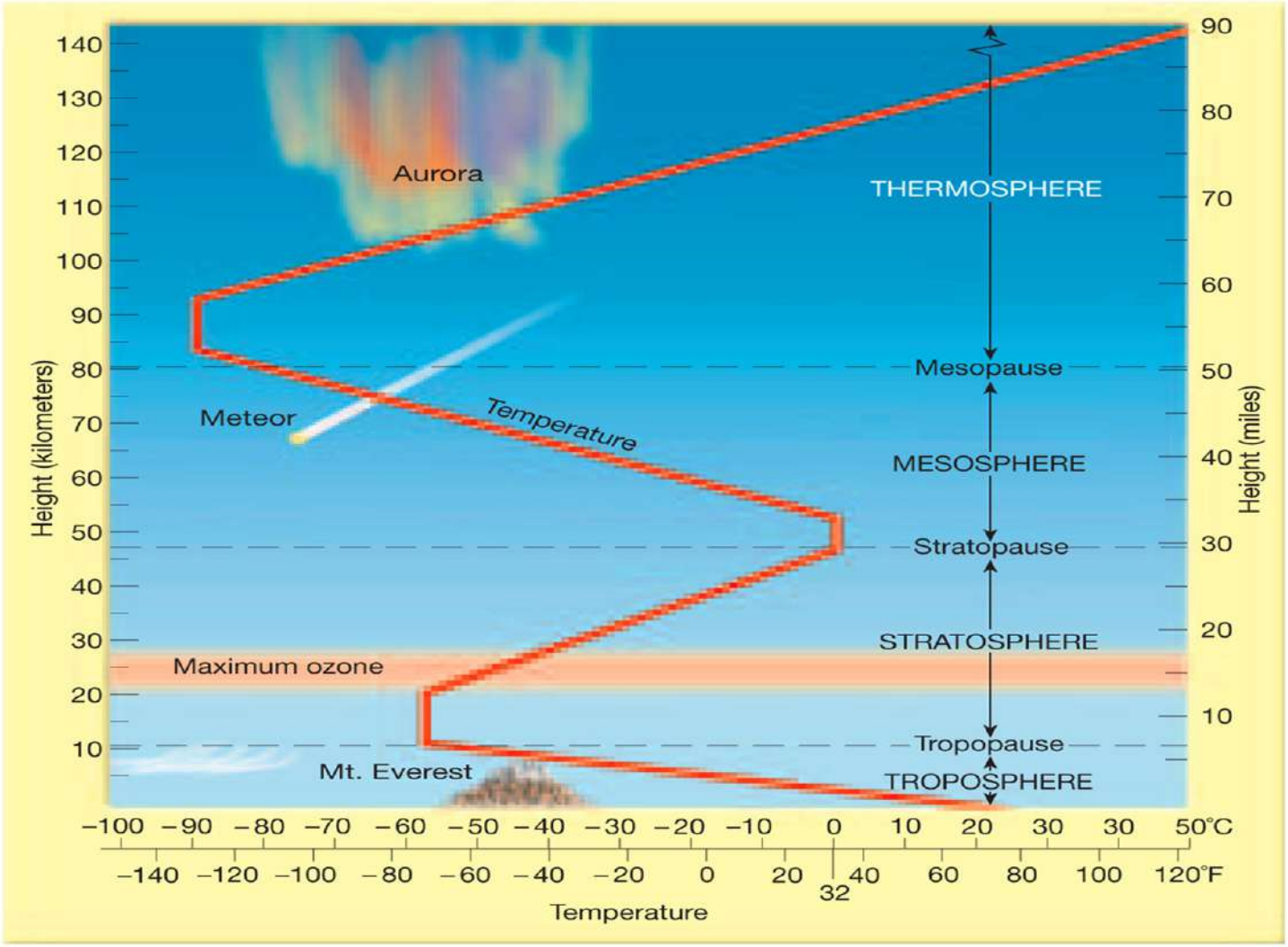
ATMOSPHERE

ESSENTIAL QUESTION:

- How are we tied to our atmosphere?
  - How has the formation of an atmosphere affected life?
  - How has life affected the atmosphere?
  - How has the atmosphere changed?
  - How has internal Earth processes affected our atmosphere, and life?
  - How can small changes cause large feedback loops?
  - In what ways are we altering our atmosphere?

LAYERS



LAYERS OF ATMOSPHERE

Layers identified by changes in *temperature*

- Troposphere-80% of total atmosphere
  - ~10 mi
  - Weather occurs here
  - Temp decreases3.5˚F per 1000 feet (average)
  - Boundary: **tropopause**

Stratosphere

- About 10 – 30 miles
- Temperature increases at top
- This is where **ozone** is found
- Outer boundary is named the **stratopause**

LAYERS, CONTINUED

- **Mesosphere**
  - 30-50 mi
  - Temp decreases (little ozone)
  - **Mesopause** is boundary
- **Thermosphere**
  - 50-90+ mi
  - Temp increases due to intense solar radiation
- **Ionosphere**
  - 90-500 mi
  - Air is ionized

ATMOSPHERIC GASES

Greenhouse gases

- CO2-traps heat and stores it near Earth's surface, preventing escape into space
- Increasing CO2 makes the Earth warmer!
- Without ANY greenhouse effect-Earth would be **FREEZING**!

Ozone-O3

- Blocks UV radiation

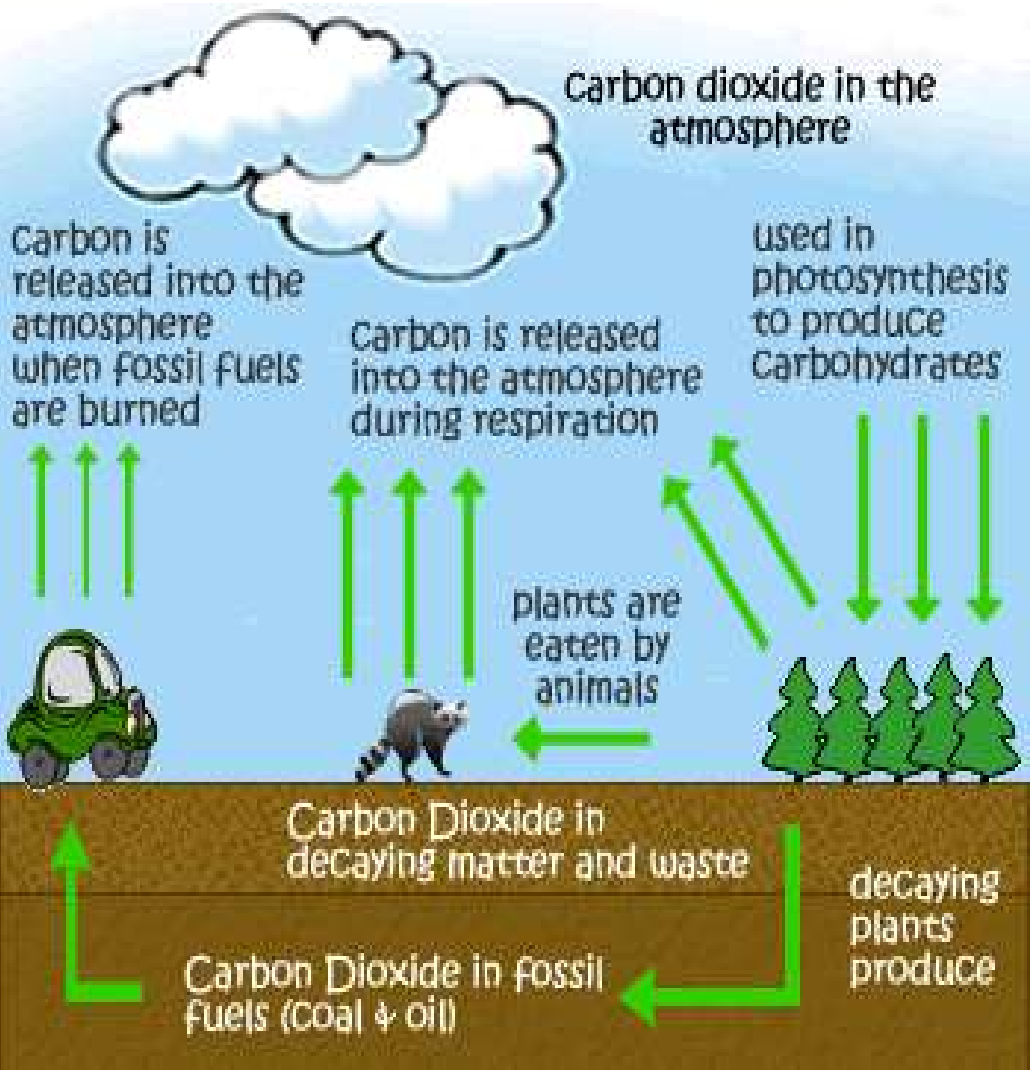
Principal gases in dry air	percentage
Nitrogen	78%
Oxygen	21%
Argon	.9%
Carbon Dioxide	.036%

