Higher Atmosphere

Earth’s Heat Budget

Global Insolation

Global Transfer Of Energy

Global Temperatures

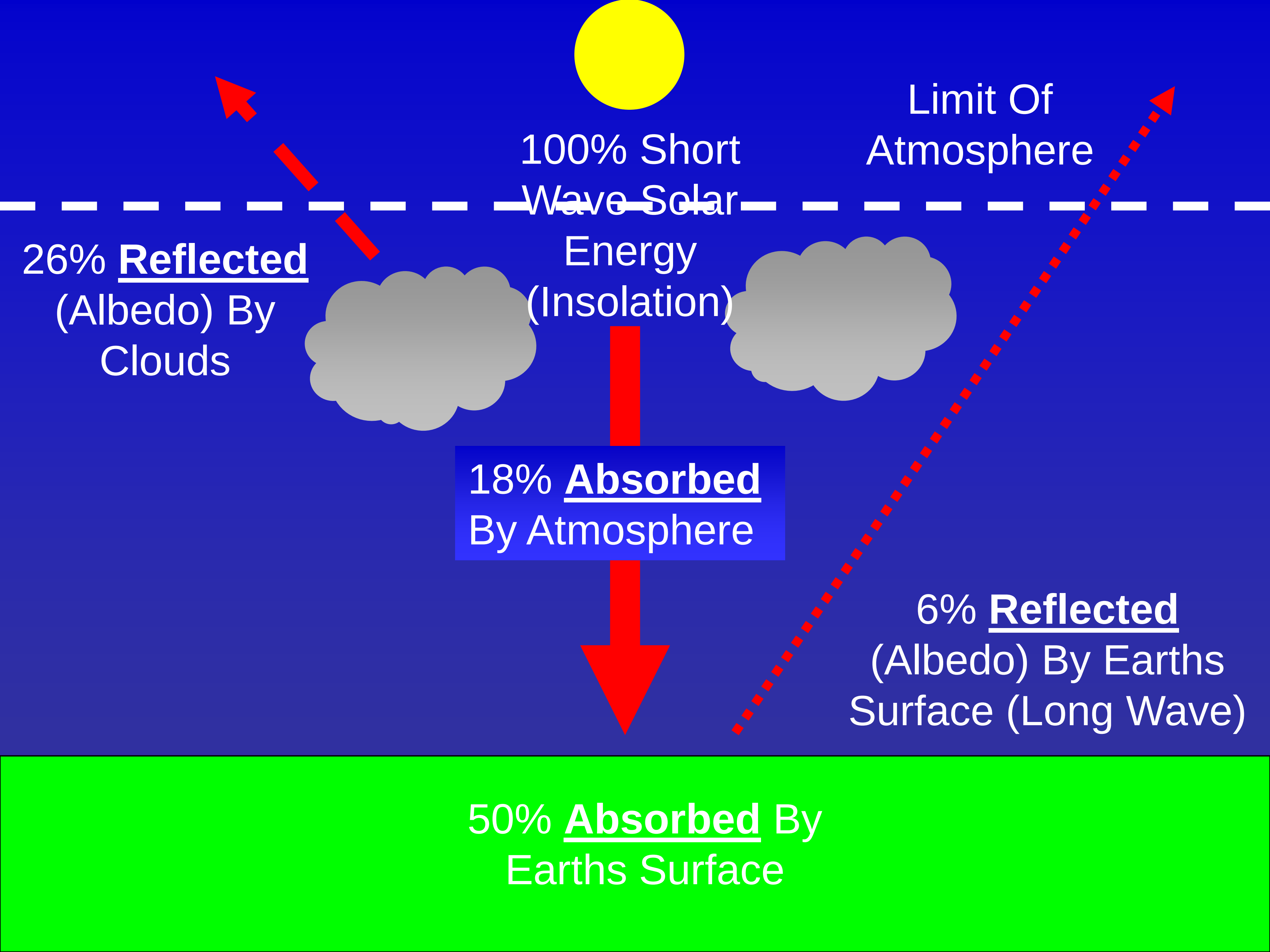
Inter Tropical Convergence Zone

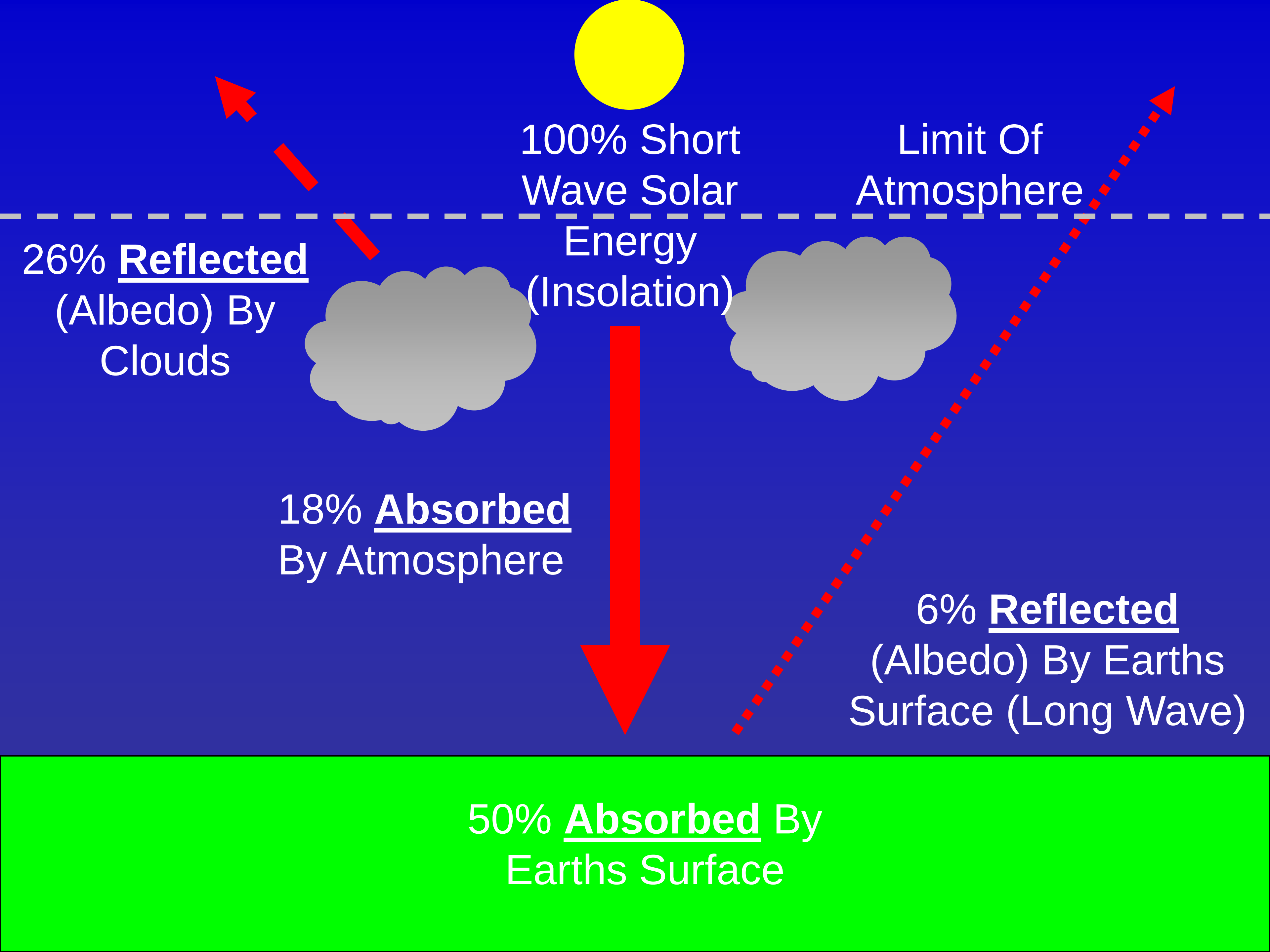
Climate Graph

Earth's Heat Budget

Task 1

Use the Power Point to help you complete the diagram of the Earth's Heat Budget.


100% Short Wave Solar Energy (Insolation)
Limit Of Atmosphere
26% Reflected (Albedo) By Clouds
18% Absorbed By Atmosphere
6% Reflected (Albedo) By Earths Surface (Long Wave)
50% Absorbed By Earths Surface


100% Short Wave Solar Energy (Insolation)
Limit Of Atmosphere
26% Reflected (Albedo) By Clouds
18% Absorbed By Atmosphere
6% Reflected (Albedo) By Earths Surface (Long Wave)
50% Absorbed By Earths Surface

SOLAR INSOLATION IN EARTHS HEAT BUDGET

- 100% solar insolation
- 26% reflected by atmosphere
- 18% absorbed by atmosphere
- 56% reaches surface
- 6% reflected by surface
- 50% absorbed by surface

TOTAL ALBEDO = 26 + 6 = 32%

TOTAL ABSORPTION = 18 + 50 = 68%

Earth's Heat Budget

Task 2

In groups of four try and match the definitions on the strips of paper to the key words in your workbook.

Report back to the class to check your answers before writing them in your workbook.

Earth's Heat Budget (Task 2)

Earth's Heat Budget

Insolation

Albedo

Long Wave Radiation

This is incoming solar energy (heat).

This is energy or heat emitted from the earth, only 6% escapes the earth the rest being absorbed into the atmosphere.

This is the total amount of energy reflected from the earth.

This is the balance between incoming and outcoming energy.

Earth's Heat Budget (Task 3)

Task3

Now try and answer the question below, found in your workbook. It is a typical exam style question (4 Marks).

Describe and explain fully the Energy Exchanges that result in the Earths Surface absorbing only 50% of the solar energy that reaches the outer atmosphere.

This basically means explain the Earth's Heat Budget!

The Earth's Heat Budget

To help you, use the following structure.

Say where the earths energy come from and name it.

Briefly explain what the earth's heat budget is.

Describe what happens to the insolation giving values;

- Atmospheric absorption (clouds)
- Atmospheric reflection (albedo + clouds)
- Surface absorption (land)
- Surface reflection (albedo + ice/water)

Earth's Heat Budget (Task 3)

The earths energy comes from solar radiation, this incoming heat energy is balanced by the amount of heat escaping back into space. This balance is called the earths heat budget.

Incoming solar heat (insolation) from the sun is absorbed and reflected meaning not all the heat reaches the earths surface. 26% of the energy is reflected back into space by the earths atmosphere and 18% of the heat is absorbed by the atmosphere due to dust particles retaining the heat.

This leaves 56% which travels to the earths surface. Not all of this is absorbed 6% is reflected from the earths surface by polar ice caps & water, and this makes up part of the earths Albedo. This means only 50% reaches the earths surface and is balanced out by the long wave radiation escaping back into the atmosphere.

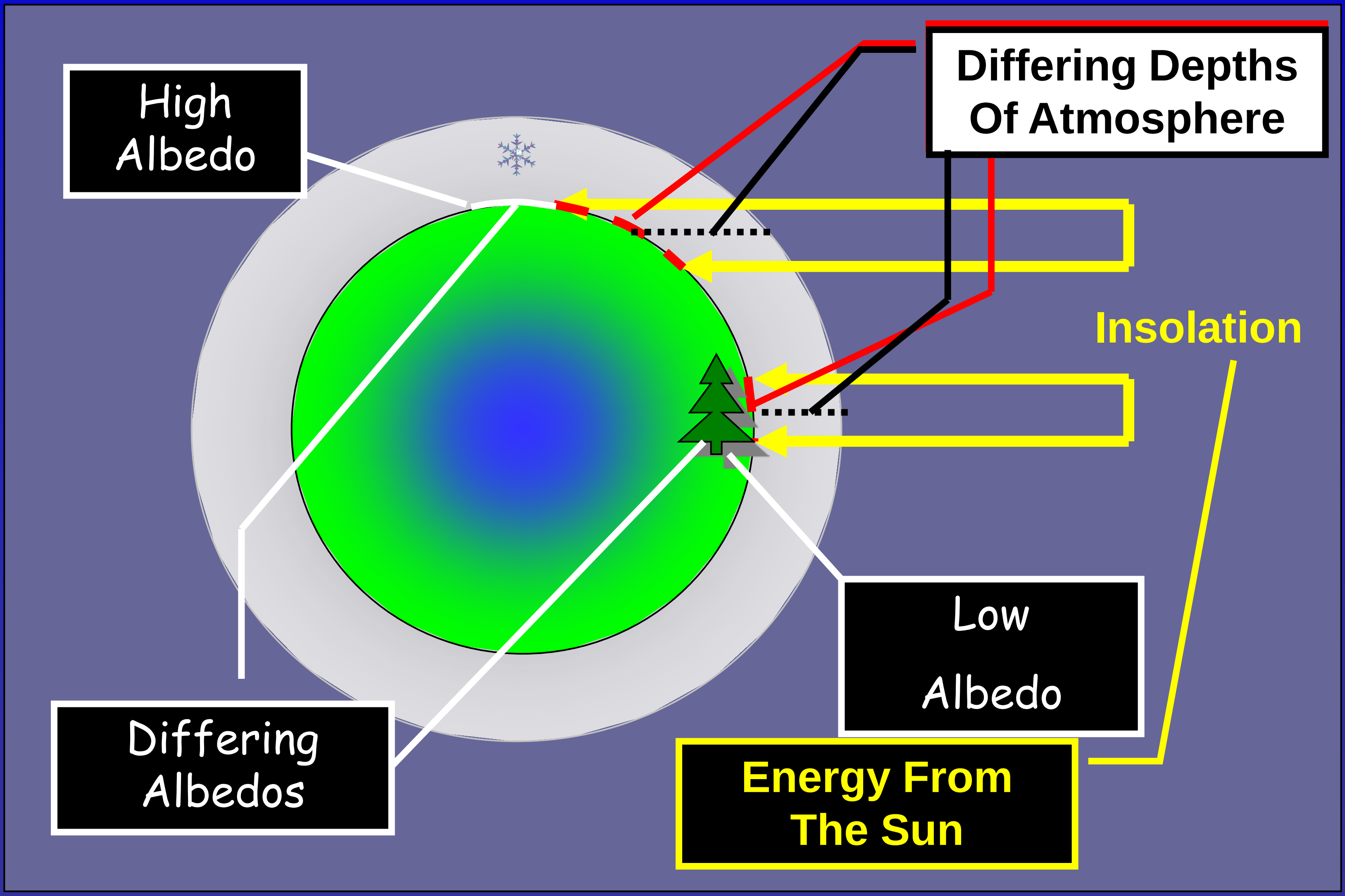
Global Insolation

The Earth's atmosphere is put into motion because of the differential heating of the Earth’s surface by solar insolation.

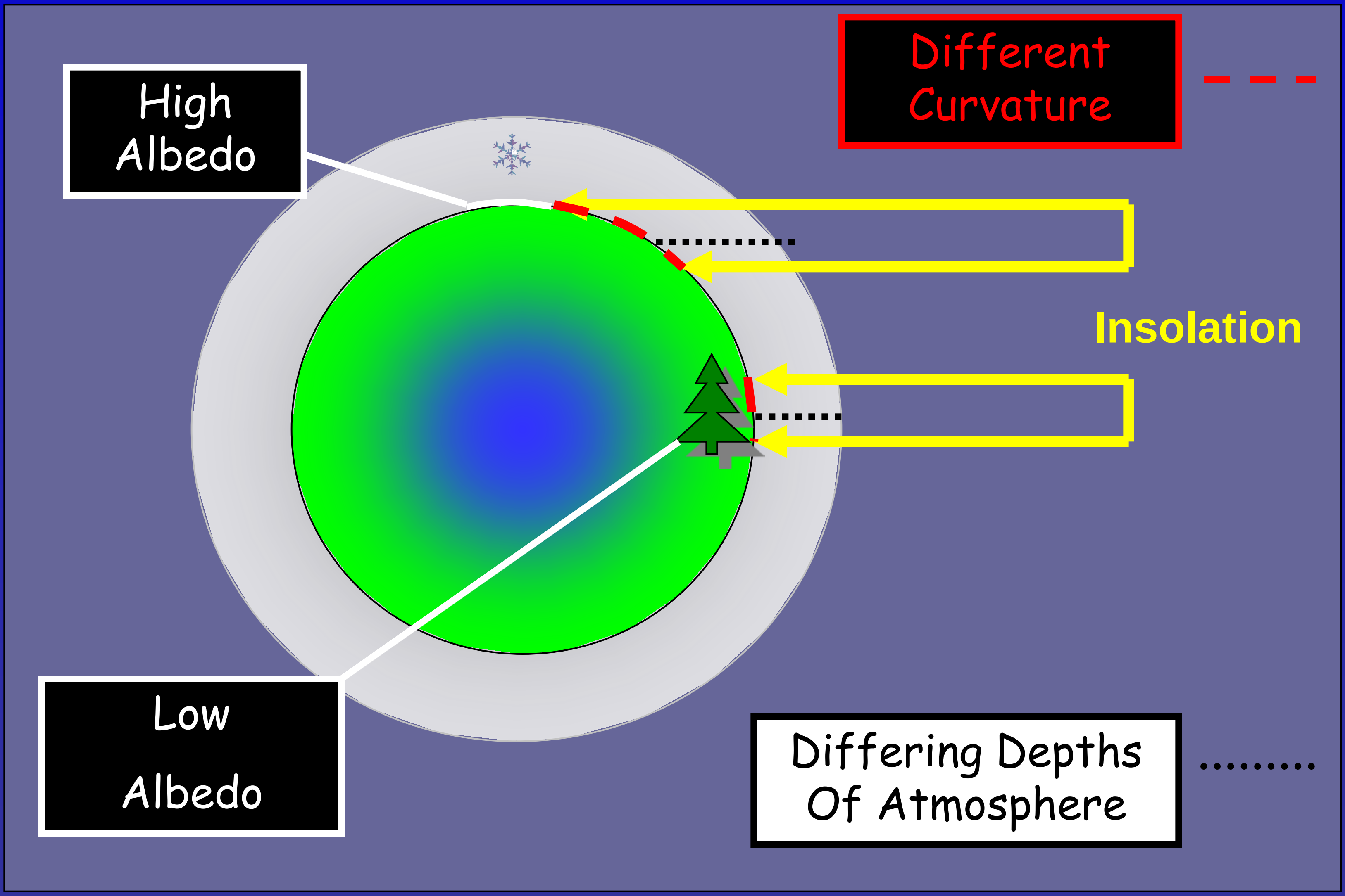
This means that the winds and clouds above us move around because there are some areas of the earth which are hotter than others.

