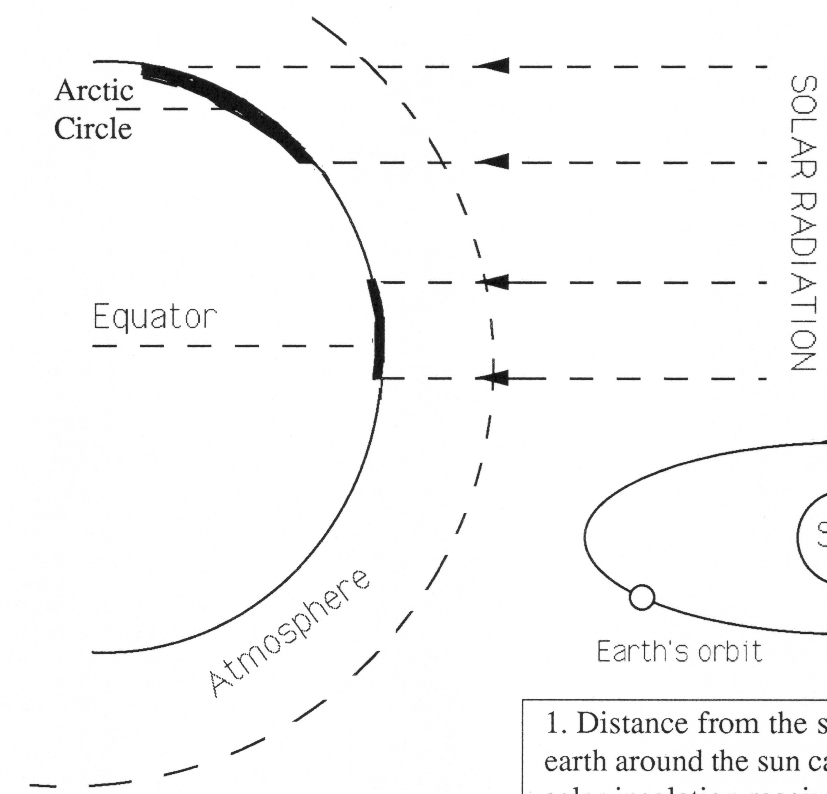
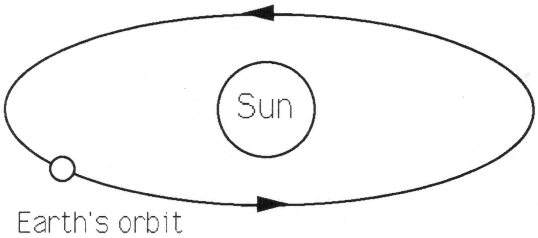
# Global Insolation



**ATMOSPHERE**

Incoming radiation from the sun is not constant - the amount of radiation received by any individual location depends on a number of factors.




1. Distance from the sun : The eliptical orbit of the earth around the sun causes up to a 6% difference in solar insolation received.

2. The curvature of the earth ensures that equivalent amounts of solar radiation have to heat three times the area at the Arctic Circle as at the Equator.

3. Sunspot activity - radiation from the sun is fairly constant but sunspot activity is variable and can affect the earth's climate.

4. Seasonal variation - the tilt of the earth's axis produces seasonal variations in insolation received at any location. At the North and South Poles there are several months without any insolation, when the Poles are in winter darkness. While at the Equator there are two maxima when the sun is overhead and two minima when the sun is overhead at either of the Tropics.

## Q

**1.**. What factors determine the amount of insolation received each day at any given place on the earth?
**2.**. Describe the relationship of insolation to latitude in some detail.
**3.**. How do the seasons affect insolation in the following three zones : Polar regions (poleward of 661/2° ); mid-latitudes (231/2° to 661/2° , north and south); Equatorial regions (between 231/2° north and south) ?
**4.**. Explain the concept of heat transfer from areas of heat surplus to areas of heat deficit.
**5.**. How do the seasons influence the areas of heat transfer?