ATMOSPHERIC GASES

- Gases remain constant due to recycling processes within Earth's "systems"
  - Balance is maintained due to equal parts leaving as entering USUALLY

- Local events can disrupt balance
  - Burning of fossil fuels and other organic materials increases atmospheric Carbon Dioxide CO_2 (Traps heat)
  - Volcanic eruptions increases atmospheric SO_2 and other gases (Overall effect is reduced heat)

CARBON CYCLE-CO2 AND METHANE (CH_4)



Carbon is crucial to every living thing!

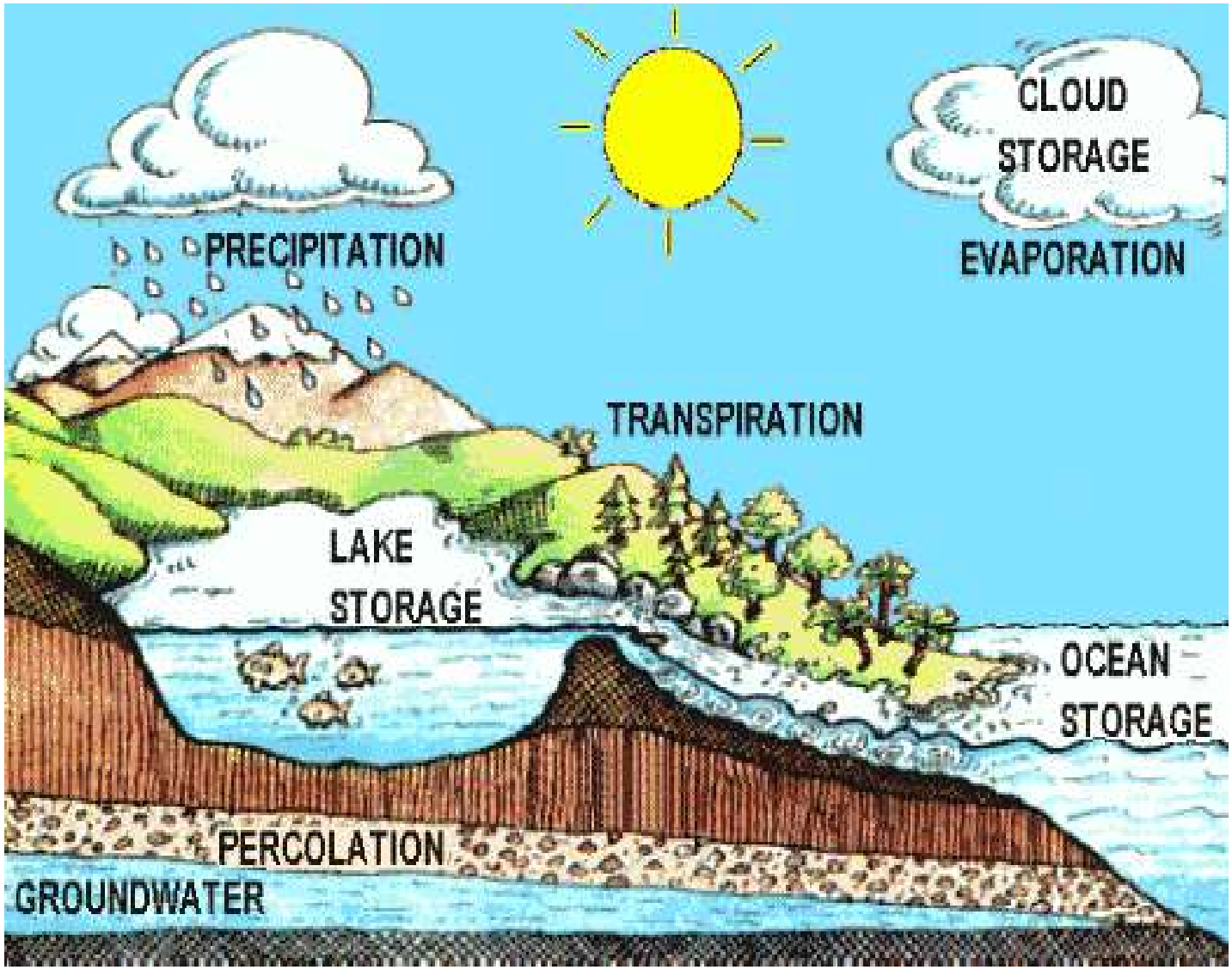
- Chemical, not physical change
- Bio-compounds
- Minerals
- Plants remove CO_2 from atmosphere, release O_2
- Animals (and us) inhale oxygen and exhale CO_2.

CARBON CYCLES: ROLE OF HUMANS

Currently-we have exceeded natural fluctuations

- Burning fossil fuels (geosphere→atmosphere)
- Higher than last 500,000, rising faster than ever
  - Altered weather
- Oceanic chemistry-increased acidity, decreased productivity
  - +temp and +CO2=decomposition-CO2 returned to air quicker than natural
- Deforestation removes a crucial carbon sink
- Warmer temps=thermal expansion of ocean water
  - Water takes up more space as it warms and expands

