

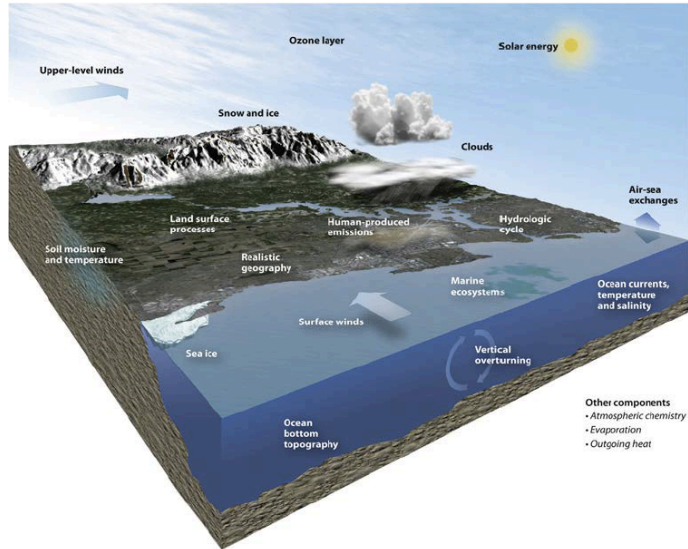
Section 2: Climate Change Review

Learning outcomes

After this section, you should be able to:

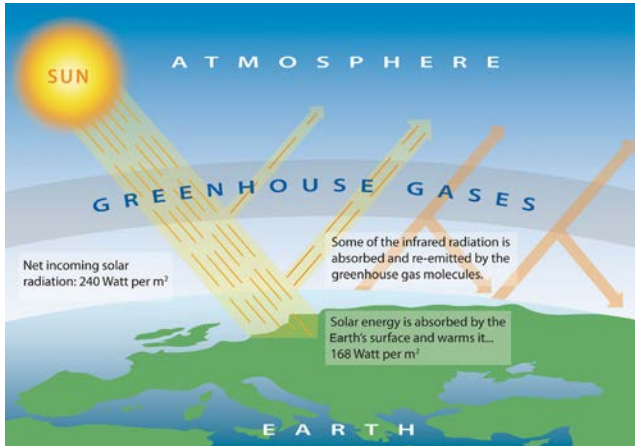
- describe how and why humans are affecting climate
- understand recent and future climate change
- discuss aspect of physical climate change important to biology

