Implications of Thermokarst Landforms on Carbon Cycling in the Yukon Kuskokwim Delta, Alaska
Tiffany Windholz*,1, Jacqueline Hung1, Ellen Bradley1, Nigel Golden1, Susan Natali1
*twindholz@woodwellclimate.org; 1Woodwell Climate Research Center

Introduction
Thermokarst processes are an often-underrepresented component of the carbon permafrost dynamic, partly due to the challenges of quantifying their emissions, which can be highly heterogeneous at small spatial scales and variable over time as thermokarst development progresses or stabilizes.

How do thermokarst features in burned and unburned shrub-tussock tundra impact active layer development and CO₂ release?

Methods
• Sampling took place over a 2-week field campaign in July 2022.
• Measured net ecosystem exchange (NEE) and ecosystem respiration (Reco) at “disturbed” (within 1-2m of ground cracking) and “control” (within 2-10m of cracking) plots using an LI-7810. Gross primary productivity (GPP) determined by the difference between NEE and Reco.
  • Burned (2015) site had 3 disturbed and 3 control plots.
  • Unburned site had 2 disturbed and 2 control plots.
  • Thaw depth/soil temperature was measured at flux plots and along a transect that ran perpendicular to the ground crack.
  • Analysis of variance (ANOVA) and Tukey post hoc tests were used to determine site differences.
  • Significance (p<0.05) is noted by different letters on the figures.

Results

Results and Discussion
• The warmer and deeper active layer observed at disturbed sites indicates the potential for thermokarst events to induce lateral thaw thereby initiating a positive feedback which further warms and thaws the area (figures 3 & 4).
• At the burned site, we observed more CO₂ uptake at disturbed sites compared to control sites (figure 5), likely due to the recovery of the feature which points to the potential of recovering vegetation at thermokarst disturbances to offset some of the initial gasses emitted.
• Increased nutrient availability due to the fire could help explain the differences in carbon fluxes, GPP and Reco (figures 5 & 6) at the burned vs. the unburned sites. Vegetation cover was also an important driver of fluxes, as the burn impacted control sites had not fully recovered yet and had less vegetation than at the unburned control sites.
• The impacts of wildfire and recovery combined with the heterogeneous nature of thermokarst disturbances both likely contribute to the difference in NEE at the unburned disturbed site compared to the other plots (figure 7).

Conclusion/Future Work
• The Arctic is warming disproportionately to the rest of the world and is being impacted by thermokarst formations and wildfires, whose combined disturbance have a heterogeneous impact on CO₂ fluxes. Incorporating disturbance and recovery are critical to understanding carbon cycling in Arctic landscapes.
• Future work includes expanding this research spatially and temporally.

Acknowledgments: Field research took place in the Yukon Wildlife Refuge which is located on Yup’ik lands. We would like to thank Alma Hernandez, Esmeralda Torres Martinez, Annemarie Timling and the whole 2022 Polaris Project cohort for assistance in the field. We would like to thank the funding source: NSF 1915307.