

How We Know That Human Activities Are Driving Climate Change

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There are multiple types of independent observations that make a compelling case: The increases in greenhouse gases that we observe are caused entirely by human activities. Focusing on carbon dioxide, CO₂ emissions from fossil fuel burning and cement production are larger than net uptake by all ecosystems in the northern hemisphere during the growing season. The contrast with the past, both recent and distant, is striking. CO₂ is now 45% higher than before the industrial revolution. Half of all cumulative emissions since the pre-industrial have occurred since 1990. The current multi-year average rate of increase is above 2 ppm/year, which is about 200 times faster than what natural processes were able to do when the Earth climbed out of the last ice age between 17,000 and 11,000 years ago. The isotopic composition of atmospheric CO₂ is changing, ruling out that the observed increase can be due to volcanic processes or to an oceanic source. Therefore the source of the added CO₂ must be organic. Atmospheric oxygen is decreasing confirming that colossal amounts of something are being oxidized. Measurements of ¹⁴CO₂ demonstrate that the organic matter being burned is very old. The difference in CO₂ mole fraction between the two hemispheres has been increasing over the last five decades, in rough proportion to the global rate of fossil fuel burning. These are observations, they are not predictions and do not depend on any models. Enhanced heat retention by the added greenhouse gases now stands at 1.25% of all solar radiation absorbed by the Earth system.

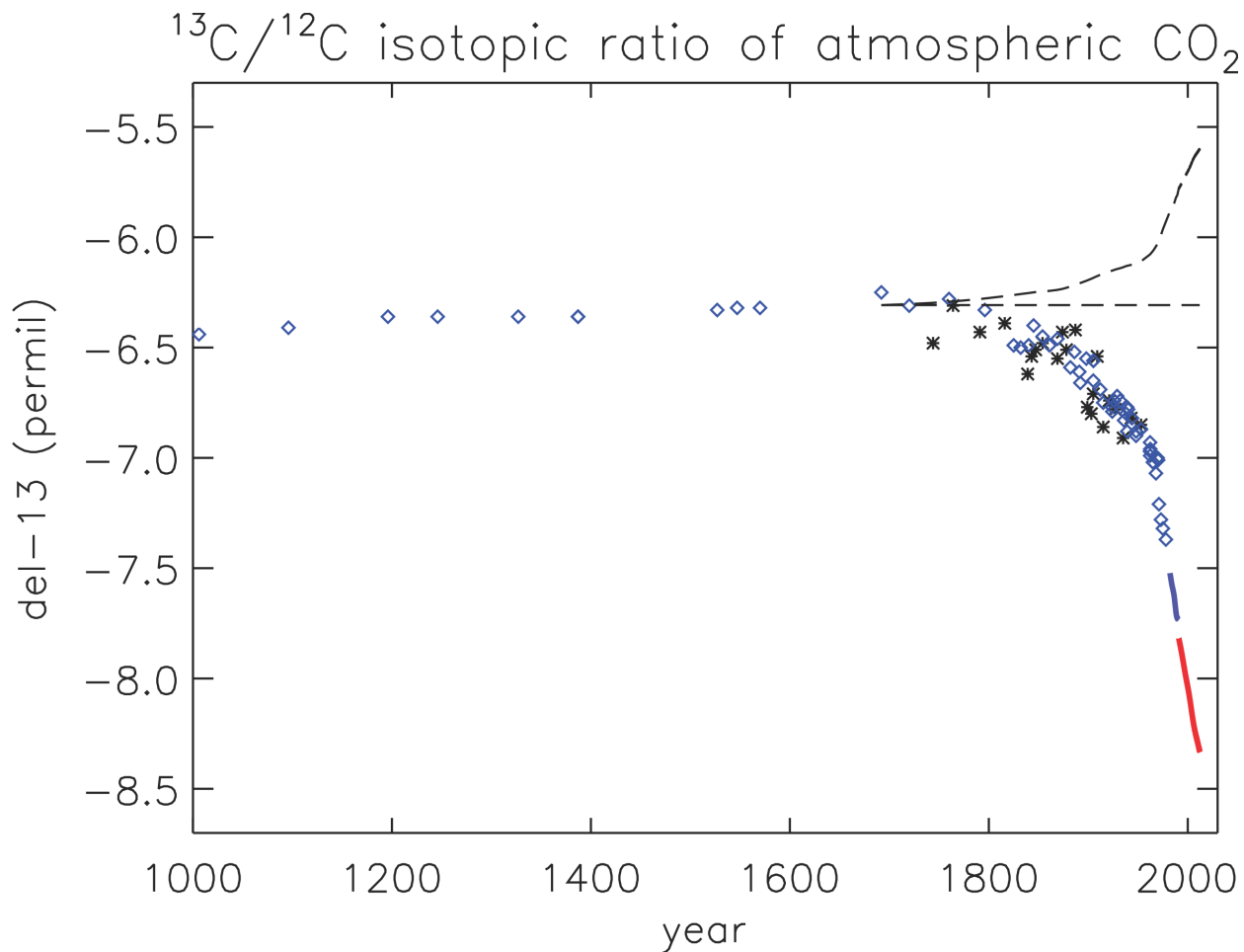


Figure 1. Ice core and firn data from CSIRO, direct atmospheric measurements from NOAA and CU/INSTAAR.