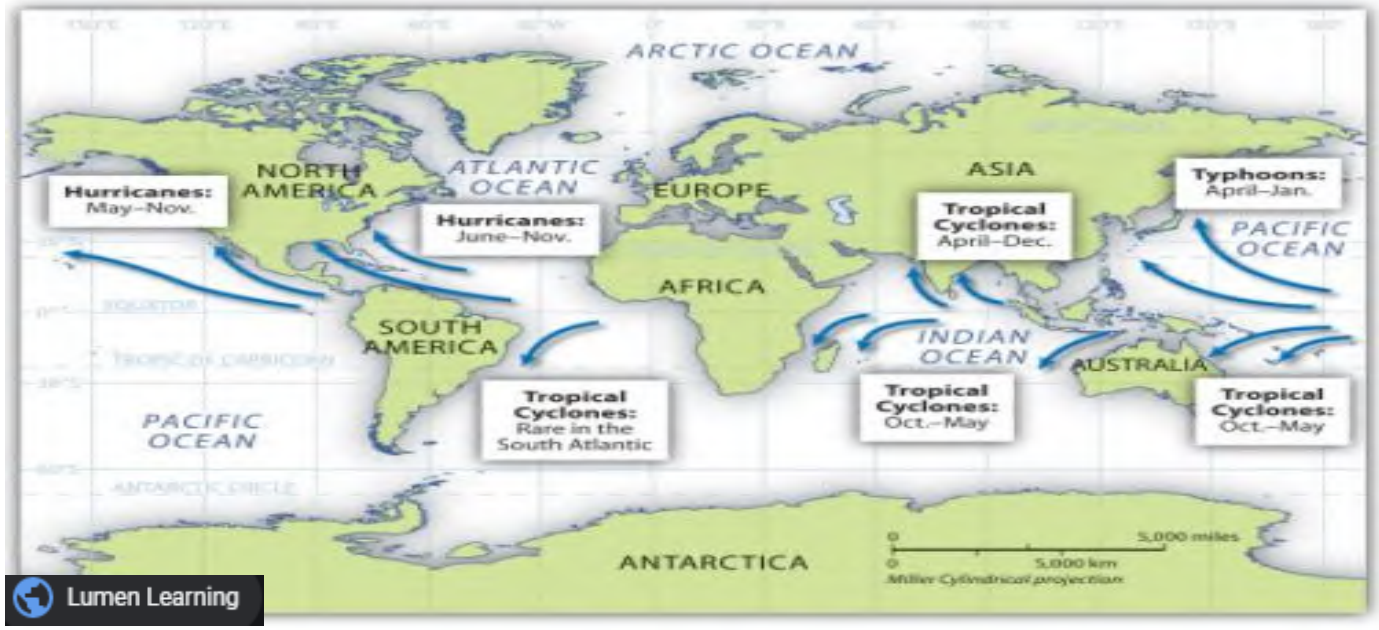
Tropical cyclone (Indian Ocean)

- Alternate names: Hurricane (North Atlantic) and Typhoon (North Pacific).
- Tropical cyclones develop at the ITCZ, but outside 5º north and south, because a Coriolis force is absent on the equator.
- Coriolis force causes deflection of wind and allows for the creation of a cyclonic vortex. (Coriolis force will cause the winds to spiral towards the low pressure. This intensifies the low pressure to such an extent that a clear funnel, called the eye of the cyclone develops)
- It is an intense low pressure storm which causes a lot of wind and flood damage.
- Tropical cyclones only form under very specific conditions (Discussed later in presentation).
- They are named alphabetically in the season they occur.
- Main source of energy is latent heat resulting from cooling and condensing of rising air.
- Tropical cyclones occur in the tropical regions over warm ocean water.
- Move from east to west.
- Originate in summer and Autumn (mostly late summer and early autumn). With temperature of at least 26.5°C



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Conditions necessary for formation

- Large sea surface with temperature higher than 26.5° C.
- Presence of the Coriolis force enough to create a cyclonic vortex.
- Small variations in the vertical wind speed.
- A pre-existing weak low-pressure area or low-level-cyclonic circulation.
- Upper divergence above the sea level system.
- Good source of latent heat. Ocean waters having temperatures of 26.5° C or more is the source of moisture which feeds the storm. The condensation of moisture releases enough latent heat of condensation to drive the storm (High humidity).
- Calm conditions

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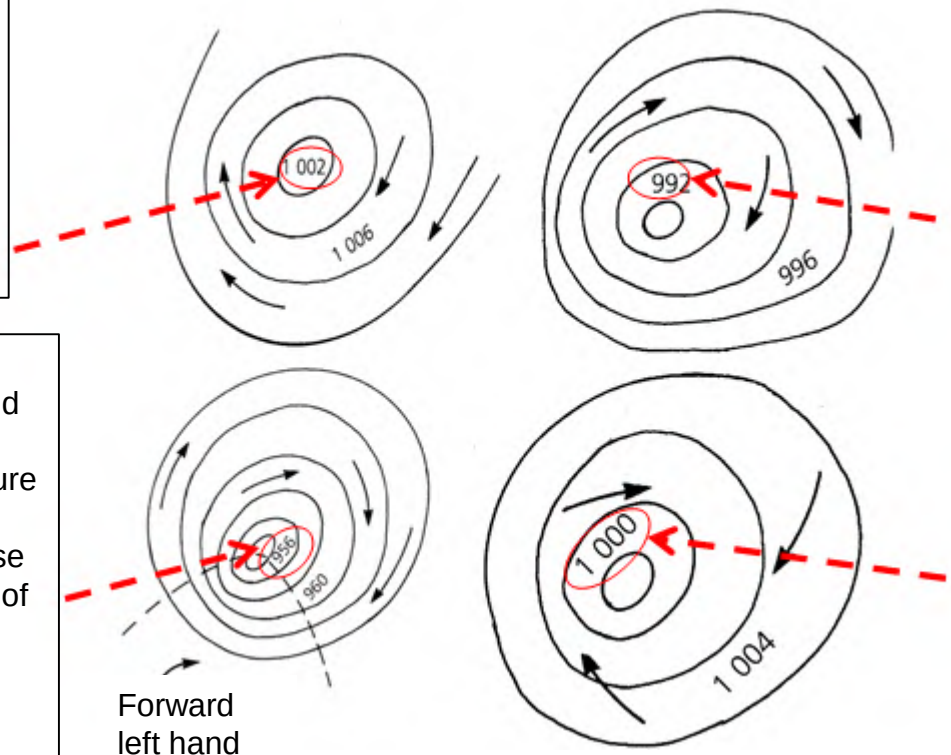
Stages in the formation

STAGE 1: FORMATIVE STAGE
In the formative stage the cyclone has very strong up draughts and the low pressure intensifies. The cyclone is not very large yet and there is no clear eye. The winds start spiralling. Pressure generally above 1000 mb.

STAGE 2: IMMATURE STAGE
The very strong updraughts of air increases as temperature increases due to release of latent heat. Eye starts to form. Pressure in the centre drops below 1000 mb

STAGE 3: MATURE STAGE
The pressure gradient is very strong and wind speeds reach hurricane strength. The calm, clear eye is well developed and the air pressure is well below 1000 mb. The forward left hand quadrant is the most destructive as the intense winds in the cyclone combines with the force of the entire cyclone. The cyclone can cover distances of more than 300km from the eye. The cyclone moves in a South Westerly direction from the equator. The low pressure and the fast wind over the ocean masses cause a storm surge (bulge of sea water) which leads to further flooding of the coastal areas hit by the cyclone.



Forward left hand quadrant

Adapted from source: http://sageography.myschoolstuff.co.za

STAGE 3: DISSIPATING STAGE
When the tropical cyclone moves over land, the wind is slowed down by friction and there is less evaporation (less humidity) to cause unstable air conditions. The cyclone also moves into cooler sub-tropical areas and the air pressure increases. The weather clears up. Pressure increases.

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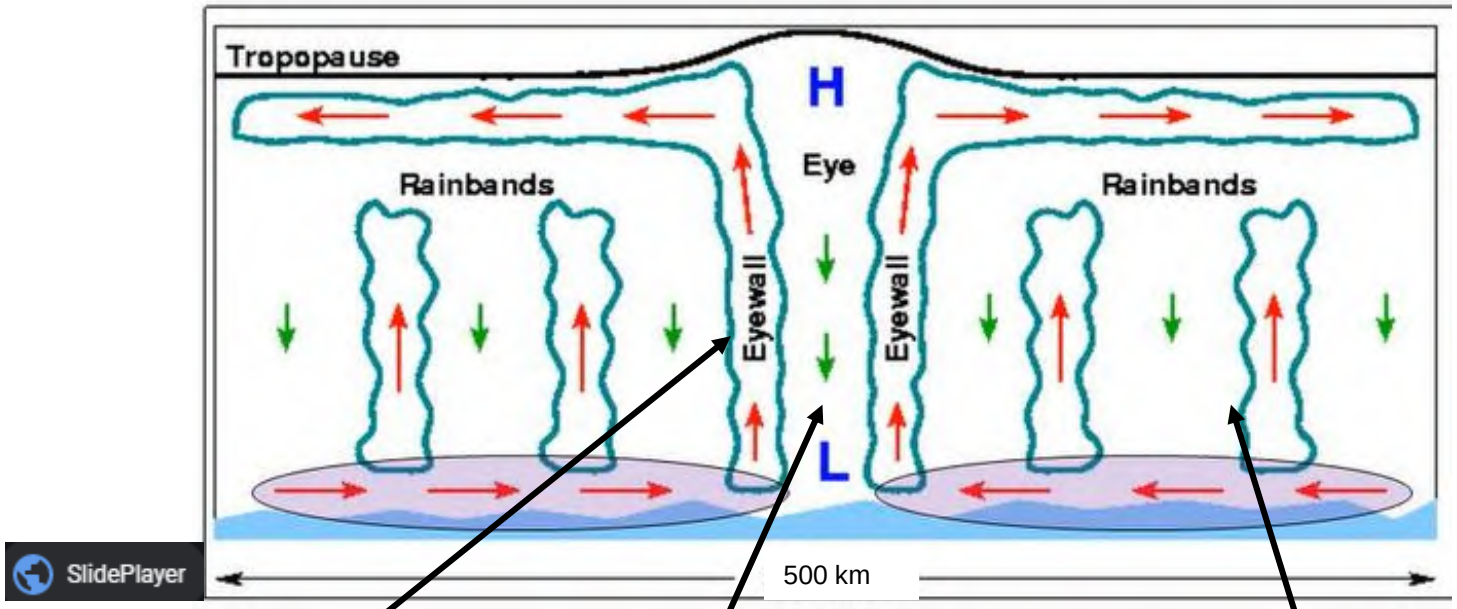
Cross Section of a Tropical Cyclone in its Mature Stage:



Eyewall/Vortex: Located on both sides of eye. Associated with rising and cooling of air resulting in cumulonimbus clouds of great vertical extent (approximately 15 km). Experiences very heavy (torrential) rainfall and highest wind speeds

Eye: It has subsiding air. As air subsides it warms up resulting in no cloud formation. Typical conditions are calm conditions, clear skies, no rainfall and high humidity. Approximately 25km in diameter.

