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A response function approach to characterize the terrestrial carbon cycle

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In order to better understand the carbon cycle response to perturbations, several Earth System Models have carried out simulations under a common protocol within the Coupled Climate Carbon Cycle Model Intercomparison Project (C4MIP). It was found that, while ocean carbon cycle response to equal atmospheric CO_2 perturbations exhibited similar behavior across different models, land carbon cycle reaction presented a large model spread.
This spread surely comes from the way different processes relevant for the carbon uptake were implemented in the different models. However, trying to understand the origin of the model spread by analyzing implementation details can be an extremely complex task without a good perspective of success. The aim of the present work is to provide an alternative approach for land carbon cycle comparison across distinct models by making use of a response function description of the problem.
Response function modelling is a well established concept in many other research fields. Former studies on the application of response functions to the carbon cycle focused mainly on the reaction of atmospheric CO_2 to anthropogenic emissions. Further, most previous studies on response function characterization of the carbon cycle have investigated the response to an impulse input. However, C4MIP simulations are not impulse experiments.
In this study we apply the response function approach to characterize the land carbon cycle by considering the net primary production (NPP) as a perturbation and then looking at the response in total land carbon. We develop methods to derive response functions from experiments with arbitrary instead of impulse forcing, discussing different methods to achieve this. By analyzing the spectra of internal model time scales, we hope to determine which processes at which time scales are relevant to explain the large model spread.