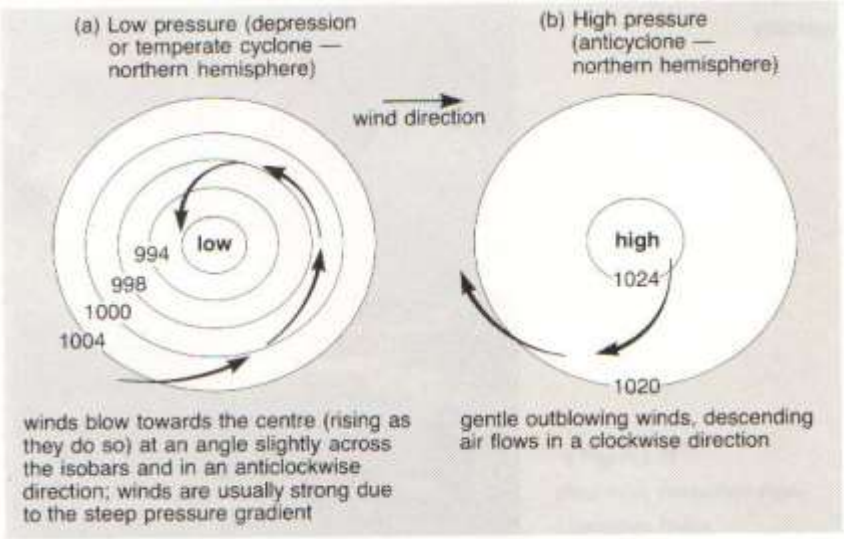
ATMOSPHERIC CIRCULATION

WIND = The horizontal movement of air.

Results from the differences in air pressure.
Always moves from HIGH to LOW.

Pressure differences result from variations in temperature.

- AIR TEMPERATURE RISES = air expands and rises, thus reducing air pressure.
- AIR TEMPERATURE FALLS = air becomes denser and sinks, thus air pressure increases.
- Air pressure is shown on a weather map as isobars and these show pressure gradients. These give rise to the movement of air from high to RELATIVELY low pressure.
- 2 basic pressure systems in the UK (see low and high on sheet). Other factors are important, such as season and whether the winds blow over land or sea.



Atmospheric Pressure =

- The pressure exerted by the weight of air in the atmosphere at the surface of the Earth.
- Unit of measurement = millibar (mb)
- Measured on a barometer
- Average atmospheric pressure at sea level = 1.013 mb
- Pressure greatest at ground level and decreases with altitude
- Atmospheric pressure varies horizontally and this causes wind. Pressure varies because of temperature (see earlier).

- HIGH AIR PRESSURE = FALLING AIR.
- If air is falling it must be warming, leading to evaporation of water vapour and DRY weather = DESERTS!

- LOW AIR PRESSURE = AIR RISING.
- If air is rising it must be cooling, condensing and forming clouds and then rain = tropical rainforests of the Equator and temperate zones like ours!

PRESSURE GRADIENTS

- http://www.bbc.co.uk/weather/features/understanding/fronts.shtml

CORIOLIS FORCE

- Definition: an effect that causes any body, that moves freely with respect to the rotating earth, to veer to the right in the northern hemisphere and to the left in the southern hemisphere.
- http://www.knowitall.org/nasa/simulations/light/atmosphere.html

Coriolis(cont)

- Earth’s rotation of 360 every 24 hours means a wind blowing in a northerly direction in the northern hemisphere appears to have been diverted to the right on a curved trajectory by 15 of longitude every hour.
- This is why prevailing winds blowing from the tropical high pressure zone approach Britain from the SW rather than the S. (Turntable throwing a ball).

GEOSTROPHIC WIND

- The previous diagrams showing high and low pressure systems in Britain also showed that the winds blow neither directly at right angles to the isobars along the pressure gradient nor parallel to them and this is because of the coriolis effect of the rotating Earth and friction with the Earth's surface!
- Winds in the upper troposphere are unaffected by friction with the Earths surface and these show a balance between the forces exerted by the pressure gradient and the coriolis deflection. This is the GEOSTROPHIC WIND and it blows parallel to the isobars.
- See geo moviefile on A2 list.

The geostrophic wind and the influence of friction.