As we move away from the eyewall we find rainbands that can more than 300 km

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EXAMPLES OF SOCIAL IMPACTS

- Results in floods/hurricane force winds – damage property –people left homeless
- Floods decrease accessibility to recreation facilities
- Floods could result in loss of lives
- Floods could damage crops/kill livestock – reduce amount of food available
- Floods decrease – decrease in production - decrease employment opportunities

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EXAMPLES OF ECONOMIC IMPACTS

- Floods – decrease in agricultural production – increase unemployment
- Floods/hurricane force winds damage infrastructure
- Floods restrict accessibility to tourist attractions – effecting tourism.
- Less production – less income to area
- Reduces number of tourists
- Governments spend a significant amount of money on repairing infrastructure and supporting people

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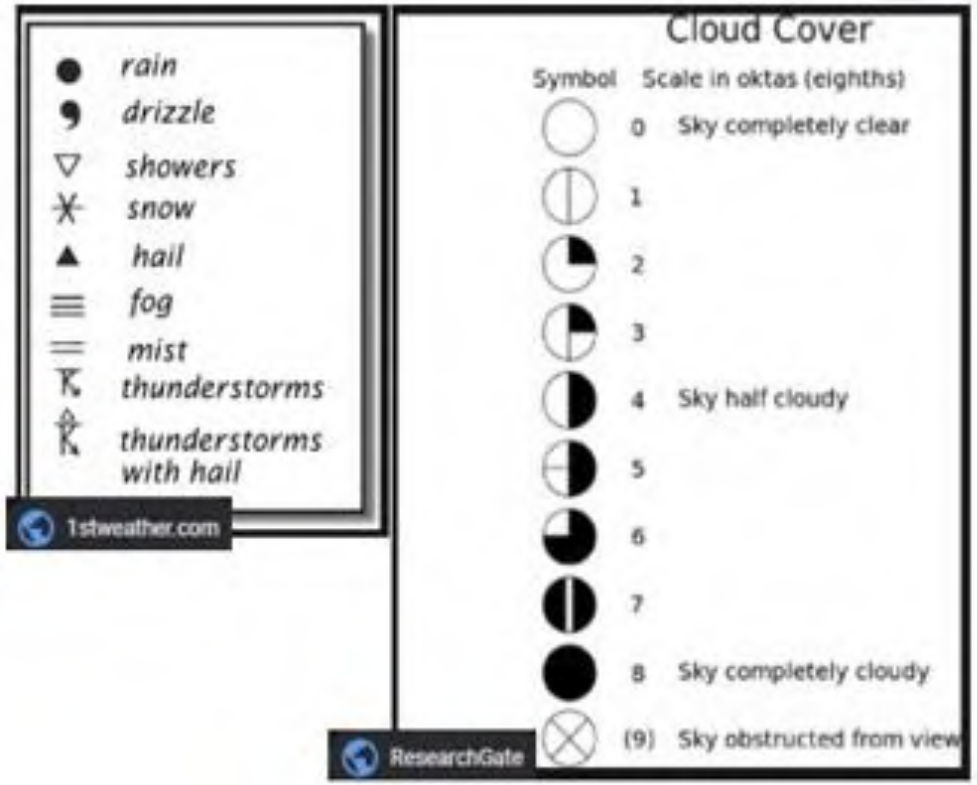

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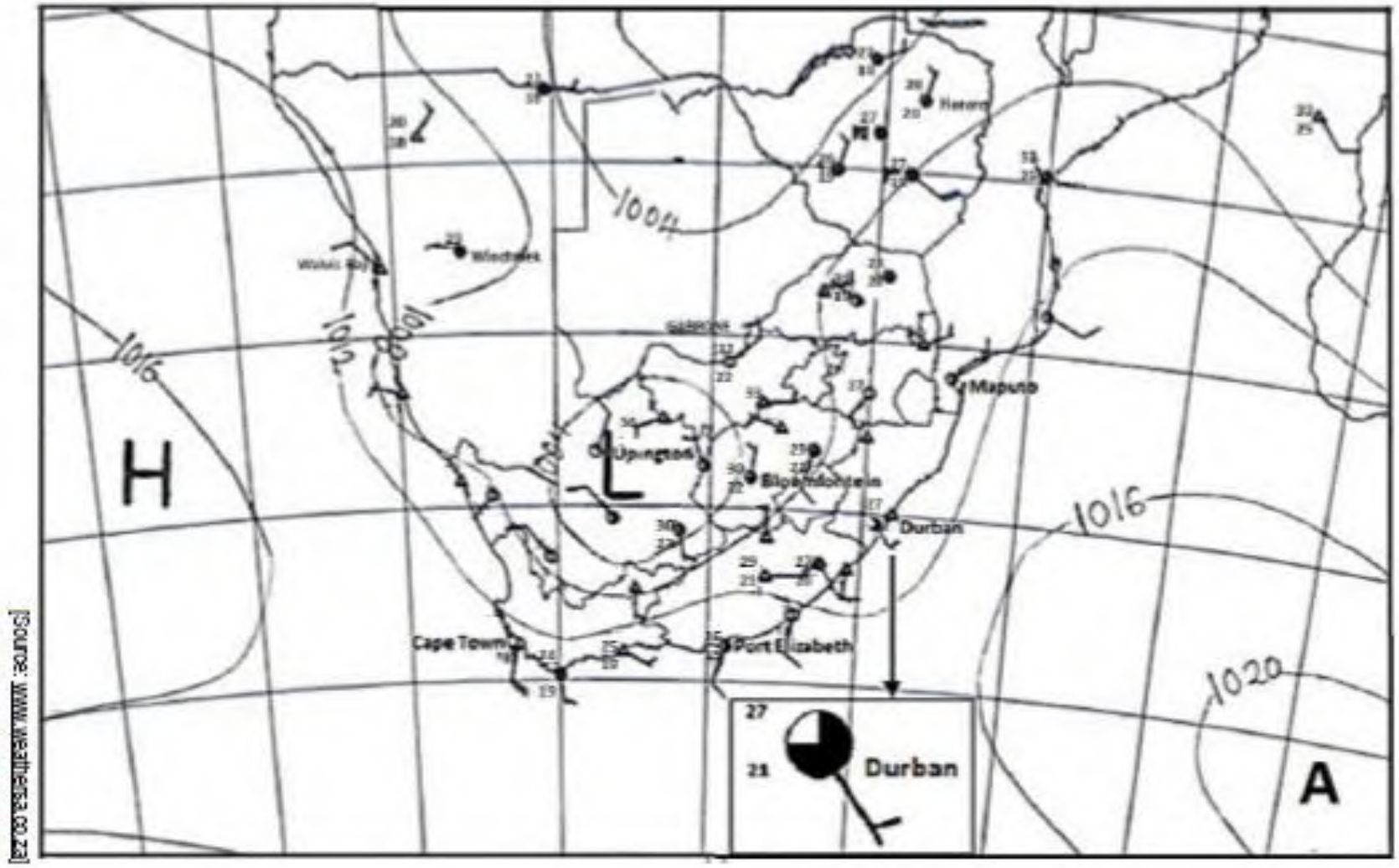

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2.3 Refer to FIGURE 2.3 showing a synoptic weather map of Southern Africa.

2.3.1 Give evidence that the synoptic weather map represents a summer condition. (1 x 1) (1)

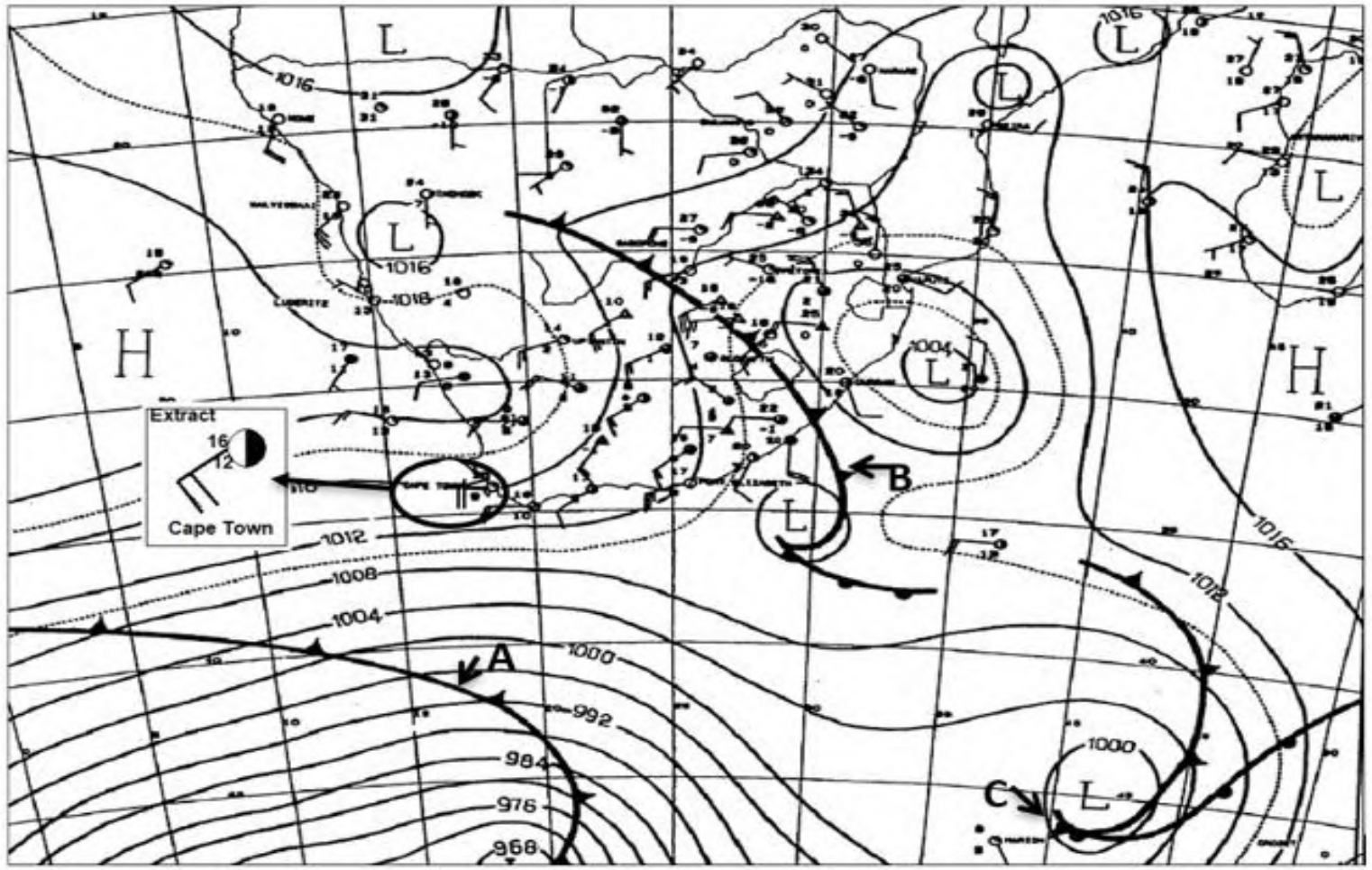
2.3.2 Determine the isobaric interval on the synoptic weather map. (1 x 1) (1)