WATER CYCLE


CLOUD
STORAGE
PRECIPITATION
EVAPORATION
TRANSPIRATION
LAKE
STORAGE
OCEAN
STORAGE
PERCOLATION
GROUNDWATER

WATER CYCLE

Movement of water from different reservoirs and to different phases

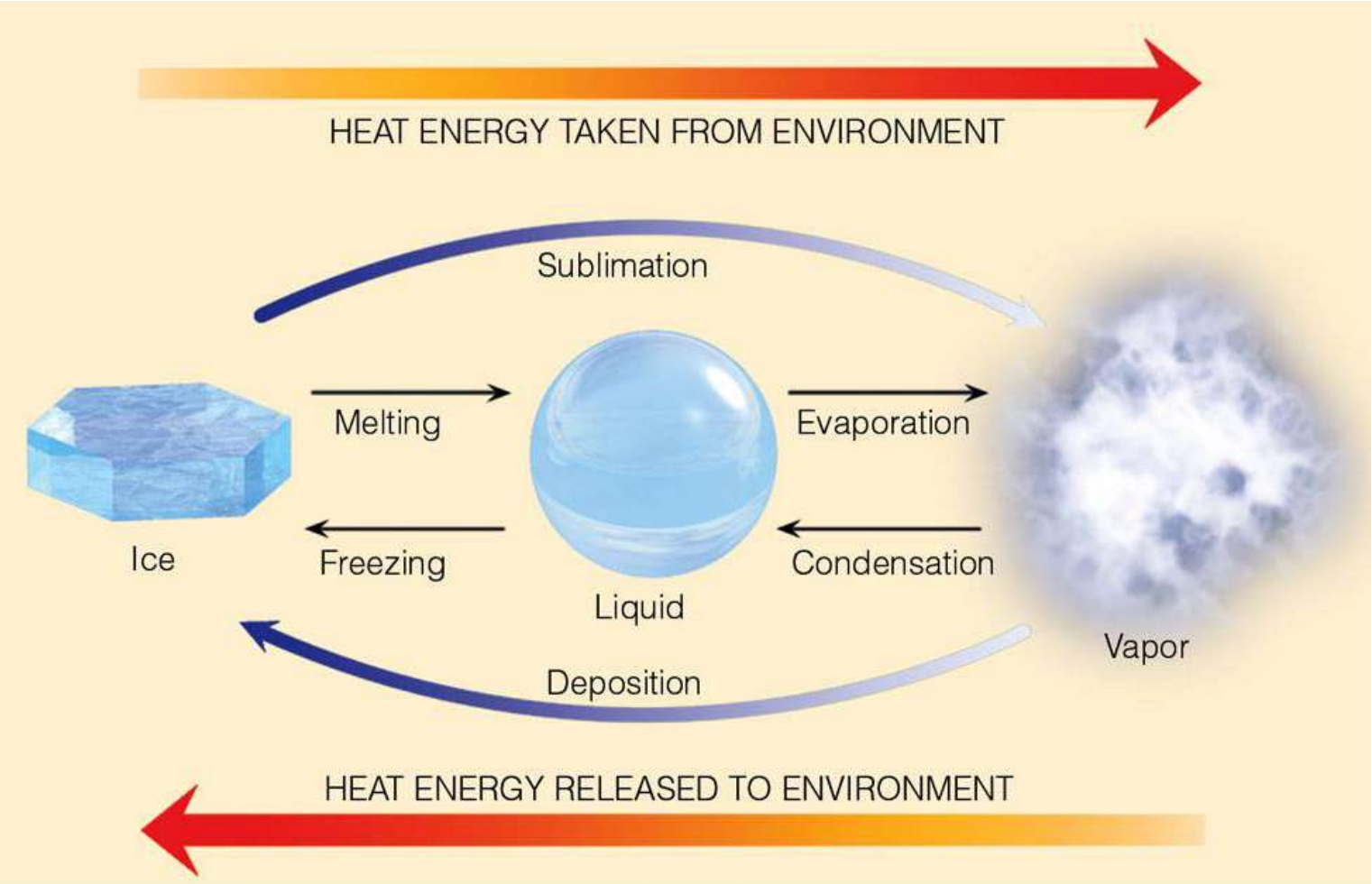
Physical processes:

- Evaporation, condensation, precipitation, Deposition (infiltration, runoff) and sublimation
  - 86% of evap. Comes from oceans, keeping temps cooler

Phases:

- Liquid, solid (ice), gas (vapor)

PHASE CHANGES



PHASE CHANGE DEFINITIONS:

Opposites—one requires/absorbs energy, the other releases

- Sublimation-solid to gas (requires energy)
- Deposition: opposite (what to what?)
- Evaporation: liquid to gas (requires energy)
- Condensation: opposite
- Melting: solid to liquid (requires energy)
- Freezing: opposite

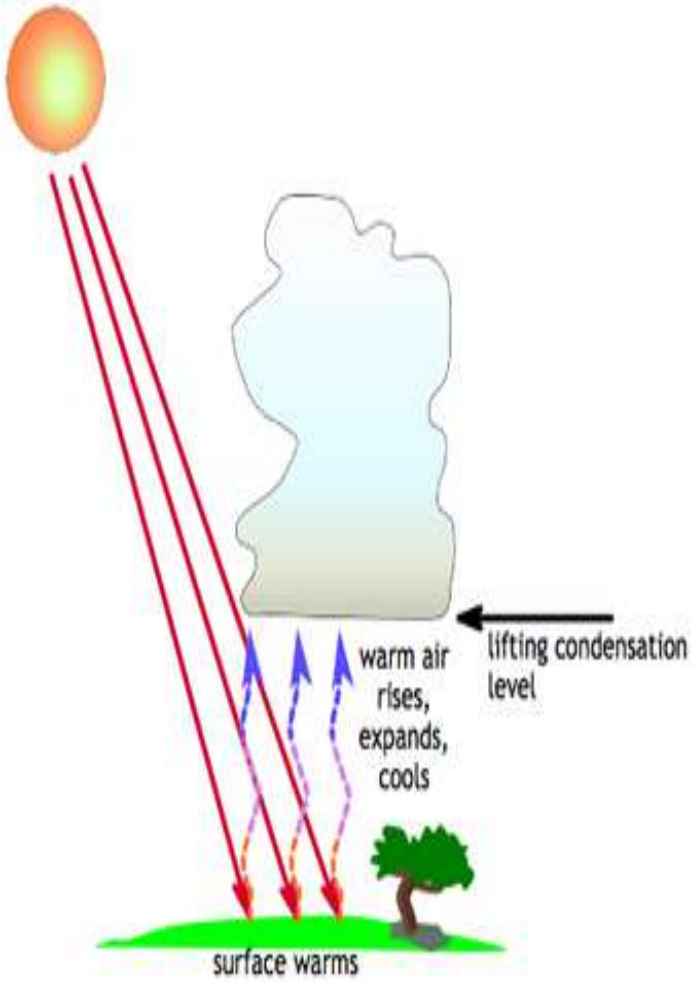
WAIT A SEC, WASN'T THIS UNIT ON ATMOSPHERE????

Yup.

It is all related-I promise!

