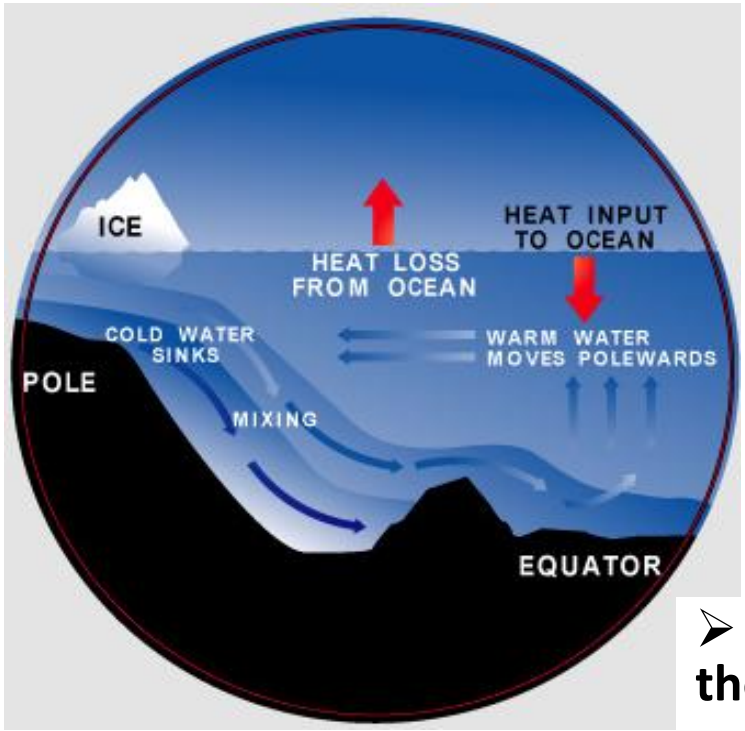
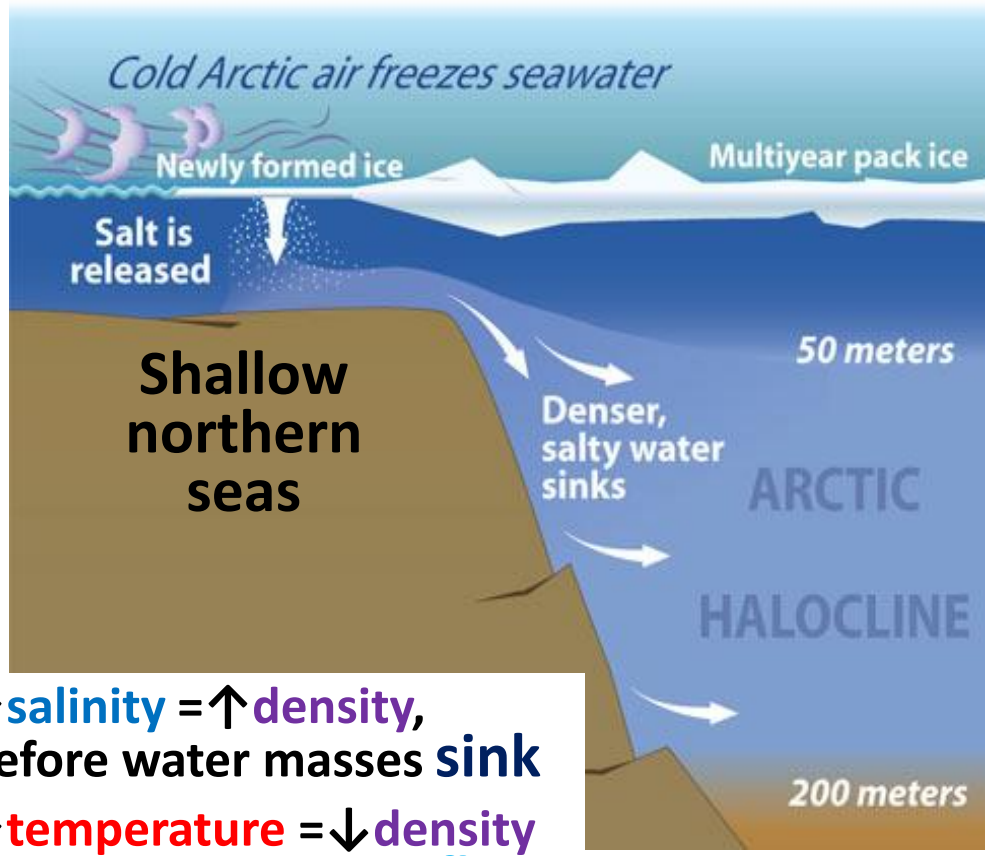
Vertical Circulation: Thermohaline

Water masses can rise and fall because of density differences due to variation of temperature and salinity with depth.