We therefore need to know why these difference occur, so we can then study the different movements of the weather in the atmosphere. This then lets us make accurate weather forecasts.

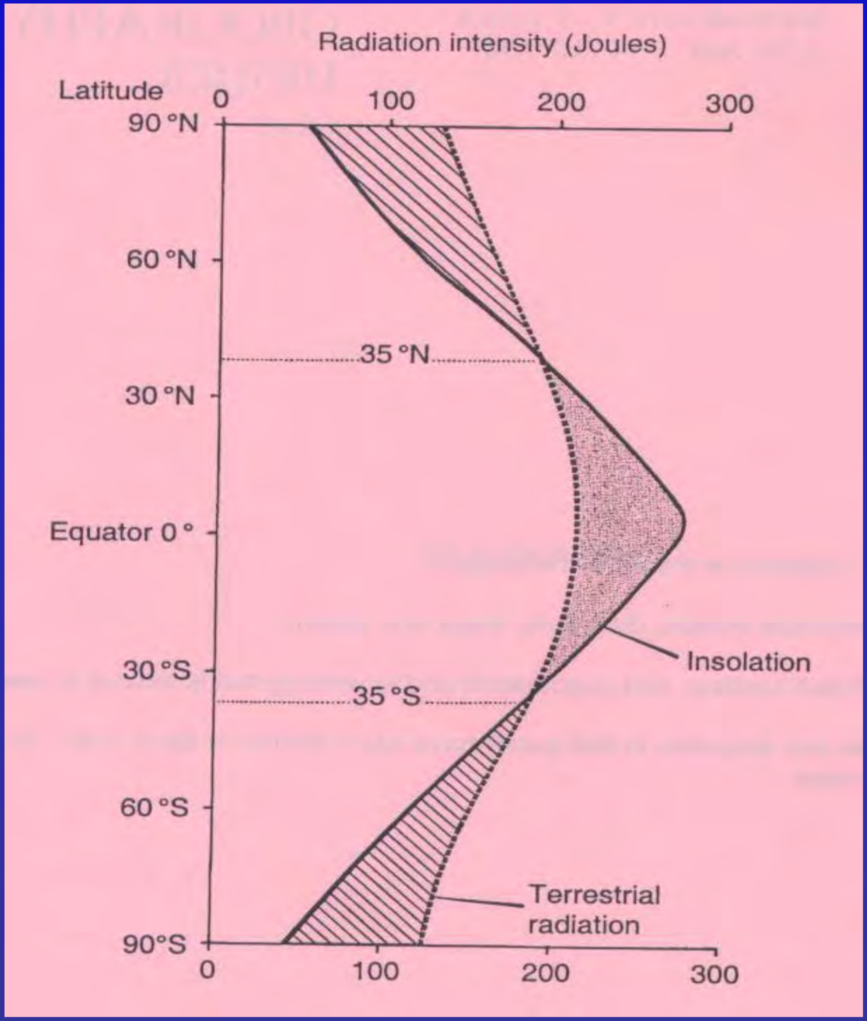
Global Insolation Task 4 (1)



Global Insolation Task 4 (1)



Variations In Global Insolation



Describe

With the aid of an annotated diagram describe and explain the energy balance shown on the diagram below.

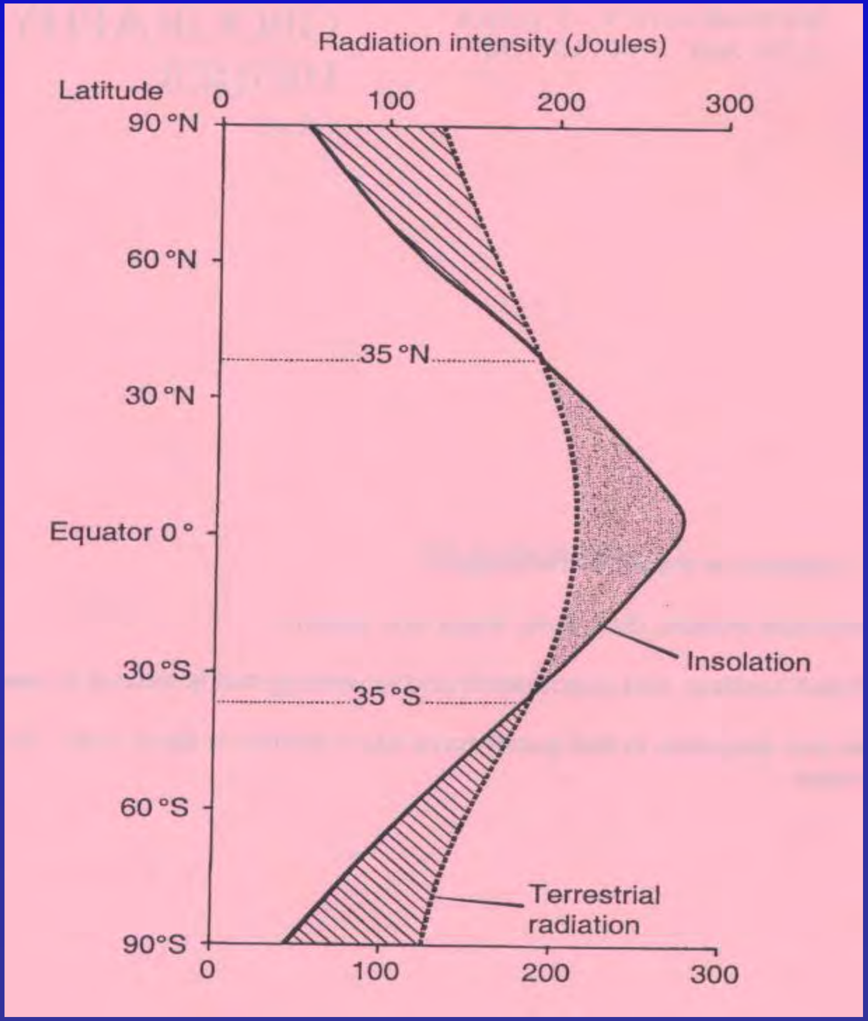
Range of latitude

35° to 0° N or S of Equ.

State if in deficit or surplus

Give values in Joules 170 to 270

Variations In Global Insolation



Explain

Why deficit in high latitudes (polar areas) and why surplus in low latitudes (equatorial areas)

Insolation - distance travelled through atmosphere greater at poles so heat lost

Concentration of insolation higher at equator due to curvature of earth

Albedo high at poles and low at equator

Global Transfer Of Energy

This is the movement of energy from the equator to the poles. Global Insolation differences should mean that the lower latitudes (equator) get hotter and hotter, whilst the higher latitudes (poles) get colder and colder.

In reality this doesn't quite happen as energy is transferred from surplus areas (equator) to deficit areas (poles) by two methods.

Atmospheric Circulation & Ocean Currents

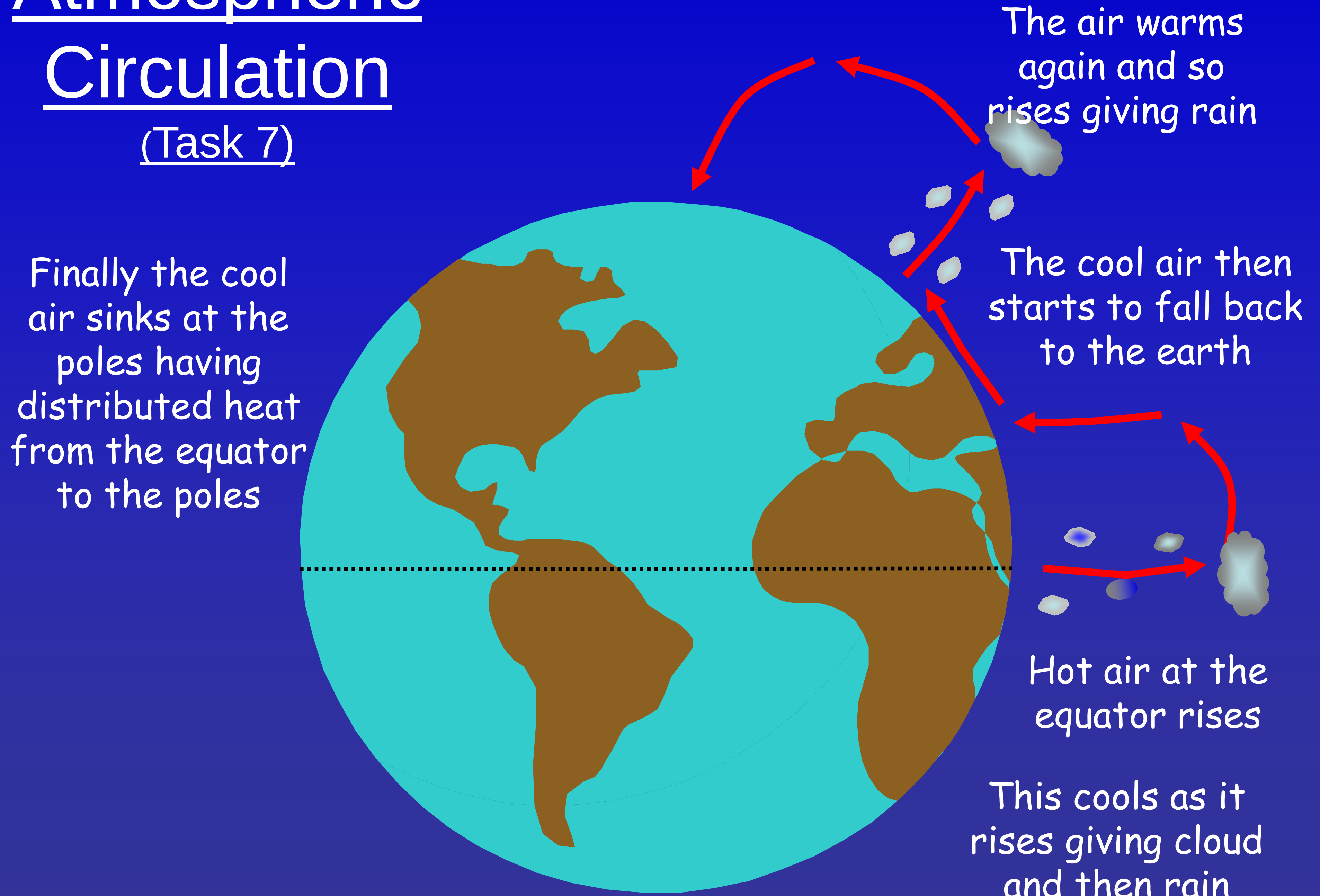
Atmospheric Circulation (Task 7)

This is the movement of heat from the energy rich areas to the energy poor areas of the earth (from the equator to the poles). Without this movement of energy, the poles would be too cold and the equator too hot to live % work in.

We will see a simplified explanation first before moving on to look at the three weather cells responsible for this energy transfer.

Atmospheric Circulation

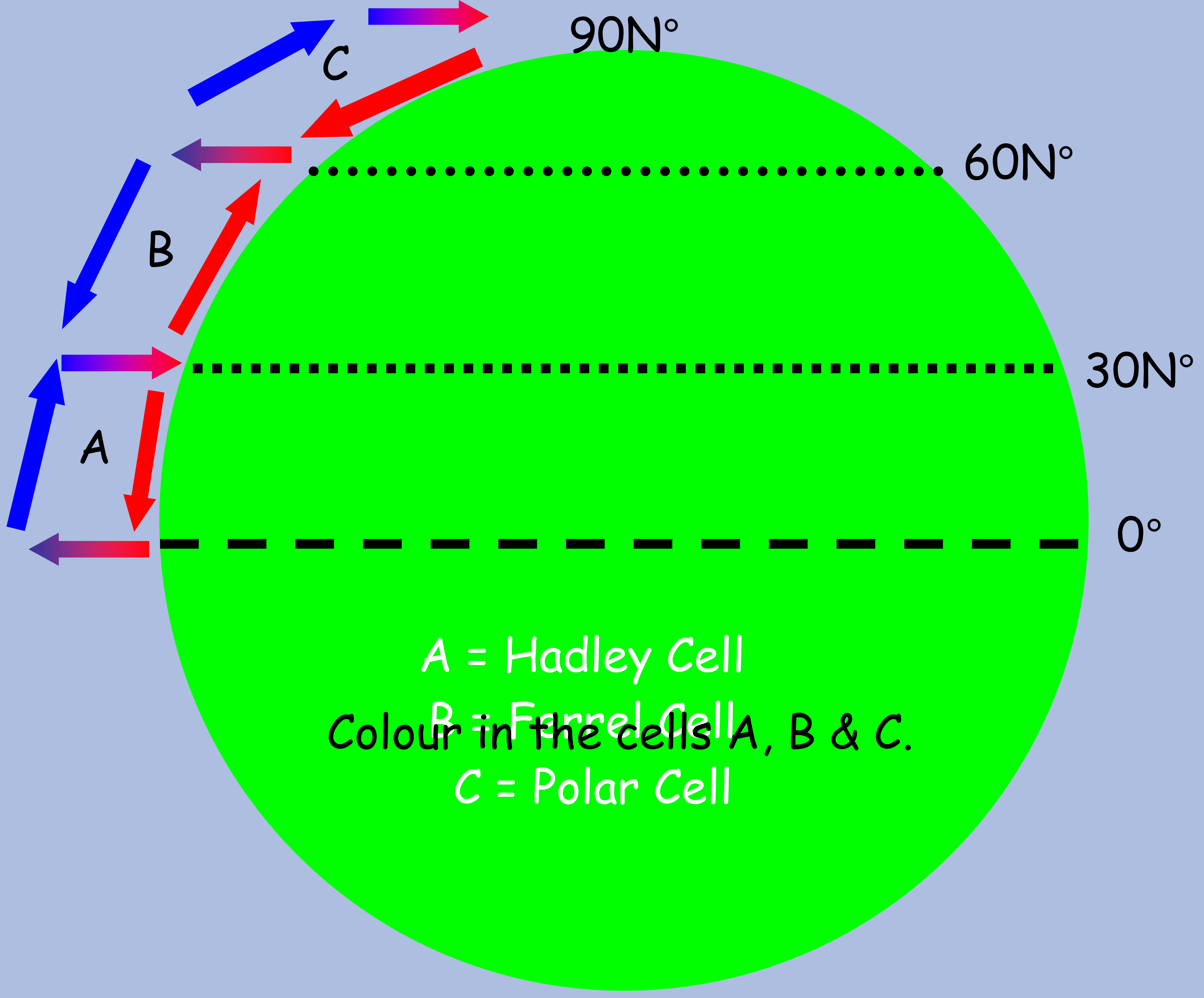
(Task 7)



Atmospheric Circulation Cells

Task 7

Now complete the diagram in your workbook showing the three weather cells responsible for circulating energy around the earth.


90N°
60N°
30N°
0°
C
B
A
A = Hadley Cell
B = Ferrel Cell
C = Polar Cell
Colour in the cells A, B & C.

Atmospheric Circulation Cells

The three weather cells.

The Hadley Cell ~ this circulates air between the equator 0° and the tropics of, Capricorn in the south (30°S) & Cancer in the north (30°N).

The Polar Cell ~ this circulates air between the North Pole & the Arctic circle (90°N & 60°N)

The Ferrel Cell ~ this isn't actually a cell but circulates air through friction between the tropic of Cancer & Arctic Circle in the North (30°N & 60°N) and the Tropic of Capricorn & Antarctic Circle in the south (30°S & 60°N)

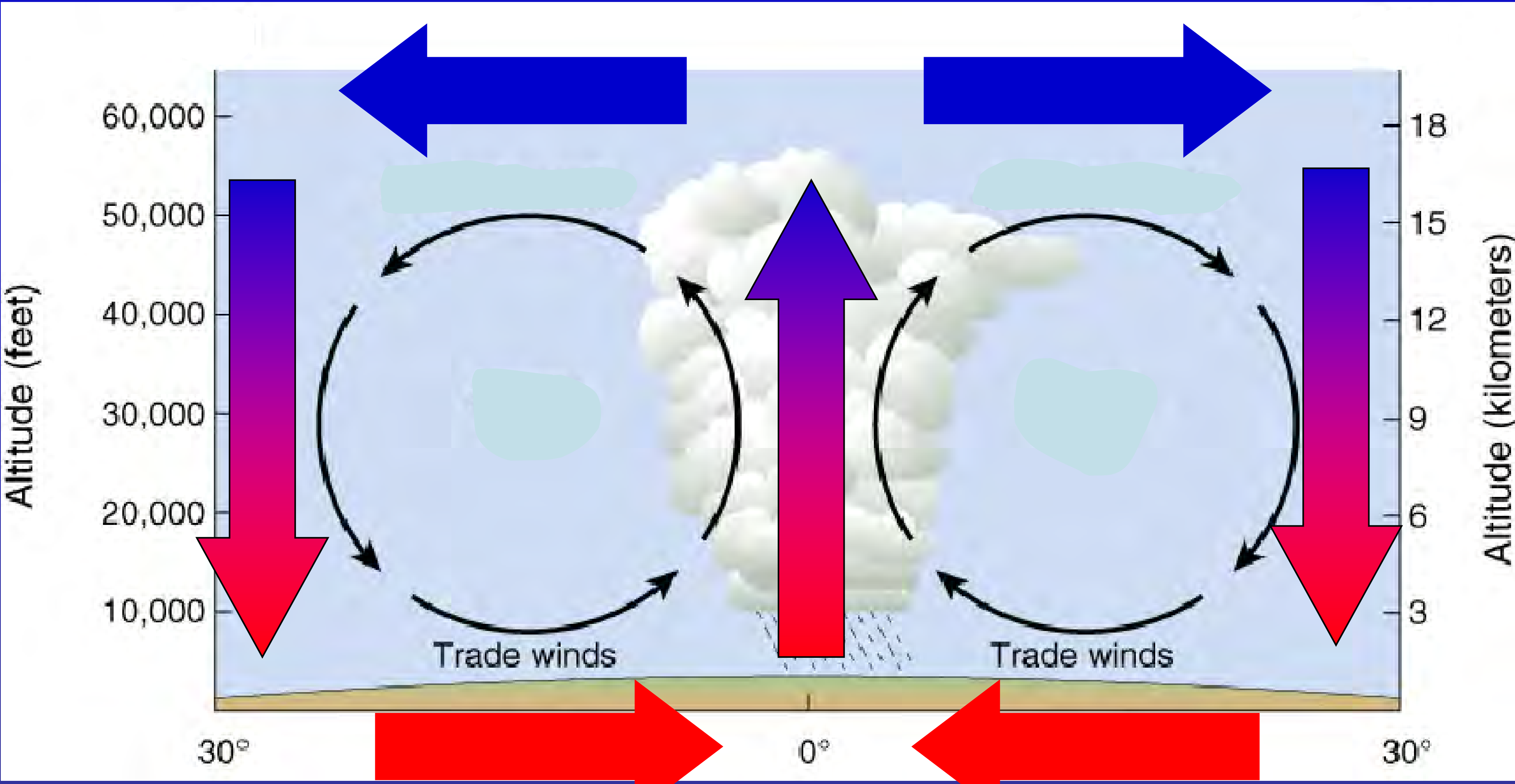
Task 8 & 9

Now watch the following slides explaining how the 3 Cells work and then complete Task 8.

