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Effects of nitrogen deposition and climate extremes on European forests: combining stable isotopes in tree rings and ecosystem fluxes

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The ability of forests to continue providing important ecosystem services and mitigating climate change depends on their ability to adapt to global change pressures, such as more frequent climate extremes (specifically drought and heatwaves) and changes in atmospheric pollutants, such as reactive nitrogen compounds. On the one hand, nitrogen deposition could stimulate tree growth in a CO2 richer word, but on the other hand increasing atmospheric nitrogen input, above the critical load, could result in forest dieback, through soil acidification and nutrient imbalances but also by making trees more vulnerable to climate extremes. How do these global change components interact and affect forest carbon, water and nitrogen cycling? What are tree ecolophysiological mechanisms involved? Are those mechanisms synchronized (in terms of magnitude and temporal trends) at tree and ecosystem scales? Does nitrogen deposition affect tree and forest responses to climate extremes?
In order to answer these fundamental questions, we considered 12 forests along a climate and nitrogen deposition gradient (from 3 to 42 kg ha-1 yr-1) in Europe, including four of the most widespread tree species in European forests: Fagus sylvatica, Quercus spp., Picea abies, Pinus sylvestris. Forests sites were selected within established networks, namely ICOS and eLTER (for the ecosystem scale measurements of carbon and water fluxes with eddy covariance technique and other ecological parameters) and ICP Forests (for atmospheric nitrogen deposition). We will present preliminary results on the combinination of existing data on ecosystem fluxes with dendroecological data (growth and stable carbon, oxygen and nitrogen isotope ratios) to explore multidecadal changes in forest water-use efficiency and elucidate tree physiological mechanisms underpinning those responses. Moreover, in specific years characterized by climate extremes, an intra-annual isotope approach will be considered to evaluate possible divergences among tree species in the physiological signal and between tree and ecosystem responses, but also to elucidate the contribution of nitrogen deposition in affecting responses to climate extremes.
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