1.10 Heating the Earth

The overall temperature of the Earth is determined by the total thermal energy received and the amount lost back to space. Any change in that balance will lead to a warming or cooling of the Earth as a whole.

1.10.1 Energy from the Sun

Most of the thermal energy received by the Earth is short wave energy from the Sun. About 47% of this energy is absorbed by the Earth's surface. The remainder is either absorbed by the atmosphere, reflected back into space by clouds or reflected by the Earth's surface.

1.10.2 Energy Retention – Greenhouse Effect

The Earth radiates energy back into space, however, all of this energy does not leave the atmosphere. Some of the gases in the atmosphere (greenhouse gases) absorb the energy and radiate it back to Earth. Only about 5% of the energy radiated by the Earth makes it into space. These gases keep the temperature of the Earth in balance and help sustain life.

However, if the amount of these gases increases in the atmosphere, less energy will make it into space. When this occurs the balance will be disrupted and the temperature will increase. The gases which contribute to the greenhouse effect are

- Water vapour
- Carbon monoxide
- Methane
- Nitrous oxide
- Ozone
- Chlorofluorocarbons

With the industrial revolution (started in the 1700's) and increased use of fossil fuels over the last 100 years Antarctic ice cores indicate an increase in the proportions of greenhouse gasses in the atmosphere. Burning fossil fuels results in the production of carbon dioxide.

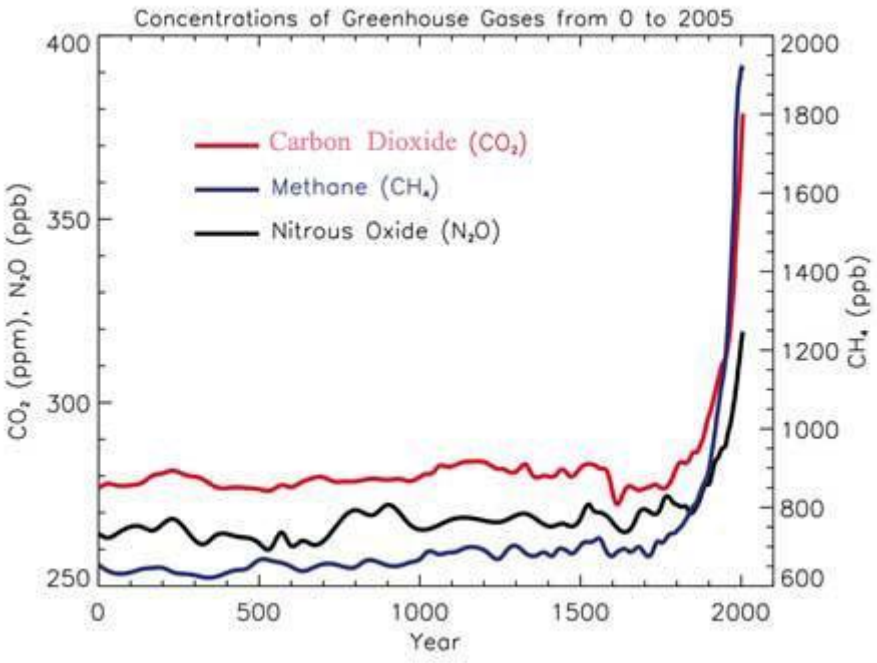
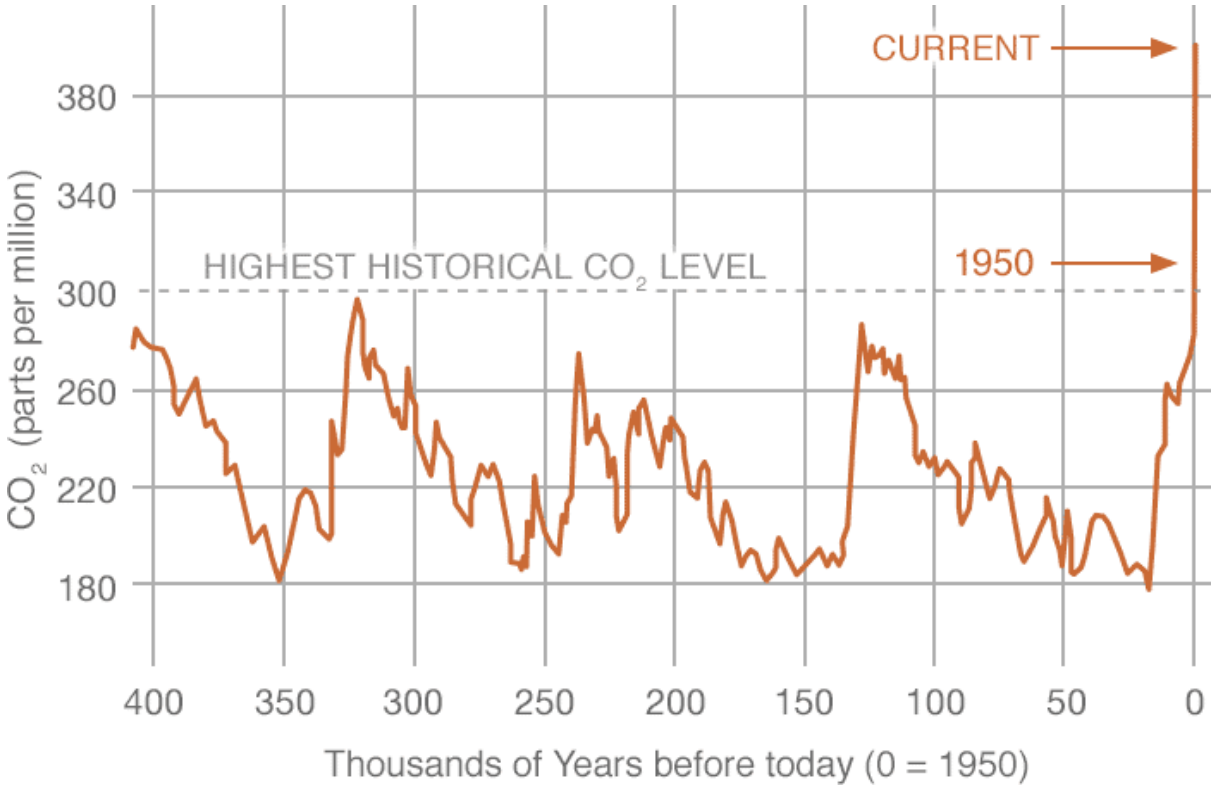