Components of the climate system



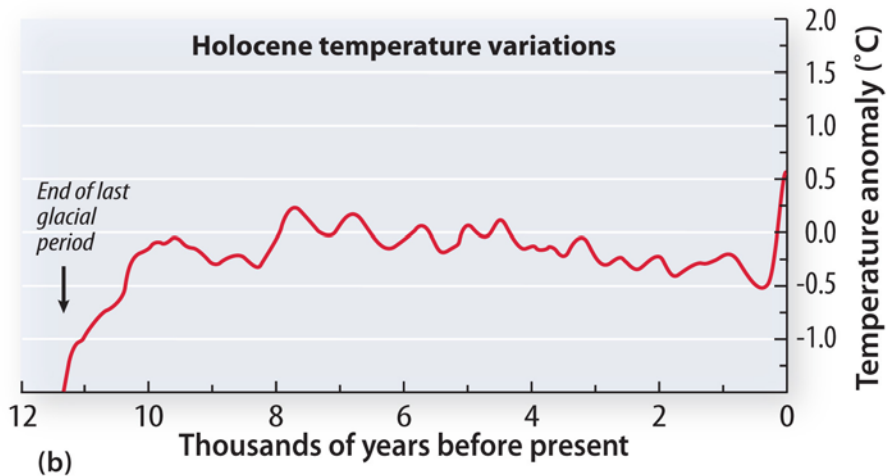
Hannah, *Climate Change Biology*, 2011

Greenhouse effect



Hannah, *Climate Change Biology*, 2011

Historical (last 12,000 years) climate change



Changes in global temperature since 1850

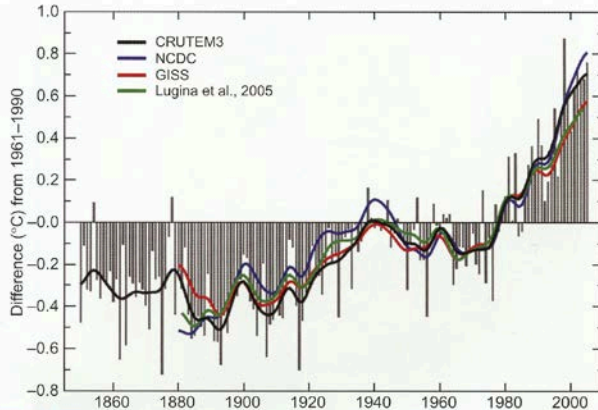
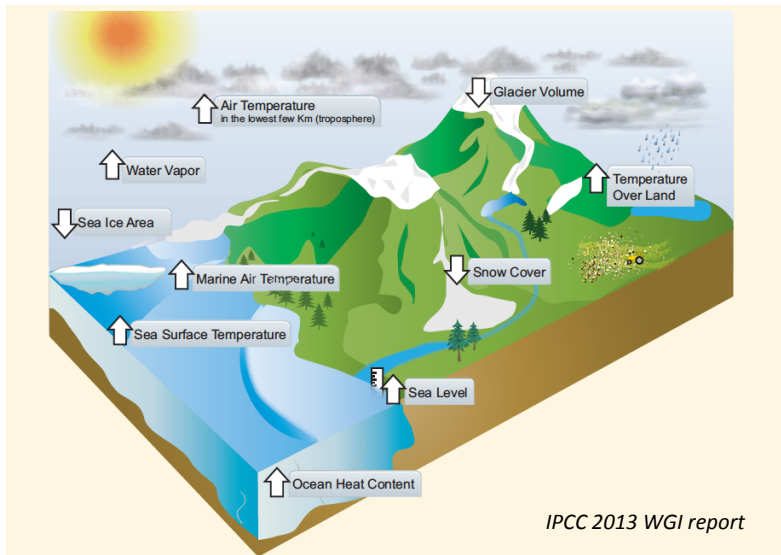


FIGURE 2.19 Historic Rise in Global Mean Temperature.

Units are deviation in degrees Celsius from the reference year 1980. Colored lines represent temperature reconstructions using different methods. Bars indicate values from the instrumental record. *From Climate Change 2007: The Physical Science Basis. Working Group I Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.*

Hannah, *Climate Change Biology*, 2011

Observed evidence is consistent with warming



Climate **FAQ 2.1, Figure 1** | Independent analyses of many components of the climate system that would be expected to change in a warming world exhibit trends consistent with warming (arrow direction denotes the sign of the change), as shown in FAQ 2.1, Figure 2.

Changes in atmospheric carbon dioxide

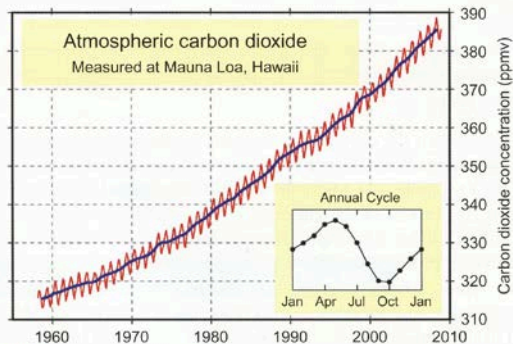
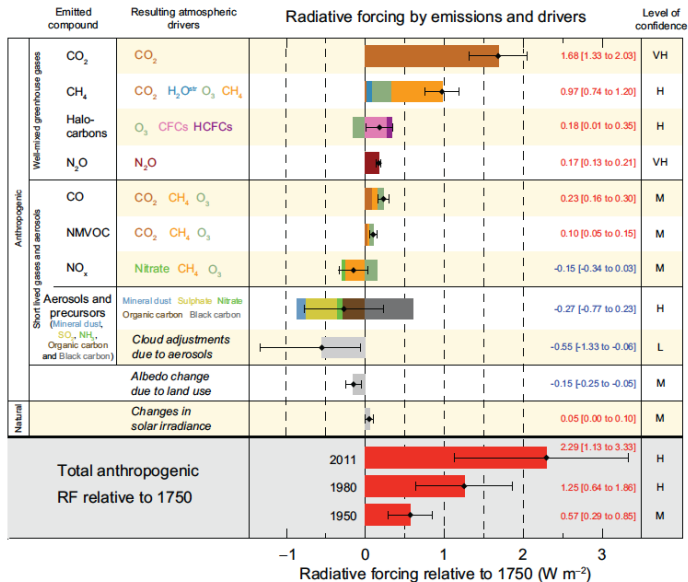


FIGURE 2.16 Mauna Loa CO₂ Record.

