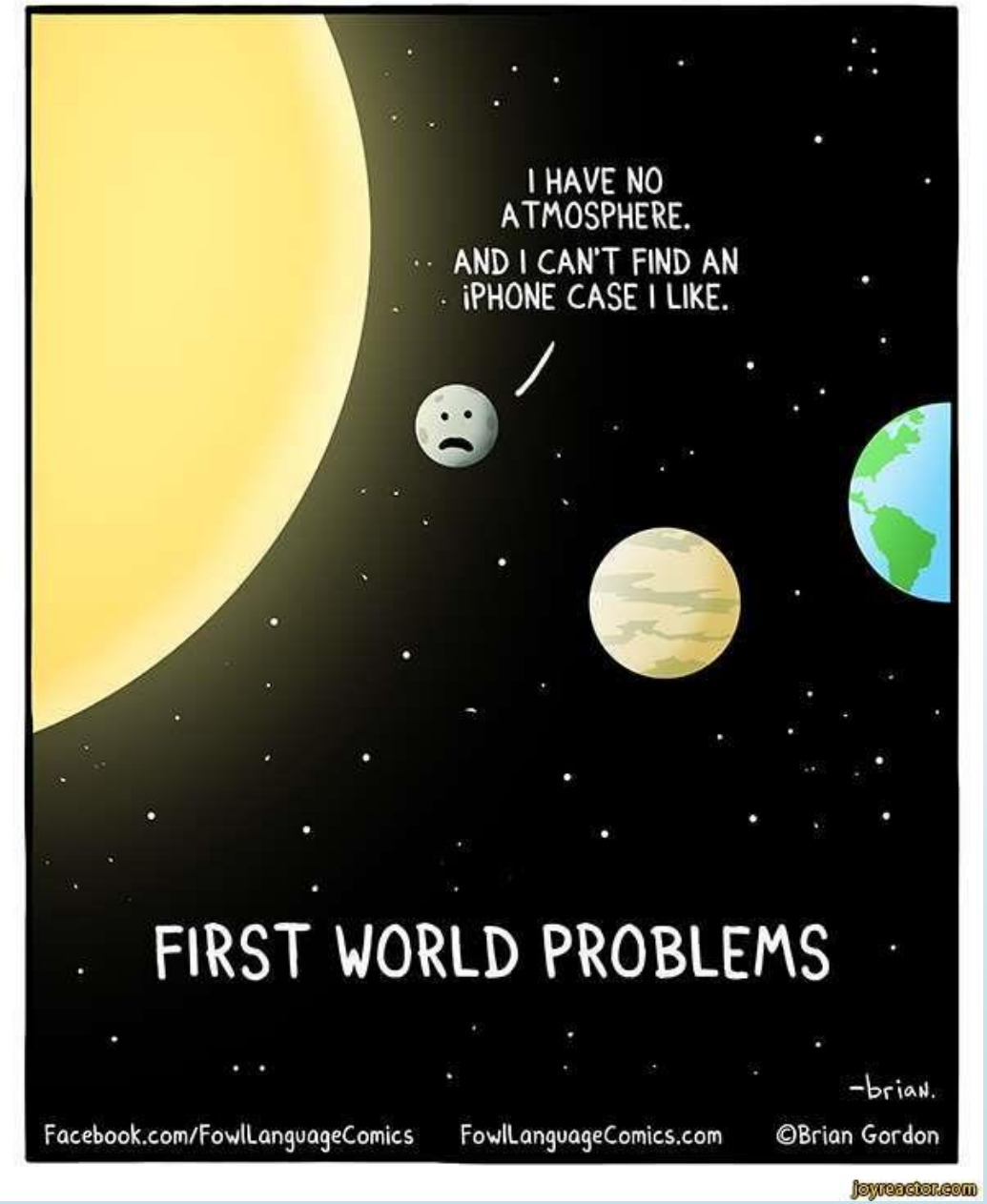
Atmosphere


I HAVE NO ATMOSPHERE.
AND I CAN'T FIND AN iPHONE CASE I LIKE.
FIRST WORLD PROBLEMS
-brian.
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Main Functions of Atmosphere

It is the layer of **air around the Earth**

Main functions:

1. **Blocks UV rays from sun**
   - *Prevents damage to humans in the form of sunburns, premature skin aging and cancer*
2. **Retains heat**
   - *Keeps heat in for life to exist.*
3. **Contains necessary gasses for cellular respiration and photosynthesis**
   - *No CO_2 plants can't convert solar energy, No O_2 plants and animals can't convert chemical energy*

Breakdown of gases in the Atmosphere

Air: **homogeneous mixture of gases** which form the **atmosphere**

- General Breakdown:
  - **Nitrogen** (~78%)
  - **Oxygen** (~21%)
  - Argon, CO_2, methane, ozone, water, nitrous oxides, sulphur dioxide, etc…

Breakdown of gases in the Atmosphere

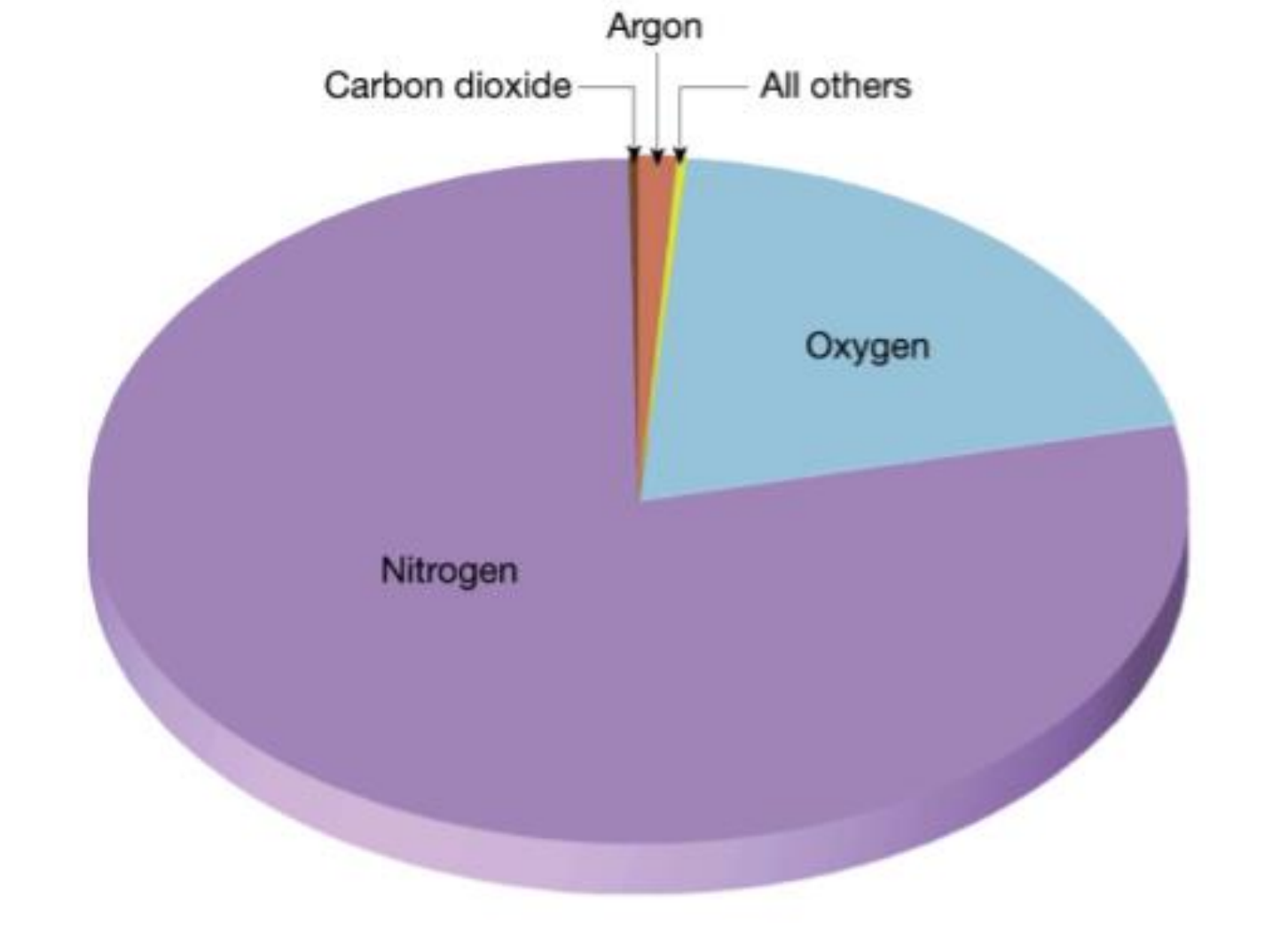
Constant gases *(concentration remained almost the same for much of Earth's history)*