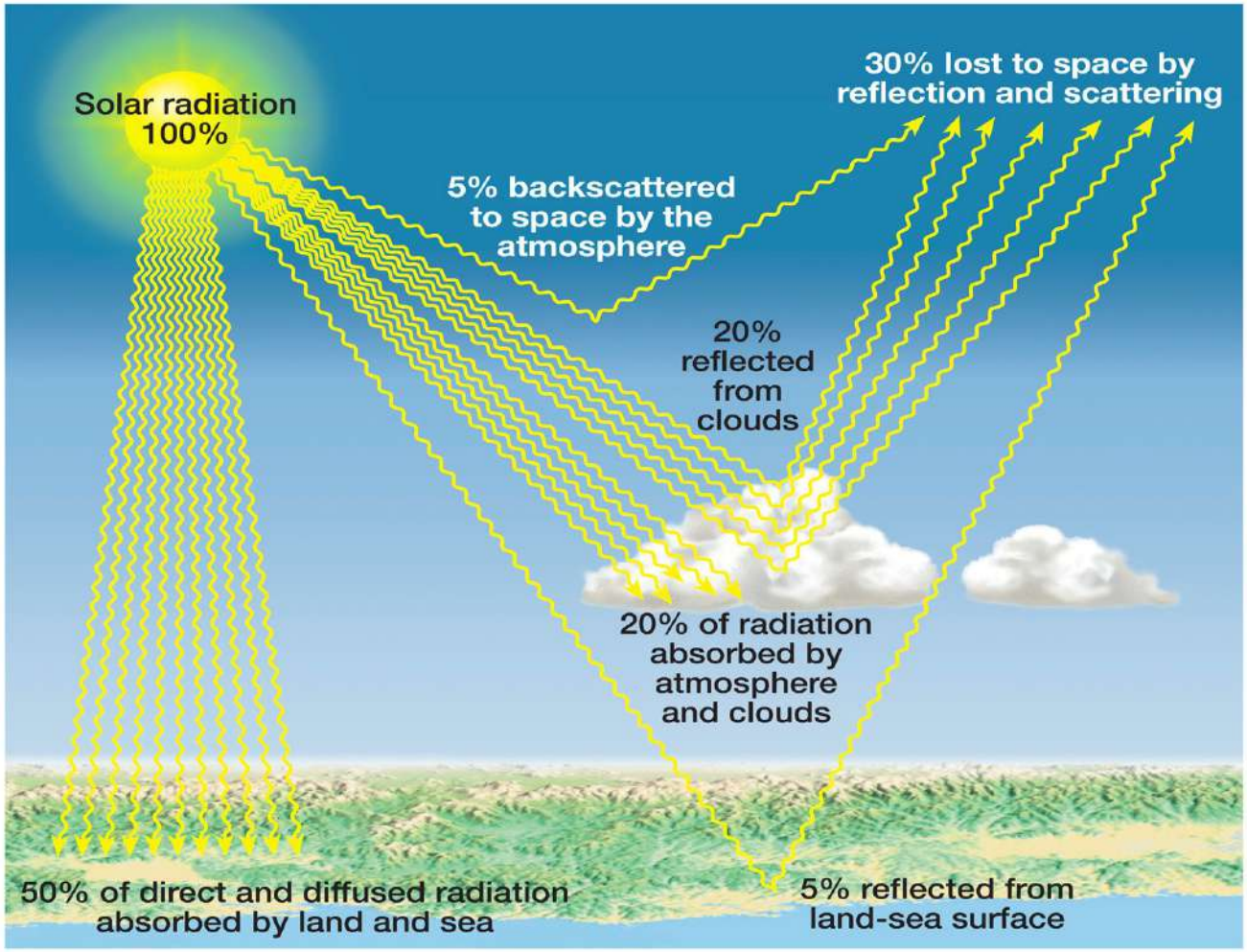
- Promotes phase changes
- clouds- (water vapor) affect incoming and outgoing radiation
  - Prime regulator of Earth's Energy

ATMOSPHERIC HEATING AND ENERGY



- All energy comes from the sun
- About 50% absorbed by land and sea-the rest radiated back to space
- Sun heats ground, ground heats the air
- Warm air rises, expands and cools
  - Clouds!!

SURFACE HEATING AND RADIATION



CLOUD FORMATION

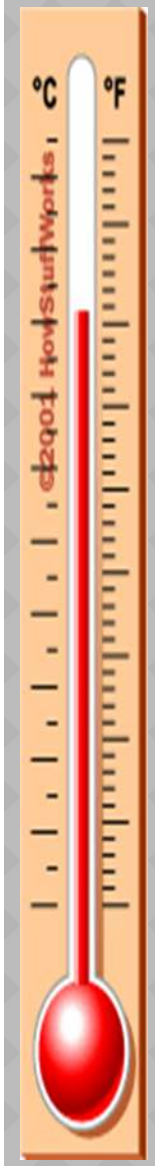
- Cold air can hold less water vapor, so it condenses out to form water droplets
- Rising higher and higher→more expansion→more condensation
- Surface COOLING produces fog

HEAT AND THE ATMOSPHERE

- Heat: measure of how fast the atoms or molecules of a substance are moving.

  - Temperature: is the average kinetic energy (Energy of movement)

  - **The faster the movement the higher the heat energy and the higher the temperature**



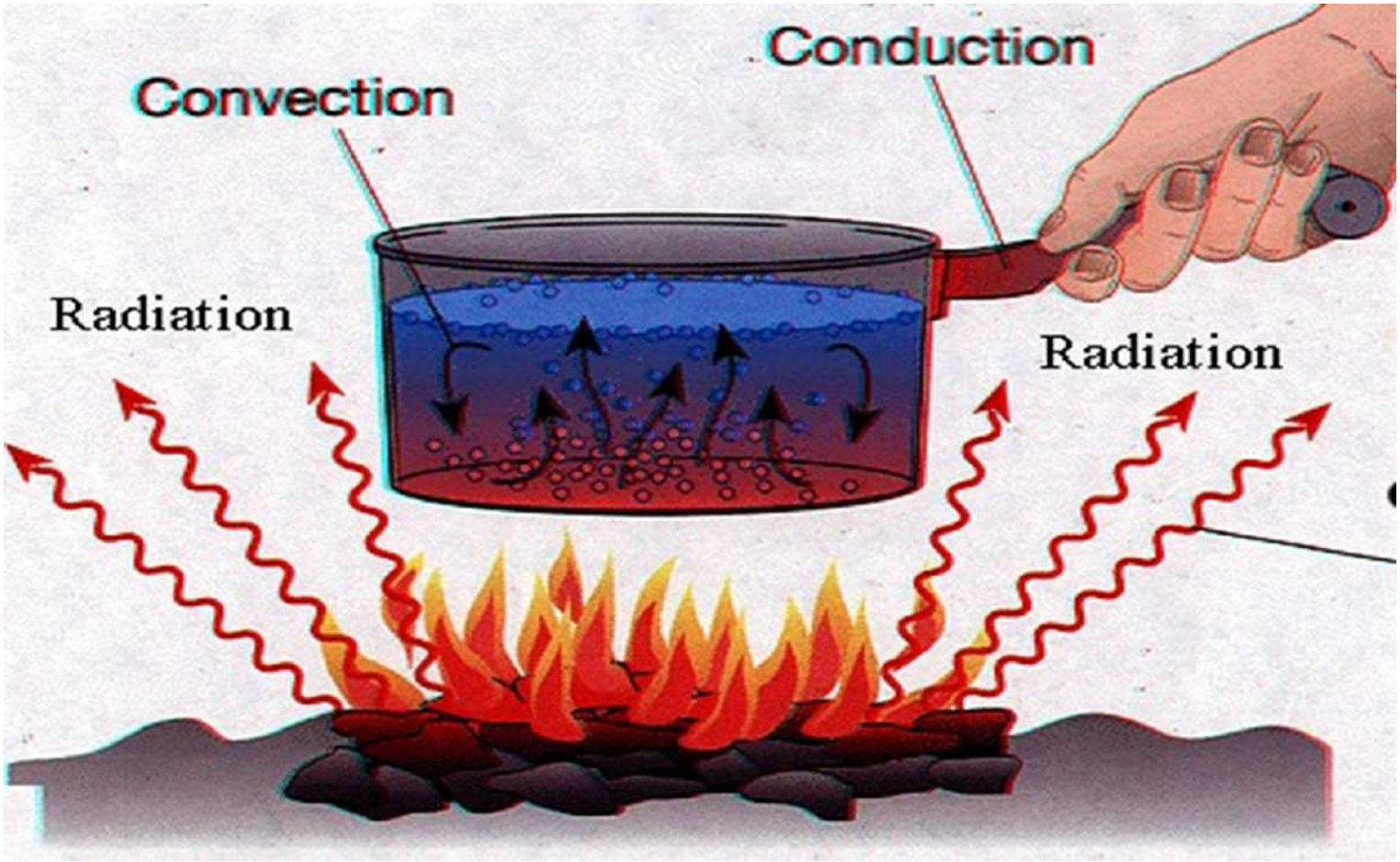
HEAT TRANSFER

- **Radiation** – the movement of energy through empty space
  - **Light travels from a sun across the solar system to the earth**
  - **Heat from a fire warms your hand without touching the fire.**

