Regional Attribution of CO_2 Seasonal Amplification in Northern Hemisphere using a Tagged Tracer Transport Model

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The atmospheric CO_2 observations from surface monitoring stations and aircraft campaigns have shown an increasing trend in CO_2 seasonal cycle amplitude (SCA) in the Northern Hemisphere (NH), especially at high latitudes, over the past decades. Despite the large signal, we have limited knowledge of the geographic regions and underlying processes that have contributed to the amplification. Here, we present a quantitative regional attribution of CO_2 seasonal amplification for the period 1980–2017, using the GEOS-Chem CO_2 tracer transport model with prescribed fluxes from two CO_2 inversion systems (CAMS and CarbonTracker). We separately tag regional CO_2 fluxes so that we can differentiate the contribution of arctic and boreal regions over North America, Europe, and Siberia, as well as temperate regions, on the spatial patterns of CO_2 amplification. The increasing amplitude of ecosystem exchange in Siberia is the dominant contributor to large-scale CO_2 amplification at the surface over northern high latitudes, while the contribution from North American tundra and boreal forests is more spatially limited. Over midlatitudes and at midtroposphere in high latitudes, the dominant contributor shifts to temperate ecosystems, but the contribution from Siberia is still significant. Our study suggests that Siberian and temperate ecosystems together shape the overall CO_2 seasonal amplification in the atmosphere over the past decades, highlighting the need for further investigation of underlying processes in these regions.

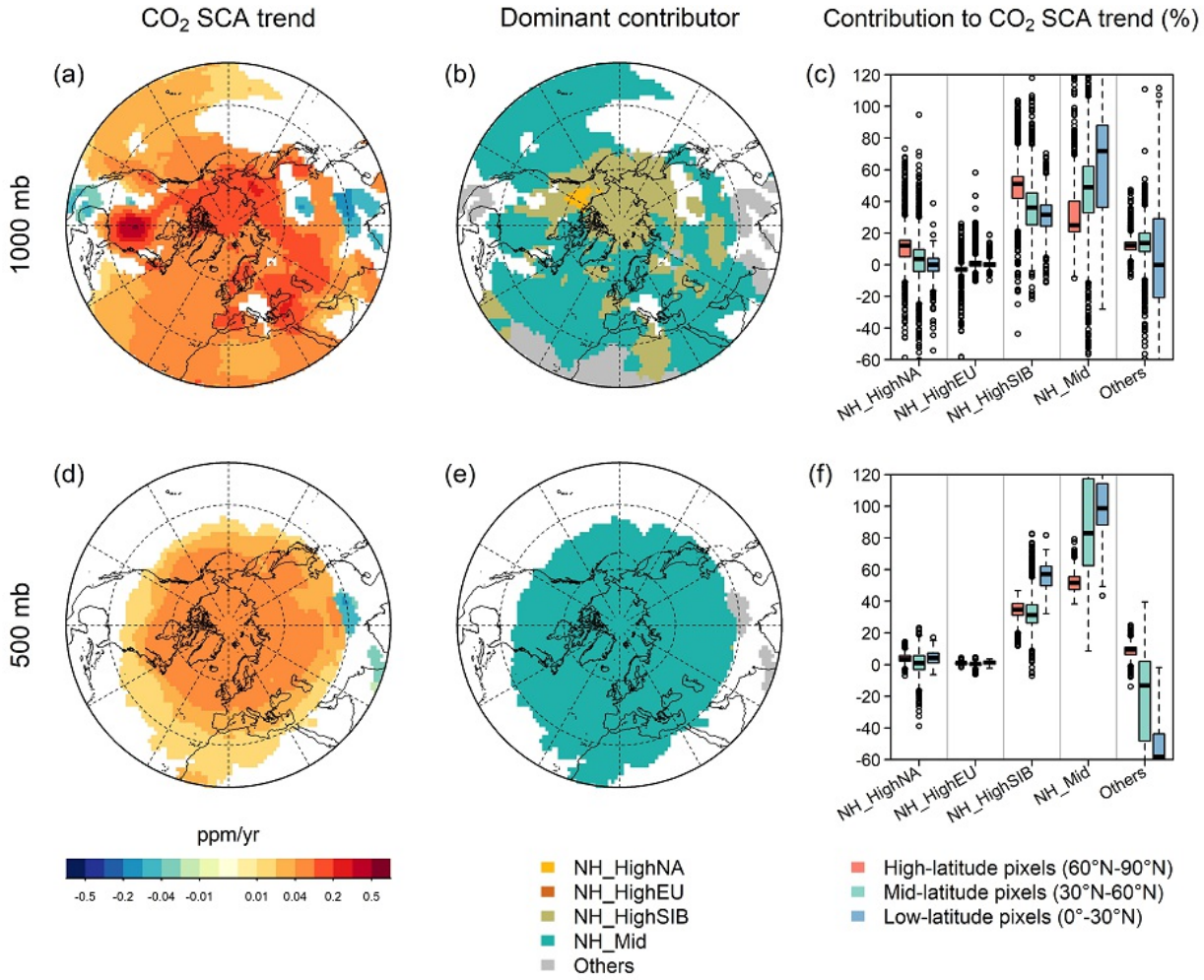

Figure 1. Spatial patterns of CO_2 seasonal cycle amplitude (SCA) trends at 1000 mb and 500 mb (a, d) and the region that imparts the largest trend (b,d). Zonal contributions are summarized in (c) and (f).