INTRODUCTION
- By 2050, land-surface mean temperature could rise 3.5°C and the CO₂ concentration could increase to 550 ppm (IPCC - Intergovernmental Panel on Climate Change) leading to environmental changes that could significantly impact agro-ecosystems, particularly the maize-soybean ecosystem, which represents the largest continuous ecosystem type in temperate North America.

- For soybean, it has been demonstrated that elevated CO₂ concentrations improve water use efficiency, raise leaf photosynthesis levels and increase yield. Also, some theoretical and modeling studies have indicated that elevated temperature and CO₂ concentration could increase net leaf photosynthesis, despite the increased respiration.

- However, it is not clear how the interactions of CO₂ and temperature will affect plant productivity and fitness in open air field conditions. In order to study their interactive effects, the T-FACE (Temperature by Free Air CO₂ Enrichment) experiment was designed to expose soybean and corn to growth at elevated temperature and CO₂.

OBJECTIVES
To understand the physiological responses and subsequent impact on carbon cycling for soybean grown in elevated [CO₂] and temperature in order to estimate the agronomic and ecological consequences.

EXPERIMENTAL DESIGN
- T-FACE is located at the SoyFACE facility, Champaign, IL. It uses IR heaters array mounted 1.2 m above the canopy to increase temperature 3.5 °C above ambient conditions. The plots have a functional area of 7 m².

- 2009 was the first year of T-FACE when soybean grew under field conditions at ambient and elevated [CO₂] (385ppm or 585ppm) at ambient or elevated temperature (+3.5 °C) in a factorial experiment.

- The measurements included: net carbon assimilation (A), respiration (Rd), stomatal limitation, leaf photosynthetic biochemistry (Vₘₐₓ and Jₘₐₓ), seed number and total biomass.

RESULTS
- The instantaneous carbon uptake (A) in elevated temperature and CO₂ had the highest photosynthesis rate during almost all the hours of the day, on 4 of the 7 diurnals taken. Opposite to that, ambient CO₂ and elevated temperature had the lowest A on 5 of the 7 diurnals.

- For all the growing season, in ambient CO₂ (385 ppm) and higher temperature (+3.5 °C), the daily integrated photosynthesis (A) significantly decreased by 6.4%, the total biomass decreased by 13%, and the fruit/pod number decreased by 6%.

- In contrast, in elevated CO₂ (585 ppm) and higher temperature, A increased by 3.9% and final biomass by 5%.

- Elevating temperature decreased Vₘₐₓ significantly in ambient CO₂.

- Elevating temperature significantly decreased maximum light driven photosynthetic electron transport, Jₘₐₓ, in both ambient and elevated CO₂.

- In elevated CO₂, Rd increased significantly but tended to decrease at higher growth temperature when measured at 25°C.

- Elevated temperature and [CO₂] caused significant decreases in stomatal limitation, with increased [CO₂] having the largest effect. Further, the minimum limitation occurred when both treatments are applied.

DISCUSSION
Higher temperatures have a negative effect on growth and physiology of soybean. The effect of temperature, however, was offset when CO₂ was increased simultaneously with temperature. The benefit of combined increases in CO₂ and temperature were less than predicted.

A combination of low stomatal limitation, potentially higher respiration, and similar photosynthetic acclimation are likely responsible for the muted synergistic responses to combined increases in CO₂ and temperature.

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