Figure 1: Concentrations of important long-lived greenhouse gases over the last 2,000 years, from measurements on air trapped in ice cores. Increases since about 1750 are attributed to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion air molecules, respectively, in an atmospheric sample. (Figure from Forster et al., 2007). [NIWA]

https://www.niwa.co.nz/our-science/climate/information-and-resources/clivar/gases#

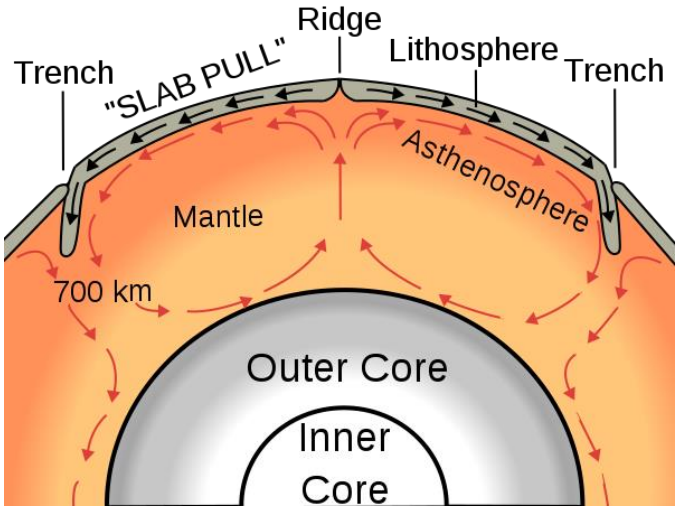


Data source: Reconstruction from ice cores.
Credit: NOAA
https://climate.nasa.gov/vital-signs/carbon-dioxide/

