The Impact of the arrival of Europeans in the Americas on the Carbon Cycle

The Great Dying of the Indigenous Peoples of the Americas resulted in a human-driven global impact on the carbon cycle in the two centuries prior to the Industrial Revolution. The abandonment of 56 million ha of land in the 1500s following the deaths of 55 million people would have resulted in widespread vegetation succession coupled with a decrease in human driven fire activity. The carbon uptake by regenerating vegetation that is thought to have occurred following the arrival of epidemics in the Americas may have reduced atmospheric CO_2 levels which contributed to the coldest part of the Little Ice Age.

Taken from "Earth system impacts of the European arrival and Great Dying in the Americas after 1492" which may be downloaded at https://www.sciencedirect.com/science/article/pii/S0277379118307261

1) Roughly indicate the outline of these regions on the map below:

North America
Caribbean
Inca Territory: current Peru, Bolivia, Ecuador, southern Colombia, Chile and parts of north-western Argentina
Central America: current Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama
Mexico
Amazonia: The vast drainage basin of the Amazon and contiguous forested areas
Rest of the Americas: Venezuela, Uruguay, Paraguay and Argentina

Region	Arable land 1500 (million ha)	Arable land 1600 (million ha)	Land use change (million ha)	% land use change
North America	6.6	0.858	5.742	87
Caribbean	0.5	0.005	0.495	99
Central America	4.5	0.45	4.05	90
Mexico	21	1.47	19.53	93
Inca kingdom	20	1.4	18.6	93
Amazonia	6	0.6	5.4	90
Remainder of Americas	2.2	0.22	1.98	90
TOTAL:	60.8	5.003	55.797	----------

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2) Complete the table by filling in the last two columns.
3) On the map, shade the regions to illustrate the % land use change
4) Calculate the mean, mode and median land use change:

Mean: ____91.7%___ Mode: ____90%_____ Median: ___90%_____

5) What is the most useful average to look at in this situation? Why?
   Several answers could be valid here: is the mean most useful when the land area of the regions varies so much? Maybe the mode is more useful?

6) "The above ground biomass of tropical forest in Amazonia is 161 MgC ha^{-1}; fourteen times greater than maize cropland." Assuming that all the land use change involved maize cropland regenerating into tropical forest, how much carbon does this imply was taken up by the vegetation?

7) What changes to the other carbon stores in the climate system might you expect to see?
   - The key point is that you'd expect to see the amount of carbon in the atmospheric store fall. However, with an increase in vegetation you'd also expect to see a flow of carbon from the atmosphere to the soil.

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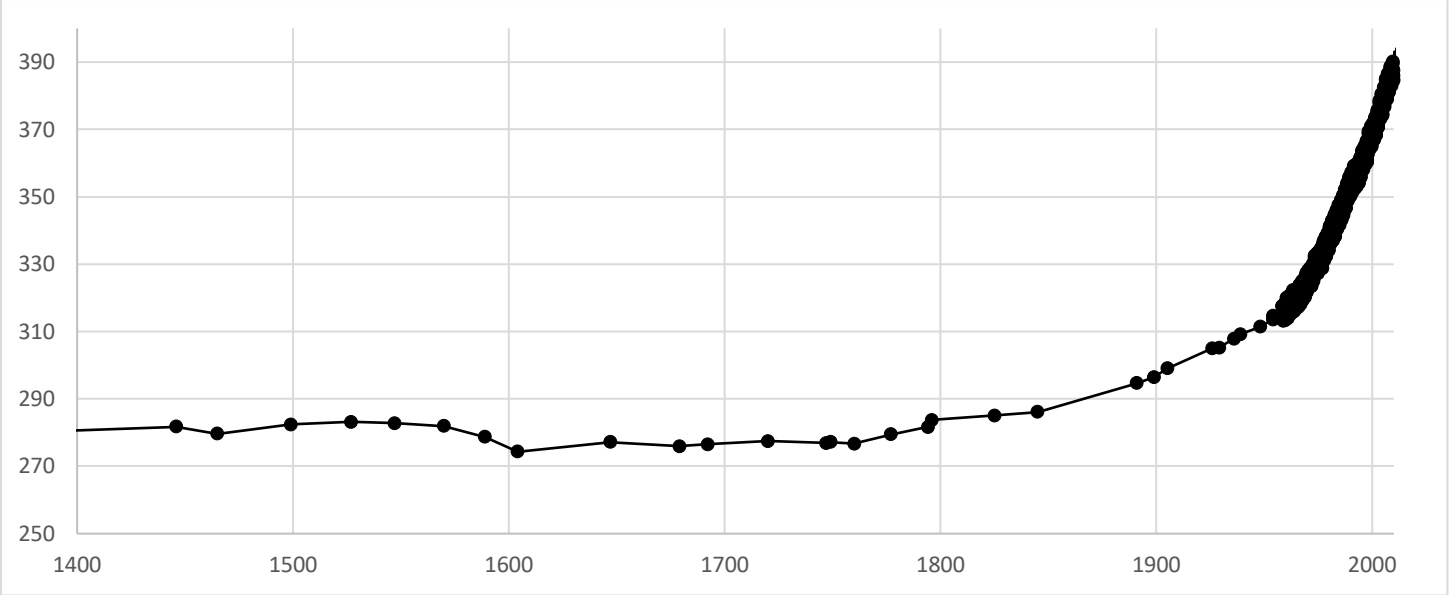

Atmospheric CO_2 (ppm) from 1400 – 2010

(data from Law Ice Dome https://cdiac.ess-dive.lbl.gov/ftp/trends/co2/lawdome.combined.dat and Mauna Loa https://www.esrl.noaa.gov/gmd/ccgg/trends/data.html)

8) With reference to the above graph, describe the impact of vegetation changes on the carbon stored in the atmosphere over time. Refer to both your existing knowledge of the carbon cycle and the information contained above.

Answers here could include

- The great dying in the 1500s in the Americas potentially contributed to the fall in atmospheric carbon dioxide in this time. However, the fall in atmospheric CO_2 through the 1500s, approximately 10ppm, is roughly equivalent to the increase in atmospheric CO_2 seen from 2005-2010.
- You would also expect to see the seasonal cycle of vegetation, with the amount of CO_2 in the atmosphere falling in the spring and early summer as vegetation grows, and rising again in the autumn and winter as the vegetation decays
- A significant proportion of the increase of CO_2 in the atmosphere since the Industrial Revolution can be attributed to land use change.