Next complete the more complicated Task 9 in pairs.

Atmospheric Circulation Hadley Cell

Equatorial Low
Pressure



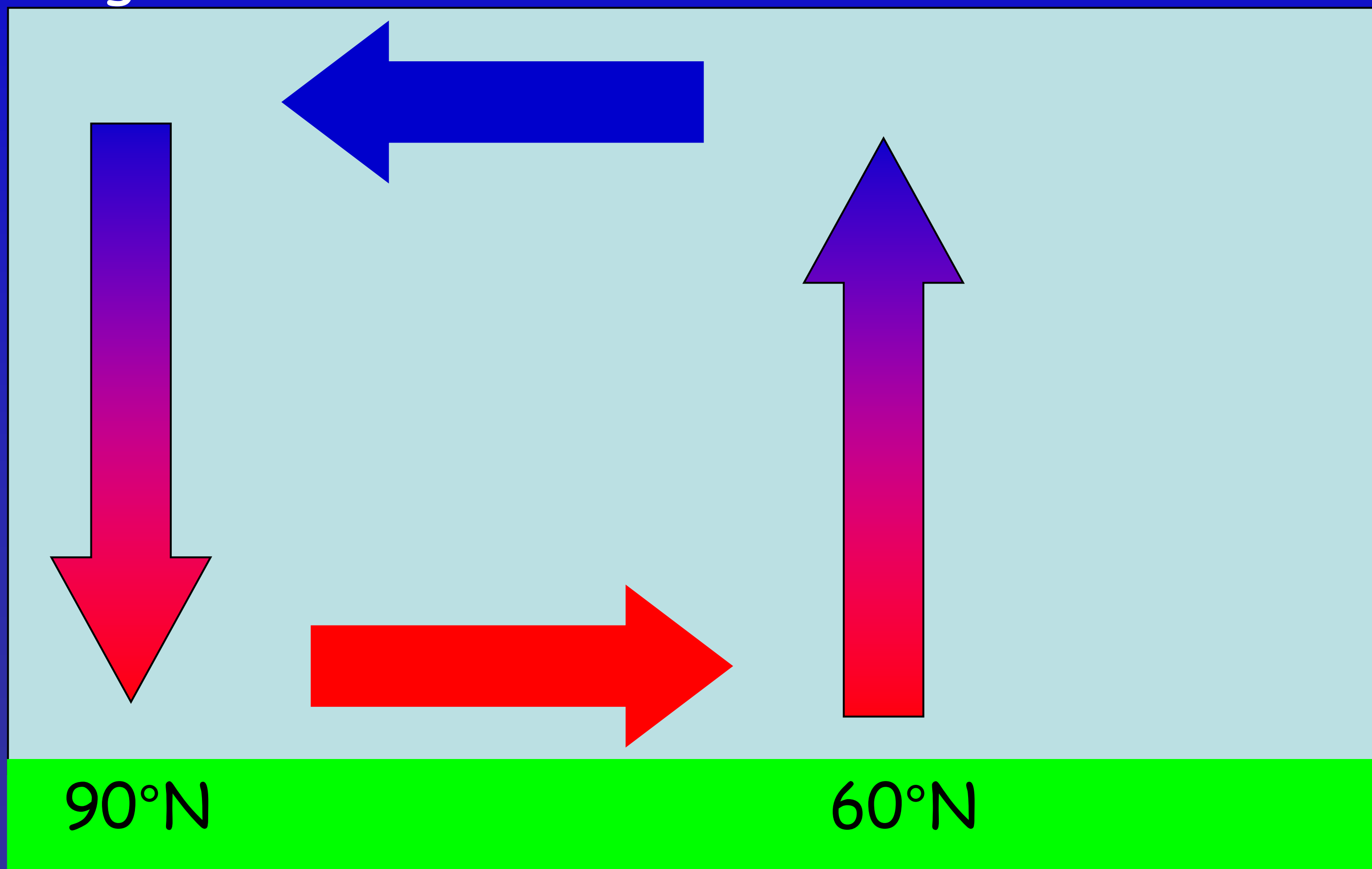
Sub Tropical
High Pressure

Sub Tropical
High Pressure

Atmospheric Circulation Polar Cell

Cool air falls at the poles.
Polar High Pressure

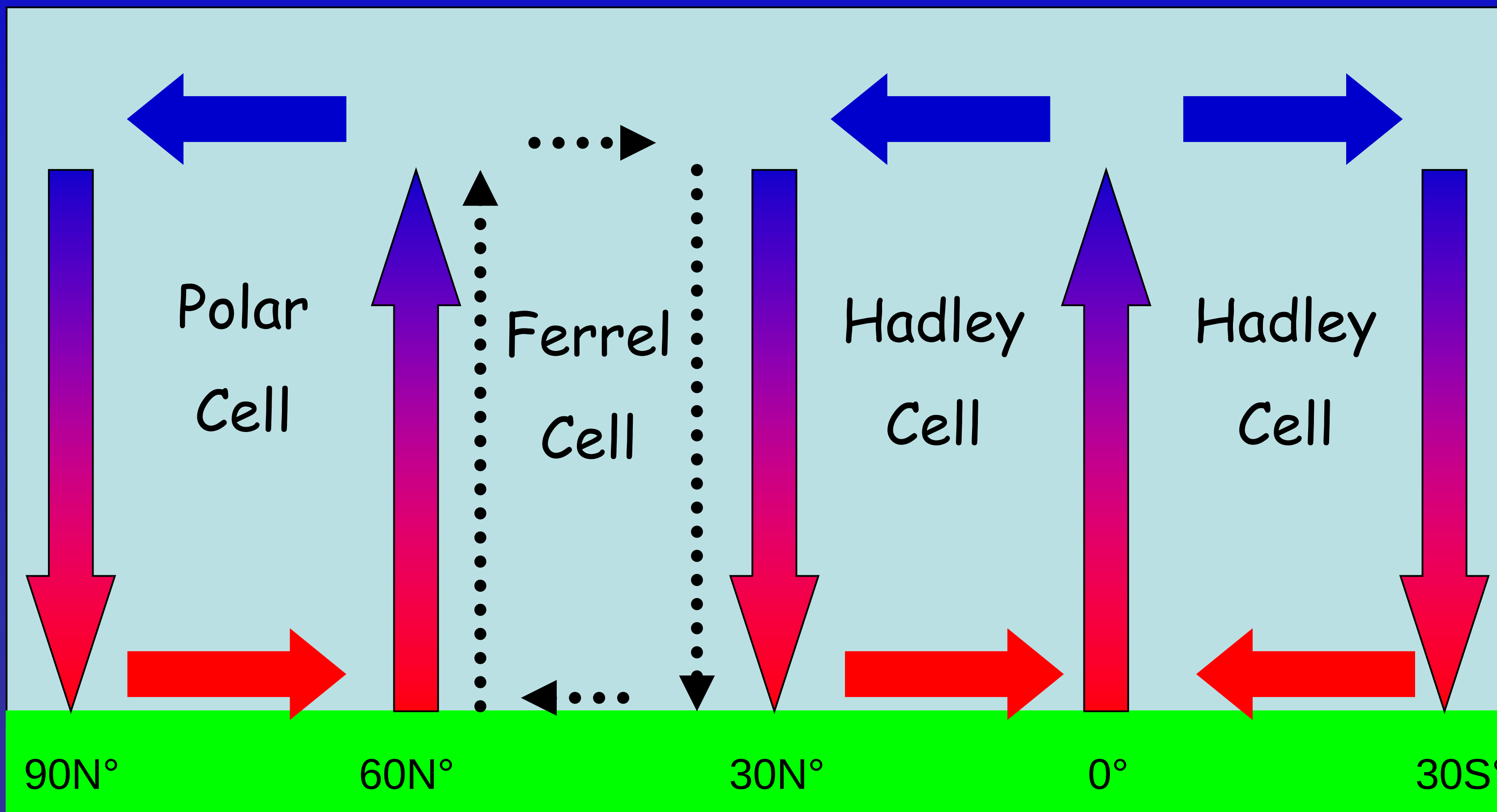
As the air rises
it starts to cool.



The air spreads south,
warmed by the sea and land.

The warm air rises at 60°N.
Temperate Low Pressure.

Atmospheric Circulation Ferrel Cell



Descending cool air from Hadley Cell drags down air with it

Rising warm air from Polar Cell drags up air with it

Air dragged by both cells causes air to circulate, Ferrel Cell, and distribute heat from the equator to the poles.

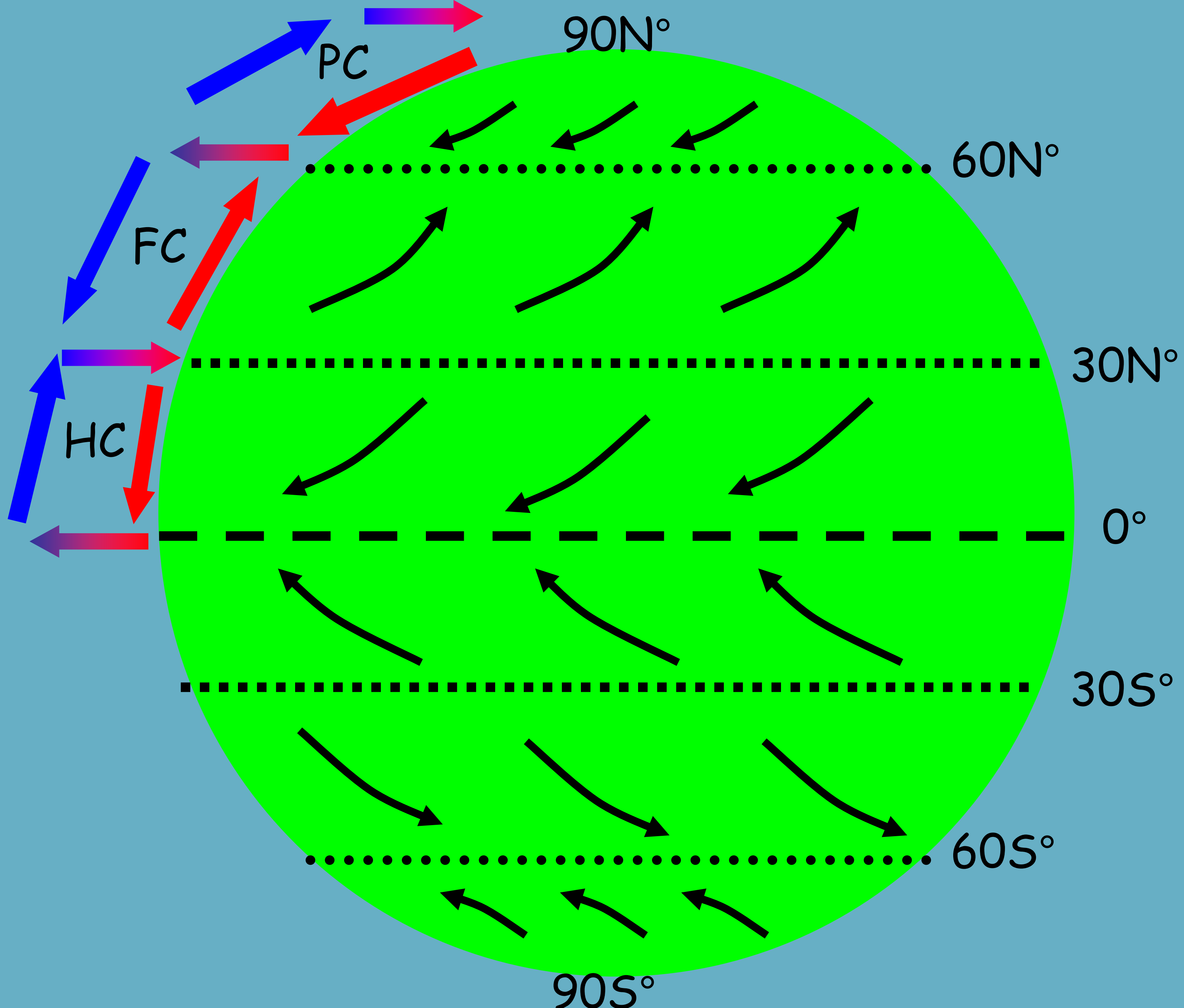
Statements	No.
This circulation of air creates a Ferrell Cell, though this is not a true cell.	12
This circulation of air is known as a Polar Cell.	10
At the poles the air is colder and heavier.	6
As it cools a rainy area of low pressure develops (Tropical Rainforest).	2
As it warms it rises creating an area of low pressure at 60°N or S.	9
The falling air forms an area of high pressure (blue skies) at the pole.	4
At 60°N and S rising winds pull up air and at 30°N & S air is dragged down by falling air.	11
At the equator warm air rises and cools higher up.	1
This circulation of air is known as the Hadley Cell.	5
The air then flows towards 60°N or S warming as it moves.	8
The air continues to cool and this denser air sinks towards the earth at 30°N & S.	3
So air sinks and forms an area of high pressure at 90°N or S.	7

Atmospheric Circulation Winds

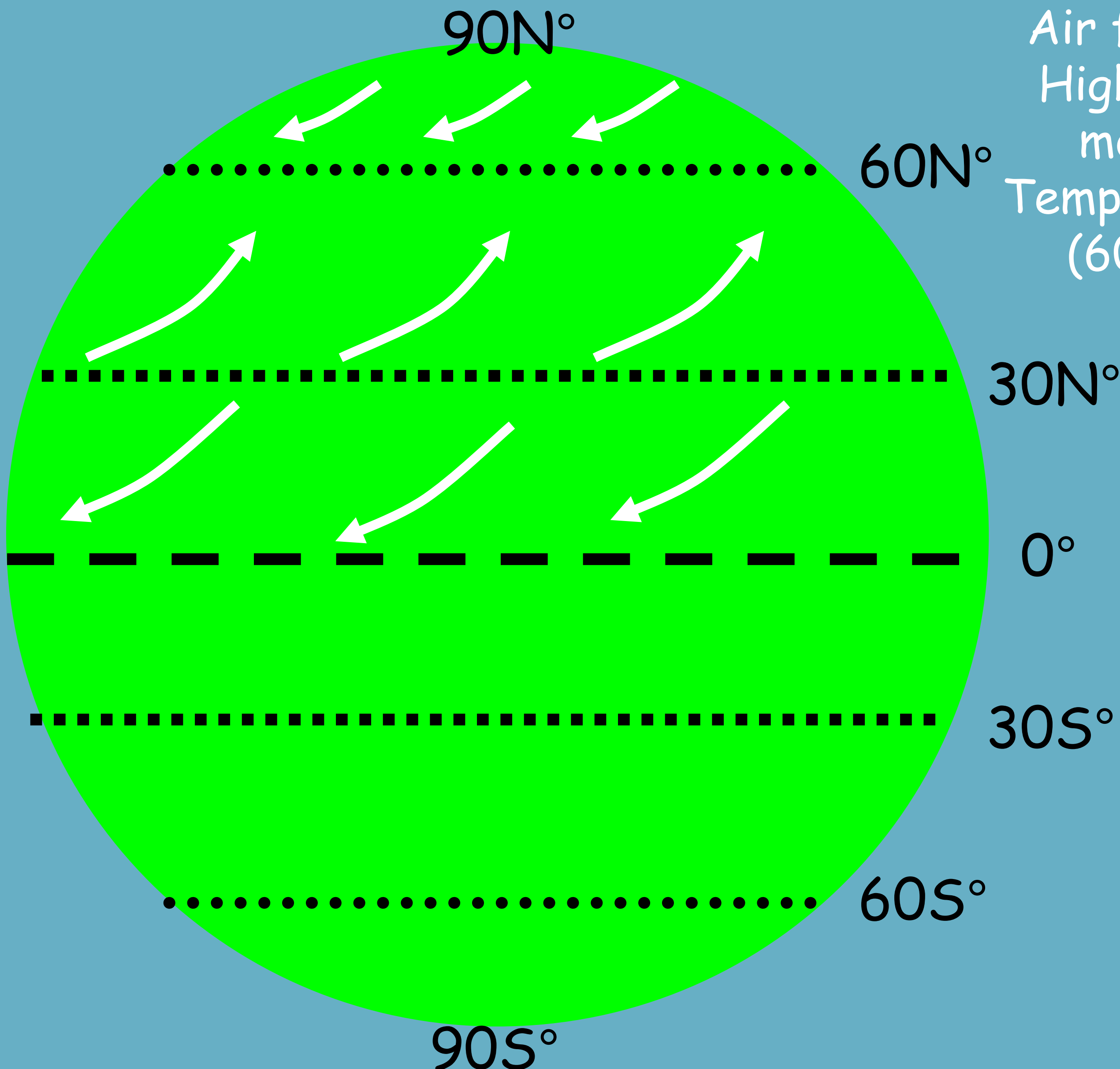
The next slide shows how winds move across the surface of the earth.

A **Key Principle** is that these winds move from areas of high pressure to low pressure.

