Human activity as the cause of the recent co2 increases

Environment, Pollution

Over the last 150 years, carbon dioxide (CO_2) concentrations have risen from 280 to nearly 380 parts per million (ppm). The fact that this is due virtually entirely to human activities is so well established that one rarely sees it questioned. Yet it is quite reasonable to ask how we know this.

One way that we know that human activities are responsible for the increased CO_2 is simply by looking at historical records of human activities. Since the industrial revolution, we have been burning fossil fuels and clearing and burning forested land at an unprecedented rate, and these processes convert organic carbon into CO_2. Careful accounting of the amount of fossil fuel that has been extracted and combusted, and how much land clearing has occurred, shows that we have produced far more CO_2 than now remains in the atmosphere. The roughly 500 billion metric tons of carbon we have produced is enough to have raised the atmospheric concentration of CO_2 to nearly 500 ppm. The concentrations have not reached that level because the ocean and the terrestrial biosphere have the capacity to absorb some of the CO_2 we produce.* However, it is the fact that we produce CO_2 faster than the ocean and biosphere can absorb it that explains the observed increase.

Another, quite independent way that we know that fossil fuel burning and land clearing specifically are responsible for the increase in CO_2 in the last 150 years is through the measurement of carbon isotopes. Isotopes are simply different atoms with the same chemical behavior (isotope means “ same type”) but with different masses. Carbon is composed of three different isotopes, 14C, 13C and 12C. 12C is the most common. 13C is about 1% of the total. 14C accounts for only about 1 in 1 trillion carbon atoms.

CO2 produced from burning fossil fuels or burning forests has quite a different isotopic composition from CO2 in the atmosphere. This is because plants have a preference for the lighter isotopes (12C vs. 13C); thus they have lower 13C/12C ratios. Since fossil fuels are ultimately derived from ancient plants, plants and fossil fuels all have roughly the same 13C/12C ratio – about 2% lower than that of the atmosphere. As CO2 from these materials is released into, and mixes with, the atmosphere, the average 13C/12C ratio of the atmosphere decreases.

Isotope geochemists have developed time series of variations in the 14C and 13C concentrations of atmospheric CO2. One of the methods used is to measure the 13C/12C in tree rings, and use this to infer those same ratios in atmospheric CO2. This works because during photosynthesis, trees take up carbon from the atmosphere and lay this carbon down as plant organic material in the form of rings, providing a snapshot of the atmospheric composition of that time. If the ratio of 13C/12C in atmospheric CO2 goes up or down, so does the 13C/12C of the tree rings.

This isn't to say that the tree rings have the same isotopic composition as the atmosphere – as noted above, plants have a preference for the lighter isotopes, but as long as that preference doesn't change much, the tree-ring changes will track the atmospheric changes.