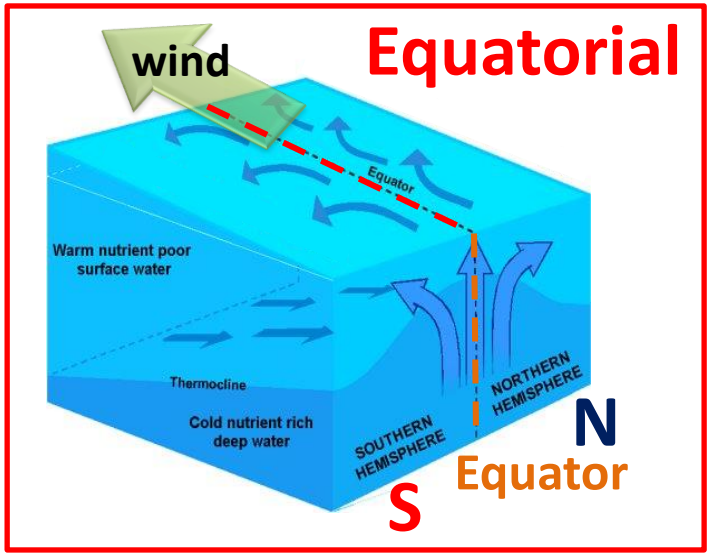




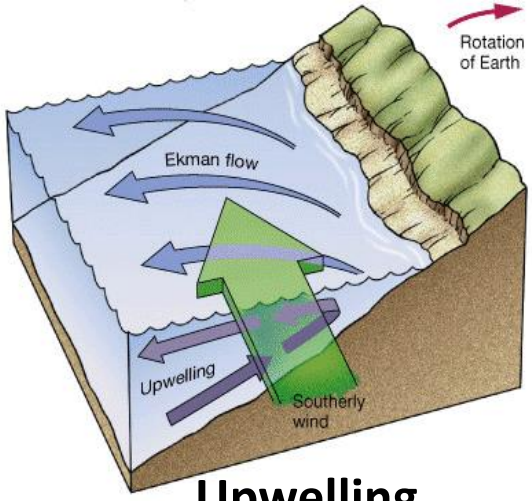
- ↑salinity =↑density, therefore water masses sink
- ↑temperature =↓density therefore water masses float

Vertical currents: Wind Driven

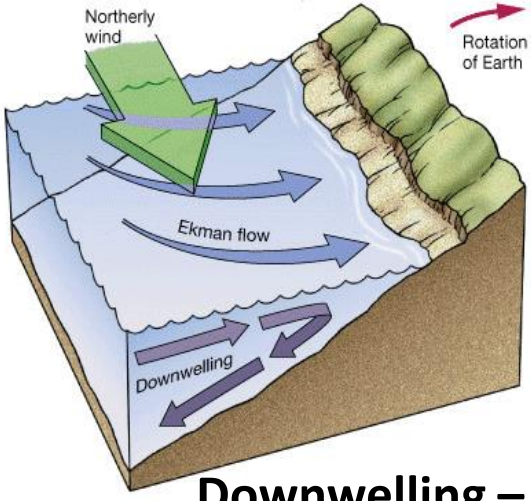
- **Wind blows, pushes surface water layer.**
- **Water is deflected to the side(s) due to Coriolis effect.**
- **Deep cold water rises up to replace it – *upwelling*.**

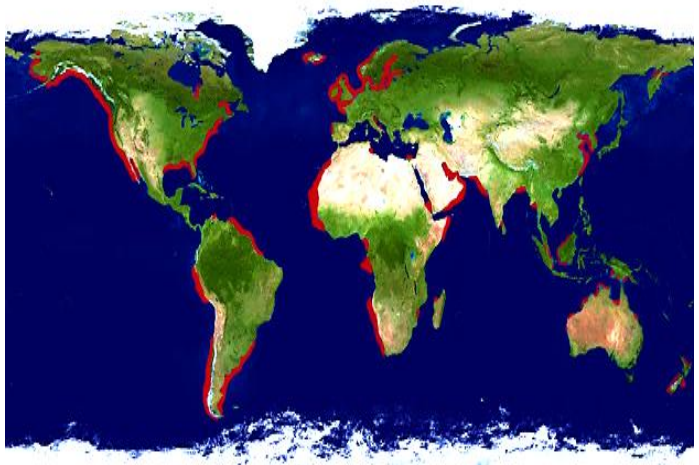


Coastal (Ex: West Coast, Southern Hemisphere)



