School of Agriculture, Policy and Development

University of Reading

The importance of empirical data in accounting for the long-term and interactive effects of climate change on cocoa

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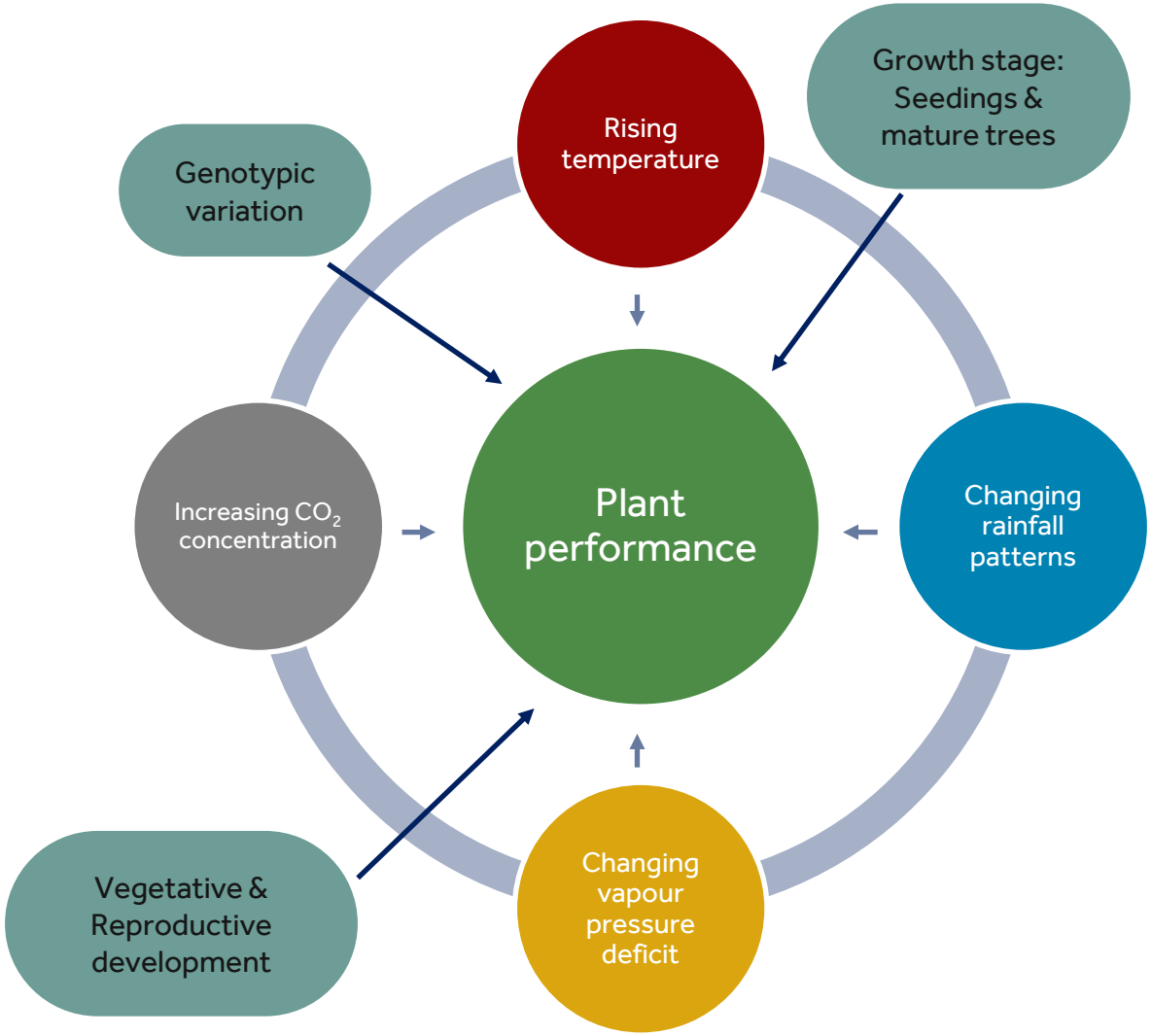
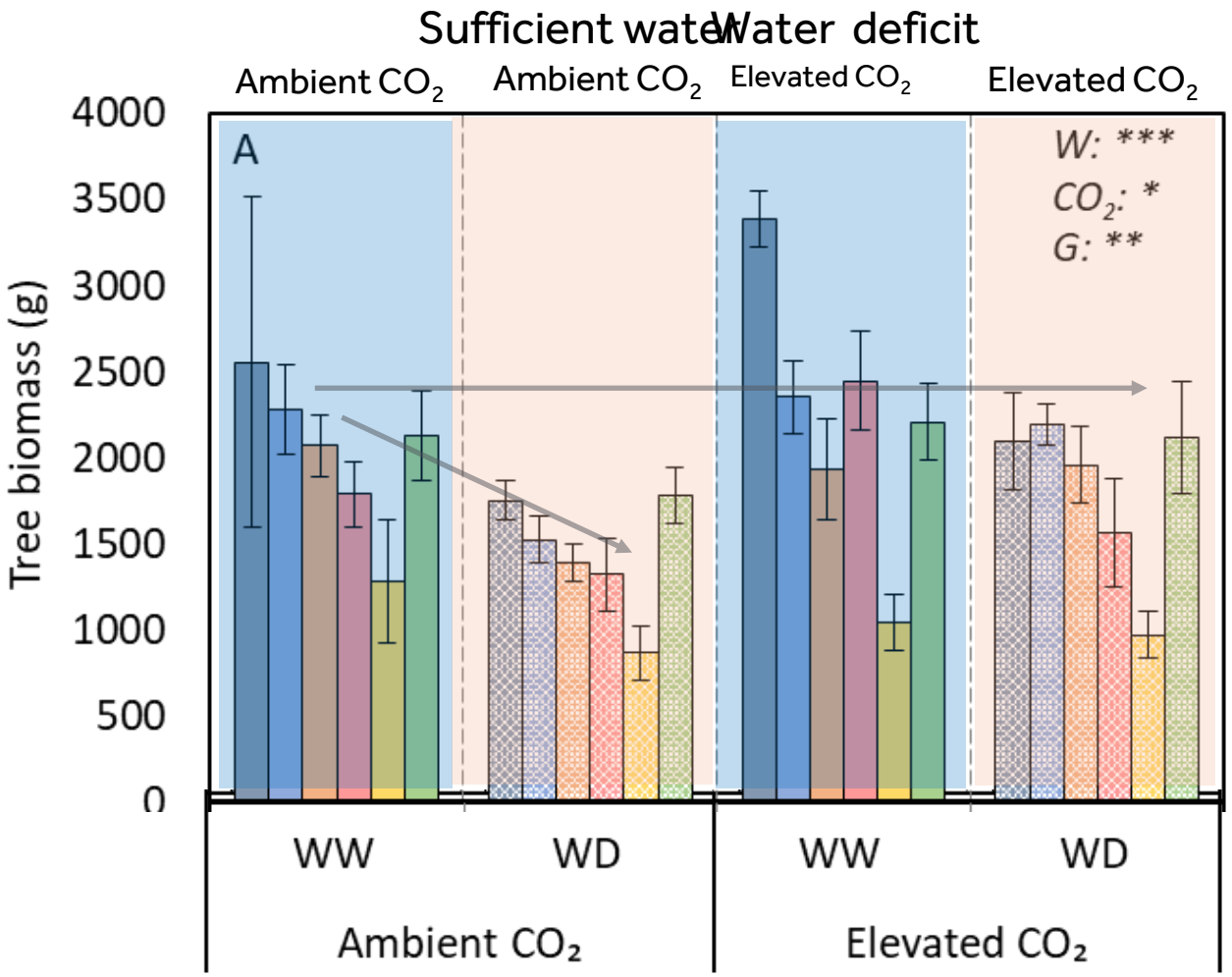
Climate change research on plant physiology needs to address:

