

Ecosystem responses and adaptation to climate change: the key role of response nonlinearity and interactions

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Introduction

In addition to long-term trends in climate variables, climate change has also led to increased weather variability, with more frequent, intense, and prolonged extreme events like droughts, heat waves, and heavy precipitation. As a result, ecosystems will face numerous possible scenarios representing diverse combinations of weather conditions, not just a few scenarios based on greenhouse gas emission reductions.

Approach

Drawing on multifactorial experiments that combined factors like atmospheric CO₂, water, temperature, and UV radiation, as well as experiments using climate gradients, we show the importance of understanding synergistic and antagonistic interactions, as well as the non-linear response to climate gradients. This is crucial for predicting future ecosystem responses and developing appropriate adaptation strategies.

Main body of the abstract

Plant responses to environmental factors often exhibit nonlinear patterns, such as sigmoidal or peak-like forms, where the response gradually changes with intensity before reaching an asymptote or maximum. For instance, photosynthetic performance may increase with temperature but then rapidly decline at higher levels. Interestingly, low intensities of factors typically considered negative can stimulate plant growth and yield, often due to the induction of protective mechanisms or root system stimulation - a phenomenon known as hormesis. This hormetic response can be an important component of plant acclimation to adverse climate change conditions. Additionally, interactions are frequently observed that are not merely additive, but also synergistic or antagonistic, resulting from the combined action of multiple environmental factors.

Conclusions and learning objectives

Experiments that evaluate the potential interactions of two or more climate change-related factors, as well as regression-based studies examining responses across a range of factor intensities, are absolutely essential for understanding the future impacts on ecosystems.

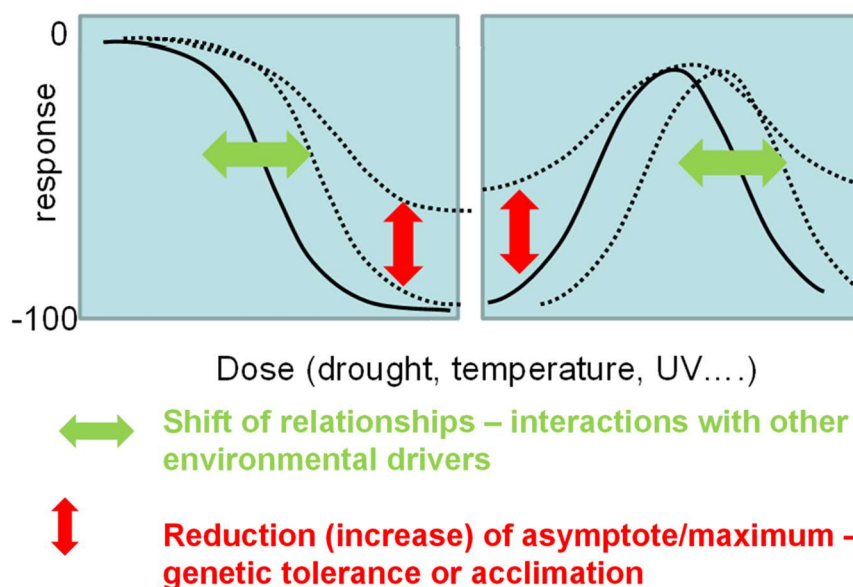


Figure 1 Ecosystem responses to climate change are highly variable due to nonlinear patterns, interactions among climate factors, and adaptive mechanisms.