- **Nitrogen (N_2), oxygen (O_2) and argon (Ar)**

Variable gases (*present in small and variable amounts)*

- **Carbon Dioxide (CO_2), methane (CH_4), ozone (O_3), water vapour (H_2O), nitrogen oxides (NO_x), sulphur dioxide (SO_2)**

Gases in the Atmosphere

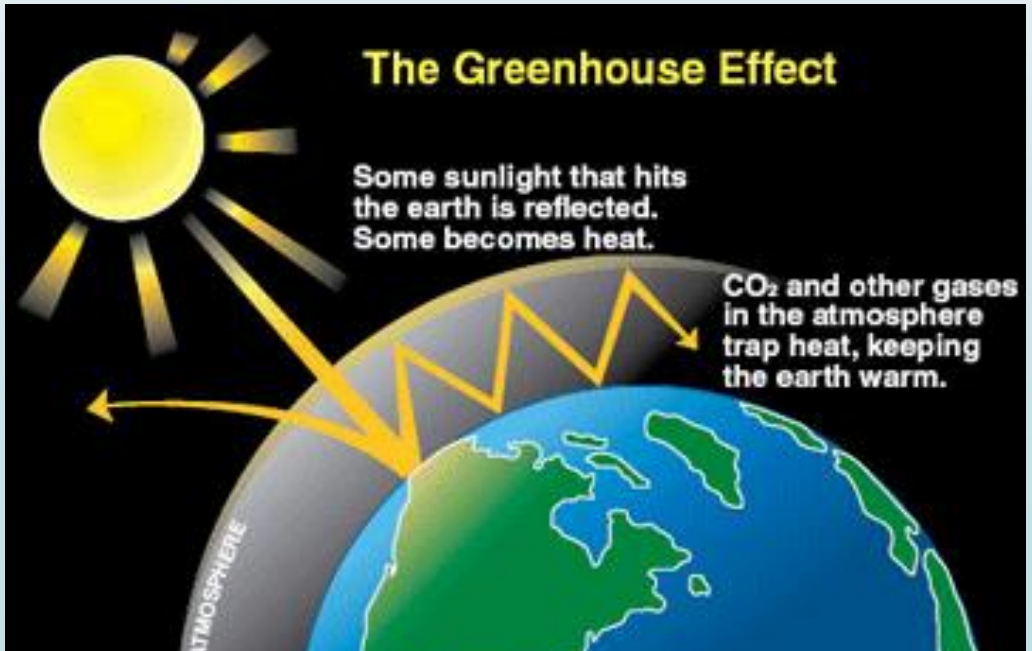


What are the GHGs?

- Main greenhouse gases:
  - Carbon dioxide **CO_2**
  - Methane **CH_4**
  - Water vapour **H_2O**
  - Nitrous oxides **N_xO**
  - Ozone **O_3**

The Greenhouse Effect

- Responsible for **retaining the sun's heat**
  - **Without GHGs**, the Earth would be cold and nearly lifeless
    - Average temp. On Earth with GHG: **15°C**
    - Average temp. on Earth without GHG: **-18°C**



How it works

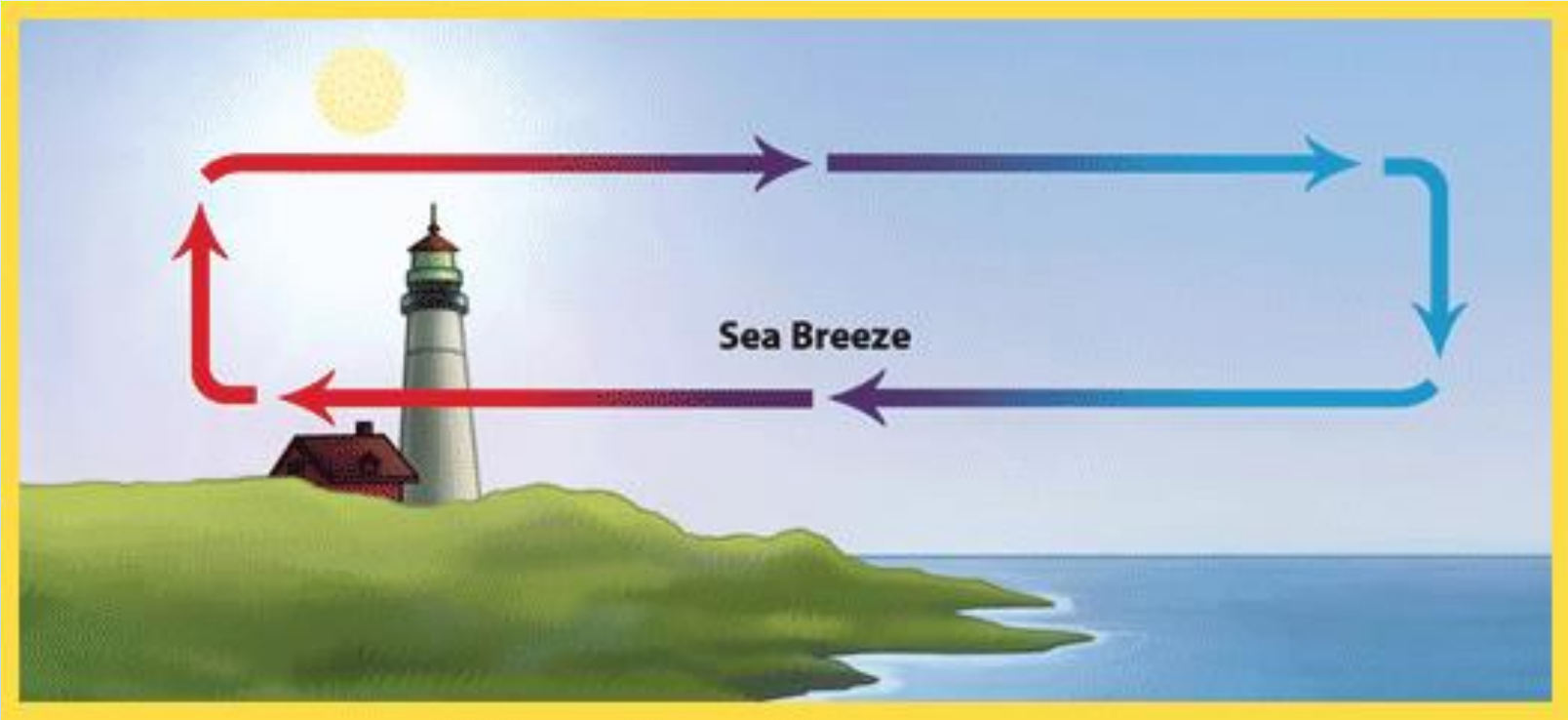
- Solar energy passes **through atmosphere** and does one of two things
  1. Is **absorbed** by surface of the Earth
  2. Is **reflected back** up into the atmosphere
- The **reflected energy** can do one of two things
  1. Energy **radiates back** towards outer space
  2. **GHG absorb** reflected radiation from Earth's surface. GHG **trap heat** in atmosphere and re-radiate it on surface of Earth
- The reflected radiation is responsible for making the **Earth's surface warmer** than it should be!