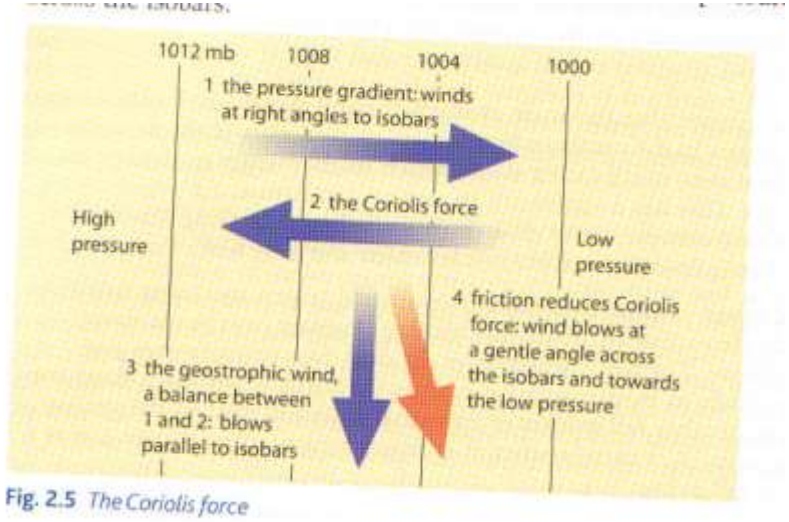


Fig. 2.5 *The Coriolis force*

If you stand in the N. hemisphere with your back to the wind low pressure will be on left and high on right!

- Friction caused by the Earths surface upsets the balance between pressure gradient and the Coriolis force, causing a reduction in the coriolis and so pressure gradient becomes relatively more important and winds blow slightly across isobars towards the low pressure.
- This deviation from the geostrophic wind is less pronounced over water (smoother surface).

Hierarchy of atmospheric motion

- 1. Planetary = 5000-10,000 km across ITCZ and the Tricellular model. Rossby winds
- 2. Synoptic = 1000-5000 km monsoons and hurricanes.
- 3. Meso scale = 10-1000 km sea breezes and thunder storms.
- 4. Small scale = 0.1-1.0 km localised breezes.

