

Climate, Weather, and Global Warming

Climate, Weather, and Global Warming are three different but obviously connected characteristics of the atmosphere, the thin envelope of gases that enclose Earth. The three represent our environmental experience over days, years, and lifetimes. We have barely a century of reliable direct measurement records of temperature, rain and snowfall, humidity, wind speed and direction, and air pressure. (Scientists infer longer period information from tree rings, snow and ice layers, and lake and ocean floor drilling cores.)

Climate is a long-term atmospheric condition defined as the sum of regional weather conditions over time. Humans' limited and recent (say, decades) of recorded experience with climate is that Syracuse, for example, has cold to frigid winters, relatively mild fall and spring, and warm summers. Within that noncommittal description, however, there is plenty of room for weather variation. Prolonged "deep freezes," blizzards, and "triple H" (hazy, hot, and humid) events are common. Typically, we don't get hurricanes and tornadoes. We can, of course, but our distance from and elevation above the oft-flooded coastal zone means that we are far from most hurricanes, and our varying elevation means that conditions necessary for tornado development are infrequent. We do get (and have gotten) local storm event and snowmelt flooding.

Weather, on the other hand, is the local condition of the atmosphere for short periods, typically associated with high and low pressure systems that characteristically move from west to east at about weekly intervals, producing relatively short term changing – and often repetitive – conditions of temperature, precipitation, wind, and storminess. These systems and their specific conditions respond to unchanging rules about how Earth's rotation, and wind, pressure, and temperature combine to form weather events. The emphasis here is on "unchanging rules": they do not and will not change.

Global warming – one of the two principal types of climate change – is the relatively long-term planet-wide trend as increasing atmosphere and ocean temperatures readily exchange heat energy by direct contact, and by the evaporation and precipitation processes that take place between air and water. Warming of the atmosphere is necessary for the start of a new ice age or glacial period: as evaporation increases, white cloud cover reflects more solar energy to space shading Earth, setting up longer-term cooling favorable to build-up of glaciers and ice caps. Warming over the long haul is properly associated with the familiar "greenhouse effect," where short wave radiation from the Sun heats Earth's surface, thereby increasing the long wave radiation back toward space, energy trapped by the atmosphere. Excess warming may become a long-term characteristic of the atmosphere owing to positive feedback loops such as extensive forest and grassland fires started by lightning in dry kindling that then release carbon and heat to the atmosphere. Current global warming is the consequence of the dramatic spurt in human population and in fossil fuel use associated with the Industrial Revolution. Thus our present challenge: excess carbon dioxide (from burning fossil fuels and on which plants – but not animals – thrive), methane (from numbers of individuals and animal production), and water vapor (from increased temperature and consequent evaporation) are particularly effective in trapping the outward-bound long wave radiation.

The amount of carbon dioxide in the atmosphere is, to be straight forward about it, frightening. Its concentration has increased from a pre-Industrial Revolution steady level of about 270 parts per million to the current 370 parts per million, a *thirty-seven percent increase*, and methane – 23 times as potent a greenhouse gas as carbon dioxide – has increased over the same time period from 233 to 600 million metric tons/year, nearly *a three fold increase*¹. Methane's life in the atmosphere, however, is much less than that of carbon dioxide. Our immediate point of attack on this alarming condition is to reduce consumption of fossil fuels to zero, immediately. However, atmospheric scientists tell us that even if that were to occur tomorrow, Earth's atmosphere would likely continue to warm for the next fifty to one hundred years. That could lead to a new ice age or eventually a carboniferous age, during which excess carbon is re-deposited in sediments respired by dead plants. Either would be a challenge to our ingenuity and survival, not to mention a considerable change in life styles.

– Peter E. Black, Syracuse, NY

¹ Keppler and R. Röckman, 2007. "Methane, Plants and Climate Change," *Scientific American* (296:2)53