

Arctic photosynthetic capacity and carbon dioxide assimilation underestimated by terrestrial biosphere models

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Alistair Rogers and Stefanie Lasota (Brookhaven National Laboratory) measuring photosynthesis and collecting samples of Arctic vegetation on the Barrow Environmental Observatory in Alaska. Credit: US Department of Energy

Carbon uptake and loss from the Arctic is highly sensitive to climate change, and these processes are poorly represented in computational models of the Earth. A key challenge is representing carbon dioxide uptake by plants in the Arctic. These models rely on details developed in warmer climates. This study provided the first Arctic dataset of two key photosynthetic parameters. The parameters were markedly lower in the models than the values measured on the coastal tundra of northern Alaska. In some case, the values were five-fold lower. On average, the capacity for carbon dioxide uptake by Arctic vegetation is double current model estimates.

This work highlights the poor representation of Arctic photosynthesis in terrestrial biosphere models. It also provides the critical data which are necessary to improve scientists' ability to project the response of the Arctic to global environmental change.

The researchers measured the maximum carboxylation rate and maximum electron transport rate in seven species representative of the dominant vegetation found on the coastal tundra near Utqiagvik, formerly known as Barrow, Alaska. They made three key discoveries. They determined that the temperature response functions of the maximum carboxylation rate and maximum electron transport rate that are used to determine how the capacity for carbon dioxide uptake changes with temperature were markedly different than the temperature response functions of temperate plants. Further, they showed that the two rates were two- to five-fold higher than the values used to parameterize current terrestrial biosphere models.

Finally, they determined the current parameterization of the models resulted in a two-fold underestimation of the capacity for leaf level [carbon](#) dioxide assimilation in Arctic vegetation. The insight and dataset provided in this study can be used to markedly improve terrestrial biosphere [model](#) representation of Arctic photosynthesis and improve

projections of how Arctic photosynthesis responds to rising [temperature](#) and [carbon dioxide concentration](#). The high-impact dataset generated during this study has already been used in four additional publications.

More information: Alistair Rogers et al. Terrestrial biosphere models underestimate photosynthetic capacity and CO₂ assimilation in the Arctic, *New Phytologist* (2017). [DOI: 10.1111/nph.14740](https://doi.org/10.1111/nph.14740)

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