Soil respiration is strongly reducing the Arctic-boreal carbon sink for atmospheric CO$_2$


**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.