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Climate extremes and the carbon cycle - a review using an integrated approach with regional examples for forests & native ecosystems -

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The terrestrial carbon cycle provides an important biogeochemical feedback to climate and is itself particularly susceptible to extreme climate events. Climate extremes can override any (positive) effects of mean climate change as shown in European and recent US-American heat waves and dry spells. They can impact the structure, composition, and functioning of terrestrial ecosystems and have the potential to cause rapid carbon losses from accumulated stocks.

We review how climate extremes like severe droughts, heat waves, extreme precipitation or storms can cause direct impacts on the CO_2 fluxes [e.g. due to extreme temperature and/ or drought events] as well as lagged impacts on the carbon cycle [e.g. via an increased fire risk, or disease outbreaks and pest invasions]. The relative impact of the different climate extremes varies according to climate region and vegetation type. We present lagged effects on plant growth (and mortality) in the year(s) following an extreme event and their impacts on the carbon sequestration of forests and natural ecosystems. Comprehensive regional or even continental quantification with regard to extreme events is missing, and especially compound extreme events, the role of lagged effects and aspects of the return frequency are not studied enough. In a case study of a Mediterranean ecosystem we illustrate that the response of the net carbon balance at ecosystem level to regional climate change is hard to predict as interacting and partly compensating processes are affected and several processes which have the ability to substantially alter the carbon balance are not or not sufficiently represented in state-of-the-art biogeochemical models.