

# Unit 11: Climate Change

## Lecture 1

### Objectives:

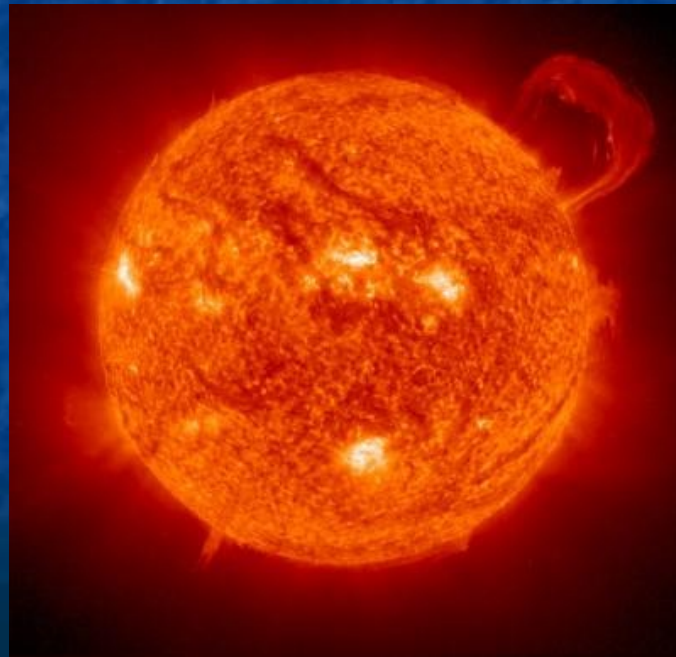
E2.2D - Identify the main sources of energy to the climate system.

E5.4B - Describe natural mechanisms that could result in significant changes in climate (e.g., major volcanic eruptions, changes in sunlight received by the Earth, meteorite impacts).

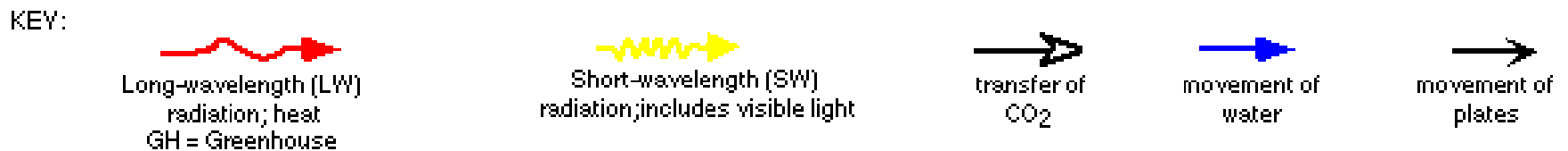
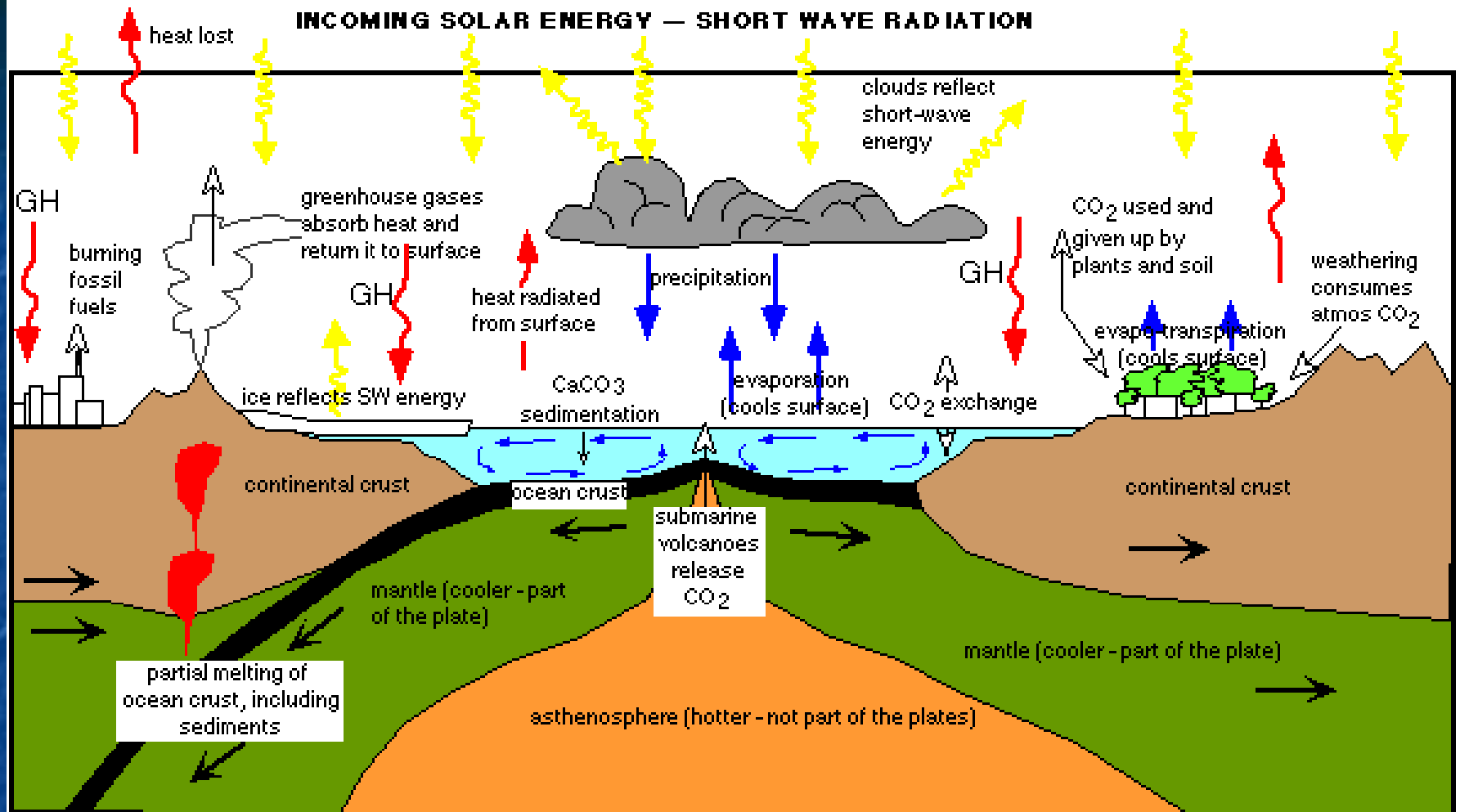
E5.r4i - Explain the causes of short-term climate changes such as catastrophic volcanic eruptions and impact of solar system objects.