Atmospheric Circulation

- Just like the water in the oceans, the air is **circulated**
- This movement is due to differences in:
  - **Density**
  - **Temperature**

Atmospheric Circulation

- Also like water:
  - **Warm air** is **less dense** so it will **rise**
  - **Cold air** is **more dense** so it will **sink**



Atmospheric Circulation

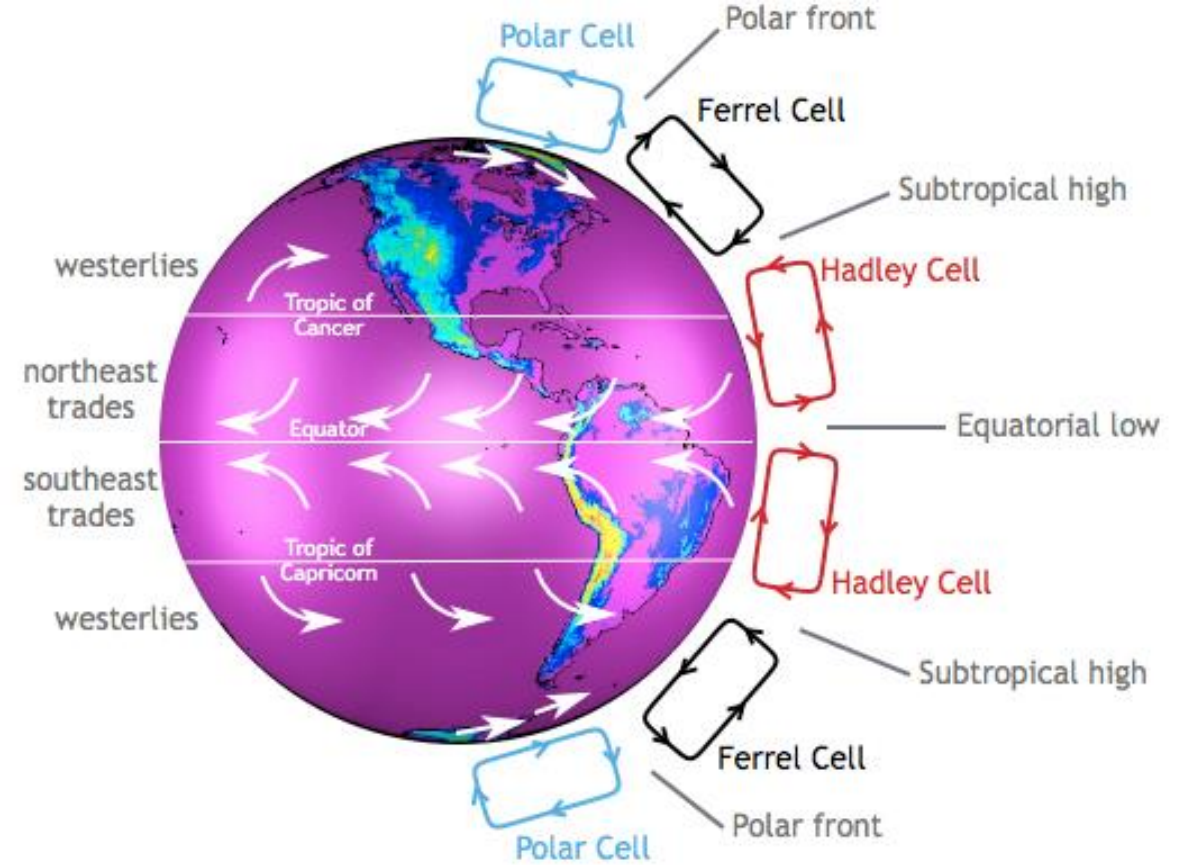
- Recall secondary 3
  - **Diffusion:** particles move from an area of high concentration (**high pressure**) to an area of low concentration (**low pressure**)

