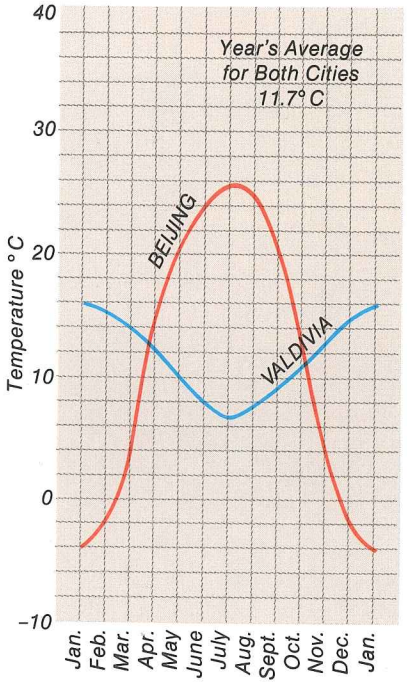
31.1 Although the average yearly temperatures of Beijing, China, and Valdivia, Chile, are the same, their climates are quite different. The cities are about the same distance, though on opposite sides from the equator.



However, almost all of Bombay's rains fall in a monsoon season of four summer months. In Mobile the rains are spread throughout the year. No month averages less than 7.6 centimeters of rain.

It is clear that climate is not necessarily the same as average weather. Climate cannot be described accurately without gathering more information.

Topic 3 Climate Controls

The temperature and rainfall patterns of present-day Earth depend upon a set of conditions called climate controls. The six main climate controls are the following:

1. latitude;
2. altitude;
3. prevailing winds;
4. topography;
5. distance from large bodies of water (oceans, lakes);
6. nearby ocean currents.

For a particular area, some factors are more important than others. For example, nearby ocean currents are not important to the climate high in the Rocky Mountains, but altitude and topography are.

Over long periods of time, the climate changes. The global climate is related to the amount of solar energy Earth absorbs and the energy Earth and the atmosphere radiate or reflect into space. The local climate is related to the global climate as well as to the six climate controls. All six can change over geologic time. For example, mountain-building and erosion change the topography and altitude of an area. Plate tectonics changes the latitude of land areas and also changes the ocean currents. The positions of continents, ice, and cloud cover are among the factors that determine the amount of sunlight Earth absorbs.

TOPIC QUESTIONS

Each topic question refers to the topic of the same number.

1. **(a)** What is climate? **(b)** Define *daily temperature range* and *yearly temperature range.*
2. **(a)** Why don't averages give a complete picture of climate? **(b)** How can two cities have the same average temperature but very different climates? **(c)** How can two cities have nearly the same yearly rainfall but very different climates?
3. **(a)** Name six factors that control climate in a region. **(b)** What controls the global climate?

II Factors That Control Temperature

Topic 4 How Latitude Controls Temperature

Latitude is the distance in degrees (north or south) from the equator. The yearly temperature range and average yearly temperature depend mainly on latitude.

At a location within 5 or 10 degrees of the equator, the sun shines for about 12 hours each day and each night is about 12 hours long. At noon the sun is never very far from being directly overhead. The climate is hot throughout the year, and the average temperature is very high, about 27°C. There are no summers and winters, only rainy seasons and dry seasons. The yearly range of temperature is only 3° or 4°C.

At a location 40 or 45 degrees north from the equator, there are 15 or 16 hours of sunshine in July. Nights are only 8 or 9 hours long. Six months later the sun shines only 8 or 9 hours a day and nighttime lasts 15 or 16 hours. On the average the yearly temperature is far lower than it is near the equator. However, the annual range of temperature may be large—as much as 30°C.

In the polar regions most of the sunshine comes in a day that lasts for many months. The winter includes an equally long night. In summer the sun is never high in the sky, so it provides little heating. It goes completely around the sky each day but does not dip below the horizon. Temperatures change very little for days at a time. The summer is comparatively mild. When the long winter night comes, however, the weather becomes very cold. In these latitudes the average annual temperature is very low. The annual temperature range is very large, but the daily temperature range is very small.