# Global Wind Circulation





**FIGURE 1** GLOBAL WIND BELTS

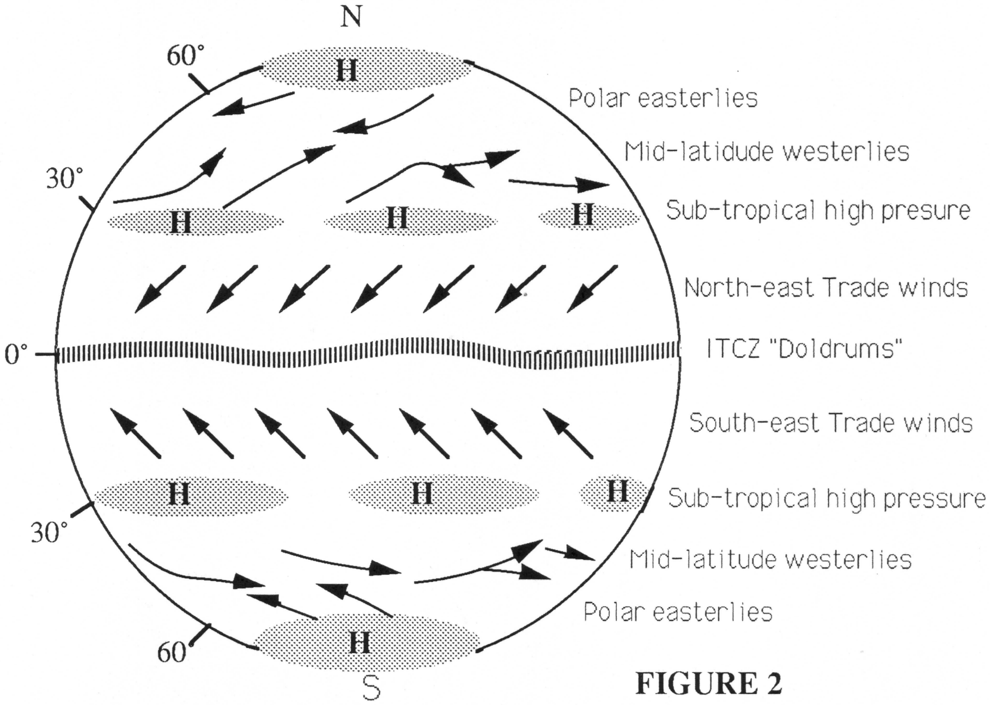
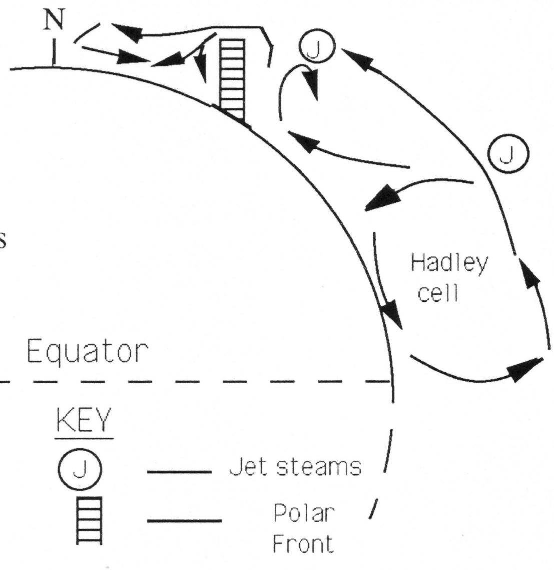



**FIGURE 2**
PALMEN'S GLOBAL CIRCULATION MODEL




*Q*

**1..** Describe the relationship between Figure 1 and Figure 2.
**2..** What weather conditions might you expect at zones of convergence?
**3..** Why is the wind direction of the major wind belts fairly constant ?
**4..** Compare the models with Atlas maps of winds in January and July.
**5..** Compare the major wind belts with a map of ocean currents and note any similarities and differences.
**6..** Why are the jet streams located where they are on Figure 2 ?
**7..** What are the differences between Figure 2 and a simple three cell model of atmospheric circulation ?

*Research Questions*

**1..** Find out about "JET STREAMS" - what function do jet steams perform and how have they been produced.
**2..** Explain the seasonal wind patterns of a Monsoon area of your choice.
**3..** How did the wind belts influence sea trade during the era of sailing ships, and do the winds still have an influence of sea going trade?