2.3.3 Name the high-pressure cell **A**. (1 x 1) (1)

2.3.4 State the wind direction and wind speed of the weather station at Durban. (2 x 1) (2)

2.3.5 Comment on the relationship between wind speed and the arrangement of the isobars in the eastern half of the country. (1 x 2) (2)

2.3.6 In a paragraph of approximately EIGHT lines, explain how high-pressure cell **A** and the low-pressure cell in the interior of the country could contribute to increased rainfall in the eastern half of the country during summer. (4 x 2) (8)



[Adapted from Surface-synoptic-weather-map-showing-a-cold-front-approaching-South-Africa-South-African 11]

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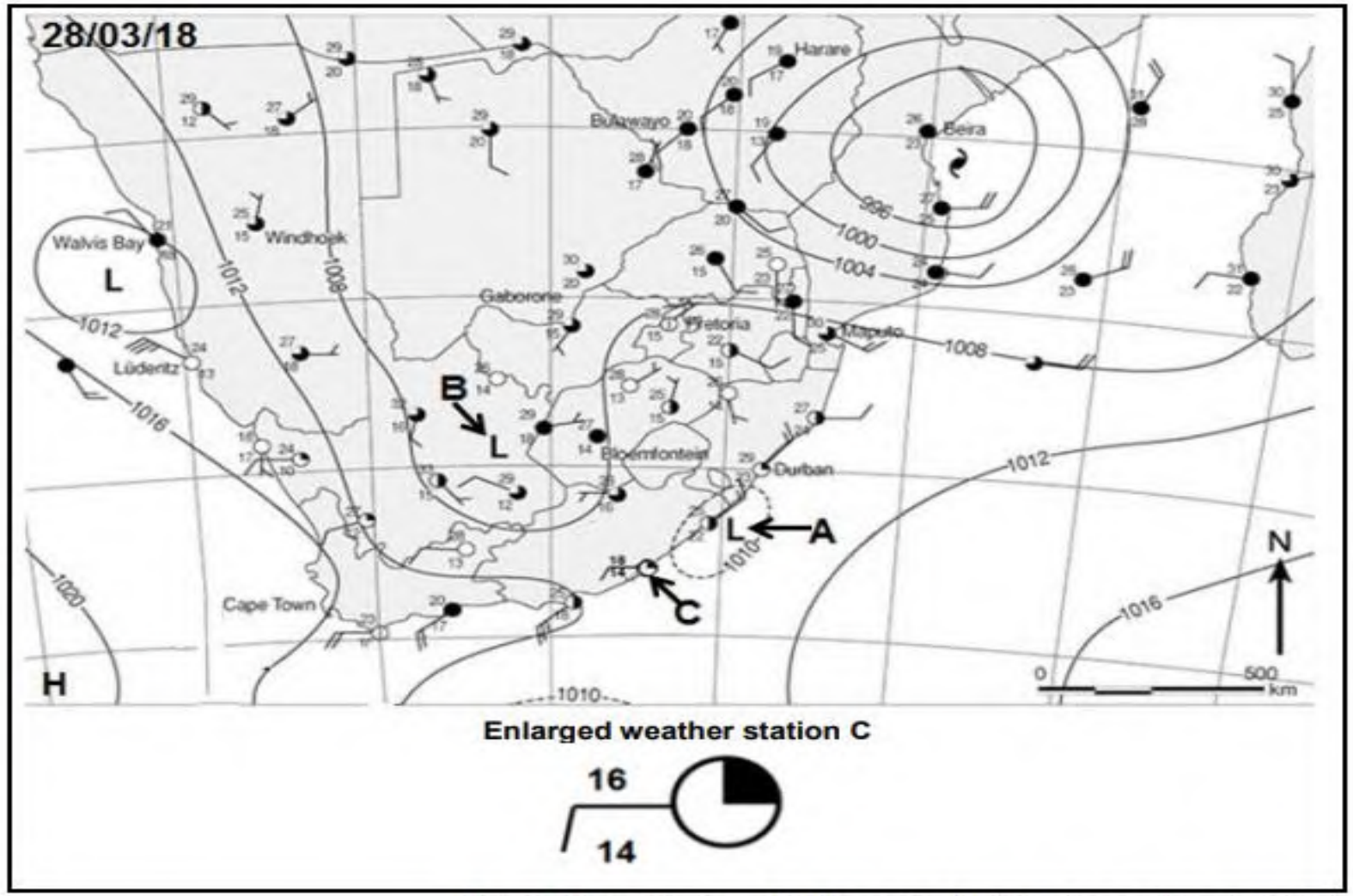

Enlarged weather station C

[Adapted from http://www.koolasun.co.za/weather/sa-weather-chart.html]

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Subtropical anticyclones (high-pressure cells) and the resultant weather over South Africa

Location and identification of the THREE high-pressure cells that affect South Africa:
South Atlantic/St Helena high-pressure cell
South Indian/Mauritius high-pressure cell
Kalahari/Continental high-pressure cell General characteristics of the THREE high-pressure cells Influence of anticyclones on South Africa's weather and climate (integration with plateau, inversion layer, ocean currents and ridging of the SAHP)- summer and winter position
Reading and interpretation of information related to the THREE high-pressure con synoptic weather maps

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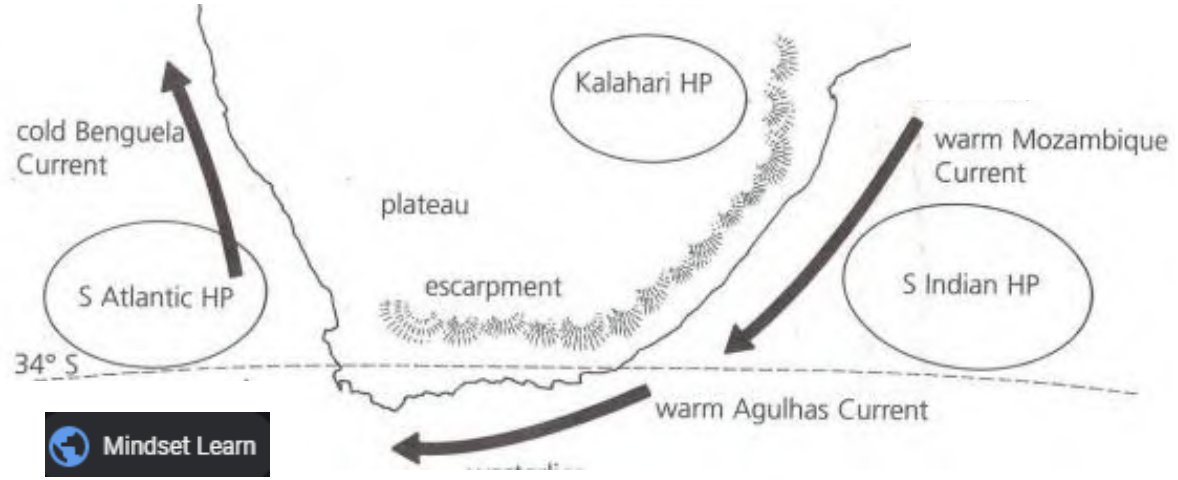
Subtropical anticyclones over South Africa



South Atlantic Anticyclone	South Indian Anticyclone	- Kalahari Anticyclone
• **Situation – Namibian coast** • **Strongest of the three anticyclones** • **Descending air heats up and lies over cold air above cold ocean causing permanent inversion** • **Drier conditions over the west coast of South Africa**	• Situation - east coast of South Africa • Blow over warm ocean • Warm, moist air • Cooler land could cause precipitation	• Situation – Central plateau • Least developed cell • Stronger in winter and weaker in summer (greater amount of subsidence in winter and less in summer)

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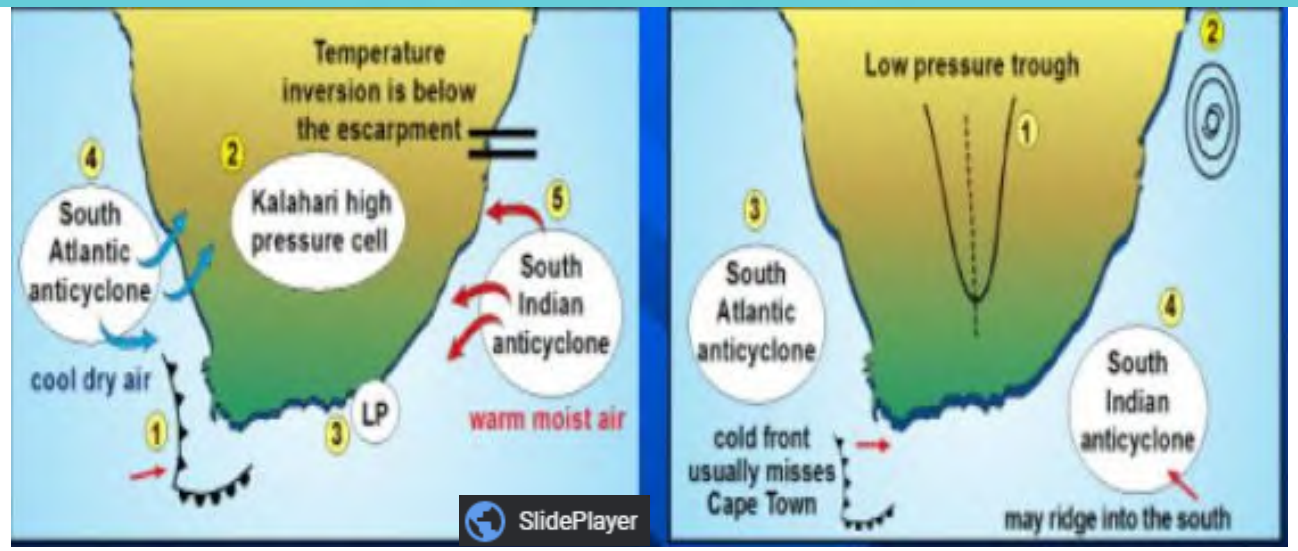

