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Enhanced Methane Uptake under Light Conditions in an Alpine Tundra Ecosystem

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Alpine tundra ecosystems are widely regarded as small but persistent sinks of atmospheric methane (CH□), yet it remains unclear how ongoing climate-driven shifts in vegetation composition and productivity will alter CH□ exchange. As a result, predicting whether the alpine tundra will act as a CH□ sink or source in the future requires an understanding of the governing mechanisms and links between vegetation CH□ production and consumption. To address this gap, we explored the drivers and magnitude of CH□ and carbon dioxide (CO□) fluxes across fine scale alpine tundra vegetation gradients in Kaska First Nations Ancestral territory, now known as northern British Columbia. Using a systematic grid approach, we measured fluxes and environmental parameters from 100 plots over a 3-day period during peak growing season. Our design captured dominant vegetation types and key transition zones of microclimatic gradients across a south facing alpine slope. We found that CH□ uptake was greater under light vs dark chamber conditions across most plant functional types, suggesting a link between photosynthesis and CH□ uptake. Our light-only chamber condition statistical model further indicated that CH□ uptake covaries most strongly with net ecosystem exchange, soil temperature, and nutrient availability (Cu, P, and total N). Together, these results suggest that climate-driven changes in vegetation structure and productivity may alter CH□ uptake strength in alpine tundra ecosystems, underscoring the importance of resolving plant-soil processes for predicting future CH□ dynamics.