April 2021

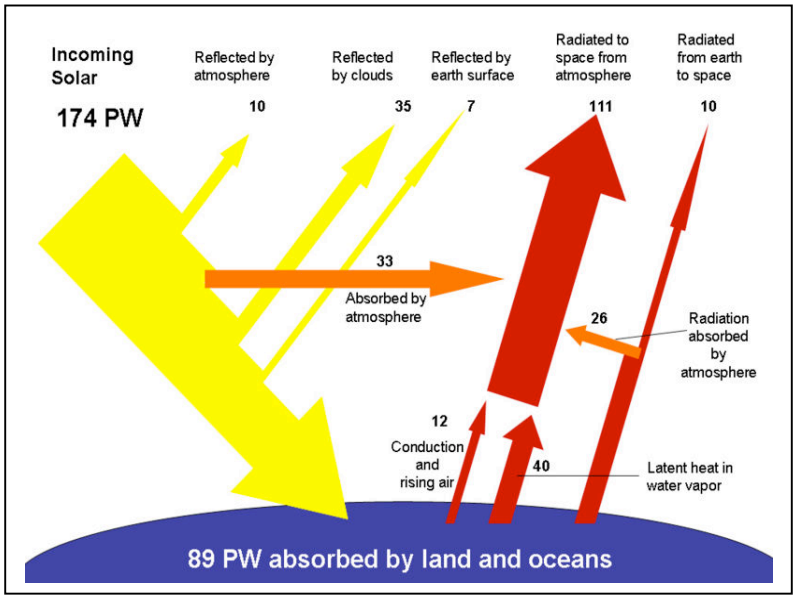
Reading - Climate Change

Center for Urban Resilience

Module 3 – Lesson 1 Narrative: *Energy and Global Climate Change*

Whenever you hear about the environment, the buzz is all about climate change and global warming. Everything from Hurricane Katrina to the melting of the polar ice caps is related to changes in the earth's climate. Climate change is defined as the systematic change in the long-term characteristics of weather patterns (such as temperature, precipitation, pressure, or winds) sustained over several decades or longer. It has become a very hot political issue because so much of our economy and way of life depends on a healthy and sustainable climate. As a citizen of your city, it's hard to know what to believe and more importantly, how to take action to defend our environment. In order to help make climate change and global warming more understandable, we will investigate the earth as a system of energy inputs and outputs. Then, with this understanding of earth as a system, we can tackle the challenge of global climate change and what we can do to mitigate the problem.

Viewed from space, the earth appears as a bright blue sphere floating in darkness. This visual perspective is actually pretty helpful in beginning to tackle the idea of the earth as a system. All of life on earth clings to a thin layer of livable environment only a few miles thick called the biosphere. It is comprised of the land surface, oceans, lakes and low level atmosphere that contains all of the living organisms on our planet. All of this life is totally dependent upon the energy that flows from the sun in the form of photons of light that strike the planet. Some of the energy is captured through photosynthesis by plants, algae and bacteria. There, the energy is locked up in the biotic (living) part of the system. However, most of the energy enters the earth's abiotic (non-living) part of the system and ultimately determines our weather and climate. Eventually, all of the energy that enters the earth's system is converted to heat and escapes the biosphere. This process has been on-going since the earth first formed approximately 4.7 billion years ago.

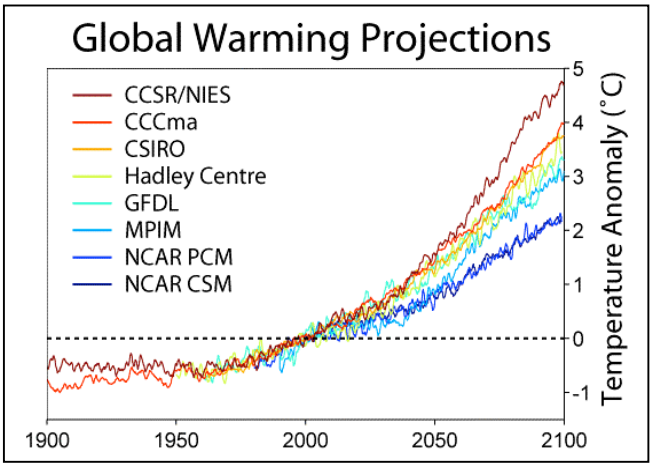


Top left: The earth as viewed from space. This photograph is from Terra, the earth observation satellite network maintained by NASA. The biosphere is the thin layer of land and oceans that covers the planet.
Top right: Energy from the sun reaches the earth, which drives both the biotic and abiotic parts of the planet system. Here you can see the outcomes of the energy as it is transferred to different parts of the world ecosystem. Human industrial practices are changing the way in which energy is absorbed into the earth and the way in which it behaves as it is radiated back to space.

The amount of energy entering the earth system as radiation from the sun and leaving the earth system as infrared rays (heat) is in a dynamic balance. This balance has been important for life for nearly four billion years. During this period, the abiotic conditions on earth have changed dramatically – sometimes causing the extinction of many thousands of species. But life has persisted, often with massive change. According to climate scientists, human industrial practices over the last 200 years have shifted the energy balance so that the earth is retaining more heat. This event is called global warming and is driven by the generation of excessive amounts of greenhouse gasses in the atmosphere.

Greenhouse gasses are those gasses that trap and radiate energy as they are struck by the light from the sun. The most important greenhouse gasses in the earth's atmosphere are water vapor, ozone and carbon dioxide. As the amount of greenhouse gasses in the atmosphere increases, the warmer the atmosphere becomes. The greenhouse gasses form a sort of blanket around the earth, preventing it from becoming too cold. However, as humans have added additional carbon dioxide and ozone from industrial pollution to the atmosphere, scientists tell us that the balance is tipping towards a warmer climate.

The warming of the atmosphere is called the *Greenhouse Effect*, because the heating resembles what happens in a greenhouse or closed car when the sun is shining. The temperature inside the greenhouse or car is much warmer than the surrounding environment outside. As you will investigate, this analogy of global warming to a greenhouse is only partially accurate, as the physical forces that drive the processes are different. However, the idea that we are trapped in our biosphere as it heats up, just like we might be in a greenhouse or car is quite accurate. Data from climate scientists suggest that global surface temperatures will rise between 2-11 degrees over the next century. That is a profound change that will impact the earth as a system in many ways. Part of the solution to this challenge is to find ways to reduce our greenhouse gas emissions. We will investigate the possibilities later in this Module.



Left: Global warming predictions from a variety of earth science models. All of the predictions are for warmer climates. They vary based on the assumptions about the impact of human industrial contributions. According to the United Nations International Panel on Climate Change report released in 2007, the increase in global temperatures since the mid-20th century is most likely due to human impacts. This data challenges us to find ways to reduce our greenhouse gas emissions and to find alternative ways to generate usable energy for the world's growing population.