In 2007, the Intergovernmental Panel on Climate Change (IPCC), a scientific panel organized by the United Nations, published its 4th assessment report. The panel states "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." The panel concludes "Most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations."

The following text is drawn from from the *Summary for Policymakers* of the IPCC's 3rd and 4th assessment reports.

Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values. Carbon dioxide (CO_2) is the most important anthropogenic greenhouse gas. The primary source of the increased atmospheric concentration of carbon dioxide since the pre-industrial period results from fossil fuel use, with land use change providing another significant but smaller contribution. Annual fossil carbon dioxide emissions increased to about 7.2 GtC (billion metric tons per year of carbon equivalent) in 2000–2005. Carbon dioxide emissions associated with land-use change are estimated to be 1.6 GtC per year over the 1990s, although these estimates have a large uncertainty. Figure 1 shows total anthropogenic fossil carbon emissions since 1900.

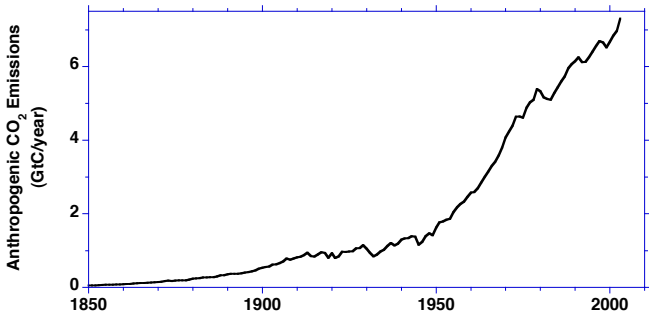


Figure 1: CO_2 Emissions from 1900 to 2005.

Natural processes gradually remove CO_2 from the atmosphere (for example, as it is used by plant life and dissolves in the ocean). Currently, the net removal of atmospheric CO_2 by natural processes is about half of the anthropogenic CO_2 emissions. As a result, the global atmospheric concentration of carbon dioxide has increased from a pre-industrial value of about 280 ppm to 379 ppm in 2005 [384 ppm in 2007] (Figure 2). The atmospheric concentration of carbon dioxide today exceeds by far the natural range over the last 650,000 years (180 to 300 ppm) as determined from ice cores.

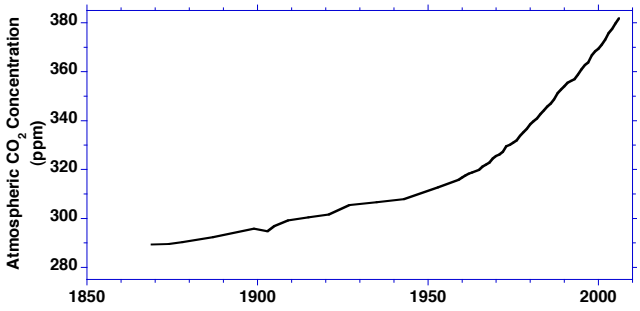


Figure 2: Concentration of CO_2 in the atmosphere, parts per million.

Changes in the atmospheric abundance of greenhouse gases and aerosols, in solar radiation and in land surface properties alter the energy balance of the climate system. These changes are expressed in terms of radiative forcing, which is used to compare how a range of human and natural factors drive warming or cooling influences on global climate. Positive forcing tends to warm the surface while negative forcing tends to cool it. Figure 3 shows that global average surface temperatures have risen over the past century.