Complete the diagram showing surface winds in your workbook.



90N°
PC
60N°
FC
30N°
HC
0°
30S°
60S°
90S°



Air falling at the Polar High Pressure (90°N) move towards the Temperate Low Pressure (60°N) called Polar Easterlies.

Falling air at the Sub Tropical High Pressure (30°N) moves towards the Temperate Low Pressure (60°N) called the Westerlies.

Falling air at the Sub Tropical High Pressure (30°N) also moves towards the Equatorial Low Pressure (0°) called the North East Trade Winds.

Where air rises at the Equatorial Low Pressure there are light wind called the Doldrums.

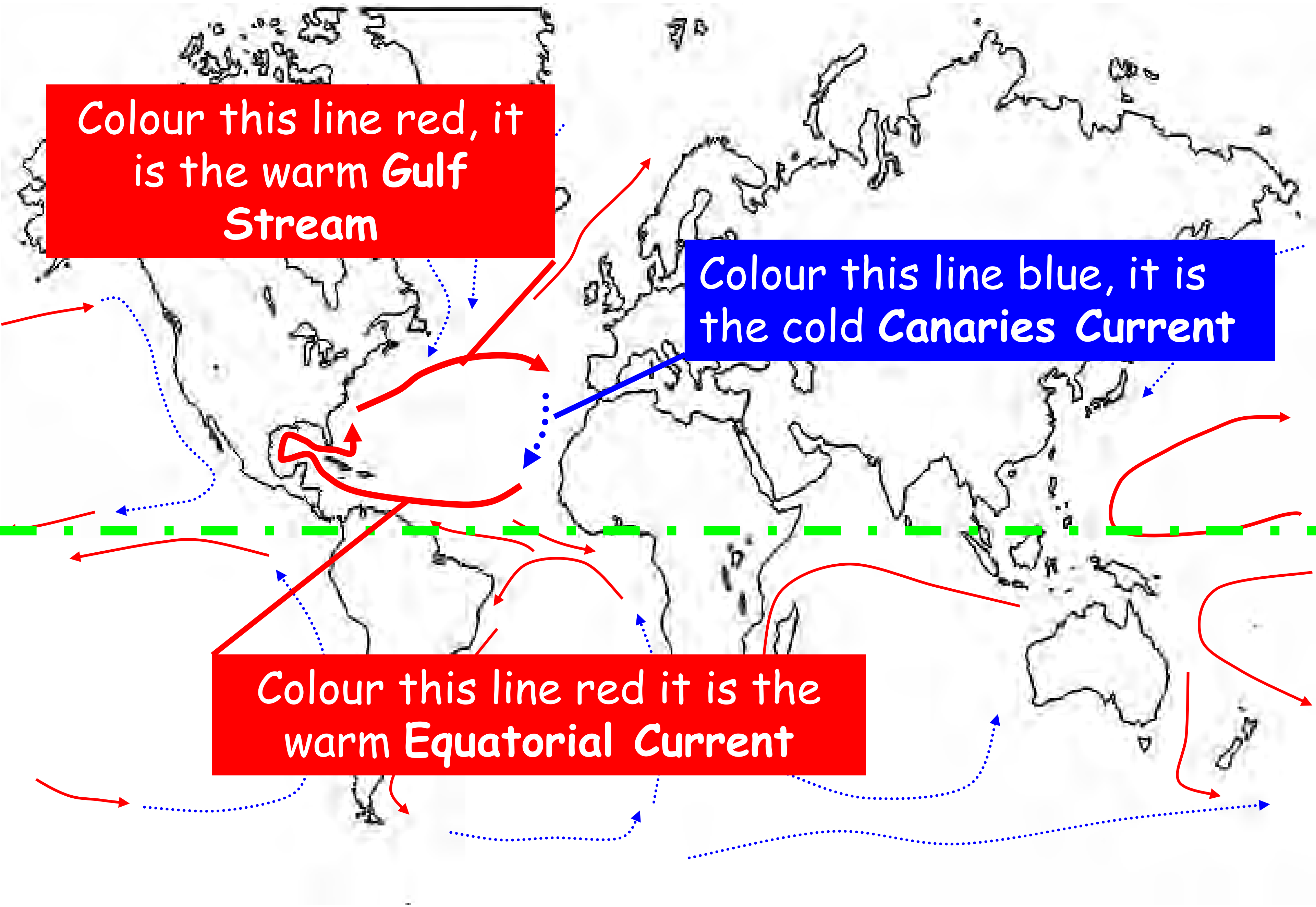
Ocean Currents

Ocean currents like Cells and wind redistribute energy. Heat is taken from the tropics and moved towards the pole.

For the exam you will have to describe the movement of these current and be able to explain why they move the way they do.

Ocean Currents

Now complete the diagram for Task 12 in your workbook using the Power Point.


Colour this line red, it is the warm Gulf Stream
Colour this line blue, it is the cold Canaries Current
Colour this line red it is the warm Equatorial Current

Ocean Currents Description

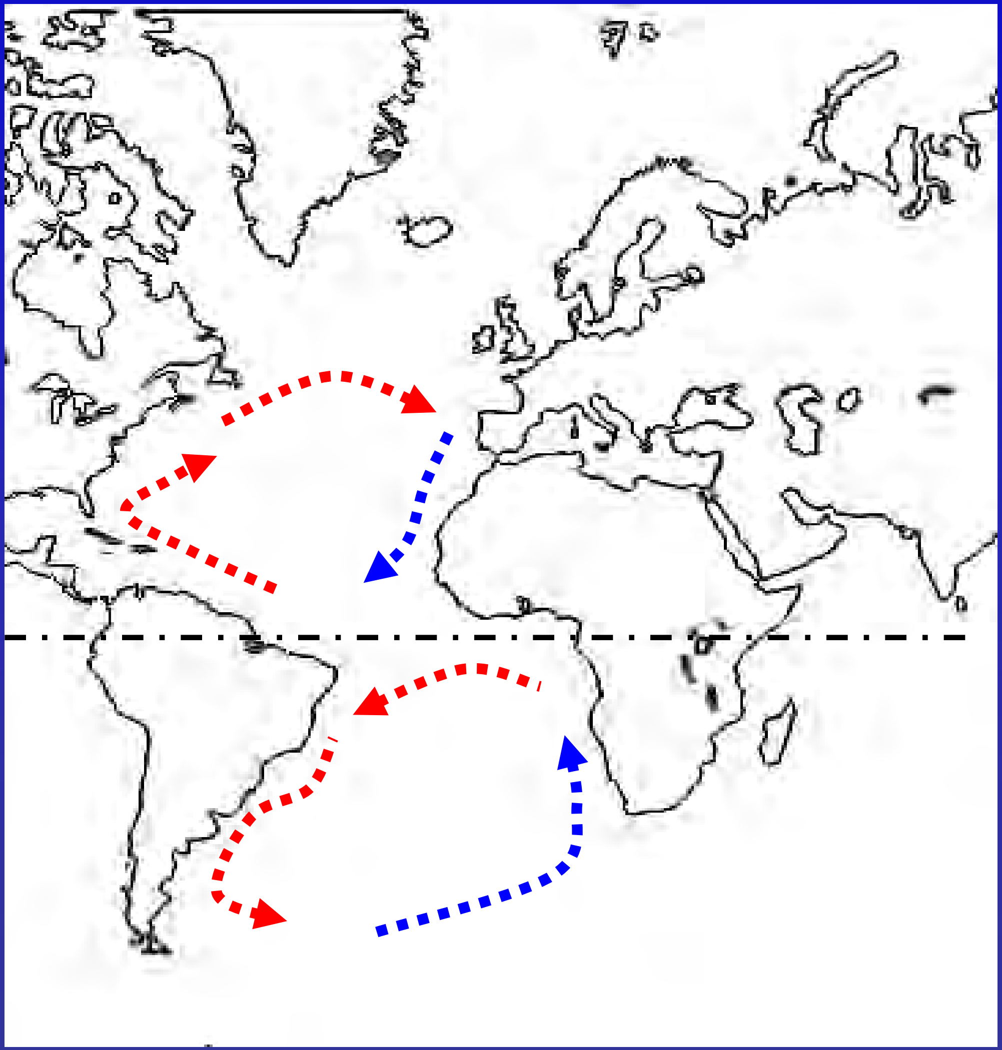
Task 13

Answer questions 1 to 7 with the aid of the Power Point & your teacher.

Ocean Currents Description

These currents form in warm equatorial areas and cold polar areas.

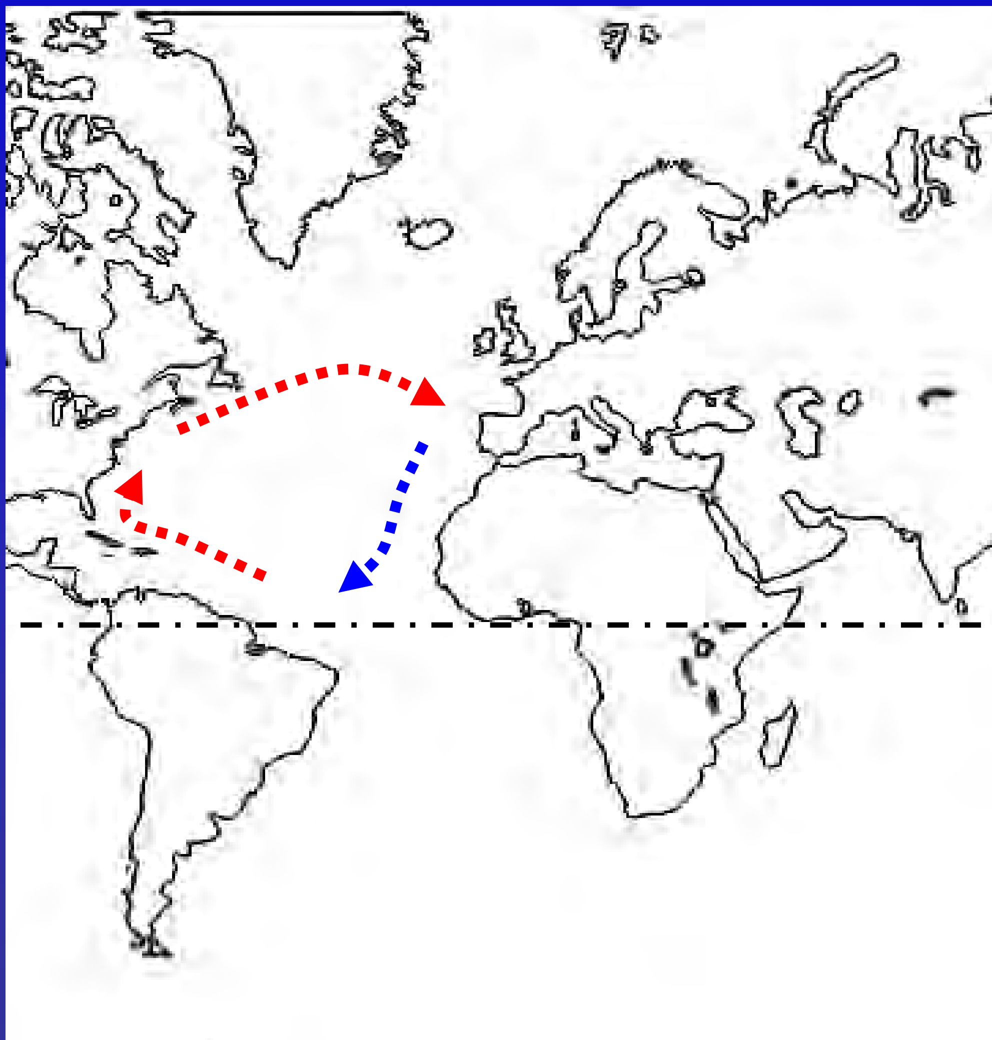
In the South the currents flow in an anticlockwis e direction.



The currents of the oceans circulate in large loops called gyres.

In the North the currents flow in a clockwise direction.

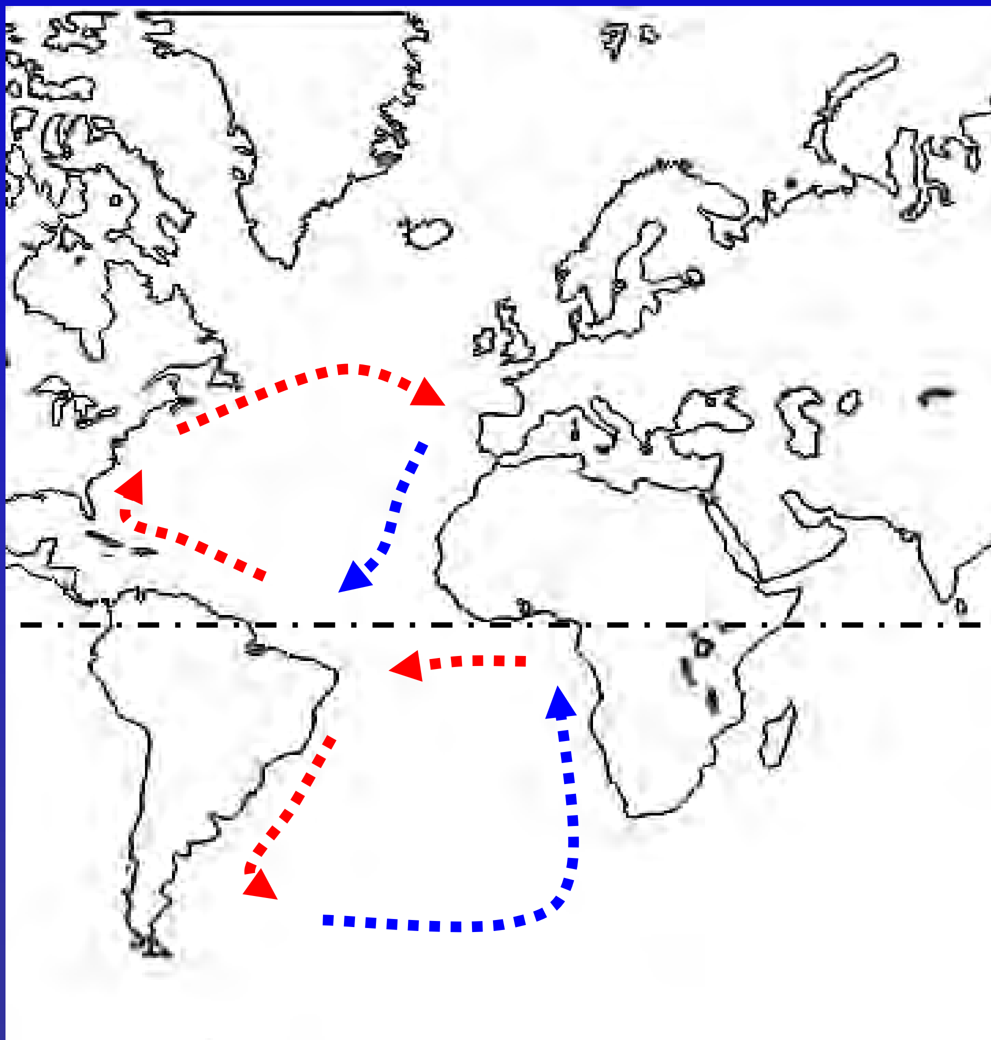
Ocean Currents Description



In the North Atlantic a warm current from the equator heads towards the Caribbean, North Equatorial Current, and then in a North Easterly direction towards Europe, the Gulf Stream Current.

The current starts to flow south down the African coast to the equator, the Canaries Current, but by now is much cooler. The cycle then starts to repeat itself.

Ocean Currents Description

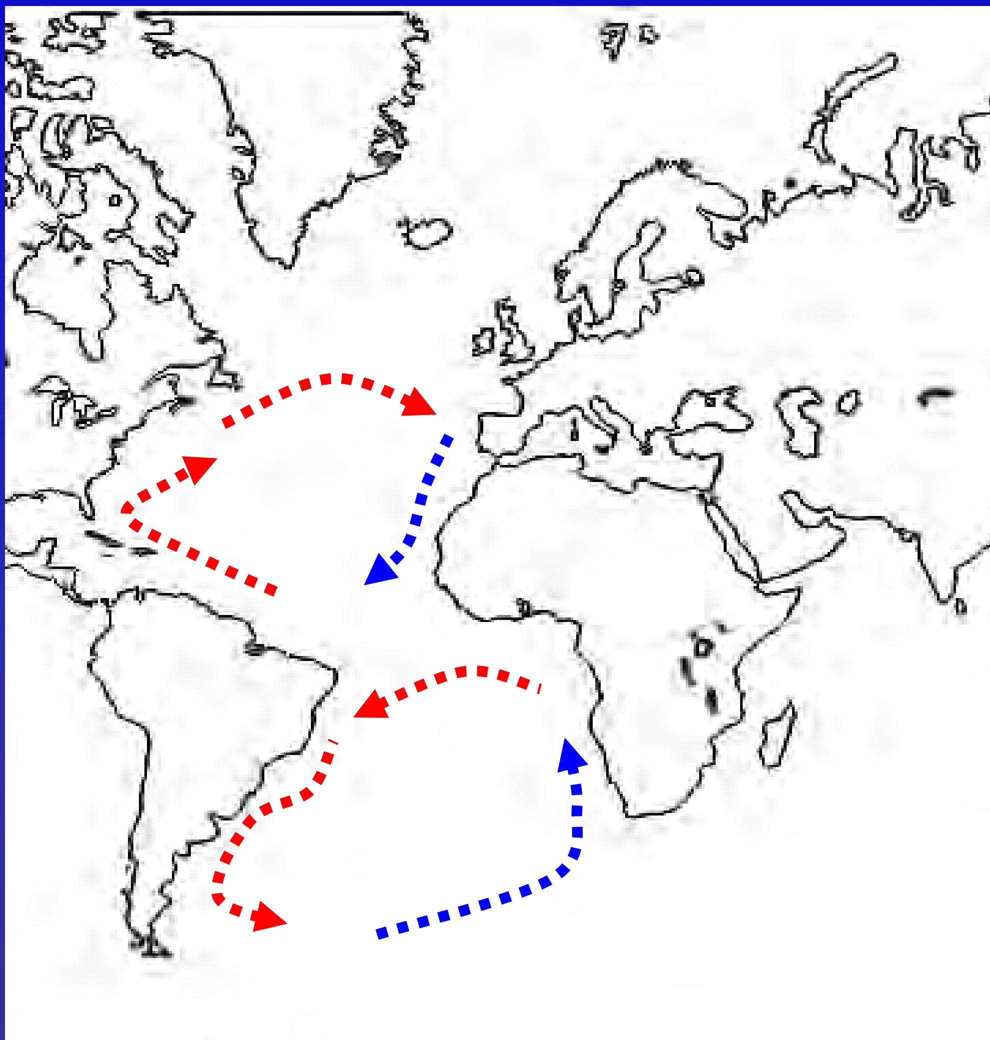


Some of the warm current from the equator, South Equatorial Current, starts to flow South West to the Brazilian coast, Brazilian Current, cooling as it travels South.