Upwelling



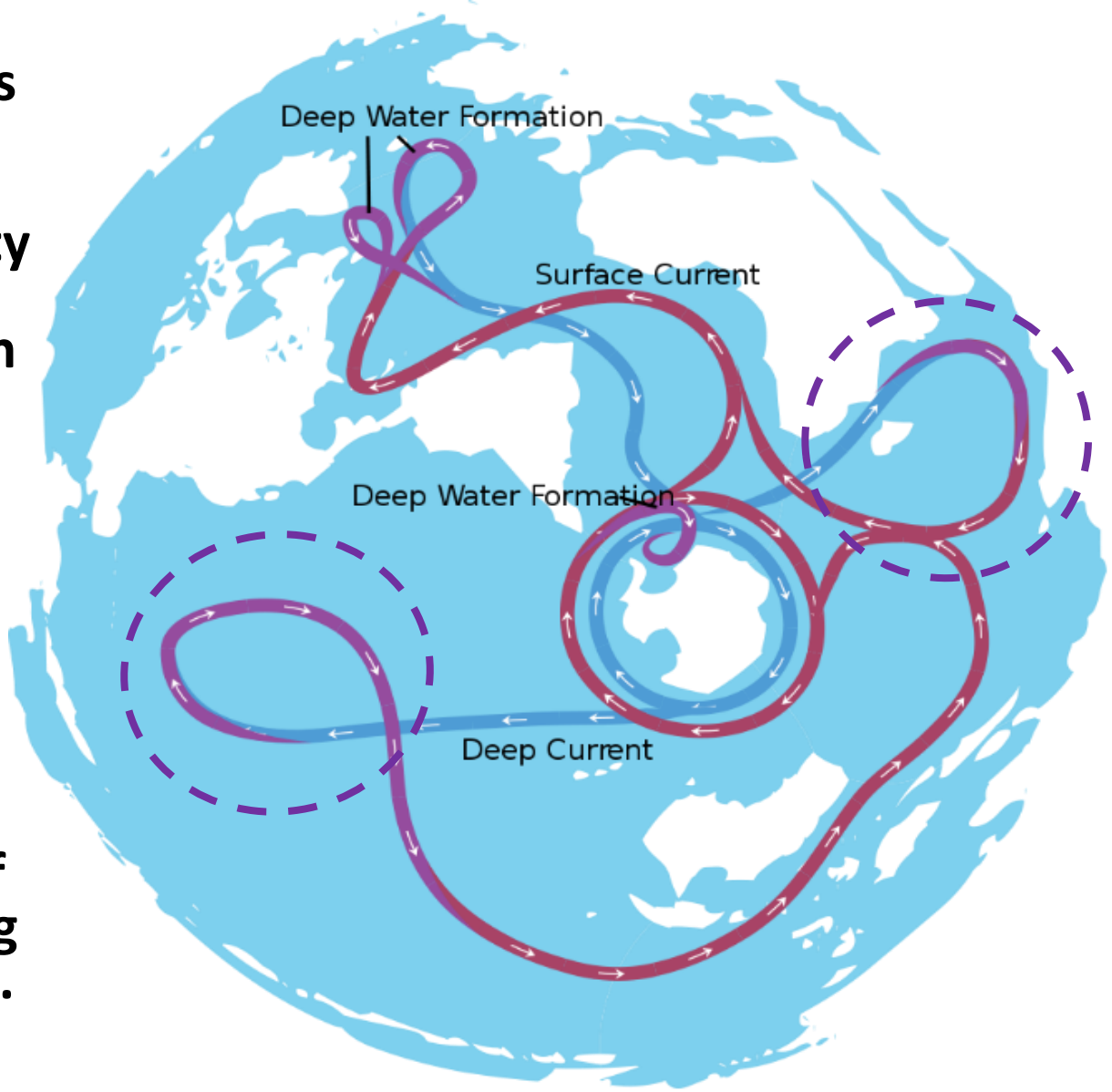


Downwelling – water moves *onshore and down*

Overturning Circulation

- **Deep water forms in polar regions: in Antarctic when the extremely frigid salty surface water sinks rapidly, and in North Atlantic due to evaporative cooling in Nordic seas.**

