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Enhanced global carbon cycle sensitivity to tropical temperature linked to internal climate variability

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The sensitivity of annual atmospheric CO_2 growth rate (AGR) variations to tropical temperature has almost doubled between 1959 and 2011, a trend that has been linked to increasing drought in tropical ecosystems. This sensitivity metric has been used to suggest an emergent constraint of the future land carbon sink in response to climate change. However, a recent study showed that this sensitivity has decreased since then. Here, we investigate whether this doubling sensitivity reflects a forced response to climate change, or if it may arise due to internal climate variability.

We show that, first, several similar events have occurred in individual simulations of Earth System Model Large Ensembles since 1851, but without changes in the ensemble mean's forced signal, suggesting the possibility of the doubling sensitivity being an internally-driven signal. Second, these observed doubling sensitivity events are linked to few strong El Niño events, such as 1982/83 and 1997/98. Such extreme events result in enhanced carbon release in tropical and extratropical terrestrial ecosystems, thus increasing the variance of the global land sink. Third, the doubling event is mostly explained by an increase in the variance of global AGR (rather than variance of tropical temperature or changes in the covariance), so that the signal constitutes only an "apparent" sensitivity change. In conclusion, the doubling sensitivity is not necessarily caused by forced climate change, but may arise from tropical and northern land sinks associated with internal climate variability.

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