The distribution of heat can actually be seen in a figure of 8 pattern as the two gyres in the Atlantic meet at the equator.

The current then turns Easterly towards South Africa and flows up its Western coast, the Benguela Current. The current starts to warm up again as it moves up the African coast where it rejoins the warm South Equatorial Current.

Ocean Currents Explanation

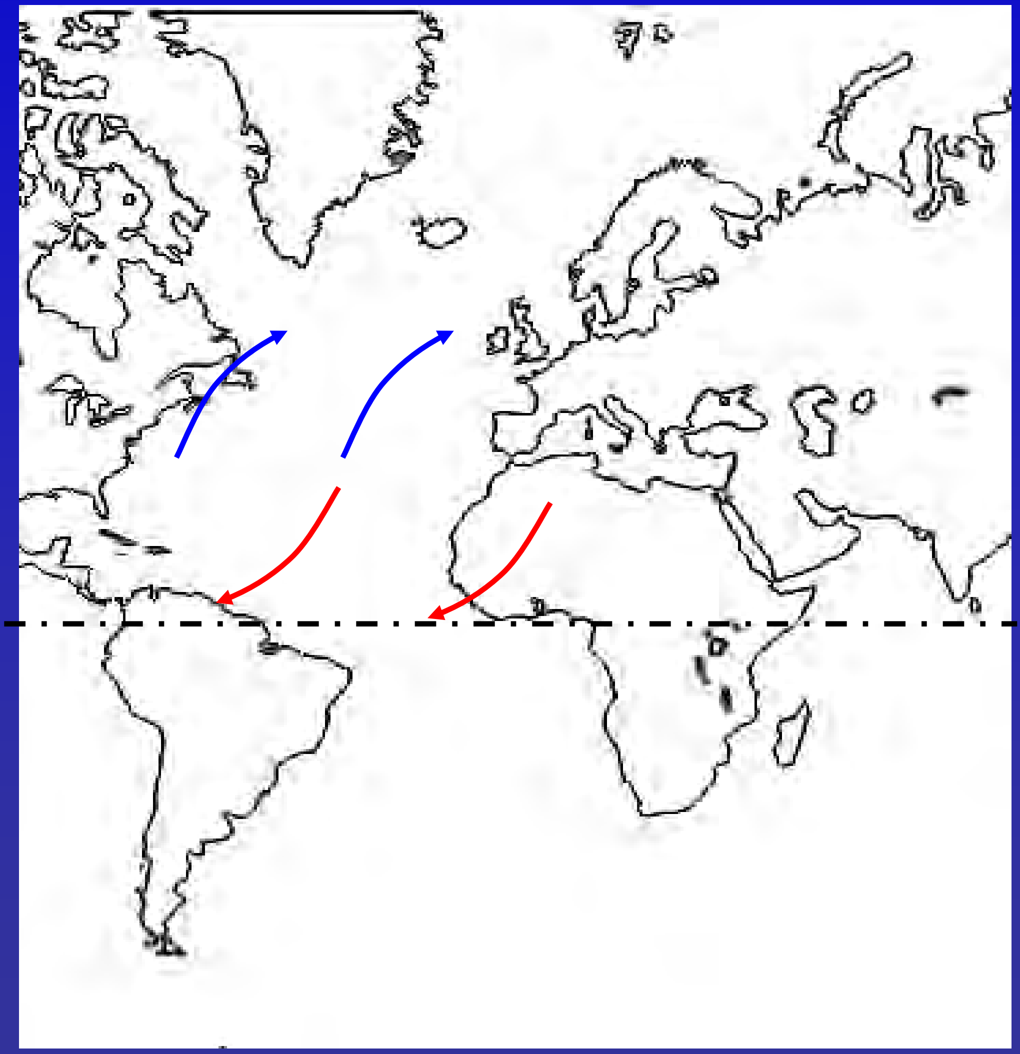


When explaining how these currents circulate there are 4 key points to make as well as one explaining temperature chnages;

For Task 14 you will split into groups to find out about these key points, reporting back to each other what you find.

1. Wind
2. Coriolis effect
3. Position Of Continents
4. Convection Currents
5. You also need to know why the currents warm or cool

Ocean Currents Explanation



Prevailing Winds

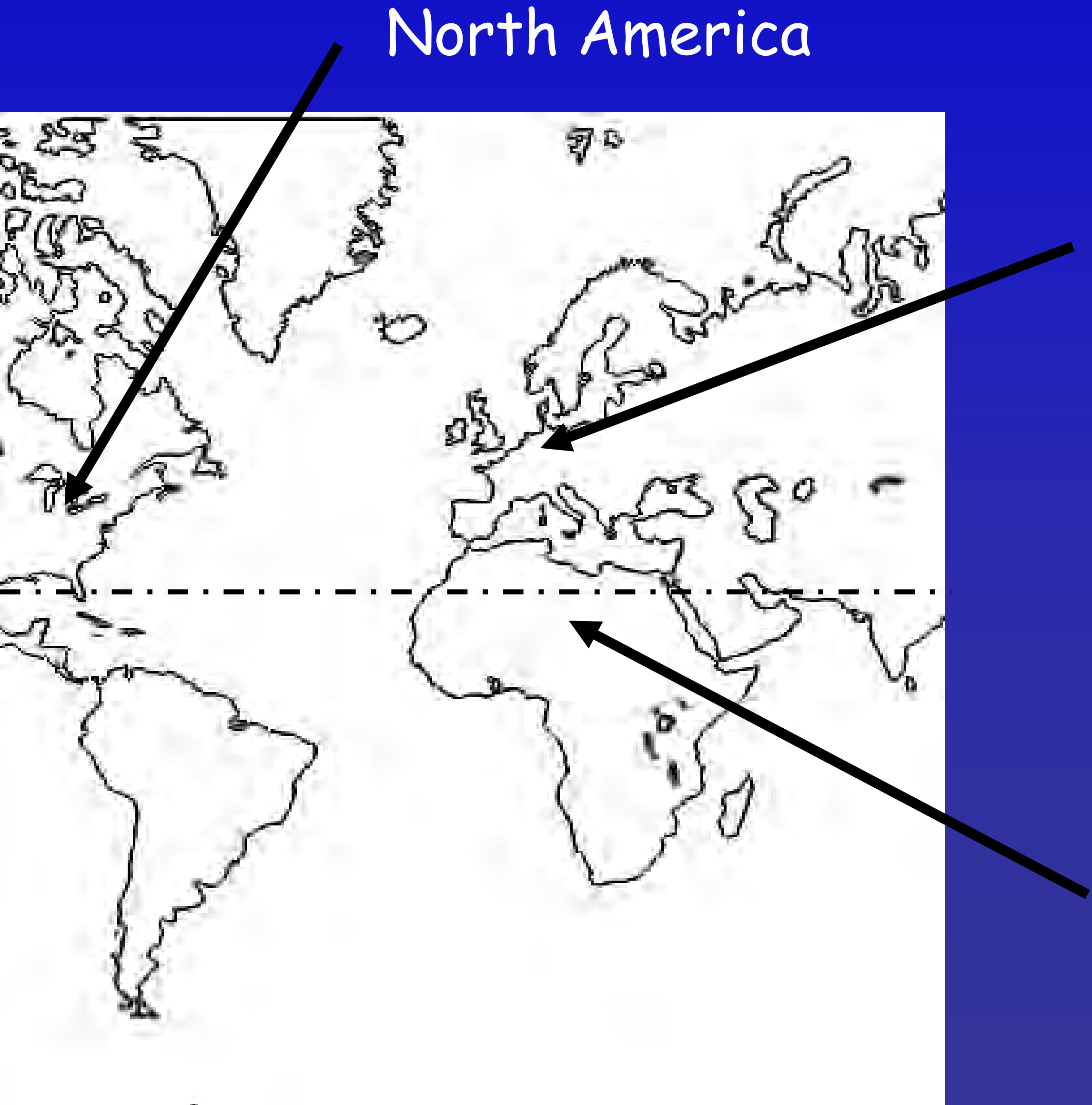
The Trade winds and the Westerlies drive the ocean currents in a clockwise direction

Ocean Currents Explanation

Coriolis Effect

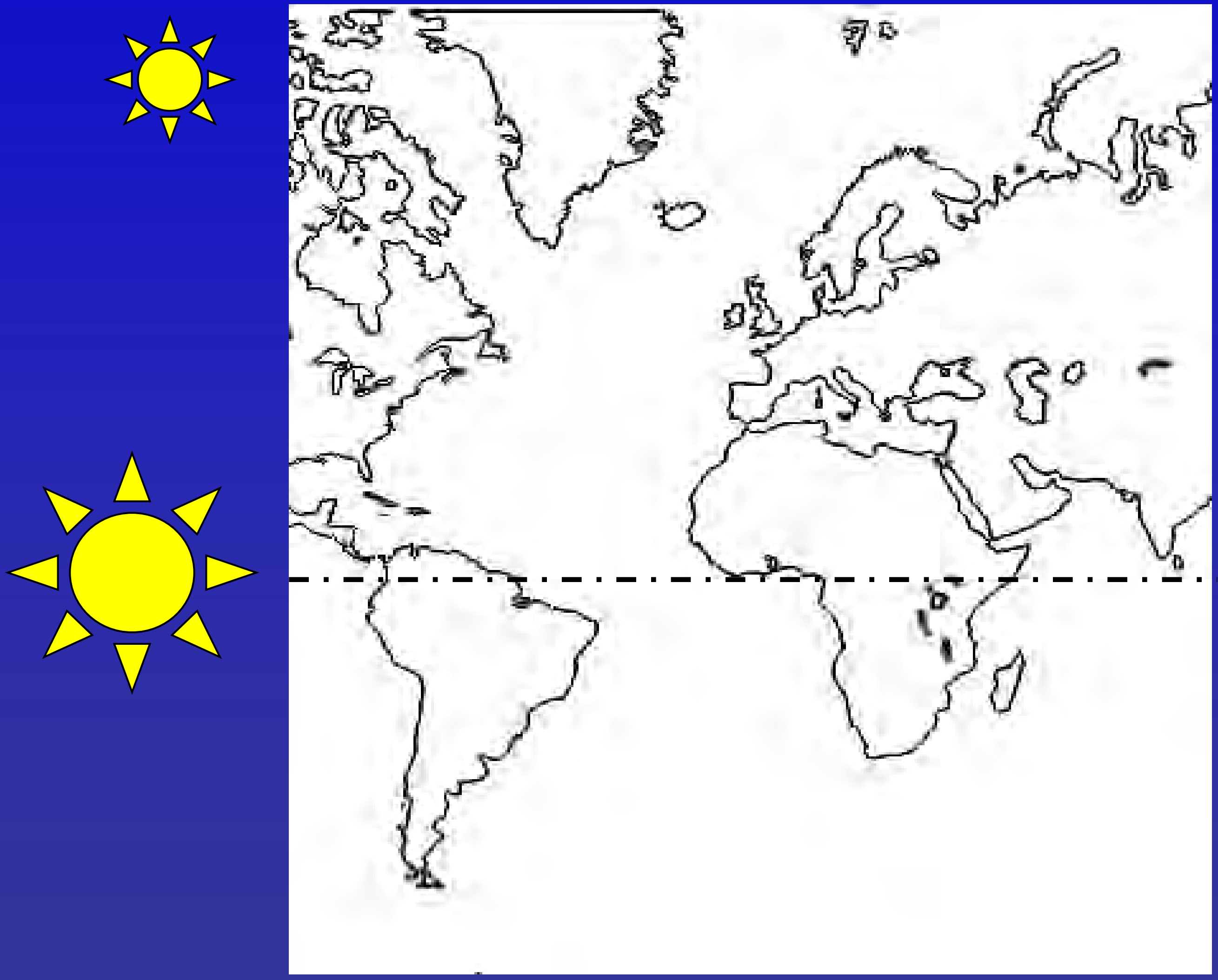
The West to East rotation of the earth helps drive the ocean currents in a clockwise direction

Ocean Currents Explanation



The continents deflect currents into a clockwise movement

Ocean Currents Explanation



More insolation received at the equator than the poles resulting in convection currents and mixing of warm and cold currents

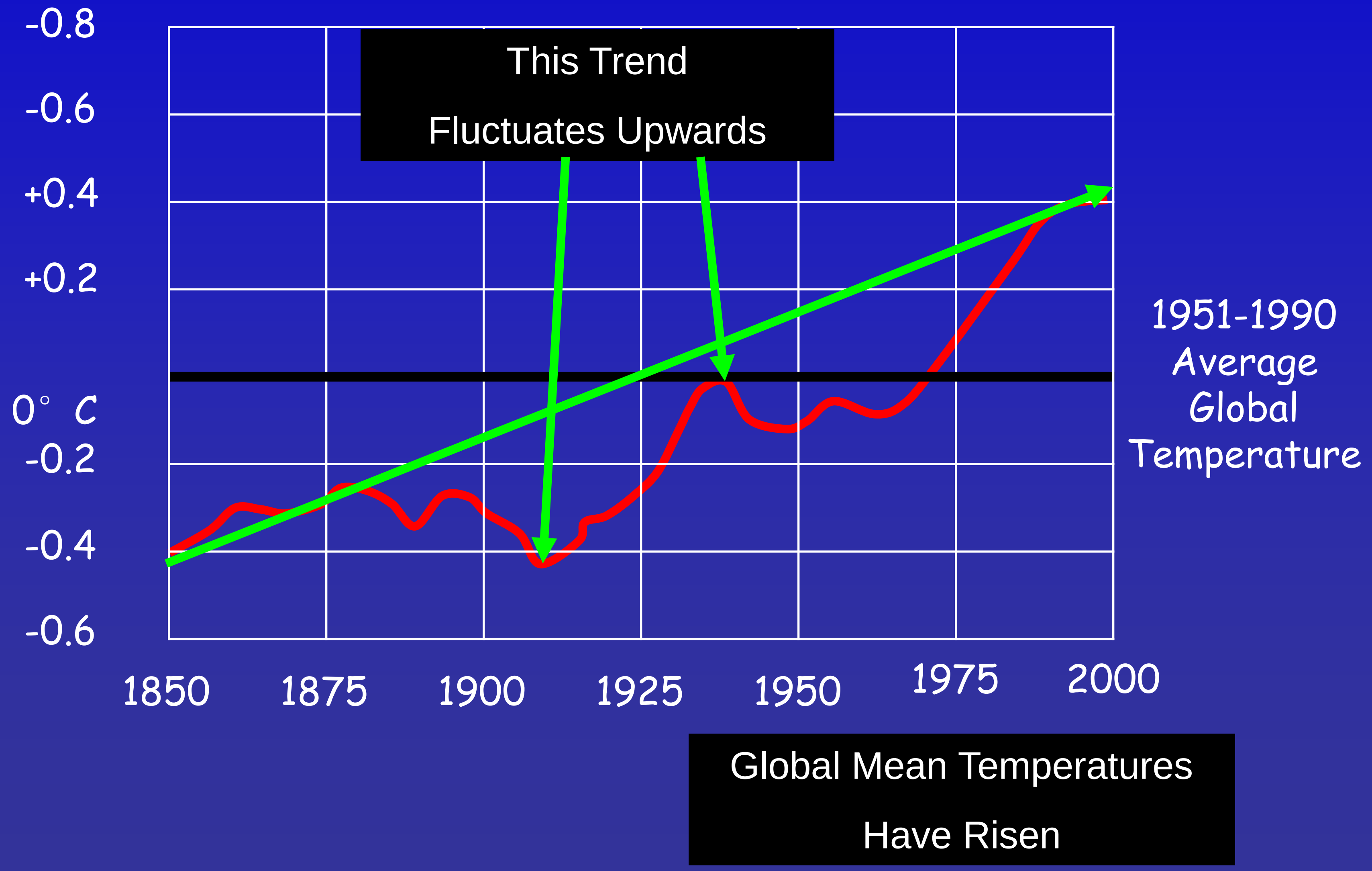
Changes In Global Temperatures

To describe a graph showing global average temperatures you should;

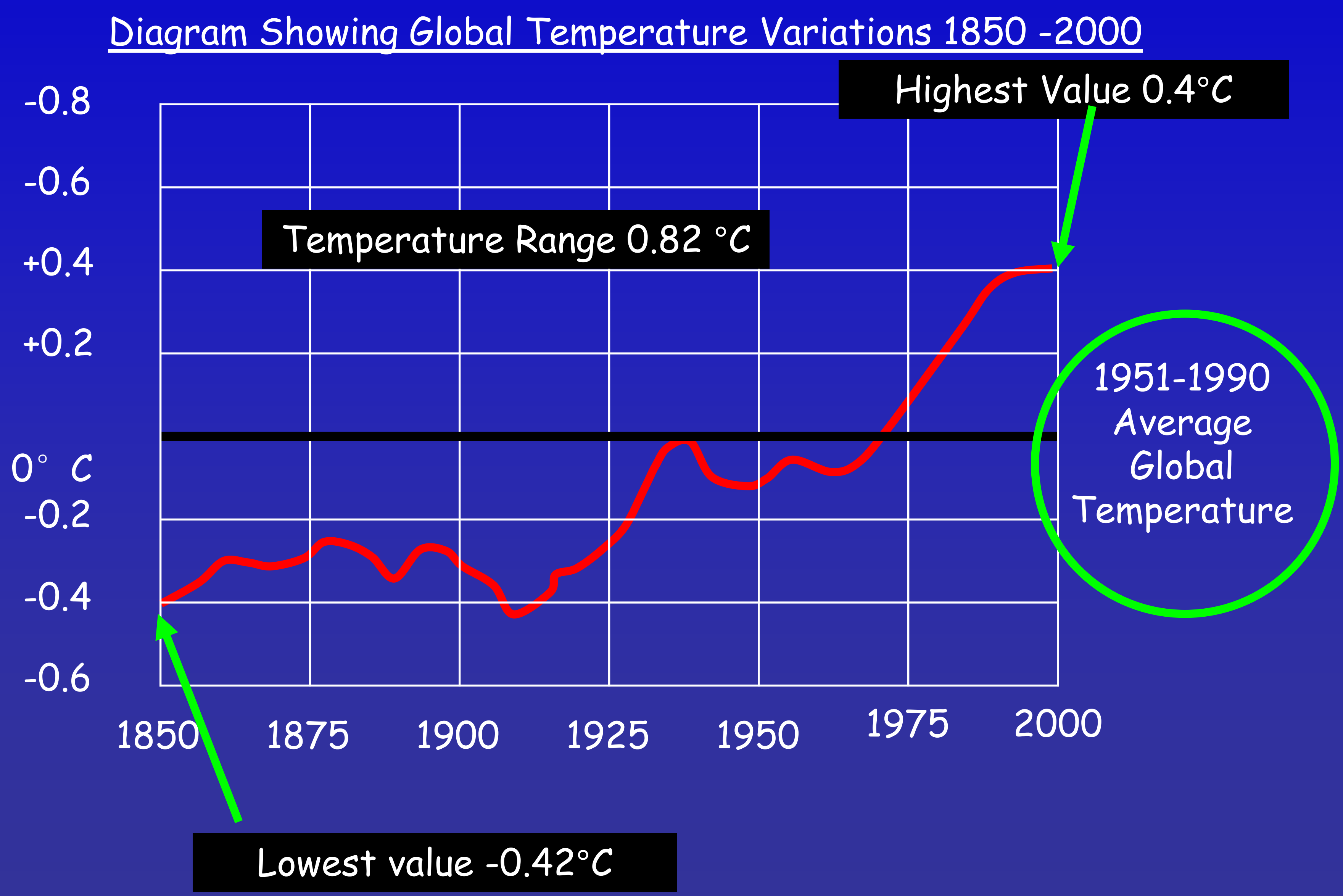
1) Mention the overall trend – is it rising/falling etc?
2) State which figure the temperature varies from – mean etc.
3) Note any minor trends; above/below average; when they occured?
4) Describe the high & low values giving a range.
5) Note how quick or slow changes is looking at steepness of line.

