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SESSION THREE: FACTORS THAT INFLUENCE WEATHER IN SOUTH AFRICA

KEY CONCEPTS:

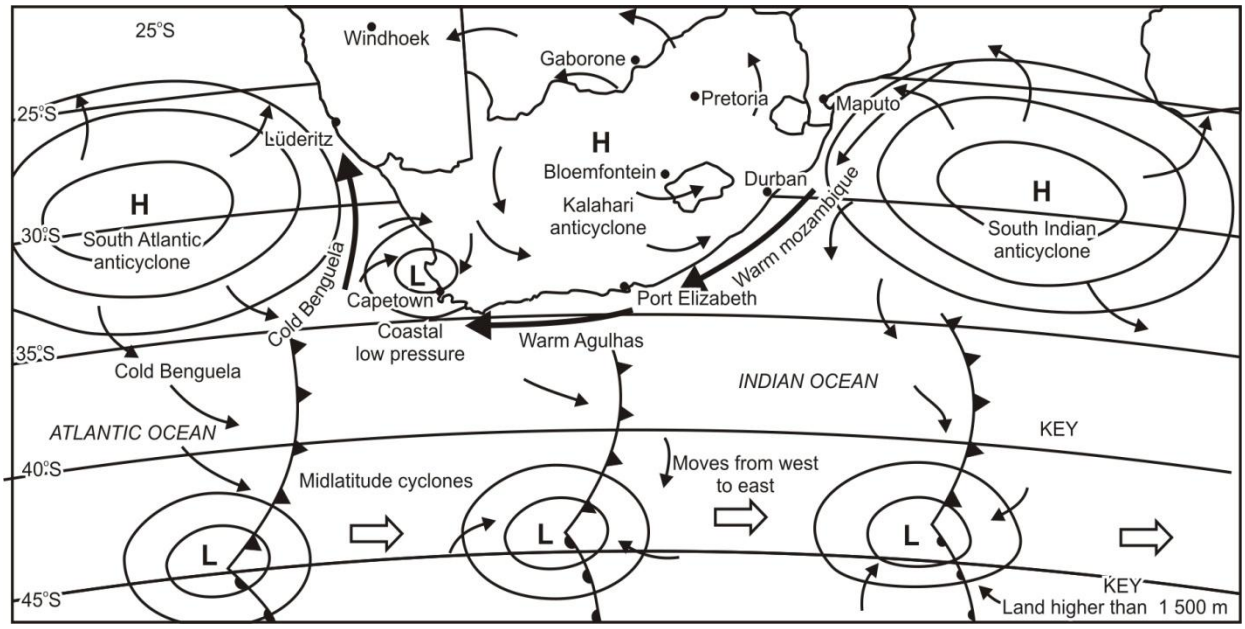
In this section we will focus on the following aspects:

Factors determining the weather of South Africa
• Influence of the oceans on South Africa's weather
• Influence of latitudinal position and altitude of the sub-continent on South Africa's weather.
• Effect of the interior plateau on South Africa's weather

Anticyclonic circulation
• Identification of three anticyclones on synoptic charts
  o South Atlantic / St Helena High
  o South Indian / Mauritius High
  o Kalahari / Continental High
  o Resultant weather and travelling disturbances

X-PLANATION:

OCEANS, LATITUDINAL POSITION ALTITUDE AND SOUTH AFRICA'S WEATHER.



The influence of the oceans

- Ocean currents influence the areas adjacent to them.
- The cold Benguela Current is found on the west coast. It causes cold air above the ocean which holds very little moisture. Fog can form on the west coast with very little rainfall.

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- The warm Agulhas current (Mozambique current) on the east causes the air to be warmer, more humid, unstable and increases the rainfall.
- Oceans moderate temperatures along the coast, causing summer to be less hot and winters less cold than in the interior. Places along the coast have a maritime climate
- (low temperature range)

The influence of South Africa's latitudinal position

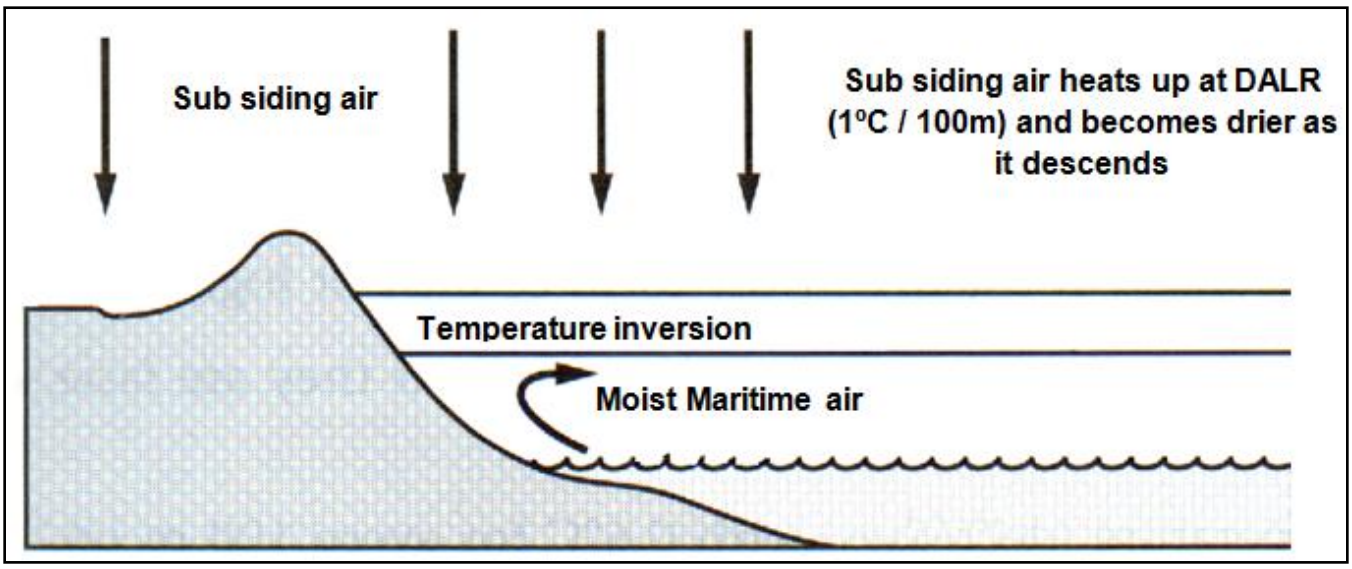
- South Africa is situated between the latitudes 22°S and 33°S. This means that our climate is dominated by the belt of subtropical highs. The three high that affect South Africa are the South Atlantic High, Kalahari High and the South Indian High.
- This subsiding air generally results in clear skies and sunshine, which is found over most of Southern Africa
- Latitudinal position also allows the influence of mid-latitude cyclones. This causes rainfall over the South Western Cape in winter. Results in a coastal low which cause Berg Winds.

The influence of South Africa's altitude

- Most of South Africa is situated on a plateau.
- These regions that are situated on the plateau are generally cooler.
- Steep escarpment along the eastern side of the plateau prevents moist air reaching the interior in winter, resulting in dry conditions over the plateau.

THE INTERIOR PLATEAU AND SOUTH AFRICA'S WEATHER.

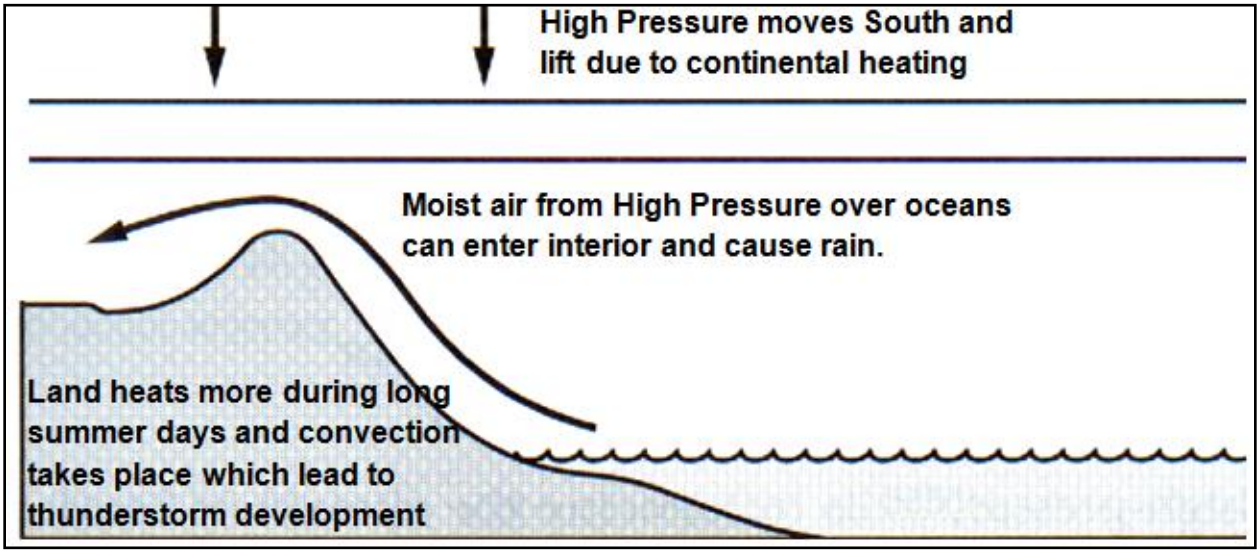
Winter:



- 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.

Summer:



- In summer the Sub tropical High pressure belt (which includes the Kalahari high pressure) moves south with the Heat Equator. The subsiding air masses and clear conditions shift to south of the country. The Kalahari high pressure system lifts due to continental heating. This allows the moist tropical air masses to bring in humid air over the interior which causes summer rain over the interior.