- **Conduction** – the movement of energy through a substance, on contact. Atoms or molecules collide with others to make them move
  - **Heat moves through the handle of a hot pot to burn your hand**

- **Convection** – the rising and falling of a substance due to its change its temperature/density
  - Water in a pot boils, heat in a room rises, cold water sinks

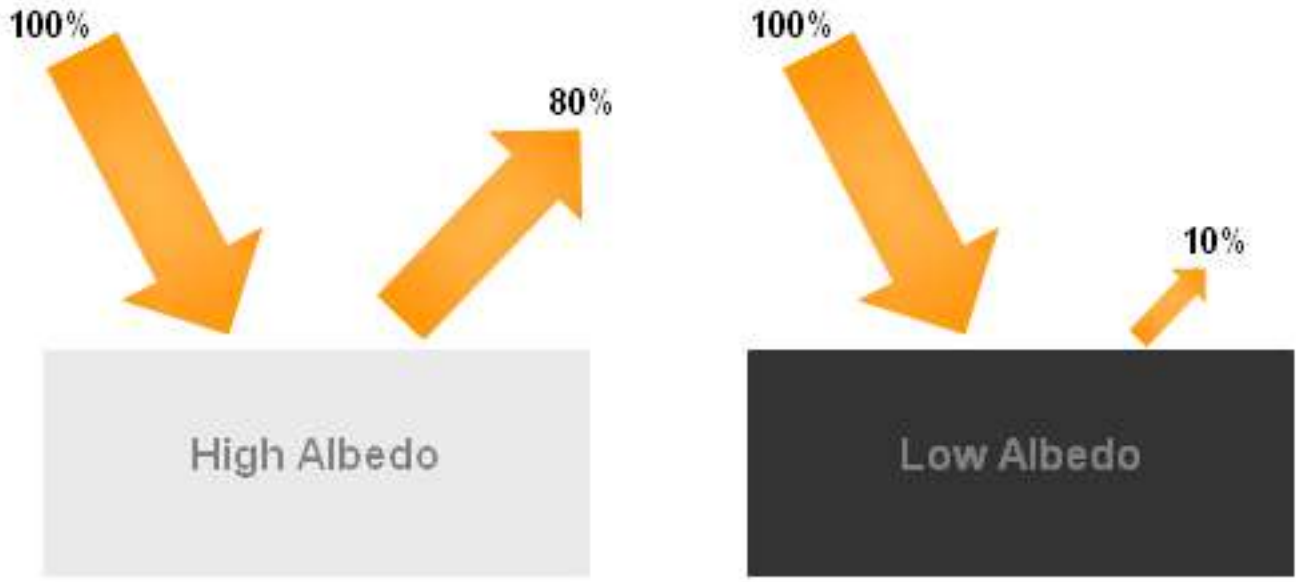
HEAT TRANSFER MECHANISMS



ALBEDO

Measure of a surfaces' reflectivity

- Very dark colors have an albedo close to zero (or close to 0%).
- Very light colors have an albedo close to 100%