1.10.3 Moving Heat Around the Earth

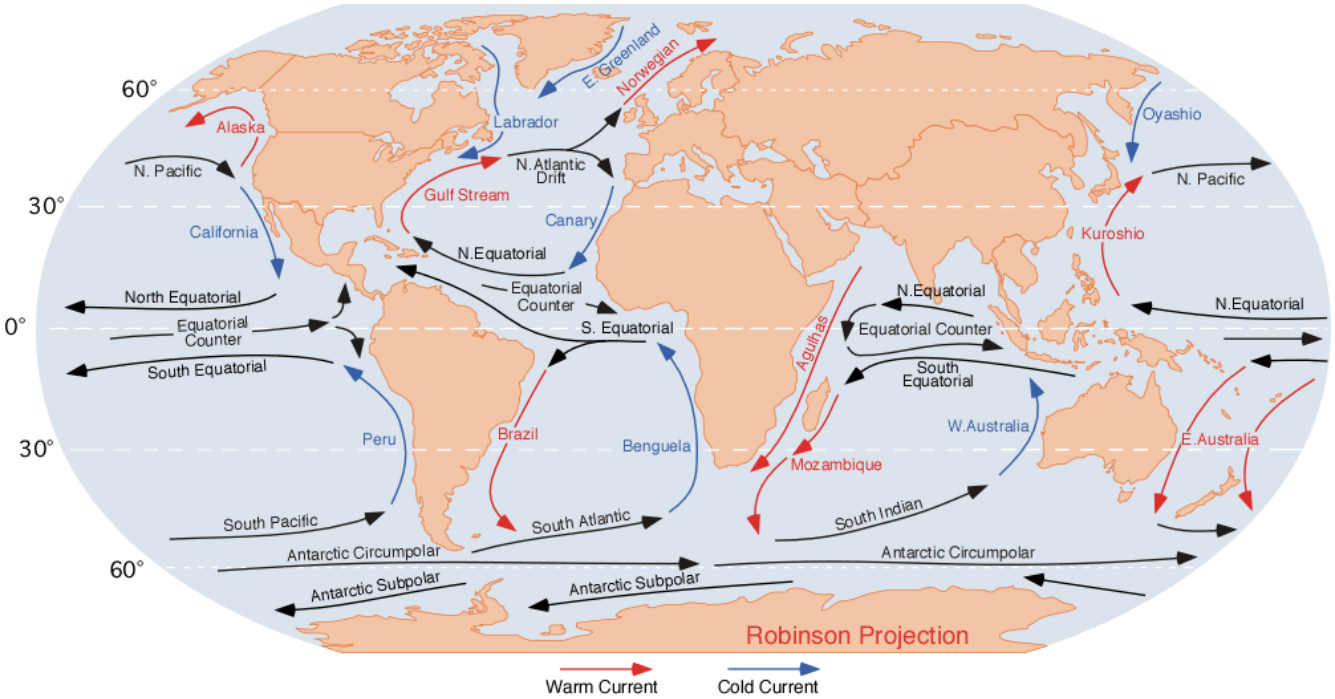
Conduction, Convection and Radiation move heat around the Earth.

Currents in the magma under the Earth's crust distribute heat with in the Earth's core, this thermal energy is then transferred through the crust by conduction.



By Surachit - Own work SVG, based on the public domain USGS image found here [1] and originally uploaded here, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2574349

On the surface of the Earth the ocean's currents distribute heat from tropical regions to polar regions. Warm currents flow from the equator to the poles and vice versa.



Dr. Michael Pidwirny (see http://www.physicalgeography.net) [Public domain], via Wikimedia Commons

The Earth's atmosphere is an essential part of the climate system. It is able to quickly transfer thermal energy around the Earth. Energy is transferred in the atmosphere by:

- Radiation – the Sun's radiant energy.
- Conduction – only in small amounts. Air is a poor conductor of thermal energy.
- Convection – Air is easily able to move and thermal energy around the Earth's atmosphere. Cold Southerly and warm Northerly winds are examples.

Problem Set #8: Text Page 54 Questions 1 – 6