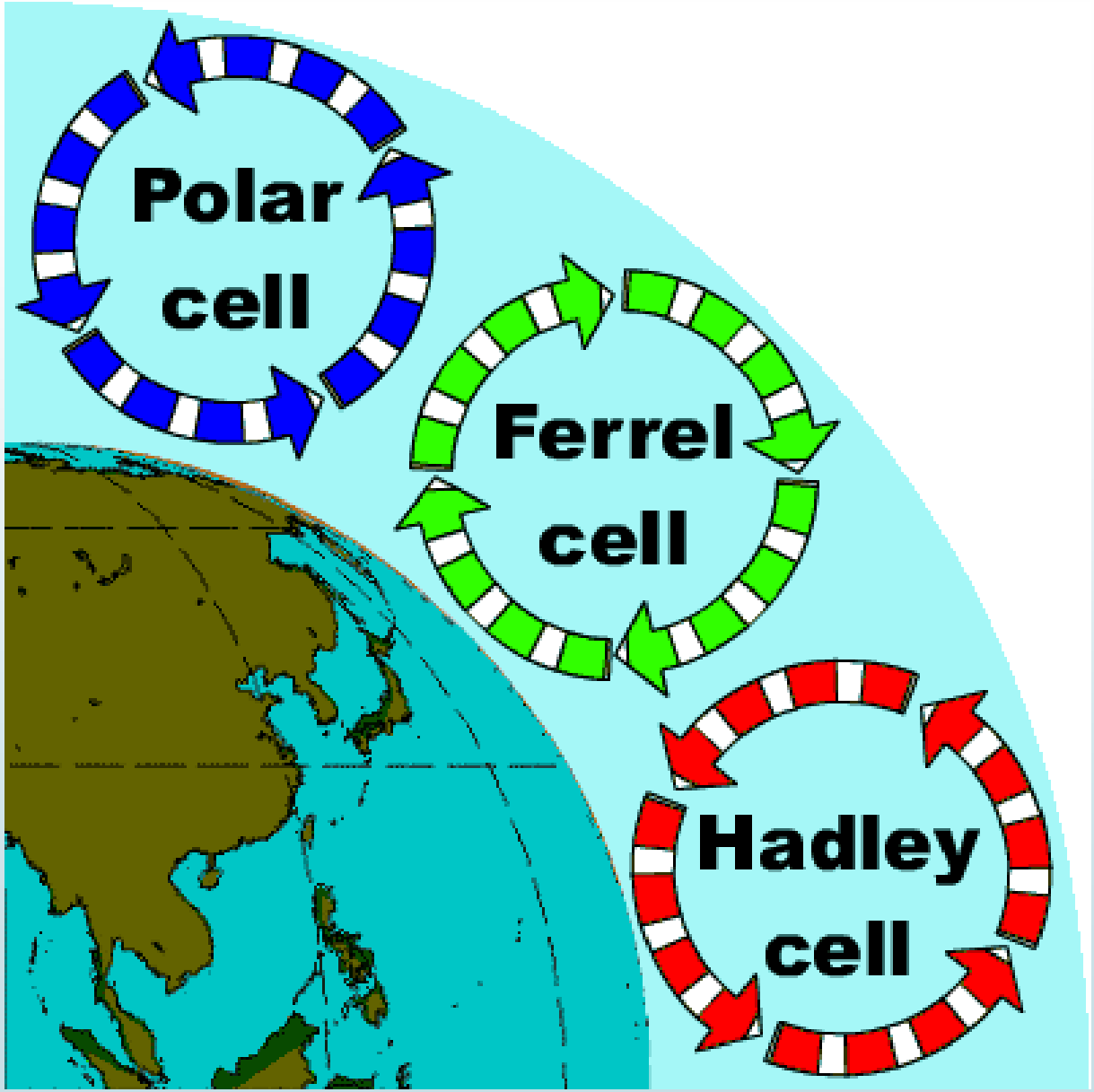
Atmospheric Circulation

- Just like with water:
  - Air is **warmer** at the **equator** and **colder** at the **poles**
    - Air will move **up** from the **equator** out towards the **poles** where it **sinks**
      - This keeps repeating

Atmospheric Circulation

- This movement of air happens in **big loops** called **circulation cells**
- There are 3 sets:
  - **Hadley cells**
  - **Ferrell cells**
  - **Polar cells**




Polar cell
Ferrel cell
Hadley cell

Atmospheric Circulation

- **Hadley cells:**
- Warm air rises at **equator** and moves to the **30th parallel**
- Collides with winds from Ferrell cells and moves back to the equator
- Creates the **trade winds**

Atmospheric Circulation

- **Ferrell cells:**
- Warm air rises from the **30th parallel** and moves to the **60th parallel**
- Collides with winds from polar cells and moves back to the 30th parallel
- Creates the **Westerlies** (from west to east)

Atmospheric Circulation

- **Polar cells:**
- Warm air rises from the **60th parallel** and moves to the **poles**
- Air **cools** at the poles and moves back to the 60th parallel
- Creates the polar **Easterlies** (from east to west)

Atmospheric Circulation

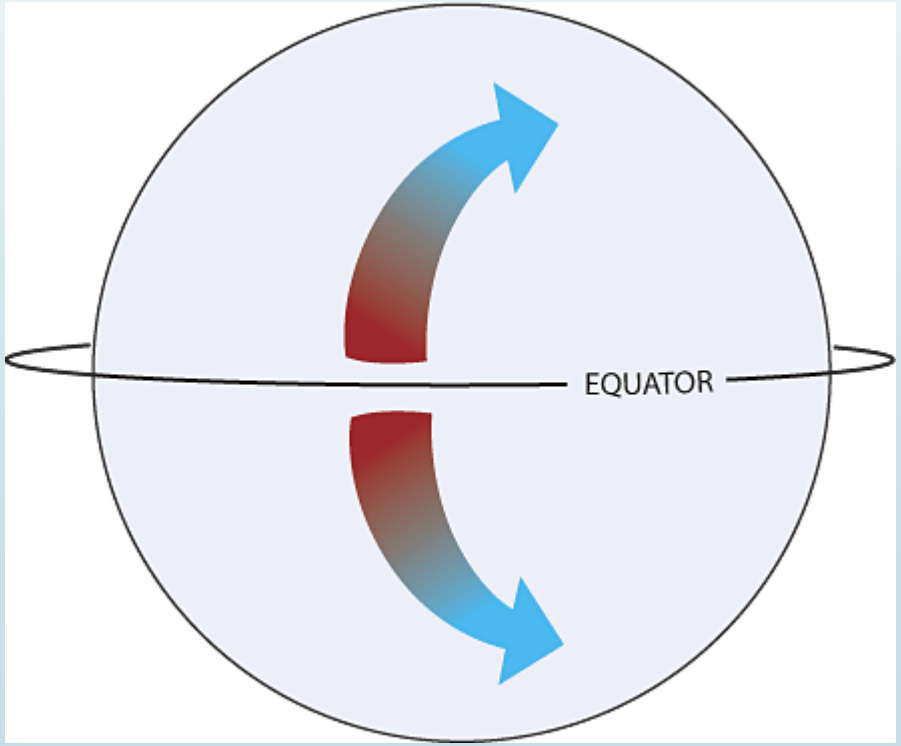
- Other winds:
- **Jet streams**
  - **Subtropical Jet stream**
    - Around the 30th parallel
    - Travels at 400 km/h 11 km above the surface
  - **Polar jet stream**
    - Around the 60th parallel
    - Travels at 300 km/h

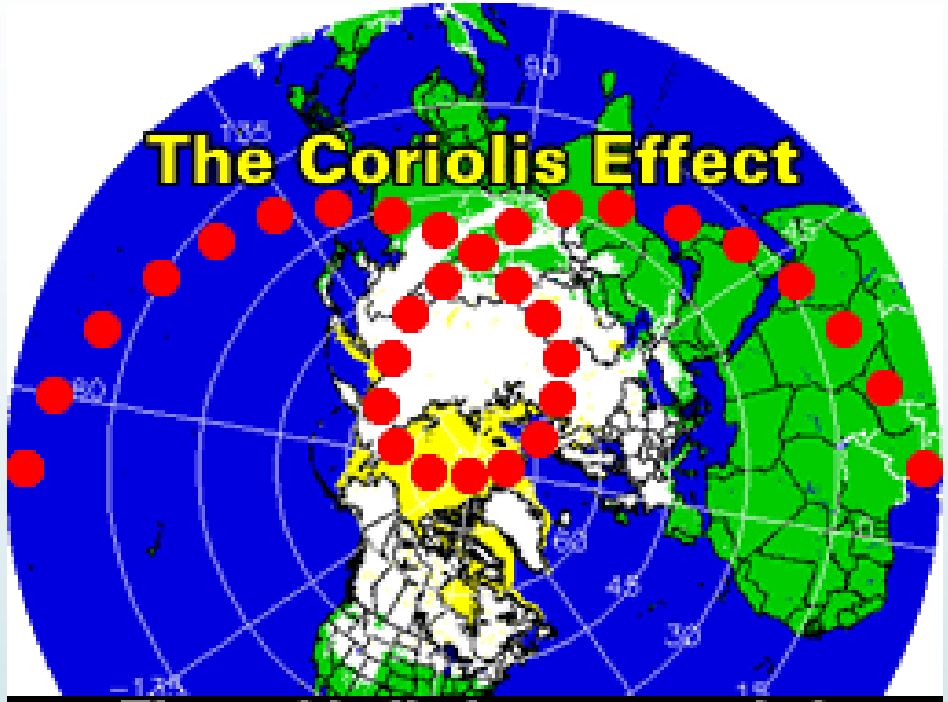
Atmospheric Circulation

- Prevailing winds:
- There are 3 sets of **major wind currents** that travel in a particular direction
- 1) **Polar easterlies:** in polar regions and blow from east to west
- 2) **Trade winds**: near equator blow from west to east
- 3) **Westerlies:** in middle latitudes blow from west to east

