CARBON CYCLING IN A CHANGING TUNDRA ENVIRONMENT

FROM LOCAL TO CIRCUMPOLAR SCALE

Anna-Maria Virkkala, PhD student
University of Helsinki
BioGeoClimate Modeling Lab
anna-maria.virkkala@helsinki.fi

ABSTRACT

This PhD project aims to understand the drivers of soil organic carbon stocks and CO_2 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 CO_2 FLUX STUDIES IN THE TUNDRA: A REVIEW

This research highlights the need for studying chamber-derived CO_2 fluxes in more extreme climatic, productivity and soil conditions. The effect of soil microclimate and vegetation on CO_2 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.

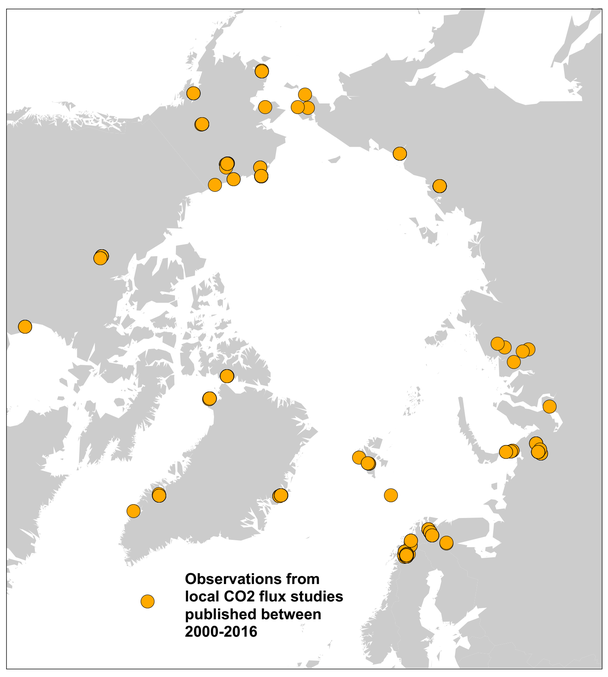

Figure 1. The distribution of CO_2 chamber studies (n=80) in the Arctic tundra. Sites are clustered to Alaska and Fennoscandia.

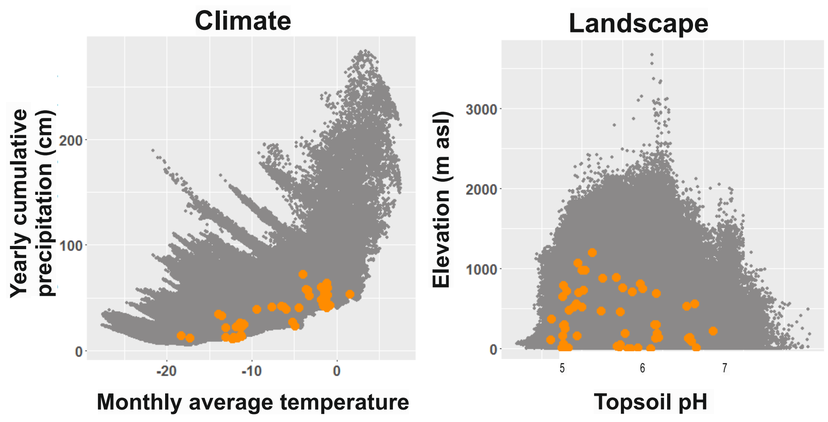

Figure 2. The environmental conditions of the CO_2 flux measurement sites (WordClim, Soilgrid, GTOPO DEM).

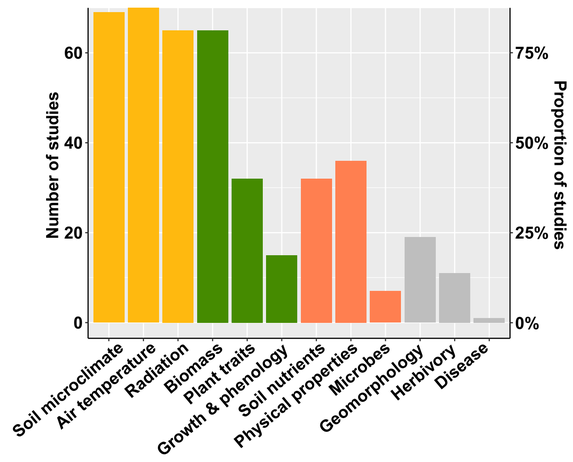

Figure 3. Number and proportion of studies in which different environmental predictors were used to understand local CO_2 fluxes.

