Soil respiration is strongly reducing the Arctic-boreal carbon sink for atmospheric CO_2

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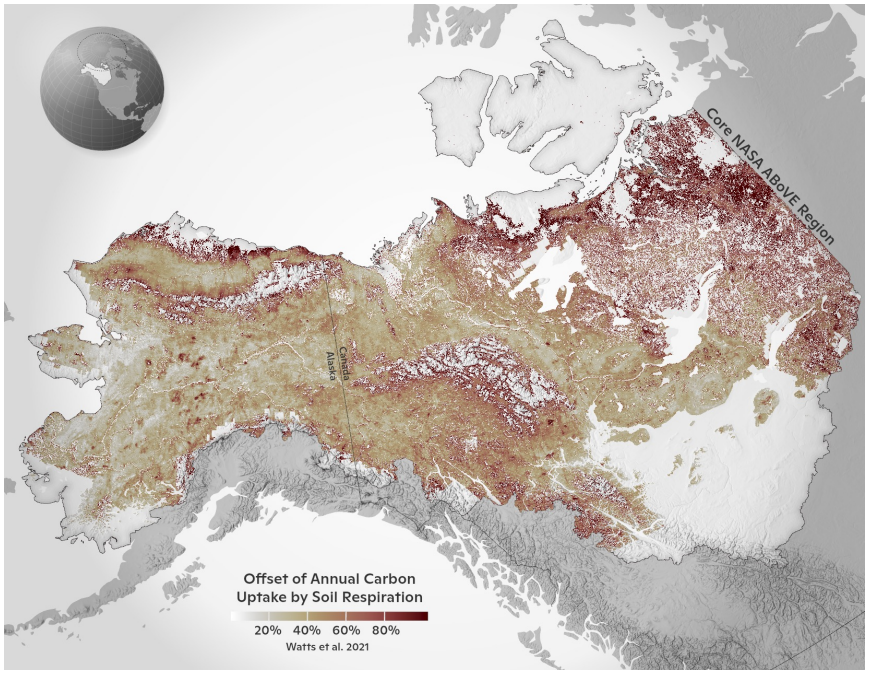
Problem: The Arctic-boreal zone contains >100 Pg of soil carbon vulnerable to permafrost thaw and enhanced CO_2 emissions from amplified polar warming; but the pattern of soil respiration (SR) carbon losses and their capacity to offset ecosystem productivity (GPP) carbon gains is uncertain.

Methods: Machine-learning was used with multi-sensor satellite data for upscaling SR observations from sparse CO_2 monitoring sites in Alaska and NW Canada. Key model drivers included GPP (incl. SMAP L4C); root zone soil moisture (RZSM) and temperature (SMAP L4SM).

Findings: Estimated SR loss of 591 Tg CO_2-C y^{-1} offset more than half (54%) of annual GPP for the permafrost domain (*see figure*), with summer, winter, and shoulder seasons accounting for 58%, 27%, and 15% of annual SR emissions. SR fully offset or exceeded GPP in tundra and recent fire disturbed areas. RZSM was the most important predictor of autumn SR.

Impact: SR expected to increasingly overcome GPP with further warming (and drying) of permafrost landscapes, reducing the northern carbon sink and reinforcing global warming.



Estimated SR offset of annual carbon (CO_2) uptake by GPP during the 2016-17 study period. The study area spans the NASA Arctic Boreal Vulnerability Experiment (ABoVE) core region, excluding non-permafrost, barren, open water (in white), and areas external to the ABoVE domain (in grey).