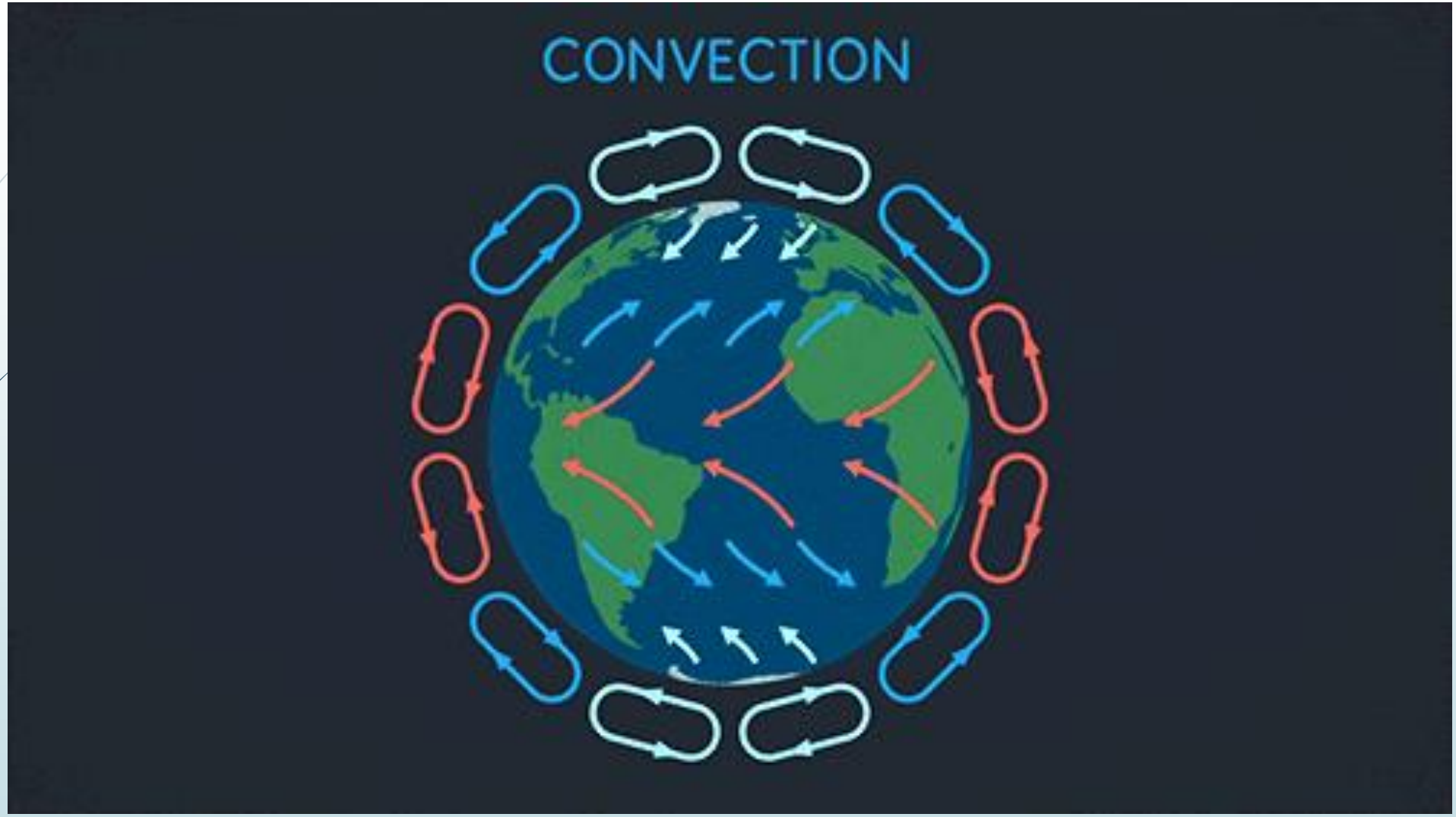
Atmospheric Circulation

- **Coriolis effect:**
  - Due to the **spinning** of the Earth, the winds don't move in a straight line between the equator and the poles
    - **Curve slightly**





The red ball always travels in a straight line but the "track" of the red ball over the spinning globe makes it appear to loop around the North Pole.


CONVECTION

Weather

- **Air masses**
  - **Large expanse of air** with relatively uniform **temperature** and **humidity**.
- Air mass characteristics:
  - **Humidity** (humid or dry)
  - **Temperature** (cold or warm)

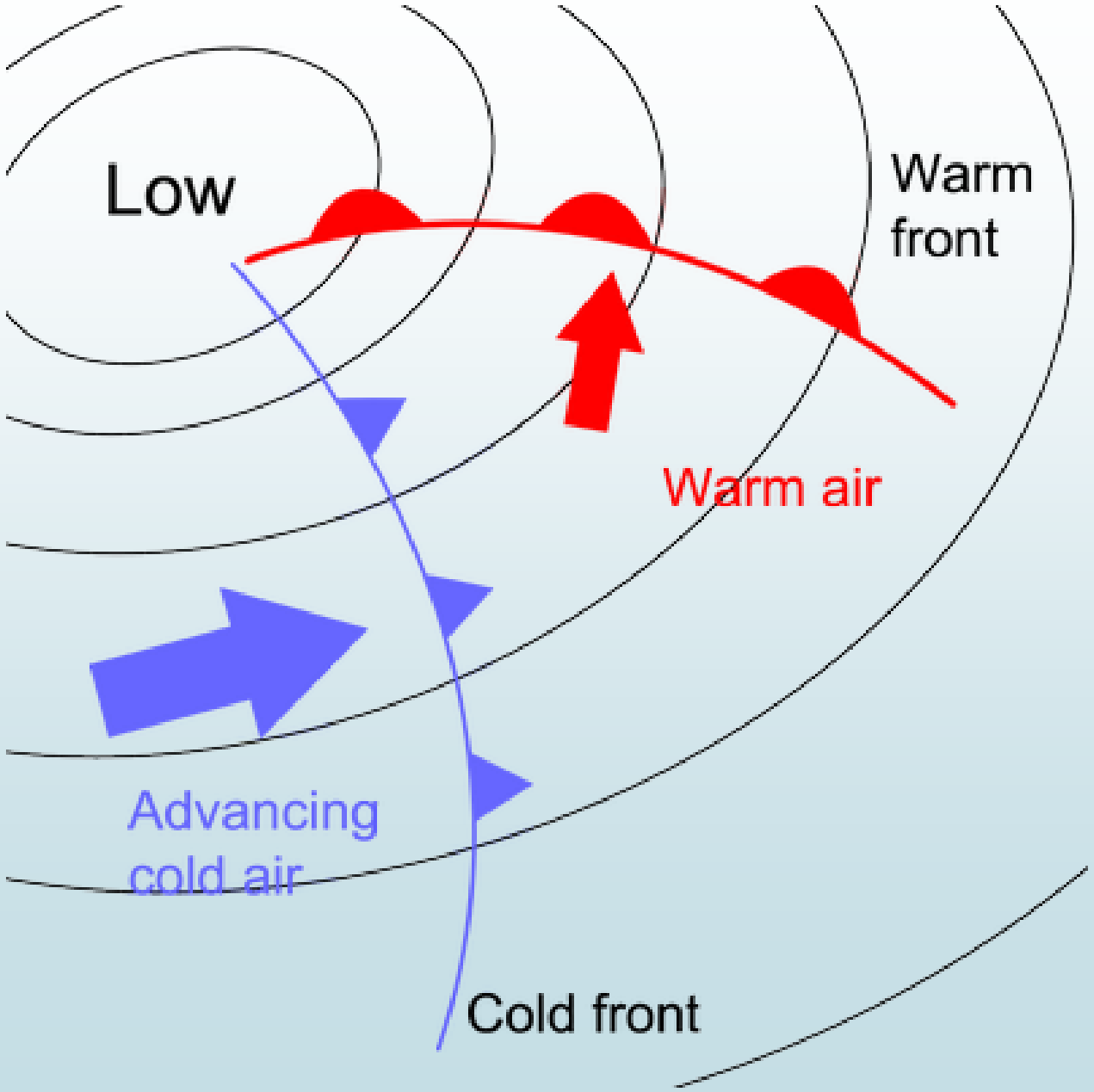
Weather

- **Fronts:** Is a boundary **separating 2 different masses** of air and causes weather. The 2 fronts do not mix they cause **weather patterns**.