- The interactive nature of climate variables
- The long-term processes in a perennial crop



Interactive effects

Elevated CO_2 & Water deficit



- Negative impact of water deficit on tree biomass production
- When grown under water deficit in a high CO_2 environment the impact of water deficit is reduced
- Genotypic differences in response to environment

*Mature grafted clones, grown under experimental conditions for 2 years

WW = well-watered

WD = water deficit

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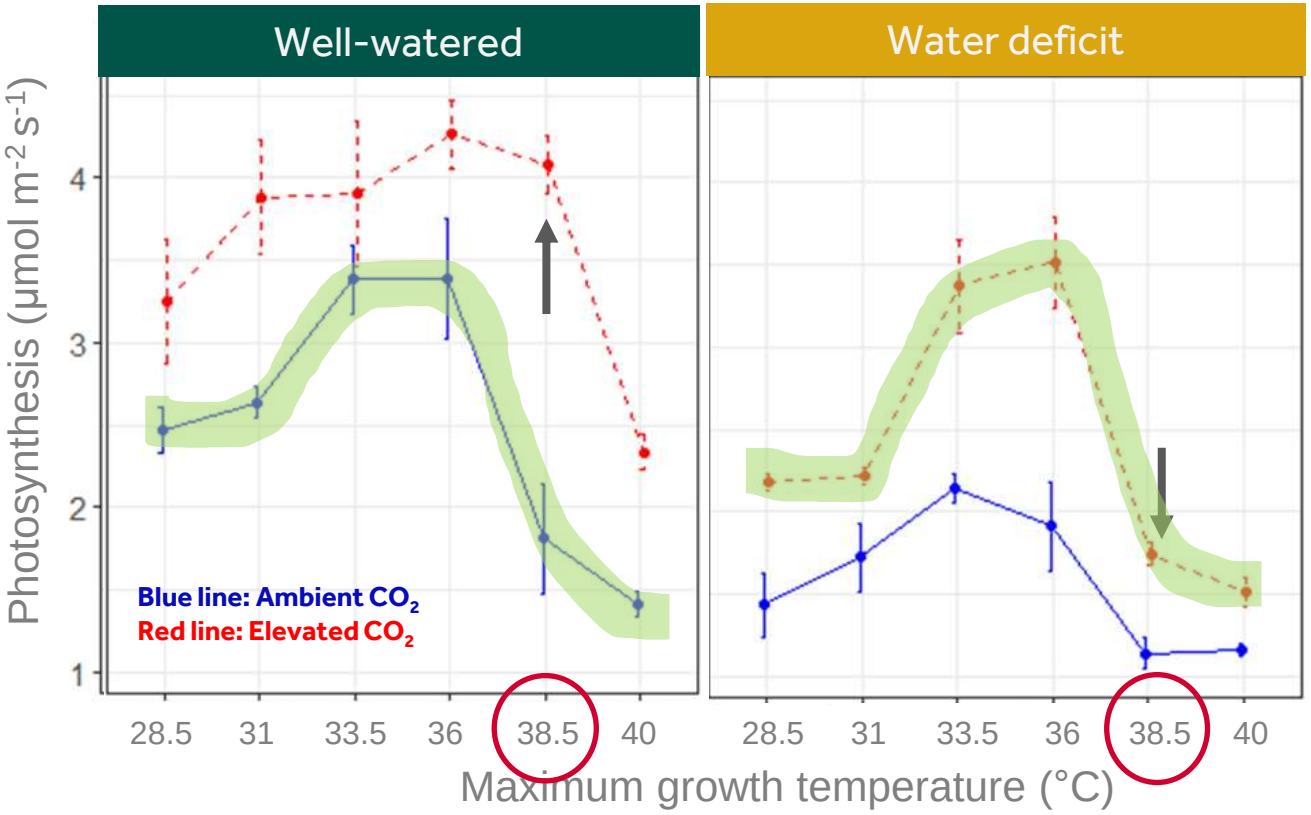
Lahive et al., Agronomy **2021**

https://doi.org/10.3390/agronomy11050818

Interactive effects

Elevated CO_2, Temperature & Water deficit



* Seedlings grown under experimental conditions for 90 days

- Positive effect of elevated CO_2 in well-watered and water deficit treatment
- The negative impact of water deficit is ameliorated by elevated CO_2
- Enhanced tolerance to high temperature in plants grown at elevated CO_2
  – but only in well-watered conditions