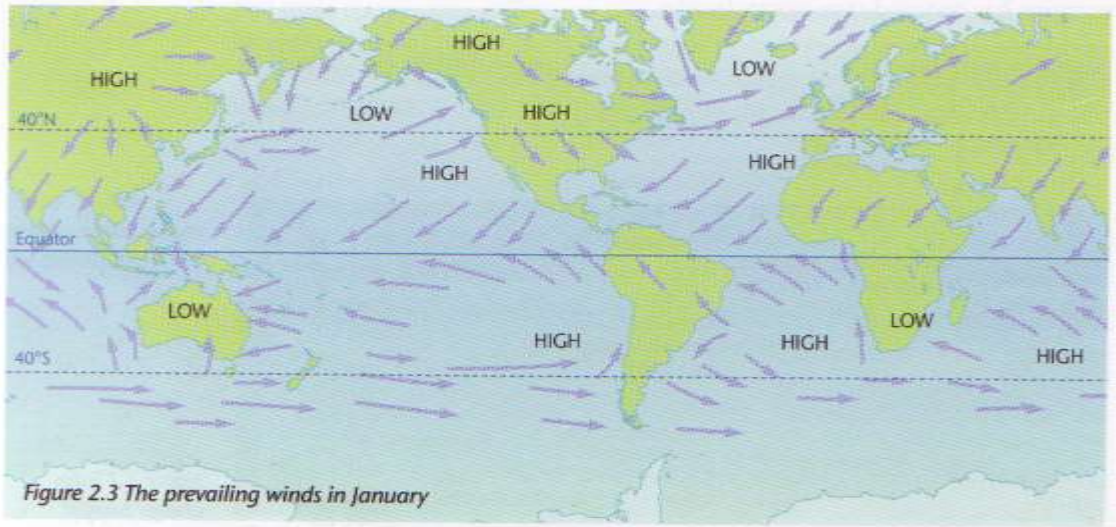


Figure 2.3 The prevailing winds in January

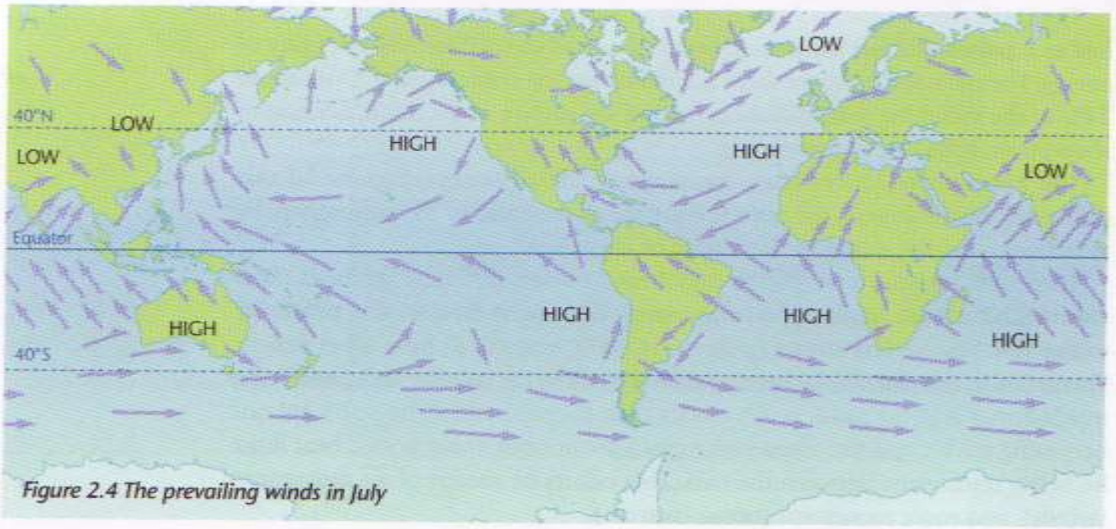
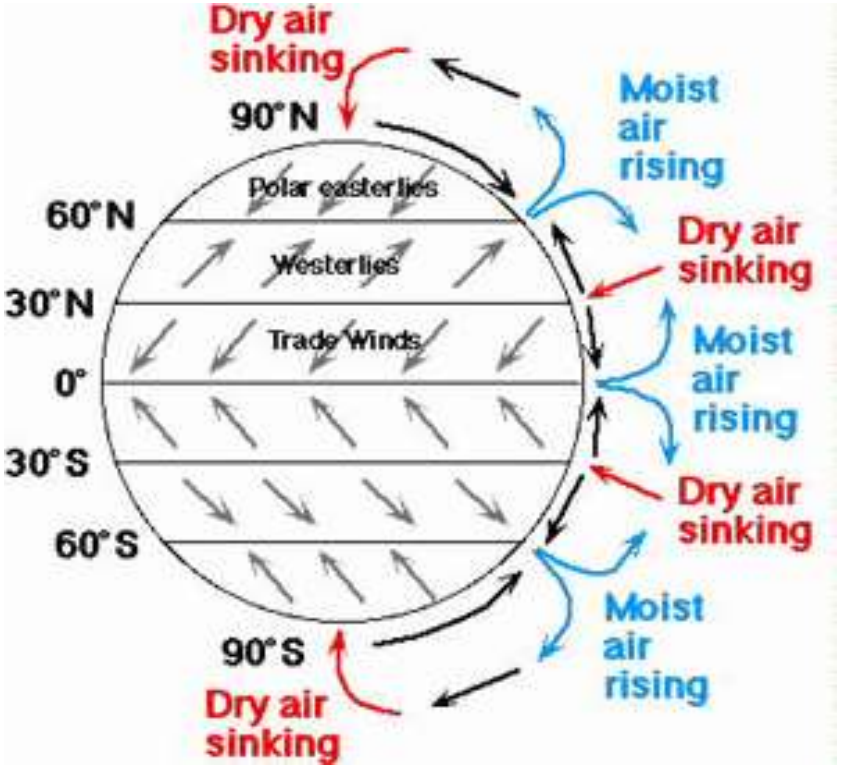


Figure 2.4 The prevailing winds in July

Planetary motion

- Equator has a surplus of energy and the poles a deficit. This differential heating of the Earths surface by the sun is sufficient to create a pattern of pressure cells.
- TRICELLULAR MODEL:

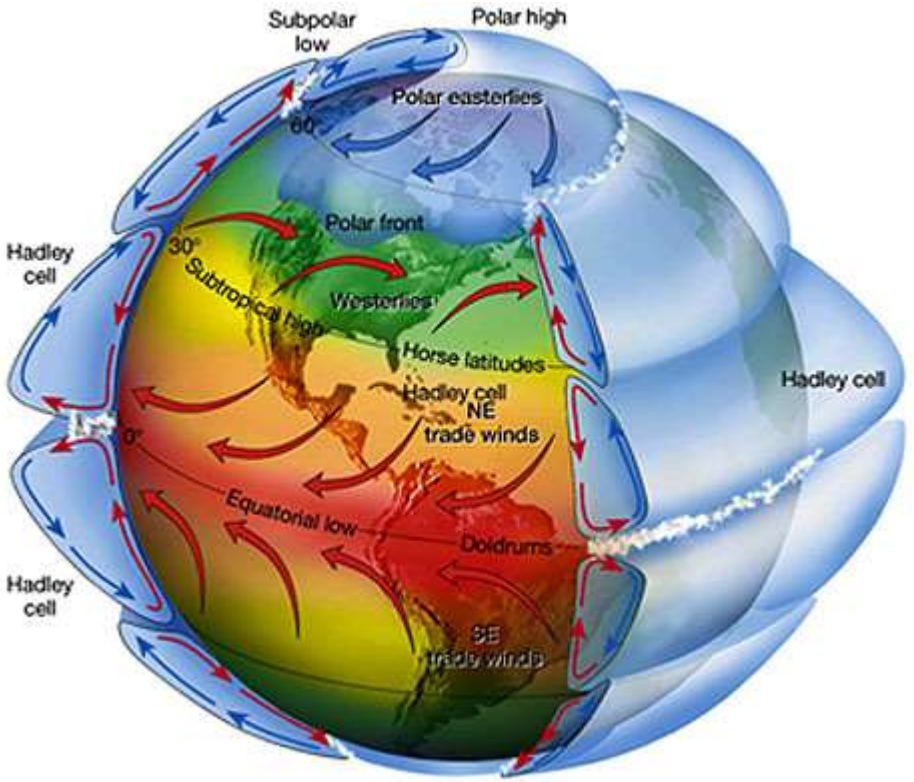


Key features of the model:

- Trade winds meet at the equatorial regions to form the ITCZ = Inter Tropical Convergence Zone.
- Trade winds pick up latent heat as they cross warm oceans and are forced to rise by violent convection currents.
- This unstable warm, moist air is rapidly cooled adiabatically to produce towering cumulonimbus clouds and low pressure systems = equatorial climate!
- This upward motion forms the power house of the general atmospheric circulation.
- At ground level the ITCZ has only gentle winds (doldrums).

Tricellular (cont)

- As the rising air cools to the temperature of the surrounding air, uplift stops and the air moves away from the Equator.
- Further cooling , increasing density and diversion by the coriolis force causes air to slow down and subside, forming the descending limb of the Hadley cell.



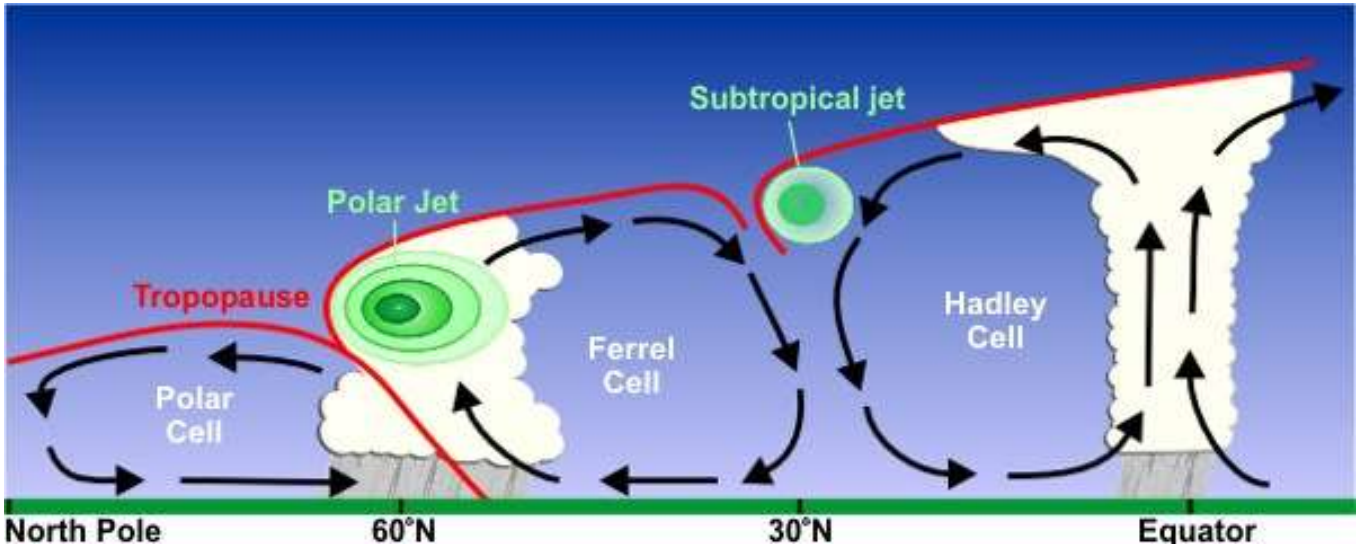
- As air subsides at 30N and 30S high pressure is created with clear skies and dry stable conditions (deserts-Sahara, Gobi, Arizona and Atacama, Kalahari and Australian).