# *Winds and Global circulation* ⑤

ATMOSPHERE

*Q*

**1.**. Write a full definition for each of the terms or phrases listed in the box below.

| | | | | |
|---|---|---|---|---|
| **Hadley cell** | **atmospheric subsidence** | **Ferrel cell** | **thermally direct cell** | |
| **pressure gradient force** | **isobars** | **Coriolis force** | **geostrophic wind** | |
| **Rossby waves** | **jet stream** | **polar front** | **trade-winds** | **mid-latitude westerlies** |
| **inter-tropical convergence zone** | **zones of convergence** | **zones of divergence** | | |
| **horse latitudes** | **sub-tropical belt of high pressure** | | | |

**2.** Describe how equatorial heating drives the tropical Hadley cells.

**3.**. Using a series of diagrams show how understanding of the atmosphere's circulation has improved since Hadley's circulation model of 1735.

**4.**. How do Rossby waves contribute to the poleward transfer of energy?

**5.**. Explain the direction of the trade winds in each hemisphere.

**6.**. Why do the large landmasses in the northern hemisphere disrupt the belted pressure pattern around the globe?

**7.**. Copy and complete the classification table below which gives a hierarchy of atmospheric motions. Choose examples from this list and your own knowledge:

**ITCZ** **THUNDERSTORMS** **DEPRESSIONS** **ROSSBY WAVES**

**HURRICANES** **URBAN HEAT ISLAND** **HARMATTAN**

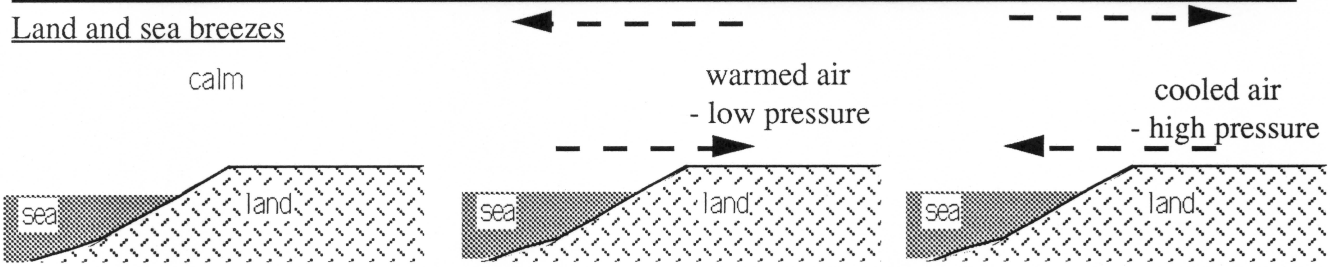
| SIZE | SCALE TYPE | EXAMPLES OF SYSTEMS |
|---|---|---|
| < 10 km. | miro-scale | e.g |
| 10-1000 km. | meso-scale | e.g. |
| 1000- 5000 km. | macro scale (synoptic) | e.g. |
| 5000-10 000 km. | planetary scale | e.g. |