Modelling interactive effects on NPP

NPP = net primary productivity (green and woody biomass)

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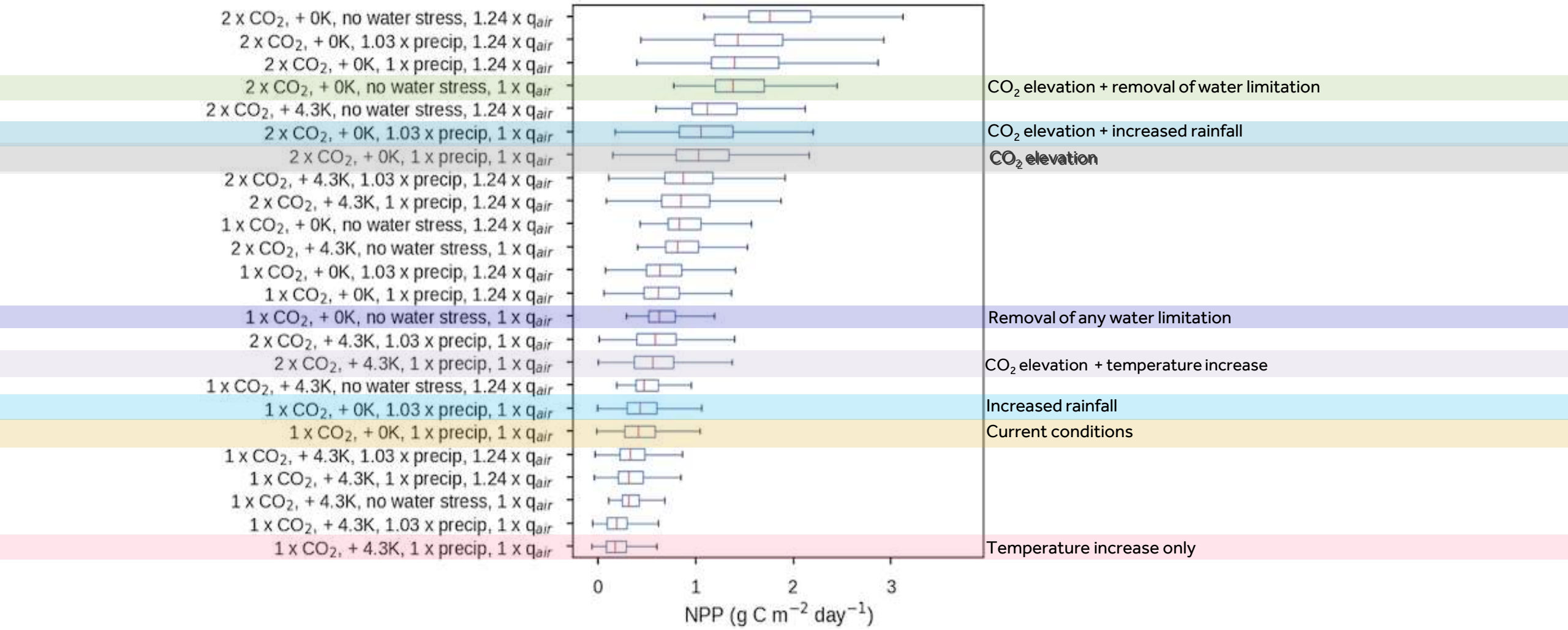


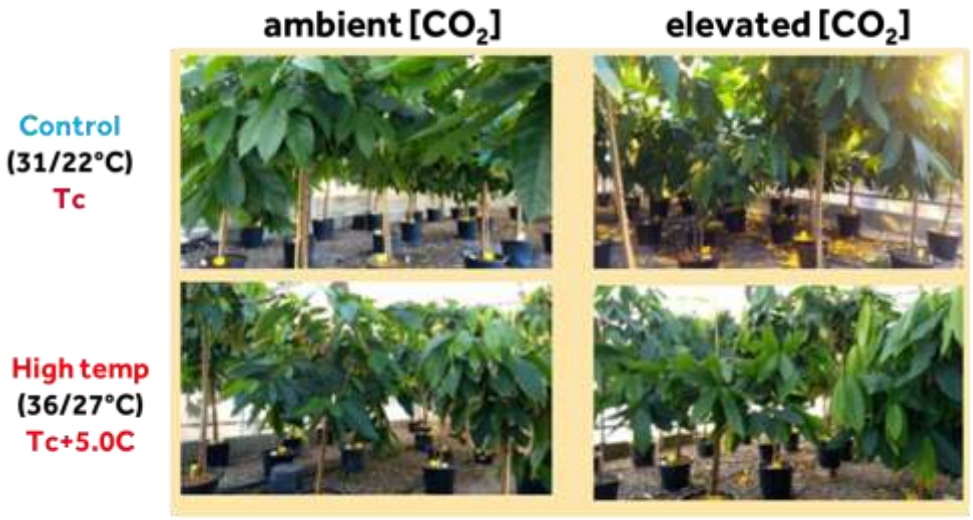
Black *et al Environ. Res. Lett.* **2021**
DOI: 10.1088/1748-9326/abc3f3

