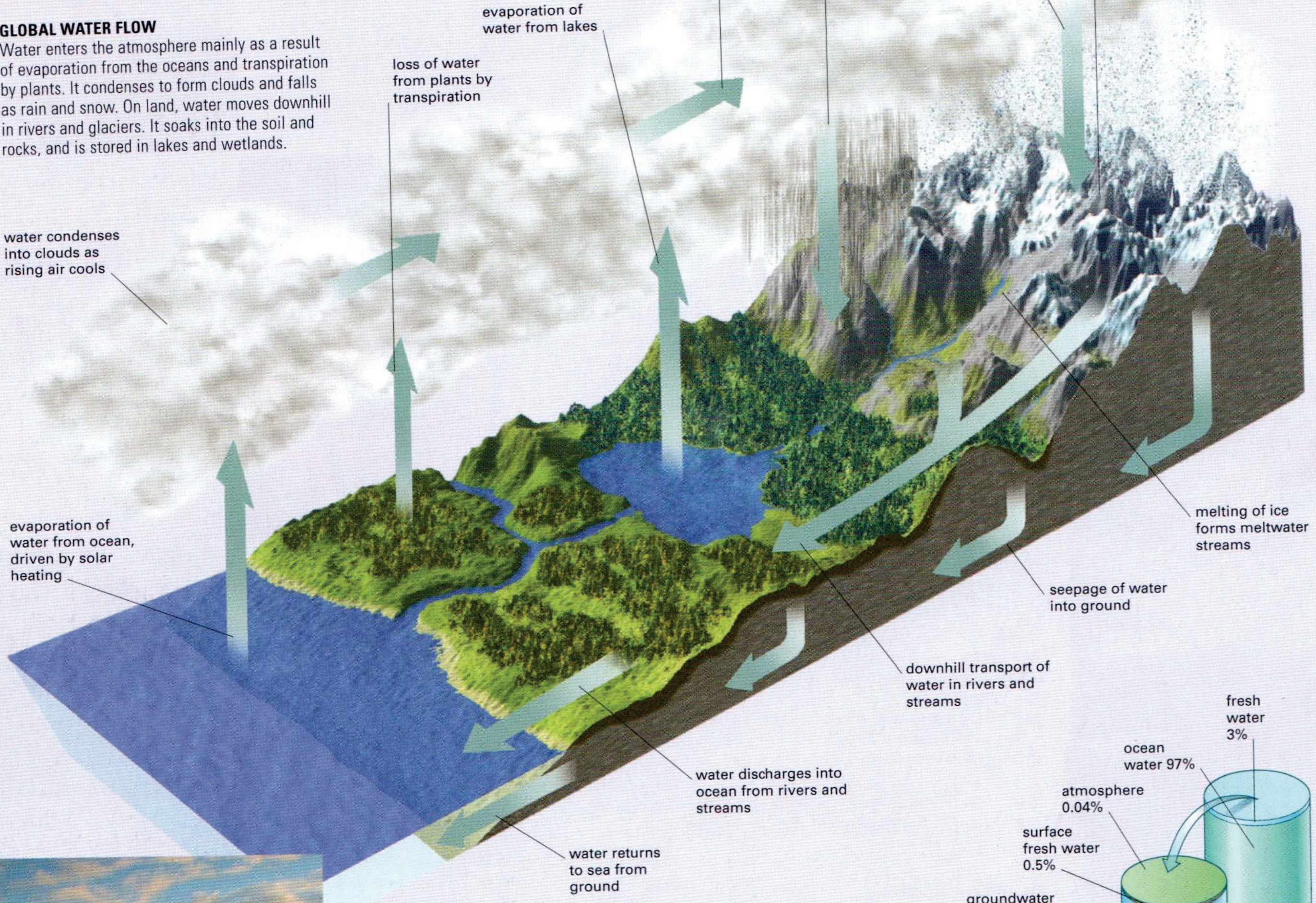
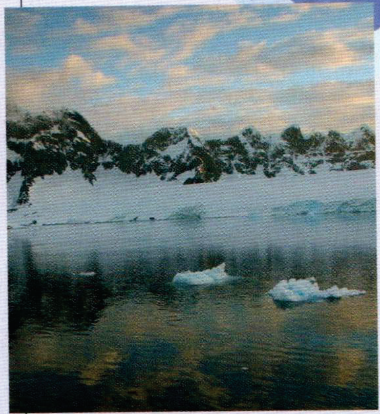
GLOBAL WATER CYCLE

