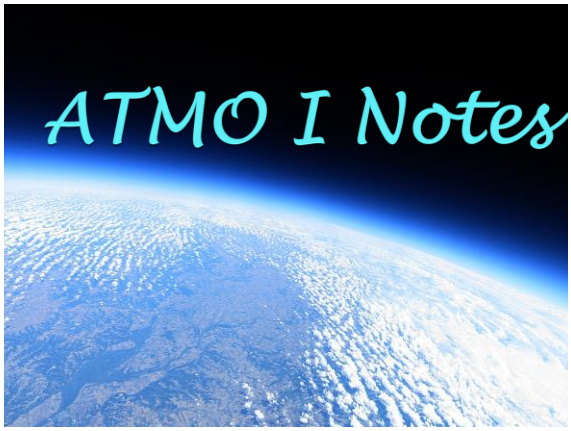


ORIGIN OF EARTH'S ATMOSPHERE

- Early Earth was HOT!
  - Consequences - Constant volcanism, surface temperature too high for liquid water or life
- Eventually cooling led to:
  - Condensation & accumulation of surface water
  - Changing atmosphere due to volcanic out-gassing
  - The right conditions for life.

Source: http://www.ux1.eiu.edu/~cf.jps/1400/atmos_origin.html

1ST ATMOSPHERE

- Composition – **Hydrogen - H_2 and Helium He**
- Lost to space early in Earth's history
- Planet was still cooling from formation

2ND ATMOSPHERE

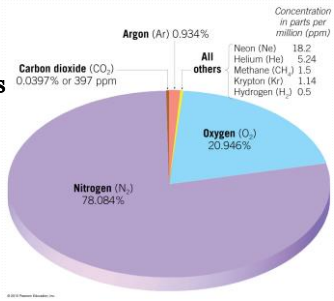
- Produced by volcanic out-gassing.
- **H_2O, CO_2**, CO, S_2, Cl_2, N_2, H_2 and NH_3 (ammonia) and **CH_4** (methane)
- No free O_2 at this time
- Ocean Formation - As the Earth cooled, H_2O produced by out-gassing was able to collect at liquid state on the surface into large bodies of water.

ADDITION OF O_2

- **Photochemical dissociation** - breakup of water molecules by UV radiation
  - *Produced O_2 levels approx. 1-2% current levels*
  - *Also O_3 (Ozone) will form to shield Earth surface from UV*
- **Photosynthesis** –
  - *CO_2 + H_2O + sunlight → glucose + O_2*
  - *O_2 produced by cyanobacteria, and eventually higher plants*

PRESENT COMPOSITION

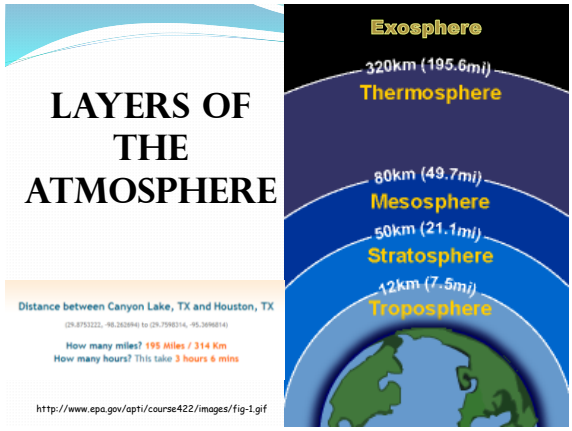
- **78% Nitrogen**
- **21% Oxygen**
- **0.934% Argon**
- **<0.1% other gases and suspended solids.**



WHY THE LAYERS ARE GOOD!

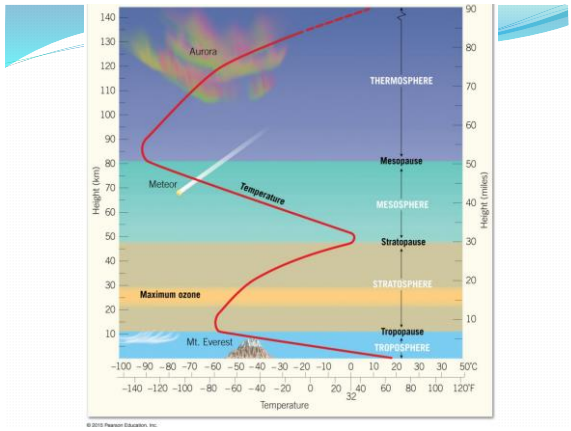
1. Protects from solar radiation
2. Prevents water from evaporating too fast and keeping it at a liquid state.
3. Maintains stable air pressure.
4. Provides O_2 & $C0_2$ for LIFE.