Long-term processes

Thermal acclimation in cocoa

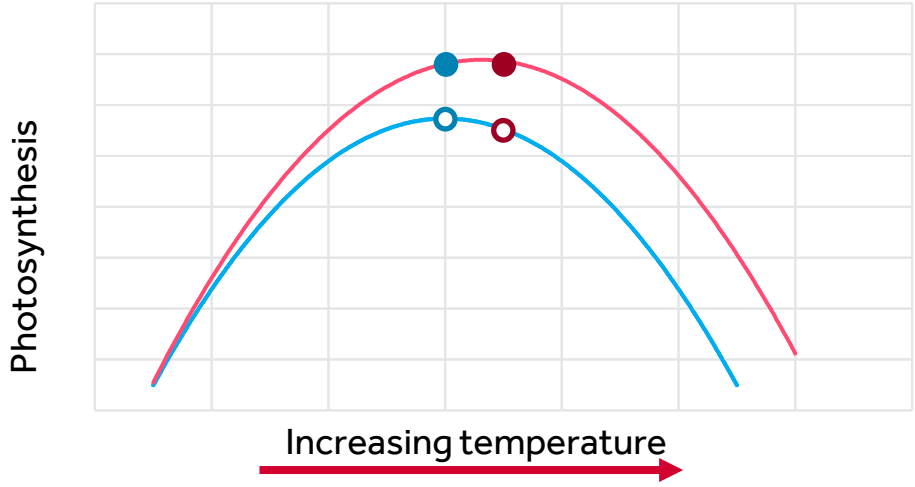
Photosynthetic acclimation: "environmentally induced changes in photosynthetic characteristics that result in an improved performance under the new growth regime" (Berry and Bjorkman, 1980)

Growing conditions for 1 year



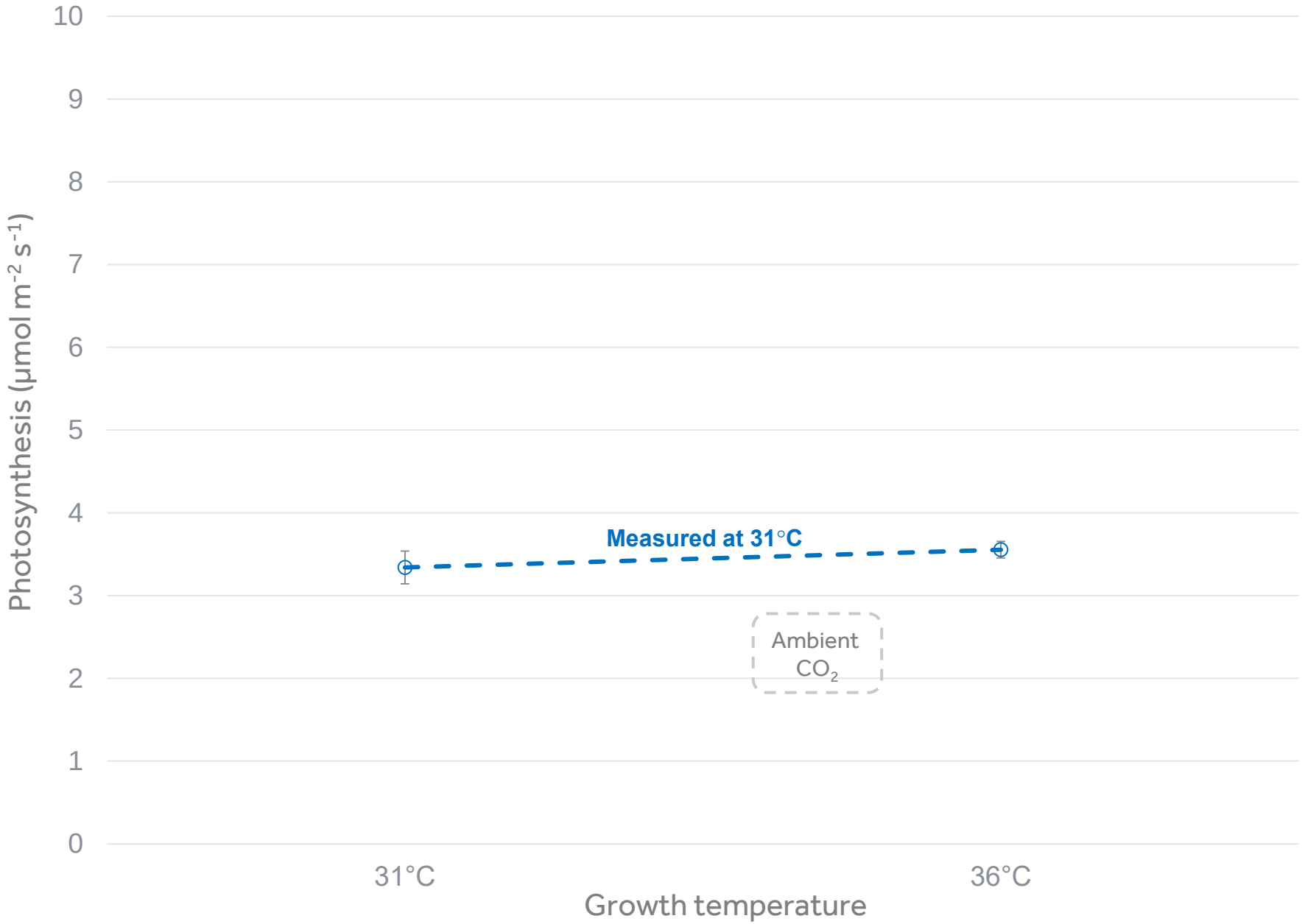
Perform reciprocal photosynthetic measurements to identify the occurrence of acclimation