THE WORLD'S OCEANS DO NOT FORM a self-contained system but continually exchange water with the atmosphere and landmasses through evaporation, cloud formation, precipitation, wind transport, and river flow. This complex of interconnected processes, which is ultimately driven by heat from the Sun, is called the global water cycle or hydrologic cycle. The cycle is made up of many smaller cycles, such as the formation and melting of sea ice.



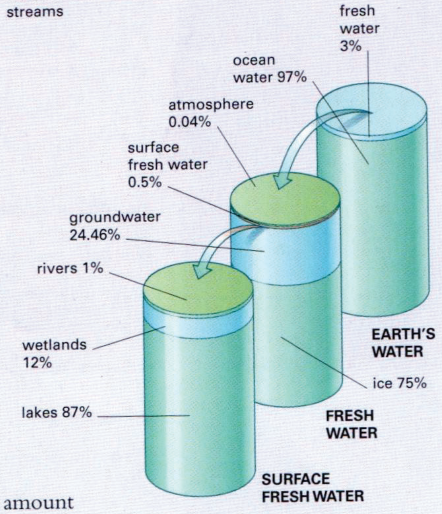
GLOBAL WATER FLOW
Water enters the atmosphere mainly as a result of evaporation from the oceans and transpiration by plants. It condenses to form clouds and falls as rain and snow. On land, water moves downhill in rivers and glaciers. It soaks into the soil and rocks, and is stored in lakes and wetlands.



PLAYERS IN THE CYCLE
The sea, ice, mountains, and clouds all play a part in the global water cycle. This coastal scene is near Port Lockeroy in Antarctica.

EARTH'S WATER RESERVOIRS

Just over one-third of a billion cubic miles (1.4 billion cubic kilometers) of water exists on Earth. More than 97 percent of this water is stored in the oceans as a component of salt water. The rest is fresh water. Of this, more than two-thirds is in the form of ice, locked up in the vast ice sheets that cover Antarctica and most of Greenland, and in icebergs and sea ice. Much of the rest is groundwater—contained in underground rocks—while a tiny amount (less than 1 part in 2,000) is water vapor in the atmosphere. Fresh liquid water on Earth's land surface, in lakes, wetlands, and rivers, makes up just 0.5 percent of all the world's fresh water, or 0.014 percent of the total water. Earth's different water reservoirs have not always had the same relative sizes that they have today. For instance, during the ice ages, a higher proportion was locked up in ice, with less in the oceans.



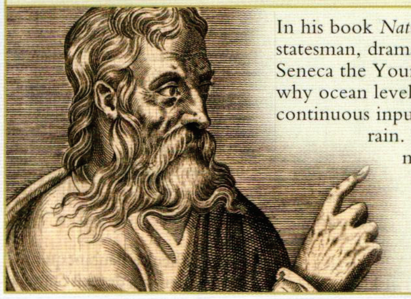
RELATIVE SIZES
Earth's ocean water (the bulk of the rear cylinder, above) hugely exceeds its reservoirs of fresh water, and the relative proportion of fresh water found on the land surface is tiny.