ANTICYCLONIC CIRCULATION

Subtropical Anticyclones in South Africa (3 High Pressure Cells)

- Anticyclones are associated with descending air, and so there are clear skies and the air is dry
- Air circulates in an anticlockwise direction around high pressure cells in the southern hemisphere.
- South Africa falls in the belt of the subtropical high pressure cells.
- The three high pressure cells are found more north in winter and are further south in summer.

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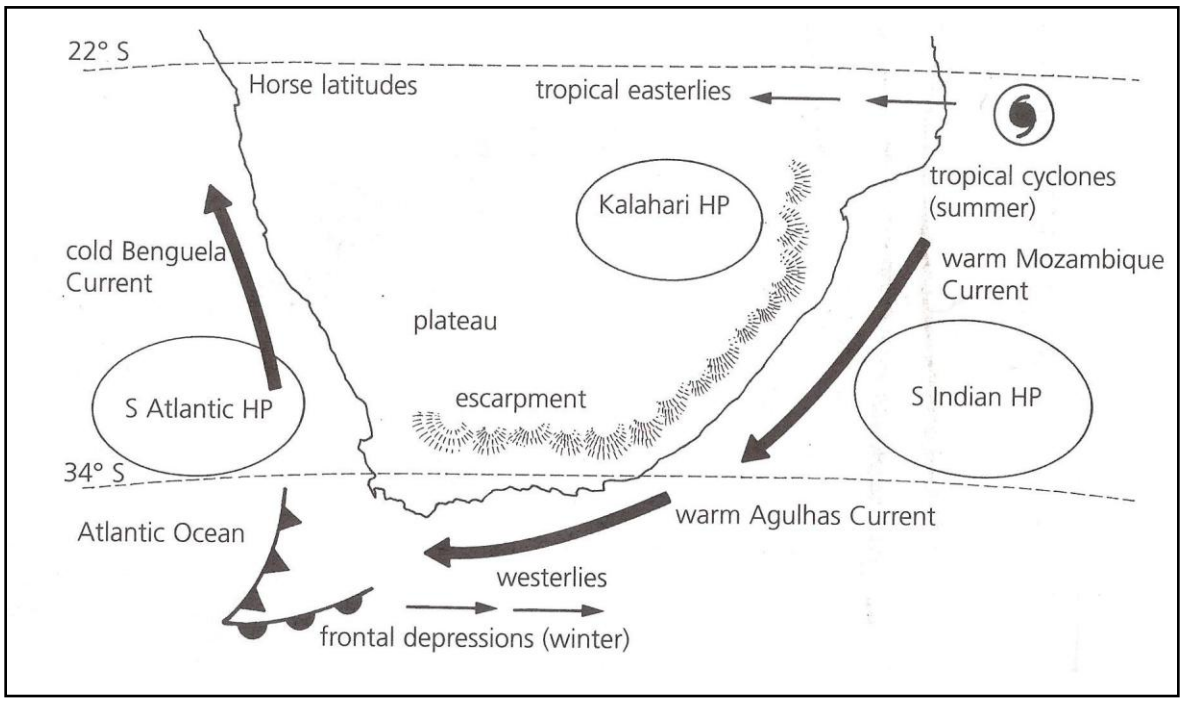


South Atlantic High Pressure	South Indian High Pressure
• Causes stable conditions on the west coast. • Can ridge in behind the front and causes the cold front to move across the land .	• Causes north easterly or south-easterly onshore winds • Brings rain to the eastern side. • It further from the land in summer, but moves over the land in winter.

Kalahari high Pressure (Inland High Pressure)
• It is lower in winter, as the landmass is cold and there is less air rising • Temperature inversion develops below the level of the escarpment in winter. Moist air is unable to reach the plateau. The inversion lies at an altitude higher than the escarpment in summer, which allows moist air to reach the plateau. • The descending air of the HP leads to stable conditions, clear skies and no rain over the plateau in winter. This lead to frost in winter. It contributes to berg winds formation

RESULTANT WEATHER AND TRAVELLING DISTURBANCES

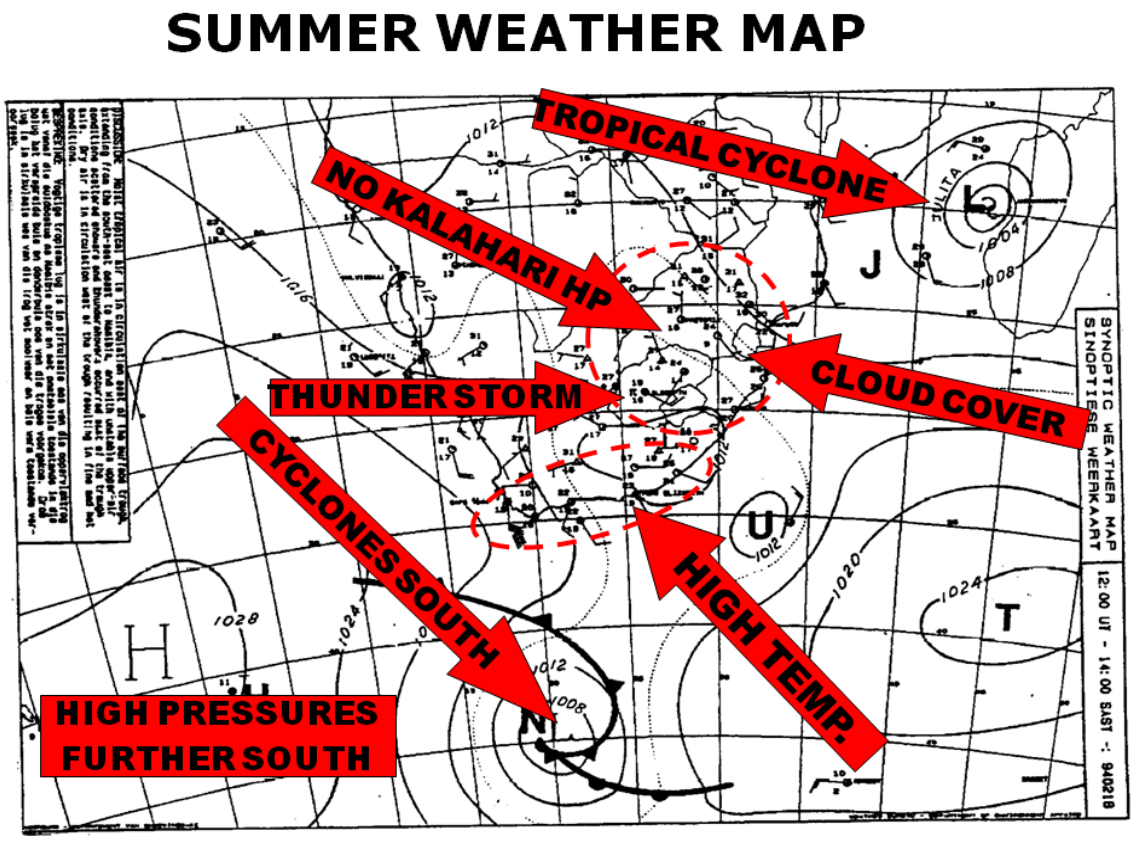
Learner Note:

- Many of the weather phenomenon explained here are found under travelling disturbances in the examination guidelines but they are a result of the movement of the three high pressure systems.
- The effect of the interior plateau on South Africa's weather is repeated as it is a winter condition.
- We also discussed Berg winds under tertiary circulation.
- Under summer conditions we will discuss:
  - Effect of interior plateau on South Africa's weather

- Line thunderstorms.

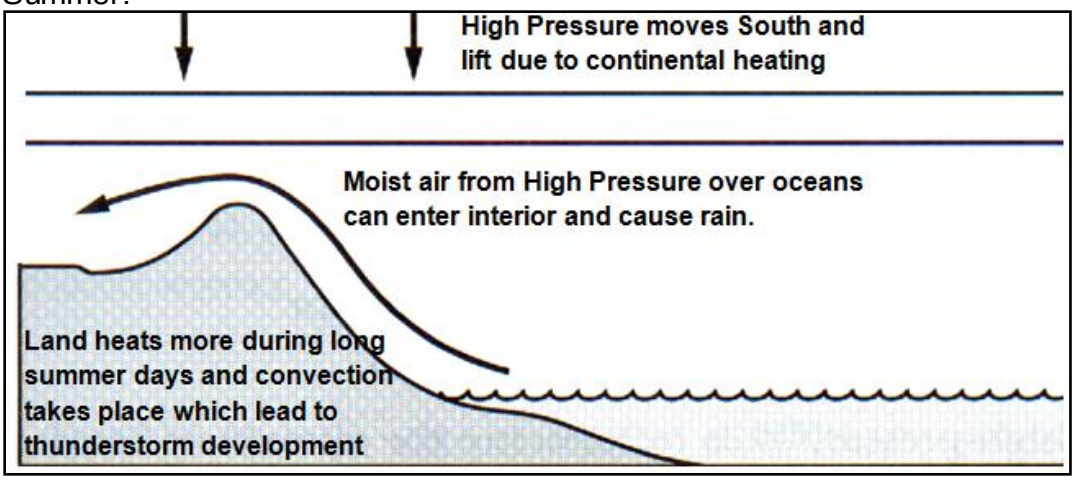
- Under winter conditions we will discuss:
  - Effect of interior plateau on South Africa's weather
  - Winter rainfall over South Western Cape.
  - Coastal low
  - Berg winds

Summer Weather Conditions:



A. Effect of interior plateau on South Africa's weather:

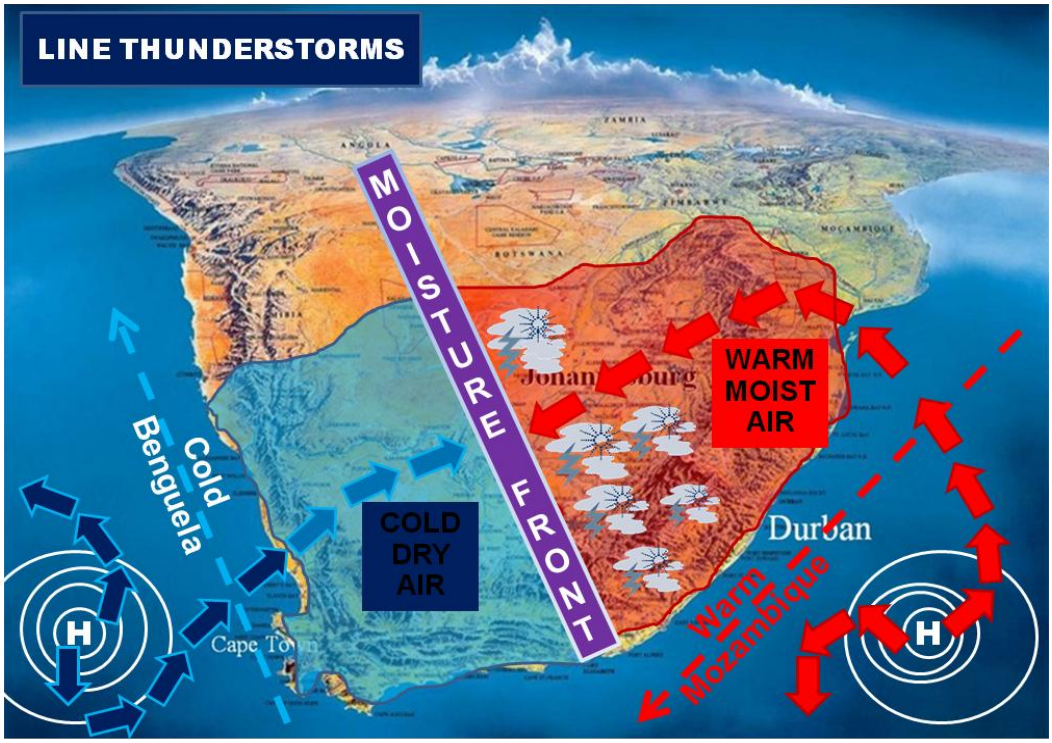
Summer:



- In summer the Sub tropical High pressure belt (Kalahari high pressure) moves south with the Heat Equator. The subsiding air masses and clear conditions shift to south of the country. The Kalahari high pressure system lifts due to continental heating. This allows the moist tropical air masses to bring in humid air over the interior which causes summer rain over the interior

B. Line Thunderstorms/ The Moisture Boundary:

The moisture boundary develop where the cool dry air from the South West pushed into the country from the South Atlantic HP meets the worm moist air coming from the North East (South Indian HP). The cool air lifts the warm air and line thunderstorms develop along this boundary. The moisture boundary develops in summer when the land heats up enough to cause low pressure cells in the interior of the country. These thunderstorms will form in a line which can extend laterally for hundreds of kilometres. These "squall lines" can persist for many hours and produce damaging winds and hail. The rain cooled air or "gust front" spreading out from underneath the squall line acts as a mini cold front, continually lifting warm moist air to fuel the storms.



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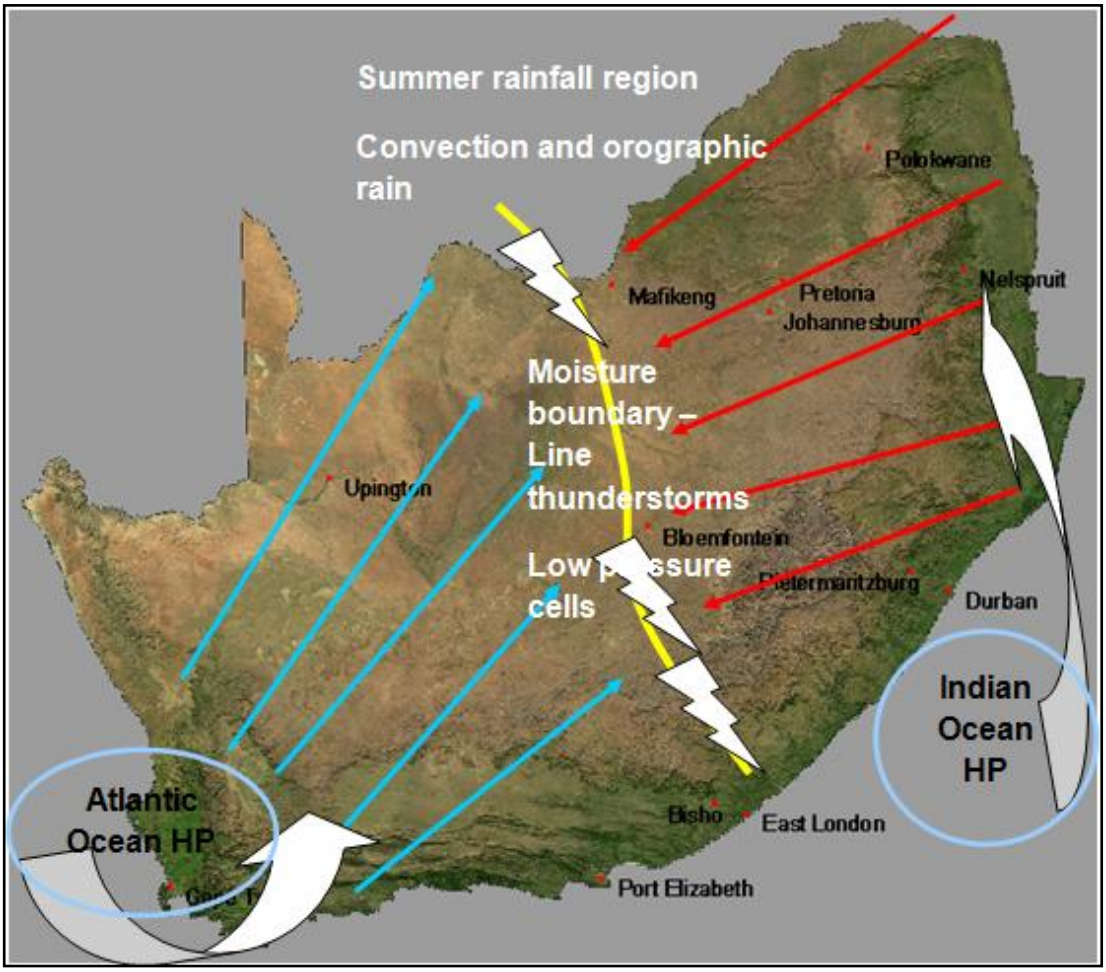

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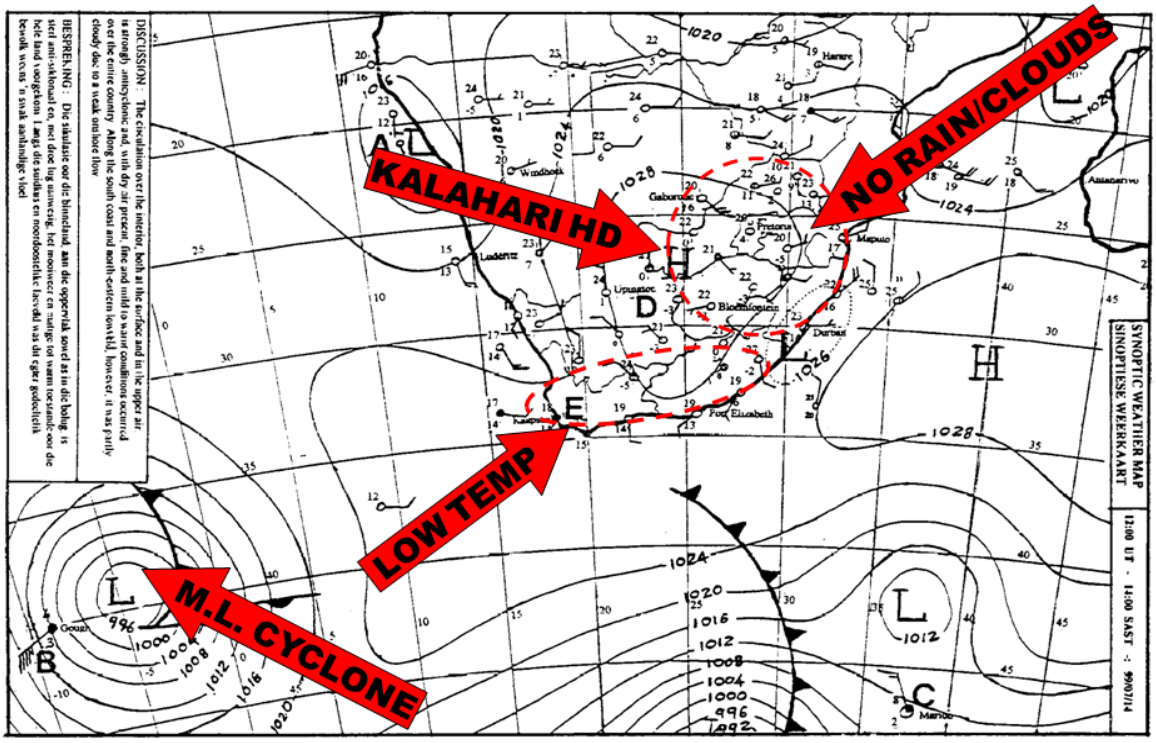
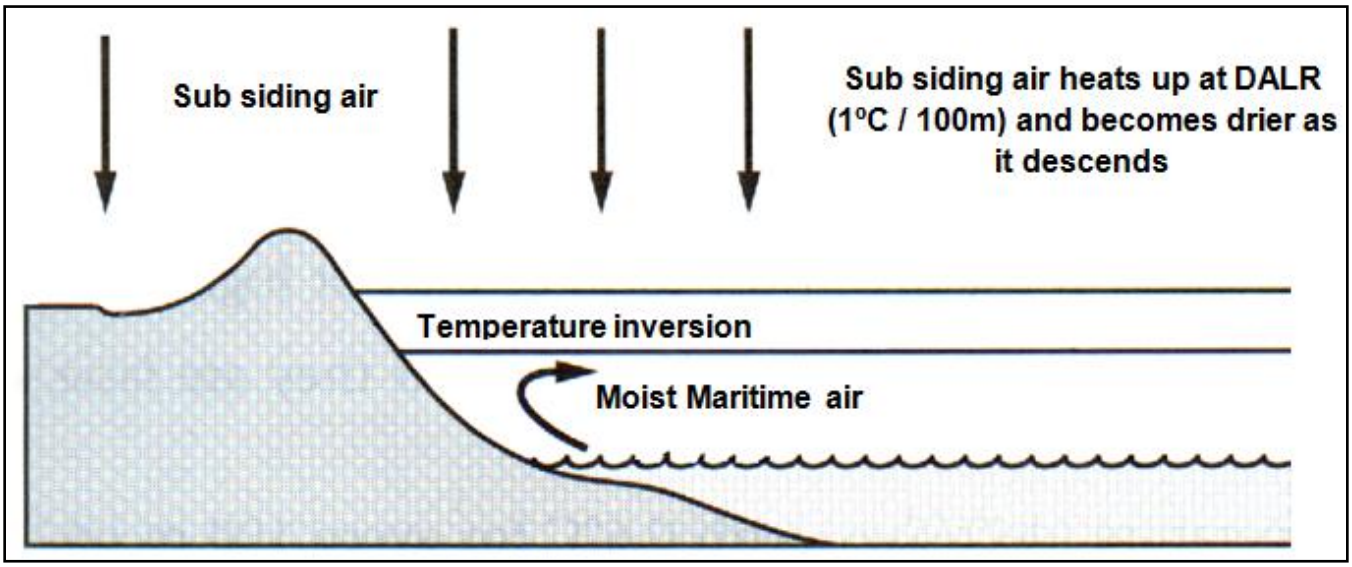
Winter Weather Conditions:

WINTER WEATHER MAP



A. Effect of interior plateau on South Africa's weather

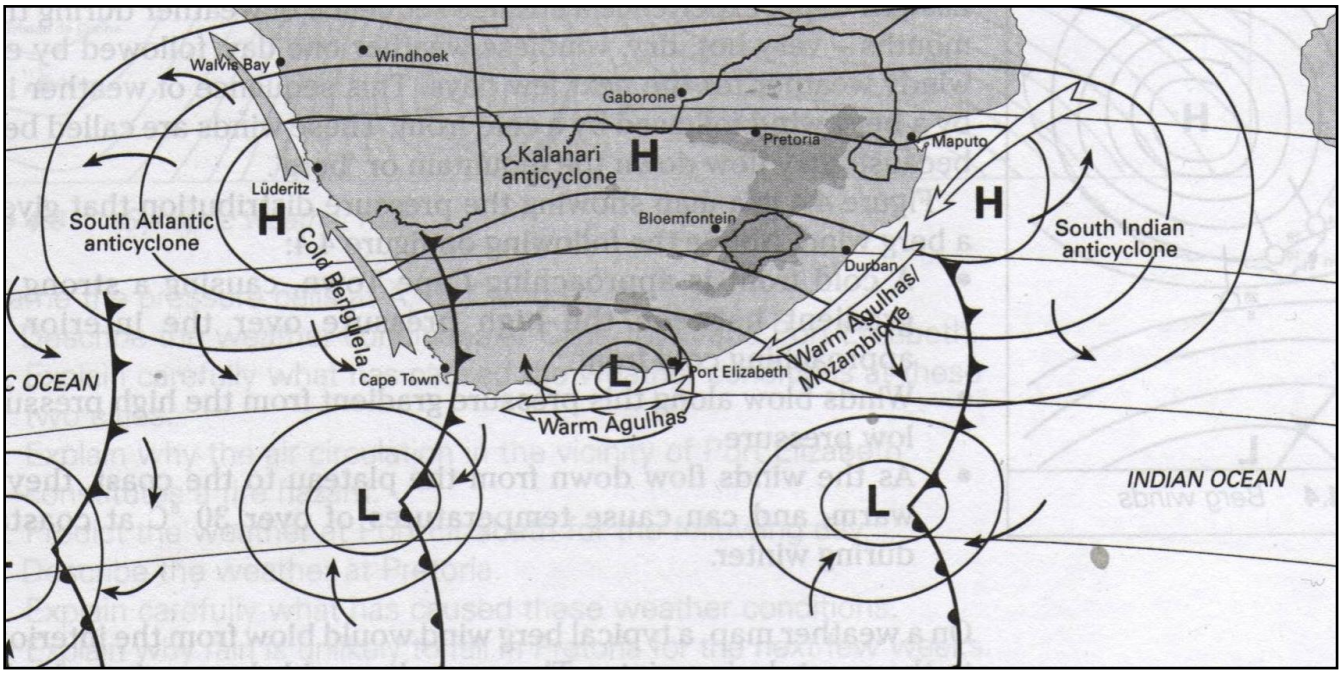
Winter:



- 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 rain occurs over the interior in winter.

B. Winter Rainfall Over South Western Cape.



Passing mid-latitude cyclones cause frontal rain over the South Western Cape in the winter rainfall area (Mediterranean area.). Here the warm air is forced to rise underneath the cool dense air. The warm air rises, cools, condenses and precipitates.

C. Coastal Low Pressure Systems:

Coastal Low pressure systems develop during summer and winter in SA. These low pressure sytems cause complete different weahter on either side of the pressure cell. The air moves in a clockwise direction around the cell. On the one side of the pressure cell, air will move from the land to the sea and will cause warmer drier conditions. On the other side of the pressure cell where the air mover from the sea to the land, moist cloudy conditions will develop that can lead to rain along the coastline (more along the east coast). Along the west coast the air is dry and cool and advection fog often developes rather that rain at the onshore side of the LP.

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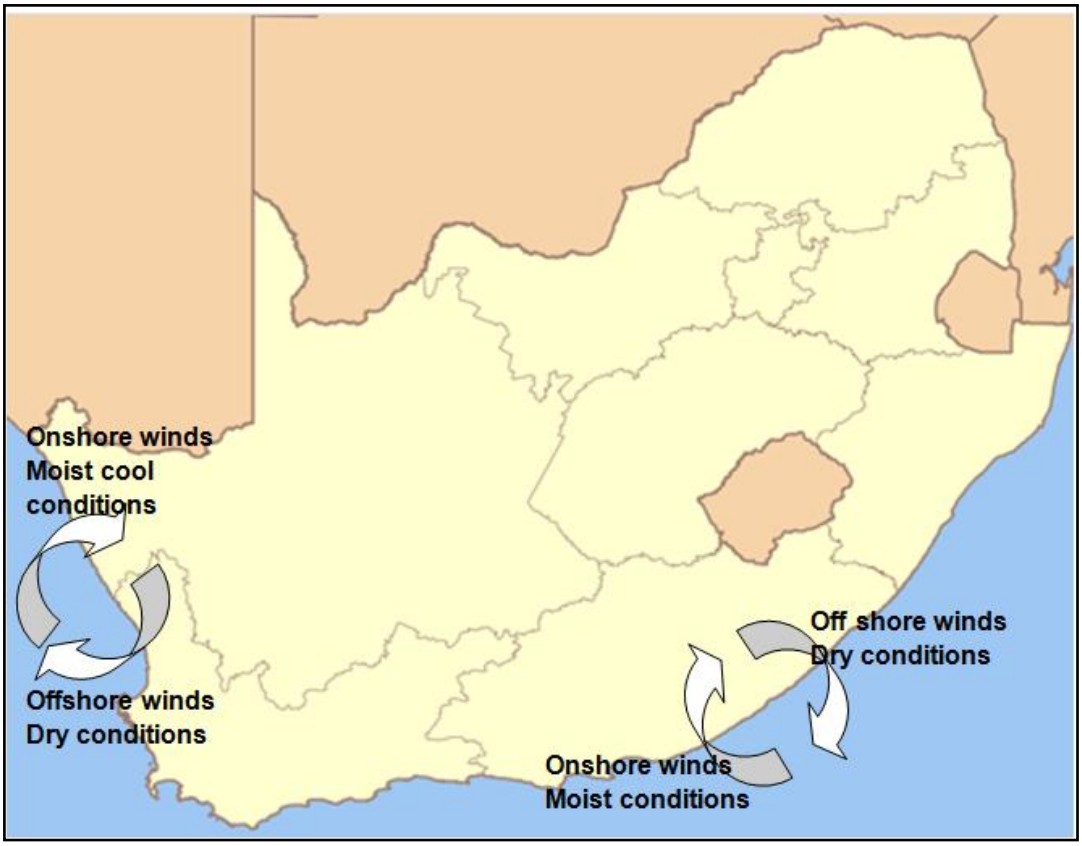
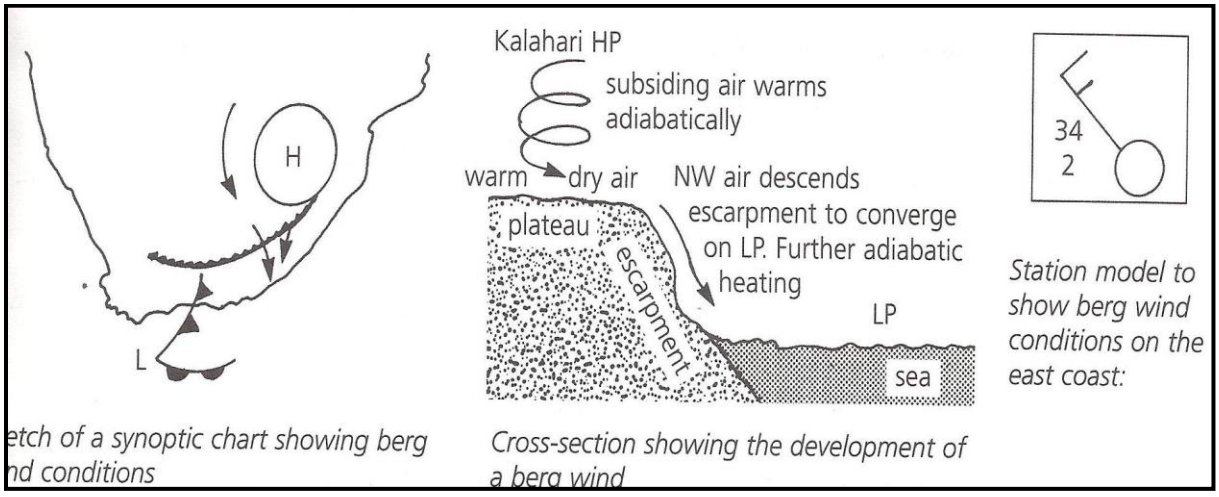