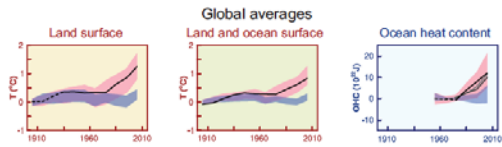
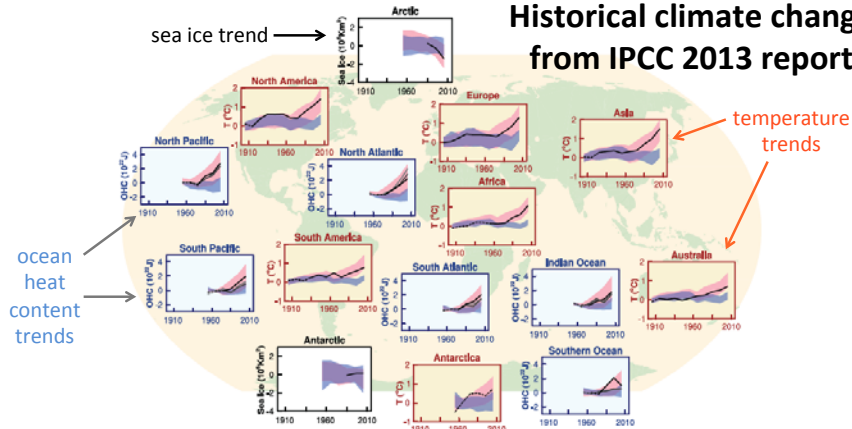
The CO₂ record from Mauna Loa clearly shows strongly rising atmospheric CO₂ concentrations during approximately the past 50 years. Superimposed on a multiyear increase is a much smaller "sawtooth" annual cycle, which results from the release and uptake of CO₂ from vegetation. *From Climate Change 2007: The Physical Science Basis. Working Group I Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.*

Hannah, *Climate Change Biology*, 2011

Causes of climate change from IPCC AR5 SPM



Historical climate change from IPCC 2013 report

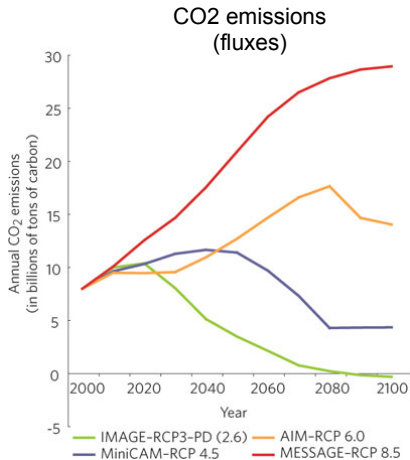


≡ Observations

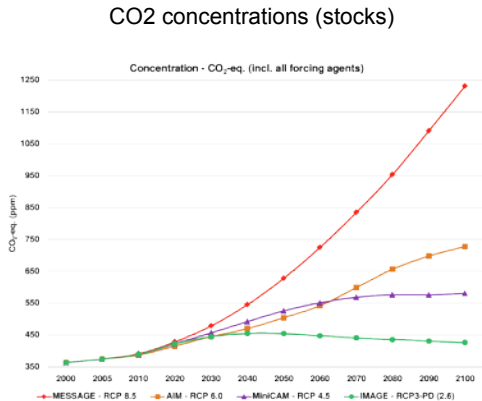
■ Models using only natural forcings

■ Models using both natural and anthropogenic forcings

Representative Concentration Pathways (RCPs)

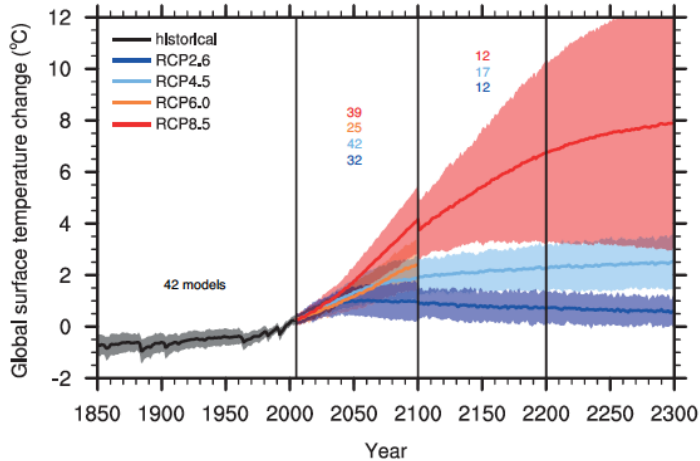


Inman, Nature Climate Change, 2011



en.wikipedia.org/wiki/Representative_Concentration_Pathways#mediaviewer/File:All_forcing_agents_CO2_equivalent_concentration.png

