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Proofs of non-stomatal limitations of potato photosynthesis during drought by using in-situ eddy covariance data

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Water stress in one of the main limiting factors in agro-systems, causing a reduction in gross primary production (GPP) and by extend, yields. However, it is still unclear to attribute whether the limitations of photosynthesis originate from a strict stomatal control (SOL) or from other non-stomatal limitations (NSOL). In this study, we investigated the effects of drought on potato crop by using eddy covariance data at the Loncée Terrestrial Observatory during three consecutive cultivation periods (2010, 2014 and 2018). Regardless the years and the timing of the drought appearance, the maximum carboxylation rate V_{cmax} (one of the NSOL) was reduced with decreasing REW, while the stomatal sensitivity to GPP parameter in the Medlyn et al. model (G_1 -SOL) remained constant. We showed that below the REW threshold of 0.55 ± 0.05 , the non-consideration of NSOL in the ecosystem CO_2 model led to an overestimation of the modelled GPP, which was about three times higher than its unstressed corresponding value. As a result, decreasing V_{cmax} while maintaining G_1 constant was sufficient to reproduce GPP and canopy conductance dynamics during drought. At a sub-daily scale, the intrinsic water-use efficiency did not vary during drought, neither its dependence on VPD nor its hourly dynamics. This reinforced the hypothesis of direct and feedback effects of NSOL on canopy conductance and photosynthesis, which was supported by the uniform coupling between carbon and water fluxes. We recommend the implementation of NSOL in ecosystem CO_2 models since non-stomatal factors were responsible for the decrease in potato crop GPP during drought.