# *Local winds*



ATMOSPHERE

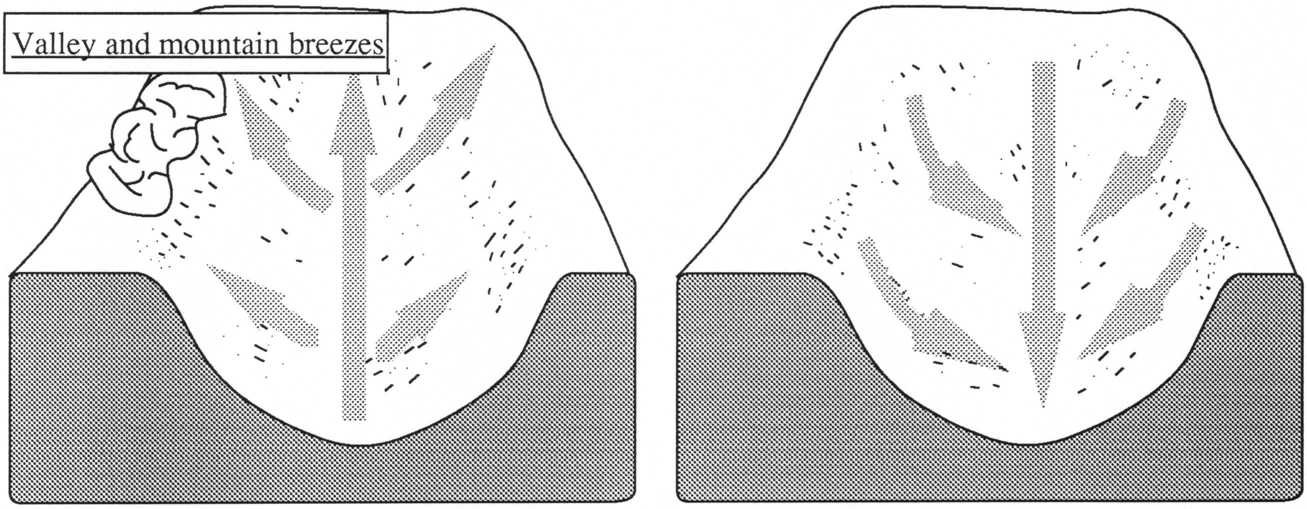
## Land and sea breezes




Early morning — Afternoon - sea breeze — Evening - land breeze

Localised coastal winds can be produced by differences in temperature between land and sea. In the British Isles the land heats up during the day causing a localised lowering of atmospheric pressure. This causes the wind to blow in from the sea. Whilst at night the sea retains heat longer and the breeze blows from the land to sea.

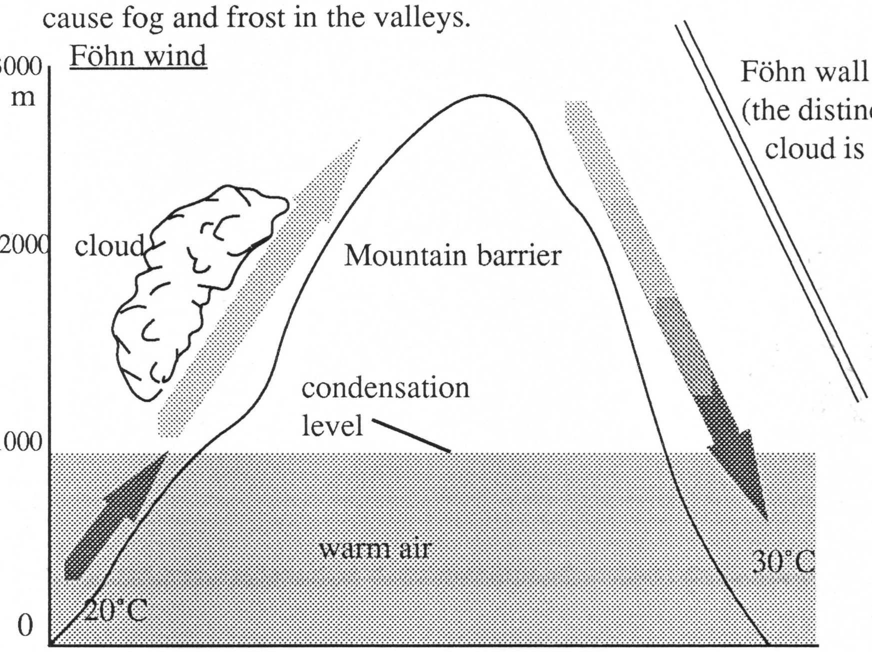
## Valley and mountain breezes



Daytime - anabatic flow — Night - katabatic flow

Air moves upward from the valleys toward the summits during the day, when the slopes are being heated (winds are less strong on north facing slopes). The updraughts may form clouds on the hills.The air moves valleyward at night as the slopes cool by radiation. Cold dense air sinks under gravity and can cause fog and frost in the valleys.

