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Human induced changes in the carbon cycle over the last 60 years

Pierre Friedlingstein

University of Exeter, College of Engineering, Mathematics and Physical Sciences, Exeter, United Kingdom

Human activities have an unprecedented impact on the global carbon cycle. Atmospheric CO₂ concentrations have been continuously monitored since 1958, and show a 30% increase, from 315 ppm in 1958 to 412 ppm in 2020. Anthropogenic emissions, primarily from fossil fuel combustion, but also from land-use changes, are the drivers of these changes, with global emissions almost tripling over that period, from 4GtC per year in 1958 to almost 12 GtC per year at present. Although fossil fuel emission declined by about 7% in 2020 due to response to the COVID-19 pandemic, there are no long-term sign of global emissions declining yet, despite climate policies being put in places in many countries.

The atmospheric CO₂ increase induces land and ocean carbon uptake, respectively driven by enhanced photosynthesis, leading to larger land biomass and soil carbon; and by enhanced air-sea CO₂ exchange, leading to larger carbon content in the surface ocean and export to the deep ocean. These mechanisms are negative feedbacks in the Earth system and are removing about 50% of the CO₂ emitted in the atmosphere. Without these land and ocean carbon sinks, current atmospheric CO₂ would already be around 600 ppm.

However, modelling studies show that climate change reduces land and ocean carbon sinks, hence amplifying the warming. Although there is agreement that such positive feedback will develop over the course of the century, there are not yet clear evidence of a major climate driven reduction of the carbon sinks. So far, observations and modelling studies of the historical carbon cycle do not show any sign of a tipping point in the global carbon cycle.