31°C ⟷ 36°C



Cooler growing environment
Warmer growing environment

Evidence of thermal acclimation in cocoa



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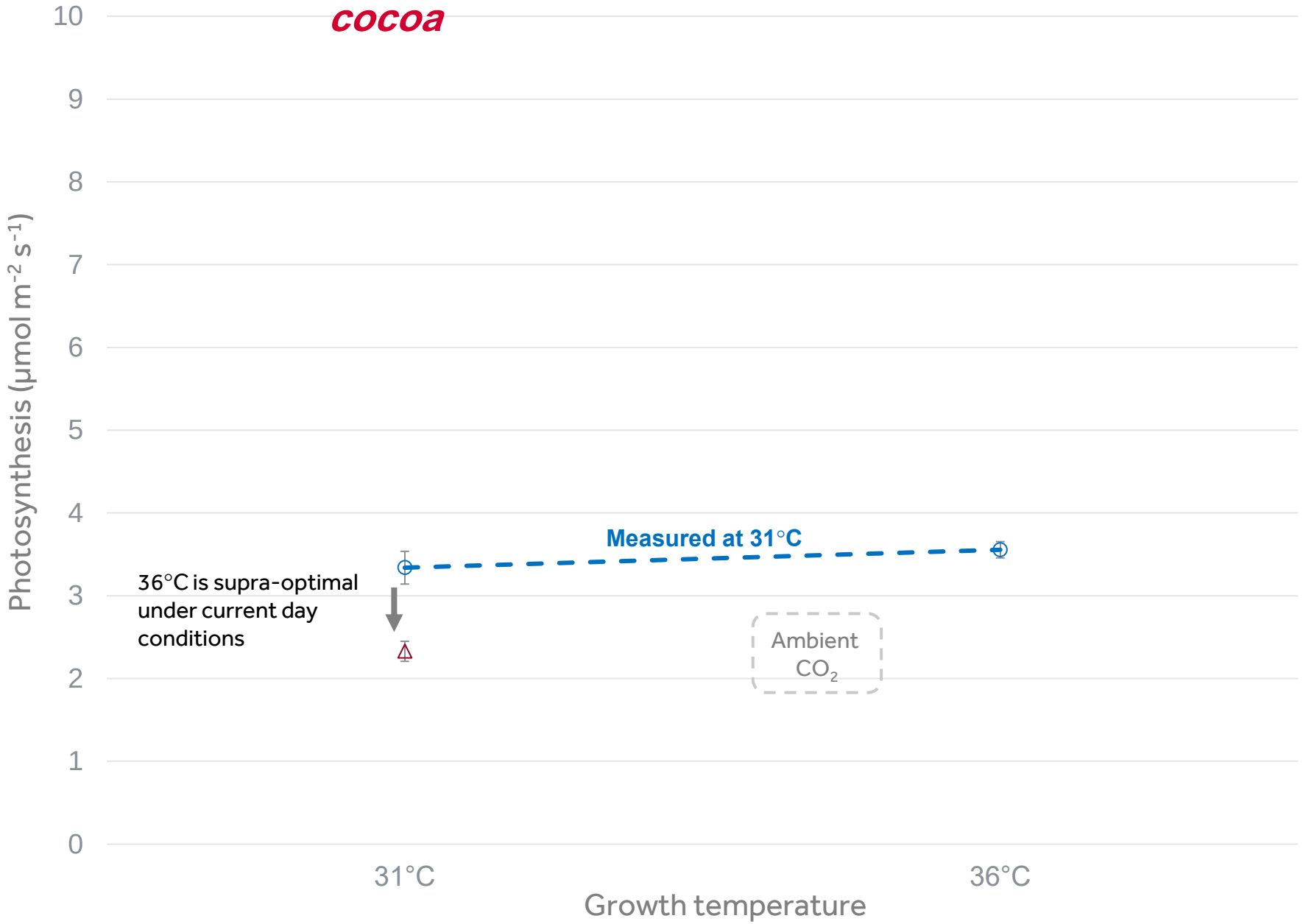

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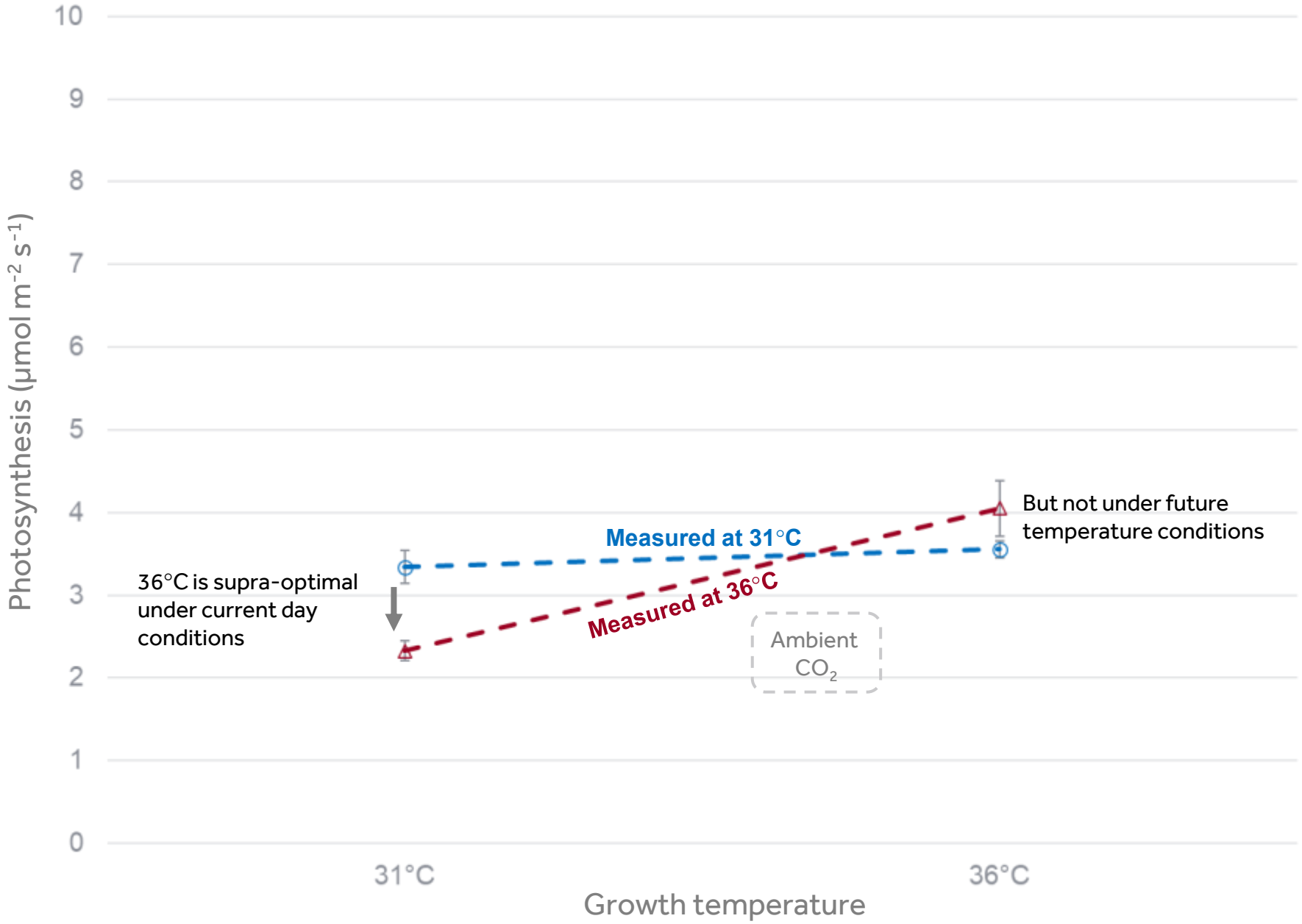