Cold Front (Anticyclone)	Warm Front (Depression)
Cold air meets warm air	**Warm air meets cold air**
High pressure system	**Low pressure** system
Descending cold air **prevents cloud formation**	Rising warm air creates **cloud** formation, **humidity and rain**
In winter **clear skies**, sunny and very cold In summer **clear skies** and sunny	In winter warmer weather and **snow** In summer **hot, humid, cloudy with rain**

Weather

Depression



Anticyclone

Weather Recap

- **Anticyclone** = cold front = high pressure = **sun and clear skies**

- **Depression** = warm front = low pressure = **rain and clouds**

Weather Changes

- When you get a change from a **cold front to warm front**
  - Get **thunderstorms**, lightning and heavy rain

- When you get a change from a **warm front to a cold front**
  - Get **clouds and rain**

Weather Changes

- When you get a very **large low-pressure system** with strong winds forming over the **ocean** it can cause a **hurricane**!
  - Characterized by **violent winds**

Past-Exam Questions

An air mass that originated in the Caribbean now lies over Québec, while a fast-moving air mass from the far north is heading down toward the southern part of the province. Explain what happens when these two air masses meet. In your explanation, discuss the various phenomena involved.

Change from warm to cold -> thunderstorms and rain!

Past-Exam Questions

- A warm air mass meets a cold air mass. What kind of weather occurs when these two air masses meet?

A) Light showers

B) A hurricane

C) Heavy thunderstorm

D) A sunny day

Change from cold to warm

The Atmosphere and Energy

Energy Resources

- Two main types
  1. **Wind Energy**
  2. **Solar Energy**

Wind Energy → Renewable resource

Advantages

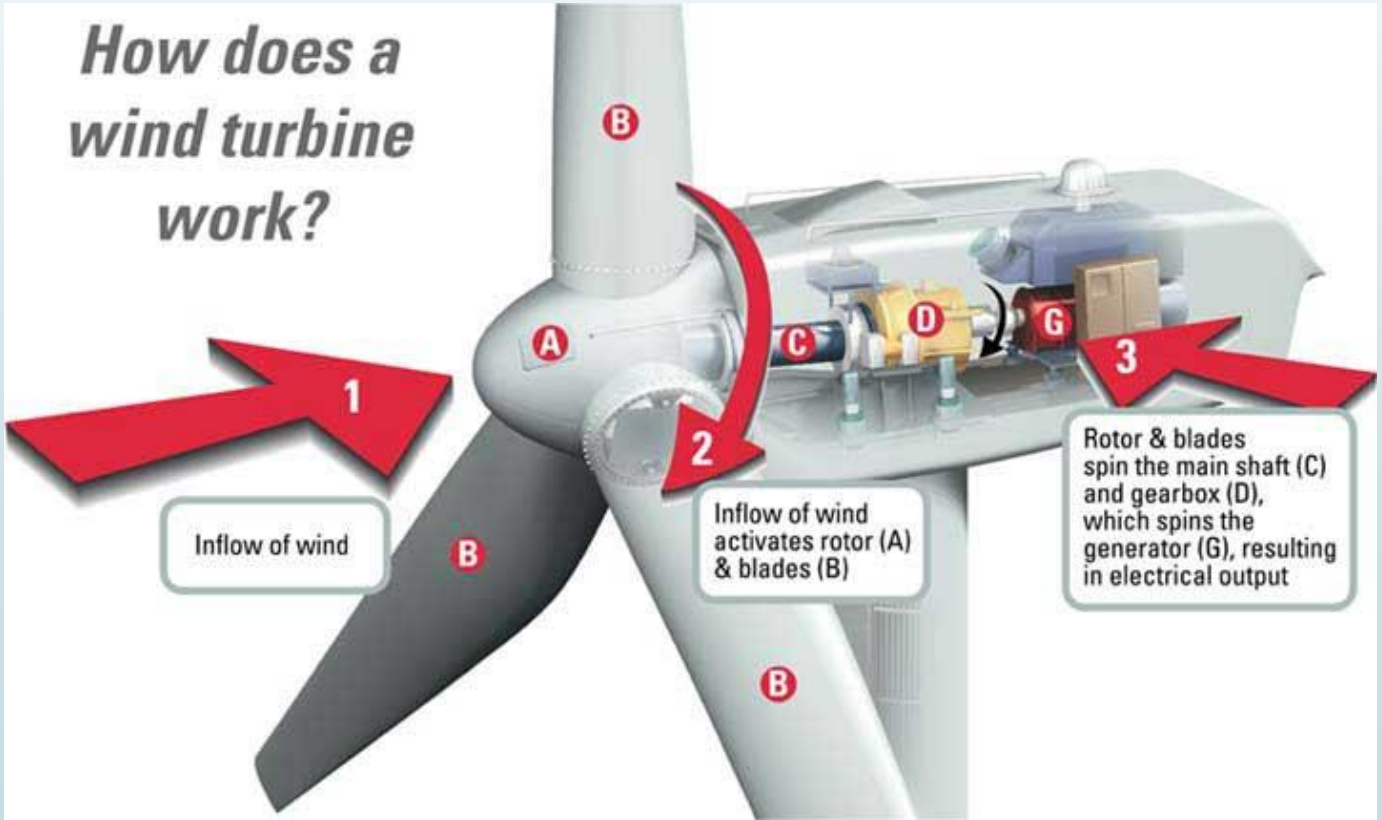
- **No emissions, renewable** ☺

Disadvantages

- Can **ruin a landscape**
- **Can't rely on wind, energy can't be stored**
- Often **used in combination** with another power generating system that can take over if wind diminishes

How energy is extracted from the wind

- **Wind (kinetic energy)** turns windmill blades, which spins a generator, **converting kinetic energy into electricity (electrical energy)**



Solar Energy

- Nuclear reactions in the sun **produce thermal and radiant energy**
- **Rays heat** the **atmosphere, oceans and land** on Earth
- Tropical regions receive more solar energy due to the **tilt** of the earth

Solar Energy → Renewable resource

- Earth receives enough solar energy in **1 hour** to meet the **world's energy needs for 1 year**

Advantages

- **Renewable, no emissions, practical for remote areas, can be stored ☺ ☺ ☺**

Disadvantages

- **Costly *, energy varies on cloud cover**

Types of Solar Energy

1. **Passive heating systems:**

- Based on **location** of building to **maximize the sun's exposure**
- Use of materials that will **store heat** and **release it slowly** overnight

2. **Photovoltaic cells**

- Placed in **large panels (solar panels)**
- Convert **solar energy into electrical energy**