# Energy Sources\*

- The Sun is the Earth's primary energy source and external driver of climate variability.



# Schematic View of the Global Climate System



**Figure 2** Basics of the global climate system showing the flows of energy, water, and CO<sub>2</sub> that are important in controlling the climate. Solar energy drives the global climate, but clouds, plants, volcanoes, ice, and the oceans all play important roles in regulating the Earth's greenhouse and determining what happens to the solar energy. CO<sub>2</sub> and water are the principle greenhouse gases that absorb heat emitted from the surface and then re-radiate the heat back to the surface; this process maintains the Earth's temperature at a comfortable level.

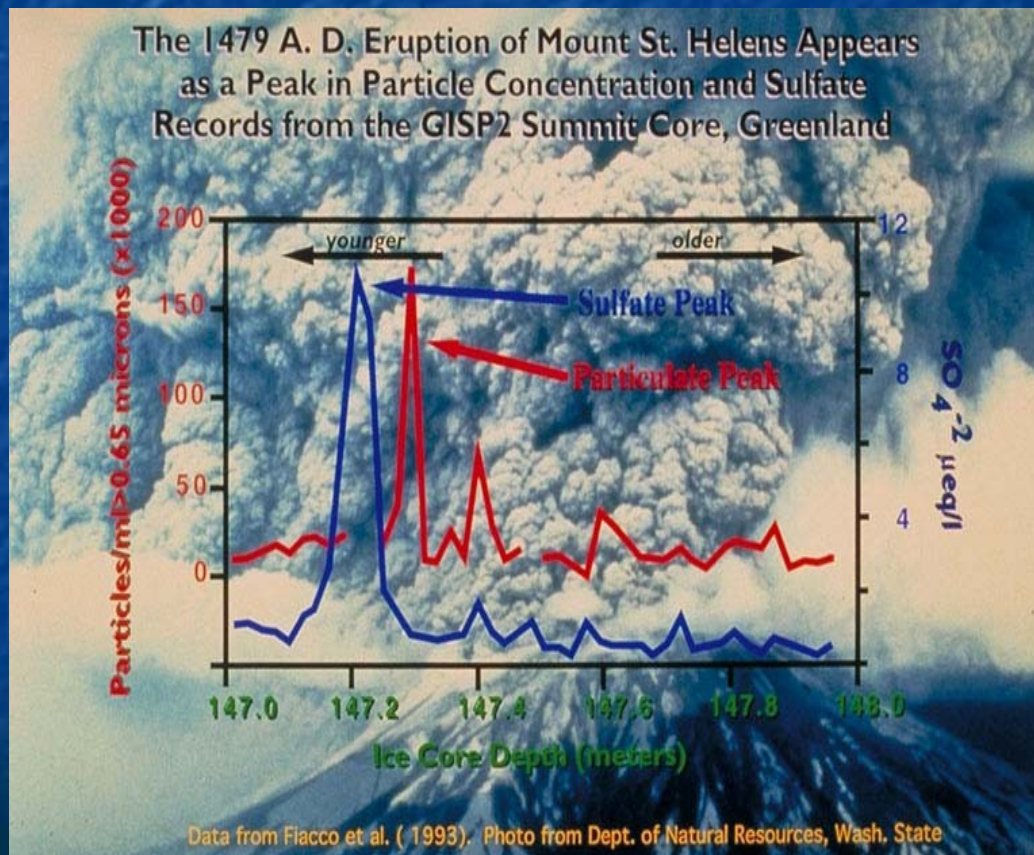
# Nine Tipping Elements

The nine tipping elements and a prediction of the time it would take them to undergo a major transition are:

- \* Melting of Arctic sea-ice (approx 10 years)
- \* Decay of the Greenland ice sheet (more than 300 years)
- \* Collapse of the West Antarctic ice sheet (more than 300 years)
- \* Collapse of the Atlantic thermohaline circulation (approx 100 years)
- \* Increase in the El Nino Southern Oscillation (approx 100 years)
- \* Collapse of the Indian summer monsoon (approx 1 year)
- \* Greening of the Sahara/Sahel and disruption of the West African monsoon (approx 10 years)
- \* Dieback of the Amazon rainforest (approx 50 years)
- \* Dieback of the Boreal Forest (approx 50 years)



# Other Natural Mechanisms\*



- Volcanic eruptions: Volcanoes can affect the climate because they can emit aerosols and carbon dioxide into the atmosphere.

