Soil organic carbon amount rather than land-use controls respiration in boreal and temperate-boreal ecotone sites

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Purpose: Agricultural intensification and expansion into cold-climate regions is an under-recognized but policy-driven reality. Soil functional state is driven by the state of soil carbon in the critical region of the temperate-boreal ecotone (*TBE*) and is a key understudied metric of cold-climate soils, governing soil health and fertility. The stability of "labile" or "recalcitrant" carbon pools is ultimately dependent on microbial activity, modified by water, temperature, and aeration. Both climate shifts and management variability associated with land-use-change affect soil carbon pools both quantitatively and qualitatively. It is thus critical that we examine boreal/alpine soils to better understand the processes that drive carbon storage and loss in the *TBE*.

Methods: We employed systematic boreal research to answer the question: 'what are the primary factors controlling boreal C cycling?' We examined soil carbon across boreal, alpine, and TBE regions globally, gathering data on four land use types from ten separate geographic locations in Eurasia, New Zealand, and North America. By consistently measuring representative samples of four land use types in each location (natural, converted wheat agriculture, converted pasture agriculture, and abandoned converted), we hypothesized that we might see clear relationships emerge in C cycling patterns based on land use type and regardless of unique site characteristics, such that soil C cycling is greatest in natural>pasture>abandoned>wheat.

Results: Our results confirmed our hypothesis. While for each individual region, soil respiration was larger for forest soils than for farm soils, globally, a consistent pattern was observed in a manner that appears to primarily link soil C cycling to total C content. Contrary to the prevalent belief, arid, former grassland soils often had low respiration and SOM, with mature forests possessing the highest of both.

Conclusion: Our results point to global patterns in boreal C cycling that may be of significant use in future land management decisions and policymaking. They indicate that C sequestration in boreal regions is not guaranteed, as often stated by policymakers and public opinion, but is linked to consistent, continuous, OM-directed land management. These results also suggest that unmanaged, or post-management converted lands would likely tend towards a low SOC state.