D. Berg Winds:

Ahead of the mid latitude cyclone, berg wind conditions occur, where air flows from the Kalahari High Pressure cell to the costal low pressure . As the air subsides from the plateau and down the escarpment, it heats at Dry Adiabatic temperature lapse rate and become drier and hotter. This causes hot dry uncomfortable conditions which is generally replaced quickly with cold conditions associated with the cold front. It causes veld fires.



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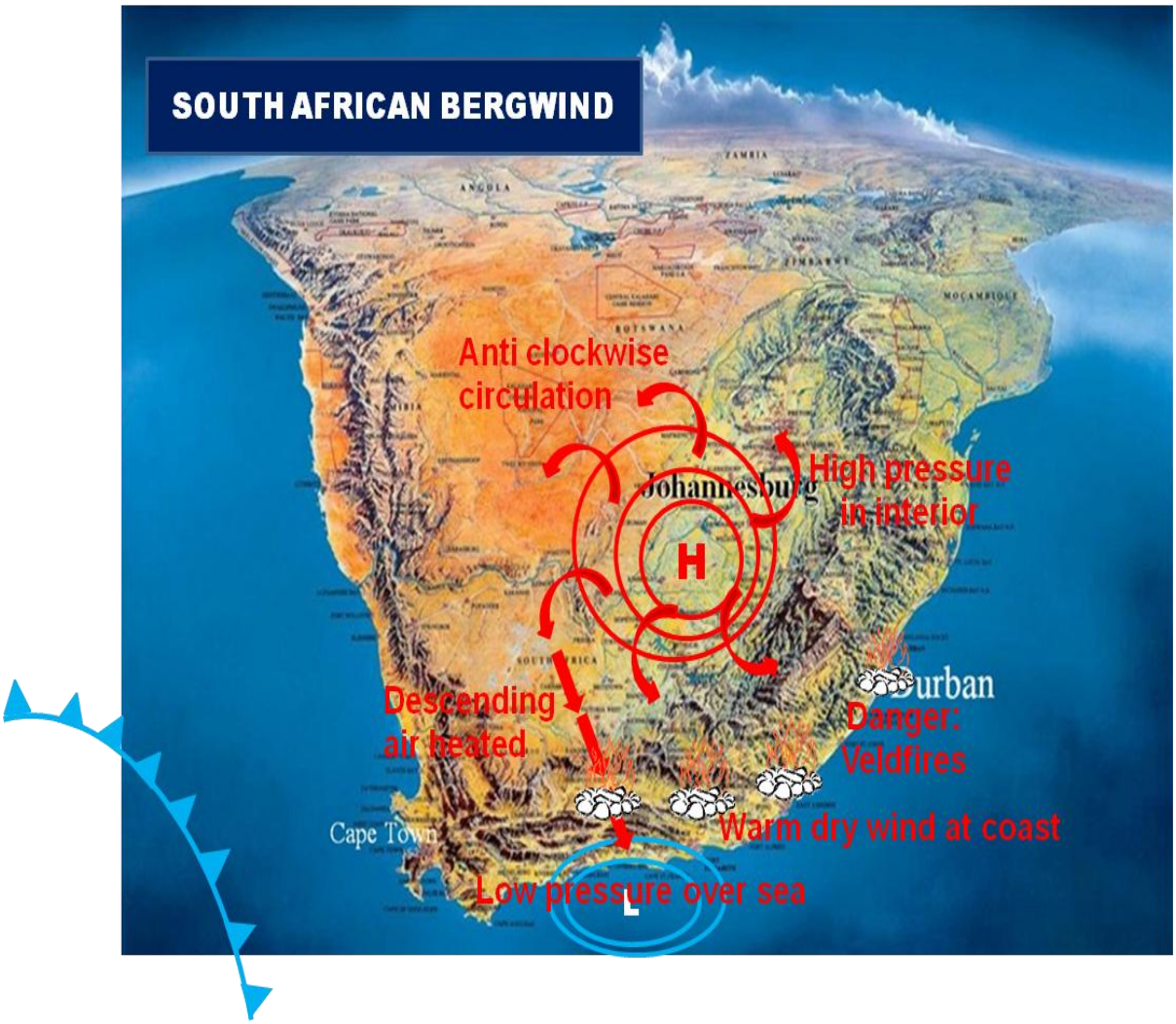

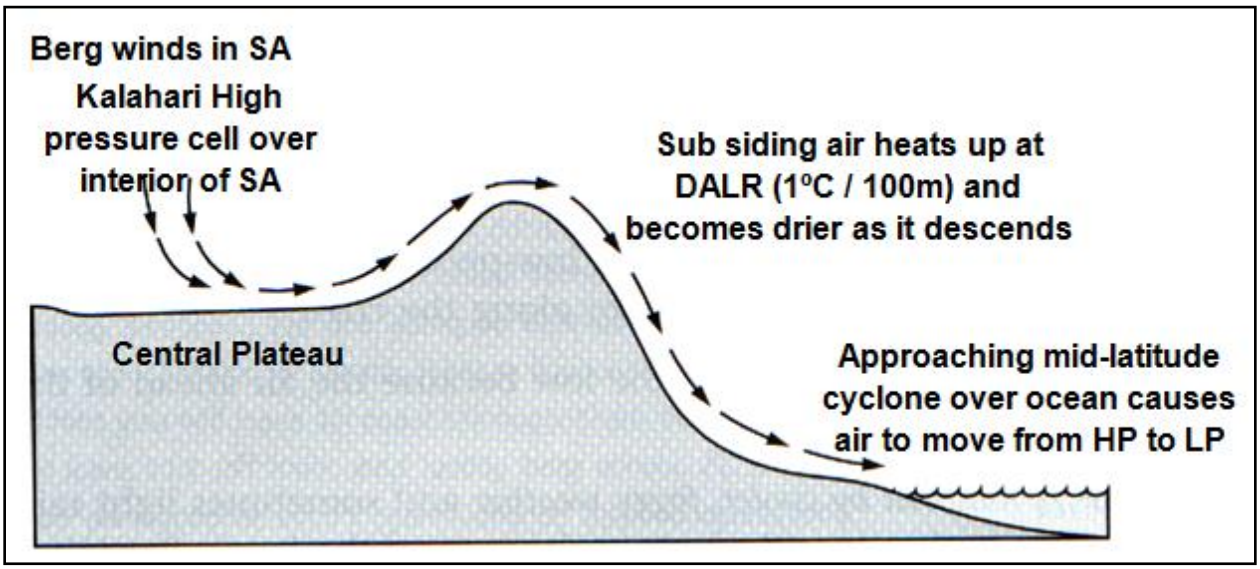

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X-AMPLE QUESTIONS:

Question 1:

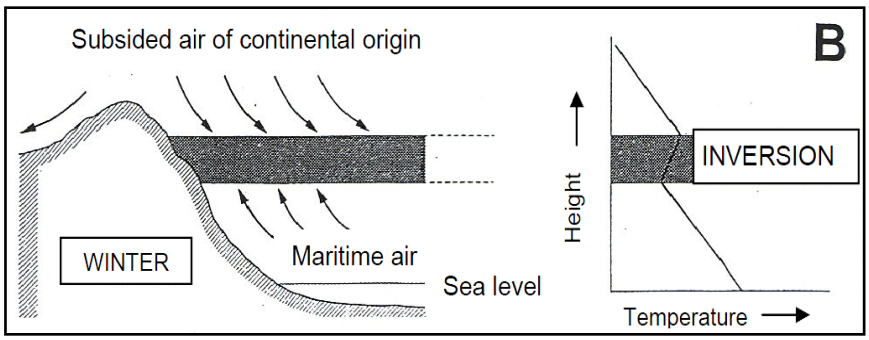
Refer to the FIGURE 1A below showing the weather forecast for 15 May 2007. FIGURE 1B is a cross-section through the eastern half of the country explaining the sunny conditions at all the inland weather stations.