Solar Energy

3. Solar collectors

- Used to **heat air** in buildings or **water** in homes or pools
- **Glass panels capture heat**, heat is **transferred** to water in pipes and is circulated through radiators

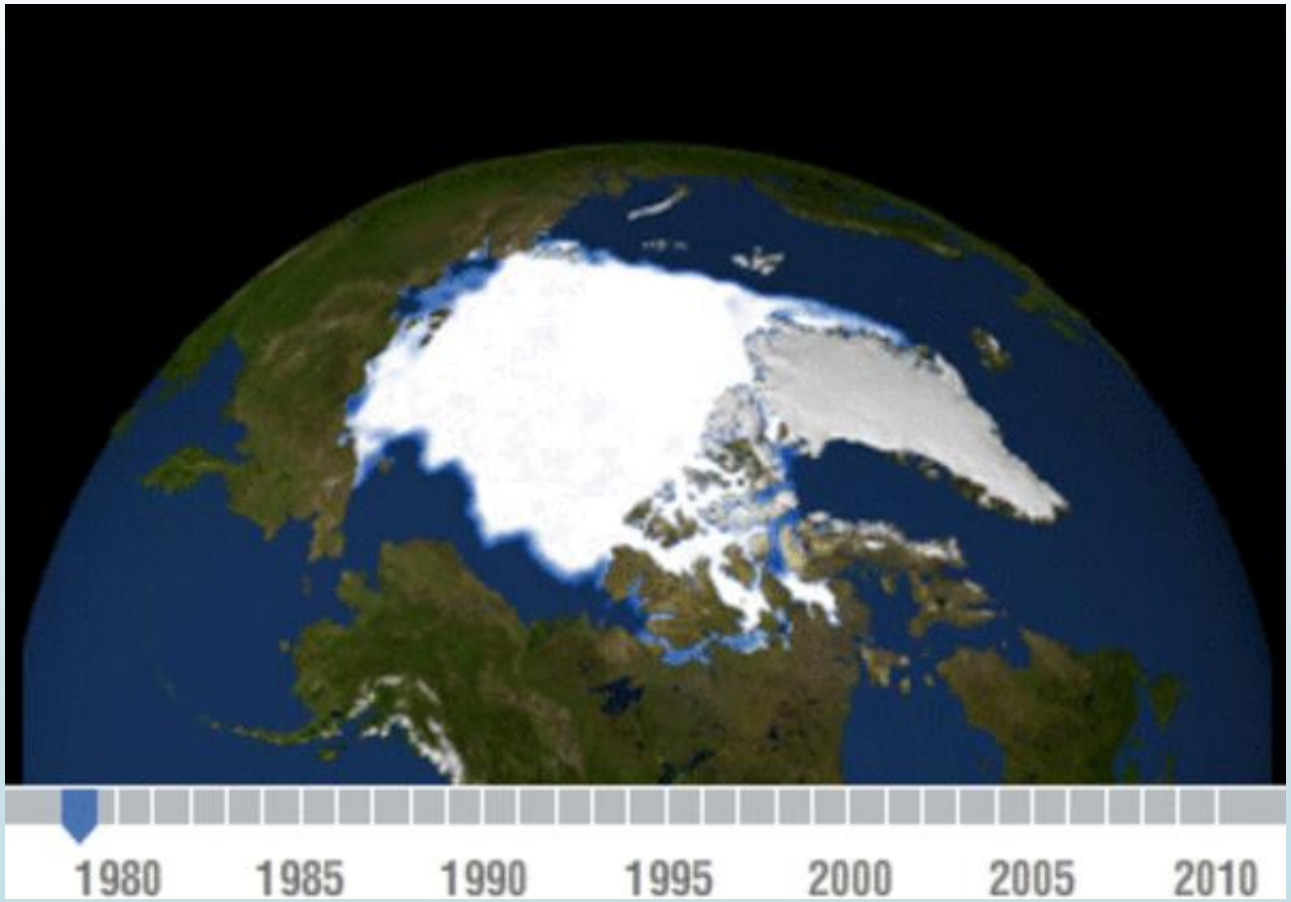
Climate Change

Climate Change

- Build-up of **GHG prevents** more and more of the solar energy from being **reflected back to space**
  - **trapping it** on Earth and causing it to **warm up too much**!
- Problem?
  - Causes **major changes** in multiple different "spheres"

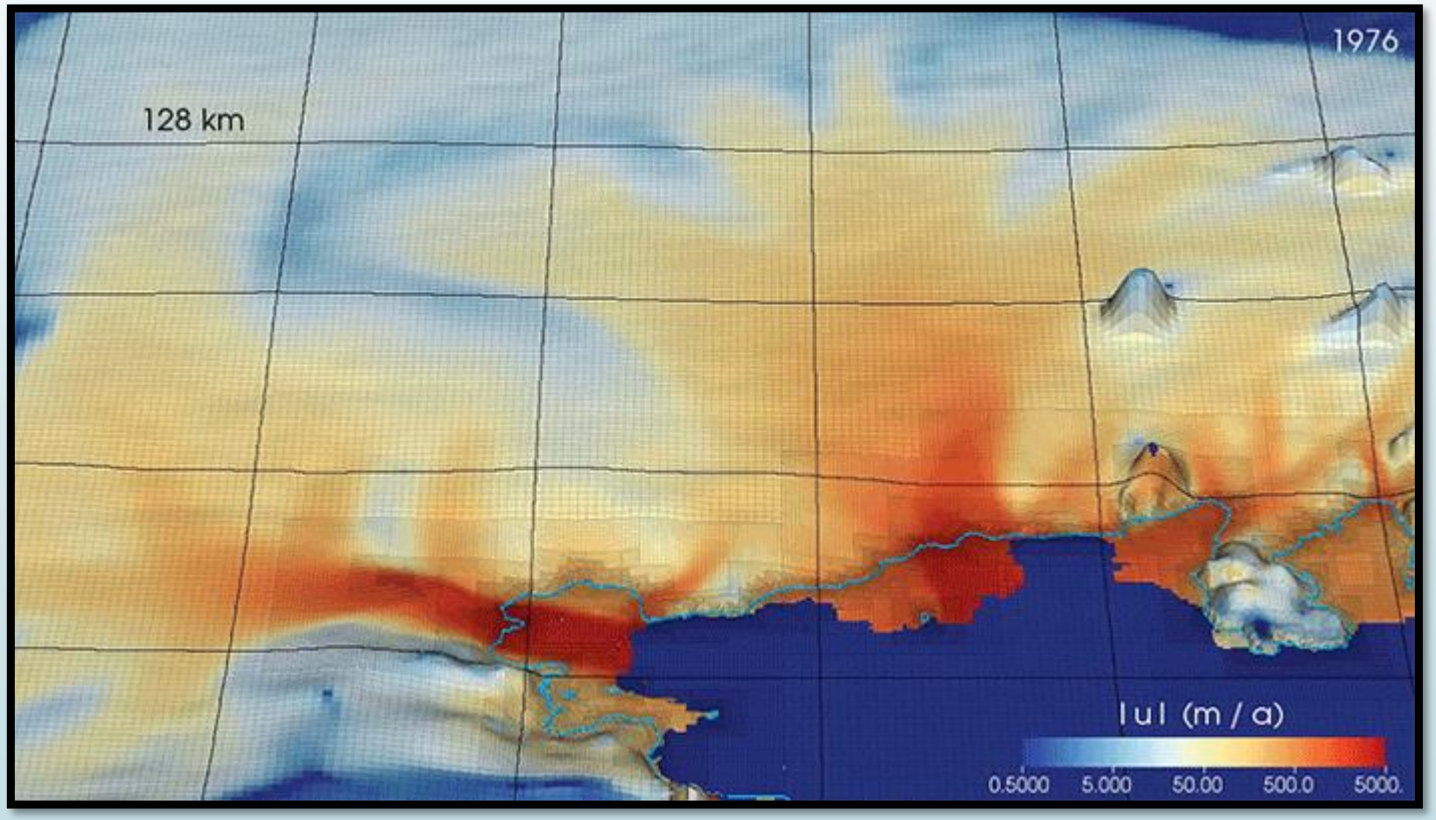
Climate Change Problems

1. **Decreases in ice cover** (hydrosphere)



