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Effects of Warming, Wildfire, and Permafrost Thaw on Carbon Dioxide Fluxes from Boreal Peat Landscapes in northwestern Canada

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The Taiga Plains ecozone in northwestern Canada is characterized by vast peat landscapes consisting of both mostly tree-less, permafrost-free and forested, permafrost-affected peat landscapes. In response to warming due to ongoing climate change, more frequent and severe wildfires and rapid permafrost thaw affect landscape composition, structure and functioning, whereas more and more ice-rich permafrost peat plateaus transform into water-saturated thermokarst wetlands or lakes. Collectively, these three agents of change, namely warming, wildfire, and thermokarst, could turn these boreal peat landscape from atmospheric carbon and nitrogen sinks into sources with potentially positive climate system feedbacks. We studied net ecosystem exchange (NEE) and its two component fluxes, i.e., gross primary productivity (GPP) and ecosystem respiration (ER), from three sites with five eddy covariance towers near the southern limit of permafrost in western Canada. Around the southernmost site Lutose, both footprint areas around the two towers have completely burned in wildfires in 2007 and 2019, respectively. We hypothesized that these two subsites would act as net CO_2 sources, because of the recent disturbance history. This has been confirmed by preliminary results. The two other sites mainly differed in permafrost extent, ranging from sporadic (Scotty Creek) to discontinuous (Smith Creek), and in peat plateau-to-wetland ratio and corresponding forest cover (Scotty Creek < Smith Creek). Between the two sites Scotty Creek and Smith Creek, we hypothesized that the overall landscape GPP and ER will be higher at Scotty Creek compared to the northernmost site Smith Creek, due to both more abundant thermokarst wetlands and higher GPP and ER of the peat plateau areas at this more southern site. We further hypothesized that the effects of warming on GPP are greater than on ER and thus that the warmer Scotty Creek site is a greater net CO_2 sink. Contrary to

expectations, preliminary results have shown that there is no difference in NEE between Scotty Creek and Smith Creek, whereas both, the overall landscape GPP and ER, are actually higher at Smith Creek. To identify differences in the NEE, GPP, and ER between their peat plateaus and thermokarst wetlands, respectively, we move forward by applying footprint analyses for Smith Creek and Scotty Creek. Through these analyses we will be able to shed light on how each of the drivers, i.e., warming, wildfire, and thermokarst, alters magnitude and direction in greenhouse gas fluxes from rapidly thawing boreal peat landscapes.