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Soil rewetting and the "Birch effect" in different ecosystems

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Future climate change projections indicate an increase in extreme weather events, with episodic droughts followed by periods of high rainfall. Earlier experiments indicated large and sustained emissions of carbon dioxide (CO2) associated with such rewetting events that have been attributed to an increased decomposition rate, enhanced mineralization and release of inorganic N. Although several possible explanations for this phenomenon have been proposed there are few detailed assessments of the “Birch effect” that cover the three major greenhouse gases and even less information on the extent to which the emissions vary with different ecosystems or land use types. More information is therefore required for a more realistic understanding of future climate change effects on GHG emissions. In the present study we investigated the effect of long-term induced drought, using field-deployed rain-out shelters, followed by rewetting, on GHG emissions from different forest ecosystems and associated grasslands (representing conditions prior to afforestation). The results show that rewetting can produce sustained ecosystem and land use-dependent emissions of GHGs. CO2 missions increased many fold after rewetting, an effect that persisted for 2-3 weeks before the values returned to control levels. Total emissions over this period comprised a significant percentage of the annual budget and would need to be taken into account in situations where episodic drought and re-wetting occurred. The effect of rewetting was relatively less significant for nitrous oxide and methane emissions. These results indicate that predictions of the impact of extreme drying and re-watering events on individual GHG emissions cannot be generalized and are likely to be site, ecosystem and land-use dependent.