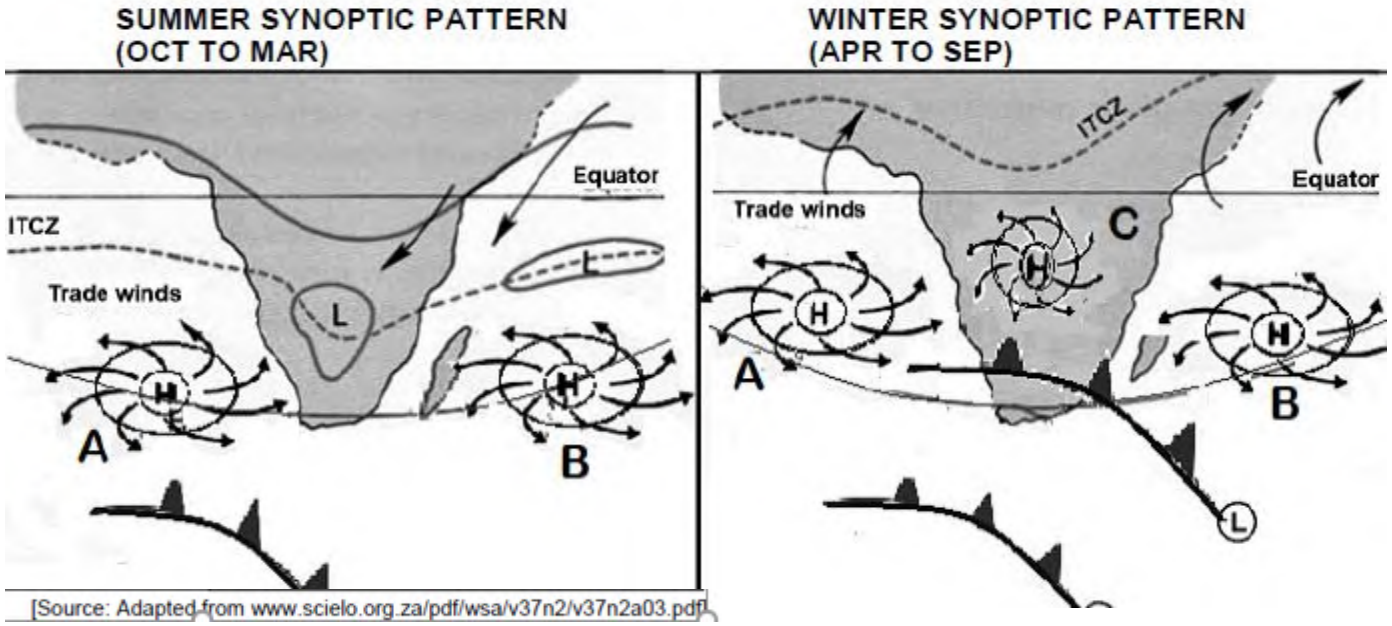

[Source: Adapted from www.scielo.org.za/pdf/wsa/v37n2/v37n2a03.pdf]

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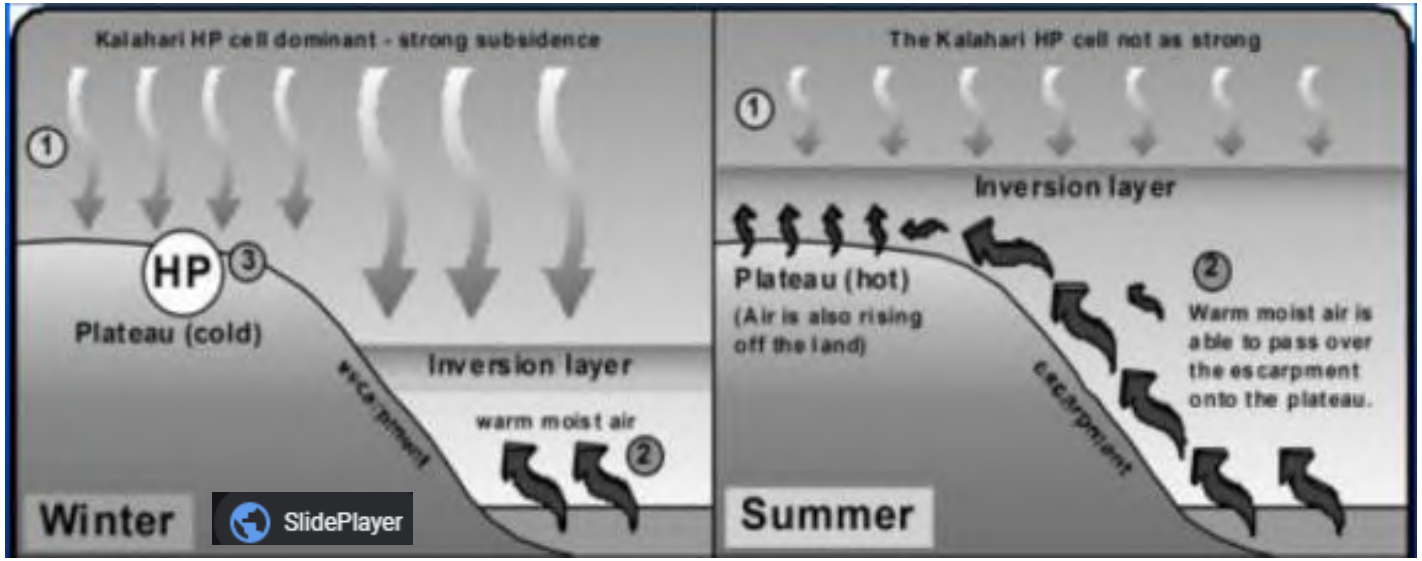

- In winter the subsiding air in the Kalahari High Pressure Cell heats up at Dry Adiabatic lapse rate and is warmer than the air from the coastal areas.
- This causes a temperature inversion.
- The temperature inversion sinks below the escarpment and prevents any moist air from entering the central plateau.
- Therefore, no or very little rain occurs over the interior in winter. There is less humidity, cloud cover and a larger temperature range.

- The Kalahari high pressure system lifts due to continental heating.
- Less subsiding air.
- Inversion layer above level of escarpment
- This allows the moist tropical air masses to bring in humid air over the interior which causes summer rain over the interior. There is more humidity, cloud cover and a smaller temperature range.

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Development of travelling disturbances associated with anticyclonic circulation:
Moisture front and line thunderstorms
Coastal low pressure
South African berg wind
Resultant weather and impact (and strategies to reduce the impact) associated with moving disturbances
Identification of moving disturbances on synoptic weather maps and satellite images
Reading and interpretation of synoptic weather maps and satellite images that illustrate weather associated with anticyclonic conditions

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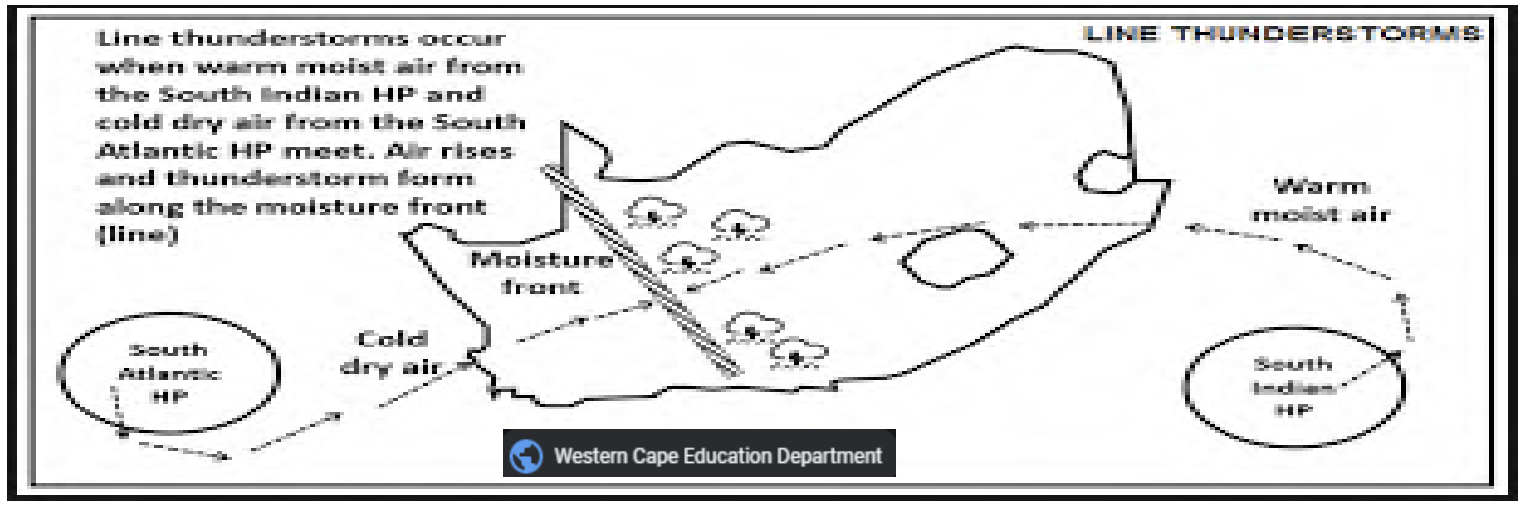

- The moisture front develop where the cool dry air from the South West comes into the country from the South Atlantic Anticyclone meets the warm moist air coming from the North East (South Indian Anticyclone).
- The moisture front is a dry line separating these two high pressure systems
- The cool air from the southwest lifts the warm air from the northeast which cools, condenses and forms cumulonimbus clouds.
- Line thunderstorms develop along the east of moisture front/boundary.
- Occurs in summer when the low pressure dominates the land

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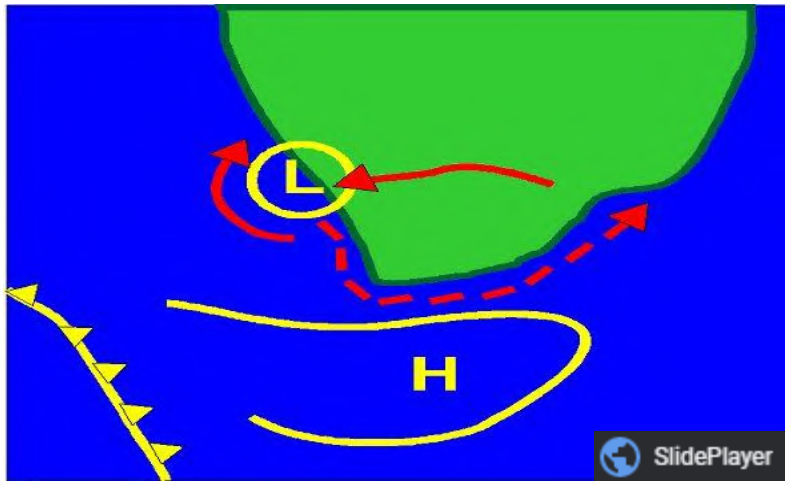
Coastal low



- Develop during summer and winter in SA.
- The air circulates in a clockwise direction around the cell in the southern hemisphere.
- These low pressure cells cause complete different weather on either side of the pressure cell.
- On the one side of the pressure cell, air will move from the land to the sea and will cause warmer drier conditions. Offshore winds
- On the other side of the pressure cell where the air moves from the sea to the land, moist cloudy conditions will develop that can lead to rain along the coastline (more along the east coast). Onshore winds.
- One of the pressure cells responsible for Berg Winds.

