Chapter 9  Air: Climate and Pollution

9.1 What Is the Atmosphere?

Earth’s atmosphere consists of gas molecules, relatively densely packed near the surface and thinning gradually to about 500 km (300 mi) above the earth’s surface. In the lowest layer of the atmosphere, air moves ceaselessly, flowing, swirling, and continuously redistributing heat and moisture from one part of the globe to another. The daily temperatures, wind, and precipitation that we call weather occur in the troposphere. Long-term temperatures and precipitation trends we refer to as climate.

The earliest atmosphere on earth probably consisted mainly of hydrogen and helium. Over billions of years, most of that hydrogen and helium diffused into space. Volcanic emissions added carbon, nitrogen, oxygen, sulfur, and other elements to the atmosphere. Virtually all of the molecular oxygen (O₂) we breathe was probably produced by photosynthesis in blue-green bacteria, algae, and green plants.

Clean, dry air is 78 percent nitrogen and almost 21 percent oxygen, with the remaining 1 percent composed of argon, carbon dioxide (CO₂), and a variety of other gases. Water vapor (H₂O) in gas form) varies from near 0 to 4 percent, depending on air temperature and available moisture. Minute particles and liquid droplets—collectively called aerosols—also are suspended in the air. Atmospheric aerosols and water vapor play important roles in the earth’s energy budget and in rain production.

The atmosphere has four distinct zones of contrasting temperature, due to differences in absorption of solar energy (fig. 9.3). The layer immediately adjacent to the earth’s surface is called the troposphere (tropos means to turn or change, in Greek). Within the troposphere, air circulates in great vertical and horizontal convection currents, constantly redistributing heat and moisture around the globe (fig. 9.4). The troposphere ranges in depth from about 18 km (11 mi) over the equator to about 8 km (5 mi) over the poles, where air is cold and dense. Because gravity holds most air molecules close to the earth’s surface, the troposphere is much denser than the other layers; it contains about 75 percent of the total mass of the atmosphere. Air temperature drops rapidly with increasing altitude in this layer, reaching about −60°C (−76°F) at the top of the troposphere.

Figure 9.2  We could stabilize or even reduce carbon emissions now if we focus on multiple modest strategies.

Another set of seven wedges, including alternative energy, preventing deforestation, and reducing soil loss, could put us on a trajectory to reduce our CO₂ emissions and prevent disastrous rates of climate change. Further details on the wedges are given later in this chapter.

The net effect of these strategies is likely to be economic gain, which contradicts many traditional fears of economists and politicians that we cannot afford climate mitigation. Many of the needed changes involve efficiency, which means long-term cost savings. Employment is likely to increase as new cars and appliances replace old ones, and as we insulate more buildings.

There are other potential benefits, too. Efficient cars will save household income. Cleaner power plants will reduce asthma and other respiratory illnesses, saving health care costs as well as improving quality of life. Less reliance on coal will reduce toxic mercury in our food chain, because coal burning is the largest single source of airborne mercury emissions.

In this chapter we’ll examine the evidence for climate change and its consequences, as well as important issues in air pollution. To begin, we’ll discuss what our climate is, and how it works.

For related resources, including Google Earth™ place marks that show locations where these issues can be seen, visit http://EnvironmentalScience-Cunningham.blogspot.com.

Further Reading