Changes In Global Temperatures

Diagram Showing Global Temperature Variations 1850 -2000

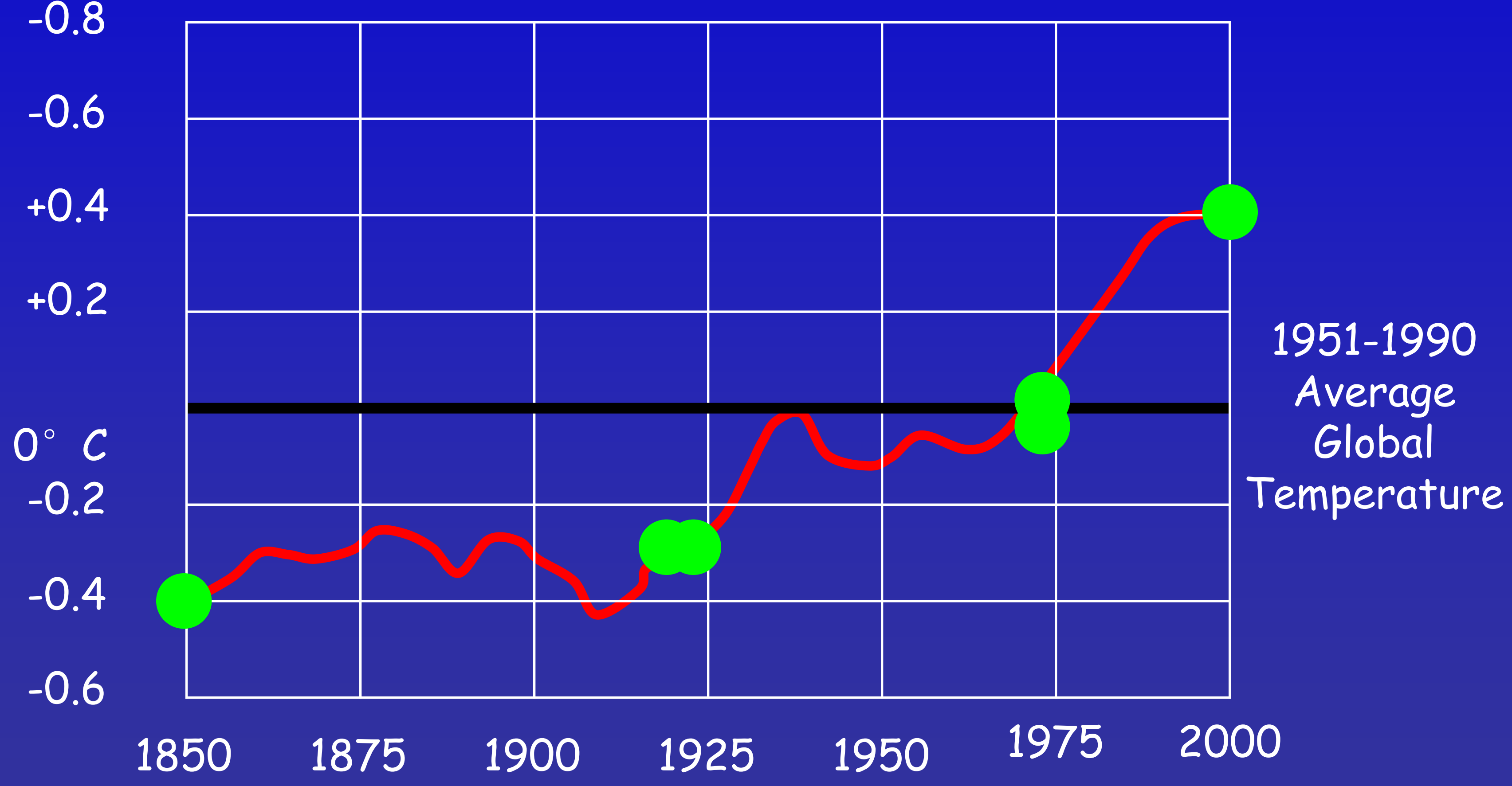


Changes In Global Temperatures



Changes In Global Temperatures

Diagram Showing Global Temperature Variations 1850 -2000



-0.4 to – 0.3°C Below Temperature 1850

Rapidly Increasing Temperature Above Average 1975 - 2000

w Average
20 - 1975

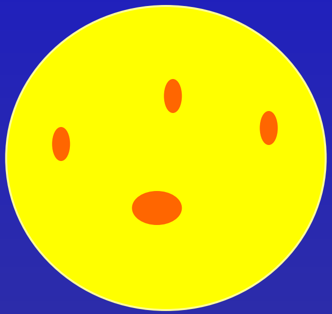
Changes In Global Temperatures

The overall trend is that the Global mean temperature has ~~fallen/stabilised~~/risen between 1850 & 2000, this has been a ~~steady~~/fluctuating trend. The temperature varies around the 1951-1990 average/~~long term average~~. The lowest value was -0.42/-~~0.38~~ ° C and the highest

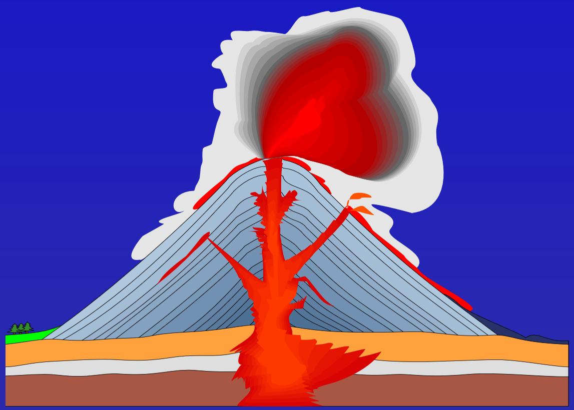
+0.4 ° C giving a range of ~~-0.2/+0.2/0.78~~/0.82 ° C. There was a period with below average temperatures of around -0.4° C to -0.3° C between 1850 & 1920/~~1850 & 1950/1940 & 2000~~. There was a period around -0.2° C to -0.1° C below the average between 1920 & 1940/~~1920 & 1975~~. A period of ~~slow/moderate~~/rapid increase took place between 1940& 2000/1975 & 2000.

Changes In Global Temperatures

Physical Factors



Sunspot activity sends more insolation to the earth

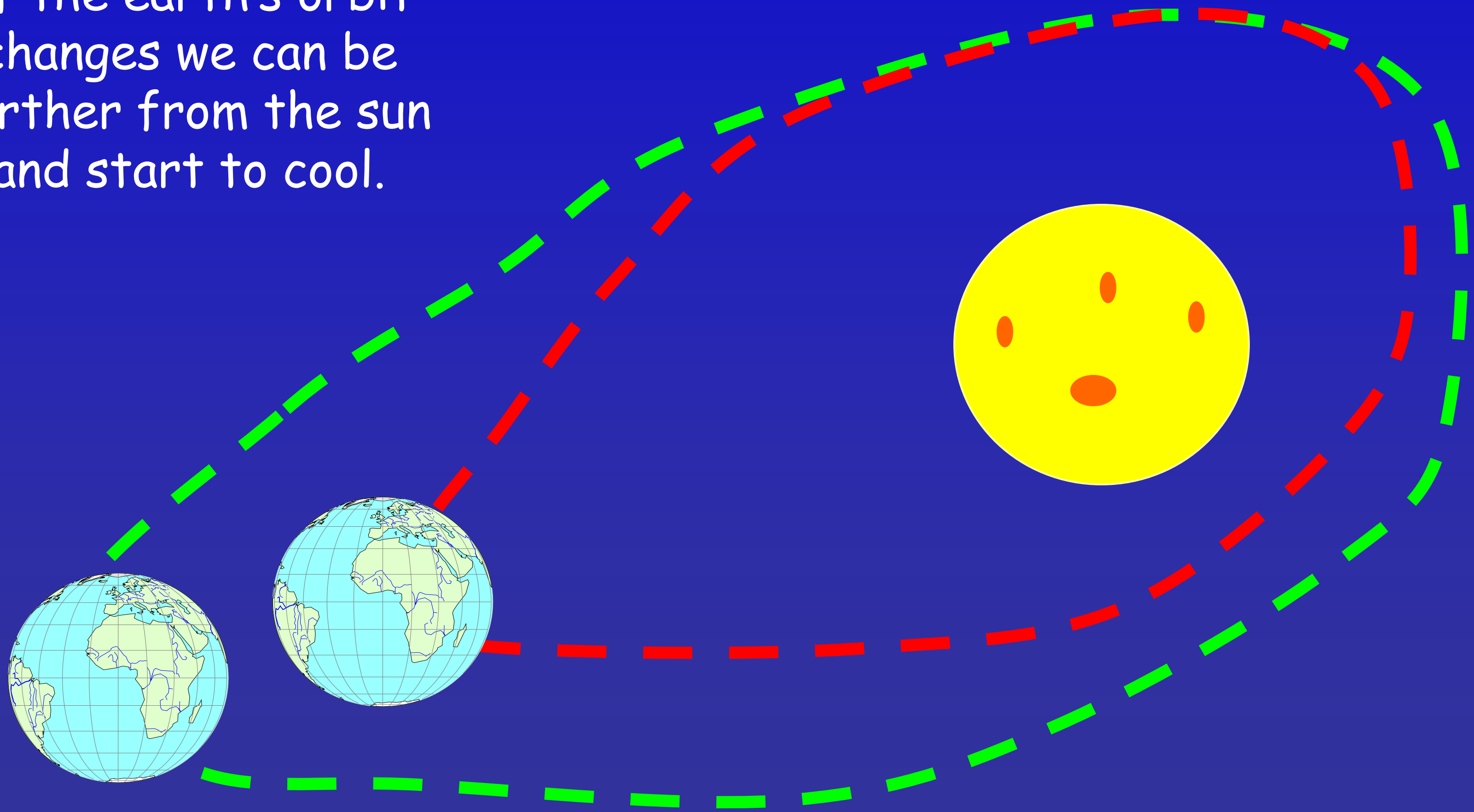


Dust from volcanoes reflects away insolation

Changes In Global Temperatures

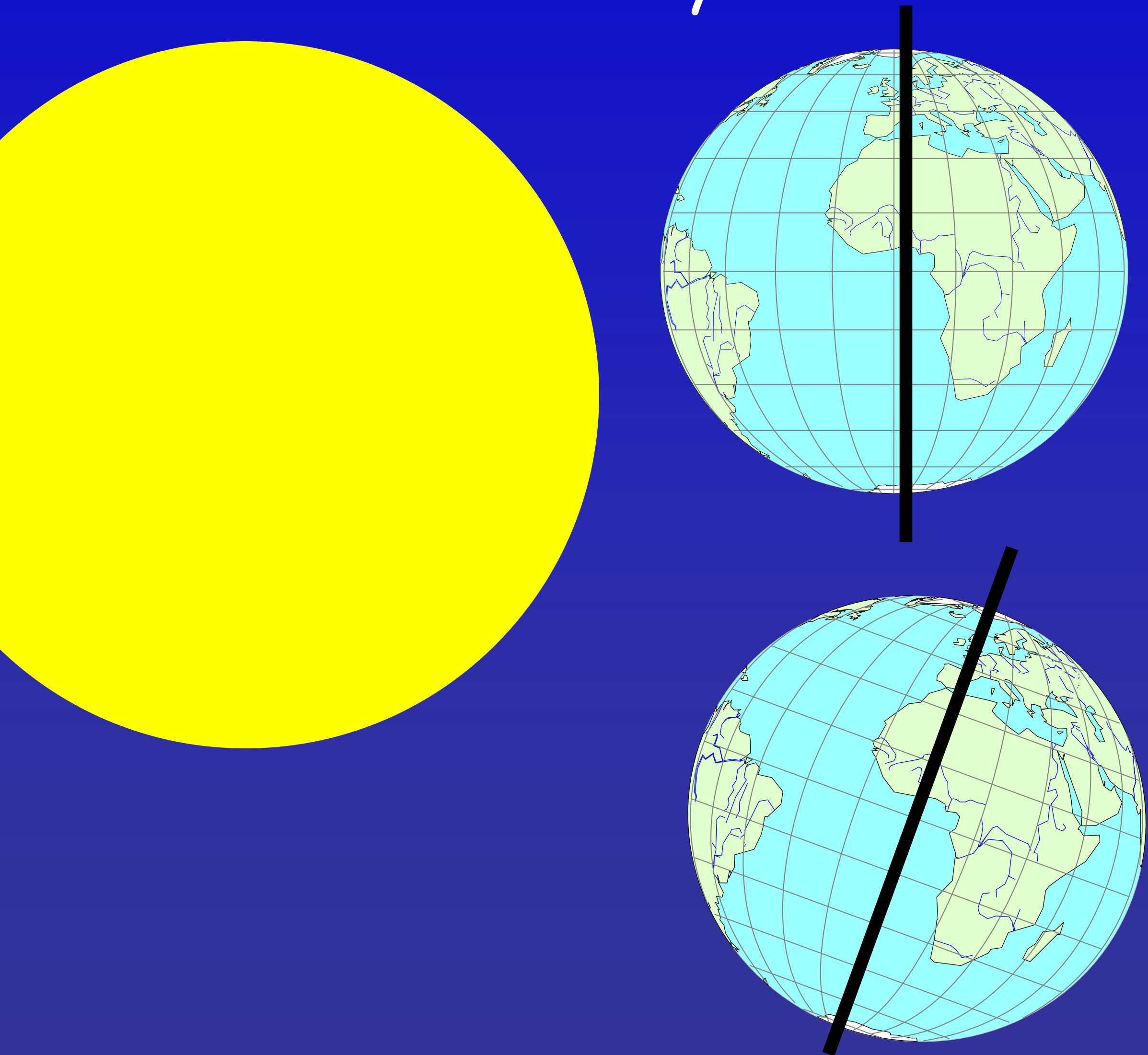
Physical Factors

If the earth's orbit changes we can be further from the sun and start to cool.



Changes In Global Temperatures

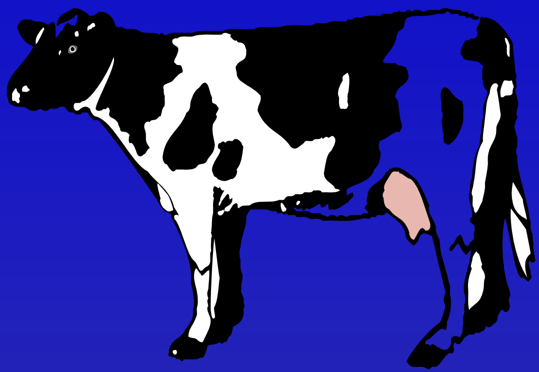
Physical Factors



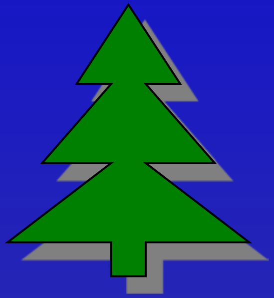
If the earth tilts away from the sun the Northern Hemisphere will cool

Changes In Global Temperatures

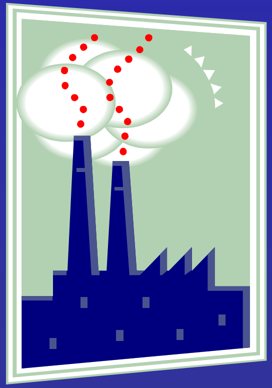
Human Factors

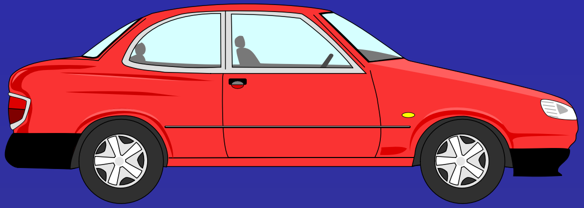


CO_2 absorbs heat and reradiates heating up the earth.