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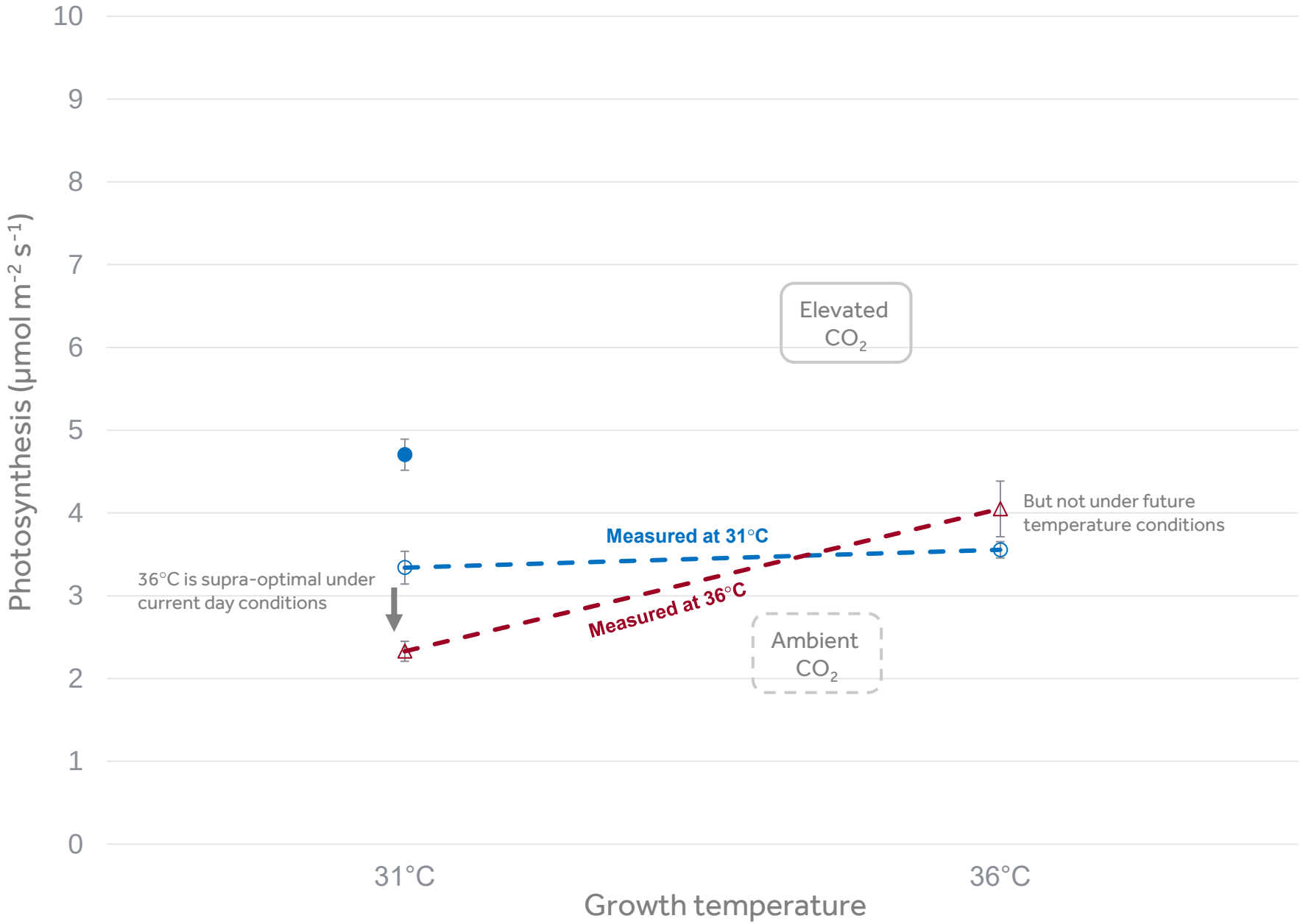

