



## Exploring the diurnal cycle of $\Delta^{17}\text{O}$ in $\text{CO}_2$ at the ecosystem level

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The triple oxygen isotope signature  $\Delta^{17}\text{O}$  in atmospheric  $\text{CO}_2$  is a potential tracer for gross primary production (GPP). However, interpretation of  $\Delta^{17}\text{O}$  in atmospheric  $\text{CO}_2$  is complicated by the contributions from respired  $\text{CO}_2$ , isotopic exchange with soil and ocean water, and the release of  $\text{CO}_2$  by fossil fuel combustion and biomass burning. We studied  $\Delta^{17}\text{O}$  in  $\text{CO}_2$  at the ecosystem level, which is the domain that integrates the contributions from vegetation and soil to the atmospheric signal.

We report for the first time the observed diurnal variation of  $\Delta^{17}\text{O}$  in  $\text{CO}_2$ , measured from air samples collected on 15-16 August 2019 at the mid-latitude pine forest Loobos (ICOS L2 ecosystem site). We also measured the isotopic signatures  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  in  $\text{CO}_2$  close to the surface (at 0.5 m height, inside the canopy) and from the top of the tower (1-2 m above the canopy). To support the interpretation of the measurements, we used a land-atmosphere model that satisfactorily reproduces the diurnal variability of the interaction between leaf/canopy and the convective boundary layer using mixed-layer theory assumptions (CLASS). Also, we used the global atmospheric transport model TM5 to (1) quantify the contribution of different sources that affect  $\Delta^{17}\text{O}$  in  $\text{CO}_2$  at Loobos; and (2) extend our analysis of the diurnal cycle to the global scale.

Our methodology demonstrates the added value of isotope measurements at ICOS ecosystem and tall-tower sites, and how to integrate meteorological and ecological observations from the canopy up to the atmospheric boundary layer. This study contributes to our ongoing effort of creating an overview of different methods for quantifying photosynthesis from a top-down perspective (concentration-based methods and remote sensing) in a review paper for which we are open to other contributions.