2. SPATIAL PREDICTIONS OF CO_2 FLUXES IN THE TUNDRA

In this article, local scale variation of CO_2 fluxes is modelled against high resolution RS data sets. We aim to identify the spatial variation and hot spots for CO_2 fluxes.

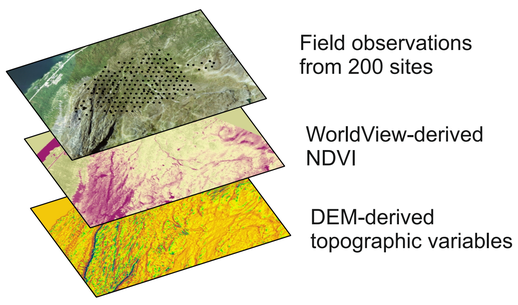

Figure 4. RS data sets for spatial modeling of GPP, ER, SR and NEE. Field data is collected with chambers from Kilpisjärvi, Finland.

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 CO_2 fluxes.

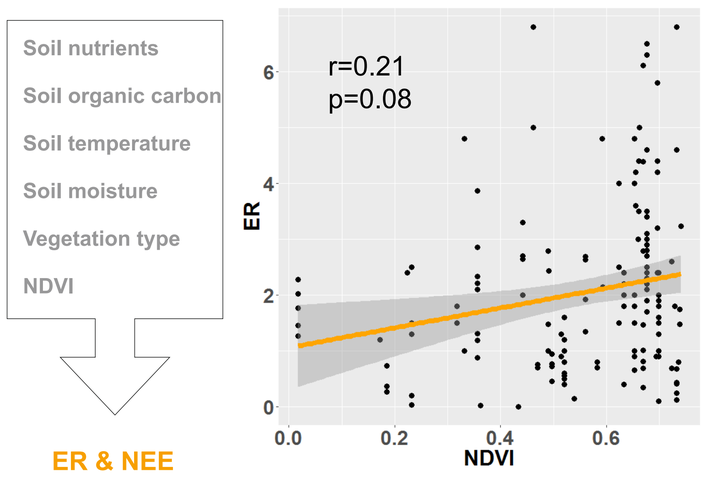

Figure 5. The relationship of NDVI (Terra/Modis) and ecosystem respiration measurements collected from CO_2 chamber studies. In the future Eddy covariance observations of growing-season NEE will be included, too.

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.

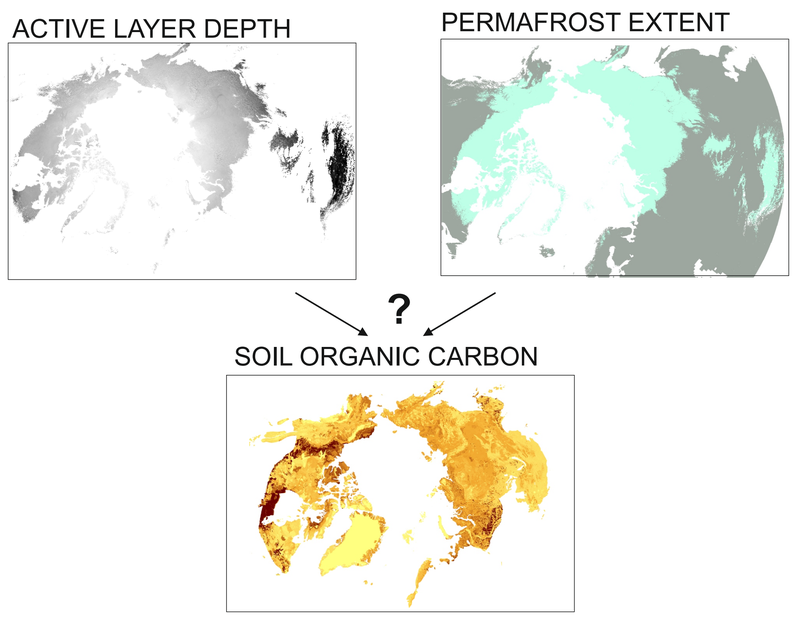

Figure 6. Circumpolar high-resolution data sets of soil properties will be used to predict the future losses of carbon from terrestrial ecosystems.

Scan the QR code for updates on our website, facebook and twitter accounts

Supervisors:
Miska Luoto (University of Helsinki),
Aleksi Lehtonen (Natural Resources Institute of Finland),
Janne Rinne (Lund University)

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI
MATEMAATTIS-LUONNONTIETEELLINEN TIEDEKUNTA
MATEMATISK-NATURVETENSKAPLIGA FAKULTETEN
FACULTY OF SCIENCE