

# Earth's Climate System Outline

## Earth's Climate System Review

### ***Earth's energy balance***

incoming solar radiation (electromagnetic spectrum)

a little ultraviolet (UV)

a lot of visible

some near infrared (IR)

outgoing radiation

longer wavelength infrared

### ***what happens to incoming solar radiation?***

scattering by gasses, aerosol particles & clouds

reflection by clouds, aerosol particles & Earth's surface

absorption by aerosol particles, clouds, gases, Earth's surface

Earth's overall albedo is 31%

greenhouse effect (water vapor, carbon dioxide, methane)

### ***insolation by latitude***

#### ***latitudinal radiation balance***

more incoming than outgoing radiation at low latitude

more outgoing than incoming radiation at high latitude

### ***seasons***

#### ***atmospheric circulation***

intertropical convergence zone (ITCZ)

easterly trade winds

westerlies

polar front

#### ***ocean surface currents*** driven by tradewinds and westerlies

ocean currents circulate clockwise in northern hemisphere

and counterclockwise in southern hemisphere

#### ***deep ocean currents*** form where cold, salty, dense surface water sinks

especially in north Atlantic (North Atlantic Deep Water, NADW)

and off the coast of Antarctica (Antarctic Bottom Water, ABW)

#### ***slowing of the ocean conveyor*** belt could greatly alter regional climates

could happen if melting & calving of Greenland ice sheet delivers too much fresh water to ocean making it less dense, preventing sinking of NADW

NW Europe would get much cooler due to slowing of Gulf Stream (which brings heat to far north Atlantic)

## **Interacting Components of Earth's Climate System** (text section 1-4)

### **Climate Forcing** (1-5)

#### **Tectonic Processes** (tens of millions of years)

- variations in volcanic outgassing of CO<sub>2</sub>
- variations in mountain building and weathering
- variations in sea level and land vs. water areas
- variations in distribution of the continents

#### **Orbital Variations** (tens to hundreds of thousands of years)

- variations in solar insolation in different seasons

#### **Solar Luminance** (decades to centuries; billions of years)

- sun spot cycles and "supercycles"
- gradual increase of sun's output over 4.55 by

## **Climate System Responses, Response Rate, Forcing Rate** (1-6, 1-7, 1-8)

### **Feedbacks in the climate system** (1-9)

#### **Positive Feedbacks**

##### **ice**

- cooling causes more ice, causes more reflection of sunlight, causes more cooling
- warming causes less ice, causes more sunlight absorbed, causes more warming

##### **water vapor**

- cooling causes less water vapor, atmosphere holds less heat, causes more cooling
- warming makes more water vapor, air holds more heat, causes more warming
- but, warming = more water vapor = more clouds = more reflection of sunlight
- increasing low thick clouds results in reduction of the net warming
- (not to mention more precipitation = more weathering = less CO<sub>2</sub>)

#### **Negative Feedbacks**

##### **weathering**

- cooling yields lower temperatures, less precipitation, and less vegetation
- lower temperatures mean slower chemical (weathering) reaction rate
- less precipitation means less chemical weathering
- less vegetation yields less weathering
- reduction in weathering removes less CO<sub>2</sub> from atmosphere
- temperature doesn't cool as much as it would otherwise

- warming yields higher temperatures, more precipitation, and more vegetation
- these three cause more weathering
- increased weathering removes more CO<sub>2</sub> from atmosphere
- temperature doesn't warm as much as it otherwise would have