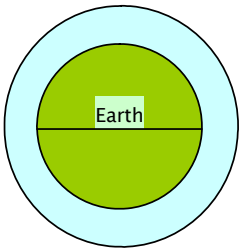
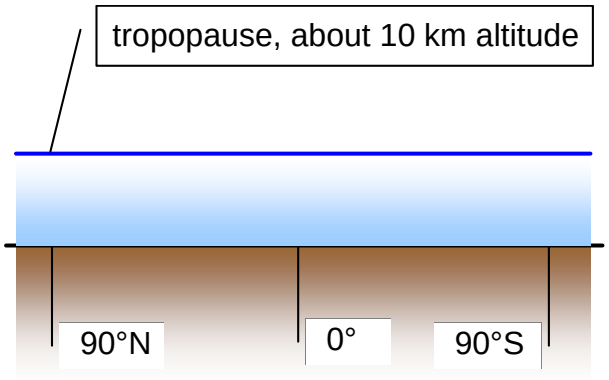
General Circulation Model

5 steps to understand the general circulation model (GCM)
[also called global or atmospheric circulation model]



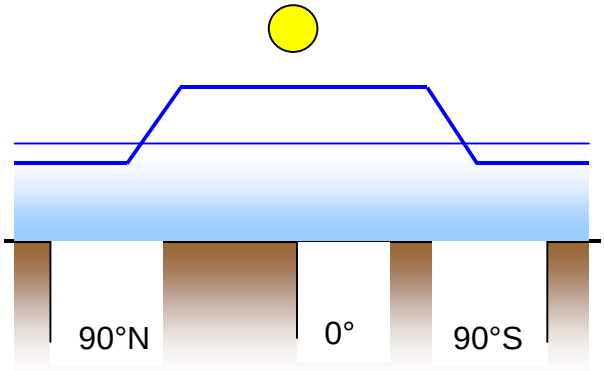
1st Step: Earth with Atmosphere

- Earth ≈ sphere
- Atmosphere = gaseous envelope of the Earth, like a fruit peel
- without sun rays ⇒ no thermal activity ⇒ even distribution of gases ⇒ atmosphere has the same thickness everywhere
- The sphere, i.e. hemisphere (from pole to pole), will be reduced and drawn on a cross-section line in the following 5 steps



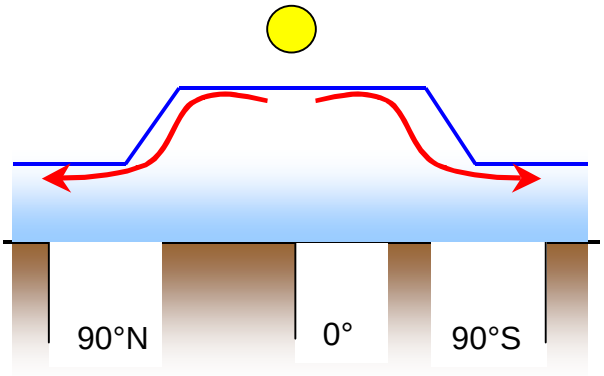
2nd Step: Fiat Lux – Let There Be Light

- Sun heats up atmosphere ⇒ highest heating in the region of the solar zenith, i.e. around the equator
- the warmer air around the equator is less dense than polar air masses ⇒ tropical air masses need more space ⇒ tropical troposphere is more massive than the polar one ⇒ tropical tropopause (TP) is higher than the polar one:
  - equatorial TP ≈ 16 km
  - polar TP ≈ 8 km



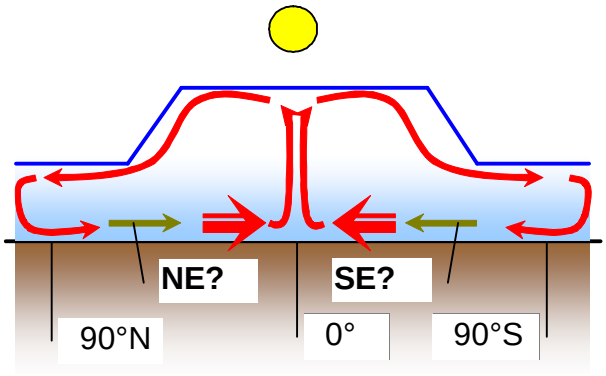
3rd Step: The Wind Comes Into Play

- wind:= moving air masses, air flow, air current
- wind flows always downwards – just as water does – from high to low pressure (cf. GGCH, p. 300)
- wind is deviated by the Coriolis force (cf. GGCH, p. 300) on the
  - **northern hemisphere in flow direction to the right**
  - **southern hemisphere in flow direction to the left**
- air flows in high altitudes from tropical to polar latitudes «downwards» as the tropical TP lies higher than the polar TP ⇒ subtropical and polar **jet streams**
- wind moves air masses ⇒ heterogeneous distribution of air pressure on the surface
  - equator: air flows poleward along the TP away from the equator ⇒ low pressure = Inner-Tropical Convergence Zone = ITCZ
  - poles: air flows poleward along the TP ⇒ Polar High pressure = PH
- ITCZ und PH are **thermal pressure centres**



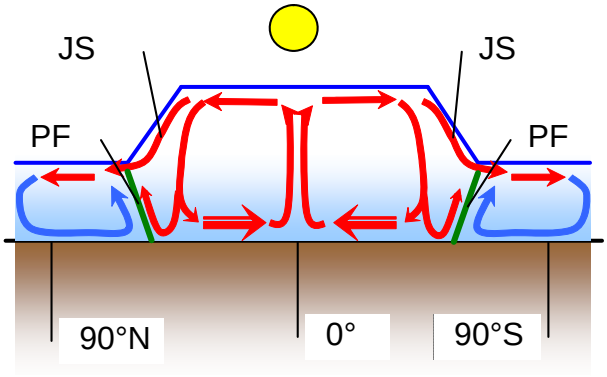
4th Step: Circulation as Compensatory Movement

- There must be a wind equatorward along the earth's surface to compensate the air movement along the TP ⇒ Hadley cell
- George Hadley: Brit. climatologist, lived in the Caribbean in the 18th century (then part of the British Empire), observed steadily flowing NE winds (= **NE trade winds**) and explained them with his model of the Hadley cell (1735 AD)
- falsification: there are prevailing winds from westerly directions in the middle latitudes (i.e. Europe ⇒ cf. green arrows)



5th Step: Jets Streams Lack Space

- equator = 40,000 km ⇔ pole = 0 km
- jet streams ascend on a width of 40,000km ⇒ approximately at 25° N/S jet streams are partially pressed downwards ⇒ SHP
- as the pressure difference increases at the polar front (PF), the jet stream accelerates to the polar jet (JS; v = 5–600 km/h)
- polar front separates cold polar air (blue arrows) from warm subtropical air (red arrows) and moves in Rossby waves around the earth (cf. AGG, p. 154)



- polar NE wind is redirected to NW winds at the Northern end of the Rossby waves by entrainment («bridge-pier effect») ⇒ SLP (cf. AGG, p. 154)
- high velocity of PJ sucks air out of SLP and reduces the pressure (Bernoulli's principle)
- SHP = subtropical high pressure (areas)
  SLP = subpolar low pressure (centres, troughs)
  ⇒ **dynamic pressure centres**