Earth's Cycles

The Energy Cycle

cycle
a sequence of events that repeats

While some **cycles** are like wheels, with matter continually circulating among the four great spheres, the movement of energy into and out of the Earth system through the energy cycle is different. It is more like a scale you would use in the laboratory. When you measure materials on the scale, you are usually looking for the two sides of the scale to balance; what is on one side should equal what is on the other side. The Earth system works in a similar way with regard to energy.

The amount of energy that enters the system should equal the amount that is removed. If the planet were to take in more energy than it released, the climate would become warmer. If it released more energy than it gained, the climate would turn cooler. Because of the balance-scale nature of Earth's energy cycle, scientists also call it Earth's energy budget. There are three main sources of energy in Earth's energy budget:

- Most of the energy that enters the Earth system (99.985 percent) is solar energy—energy that comes from the Sun. Solar energy drives the winds, ocean currents, and waves. It is also the source of the energy that causes rocks to weather, forming soil.
- A much smaller part of the energy budget (0.013 percent) originates as heat from within the Earth. This is called geothermal energy, which drives the movement of Earth's crust; powers volcanoes, geysers, and earthquakes; and plays an important part in the rock cycle.
- Tidal energy, the third and smallest part of the energy budget (0.002 percent), results from the Moon's pull on Earth's oceans. Although small when compared with solar energy, tidal energy is powerful enough to slow down Earth's rotation, acting as a brake.

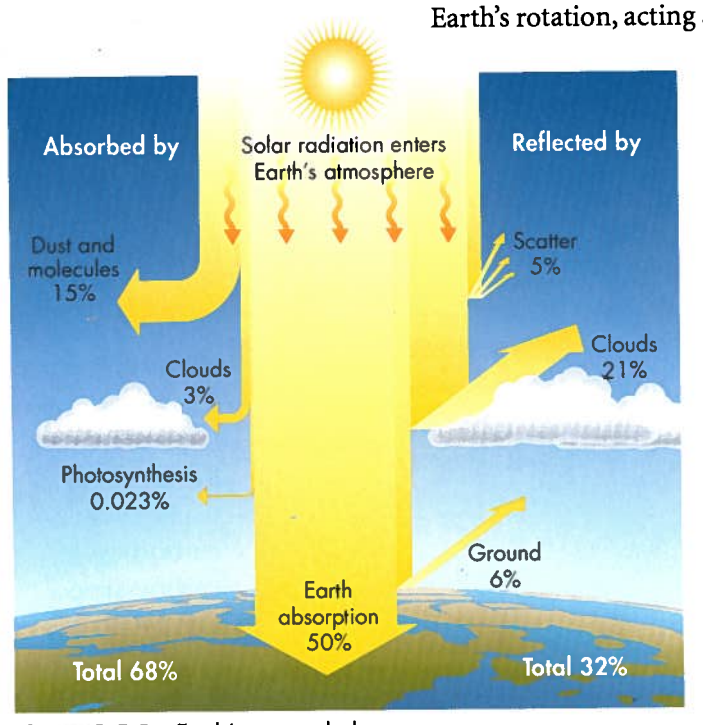

Figure 1.5.1 Earth's energy balance

To maintain balance in the energy budget, the incoming energy must go somewhere. About 30 percent of it is reflected back into space without being changed. Different areas of Earth's surface and different types of clouds reflect varying amounts of energy.

The remaining solar energy, along with the tidal and geothermal energy, is used within the Earth system, where it may bring about evaporation and precipitation in the water cycle. It may be changed to wave and wind energy, or be converted to heat energy and radiated back into space. Some of the energy is stored in water and ice, in plants, and even in sedimentary rocks. The great reservoirs of fossil fuels—coal, gas, and oil—were formed from dead plants, so fossil fuel energy is, in reality, old solar energy.

As the energy moves through the Earth system, it changes. With every change, a little bit of it is converted to heat and is lost to the cycle. According to a basic principle of physics, energy can never be completely recycled. This degradation of energy is an important difference between the energy cycle and the carbon and water cycles.

The Laws of Thermodynamics

Energy follows certain predictable rules that explain what it will do. These rules are called the laws of thermodynamics. Thermodynamics is a branch of physics that deals with the conversion of heat energy into other forms of energy within a closed system. The laws of thermodynamics deal with the ways in which energy flows.

- The *First Law of Thermodynamics* states that energy can never be created or destroyed, only changed from one form to another. These changes can happen many times. For example, solar energy can be stored in plants, which die and eventually become fossil fuels. Fossil fuels can be burned at an electric power plant to generate electricity, which then powers a light bulb.
- The *Second Law of Thermodynamics* states that when energy changes, it is converted from a more generally useful, more concentrated form to a less generally useful, less concentrated form. This means that, unlike water, which can turn from ice to water to vapour and back to water or ice without loss, energy can never be recycled completely. Some energy will always be lost, usually as heat.

The Effects of Earth's Surface

Earth's surface is not uniform. It is covered by oceans, deserts, grasslands, forests, cities, and glaciers. These different parts of Earth reflect solar energy at various rates. The percentage of energy that is reflected without being changed is called **albedo**.

A forest has a low albedo, reflecting between 5 and 10 percent of the energy that reaches it. A field of freshly fallen snow has a considerably higher albedo than a forest, reflecting 80 to 90 percent of the energy that reaches it from the Sun. Desert areas fall between the two, reflecting about one-third of the energy back into space.

Figure 1.5.2 Which of the two photographs shows an area with a higher albedo? Explain.