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Reconsideration of atmospheric CO2 lifetime: potential mechanism for explaining CO2 missing sink

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Carbon cycle data (Intergovernmental Panel on Climate Change 1996) indicate that fossil fuel use accounts for emissions to the atmosphere of 5.5±0.5 GtC (Gigatons of carbon) annually. Other important processes in the global CO2 budget are tropical deforestation, estimated to generate about 1.6±1.0 GtC/yr; absorption by the oceans, removing about 2.0±0.8 GtC/yr; and regrowth of northern forests, taking up about 0.5±0.5 GtC/yr. However, accurate measurements of CO2 show that the atmosphere is accumulating only about 3.3±0.2 GtC/yr. The imbalance of about 1.3±1.5 GtC/yr, termed the "missing sink", represents the difference between the estimated sources and the estimated sinks of CO2; that is, we do not know where all of the anthropogenic CO2 is going.

Several potential mechanisms have been proposed to explain this missing carbon, such as CO2 fertilization, climate change, nitrogen deposition, land use change, forest regrowth et al. Considering the complexity of ecosystem, most of ecosystem model cannot handle all the potential mechanisms to reproduce the real world. It has been believed that the dominant sink mechanism is the fertilizing effects of increased CO2 concentrations in the atmosphere and the addition to soils of fixed nitrogen from fossil-fuel burning and agricultural fertilizers. However, a recent analysis of long-term observations of the change in biomass and growth rates suggests that such fertilization effects are much too small to explain more than a small fraction of the observed sink. In addition, long-term experiments in which small forest patches and other land ecosystems have been exposed to elevated CO2 levels for extended periods show a rapid decrease of the fertilization effect after an initial enhancement.

We will explore this question of the missing sink in atmospheric CO2 residence time. Radioactive and stable carbon isotopes (13-C/12-C) show the real CO2 lifetime is about 5 years; i.e. CO2 is quickly taken out of the atmospheric reservoir. There is a theoretical possibility that the given fast CO2 flux (short lifetime) is greater than 5.5±0.5 GtC of fossil fuel CO2 contributed annually to the atmosphere. However, the Intergovernmental Panel on Climate Change (1996) reports that the CO2 lifetime (residence time) in the atmosphere is 50 to 200 years. This long probably creates the inexplicable "missing sink" of 1.3±1.5 GtC/yr in carbon cycle budget.