## Föhn wind

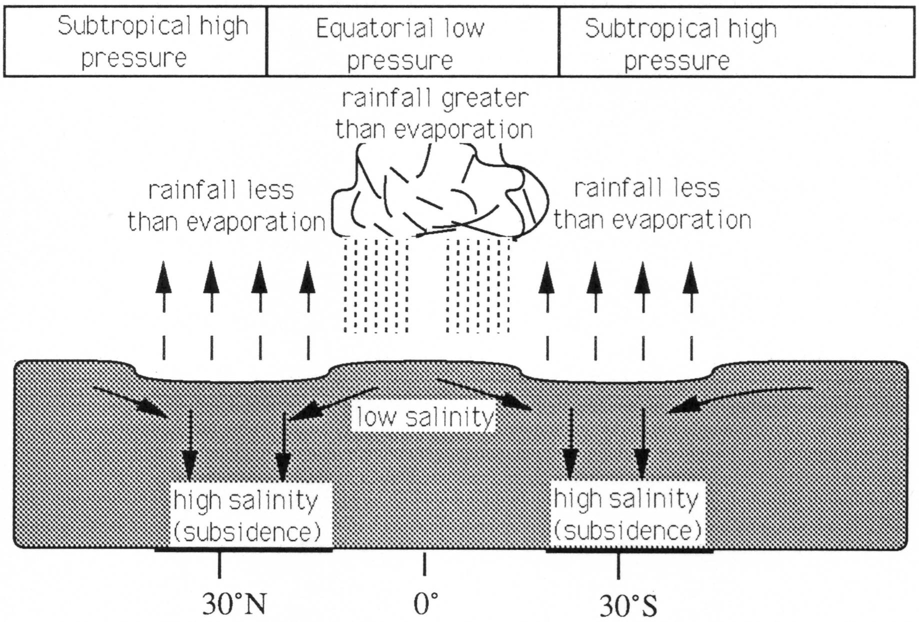



Föhn wall
(the distinctive edge to mountain cloud is called the Föhn wall)

Föhn winds are occur on the leeward side of major mountain barriers, such as the Alps. Air rising on the windward side cools by 1°C for every 100m. The ascent produces cloud and rain. The air sinks on the leeward side and warms. When it reaches sea level it is warmer and drier than it was on the windward side.

# *Ocean Currents*

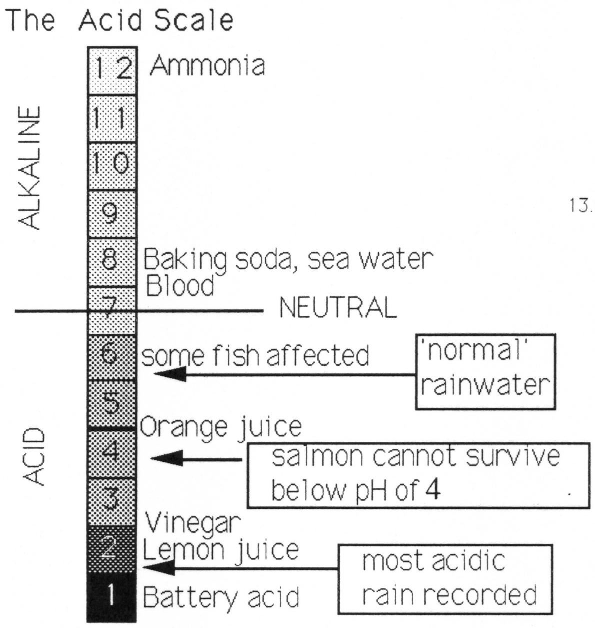


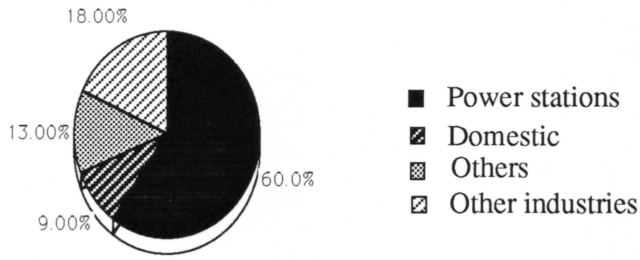



Ocean currents are largely produced by temperature differences and energy transfer from wind to water. As with the atmosphere the temperature contrasts in the oceans create convection currents in an attempt to distribute heat more evenly over the globe. Winds over the ocean surface also drag surface water. However the Coriolis force causes ocean currents to flow at about 45° to the right of the prevailing winds (in the northern hemisphere). Density differences can also produce flow in ocean waters. Density differences may be due to temperature differences e.g. cooled water in polar regions may sink to the ocean floor and be replaced by less dense warmer water. They may also be due to salinity differences (see diagram above), e.g. in the Tropics, equatorial rainfall reduces salinity of the ocean water while in the drier sub-tropics evaporation is greater than rainfall and hence increased salinity. High salinity water tends to subside while on the surface a current tends to flow from areas of low salinity to areas of high salinity. This flow is however deflected by the Coriolis force by about 90° to the right in the northern hemisphere. Therefore currents caused by salinity differences tend to move parallel to the salinity gradient.