OCEAN EVAPORATION AND PRECIPITATION

A total of 102,000 cubic miles (425,000 cubic kilometers) of water evaporates from the oceans per year. Of this, 93,000 cubic miles (385,000 cubic kilometers) falls back into the sea as precipitation (rain, snow, sleet, and hail). The remainder is carried onto land as clouds and moisture. Evaporation and precipitation are not evenly spread over the surface of the oceans. Evaporation rates are greatest in the tropics and lowest near the poles. High rates of precipitation occur near the equator and in bands between the latitudes of 45° and 70° in both hemispheres. Drier regions are found on the eastern sides of the oceans between the latitudes of approximately 15° and 40°.

PEOPLE

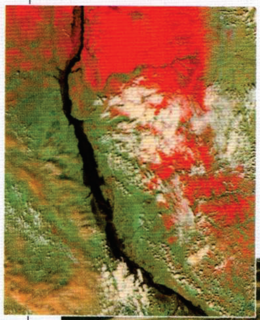
SENECA THE YOUNGER



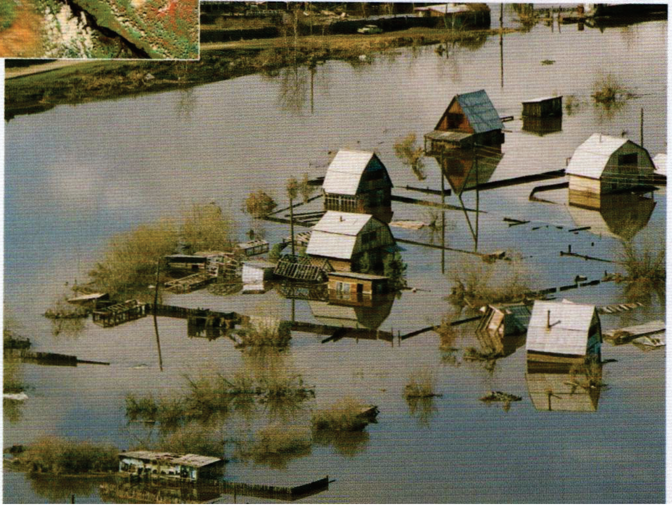
In his book *Natural Questions*, the Roman statesman, dramatist, and philosopher Seneca the Younger (4 BC–AD 65) pondered why ocean levels remain stable despite the continuous input of water from rivers and rain. He argued there must be mechanisms by which water is returned from the sea to the air and land and proposed an early version of the hydrologic cycle to explain this.

