Changes in the Earth's Energy Balance

Any changes to the Earth's climate system that affect how much energy enters or leaves the system alters Earth's energy balance and can force temperatures to rise or fall. There are three fundamental ways to change the radiation balance of the Earth: 1) by changing the incoming solar radiation (e.g., by changes in Earth's orbit or in the Sun itself); 2) by changing the fraction of solar radiation that is reflected; and 3) by altering the long-wave radiation from Earth back towards space (e.g., by changing greenhouse gas concentrations). These destabilizing influences are called **climate forcings**. Climate, in turn, responds directly and indirectly through a variety of feedback mechanisms.

Radiative forcing is the change in the balance between solar radiation entering the atmosphere and the Earth's radiation going out. Radiative forcing is measured in Watts per square meter, which is a measure of energy. For example, an increase in radiative forcing of +1 Watt per square meter is like shining one small holiday tree light bulb over every square meter of the Earth.

On average a **positive radiative forcing** tends to warm the surface of the Earth while **negative forcing** tends to cool the surface. A forcing can trigger feedbacks that intensify or weaken the original forcing. The loss of ice at the poles, which makes them less reflective, is an example of a feedback.

Natural climate forcings include changes in the Sun's brightness, **Milankovitch cycles** (small variations in the shape of Earth's orbit and its axis of rotation that occur over thousands of years), and large volcanic eruptions that inject light-reflecting particles as high as the stratosphere.

Manmade forcings include particle pollution (aerosols), which absorb and reflect incoming sunlight; deforestation, which changes how the surface reflects and absorbs sunlight; and the rising concentration of atmospheric carbon dioxide and other greenhouse gases, which decrease heat radiated to space.

Greenhouse gases have a positive radiative forcing because they absorb and emit heat. Aerosols can have a positive or negative radiative forcing, depending on how they absorb and emit heat and/or reflect light. **Land use change** (including urbanization, deforestation, reforestation, desertification, etc.) can have significant effects on radiative forcing (and the climate) at the local level by changing the reflectivity of the land surface (or albedo). For example, farmland is more reflective than forests (which are strong absorbers of heat). The radiative forcing contribution from increasing **tropospheric ozone**, an unevenly distributed greenhouse gas, results in a relatively small warming effect.

The effect of **changes in the sun's intensity** on radiative forcing is estimated to be relatively small in this time period. Changes in the incoming radiation from the sun have resulted in major temperature changes in geologic history.

Source: http://www.epa.gov/climatechange/