# Other Natural Mechanisms\*

- Changes in the sun's intensity: Changes occurring within (or inside) the sun can affect the intensity of the sunlight that reaches the Earth's surface. The intensity of the sunlight can cause either warming (for stronger solar intensity) or cooling (for weaker solar intensity).



# Other Natural Mechanisms

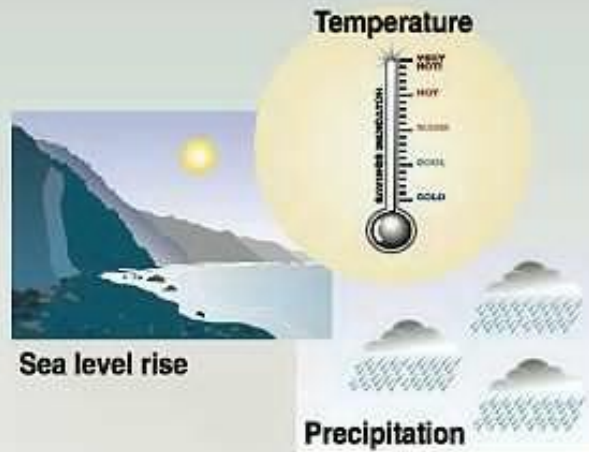
- Meteorite impacts. Example is the Chicxulub Meteor 65 MYA.
- Dust particles in the vapor-rich impact plume ejected from the Chicxulub crater rose above the Earth's atmosphere, enveloped the Earth, and rained back through the atmosphere around the entire world. The dust in the atmosphere blocked sunlight from reaching the surface around the entire globe. Current estimates suggest that the dust made it too dark to see for 1 to 6 months and too dark for photosynthesis for 2 months to 1 year, seriously disrupting marine and continental food chains. During this period, land surface temperatures decreased dramatically, possibly remaining below freezing in many areas.

# Other Natural Mechanisms\*

- Changes in the Earth's orbit: Changes in the shape of the Earth's orbit (or eccentricity) as well as the Earth's tilt and precession affect the amount of sunlight received on the Earth's surface.



# Potential climate changes impact



## Impacts on...

### Health



Weather-related mortality  
Infectious diseases  
Air-quality respiratory illnesses

### Agriculture



Crop yields  
Irrigation demands

### Forest



Forest composition  
Geographic range of forest  
Forest health and productivity

### Water resources



Water supply  
Water quality  
Competition for water

### coastal areas



Erosion of beaches  
Inundation of coastal lands  
additional costs to protect coastal communities

### Species and natural areas



Loss of habitat and species  
Cryosphere:  
diminishing glaciers