Future increase in plant photosynthesis revealed by seasonal carbon dioxide cycle

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Doubling of the carbon dioxide concentration will cause global plant photosynthesis to increase by about one third, according to new research. Credit: University of Exeter

Doubling of the carbon dioxide concentration will cause global plant photosynthesis to increase by about one third, according to a paper published in the journal *Nature*.

The study has relevance for the health of the biosphere because photosynthesis provides the primary food-source for animal life, but it also has great relevance for future climate change.

Vegetation and soil are currently slowing down global warming by absorbing about a quarter of human emissions of carbon dioxide. This land carbon sink is believed to be in part due to increases in photosynthesis. It is widely accepted that plant photosynthesis will increase with carbon dioxide, so long as nutrients, such as nitrogen and phosphorus, are not limiting.

Global Earth System Models (ESMs) all predict that global photosynthesis will increase with carbon dioxide, but they differ by a factor of three in the size of this 'CO2 fertilization'.

The authors of the Nature study, which are based at DLR in Germany and the University of Exeter in the UK, have discovered that the size of the CO2 fertilization is revealed by how the seasonal cycle in carbon dioxide concentration varies in the atmosphere.

Lead author of the study, Sabrina Wenzel of DLR explains: "the carbon dioxide concentrations measured for many decades on Hawaii and in Alaska show characteristic cycles, with lower values in the summer when strong photosynthesis causes plants to absorb CO2, and higher-values in the winter when photosynthesis stops. The peak-to-trough amplitude of the seasonal cycle therefore depends on the strength of the summer photosynthesis and the length of the growing season".

The measurements made on Hawaii and in Alaska show an increasing amplitude of the seasonal cycle, but what does this mean for the future? The Wenzel et al. study answers that question, by showing a link between the increase in CO2 amplitude that a model simulates and the CO2-fertilization that it predicts.

This in turn means that the observed increase in the CO2 amplitude can be converted into a much improved estimate of the CO2-fertilization, which the authors call an Emergent Constraint.

Co-author Professor Peter Cox, of the University of Exeter, summarises the consequences of the study: "despite nutrient limitations in some regions, our study indicates that CO_2-fertilization of photosynthesis is currently playing a major role in the global land carbon sink.

"This means that we should expect the land carbon sink to decline significantly when we begin to stabilize CO_2."

More information: Sabrina Wenzel et al. Projected land photosynthesis constrained by changes in the seasonal cycle of atmospheric CO_2, *Nature* (2016). DOI: 10.1038/nature19772

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