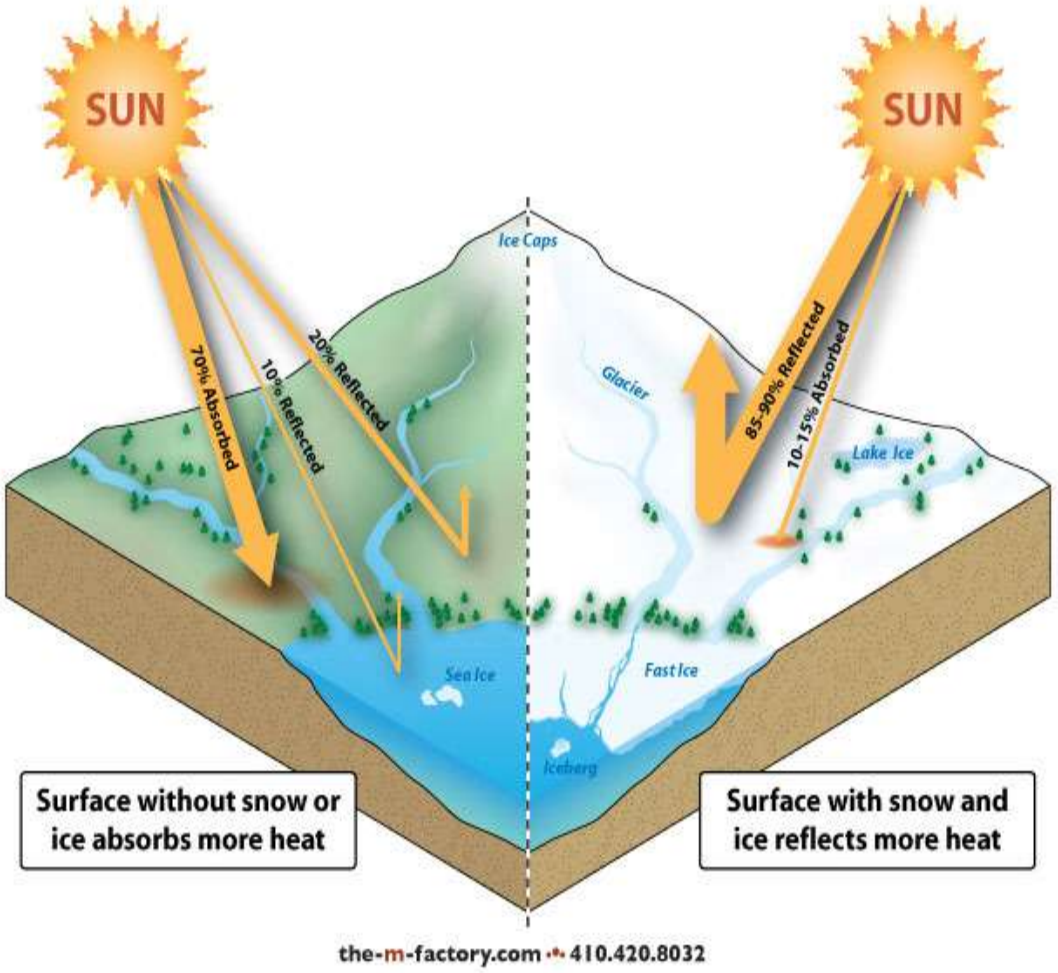


GROUND SURFACE HEATING

Albedo vs **absorption**

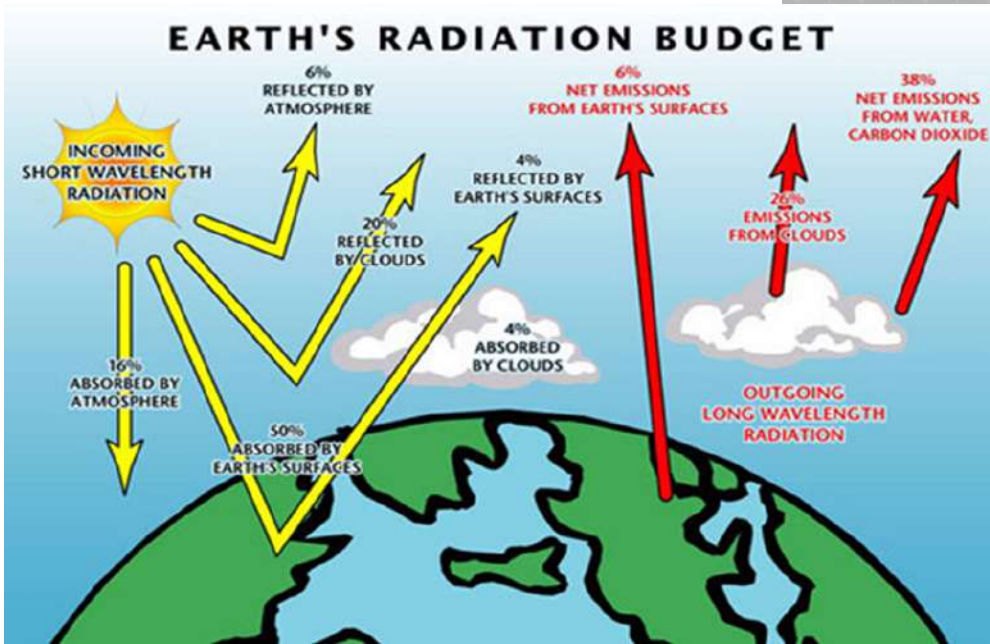
Albedo

- Solar energy reflected from Earth back into space
- Albedo-cool temps
- Absorption-warm temps



ALBEDO VS ABSORPTION CONTINUED

- Two surfaces-Land and Water
  - Dark materials (most land surfaces) absorb more heat
- Trees-low albedo, high absorption
- Snow-high albedo, low absorption
  - temperature feedback
- Clouds



BLACK CARBON

- When fossil fuels are not burned completely,

They produce black carbon or SOOT

- LARGE climate impact:
- Remains in atmosphere for days-weeks, absorbing sunlight and generating heat
  - When it settles, it darkens snow and ice, decreasing albedo, warming the area, melting the ice (feedback)

HUMAN IMPACTS ON THE ATMOSPHERE

Air pollution-any airborne gas or particle that occurs at a concentration capable of harming humans or the environment

- Dust, pollen and mold can be suspended

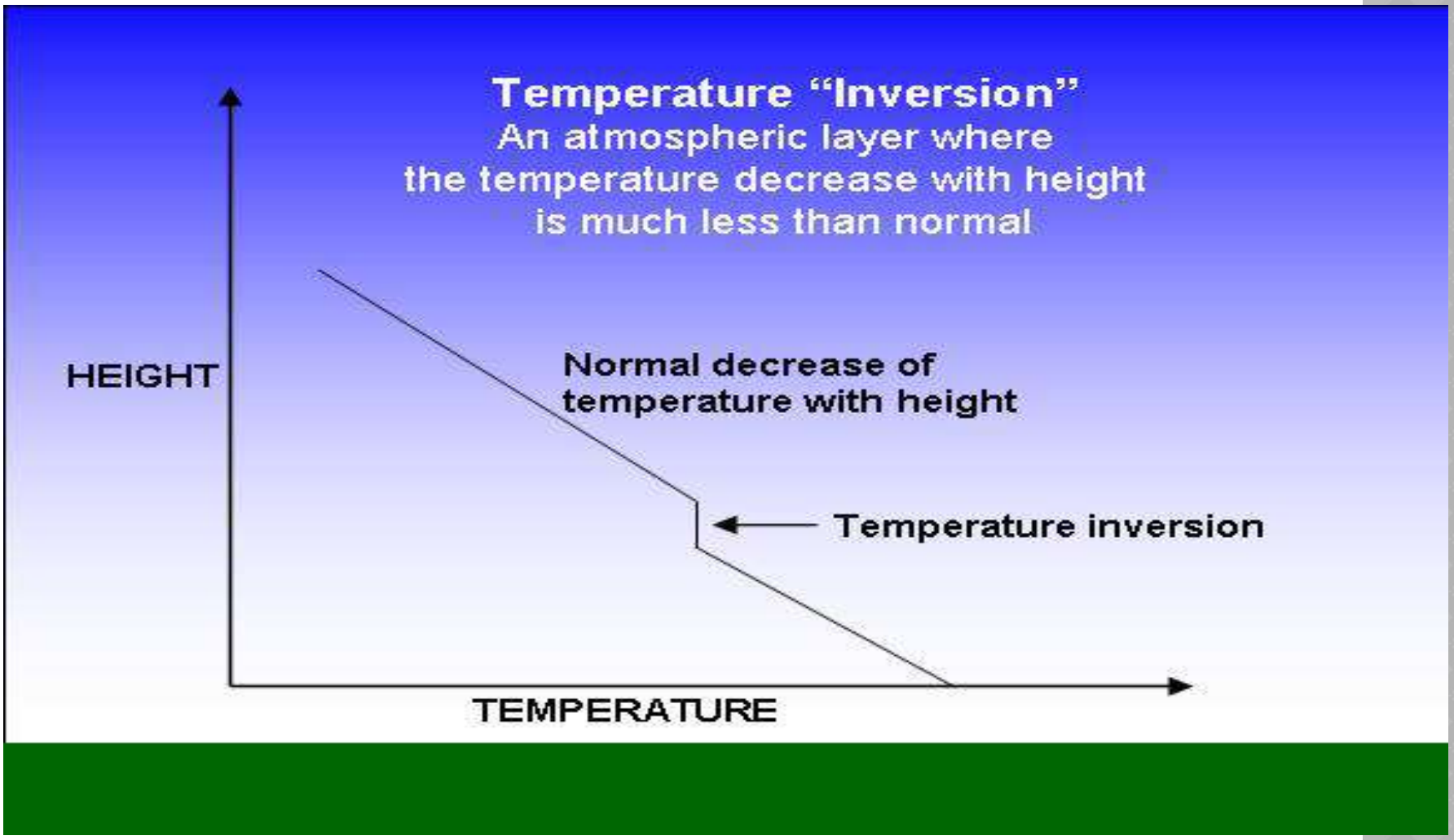
SMOG

- Brownish haze formed mainly from auto exhaust
- When sunlight interacts with smog, can cause **ozone** to form
  - Although atmospheric ozone is helpful to us, ground-based ozone can cause respiratory problems
  - From the term *Smoky Fog*

TEMPERATURE INVERSIONS

- When the air at Earth's surface is colder than the air above
- Convection does not occur
- Warm air above acts as a lid, trapping pollutants
- Smog rises to dangerous levels