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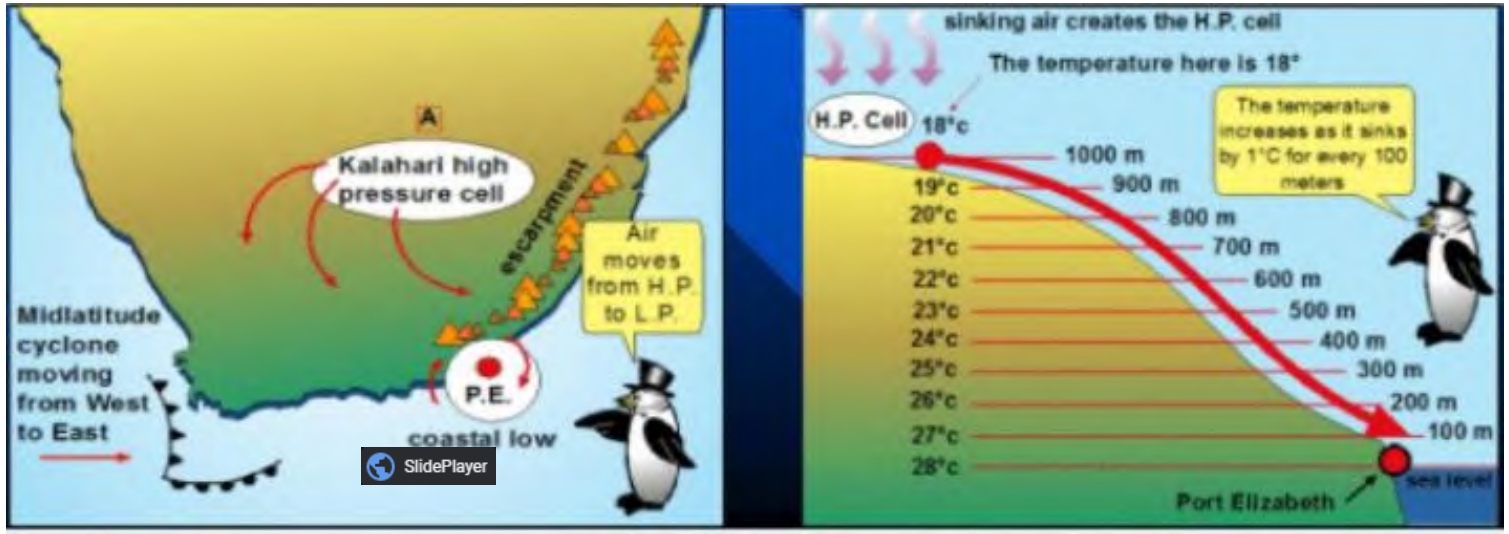
Berg Winds



- Occurs in winter
- There must be a well developed Kalahari High Pressure cell and costal low pressure cell present.
- Air flows from the Kalahari High Pressure cell to the costal low pressure cell .
- As the air subsides from the plateau and down the escarpment, it heats at dry adiabatic temperature lapse rate and become drier and hotter.
- It is dry because moisture evaporates as air is heated.
- Is an offshore wind
- This causes hot dry uncomfortable conditions. It causes veld fires.

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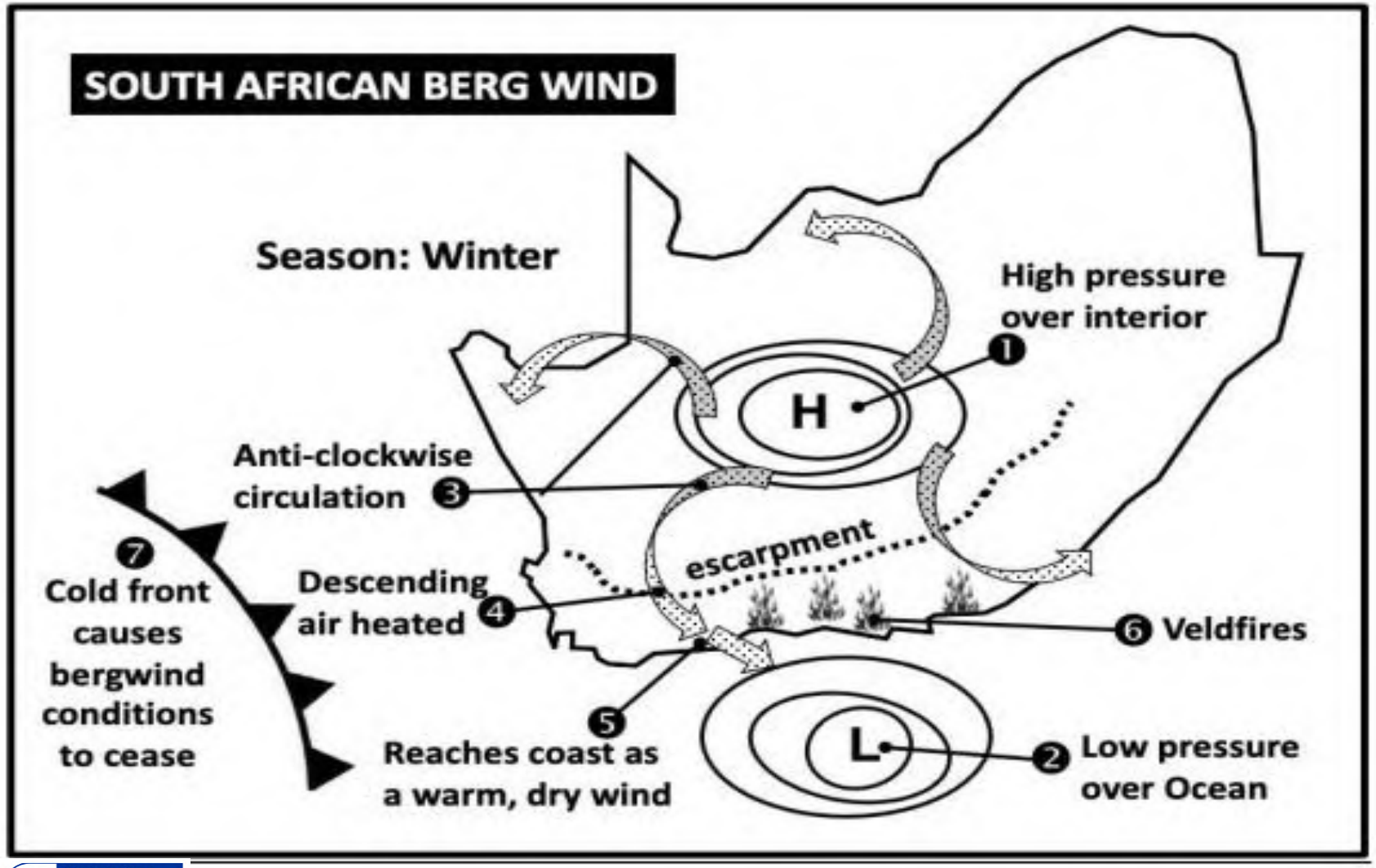

Western Cape Government Education

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Valley climates

Slope aspect:
Definition
Impact on the distribution of temperature in a valley
Definition and development of:
Anabatic winds
Katabatic winds
Inversions/Thermal belt
Frost pockets
Radiation fog
(Draw/label simple free-hand sketches to depict anabatic and katabatic winds)
Influence/impact on human activities (economic, social and environmental):
Settlement
Farming

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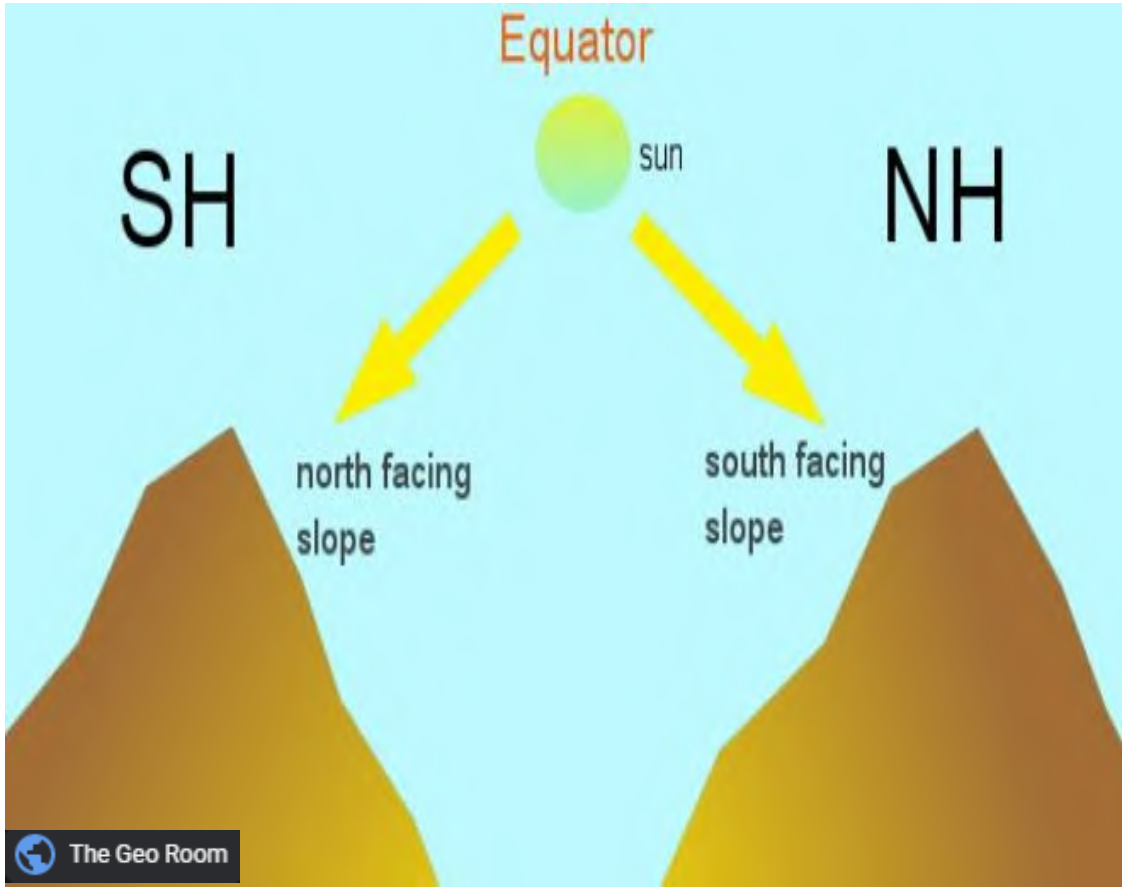
Slope aspect