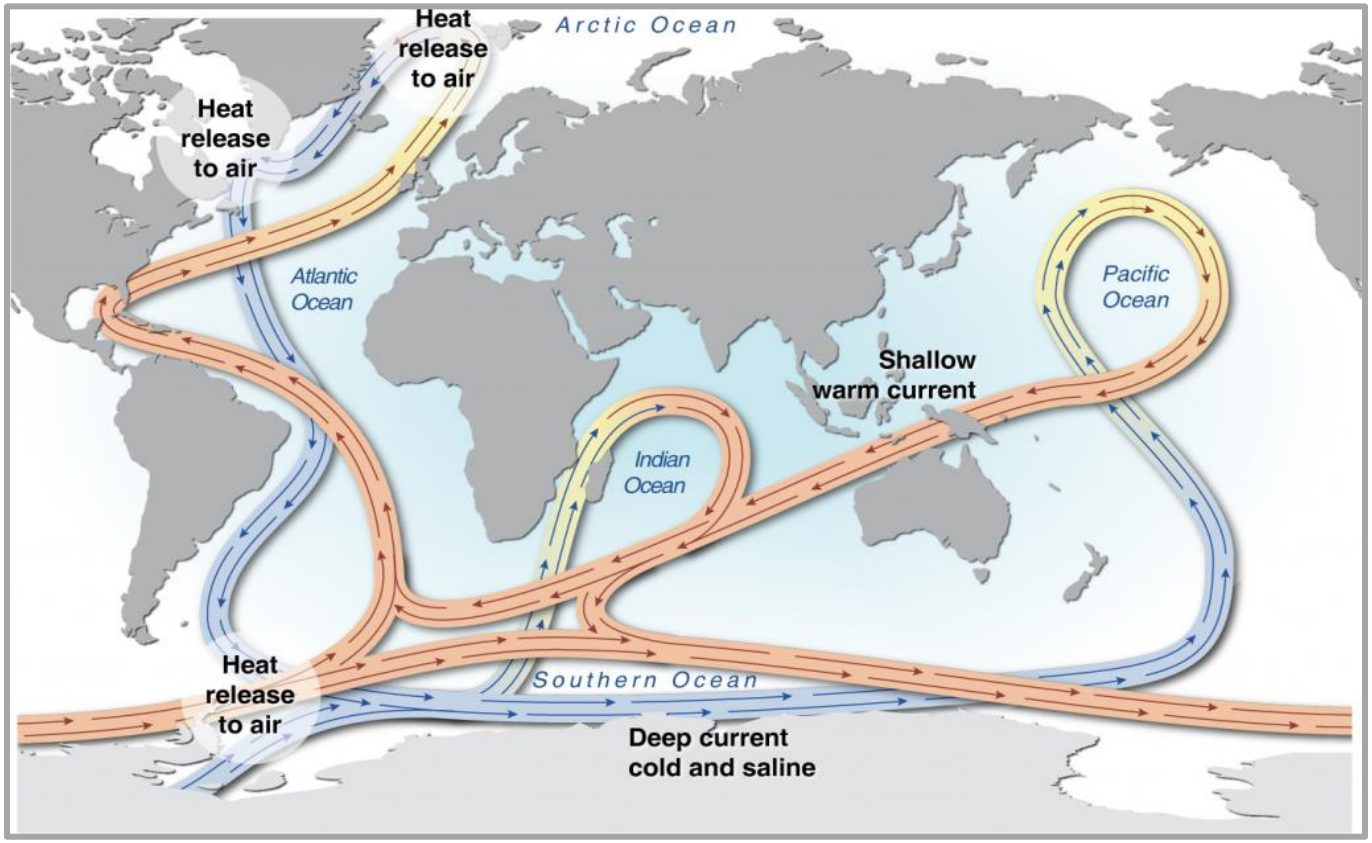
- **Upward flow overturning occurs in the Pacific and Indian Oceans mainly as a result of equatorial upwelling followed by heating.**



Conveyor Belt Circulation

Vertical **currents combined with** ***surface and deep*** **currents result in global conveyor belt movement of water.**

It takes **several hundred years** for the conveyor belt to turn over the ocean's waters and make **one complete trip around the Earth**.



The <u>ocean plays a major role</u> in the <u>distribution of the Earth's heat</u> through deep sea circulation.