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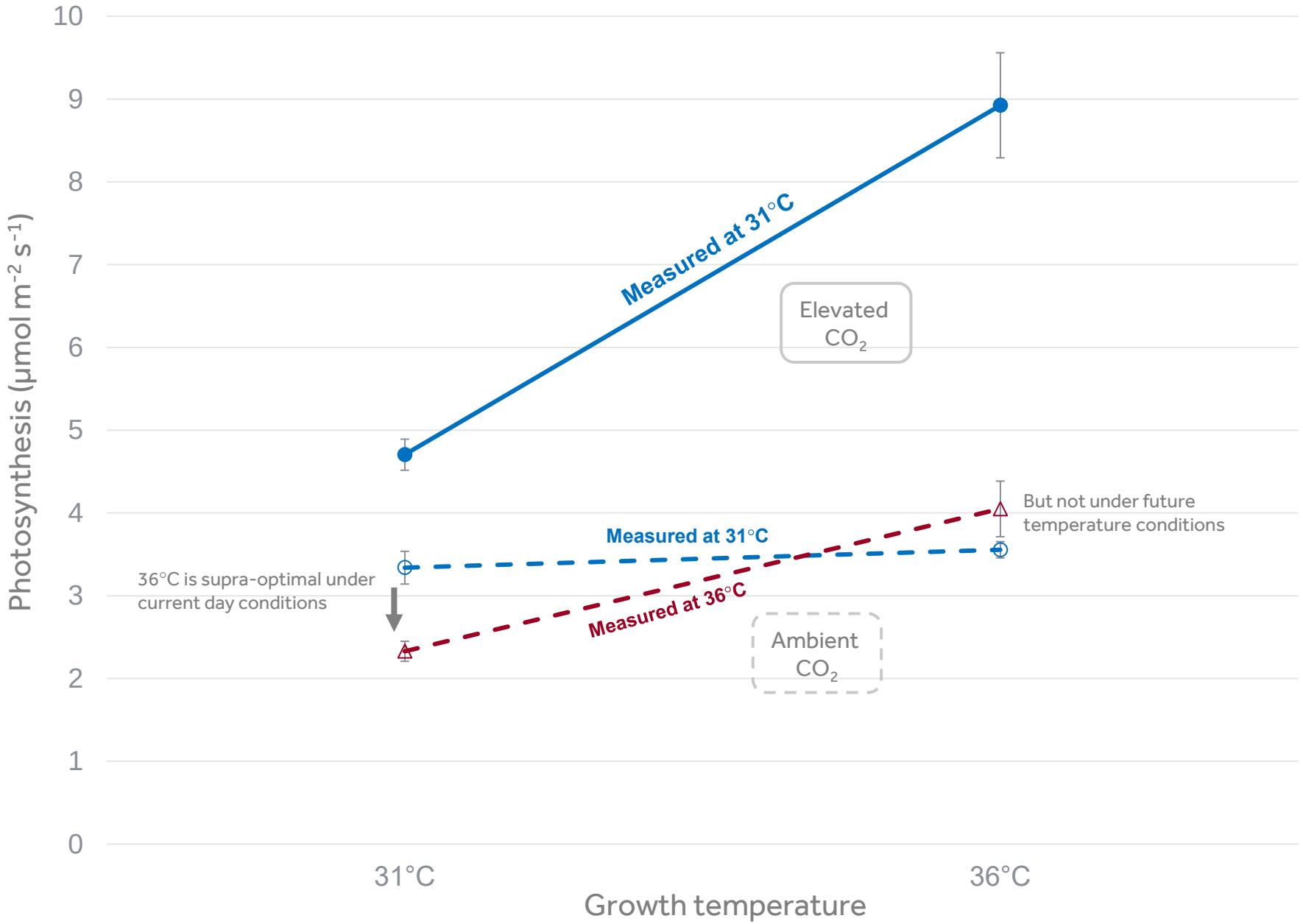

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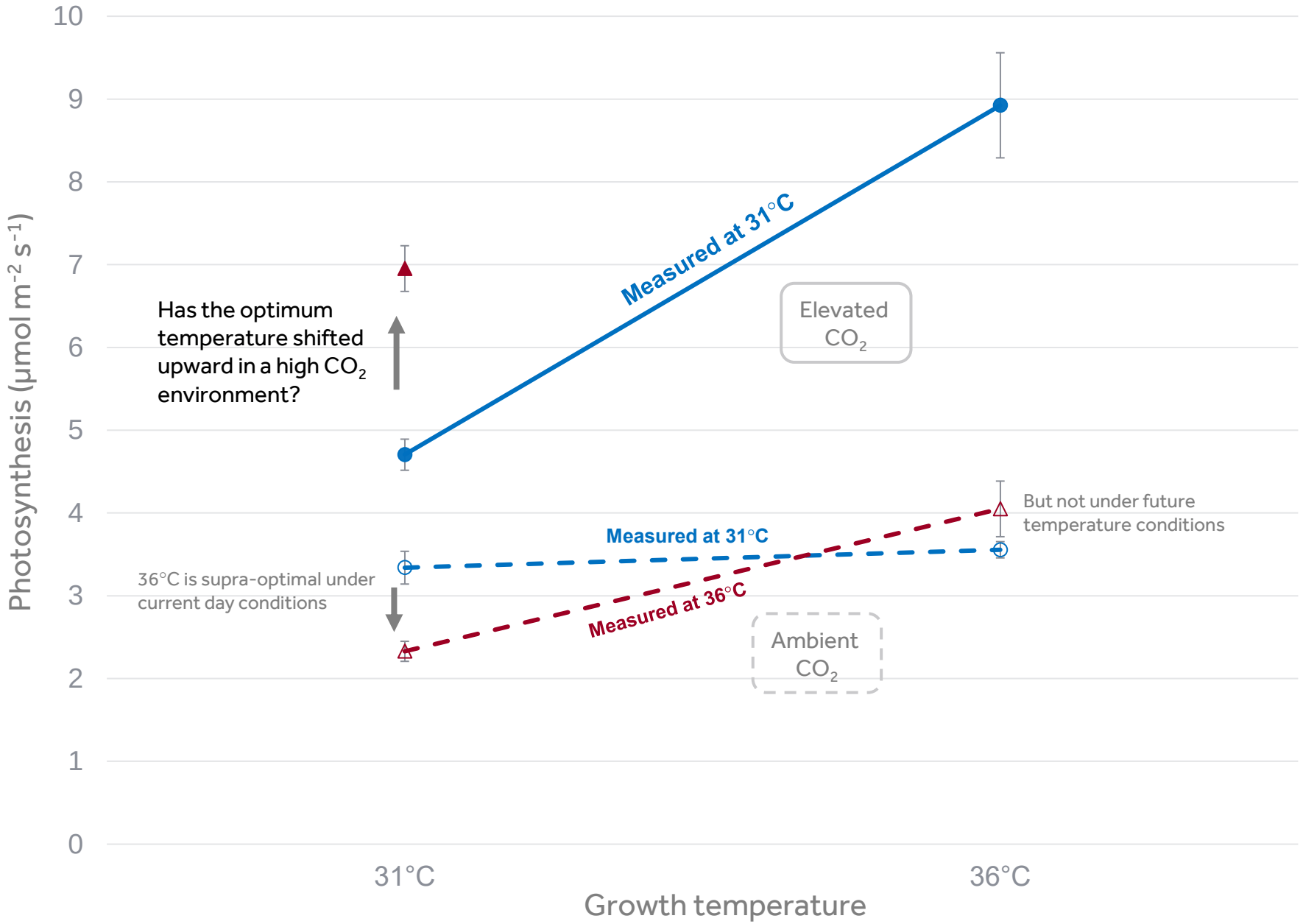