Deforestation adds CO2 when trees burnt and less CO2 converted into water by trees.





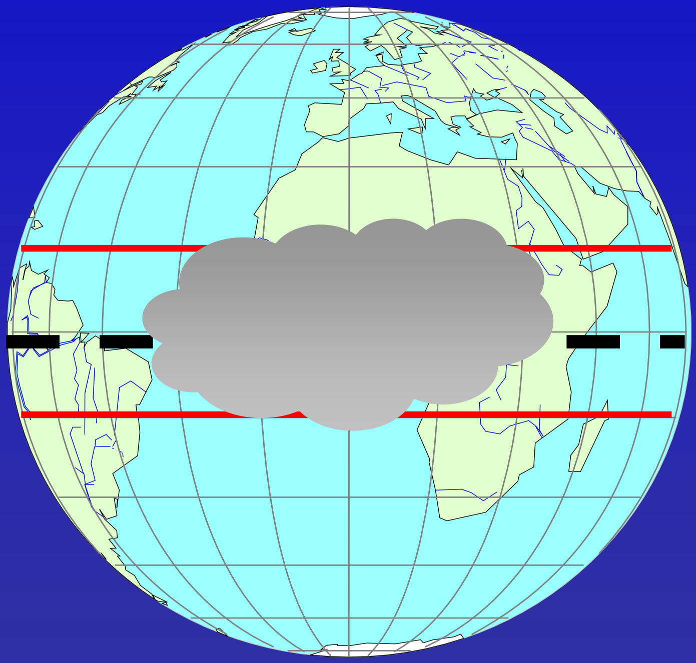
Methane, Nitrous Oxides & CFC emissions do the same as CO_2.

Inter Tropical Convergence Zone (ITCZ)

Inter Tropical — between the tropics of Cancer & Capricorn.

Convergence — where two or more things meets

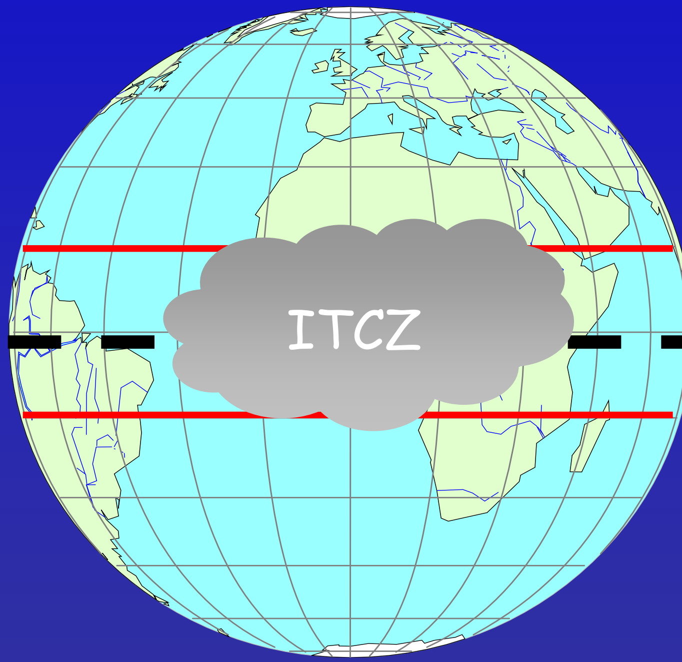
Zone — an area



Task 16

ITCZ Task 16

The ITCZ is an area between the two tropics where two different air masses meet giving rain.



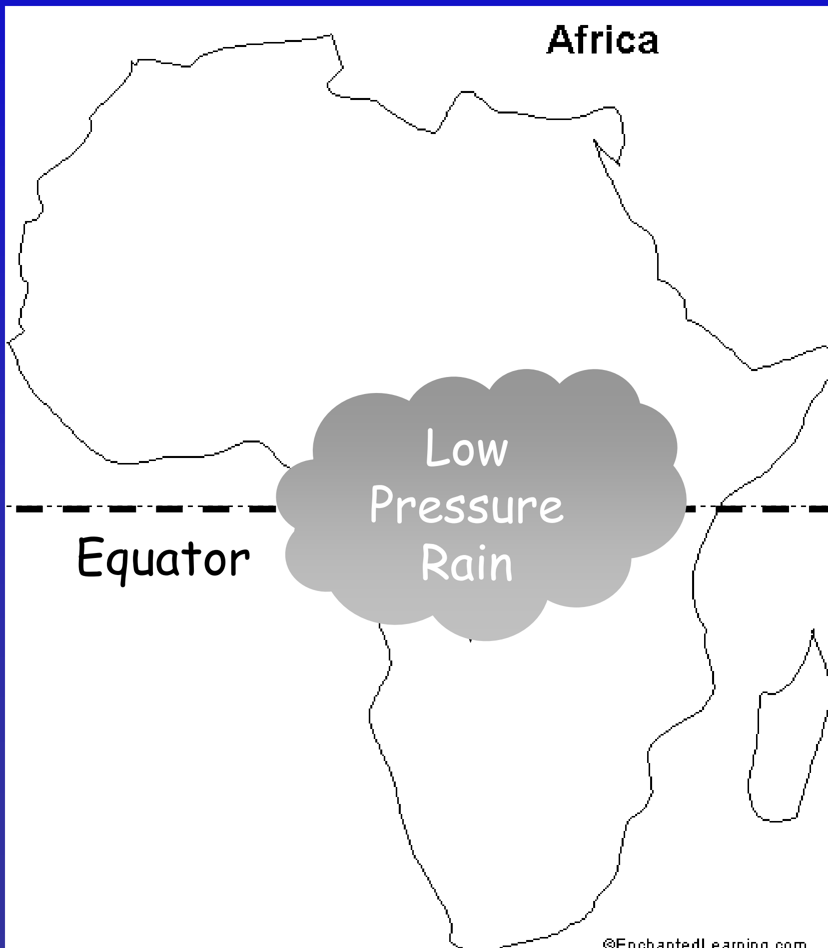
It moves throughout the year as the earth's tilt changes.

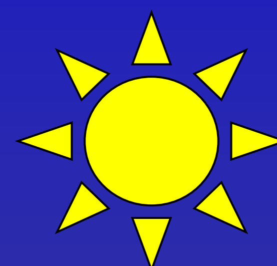
ITCZ Task 16

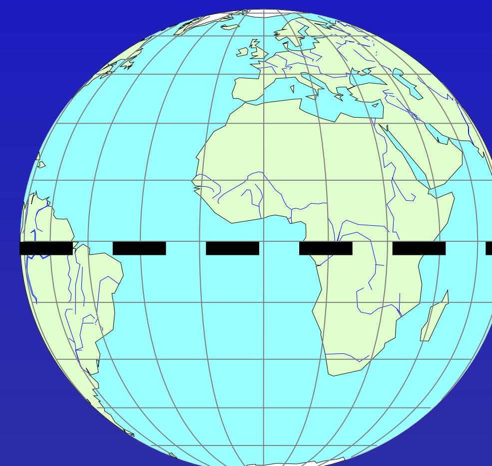
At the Spring Equinox
21st March

When is the sun overhead
the equator?

At the Autumn Equinox
23rd September

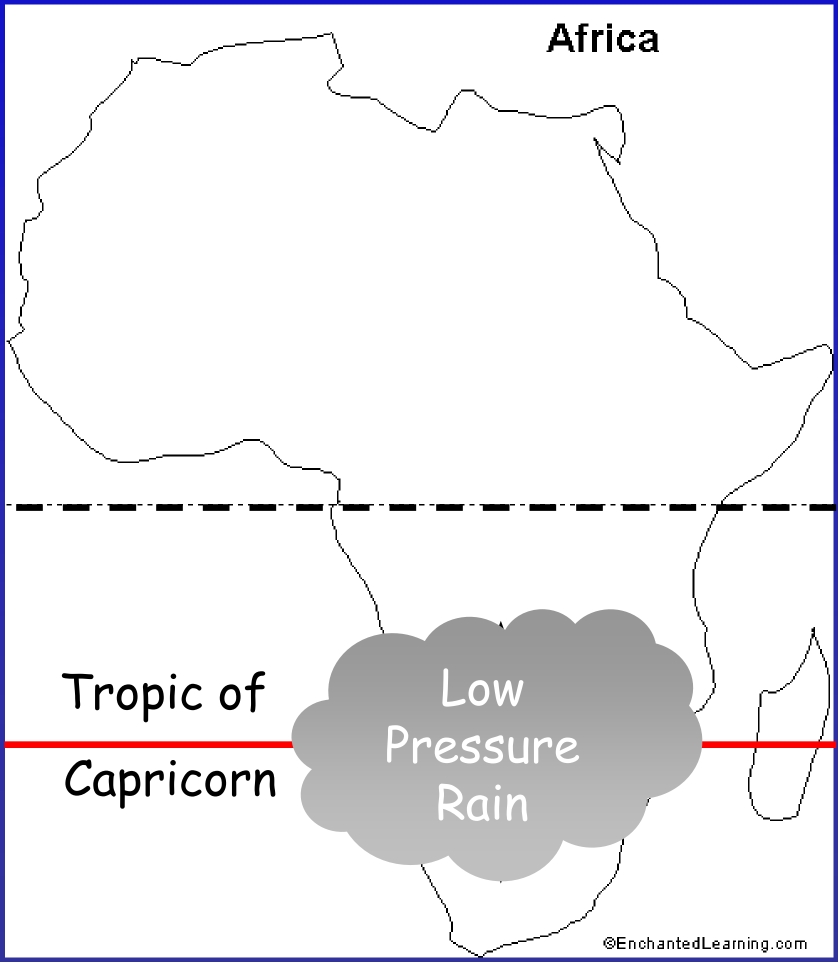






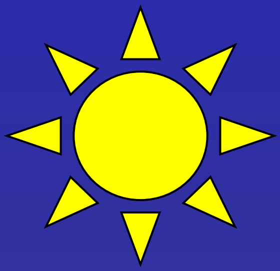
When the sun is overhead air rises, it starts to cool forming clouds and giving rain.

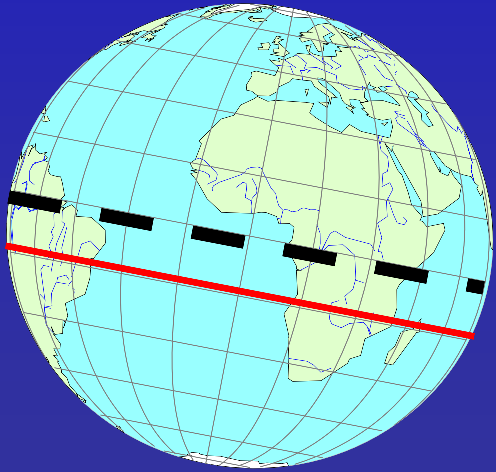
ITCZ Task 16



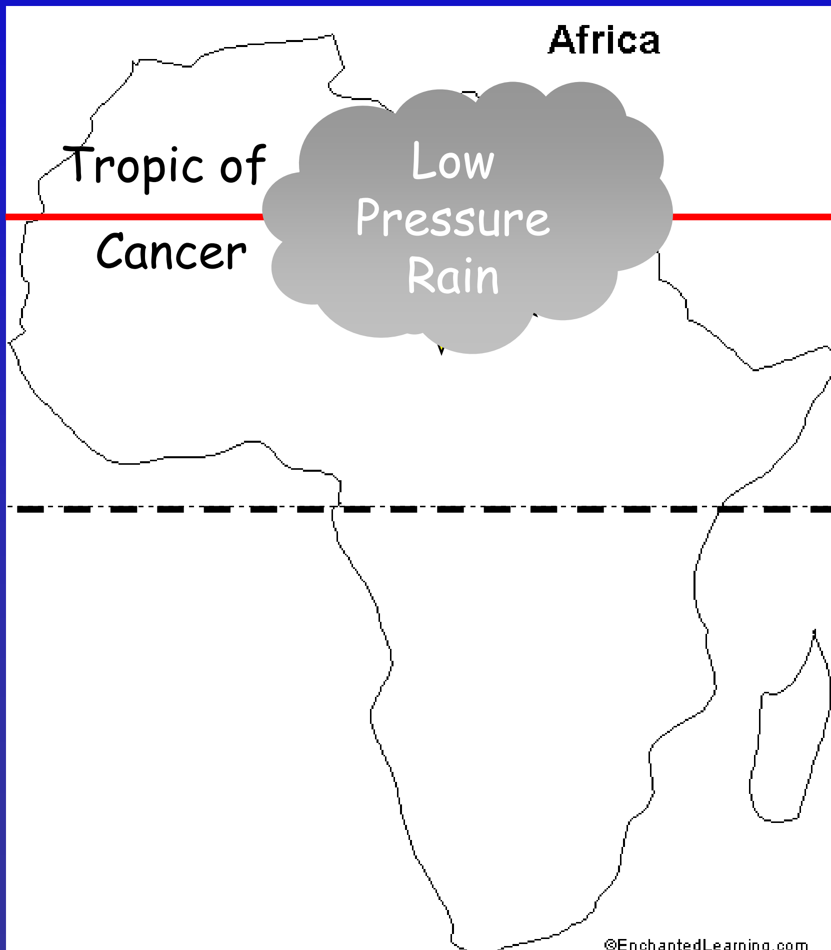
When is the sun overhead the Tropic Of Capricorn?

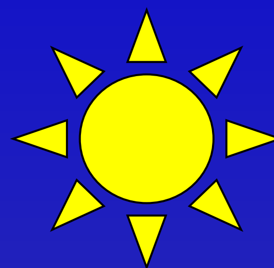
At the Winter Solstice
December 22nd

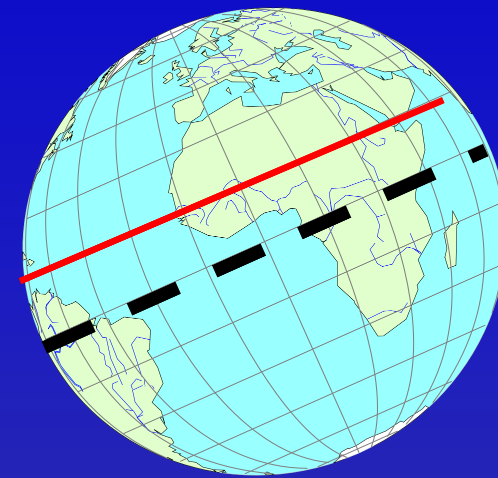




ITCZ Task 16



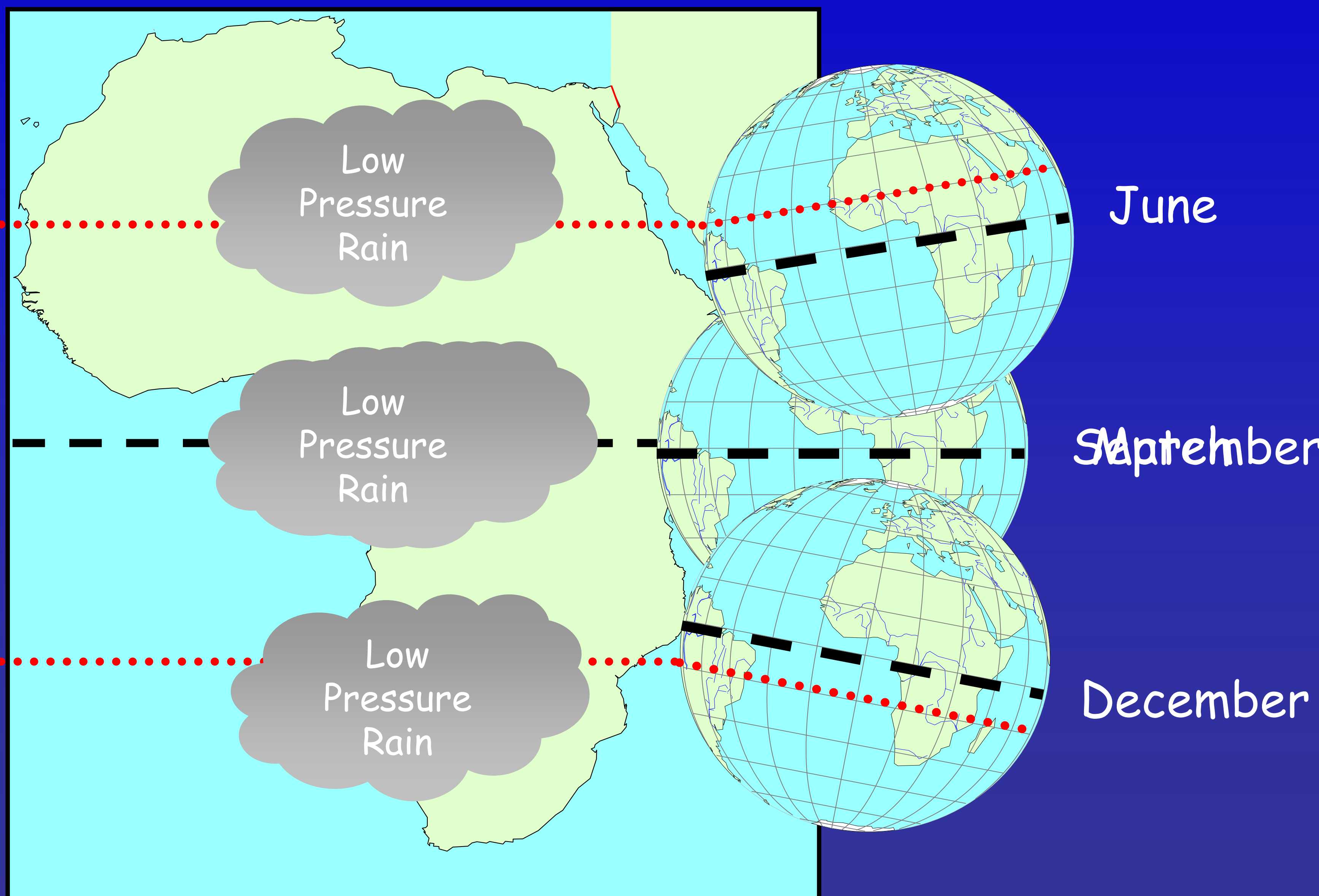




When is the sun overhead the Tropic Of Cancer?