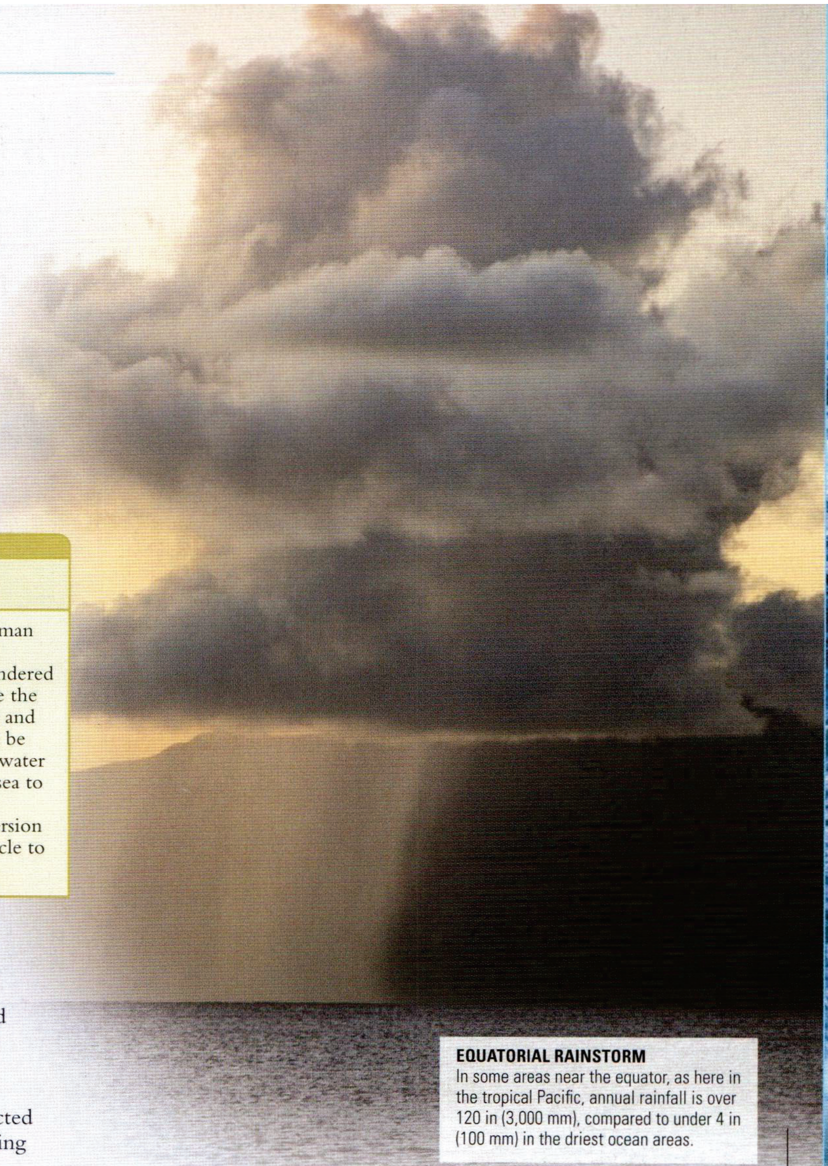
FRESHWATER INFLOW

The 9,000 cubic miles (40,000 cubic kilometers) of water lost from the oceans each year by evaporation and transport onto land is balanced by an equal amount returned from land in runoff. Just 20 rivers, including the Amazon and some large Siberian rivers, account for over 40 percent of all input into the oceans. Inflows from the different river systems change over time as they are affected by human activity and climate change. For instance, global warming appears to have increased the flow from Siberian rivers into the Arctic Ocean, as water frozen in the tundra melts. These inflows lower the salinity of Arctic waters and may influence global patterns of ocean circulation (see p.63).



SIBERIAN LENA RIVER FLOODING
Climate change is thought to have contributed to severe flooding of the Lena River in recent years (below). A false-color satellite image (left) shows the engorged river in black; red areas are ice.

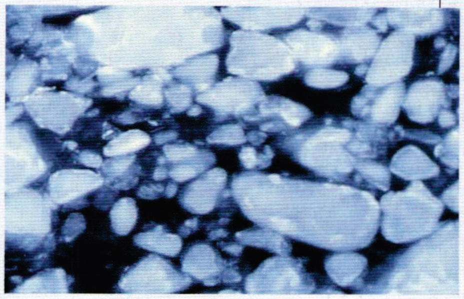




EQUATORIAL RAINSTORM
In some areas near the equator, as here in the tropical Pacific, annual rainfall is over 120 in (3,000 mm), compared to under 4 in (100 mm) in the driest ocean areas.

THE SEA-ICE CYCLE

In addition to the overall global water cycle, there is a local seasonal cycle in the amount of water locked up as sea ice. In the polar oceans, the extent of sea ice increases in winter and decreases in summer. This has important climatic consequences, because sea ice formation releases, and its melting absorbs, latent heat to and from the atmosphere; and because the presence or absence of sea ice modifies heat exchange between the oceans and atmosphere. In winter, sea ice insulates the relatively warm polar oceans from the much colder air above, thus reducing heat loss. However, especially when covered with snow, sea ice also has a high reflectivity (albedo) and reduces the absorption of solar radiation at the surface. Overall, the sea ice cycle is thought to help stabilize air and sea temperatures in polar oceans. Also, because it affects surface salinity, sea ice formation helps drive large-scale circulation of water through the world's oceans (see p.61).



SEA ICE FORMING
As sea ice forms, it releases heat to the atmosphere and increases the saltiness of the surrounding water (by rejecting salt). These processes affect climate and the circulation of seawater.