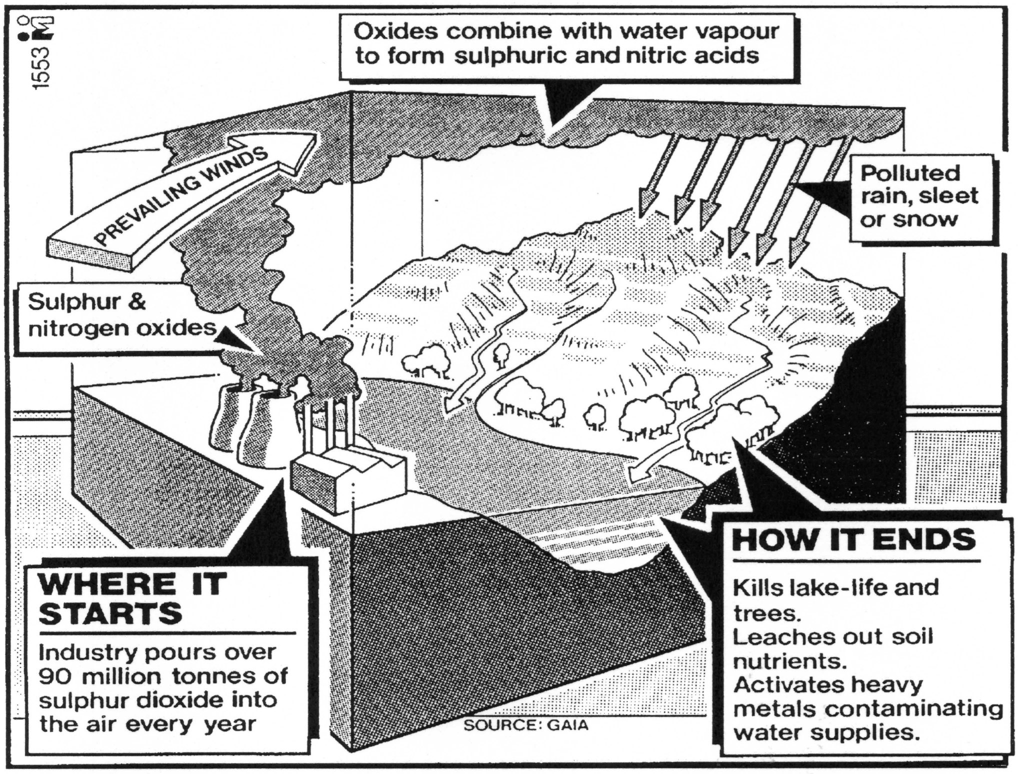
*Q*

**1.**. Describe the causes of ocean currents, mentioning the effect of the Coriolis force.
**2.**. Examine an atlas map of ocean currents;
Make a simplified sketch of the pattern in the Altantic ocean (northern and southern hemisphere). Mark on warm and cold currents.
**3.**. Examine ocean currents in the North Atlantic and explain the effects of warm and cold currents on air temperature - quote examples in your answer.
**4.**. By examining the pattern of ocean currents in the North Atlantic predict the areas most likely to experience drifting icebergs.
**5.**. What happens to ocean water flow near the equator?
**6.**. Plan a route from the UK to Australia making maximum use of the prevailing ocean currents.
**7.**. Some major fishing grounds are located where warm and cold currents mix, find out what other factors influence the location of major fishing areas.