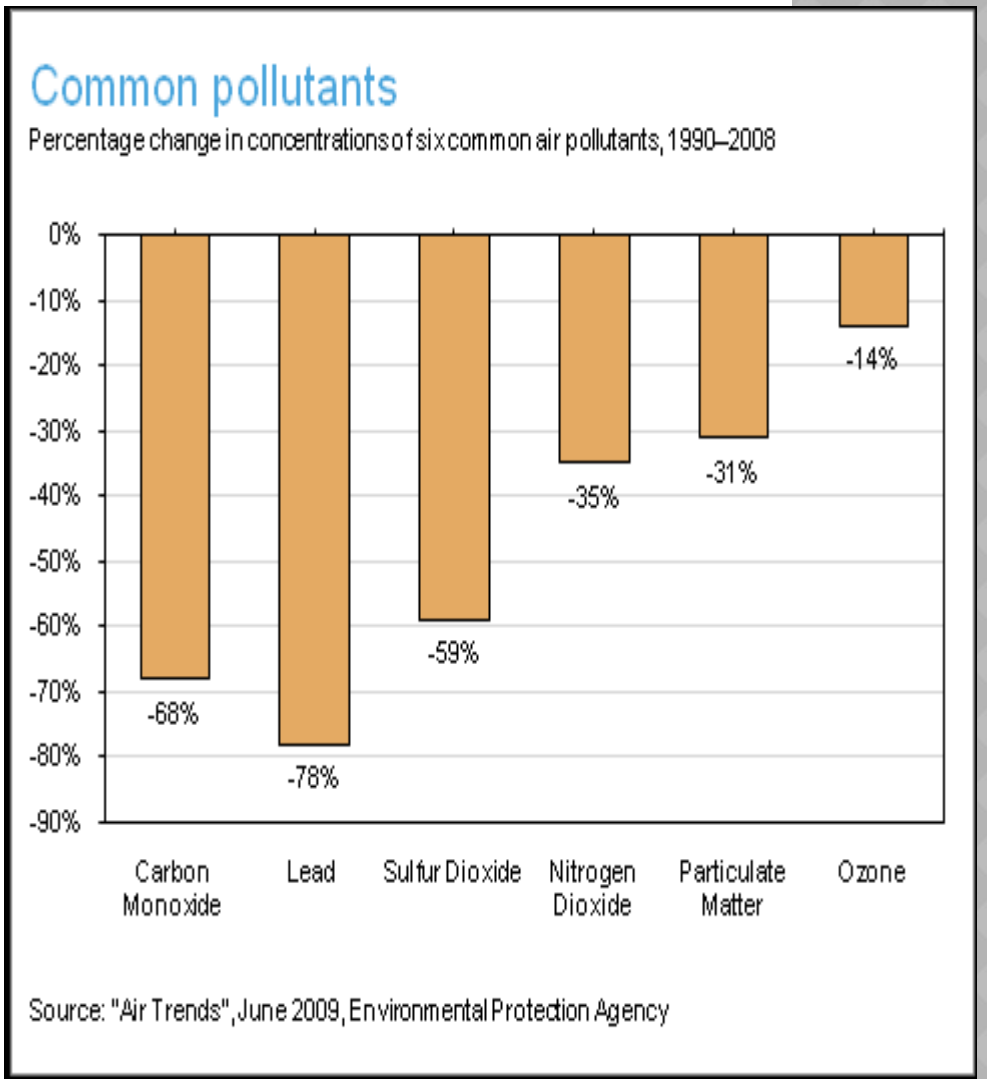
TEMPERATURE INVERSION



MAJOR POLLUTANTS

	MAJOR SOURCES	HEALTH EFFECTS	ENVIRONMENTAL EFFECTS
SO_2	Industry	Respiratory and cardiovascular illness	Precursor to acid rain, which damages lakes, rivers, and trees; damage to cultural relics
NO_x	Vehicles; industry	Respiratory and cardiovascular illness	Nitrogen deposition leading to over-fertilization and eutrophication
PM	Vehicles; industry	Particles penetrate deep into lungs and can enter bloodstream	Visibility
CO	Vehicles	Headaches and fatigue, especially in people with weak cardiovascular health	
Lead	Vehicles (burning leaded gasoline)	Accumulates in bloodstream over time; damages nervous system	Fish/animal kills
Ozone	Formed from reaction of NO_x and VOCs	Respiratory illness	Reduced crop production and forest growth; smog precursor
VOCs	Vehicles; industrial processes	Eye and skin irritation; nausea; headaches; carcinogenic	Smog precursor

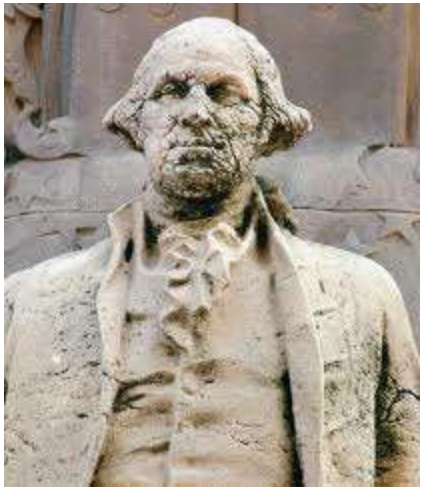
See also: Australian National Pollutant Inventory – Substance Fact Sheets



Acid Rain

Pollutants (sulfur dioxide and nitrogen oxides) react with water vapor in the air

- acid rain lowers pH
- Most life has limited range of pH
- Lakes and streams-large fish death
- Regional Forests-strips away vital nutrients from soil, limiting tree growth and increases vulnerability to disease
  - →tree death→less CO_2 removal
- Damages structures-limestone and marble buildings and gravestones, Parthenon in Greece