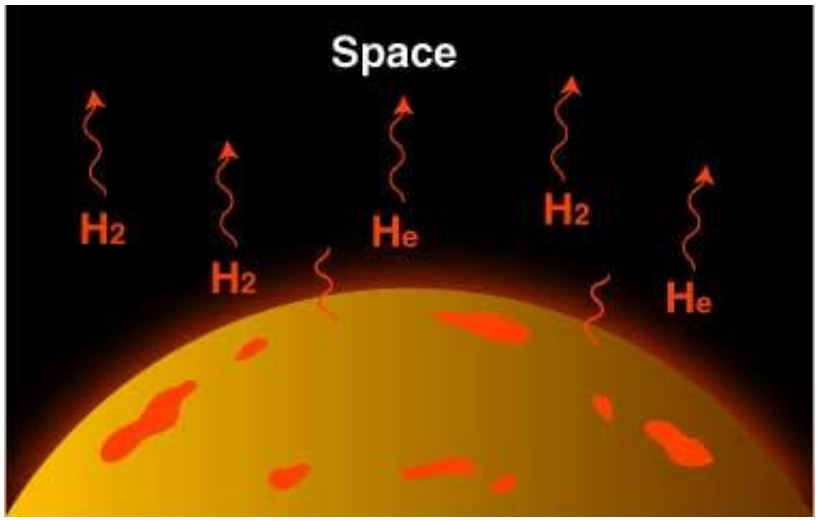
Atmosphere

from Greek ἀτμός [*atmos*] "vapor"and σφαῖρα [*sphaira*] "sphere"

- **An <u>atmosphere</u> is a layer of gases surrounding a material body of sufficient mass that is held in place by the gravity of the body.**
- **The Earth's atmosphere protects life on Earth by absorbing ultraviolet solar radiation, warming the surface through heat retention (*greenhouse effect*), and reducing temperature extremes between day and night.**

- The atmosphere is a **gas**.
- The atmosphere is a **fluid**.
- The atmosphere has a **mass of about 5.15×10^{18} kg** (~1-millionth of the Earth's mass!)

Evolution of the Early Atmosphere

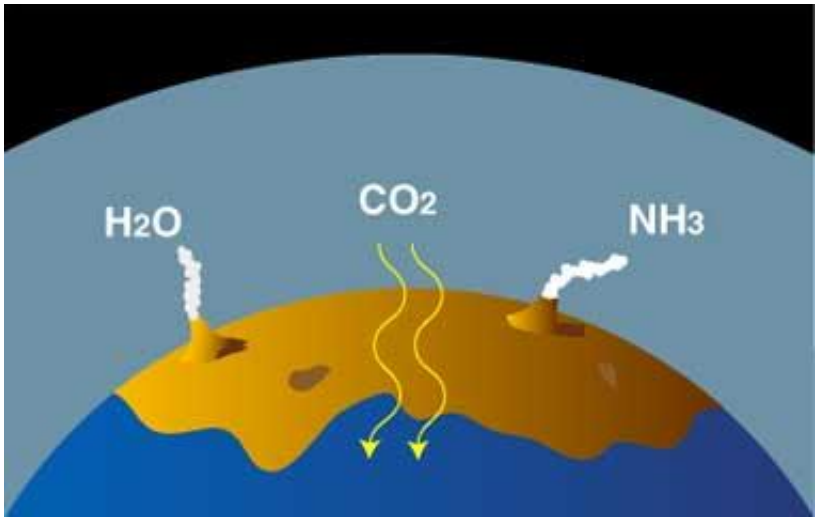


- **Primitive <u>first</u> atmosphere**

(*stellar gas* composition: H, He, CH_4 – hot and light, able to quickly escape to space)

- ***Outgassing*** **and the <u>second</u> atmosphere**

(volcanoes released H_2O, NH_3, Ar, CO_2 – <u>still no oxygen</u>!)

