Difficulties in setting global greenhouse gas (GHG) emissions targets can arise from problems associated with calculating exactly how much carbon is in the atmosphere. However, recent research has produced quantitative data on the 'climate-carbon cycle feedback', which have strong implications for emissions policies.

The amount of emitted carbon dioxide remaining in the atmosphere is controlled by carbon cycle processes in the ocean and on land. These processes are themselves affected by climate, creating positive and negative ‘feedback loops’. For example, rising temperatures will reduce the natural ability of oceans to absorb carbon from the atmosphere, as warming makes CO2 less soluble. This is an example of ‘positive feedback’ where more carbon is released as the climate warms.

However, climate change will also lead to cases of ‘negative feedback’. For example, in some European countries, higher temperatures will trigger increased plant growth, thereby drawing CO2 out of the atmosphere via photosynthesis. While the net result of climate change is likely to be one of overall warming, these complex feedback loops have made it difficult to make precise predictions about its future impacts.

The researchers combined a number of existing climate models to develop a new model which incorporates the complexity of many of these feedback loops to build a more accurate picture of climate change over the next three centuries. The study focused on CO2, as it persists in the atmosphere much longer than other GHGs.

Eleven existing global climate models that were used in a recent IPCC assessment (2007)1 were coupled with carbon cycle models. These models incorporated a range of climate sensitivities, i.e. potential changes in surface temperatures. Such changes are one of the key uncertainties in climate modelling. It also represented a broad range of carbon cycle processes, which are also sources of uncertainty. Simulations using the model identified precise feedback responses of ocean and land carbon sinks to increases in temperature and cuts in carbon emissions.

The results of the study suggest that the true impact of increasing carbon levels in the atmosphere will be greater than expected. If current global emissions are cut by 50 per cent by 2050, and if emissions stay constant at this level, then atmospheric CO2 concentrations are projected to continue to rise as a result of continued net positive feedback. By 2100, the global mean-temperature is predicted to be 1.3-3.1°C above pre-industrial levels. By 2300, this figure will be 2.2-5.7 °C.

However, the results also suggest that atmospheric concentrations of CO2 could be stabilised if carbon emissions were reduced by 80 percent before 2100, provided cuts were to continue into the next century. The researchers stress that to halt climate change altogether, policy makers need to think in terms of the long-term impacts of carbon emissions – over centuries to millennia, rather than decades to centuries. Whereas levels of other greenhouse gases (GHGs), such as methane, may be reduced relatively quickly much of the CO2 emitted remains in the atmosphere for thousands of years.


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