Climate Change Problems

1. **Decreases in ice cover** (hydrosphere)
2. **Sea level rise** (hydro/lithosphere)



Climate Change Problems

1. **Decreases in ice cover** (hydrosphere)
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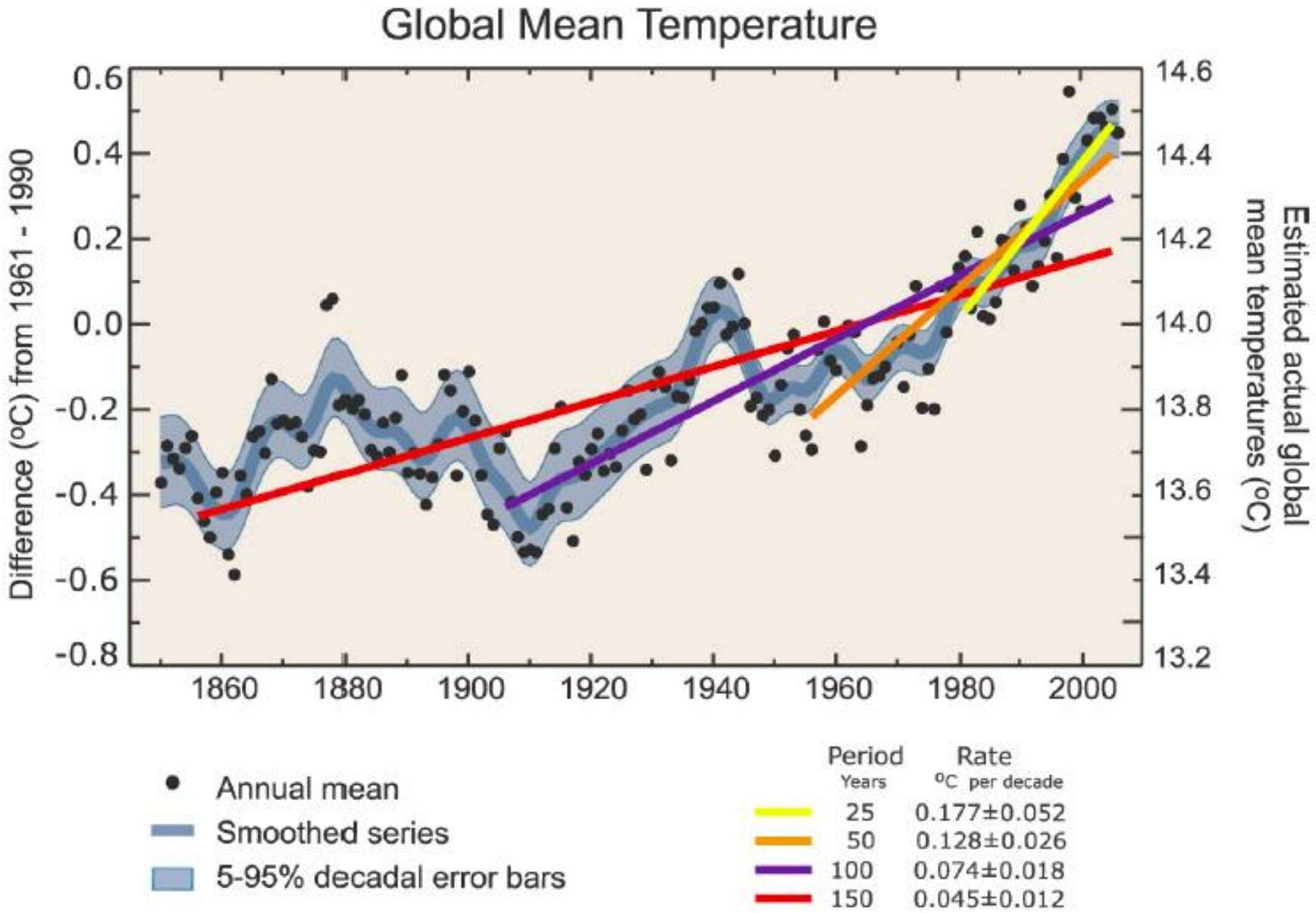
3. **Changes in precipitation** (atmo/hydrosphere)

Climate Change Problems

1. **Decreases in ice cover** (hydrosphere)
2. **Sea level rise** (hydro/lithosphere)
3. **Changes in precipitation** (atmo/hydrosphere)
4. **Increase of smog** (atmosphere)

Climate Change Pro

1. **Decreases in ice cover**
2. **Sea level rise** (hydro/lith
3. **Changes in precipitatio** (atmo/hydrosphere)
4. **Increase of smog** (atmo
5. **Increase of temperature** (atmo/lithosphere)


Global Mean Temperature
Difference (°C) from 1961 - 1990
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
1860
1880
1900
1920
1940
1960
1980
2000
14.6
14.4
14.2
14.0
13.8
13.6
13.4
13.2
Estimated actual global mean temperatures (°C)
Annual mean
Smoothed series
5-95% decadal error bars
Period Years
Rate °C per decade
25 0.177±0.052
50 0.128±0.026
100 0.074±0.018
150 0.045±0.012

Climate Change Problems

1. **Decreases in ice cover** (hydrosphere)
2. **Sea level rise** (hydro/lithosphere)
3. **Changes in precipitation** (atmo/hydrosphere)
4. **Increase of smog** (atmosphere)
5. **Increase of temperature variability** (atmo/lithosphere)
6. **Species extinction** (biosphere)

Climate Change Problems

1. **Decreases in ice cover** (hydrosphere)
2. **Sea level rise** (hydro/lithosphere)
3. **Changes in precipitation** (atmo/hydrosphere)
4. **Increase of smog** (atmosphere)
5. **Increase of temperature variability** (atmo/lithosphere)
6. **Species extinction** (biosphere)
7. **Rearranging species dispersal** (biosphere/lithosphere)

Example Questions- GHG

Which of the following gases does not contribute to the greenhouse effect?

A) CO_2

B) CH_4

C) NO_2

D) SO_2

Example Questions- GHG

Which of the following statements about the Greenhouse effect is true?

A) An increase in greenhouse gases in the atmosphere leads to an increase in the amount of heat that escapes into space.

B) A decrease in greenhouse gases in the atmosphere leads to an increase in the amount of heat that escapes into space.

C) An increase in greenhouse gases in the atmosphere leads to an increase in the amount of solar radiation that will enter the atmosphere.

D) A decrease in greenhouse gases in the atmosphere leads to an increase in the amount of solar radiation that will enter the atmosphere.

Example Questions- GHG

Which of the following does not contribute to the formation of greenhouse gases?

A) Decomposition of waste in landfills

B) Burning of fossil fuels

C) Melting of the permafrost

D) Photosynthesis in plants