CARBON CYCLING IN A CHANGING TUNDRA ENVIRONMENT
FROM LOCAL TO CIRCUMPOLAR SCALE

ABSTRACT
This PhD project aims to understand the drivers of soil organic carbon stocks and CO₂ fluxes, namely gross primary production (GPP), ecosystem respiration (ER), soil respiration (SR) and net ecosystem exchange (NEE), in current and future conditions. Moreover, the spatial patterns of carbon cycling at local and circumpolar scales will be investigated. The project is based on a local-scale field data set collected from Kilpisjärvi, Finland, and a circumpolar data set collected from publications and created by the research team. The data will be analyzed with spatial modeling methods. All planned articles for the PhD project are shortly presented here.

1. THE CURRENT STATE OF LOCAL CO₂ FLUX STUDIES IN THE TUNDRA: A REVIEW
This research highlights the need for studying chamber-derived CO₂ fluxes in more extreme climatic, productivity and soil conditions. The effect of soil microclimate and vegetation on CO₂ fluxes is relatively well understood, but soil nutrients and disturbance regime require more research. Particular attention should be paid to the effects of shrubification and geomorphological processes.

2. SPATIAL PREDICTIONS OF CO₂ FLUXES IN THE TUNDRA
In this article, local scale variation of CO₂ fluxes is modelled against high resolution RS data sets. We aim to identify the spatial variation and hot spots for CO₂ fluxes.

3. THE IMPORTANCE OF LOCAL DRIVERS IN CIRCUMPOLAR CARBON BALANCE
The aim of this meta-analysis is to study the effects of local-scale drivers (soil and vegetation properties) on growing-season CO₂ fluxes.

4. CIRCUMPOLAR GROUND THERMAL STATE & CARBON CYCLING
This research focuses on the effect of changing active layer depths and permafrost extent to soil organic carbon stocks and carbon balance.

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Figure 1. The distribution of CO₂ chamber studies (n=80) in the Arctic tundra. Sites are clustered to Alaska and Fennoscandia.

Figure 2. The environmental conditions of the CO₂ flux measurement sites (WordClim, Soilgrid, GTOPO DEM).

Figure 3. Number and proportion of studies in which different environmental predictors were used to understand local CO₂ fluxes.

Figure 4. RS data sets for spatial modeling of GPP, ER, SR and NEE. Field data is collected with chambers from Kilpisjärvi, Finland.

Figure 5. The relationship of NDVI (Terra/Modis) and ecosystem respiration measurements collected from CO₂ chamber studies. In the future Eddy covariance observations of growing-season NEE will be included, too.

Figure 6. Circumpolar high-resolution data sets of soil properties will be used to predict the future losses of carbon from terrestrial ecosystems.

Figure 7. The environmental conditions of the CO₂ flux measurement sites (WordClim, Soilgrid, GTOPO DEM).