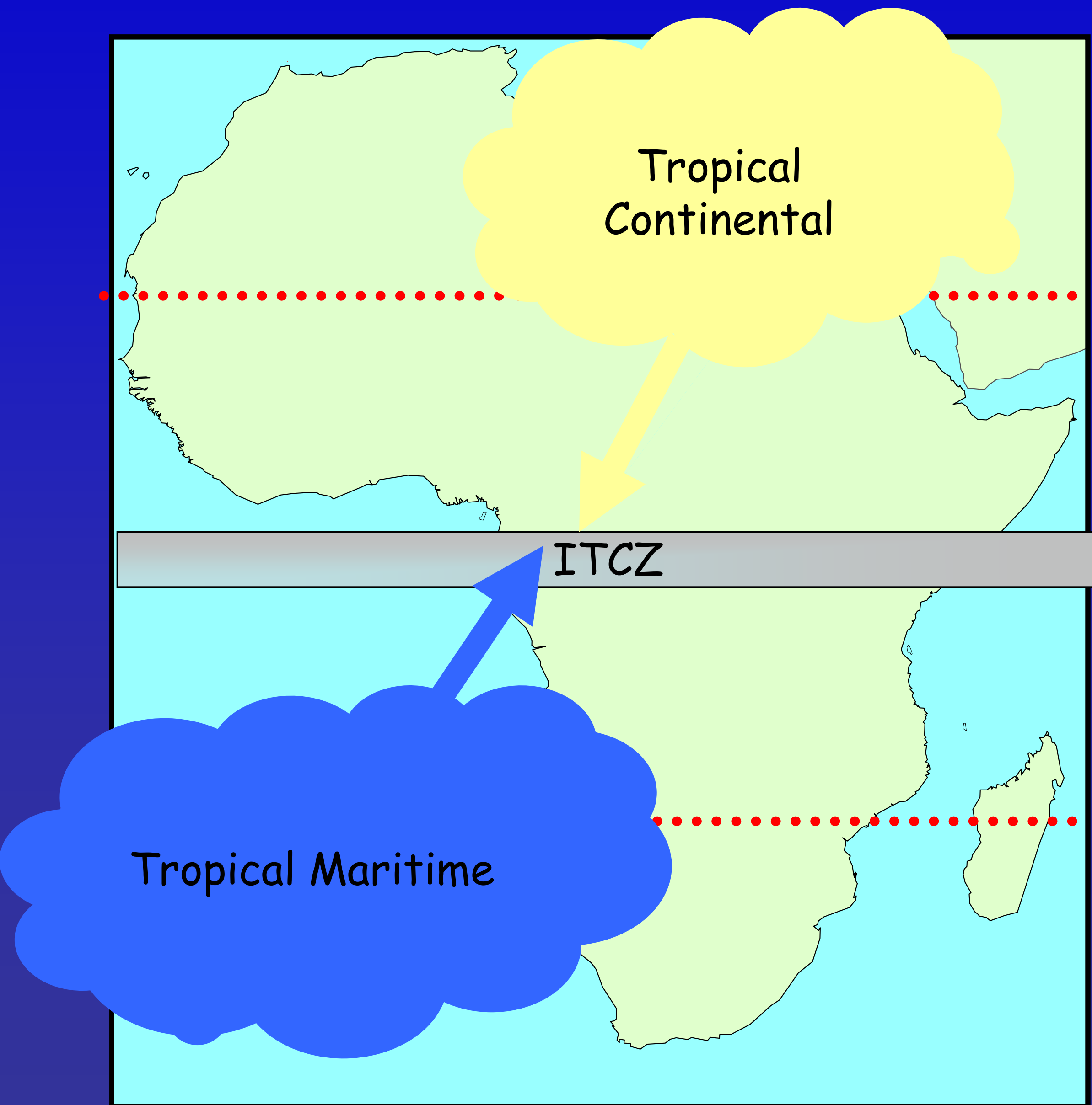
At the Summer Solstice
June 21st

ITCZ Task 16



Low
Pressure
Rain
Low
Pressure
Rain
Low
Pressure
Rain
June
September
March
December

ITCZ Task 17



When describing air masses you must say;

Where they develop

Where they move to

How stable they are

Their temperature & moisture characteristics

What the weather will be like

An air mass is a large area of air with similar qualities such as temperature & humidity (weather!)

The Tropical continental (Tc) air mass is hot as it is close to the equator and develops over the Sahara so is dry.

The Tropical maritime (Tm) air mass is hot as it is close to the equator and develops over the Atlantic Ocean so is wet.

ITCZ Task 17

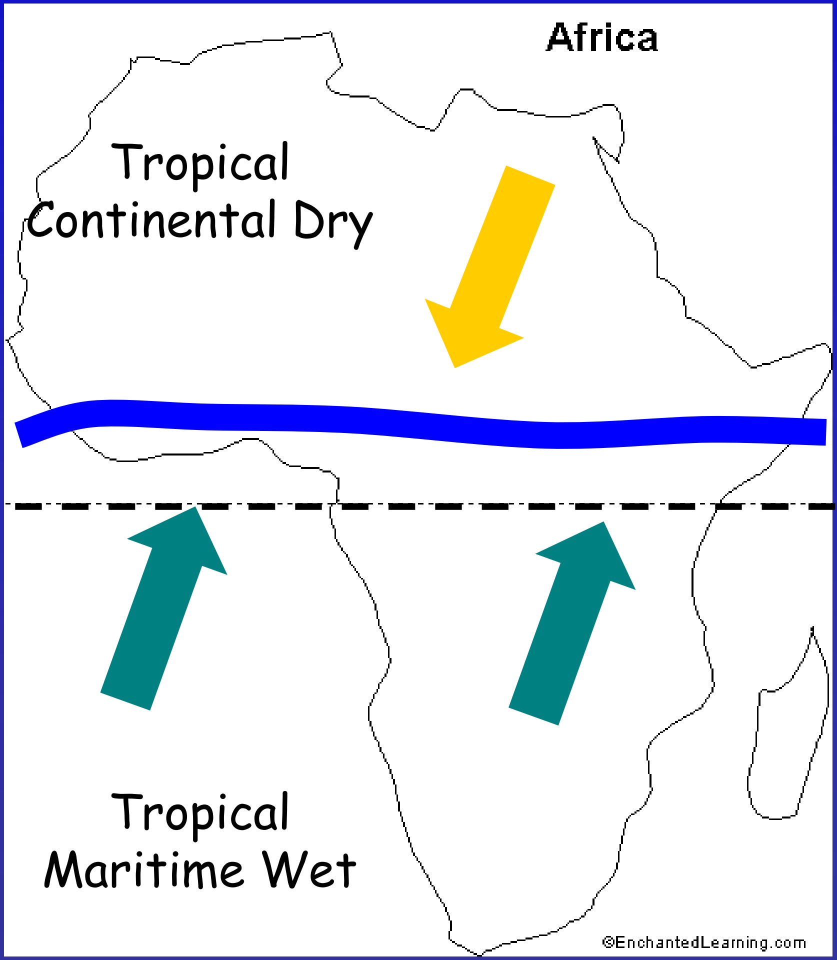
Below is an answer to a typical question on Air Masses, try and mark it, we'll check how you did after you've finished.

"Describe the origin and weather characteristics of the Tropical Maritime and Tropical Continental air masses."

The Tropical Maritime air mass develops over the Atlantic Ocean near the equator and moves towards Africa. As its latitude is close to the equator it means receives much insolation and so is warm, and developing over water means it will be wet. It is an unstable air mass and the weather it brings is wet and warm.

The Tropical Continental air mass develops over land (Africa) meaning it is warm and dry. It moves towards the Equator but travels over little water so remains very dry. It is a stable air mass and the weather it brings is dry and warm.

Task 18 ITCZ March

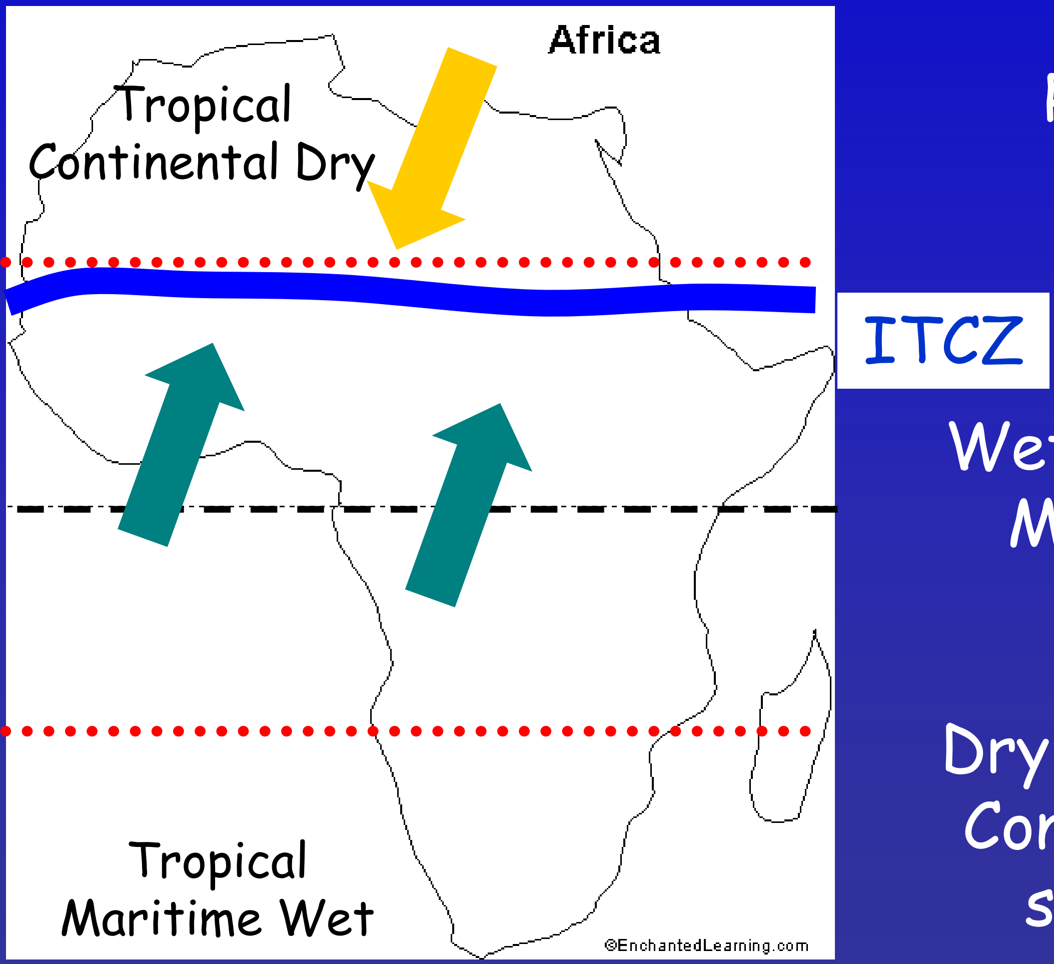


Rain around equator as ITCZ located by it

Wet area south of ITCZ as Maritime air is wet and unstable

Dry area north of ITCZ as Continental air is dry and stable

Task 18 ITCZ July

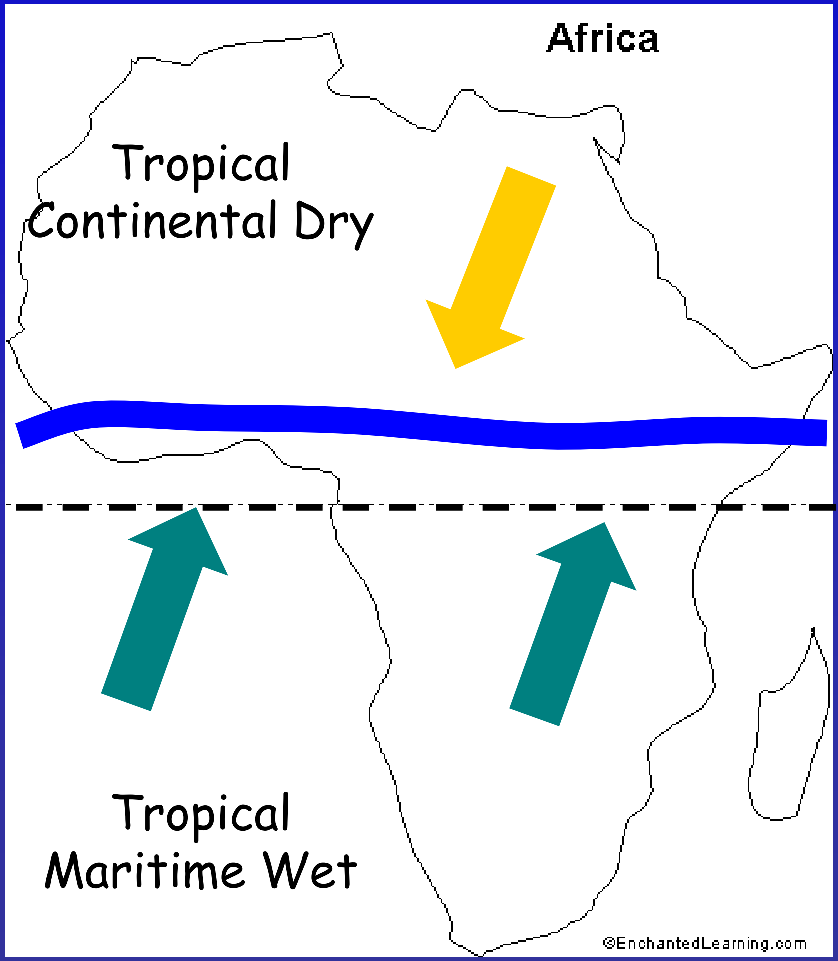


Rain around 20°N as ITCZ located by it

Wet area south of ITCZ as Maritime air is wet and unstable

Dry area north of ITCZ as Continental air is dry and stable, hence Sahara Desert

Task 18 ITCZ September

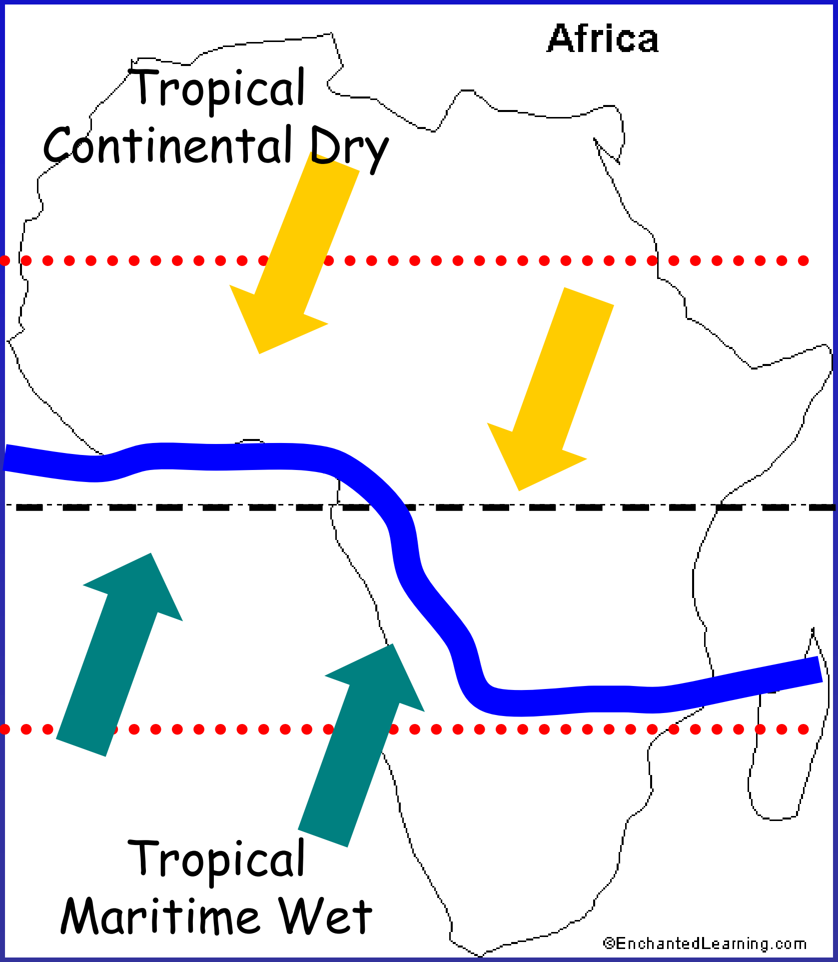


Rain around equator as ITCZ located by it

Wet area south of ITCZ as Maritime air is wet and unstable

Dry area north of ITCZ as Continental air is dry and stable

Task 18 ITCZ January



ITCZ

Rain around 20°S as ITCZ located by it

Wet area south of ITCZ as Maritime air is wet and unstable

Dry area north of ITCZ as Continental air is dry and stable, hence Sahara Desert

ITCZ Task 18

You will each be given information on the ITCZ. You must then report back what you found out to the rest of your group. Now answer these questions on what you found out.

Task 19 ITCZ
Exam Question (2003 7 Marks)

Describe and account for the variation in rainfall within West Africa.

There is a set way of tackling this question you need to do the following;

Task 20 Climate Graphs

One of the course requirements is to be able to draw and describe the different climate graphs linked to the ITCZ. You are just revisiting work done in Standard Grade here it is very easy!

We will look at the Equatorial areas 0° to 5° N/S

and the Savannah areas 5° to 15° N/S

Task 20 Climate Graphs

Equatorial

	Temp.	Rainfall
Oct	28°C	200mm
Nov	27°C	225mm
Dec	26°C	250mm

Savannah

		Temp.
	Oct	30°C
	Nov	27°C
	Dec	23°C

Climate Graphs Task 20

You will need to describe your climate graph, you have to do the following;

Say if rain falls throughout the year

Say if the temperature varies

Describe the amount of annual rainfall

Say when most rain falls

Say which month is hottest

Quote the hottest temperature

Which month has the most rain

Quote the highest monthly rainfall

Say which month is the coldest

Which month has the least rainfall

Quote the lowest temperature

Quote the lowest monthly rainfall

Work out the temperature range

Describe the temperatures


The End