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Diurnal variation in the $\delta'^{17}O$ of atmospheric CO_2 in the temperate scots pine forest ecosystem

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$\delta'^{17}O$ ($\delta'^{17}O = \ln(\delta^{17}O+1)-0.528 \times \ln(\delta^{18}O+1)$) of atmospheric CO_2 has been proposed as a possible tracer of gross primary production (GPP). However, how $\delta'^{17}O$ of atmospheric CO_2 varies diurnally at the ecosystem scale in different seasons has not been investigated. To use $\delta'^{17}O$ of atmospheric CO_2 as a tracer for GPP requires understanding the factors that control the $\delta'^{17}O$ signal and knowing how $\delta'^{17}O$ varies both diurnally and seasonally.

In this study, we explored the diurnal variation in $\delta'^{17}O$ of CO_2 along with $\delta^{13}C$ and $\delta^{18}O$ at different seasons in a temperate scots pine forest ecosystem. $\delta'^{17}O$ is measured with a precision of < 10 ppm. For all the seasons, $\delta^{13}C$ is enriched during the day when photosynthesis occurs and is depleted in the night when respiration dominates, mirroring the CO_2 mole fraction. The highest amplitude in $\delta^{13}C$ and CO_2 mole fraction is observed during the growing season.

The $\delta^{18}O$ and $\delta'^{17}O$ are mainly controlled by exchange with leaf water and soil water rather than by plant uptake. Thus, the observed enrichment or depletion in $\delta^{18}O$ and $\delta'^{17}O$ is strongly dependent on the enrichment or depletion of leaf water which is strongly dependent on vapor pressure deficit. Except in the growing season, $\delta^{18}O$ is enriched (during the day) and depleted (in the night) and $\delta'^{17}O$ is vice versa (depleted in the day and enriched in the night). However, during the growing season, $\delta^{18}O$ is higher during the night when respiration dominates and lower during the day when photosynthesis dominates. For the growing season, $\delta'^{17}O$ of CO_2 is higher during the day when photosynthesis dominates and lower during the night when respiration dominates.