- On reaching Earth some air is diverted back to the Equator as trade winds and the rest polewards, as warm south westerlies which collect moisture if they cross oceans.
- These warm winds meet cold Arctic air at the polar front (60) and are uplifted to form an area of low pressure and the rising limb of the Ferrel and Polar cells. Heavy cyclonic rainfall here (depressions).

- Some of this rising air returns to the tropics, but some travels polewards where it descends to form a stable high pressure area, these are the cold easterlies.

Tricellular Model

- Using the diagram below describe the movement of winds around the Earth. Use as many terms as possible.

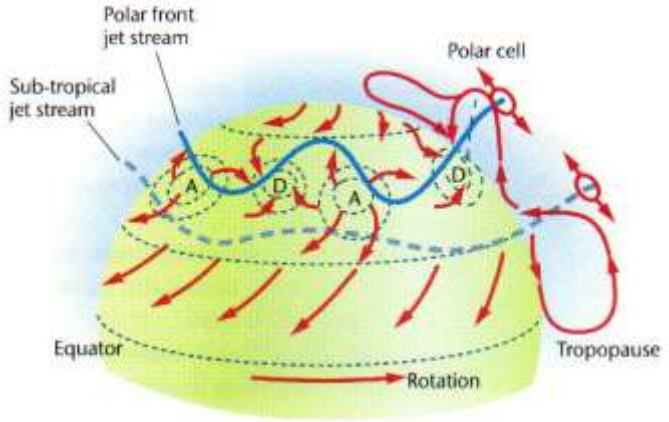


What changes this system?

- The movement of the overhead sun to the north and south of the Equator!
- This causes the seasonal shift of the heat Equator (ITCZ) and therefore the equatorial low pressure zone.
- This affects global climate!

How else is energy redistributed?

- The 3 cell model does not allow for the influence of depressions and anticyclones, which we shall study later with reference to the climate of the British Isles. Nor does it include the high level winds called jet streams.
- Rossby redefined the tricellular model in 1941 to take these into account.



- **Rossby waves** = A series of large waves that occur in the westerlies in the mid-latitudes in both the northern and southern hemispheres. It is thought that they are caused by the upper air flow being forced to divert around the great north-south mountain ranges of the Rockies and Andes. Once a wave motion has begun, it is perpetuated around the planet. Wave amplitude varies throughout the year.
- **Jet stream** = A narrow belt of fast-moving air near the top of the troposphere.They are within the upper westerly winds.

JET STREAMS

- http://www.srh.weather.gov/jetstream/global/jet.htm

What are jet streams?

- Evidence from WW2 of strong winds in the upper troposphere causing flights to be blown off course and eastwards flights across the Atlantic were much faster than westward.
- This was explained by Rossby Waves. These zig-zag around both hemispheres.
- Within these upper westerlies there are narrow bands of extremely fast moving air called JET STREAMS(exceed 230km/hr). These help with rapid transfer of heat around the Earth.
- Polar front jet stream is most important to us.
- Why?

The polar front jet stream(PFJS)

- At between 40-60 latitude in both hemispheres and marks the division between the Farrel and Polar cells i.e. boundary between warm tropical and cold polar air.
- The PFJS varies in extent and location.
- If the jet stream is in the north and then veers south it brings cold air which descends in a clockwise direction to give dry, stable conditions. These are high pressure systems (anticyclones).
- If the jet stream is in the south and then veers north it takes warm air which rises anticlockwise to give strong winds and heavy rainfall.
- These are low pressure systems (depressions).

PFJS

- The PFJS moves over Britain towards the NE from the SW and so accounts for our wet and windy weather.
- Occasionally its path is blocked by a stationary or blocking anticyclone. In winter this causes very cold conditions with snow (Christmas 09 and 10) and in summer very settled fine weather!
- Watch ‘Jet Streams’ video.

The Sub-tropical jet stream

- A second important jet stream which is also generally westerly. It is associated with the poleward ends of the Hadley Cell at approx 25N -35N.(Boundary between the Hadley and Ferrel cell).
- However, in summer above west Africa and southern India this jet may become easterly. This is due to higher temperatures over land than over the more southerly sea areas.

NASA website:

- http://www.physicalgeography.net/fundamentals/7p.html

- www.nasa