FIGURE 1A:

Main City Weather
Tuesday 15 May 2007

	Min.	Max.
Bloemfontein	7 °C	19 °C
Cape Town	15 °C	19 °C
Durban	15 °C	27 °C
East London	17 °C	24 °C
Johannesburg	13 °C	25 °C
Kimberley	8 °C	19 °C
Mafikeng	10 °C	27 °C
Nelspruit	10 °C	30 °C
Pietermaritzburg	13 °C	26 °C
Polokwane	9 °C	28 °C
Port Elizabeth	14 °C	23 °C
Pretoria	15 °C	27 °C

FIGURE 1B

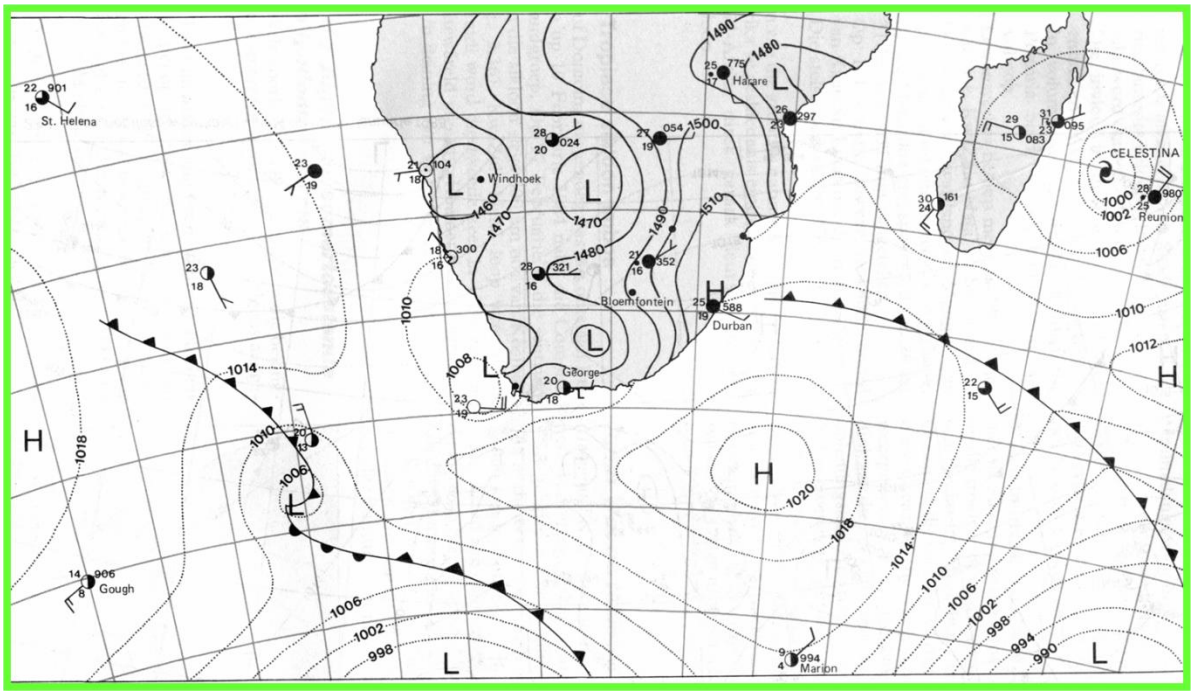


1.1 What is meant by the term *inversion* shown in FIGURE 1B? (1 x 2) (2)
1.2 Name the high-pressure cell associated with the label *subsided air of continental origin*. (1 x 2) (2)
1.3 Why does an inversion develop at the lower side of the high pressure cell mentioned in QUESTION 1.2? (2 x 2) (4)
1.4 With reference to FIGURE 1B, explain why sunny conditions are indicated for all the inland weather stations. (3 x 2) (6)
1.5 Will the inversion shown in FIGURE 1B be higher or lower than its current position during the summer months? (1 x 2) (2)
1.6 The vertical positional change of the inversion from winter to summer is of great importance to farmers on the South African plateau. Explain this statement. (2 x 2) (4)
[20]

Question 2:

2.1 Refer to MAP 1 to answer the questions

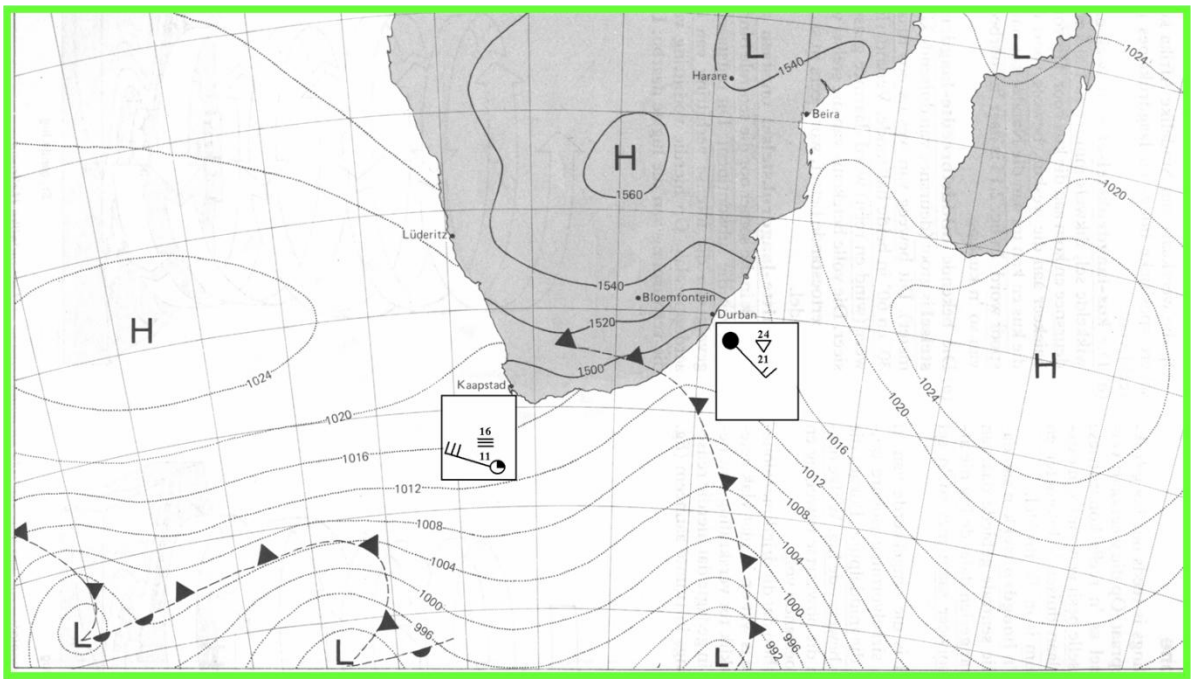
MAP 1



2.1.1. Does this map illustrate summer or winter conditions? (1 x 2) (2)
2.1.2. Motivate you answer in 2.1.1. (3 x 2) (6)
2.1.3. Identify the weather feature called Celestine in the North Eastern corner of the map. (1 x 2) (2)
2.1.4. Where and under what conditions did Celestine develop? (4 x 2) (8)
2.1.5. Explain what weather can be expected at Celestine. (3 x 2) (6)
2.1.6. Which parts of SA will be influenced by the weather systems like Celestine? (1 x 2) (2)
2.1.7. When will Celestine dissipate? (3 x 2) (6)
2.1.8. Explain how the rain over the central interior developed. (3 x 2) (6)

2.2 Refer to Map 2 on the following page o answer the following questions:

MAP 2



2.2.1.	Does this map illustrate summer or winter conditions?	(1 x 2) (2)
2.2.2.	Motivate you answer in 2.2.1.	(3 x 2) (6)
2.2.3.	Identify the weather systems South of SA and over SA.	(1 x 2) (2)
2.2.4.	Describe the weather conditions in Durban.	(3 x 2) (6)
2.2.5.	Explain why the weather is like what you mentioned in 2.2.4.	(3 x 2) (6)
2.2.6.	Identify the 3 high pressures on the map.	(3 x 2) (6)
2.2.7.	Describe the weather over the interior of SA.	(3 x 2) (6)
2.2.8.	Account for the weather over the interior of SA.	(3 x 2) (6)

Question 3:

Refer to FIGURE 3.1 showing the formation of a storm line.

3.1	What is meant by the term storm line as mentioned in the statement above?	(1 x 2) (2)
3.2	Describe some of the processes (air movement, influx of air) which lead to line thunderstorms occurring.	(3 x 2) (6)
3.3	What name is given to the band of low pressure that extends across the South African interior along which line thunderstorms develop?	(1 x 2) (2)
3.4	Do line thunderstorms develop on the eastern or western side of the band of low pressure mentioned in QUESTION 3.3?	(1 x 2) (2)
3.5	Discuss the consequences of line thunderstorms for farming activities in South Africa's interior.	(2 x 2) (4)