Acid Rain Effects on Sculptures

1908 1969

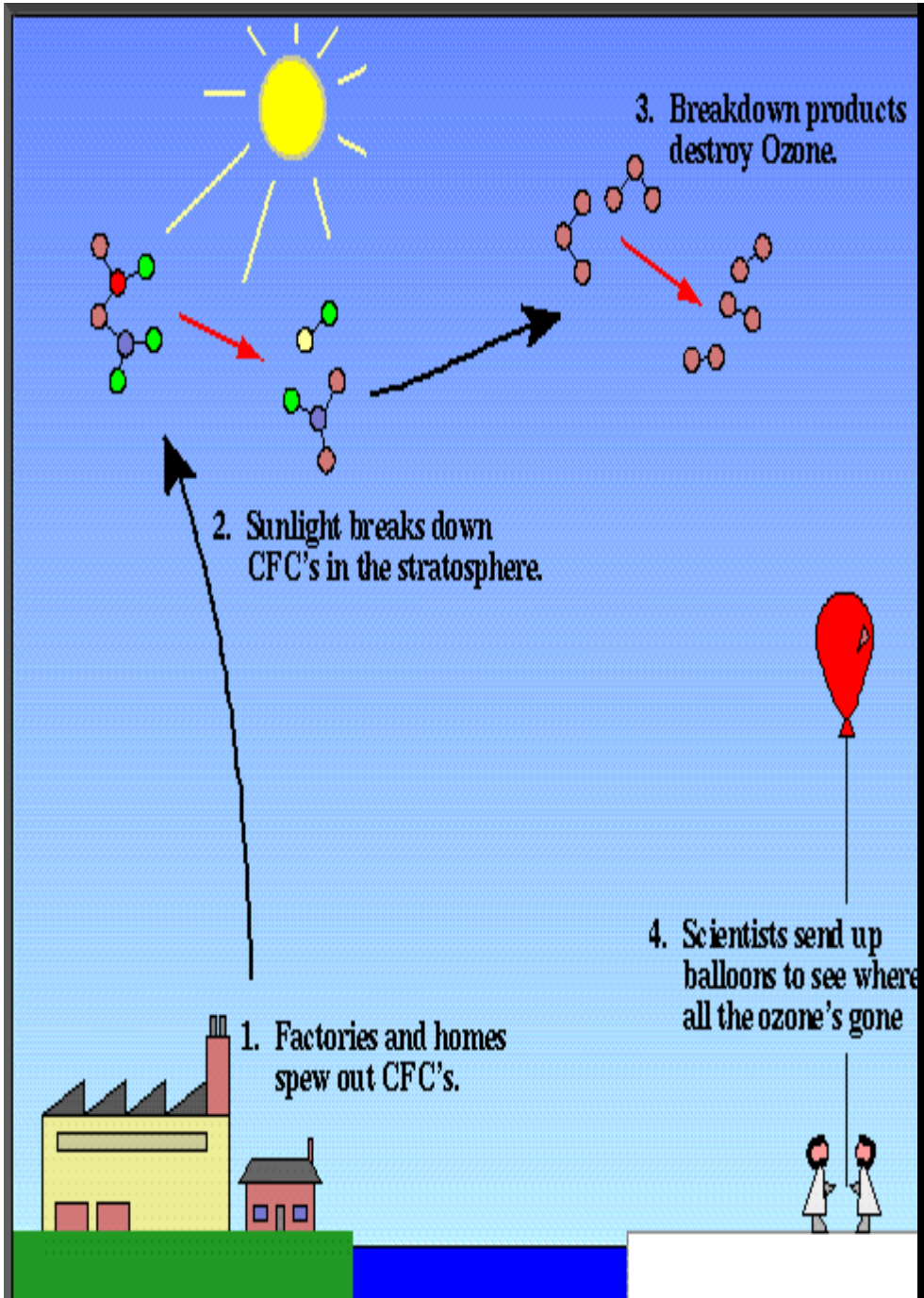
C. Ophardt, c. 2003

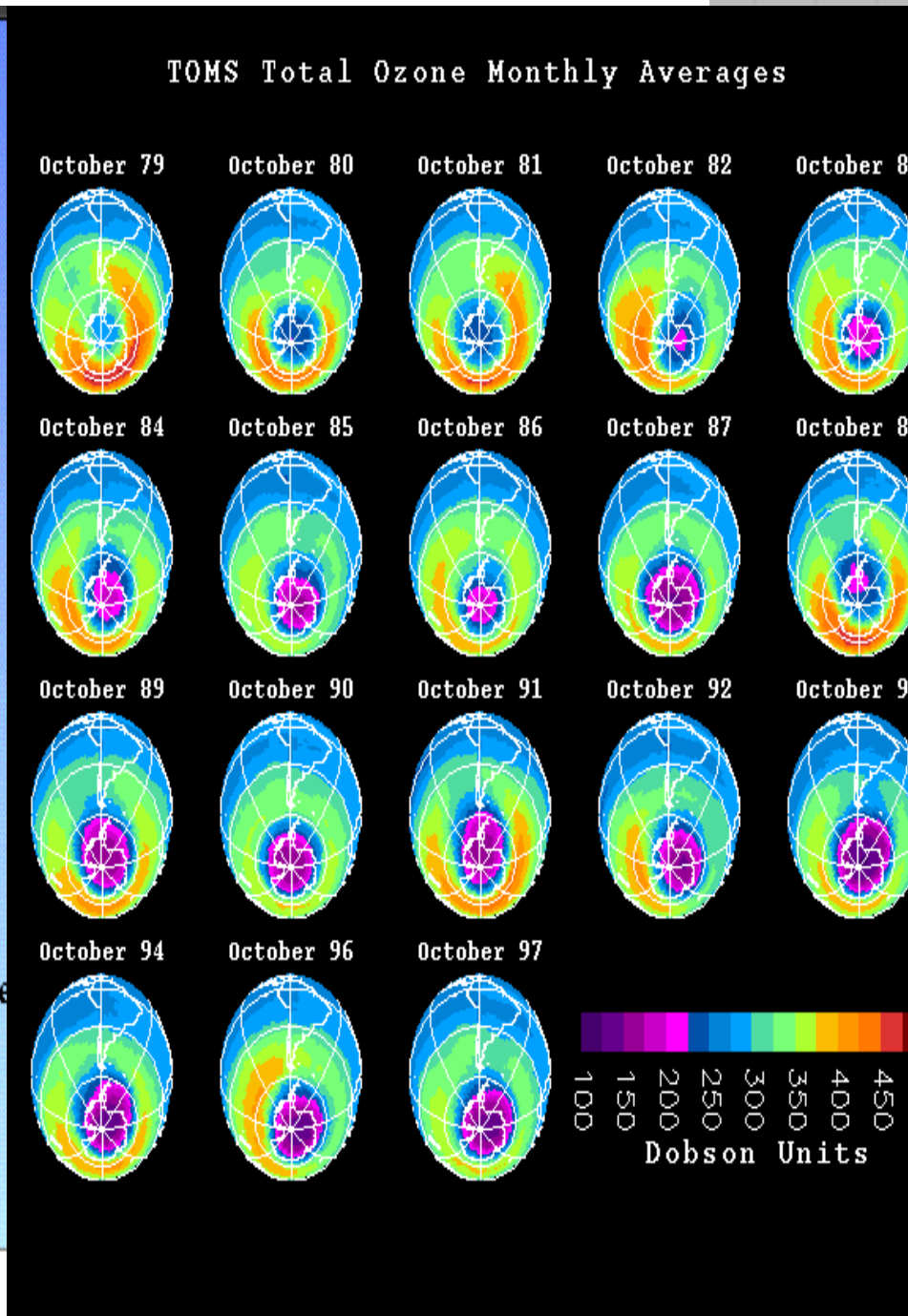
OZONE DEPLETION

- Not a layer…
- Chloroflourocarbons (CFC's)

from aerosol sprays-breaks apart ozone into O2 and a free radical

- "PFC's" have been proposed to re-unite the ozone
- Lack of UV protection→skin cancer, harm food crops, destroy phytoplankton (largest CO2 absorbers)
- Antarctic Spring "hole"


3. Breakdown products destroy Ozone.
2. Sunlight breaks down CFC's in the stratosphere.
4. Scientists send up balloons to see where all the ozone's gone
1. Factories and homes spew out CFC's.


TOMS Total Ozone Monthly Averages
October 79
October 80
October 81
October 82
October 84
October 85
October 86
October 87
October 89
October 90
October 91
October 92
October 94
October 96
October 97
100
150
200
250
300
350
400
450
Dobson Units

FEEDBACK LOOPS

WATER: Atmosphere→water→atmosphere

- Condensing to form rain, running off into oceans, evaporating or collecting in deposits
- Can also leave oceans through tectonic/volcanic activity

Carbon Dioxide—LIFE has affected the atmosphere!

- CO_2→ temperature!
- As forests bloomed and died, microbes decomposed material and released CO_2
  - As layer upon layer of dead material piled up with no contact to Oxygen, level of CO_2 dropped→cooled the planet
  - +MY of heat/pressure, buried material is transformed into coal, petroleum and natural gas (hence FOSSIL fuel)

FEEDBACK-CONTINUED

- Oceanic carbon sinks-absorb the largest amount of CO2 (plankton)
  - Sequestering by rocks is slower than CO2 produced
  - Increases oceanic salinity→decrease in oceanic biosphere (everything dies)
  - Decrease in biosphere=less CO2 uptake
- Carbon dioxide+ water=carbonic acid
  - Absorbed by rocks through weathering

SUMMARY:

- Formation of the Atmosphere---life
- Layers of atmosphere
- Gases in the atmosphere
- Phase changes
- Water, the water cycle, and water storage
- Ozone, smog and temperature inversions
- Acid rain, black carbon and pollution
- Heat transfer, albedo vs. absorption
- FEEDBACK LOOPS—examples of