OCEANS AND CLIMATE

THE OCEANS HAVE A PROFOUND INFLUENCE on the world's climate, most strikingly in the way they absorb solar energy and redistribute it around the world in warm surface currents. Cold currents also produce local climatic effects, while alterations in currents are associated with climatic fluctuations such as El Niño (see p.68). The future behavior of the oceans is crucial to the future course of climate change, as they are an important store for carbon dioxide, the principal greenhouse gas.

SOLAR HEATING
The surface layers of the oceans absorb over half the solar energy that reaches Earth. Currents move this from the equator toward the poles at a rate of about 1 billion megawatts.

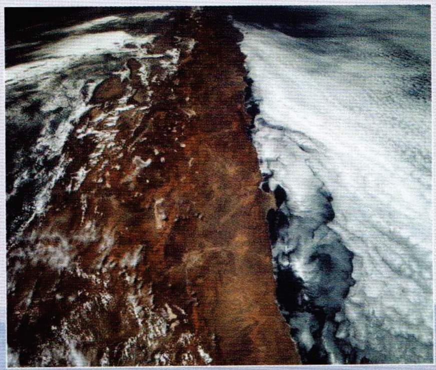
WARM CURRENTS

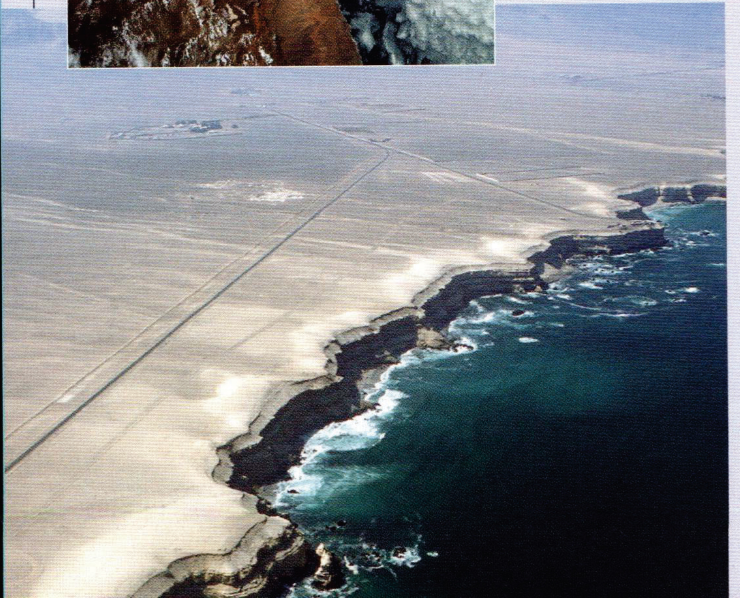
Five or six major surface currents (see p.58) carry heat away from the tropics and subtropics toward the poles, giving some temperate regions a warmer climate than they would otherwise enjoy. A prime example is the effect of the warm Gulf Stream and its extension, the North Atlantic Drift, on Europe. The North Atlantic Drift carries heat originally absorbed in the Caribbean Sea and Gulf of Mexico across the Atlantic, where it is released into the atmosphere close to the shores of France, the British Isles, Norway, Iceland, and other parts of northwestern Europe. As the prevailing westerly winds blow this warmed air over land, these countries benefit from a milder climate than equivalent regions at similar, or even lower latitudes, on the western side of the Atlantic. For example, winter temperatures are typically higher in Reykjavik, the capital of Iceland, than in New York. Similarly, in the northwest Pacific, the Kuroshio Current warms the southern part of Japan, while in the extreme southwest Pacific, the East Australian Current gives Tasmania a relatively mild climate.

BALMY BEACHFRONT
Penzance, in southwest England, has a mild climate that supports subtropical vegetation—the effect of the North Atlantic Drift is to raise temperatures here by about 9°F (5°C).

COLD CURRENTS

In some instances, the climatic effect of cold currents is simply to produce a cooler climate than would otherwise be the case. For instance, the west coast of the US is cooled in summer by the cold California Current. Cold currents also affect patterns of rainfall and fog formation. In general, the various cold currents flowing toward the equator on the eastern sides of oceans—combined with upwellings of cold water from the depths in these regions—cool the air, reduce evaporative losses of water from the ocean, and cause downdrafts of drier air from higher in the atmosphere. Although clouds and fog often develop over the ocean in these areas (as what little moisture there is condenses over the cold water), these quickly disperse once the air moves over land. Thus, cold currents contribute to the development of deserts on land bordering the eastern sides of oceans, such as the Namib desert in southwestern Africa.