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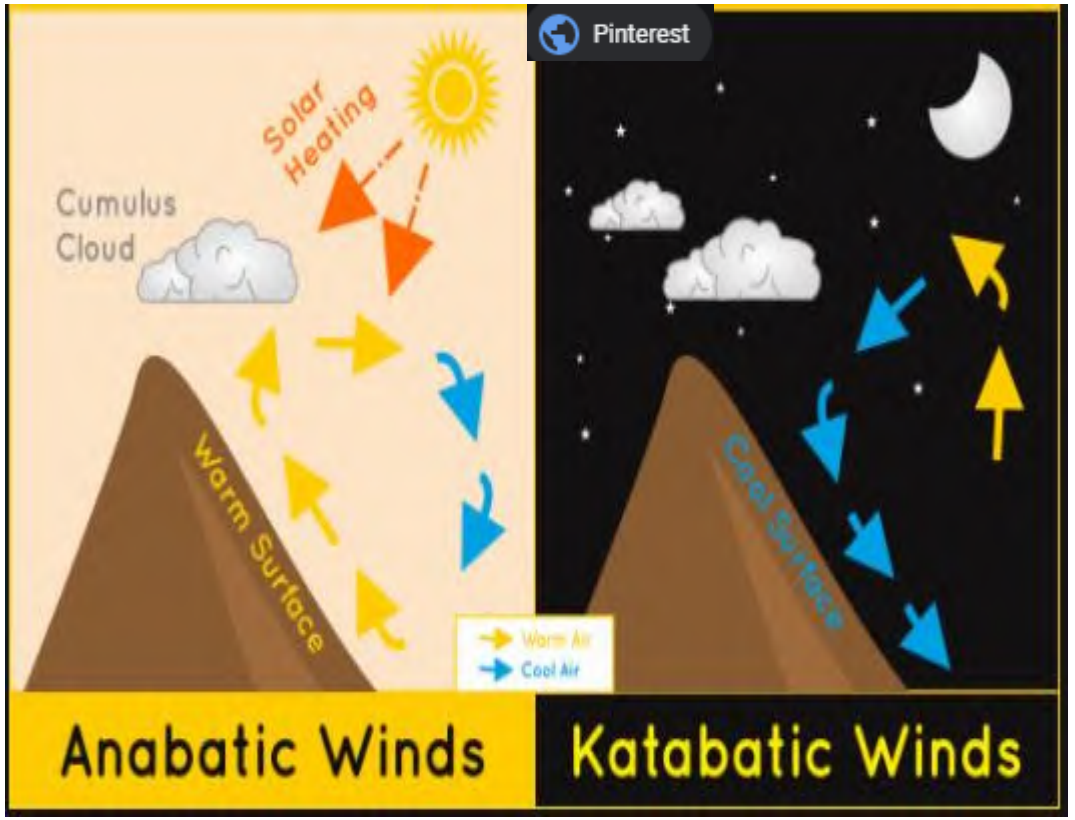
Micro-climate

Also known as local climate, is the climate of a local area e.g. valley climate.

- Slope aspect is the angle at which the sun's rays strike a slope.
- In the northern hemisphere, the south-facing slopes receive more sunshine than north-facing slopes. In the southern hemisphere, the north-facing slopes receive more sunshine than south-facing slopes.
- In the southern hemisphere the north-facing slopes are hot, sunny and drier and south-facing slopes cool, shady and retain moisture .
- Soils on cooler south-facing slopes as they are on the shadow zone.
- Farmers have to select a slope which is best suited for certain crops. For example crops that require less moisture and more sunlight will grow on the north facing slopes in the southern hemisphere. Trees and shade loving plants such as ferns will grow on the south facing slopes.
- Also note that humans tend to build their houses on north-facing slopes in the southern hemisphere because they are warmer.

Anabatic and katabatic winds

Occurs during the day when the slopes warm due to insolation.
The air above the slopes warms, becomes lighter and rises up the slopes of the valley.



Occurs at night when the slopes cool due to terrestrial radiation.
The air above the slopes becomes cold and dense and sinks down the valley slopes. Associated with cold conditions and frost generally at the bottom of the valley.
Damages crops, cold conditions, fog creates poor visibility.

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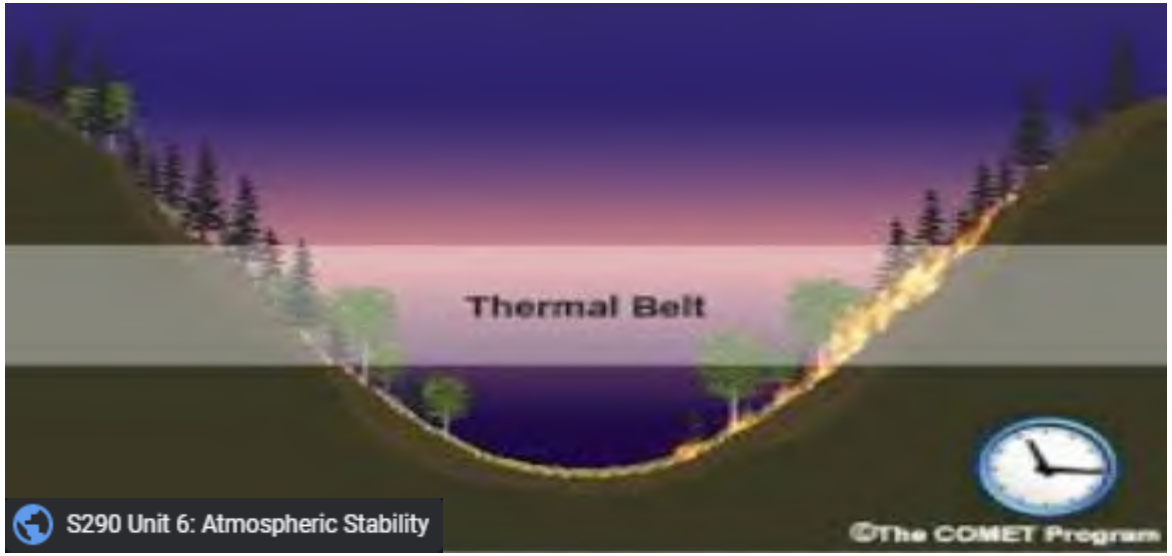
Thermal belt



- It is a layer of warm air trapped between two layers of cold air
- Occurs during the nights, especially a cold and calm winter's night.
- Due to terrestrial radiation upper slope air cools, becomes dense and flows down the slope pushing the warm air up.
- We have cold air above and cold air below with the warm air in between

Impact of the thermal belt .

People will build their houses halfway up the slope of a valley to be in the warmer thermal belt

- Crops which need warm, frost-free conditions will be planted in the thermal belt, for example sugar cane

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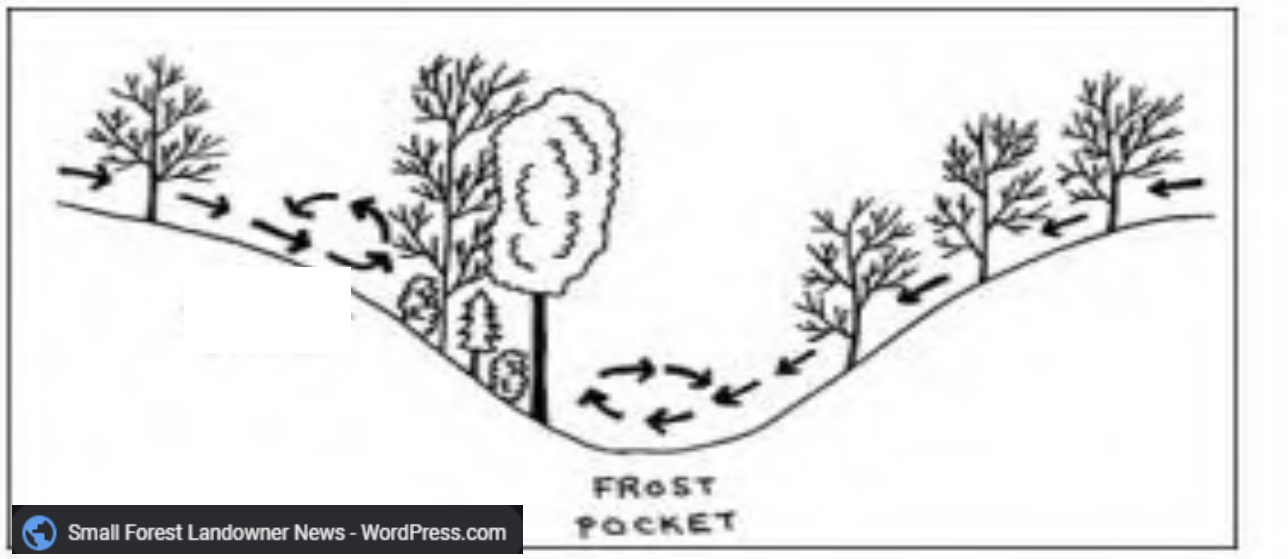
Geography with Dave

Frost pockets



- It is the name for low-lying area (e.g. a valley bottom or a smaller hollow) where frosts occurs more frequently than in the surrounding area.
- This is normally after a dry, clear and cold night
- Cold air drains down slopes
- If dew point temperature is below freezing point, it condenses to ice crystals
- Forming frost pockets where the cold air collects.
- Damages vegetation and crops
- Could plant frost resistant crops.

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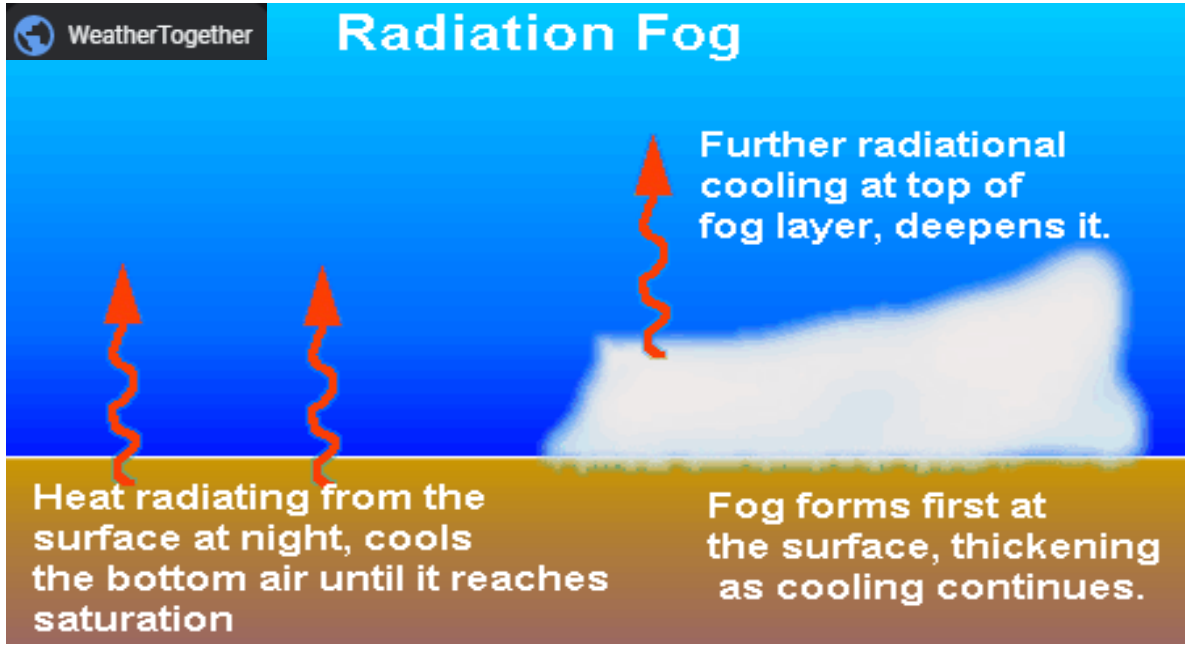
Radiation fog