LAYERS OF THE ATMOSPHERE



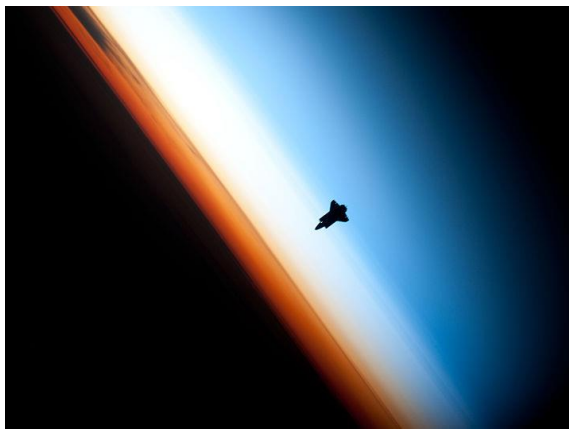
LAYERS OF THE ATMOSPHERE

- Caused by temperature differences
- These differences result from how solar energy is absorbed as it moves through the atmosphere



LAYERS LATIN MEANING

- Exo – "to leave/exit"
- Thermo – "heat"
- Meso – "middle"
- Strato – "army/to protect"
- Tropo – "turning/turbulent"

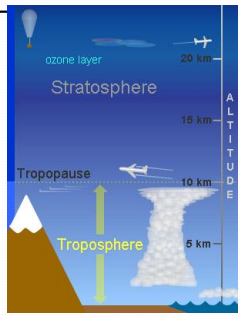


TROPOSPHERE

- 10-12km 5-8 miles
- Closest to Earth
- Nearly all weather occurs here
- Almost all H_2O (vapor) and CO_2
- Temp. decreases with altitude
- heated from below by thermal energy that is re-radiated from Earth's surface

TROPOPAUSE

- Upper boundary of the troposphere
- Jet stream
  - Varies with latitude & seasons
  - 250 mph
  - Westerly winds (from the west)



STRATOSPHERE

- 25 – 50 km, 16-24miles
- Ozone layer is here
- Temp. increases because air is heated from ozone layer
- Jets fly here to avoid turbulence
- Stratopause - upper boundary

OZONE LAYER

- Ozone is made of 3 atoms of oxygen (O_3)
- absorbs harmful UV radiation from the Sun
- ≈ 2-3 mm thick if it were at sea level

MESOSPHERE

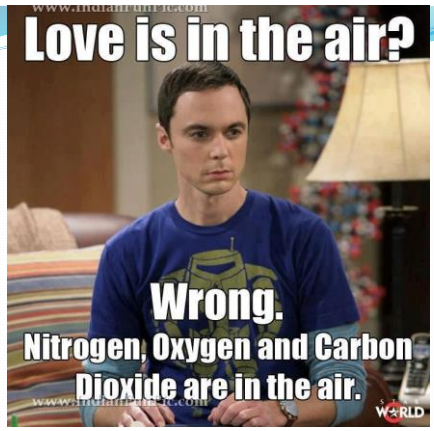
- 50 – 85 km 30-55miles
- Temp. decreases as altitude increases
- Avg Temp. = - 90°C
- COLDEST layer in the atmosphere
- Meteors begin to disintegrate here
- Mesopause - Upper boundary

THERMOSPHERE

- 200 ~ 350 km 90-220miles
- Temp. increases as altitude increases
- Hard to read temperature with a thermometer because air particles are too far apart
- Space Shuttle & ISS(International Space Station) orbit here
- Ionosphere (charged particles) found here
- ….auroras also occur here

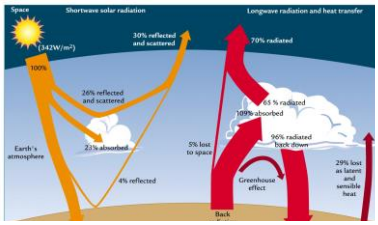
EXOSPHERE

- Beyond 350km
- Escaping particles are the only thing found here.
- Hard to figure out where the atmosphere stops and "space" begins almost a complete vacuum.



SOURCE OF ALL THINGS ATMO

The Sun's heat is the source of energy that drives all pressure, wind, temperature, and therefore all weather.