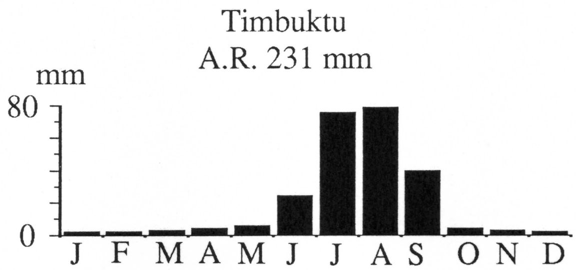

Origin of sulphur dioxide pollution

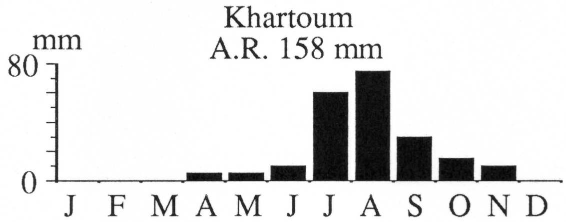


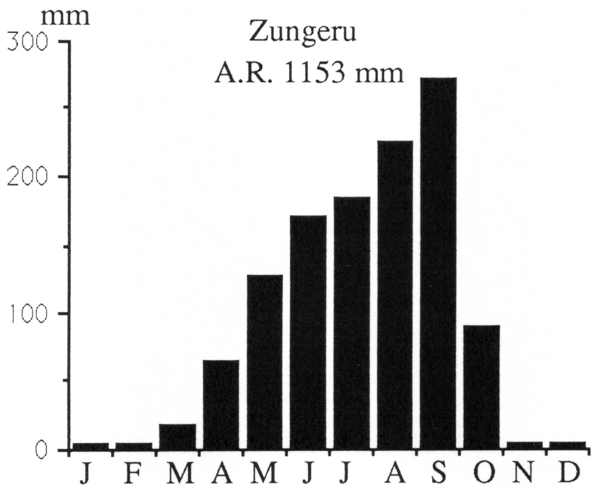

*Q*

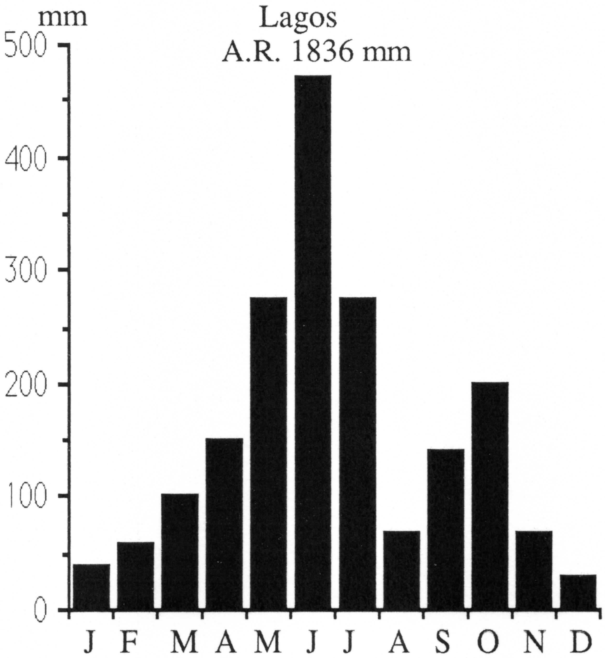
**1.**. Explain how acid rain might affect people's livelihoods.
**2.**.What does acid rain do to the natural environment?
**3.**. Describe how acid rain is formed.
**4.**. Why is increasing car ownership, on a world scale, likely to make a major contribution to higher acid rain levels?
**5.**. Why is it so difficult to reduce the level of acid rain for any one country?

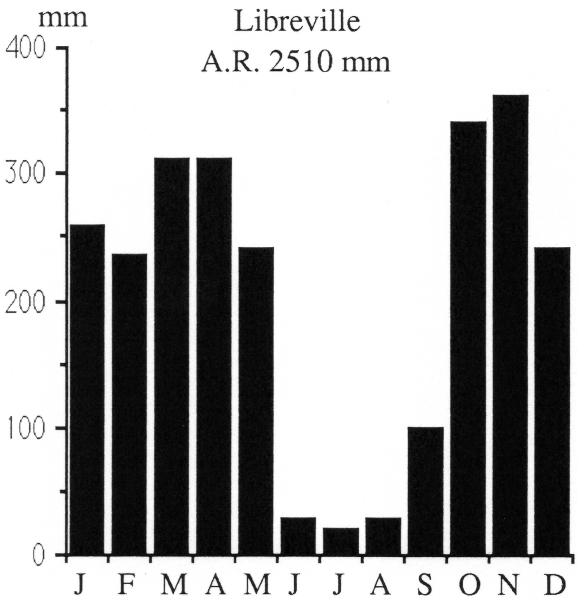
# ITCZ Migration




## Q

**1.**. Locate each of the rainfall graphs on a blank map of Africa, using an atlas.

**2.**. On your map indicate the position of the ITCZ (Inter-tropical convergence zone) in January and July.

**3.**. Identify the climate indicated by the rainfall pattern, in each graph - select from the following :
Equatorial/Tropical rainforest;
Savanna/Tropical grassland;
Sahel;
Hot Desert.

**4.**. How is the rainfall pattern in the graphs affected by the passage of the ITCZ?

**5.**. Explain the annual passage of the ITCZ and use the graphs to illustrate your explanation.

**6.**. Why is rainfall so varible in the Sahel zone?

**7.**. What human problems have been caused by droughts in the Sahel zone?

**8.**. What human factors have worsened the impact of drought in the Sahel?