- The ground becomes cool at night due to terrestrial radiation
- The air above the ground also cools
- When this air is below due point temperature, it causes water vapour to condense around dust and other particles in the atmosphere to create radiation fog.
- In the morning the sun's rays heat the surface
- The warm air rises and evaporates. (Fog lifts)
- Effects visibility

Urban climates

Reasons for differences between rural and urban climates

Urban heat islands:

Definition

Causes of urban heat islands/factors contributing to higher city temperatures

Effects of urban heat islands (economic, social and environmental)

Strategies to reduce the urban heat island effect

Pollution domes:

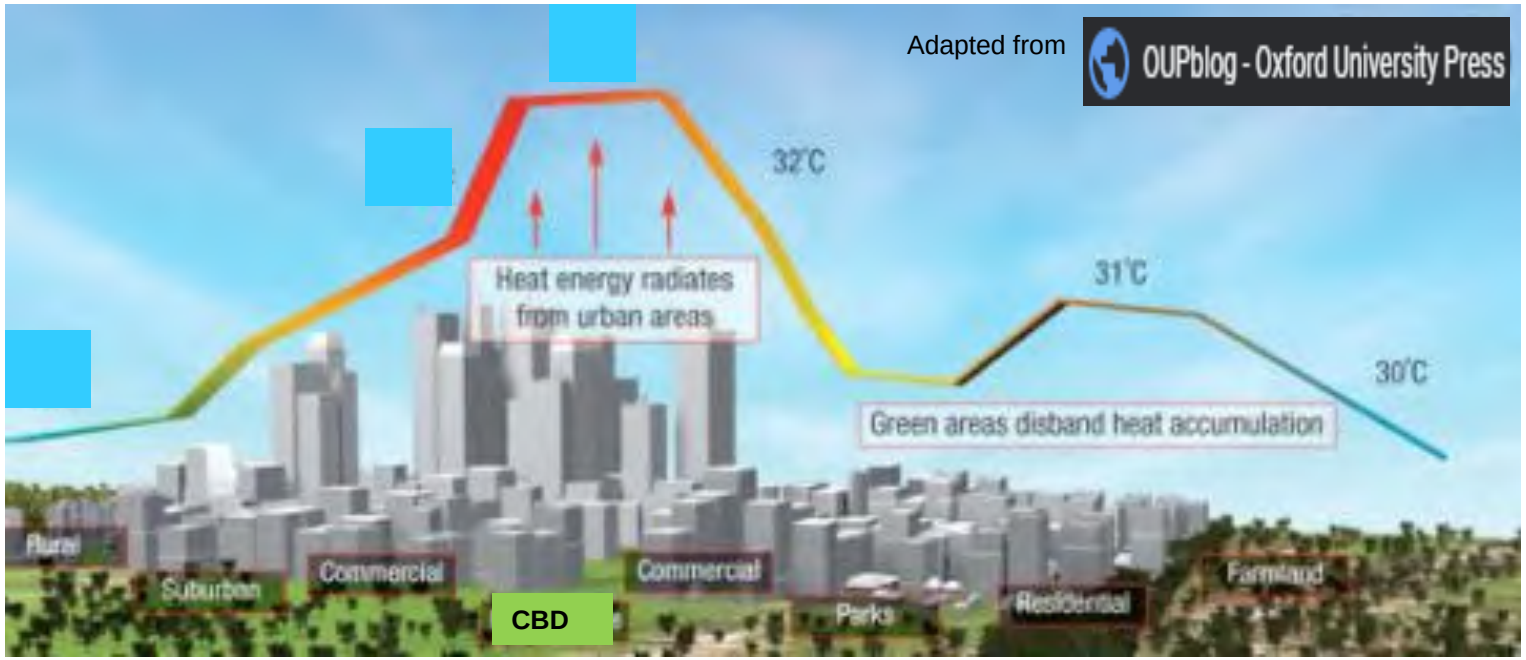
Definition

Causes of pollution domes

Effects of pollution domes (economic, social and environmental)

Strategies to reduce the pollution dome effect

Urban heat islands



Definition: An urban area of higher temperature surrounded by a rural area of lower temperature

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Reasons for difference between rural and urban climates

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Reasons/Causes

- Human activities in urban areas contribute greatly differences between rural and urban climates.
- They alter the local climate e.g. through industries
- Higher temperature, due to more artificial surfaces found in Urban area, buildings, factories concrete, concrete, steel and tar absorb more heat (artificial surfaces)
- More activities e.g. vehicles more fuel combustion, businesses, air conditioners etc make urban area warmer
- More cloud cover, fog and precipitation due to more hydroscopic nuclei. Moisture comes from rural area
- Slower wind speeds due to Friction from more tall buildings found in urban areas
- Low relative humidity due to less vegetation and urban drainage system.
- Multiple reflections
- Removal of water via Urban drainage system (storm water pipes)
- Large amount of people

Geography with Dave

Effects of urban heat islands

- Heat-related illness and fatalities, due to the incidence of thermal discomfort on the human cardiovascular and respiratory systems. Heatstroke, heat exhaustion.
- Increased pollution results in respiratory problems.
- Smog creates reduced visibility
- High temperatures may produce physiological disturbances on plants.

Pollution dome

Definition: is a layer of air pollution above an urban area

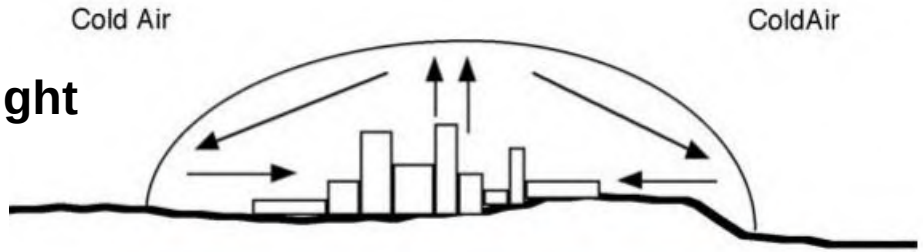
Causes of pollution domes

- Contributing factors are human activities, industries, vehicles etc.
- Stable air over urban area traps the pollution
- Pollution dome is higher during the day and lower and more concentrated during the night. More subsiding air during the night

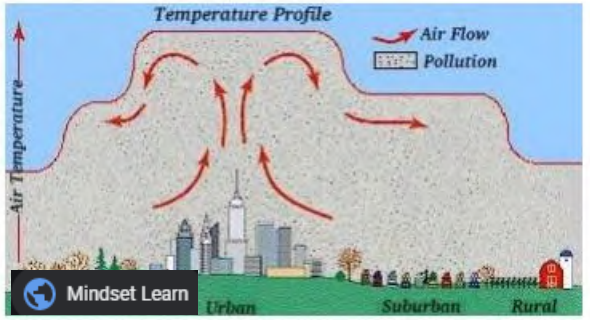
Effects of pollution domes

- Contributes to the formation of heat islands
- Respiratory related illnesses
- More pollutants, more condensation nuclei, more precipitati
- Lead poisoning from trapped petrol fumes

Night



Day



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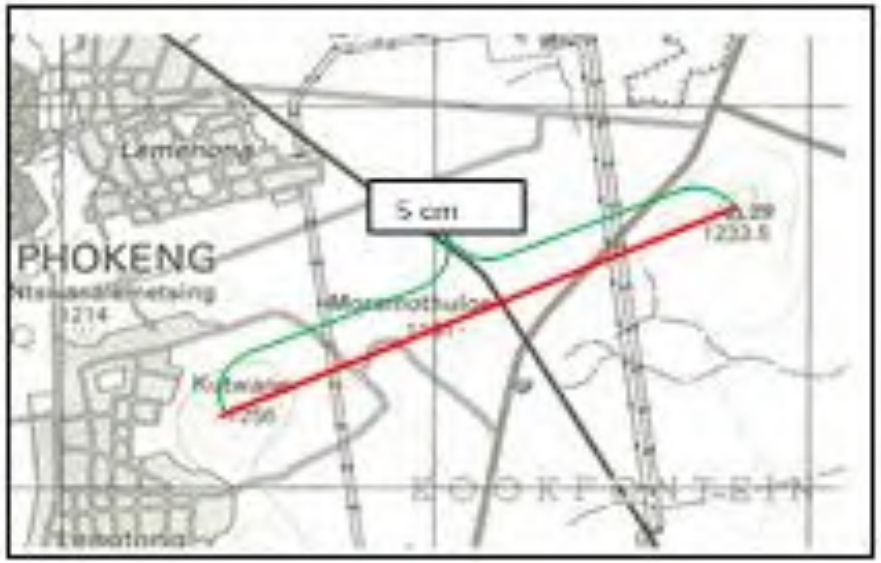
Geography with Dave

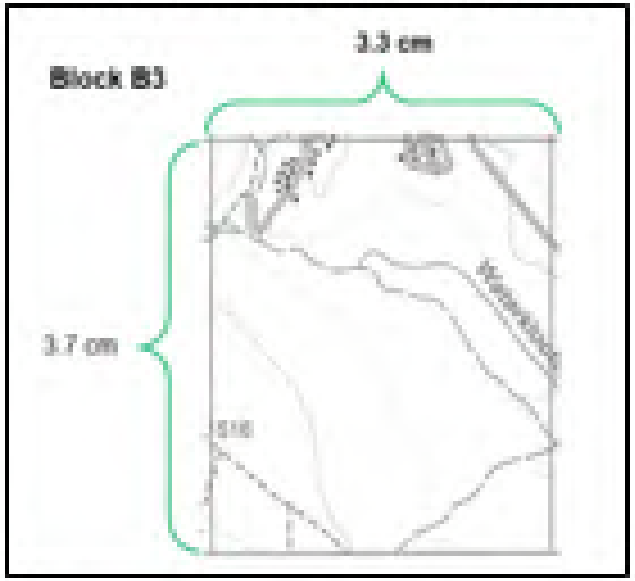
DISTANCE: Calculating the distance between spotheight 1256 and Trigonometrical station 29 in km



Actual Distance = Map distance x Scale
5 ✓ cm x 0.5 [Only allowed 1 mm deviation for map distance e.g. 4.9 cm to 5.1 cm]
= 2.5 km ✓