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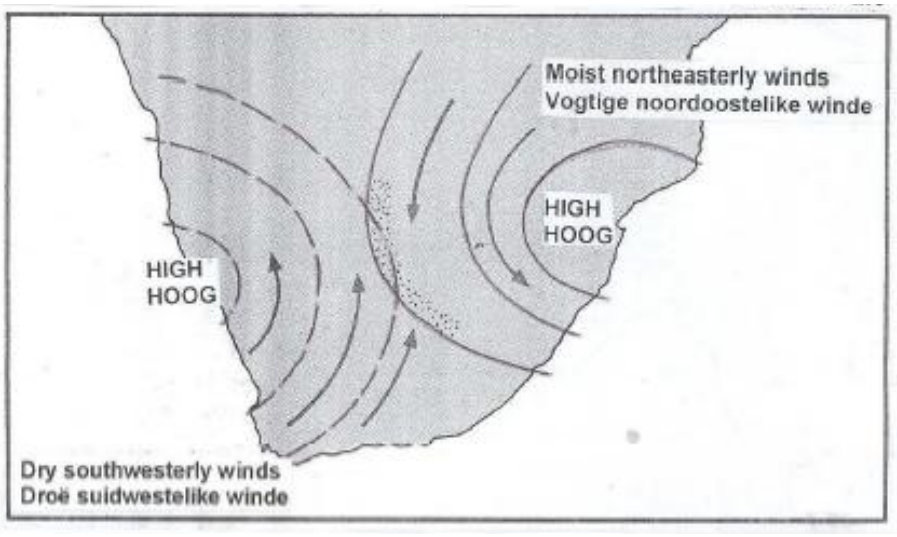
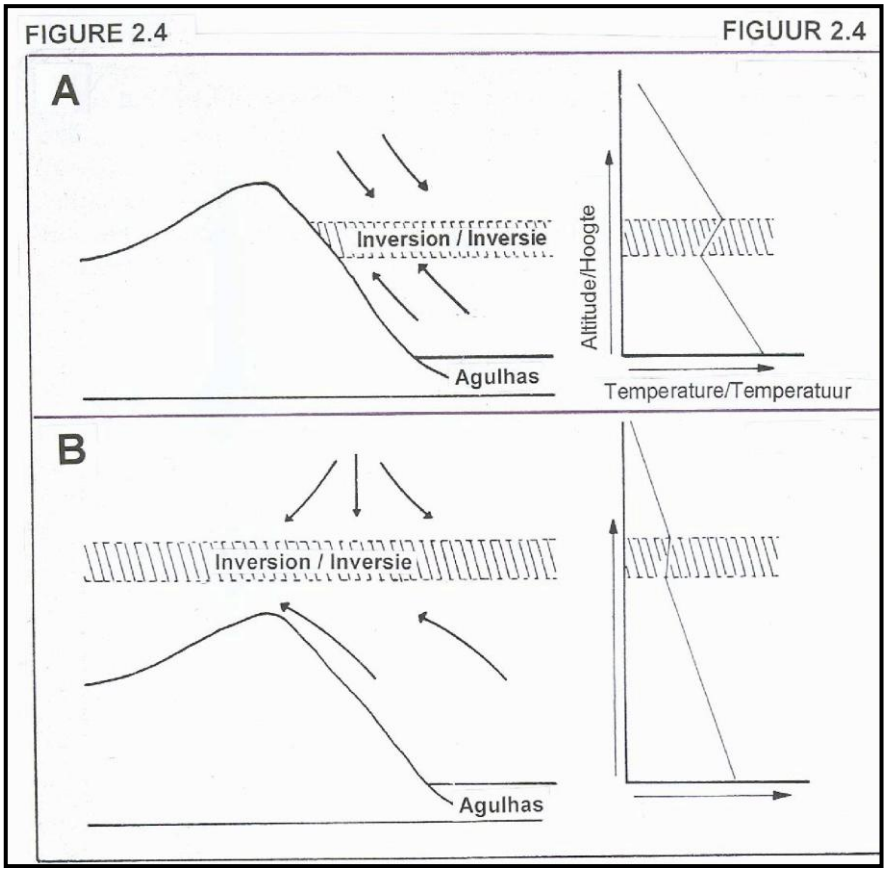
Figure 3.1.



X-ERCISE QUESTIONS

Question 1:

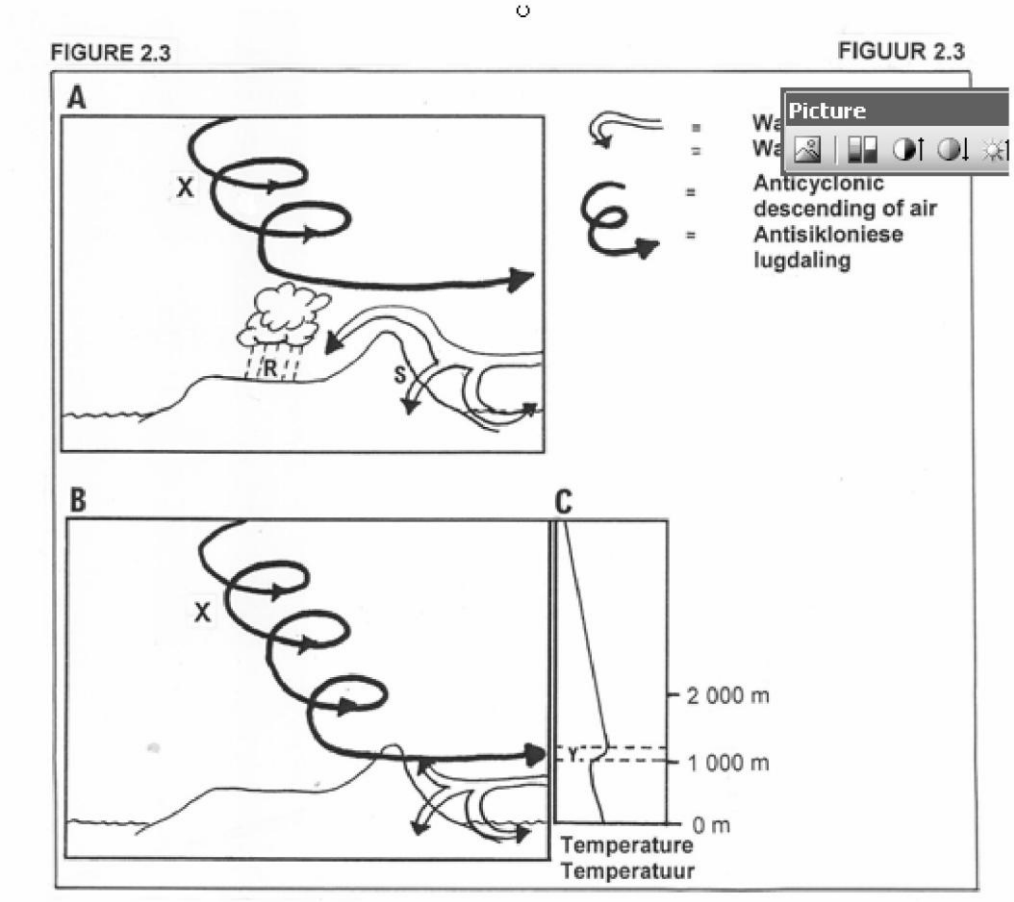
The Kalahari high-pressure cell causes a subsidence inversion over the South African interior. The base height of this subsidence inversion varies from summer to winter. Study FIGURE 2.4 below, a cross-section that shows how the base height of the subsidence inversion varies from summer to winter.



1.1 Define the term *temperature inversion.* (1x2) (2)
1.2 Which of the diagrams, Figure 2.4A or 2.4B, represents summer months? (1x2) (2)
1.3 Give one reason for your answer to Question 1.2. (1x2) (2)
1.4 Describe the effect that the base height of the subsidence inversion will have on the climate of the South African interior during summer months. (4x2) (8)

Question 2:

Figures 2.3A and 2.3B show weather conditions that South Africa experience at different times of the year. Also read the extract on droughts below. If the conditions illustrated in Figure 2.3B persist, South Africa may experience a severe drought.



EXTRACT

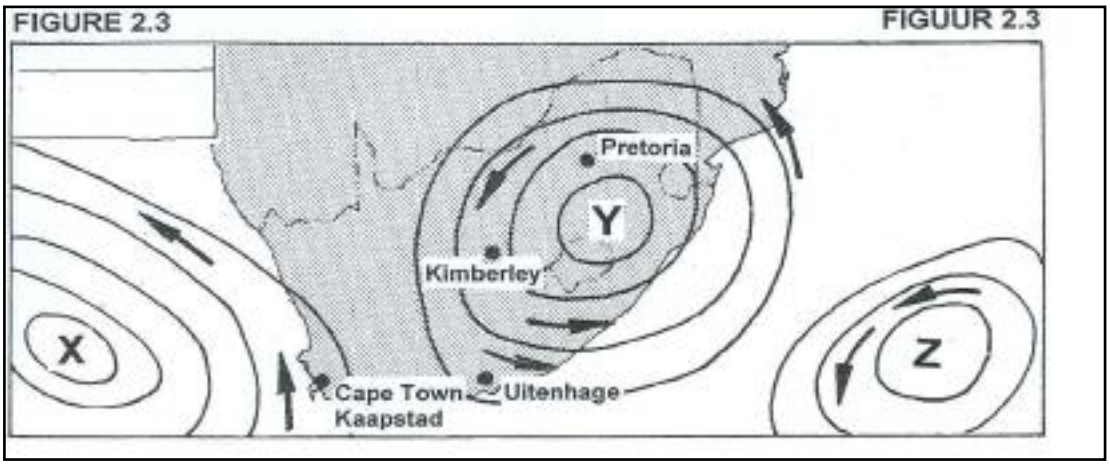
Hot, dry weather from January to March 2007 wilted crops in southern Africa. The severe drought produced near-record temperatures that, combined with a lack of rainfall, caused extensive crop damage, particularly in western crop areas. In South Africa, the anticipated yield from the corn crop dropped from ten million tons in December to six million tons in April,
because farmers could not plant in the dry conditions and many of the crops that were planted, wilted in the dry heat. The last South African drought of this magnitude occurred in 1992.The CSIR said, The 1982-83 and 1991-92 droughts were the most

severe meteorological droughts of the 20th century in southern Africa. In the 1991-92 drought, 70% of the crops failed. It was estimated that half of the population in the affected area was at risk of malnutrition, other related health problems, and even starvation.

2.1 During which season would South Africa experience the weather conditions represented in A and B respectively? (2x2) (4)
2.2 Name the weather system labelled **X** on both diagrams. 1X2) (2)
2.3 Weather system **X** is responsible for the development of stable conditions which frequently occur over the South African interior during winter. Briefly explain why weather system **X** is responsible for the development of the stable conditions over the interior. (2X2) (4)
2.4 In which one of the diagrams, **A** or **B**, is the above-mentioned condition clearly visible? (1X2) (2)
2.5 Figure 2.3C is a graph showing the vertical temperature gradient as experienced in Figure 2.3.B.
(a) Describe the temperature changes as shown on the graph in figure 2.3C. (3X2) (6)
(b) What is the zone labelled **Y** known as? (1X2) (2)
2.6 What is a drought? (1X2) (2)
2.7 Explain why the persistence of the condition illustrated in Figure 2.3B can result in drought over the South African interior. (3x2) (6)
2.8 Write a short essay (no longer than 12 lines) in which you discuss measures that can be introduced to reduce the effect of persistent droughts in South Africa. Also give reasons why it is important to reduce the effect of persistent droughts. (6x2) (12)

Question 3:

Refer to FIGURE 2.3 showing the position of the three high-pressure cells over Southern Africa that has major effects on the weather and climate.



