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Oxygen flux measurements as a new tracer for the carbon and nitrogen cycles in terrestrial ecosystems

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Atmospheric oxygen (O_2) measurements have proven to be one of the most powerful tools to study the carbon cycle at global scale, for example, quantifying the net global carbon dioxide (CO_2) sinks of terrestrial ecosystems and oceans. At ecosystem level, O_2 is closely related to CO_2 through the processes of photosynthesis and respiration, and is also influenced by sources of nitrogen during plant uptake. Oxygen measurements thus carry valuable information about terrestrial ecosystem processes that cannot be gained from CO_2 measurements alone. The potential of O_2 measurements at ecosystem level, however, has not been exploited. The major hindrance has been the significant technical challenges to measure atmospheric O_2 at ppm-level against the high background concentration of $\sim$21%.

We present the new European Research Council-funded project, 'OXYFLUX', that aims to develop high precision O_2 flux measurement as a new tool for carbon and nitrogen cycle processes at ecosystem level in the terrestrial biosphere. Commercially available O_2 analysers, including a brand new prototype from Aerodyne Research Inc., will be optimised for applications with leaf and soil gas exchange chambers, as well as with micrometeorological approaches at ecosystem scale, that is, flux gradient, eddy accumulation and eddy covariance approaches. These measurements will be further utilised in modelling work where we will integrate O_2 into two complementary terrestrial ecosystem models at canopy (CANVEG) and global scale (CLM). The models will be used to infer the sensitivity of the ecosystem net O_2 exchange to the O_2 exchange of various ecosystem components as well as to upscale O_2 fluxes to global levels. In this presentation we discuss the overall concept and plans for OXYFLUX, and we show first test results demonstrating the performance of the new Aerodyne instrument.