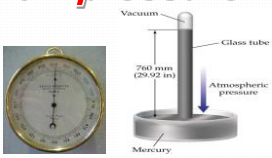
What instrument is used to measure:

wind speed

anemometer

[ORIGIN from Greek *anemos* 'wind']

air pressure

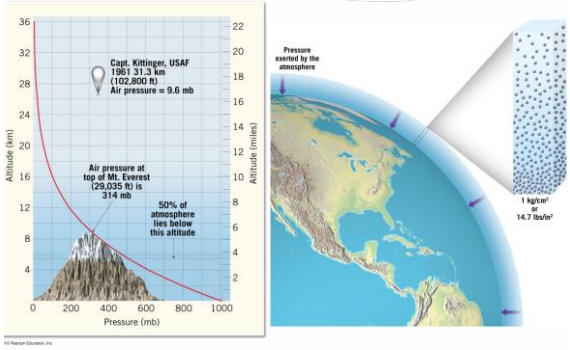


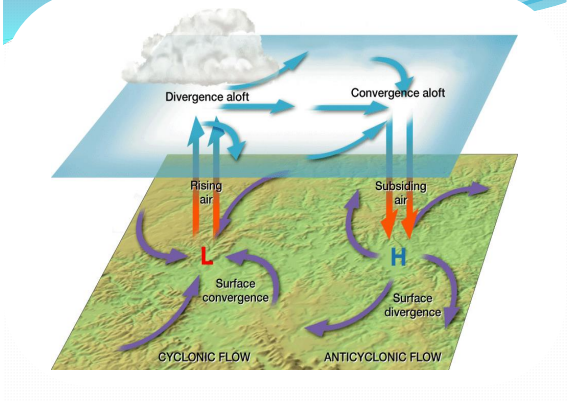
barometer

ORIGIN from Greek *baros* 'weight

AIR PRESSURE

- Created by collisions of air molecules
- Avg. surface air pressure =
  - 14.7 pounds per square inch (psi)
  - 1013 millibars (mb)
  - 1 atmosphere (atm)
- Decreases with altitude
- Low pressure = Rising air = Clouds
- High pressure = Sinking air = Clear skies

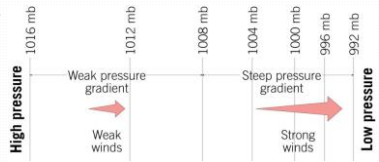




WIND

- Moving currents of air
- Develops due to differences in air pressure
  - *High → Low*
- **Pressure gradient** – the difference in air pressure over a horizontal distance
  - *> PG = > Winds*
- **Isobars** – lines of equal pressure

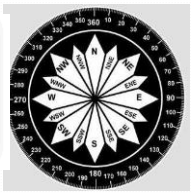
Close lines = Strong winds

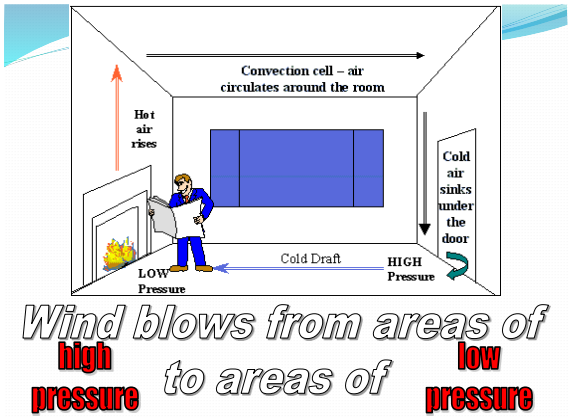


WIND (CONT.)

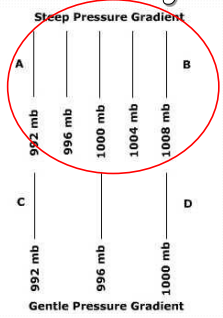
- **Winds always blow from high pressure areas to low pressure areas.**
- **Winds are named for the direction they come from**

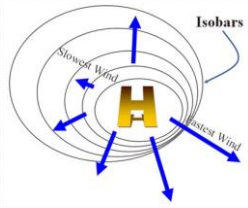
Easterly	South Westerly
Westerly	South Easterly
Southerly	North Easterly
Northerly	North Westerly

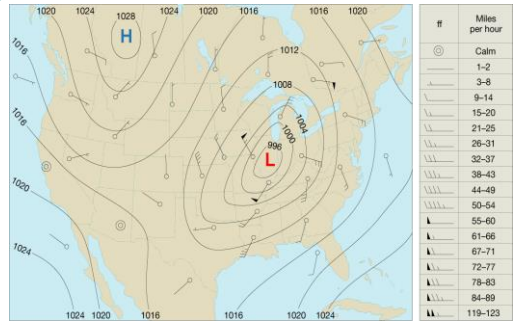




Which pressure gradient would result in greater wind velocity?