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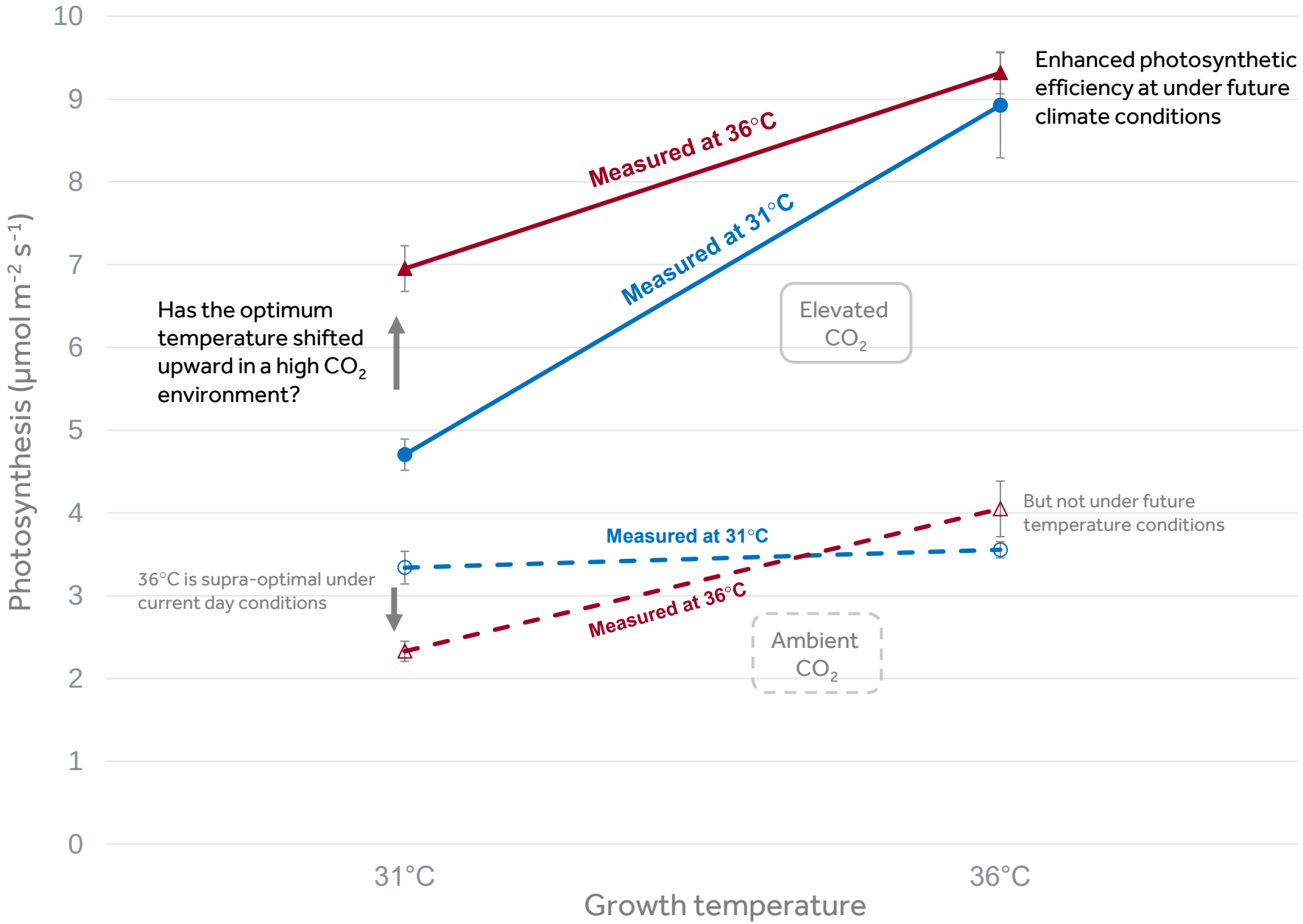

Conclusions

- To future proof cocoa production we need to understand how climate change will impact cocoa tree performance

- Experimental data capturing complex climate x plant interactions is required to better predict future outcomes, develop more resilient planting material and develop effective management strategies to secure production for farmers

- The perennial nature of the cocoa tree adds complexity to this picture. Acclimation to prevailing growing conditions can occur over time. Our understanding of these processes and their effects is currently very limited.

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