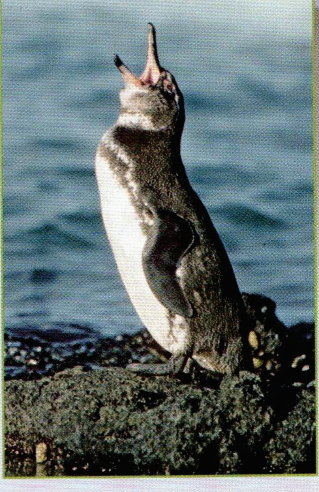




COAST OF NORTHERN CHILE
The cold Peru Current flows along the coast of northern Chile. It encourages the development of clouds and fog over the sea (visible above left in the satellite image) but also contributes to the extreme aridity of the coastal strip (left).

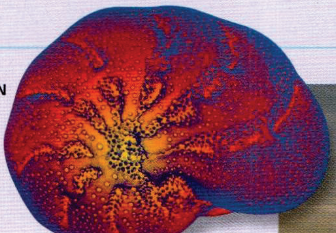
STRAYING NORTH

Most penguins live in Antarctica but, somewhat surprisingly, the world's most northerly-living penguins inhabit the Galápagos Islands, on the equator. The islands have a cool climate—sea-surface temperatures in most years average 9°F (5°C) less than typical temperatures in the tropics, due to the cold Peru Current that flows up the west coast of South America.



CARBON IN THE OCEANS

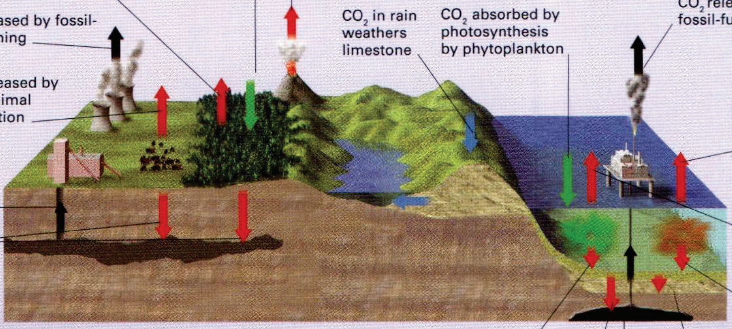
The oceans contain Earth's largest store of carbon dioxide (CO_2)—the main greenhouse gas implicated in global warming. Huge amounts of carbon are held in the oceans, some in the form of CO_2 and related substances that readily convert to CO_2, and some in living organisms. The oceanic CO_2 is in balance with the atmospheric content of the same gas. For many years, the oceans have been alkaline, and acted as an important store for the excess CO_2 released by human activity. Biological and chemical processes turn some of this CO_2 into the calcium carbonate shells and skeletons of organisms, other organic matter, and carbonate sediments. However, the increasing CO_2 concentration is beginning to acidify the oceans, threatening shell and skeleton formation in marine organisms, as acid tends to dissolve carbonates. Further, some scientists fear that the rate at which the oceans can continue to absorb CO_2 will soon slow down, further aggravating global warming.



FORAMINIFERAN SHELL

CARBON CONVERSION
CO_2 released from burning fossil fuels (right), after absorption into the oceans, can eventually end up in the shells of marine organisms in the form of carbonate.

METHANE HYDRATE DEPOSIT
This substance is found as a solid on some areas of sea floor. There are concerns that ocean warming could release this into the atmosphere as methane gas, which traps more heat than CO_2.



CARBON SOURCES AND STORES
At present, more CO_2 is added to than subtracted from the atmosphere. Some of the excess is absorbed by the oceans, where some is held in solution and some incorporated into living organisms and sediments.

GOLDEN GATE FOG
The climate of San Francisco is influenced by exceptionally cold water, produced by upwelling, off the California coast. Fog is produced as westerly winds blow moist air over this cold water.