Figure 31.2 on page 578 shows the relationship between latitude and yearly temperature range. In general, the higher the latitude, the lower the average yearly temperature and the larger the yearly temperature range.

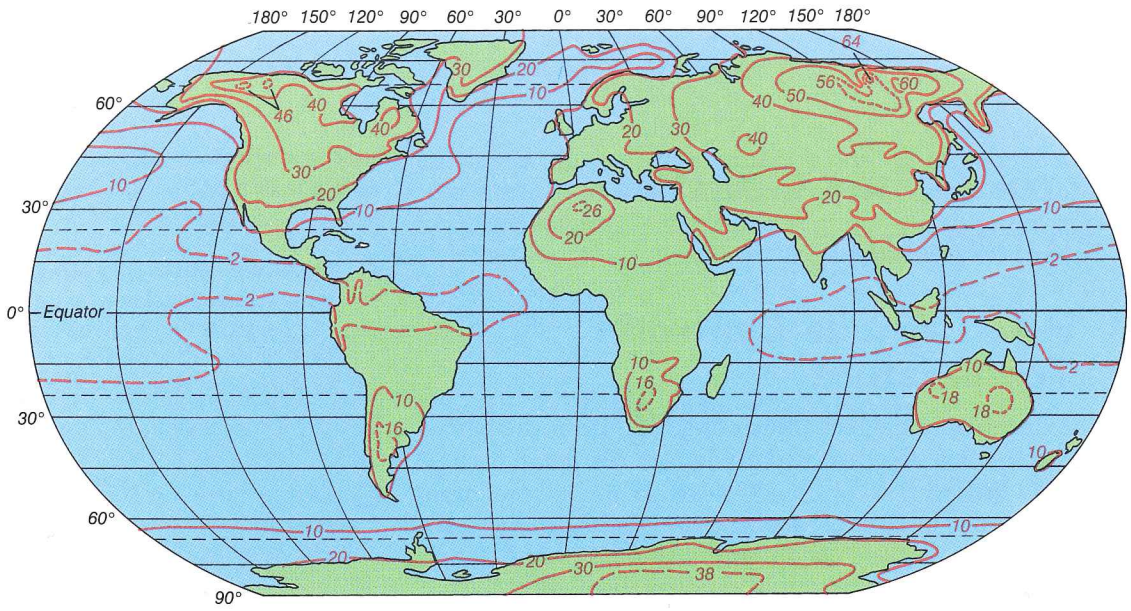
Topic 5 Altitude and Temperature

Altitude is height above sea level. Its effect on temperature is somewhat like that of latitude. On the average, temperatures drop about 1°C for every 160 meters of altitude. The higher the altitude, the lower the average yearly temperature.

For example, Vera Cruz and Mexico City have the same latitude but very different climates. Vera Cruz, at sea level in the tropics, is hot and humid. Mexico City, 2300 meters above sea level, is pleasantly cool even in summer.

OBJECTIVES

- **A** Show the relationship between latitude and average temperature and between latitude and daily and yearly temperature ranges.
- **B** Differentiate between marine and continental climates.
- **C** Discuss the effects of altitude, prevailing winds, topography, and ocean currents on climate.



31.2 Average annual range of surface air temperatures (in degrees Celsius)

Topic 6 Land, Sea, and Temperature

Land gains and loses heat much more quickly than water. Land areas in the middle latitudes tend to have hot summers and cold winters. As shown in Figure 31.2, the annual average temperature ranges of land areas are larger than those for the oceans at the same latitudes. These land areas with large yearly temperature ranges have **continental climates.** Areas near the ocean, on the other hand, have small yearly temperature ranges. These areas have **marine climates.**

Reykjavik (RAKE-yuh-vik), Iceland, 64°N, and Verkhoyansk (vyer-koh-YANSK), Siberia, 68°N, are at nearly the same latitude. Reykjavik is on the south coast of Iceland. Its marine climate has an annual temperature range of only 11°C. Verkhoyansk is deep in the interior of the great Asian landmass. It has a continental climate with a yearly temperature range of almost 67°C.