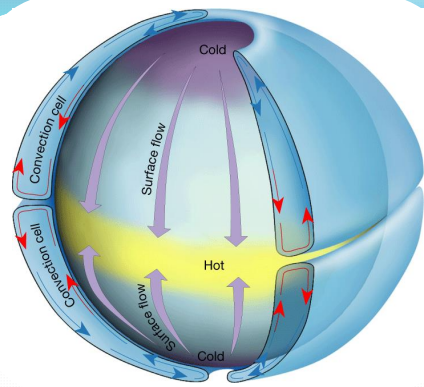




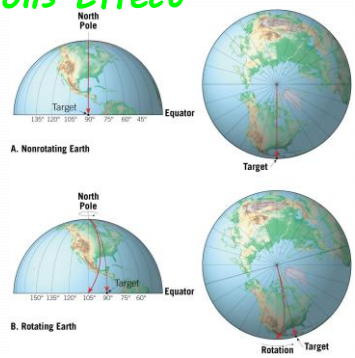
EFFECT OF EARTH'S ROTATION

Non-Rotating Earth Model

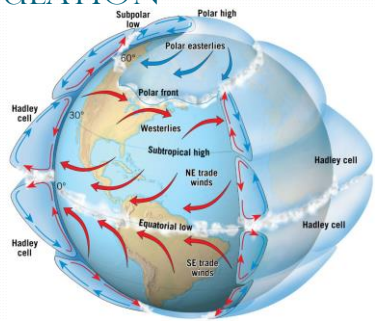
- On a hypothetical non-rotating planet with a smooth surface of either all land or all water, two large thermally produced cells would form.



Coriolis Effect



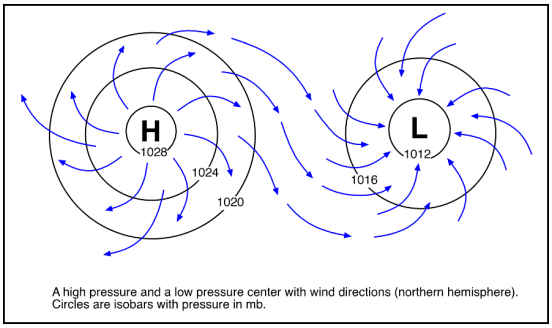
ACTUAL GLOBAL CIRCULATION



ROTATING EARTH MODEL AKA - COREOLIS EFFECT

- Winds "try" to take the most direct route possible (straight equator or poles), but because of Earth's rotation:
  - N.Hemis–winds deflect to the right
    - *High pressure - clockwise*
    - *Low pressure - counterclockwise*
  - S.Hemis–winds deflect to the left
    - *High pressure - counterclockwise*
    - *Low pressure - clockwise*

WINDS AROUND HIGH AND LOW IN NORTH HEMISPHERE



A high pressure and a low pressure center with wind directions (northern hemisphere). Circles are isobars with pressure in mb.

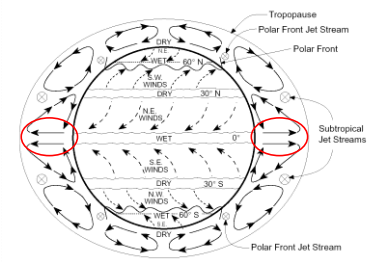
Let's Review...

In a high pressure area, air will (rise, sink) because the air is (less, more) dense. This is because the air is (cold, warm) and (rises, sinks). Therefore, clouds CANNOT form.

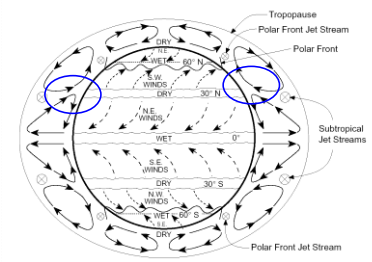
In a low pressure area, air will (rise, sink) because the air is (less, more) dense. This is because the air is (cold, warm) and (rises, sinks). Therefore, clouds are LIKELY to form.

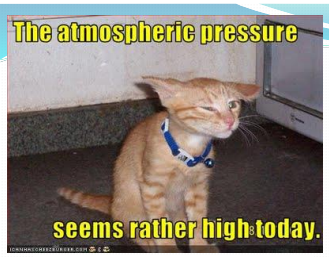
	low pressure	high pressure
warm or cold air	warm	cold
air rising or sinking	rising	sinking
clouds or no clouds	clouds	no clouds
clockwise or counterclockwise wind direction	counter clockwise	clockwise
winds toward or away from the center	toward	away

Is air rising or sinking at the equator?



Is air rising or sinking at 30°N?





The Weather Rises and Falls