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Seasonal CO_2 amplitude in northern high latitudes

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Abstract

Global climate change is influencing the seasonal cycle amplitude of atmospheric CO_2 (SCA), with the strongest increases at northern high latitudes (NHL; >45° N). In this Review, we explore the changes and underlying mechanisms influencing the NHL SCA, focusing on Arctic and boreal terrestrial ecosystems. Latitudinal gradients in the SCA are largely governed by seasonality in temperature and primary production, and their influence on ecosystem carbon dynamics. In the NHL, the SCA has increased by 50% since the 1960s, mostly due to enhanced seasonality in net carbon dioxide (CO_2) exchange in NHL terrestrial ecosystems. Temperature most strongly influences this trend, owing to warming impacts on growing season length and plant productivity; CO_2 fertilization effects have a secondary role. Eurasian boreal ecosystems exert the strongest influence on the SCA, and spring and summer are the most influential seasons. Enhanced ecosystem respiration during the non-growing season exhibits most uncertainty in the SCA response to global and landscape drivers. Observed changes in the seasonal amplitude are projected to continue. Key priorities include extending

carbon flux and ecosystem observation networks, particularly in tundra ecosystems, and including drivers such as vegetation cover and permafrost in process models to better simulate seasonal dynamics of net CO_2 exchange in the NHL.

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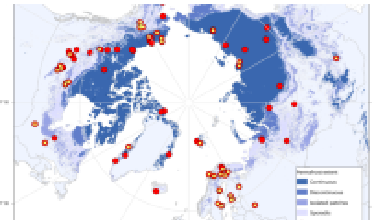

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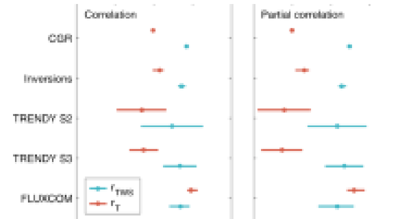

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Data availability

All synthesized data are publicly available. The in situ carbon dioxide (CO_2) data are from the archive of the Earth System Research Laboratory, National Oceanic and Atmospheric Administration (NOAA)[177], and the Copernicus Atmospheric Modelling Service (CAMS) global inversion-optimized CO_2 concentration data are from the Copernicus Atmosphere Monitoring Service[178]. Code is available from the corresponding authors upon request.

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