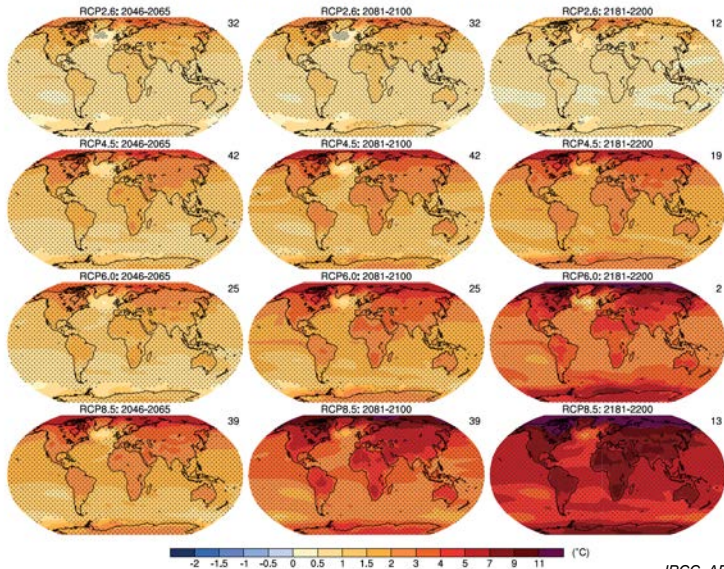
Warming projections



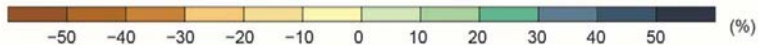
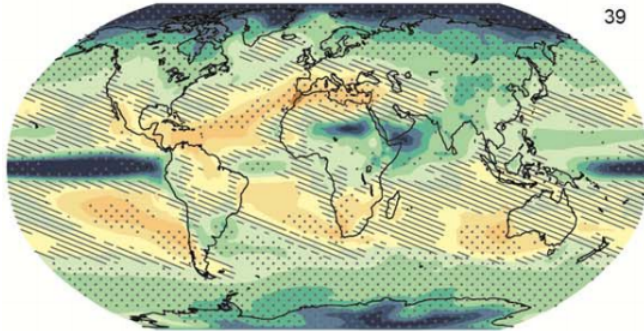
IPCC, AR5, WGI, 2013

Increasing T for higher RCP, later periods

Annual mean surface air temperature change



Projected Precipitation Change (%) Model Mean, RCP85 2081-2100 minus 1985-2005



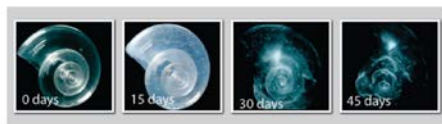
Ocean acidification from increased CO₂

ocean pH (acidity)

- 1900-2000: observed increase by 30%
- by 2100: projected doubling



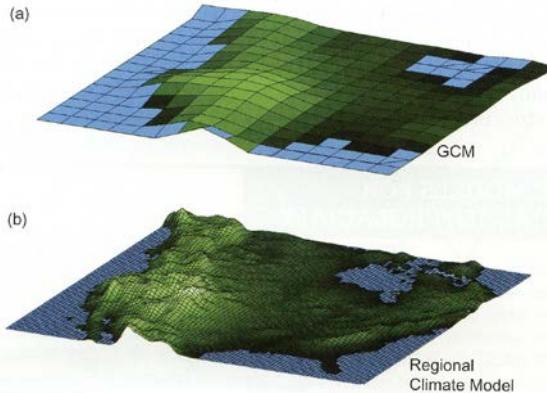
Shells Dissolve in Acidified Ocean Water



National Climate Assessment, draft, 2013

NOAA, State of Washington Report on Ocean Acidification, 2012

Why does finer spatial resolution climate data help climate change ecology studies?



Hannah, *Climate Change Biology*, 2011

“Climate velocity”