In summary, ocean areas have marine climates with small yearly temperature ranges. Continental interiors have continental climates with large yearly temperature ranges.

Topic 7 Prevailing Winds and Temperature

The west coasts of continents in the middle latitudes have marine climates. The prevailing westerlies blow at these latitudes. When they come from the ocean, they carry maritime air masses onto the west coasts of continents and large islands. Air masses from the Pacific Ocean are carried over the west coasts of North America and South America. Air masses from the Atlantic Ocean are carried over the west coasts of the British Isles and Europe. Portland, Oregon, and London, England, have marine climates.

How far inland does a marine climate reach? The distance depends chiefly on the topography. Usually, a marine climate

reaches no farther than the first high mountain range. Beyond the mountains, the continental interiors have continental climates.

In middle latitudes, east coasts do not have marine climates. Most of the air masses that come to east coasts are brought by the prevailing westerlies from the interiors of the continents. As a result, east coasts have continental climates. Their temperatures are only slightly moderated by the ocean. Boston and New York, for example, are on the Atlantic Coast. Nevertheless, their summers and winters are nearly as extreme as those of the interior of the continent.

In summary, in the latitudes of the prevailing westerlies, west coasts have marine climates with cool summers and mild winters. East coasts have continental climates with hot summers and cold winters.

Topic 8 Topography and Temperature

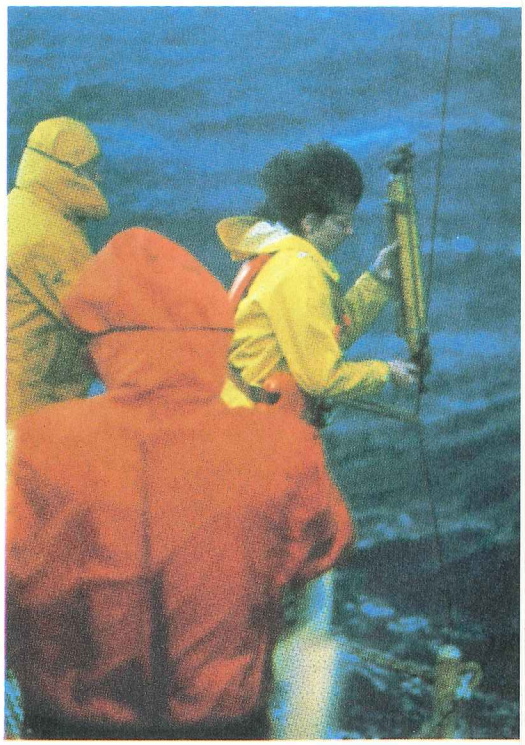
Mountain ranges may block wind that could affect temperature. For example, the marine climate of the western United States reaches no farther inland than the Coast Ranges. The Sacramento Valley lies just east of the Coast Ranges, not far from the Pacific Ocean. Nevertheless, it has intensely hot summers and cold winters.

Southern Italy has mild winters, mainly because the Alps keep out cold winds from the north. On the Great Plains of Canada and the United States, just the opposite situation occurs. The plains have no mountain range running across them to block winds from the north. Therefore, winter cold waves, with icy winds from the Arctic, may reach all the way to the Gulf of Mexico.

Topic 9 Ocean Currents and Temperature

Ocean currents may be considerably warmer or colder than the normal surface air temperatures for their latitudes. Warm currents have an effect on the places they pass. Their effect is greatest when the prevailing winds blow from the water to the land. For example, the warm *Gulf Stream* heats the air above it. The prevailing westerlies blow the warmed air to the shores of Iceland, the British Isles, and Scandinavia. As a result, these regions are as warm as places that are closer to the equator. London, England, is about 1100 kilometers nearer the North Pole than Cleveland, Ohio. Nevertheless, its average annual temperature is higher than Cleveland's.

Cold currents also affect temperature. Northern Labrador is chilled by the *Labrador Current*. Its yearly average temperature is more than 11°C lower than that of Stockholm, Sweden, which is at the same latitude.



31.3 Current meters are used to determine the speed, direction, and properties of both surface and subsurface currents.