Science for Environment Policy
DG Environment News Alert Service
European Commission

10 November 2011

High atmospheric CO_2 levels stimulate GHG emissions from soil

Rising levels of atmospheric carbon dioxide (CO_2) is likely to cause some soils to release large quantities of two potent greenhouse gases (GHGs), nitrous oxide and methane, according to a recent analysis. The results suggest that the contribution of soils and terrestrial ecosystems to slow climate change has been overestimated.

Previous research has found that increasing levels of CO_2 in the atmosphere will lead to increased plant growth. This in turn means that more CO_2 is drawn from the atmosphere by plants and, ultimately, some of that carbon would be locked away in the soil. Researchers had predicted that such increases in carbon sequestration in soils would partly counteract human emissions of CO_2, slowing the rate of climate change over the next century.

However, increased CO_2 can also affect the production of other GHGs, such as nitrous oxide and methane in soils. Should rising atmospheric CO_2 concentrations cause large quantities of these gases to be released from soils, the overall contribution of those soils to climate change mitigation will be less than would appear if only carbon were to be considered.

To establish whether rising CO_2 levels would affect nitrous oxide and methane emissions from soils, the researchers analysed the findings of 49 published studies on the topic. The analysis covered both nitrous oxide and methane fluxes, as well as changes to overall root size (root biomass) and soil water content. The results were scaled up to represent the total global land area covered by the relevant soil types.

The analysis suggested that, as CO_2 levels rise, emissions of nitrous oxide from upland soils would increase by 18.8%. Methane emissions from wetlands and rice paddies would also rise by 13.2% and 43.4%, respectively.

By including soil water content and root biomass, the researchers could also explore the mechanisms behind the increased emissions of nitrous oxide and methane. Higher soil water content, possibly caused by more efficient use of water by plants, and increased root biomass in soils both encourage anoxic – low oxygen – conditions in soils. Anoxic conditions encourage microbes to break down nitrate; one of the major sources of nitrous oxide from soils.

In rice paddies and wetlands, anaerobic conditions favour production of methane by methanogenic *Archaea*. These microbes rely on plants to supply the carbon they need, so increased soil carbon storage as CO_2 levels rise will boost soil methane emissions.

The emissions of nitrous oxide and methane will partly counteract increased sequestration of carbon into soil by plants as levels of atmospheric CO_2 rise. Overall, release of the two gases could negate 16.6% of the sequestration of carbon in soils and plant biomass once CO_2 levels rise to 630 parts per million by volume. At current emission rates, atmospheric CO_2 will reach that concentration before the end of this century.

As the effect of increased atmospheric CO_2 on the production of GHGs, such as nitrous oxide and methane, by soil is quantitatively important, future assessments should consider these 'feedback effects'.

Source: van Groenigen, K.J., Osenberg, C.W. & Hungate, B.A. (2011). Increased soil emissions of potent greenhouse gases under increased atmospheric CO_2. *Nature.* 475: 214-216.

Contact: cjvangroenigen@nau.edu

Theme(s): Climate change and energy, Soil