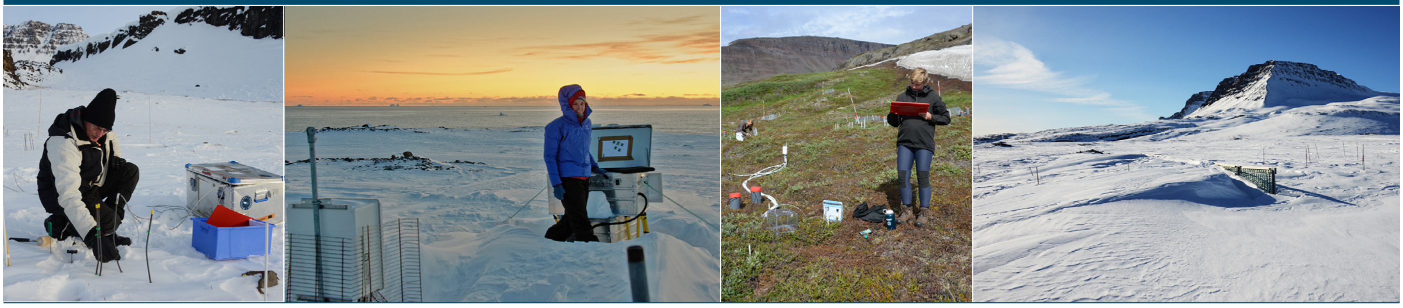
# CENPERM HIGHLIGHTS 2019



**In 2019 two publications from CENPERM highlighted the importance of year-round measurements of carbon (C) fluxes. One study is based on detailed field and model work from the CENPERM key site at Disko in West Greenland; the other study is a multi-site circumpolar international collaboration project comparing non-growing season C fluxes. Both studies address the importance of winter (or non-growing season) on the annual C budget and suggest that projections of long-term ecosystem C storage also rely on environmental controls on winter processes.**

1. Terrestrial carbon cycling in the High Arctic tundra depends on ecosystem responses to climatic changes and associated changes in environmental conditions. However, only a few studies have aimed to quantify long-term carbon budget in the High Arctic tundra, simply due to lack of sufficient measurements. Thus, it remains unclear to what extent Arctic tundra ecosystems currently act as $CO_2$ sources or sinks or if they are in balance. In *Agricultural and Forest Meteorology*, Wenxin *et al.* (2019) were the first group to use year-round eddy $CO_2$ flux measurements in West Greenland to calibrate and validate a process-oriented model (CoupModel). Based on year-round $CO_2$ fluxes and soil/plant characteristics, the CoupModel has succeeded in characterizing seasonal patterns of $CO_2$ fluxes, mimicking underlying ecosystem processes and quantifying an annual C budget. The seasonal patterns of photosynthesis and soil respiration were described using response functions of the forcing atmosphere and soil conditions. The results show that total photosynthesis corresponds to -202 ± 20 g C $m^{-2}$ $yr^{-1}$ with ecosystem respiration of 167 ± 28 g C $m^{-2}$ $yr^{-1}$, resulting in a net ecosystem exchange of -35 ± 15 g C $m^{-2}$ $yr^{-1}$. The carbon loss through respiration was mainly due to decomposition of near-surface organic matter newly derived from plants. A year with an anomalously deep snowpack and hence warmer soils in late winter due to the insulating capacity of snow shows a three-fold increase in the rate of ecosystem respiration in the non-growing season compared to other years. Due to the high $CO_2$ emissions during that winter, the annual budget results in a marked reduction in the $CO_2$ sink. Snow depth, soil moisture and growing season temperatures were identified as important environmental variables, which influence seasonal rates of gas exchange.

2. Recent warming in the entire Arctic region has been amplified during the winter. This greatly enhances microbial decomposition of soil organic matter and subsequent release of carbon dioxide ($CO_2$) during the non-growing seasons. But the amount of carbon released as $CO_2$ in winter has not been quantified across the entire Arctic region. In *Nature Climate Change*, Natali *et al.* (2019) used regional in-situ observations of $CO_2$ flux from Arctic and boreal soils to assess current and future winter carbon losses from the northern permafrost domain. A contemporary mean loss of 1,662 TgC per year has been estimated from the permafrost region during the winter season (October–April). This loss is greater than the average growing season carbon uptake for the region. Extending model predictions to warmer conditions up to 2100 indicates that winter $CO_2$ emissions will increase 17% under a moderate mitigation scenario (RCP 4.5) and 41% under a business-as-usual emissions scenario (RCP 8.5). Results provide a baseline for winter $CO_2$ emissions from northern terrestrial regions and indicate that enhanced soil $CO_2$ loss due to winter warming may offset growing season carbon uptake under future climatic conditions.

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