3.1 Identify the THREE high pressure cells labelled X, Y and Z respectively (3x2) (6)

3.2 Which ONE of the three high-pressure cells mentioned in QUESTION 3.1(a) is mainly responsible for the different weather conditions experienced over the South African interior during summer and winter? (1x2) (2)

3.3 State and explain THREE difference in the weather conditions experienced during winter and summer over the South African interior by referring to the role played by the high-pressure cell mentioned in QUESTION 3.1(b). (3x2) (6)

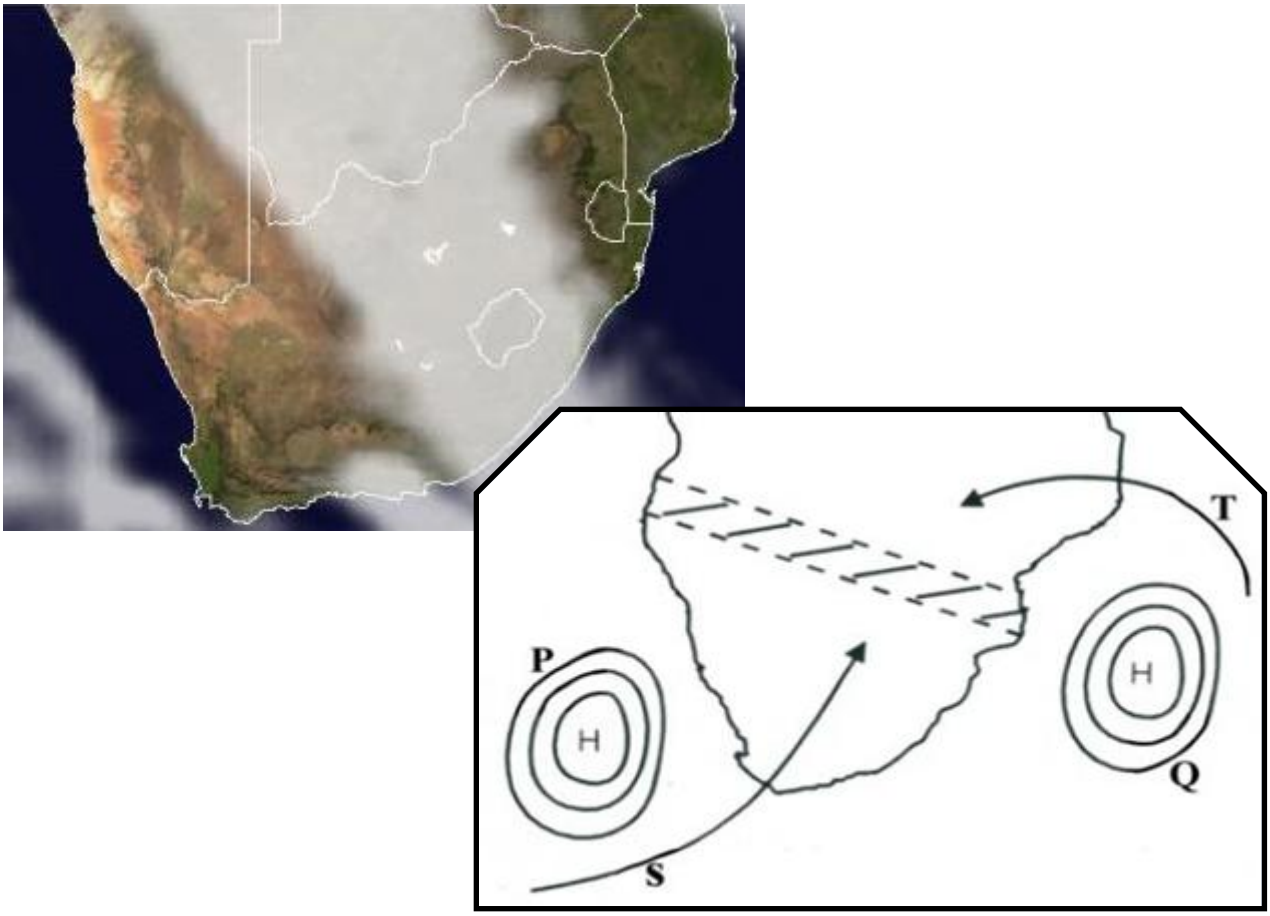
3.4 Which season does this synoptic map represent and give a reason for you answer. (2x2) (4)

3.5 Give a reason from the map to support that the weather systems are high pressure cells (1x2) (2)

3.6 Name the ocean currents that are found on the east and west coast of RSA. (2x2) (4)

Question 4:

The Figure below illustrates the development of thunderstorms belt over South Africa. Refer to the diagrams below to answer the following questions.



4.1. Identify the weather features labelled P and Q respectively on the map. (2)

4.2. State the season that is indicated in the figure. (1 x 2) (2)

4.3. Motivate your answer in 4.2. (2 x 2 = 4)

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4.4.	Compare the winds labelled S and T in table form.	(4 x 1 = 4)
4.5.	Explain why clouds form over the central part of South Africa.	(2 x 2 = 4)
4.6.	What type of rain will occur along the thunderstorm boundary?	(1)
4.7.	Give one advantages and one disadvantage of line thunderstorms.	(2 x 2 = 4)

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ANSWERS TO HOMEWORK X-ERCISES

SESSION 3: FACTORS THAT INFLUENCE WEATHER IN SOUTH AFRICA

Question 1:

1.1 A rise/ increase in temperature with increase in height/ altitude. ✓✓ (1x2) (2)
1 2. 4B. ✓✓ (1x2) (2)
1.3 Inversion layer is above the escarpment. ✓✓
The base of the inversion is higher above sea level ✓✓
Moist air is adverted onto the plateau ✓✓ (1x2) (2)
1.4 **Summer**
Moist air will reach the interior✓✓
High humidity ✓✓
More condensation ✓✓
Cloud formation ✓✓
Precipitation ✓✓
[Any four for Summer] (4x2) (8)

Question 2:

2.1 A = summer ✓✓
B = winter ✓✓ (2X2) (4)
2.2 Kalahari / Continental High Pressure Cell ✓✓ (1X2) (2)
2.3 Descending air ✓✓
Air warms adiabatically as it goes down✓✓
Blocks moisture ✓✓
No condensation will occur ✓✓
[Any two] (2X2) (4)
2.4 B ✓✓ (1X2) (2)
2.5 (a)
From 0 to 1000 m there is a decrease in temperature with height ✓✓
At Y there is an increase in temperature with height ✓✓
Above Y there is a decrease in temperature with height ✓✓ (3X2) (6)
(b)
Temperature inversion ✓✓
(1X2) (2)
2.6 A period when rainfall is below average for a region during which vegetation cover decreases. ✓✓ (1X2) (2)
2.7 Kalahari HP remains lower than the escarpment ✓✓
Moisture is blocked from the ocean to reach the interior ✓✓
The Kalahari HP is associated with stable air ✓✓
Rainfall will decrease over the interior ✓✓
If the stability of air persists the interior will experience dry conditions over a period of time ✓✓ (3X2) (6)
2.8 **Prevention measures**
Plant trees to reduce run-off and increase infiltration ✓✓
Eliminate alien trees which use high quantities of water ✓✓
Build dams in areas with low evaporation ✓✓

Contour ploughing to reduce run-off/ apply scientific ploughing techniques ✓✓
Limit irrigation in dry areas/ less wasteful irrigation techniques ✓✓
Water transfer schemes to increase water ✓✓
Recycling of water for re-use ✓✓
Conserve underground water supplies ✓✓
Decentralisation of activities away from one major water source ✓✓
Public awareness campaigns on importance of using water sparingly ✓✓
Importance of introducing preventative measures
Droughts reduce yields of crop farmers ✓✓
Reduction in number of livestock ✓✓
Negative implication for exporting ✓✓
Farmers suffer economically ✓✓
Farm workers laid off ✓✓
Fewer raw materials for industries ✓✓
Unemployment rises ✓✓
Balance of trade affected negatively ✓✓
[Any SIX – must include both sections] (6x2) (12)

Question 3:

3.1 X - South Atlantic (St. Helena) HP
Y- Kalahari (Continental) HP
Z - South Indian (Mauritius) HP (3X2) (6)

3.2 Y / Kalahari (Continental) HP (1x2) (2)

3.3

Summer	**Winter**	
Moist air	Dry air	
Cloudy	No clouds	
Rainfall	Little/no rain	
No frost	Frost at night	(3x2) (6)

3.4 Winter – the inland HP / Kalahari HP on the land (2x2) (4)

3.5 Anticlockwise circulation in SH (1x2) (2)

3.6 Warm Mozambique Current – East and Cold Benquela – West (2x2) (4)

Question 4:

4.1. P South Atlantic Ocean High pressure
Q South Indian Ocean High Pressure cell (2 x 1) (2)

4.2. Summer (1x2) (2)

4.3. Cloud formation over the interior indicates Low Pressure over central plateau – no Kalahari HP
Land must be warm to cause Low pressure and drag wind in from HP's
Moisture boundary over land
HP's far from land (2x2) (4)

4.4.

S – South Westerly's	T - North Easterlies
Cold, dry, stable	Moist, warm, unstable

(2x2) (4)

4.5. The stable cold air from the SW lifts the warm moist unstable air from NE as it meets along the moisture front. Warm conditions overland in summer contributes to instability. Air is lifted, cooled and reaches dew point temperature and condensation takes place and clouds form. (2x2) (4)

4.6. Convection rain – heavy thunder showers (2x2) (2)

4.7. Advantage:
- supply water for rivers,
- faming

Disadvantage:
- showers cause flooding
- hail can cause damage to crops
- many areas does not get rain (2x2) (4)