CHAPTER 2 Climate

Commentary

The goal of this chapter is not to provide a detailed background on climate, as in a geography course, but rather to introduce the basic concepts of climate, as it affects terrestrial and aquatic environments. There is a strong emphasis on solar radiation as the climatic factor that provides the energetic foundation for life on Earth. Section 2.1 describes the physical processes that govern how Earth intercepts solar radiation, and the different fates of radiation. Emphasize the importance of the atmosphere and in particular, its chemical makeup, as these aspects will be vital for understanding global climate change (Chapter 28). A major goal of ecology is to understand the distribution and abundance of organisms on Earth. To develop this understanding at a global scale, students must realize how intercepted solar radiation and resulting mean temperatures vary with latitude (Section 2.2), and how temperature varies with altitude (Section 2.3). These fundamental climatic gradients contribute to some of the most striking ecological patterns on Earth, including the annual cycle of seasons and global patterns in species diversity.

The latitudinal gradient in intercepted solar radiation contributes indirectly to vital climatic variables such as the circulation of air masses (Section 2.4) and ocean currents (Section 2.5). Students should understand how high solar input at the equator causes rising air masses there; and how the movement of these air masses is subsequently influenced by Earth's rotation as they flow northward (the Coriolis effect, Section 2.4). Similarly, the major patterns of water flow in the Earth's oceans are influenced by the latitudinal gradient in solar radiation, Earth's rotation, and global patterns of airflow (Section 2.5). An important principle involved in understanding global climate patterns is that warm air can hold more moisture than cold air (Section 2.6). Students should understand relative humidity and saturation vapour pressure, particularly its implications for the geographical patterns in precipitation that influence the distribution and abundance of species.

Global patterns of precipitation (Section 2.7) bring together all facets of climate discussed so far, including temperature, winds, and ocean currents. A basic understanding of the Intertropical Convergence Zone (ITCZ) will help students comprehend the distribution of the major tropical and subtropical biomes later in the text. Understanding global patterns of rainfall requires students to integrate important climatic principles. Although part of precipitation, snow and ice have impacts on individuals and ecosystems that go beyond the mere quantity of their moisture, particularly as they interact with cold temperature and wind events (Section 2.8). It is easy for students to grasp how precipitation patterns of both rainfall and snow are affected by topography, particularly in mountainous regions (Section 2.9).

Until this point, the chapter has focused on the predictable patterns of climate, so stressing the importance of irregular climate occurrences, such as the El Niño–Southern Oscillation (Section 2.10), is useful. Because students are aware first-hand of the impacts of climatic variation on their own lives, exploring the contributing factors usually interests them.

So far, we have emphasized macro-scale climatic patterns. Students should understand that while global patterns strongly influence the baseline conditions of a habitat, most organisms experience conditions that vary locally from the regional average (Section 2.11). These local conditions are called microclimates, and reflect a variety of factors, including topography (see also Section 2.9), vegetation, slope, and aspect. Depending on where students live, their own personal experience will help them relate to the impact of local climatic factors (Ecological Issues: Urban Microclimates).

Learning Objectives

The overall objective of Chapter 2 is to convey the fundamental drivers of climate, as it determines the abiotic factors that affect organisms and ecosystems. After studying this chapter, students should understand:

(1) the nature of solar radiation, particularly its role as the primary driver of climate (2.1).
(2) the impact of radiation and elevation on temperature regime (2.2 and 2.3).
(3) global circulation patterns of the atmosphere and oceans, and factors influencing them (2.4 and 2.5).
(4) the factors that determine humidity, and the significance of saturation vapour pressure and relative humidity for precipitation (2.6).
(5) basic global patterns of precipitation, as affected by global circulation patterns (2.7).
(6) the impact of the Intertropical Convergence Zone on tropical and subtropical precipitation (2.7).
(7) the multiple effects of frozen precipitation, in interaction with temperature and wind events (2.8).
(8) how topography affects climate, particularly the impact of mountains on precipitation (2.9).
(9) the factors that contribute to irregular climatic variation on differing time scales (2.10).
(10) the importance of microclimate for both individual response and ecosystem distribution (2.11).

Additional Exercises and Discussion Topics

1. Ask students to assume that they are camping in mountainous or hilly terrain. Where would place their campfire so that smoke will not drift into their tent site? Move from this specific question to the broader question of what other climate-related factors would influence what site they would choose as habitat if they were living in nature, and how these choices might affect their chances of survival as individuals and persistence as a population. Students often enjoy camping or other outdoor experiences, so having them make the connection between climate at a global scale affecting the distribution of species and ecosystems and their own imagined experience can be an eye-opening exercise, particularly in cold habitats where the harsh climate would be a critical factor affecting survival.
2. Although the El Niño–Southern Oscillation is far removed from students in most parts of Canada, it has considerable local influence. Ask students how they (or other local organisms) are influenced by the El Niño–Southern Oscillation. How long do these effects last?
3. Ask students to monitor the accuracy of weather forecasts over a 3-week period. Discuss how we can have such a solid understanding of what determines global climate patterns and yet have such difficulty predicting weather. Ask them to relate this discrepancy to the reality faced by organisms that have evolved in a particular climate regime, and yet experience erratic weather fluctuations. Appreciating the consequences of varying abiotic conditions on the fates of organisms and populations is essential.
4. Ask students to observe the movements of a local animal. (A domesticated animal will do, but depending on the time of year a bird, squirrel, or other wild animal might be possible candidates. If domesticated, an animal living outdoors, such as a horse, is preferable, but even a house cat could be used.) What special microclimate situations is it exploiting and why? What factors are creating microclimates that are significantly different from the average climate of the region?
5. Choose an example of two microclimate that occur locally in close juxtaposition to each other (e.g., a forest interior and an open field; or the north and south-facing sides of a hilly slope; or a protected bay in a lake and an open water portion of the same lake; etc.) and ask students to discuss the global, regional, and local influences that determine the conditions experienced by organisms there.