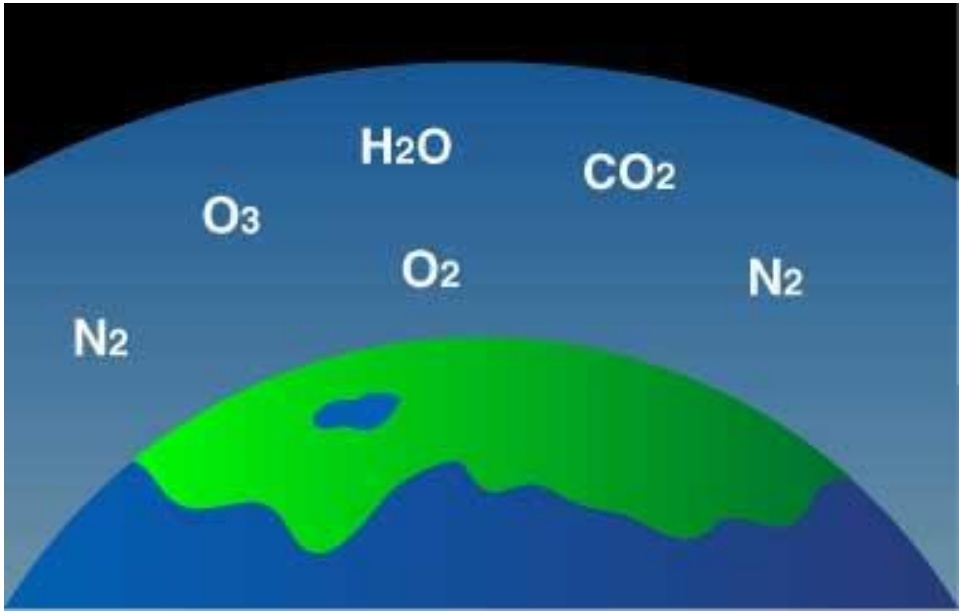


The Modern Atmosphere
upon which life depends was created by life itself!

The evolution of life and atmosphere are closely linked – life produces free oxygen (photosynthesis) and cycles carbon (limestone formation).

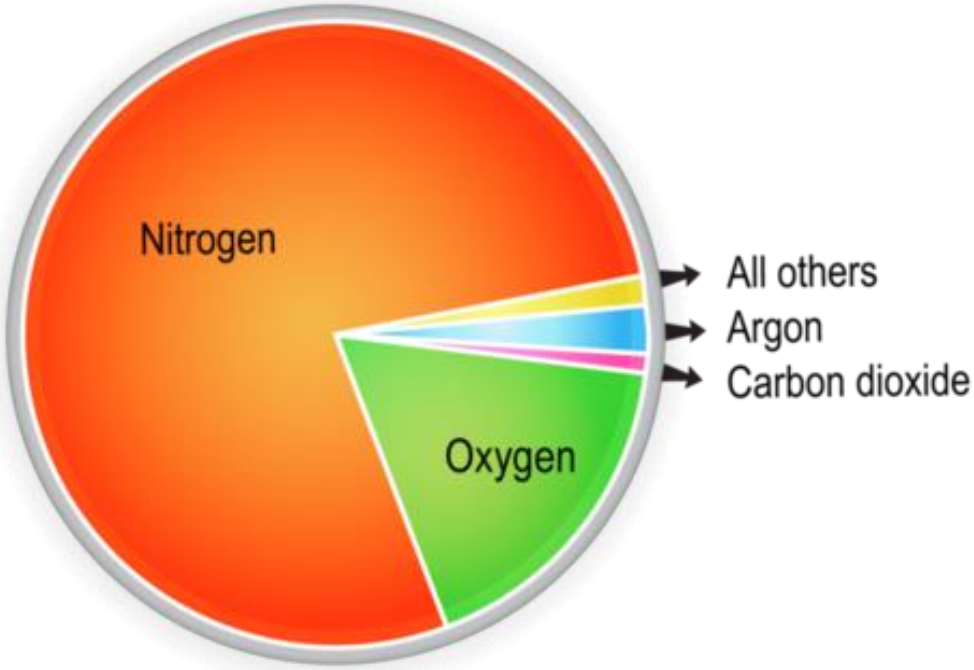
- ***Free oxygen is very reactive!***
- ***Oxidized*** **modern atmosphere**

(mostly N_2, O_2,
***and very little H_2O and CO_2…* playing a *very important role*!)**



Atmospheric Gases

- **Nitrogen - 78%**
- **Oxygen - 21%**
- **Argon - .93%**
- **Water vapor – 0 to 4%**



- ***Traces*** **of neon, helium, methane, krypton, xenon, hydrogen, ozone, and…**
- **…carbon dioxide - .0415% (end of year 2020)**
  - **keeps Earth warm and is used by plants to make food**

Layers of the Atmosphere

- **5 main layers (based on temperature and composition):**
  - **Troposphere**
  - **Stratosphere**
  - **Mesosphere**
  - **Thermosphere**
  - **Exosphere**

- **There is a bottom but no "top" – the atmosphere gradually thins out with increasing altitude.**
- **Atmospheric effects become noticeable during atmospheric reentry of spacecraft at an altitude of around 120 km (75 mi).**