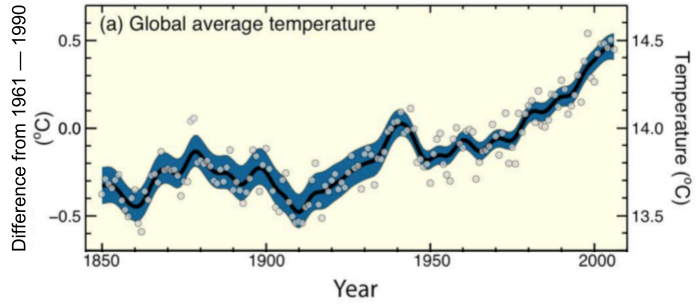
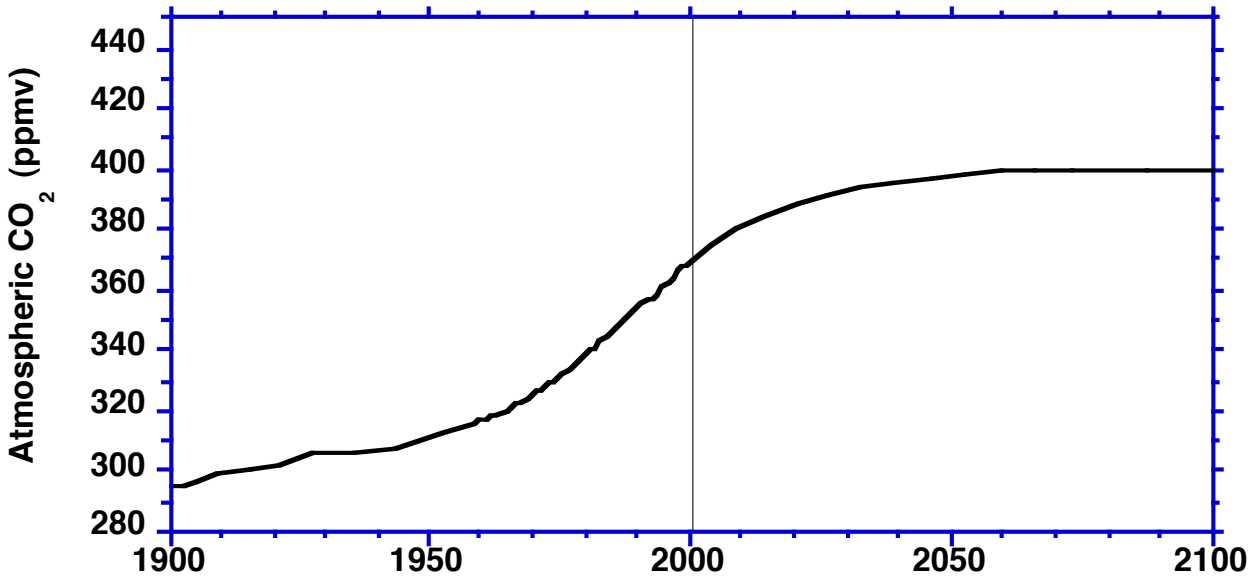


Figure 3: Average global temperature.

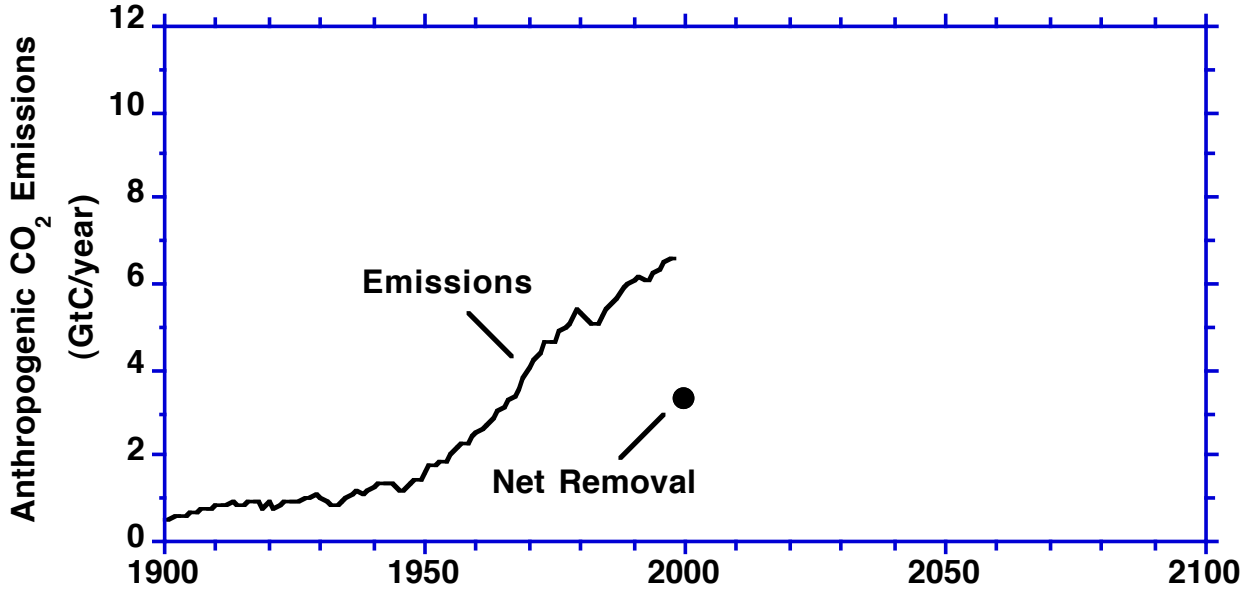
Now consider a scenario in which the concentration of CO_2 in the atmosphere gradually rises to 400 ppm, about 8% higher than the level in 2000, then stabilizes by the year 2100, as shown here:



The graph below shows anthropogenic CO_2 emissions from 1900-2000, and current net removal of CO_2 from the atmosphere by natural processes. Sketch:

a. Your estimate of likely future net CO_2 removal, given the scenario above.

b. Your estimate of likely future anthropogenic CO_2 emissions, given the scenario above.



Check here if you have done or learned about this task before: ☐