Recent Siberian heatwave increased spring CO_2 uptake but not annual CO_2 uptake

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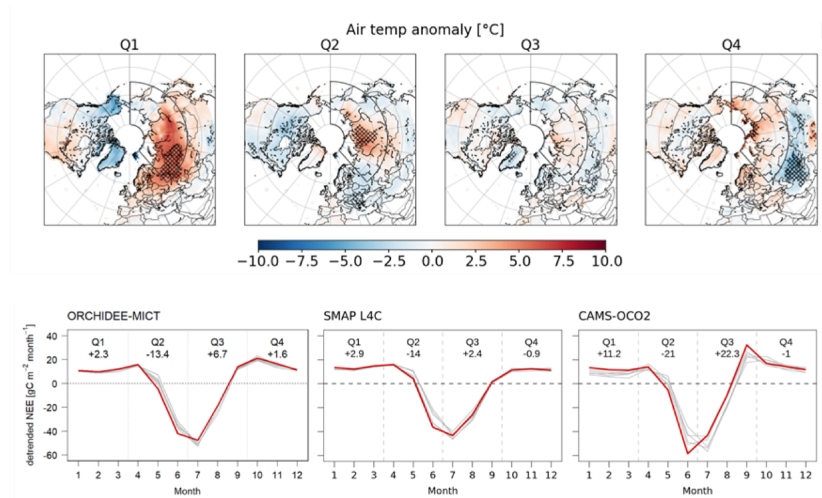
Problem: Siberia has vast permafrost areas vulnerable to Arctic warming, where carbon emissions from thawing permafrost may be degrading the northern land sink for Atm. CO_2. Siberia experienced an extreme heatwave in 2020, with uncertain impacts to the ecosystem carbon (CO_2) sink.

Methods: Integrated analysis of carbon flux estimates from satellite observations (SMAP L4C), land surface models (ORCHIDEE-MICT), and Atm. CO_2 inversions (CAMS-OCO2) using global reanalysis climate data (ERA5, 1979-2020).

Findings: The heatwave produced earlier and stronger photosynthetic CO_2 uptake in spring (~22 gC m^{-2}), which was offset by larger CO_2 respiration losses in the other seasons and a summer drought-induced decline in photosynthesis. The large seasonal compensation led to a net annual CO_2 sink (~3 g C m^{-2} y^{-1}) that was only slightly lower than previous less warm years.

Impact: Seasonal compensation of enhancements in both photosynthetic CO_2 uptake and respiration losses from amplified Arctic warming and permafrost thaw may limit northern carbon sink capacity.



Top: Quarterly surface temperature anomalies in 2020 showing anomalous Siberian heatwave. **Bottom:** Detrended monthly anomalies in net ecosystem CO_2 exchange (NEE) in 2020 over Siberia from SMAP L4C, ORCHIDEE-MICT, and CAMS-OCO2 (in red) in relation to other recent years (2015-2019, **in grey**); NEE shows earlier and stronger photosynthetic CO_2 uptake in spring and early summer, which is offset by enhanced CO_2 respiration losses in the other seasons.