Section 1: Introduction to Climate Change

Learning outcomes

- definition of climate
- climate change has occurred over millions of years
- recent warming was caused by humans
- projections indicate continued warming
- climate change is acknowledged by almost all climate scientists, but not as many of the (US) public

Climate system and its components

Ocean is key climate component
Recent (last 100+ years) climate change

Five-Year Global Temperature Anomalies from 1880 to 2012

http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=4030

Historical (last 12,000 years) climate change
Historical (last 2,000 years) climate change

Northern hemisphere temperature variations

Temperature anomaly (°C)

Year

(a)

Historical (last 1,000 years) climate change

famous “hockey stick” graph

Northern Hemisphere temperature change over the past 1,000 years

Temperature change (°C)

Year

Historical (last 2,000 years) climate change

Conditions in Europe during Little Ice Age
Radiative forcing

"Radiative forcing is a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system and is an index of the importance of the factor as a potential climate change mechanism. In this report radiative forcing values are for changes relative to preindustrial conditions defined at 1750 and are expressed in Watts per square meter (W/m²)."  IPCC, AR4, 2007
Explosive volcanoes influence climate

Orbital, solar forcing

Increases in greenhouse gases
Where does this extra energy go?

![Graph showing energy distribution](image1)

**Historical climate change**

- Sea ice trend
- Temperature trends
- Ocean heat content trends

**Change in components of climate system**

![Diagram showing climate system changes](image2)
Emissions scenarios

Climate change projections using models

Projections of future climate
National Climate Assessment: 21st Century Temperature Scenarios

http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=4029

Climate change "denialism" abounds!