Short-term kinetics associated with triose phosphate utilization stress during photosynthesis addressed with dynamic assimilation measurements

Thomas Sharkey[1] and Alan McClain[1]

[1]Michigan State University

November 21, 2022

Abstract

Oscillations in CO $_2$ assimilation rate and associated fluorescence parameters have been observed alongside the triose phosphate utilization (TPU) limitation of photosynthesis for nearly 50 years. However, the mechanics of these oscillations are poorly understood. Here we utilize the recently developed Dynamic Assimilation Techniques (DAT) for measuring the rate of CO $_2$ assimilation to increase our understanding of what physiological condition is required to cause oscillations. We found that TPU limiting conditions alone were insufficient, and that plants must enter TPU limitation quickly to cause oscillations. We found that ramps of CO $_2$ caused oscillations proportional in strength to the speed of the ramp, and that ramps induce oscillations with worse outcomes than oscillations induced by step change of CO $_2$ concentration. An initial overshoot is caused due to a temporary excess of available phosphate. During the overshoot, the plant out-performs steady state TPU and ribulose 1,5-bisphosphate regeneration limitations of photosynthesis but cannot exceed the rubisco limitation. We performed additional optical measurements which support the role of photosystem I reduction and oscillations in availability of NADP $^+$ and ATP in supporting oscillations.

Hosted file

`2022_11_13 DAT project AMM.docx` available at https://authorea.com/users/344967/articles/596349-short-term-kinetics-associated-with-triose-phosphate-utilization-stress-during-photosynthesis-addressed-with-dynamic-assimilation-measurements

Hosted file

`2022_11_13_Figures.pptx` available at https://authorea.com/users/344967/articles/596349-short-term-kinetics-associated-with-triose-phosphate-utilization-stress-during-photosynthesis-addressed-with-dynamic-assimilation-measurements