Geography with Dave

Calculate the area, in Kilometres, of block **B3** on the topographic map



Area = Length x Breadth

= (3.7 ✓ cm x 0.5 km) x (3.3 ✓ cm x 0.5 km) [Only allowed 1 mm deviation for map distance]
= 1.85 ✓ Km x 1.65 ✓ Km
= 3.05 Km^2 ✓

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Geography with Dave

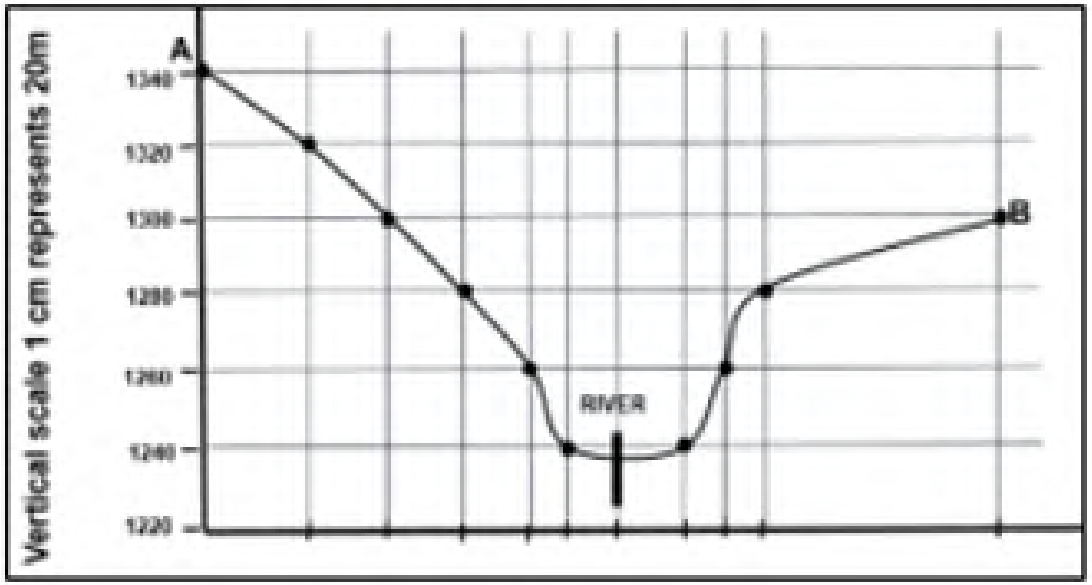
Vertical exaggeration (VE) = $\frac{\text{Vertical scale (VS)}}{\text{Horizontal scale (HS)}}$

20 x 1000 = 2000cm ✓
VS- 1: 2000 ✓
HS- 1: 50 000 ✓
VE = $\frac{1}{2000}$ or $\frac{1:2000}{1:50\,000}$ ✓

$\frac{1}{50\,000}$

= $\frac{1}{2000}$ x $\frac{50\,000}{1}$

= 25 times ✓



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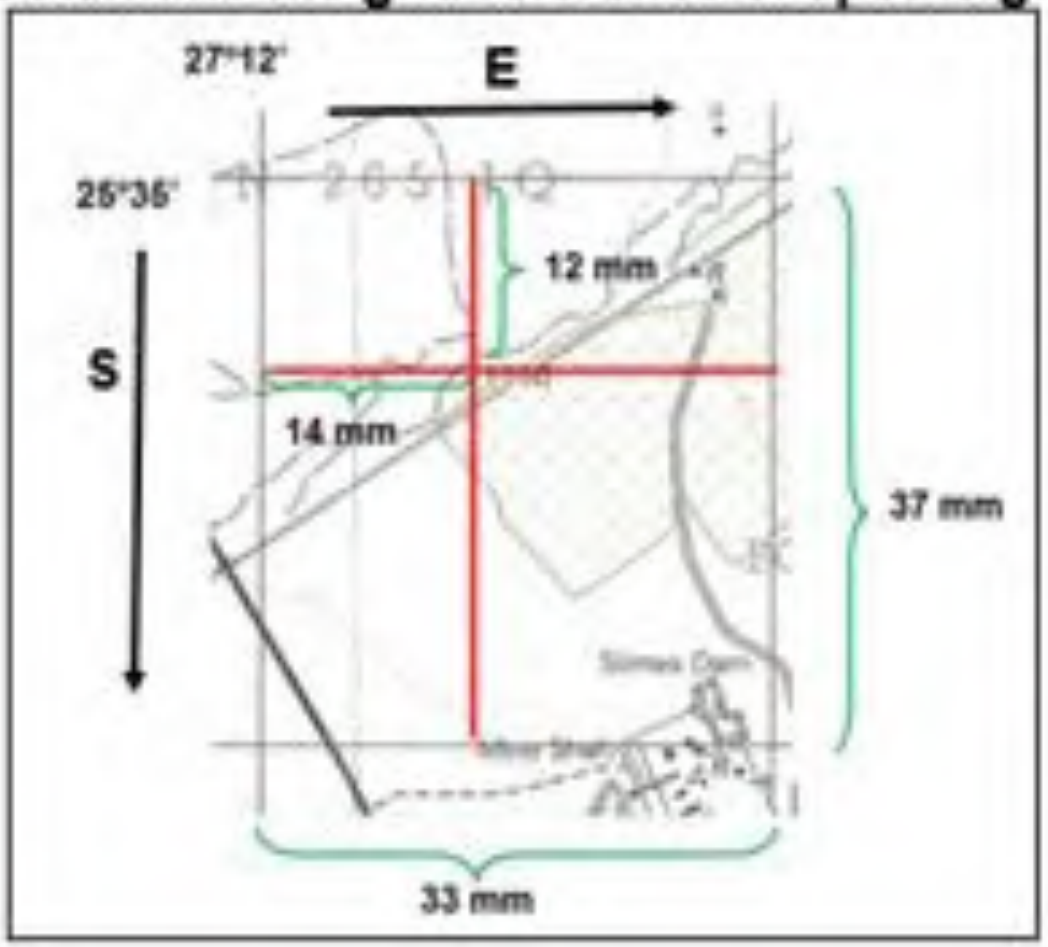
Determine the grid reference of spotheight 1146



25°35'?"S;27°12'?"E

Latitude (S)

12 mm ÷ 37 mm x 60" = 19.45"

Longitude (E)

14 mm ÷ 33 mm x 60" = 25.45"

Final answer

25°35'19"S ; 27°12'25"E

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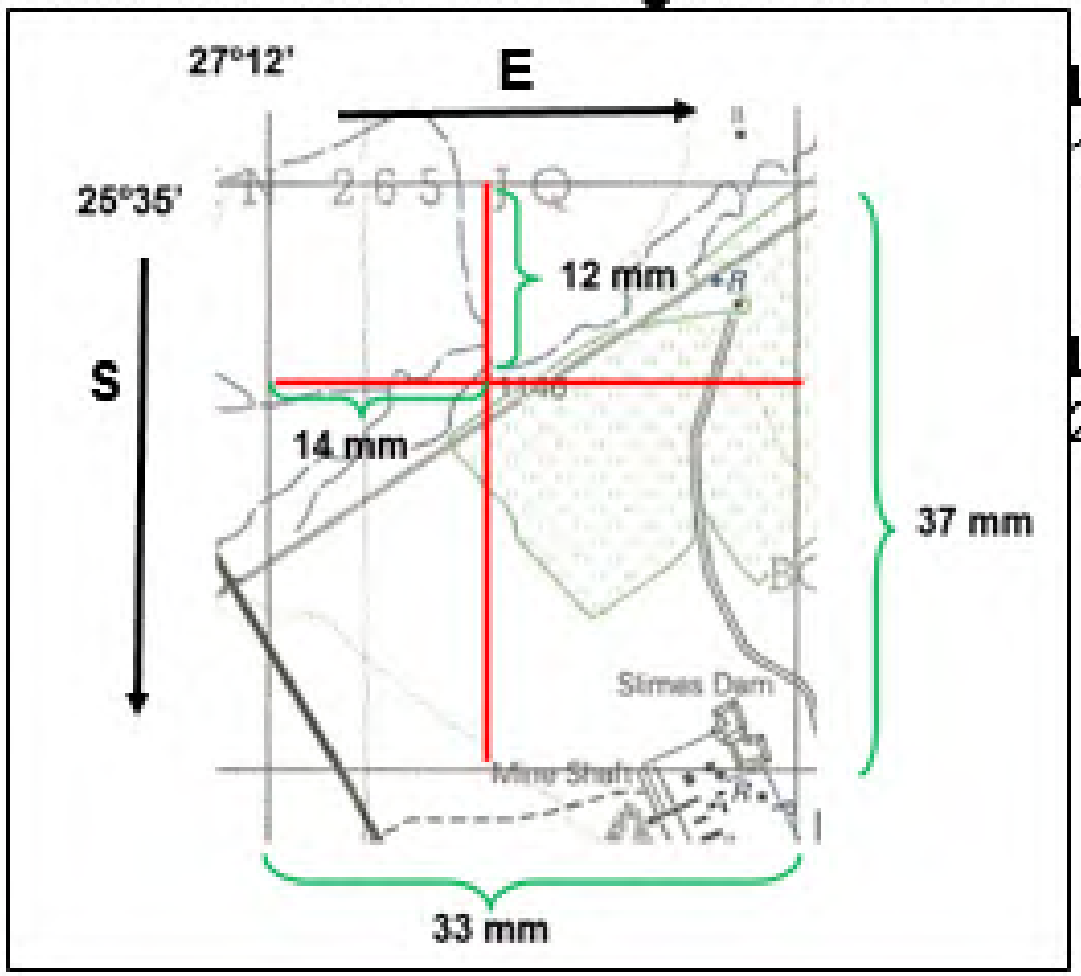
Geography with Dave

State the feature fond at grid reference 25°35'19"S ; 27°12'25"E



Latitude (S)

19" ÷ 60" x 37 mm = 11.71 mm
(12 mm)

Longitude (E)

25" ÷ 60" x 33 mm = 13.75 mm
(14 mm)

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Geography with Dave

MAGNETIC BEARING

EXAM FORMAT

True bearing = 213° ✓

Difference in years: 2021 – 1997 = 24 ✓ years

Mean annual change: 2' ✓ W

Total change: 24 x 2' = 48' ✓ W

Magnetic declination for 2021: 15° 57' W + ✓ 48' W

16° 45' West of true north ✓

Magnetic bearing = 213° +16°45'

= 229°45' ✓

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Formula: **Average Gradient** = $\frac{\text{vertical interval (VI)}}{\text{horizontal equivalent (HE}}$

VI = 1256 m – 1233.5 m
= 22.5 ✓ m

HE = 5 ✓ cm x 500
= 2 500 ✓ m

$= \frac{22.5}{2500}$ ✓ (One mark for correct substitution)

$= \frac{1}{111.11}$

= 1 : 111.11 / 1 in 111.11 ✓