CENPERM HIGHLIGHTS 2018

CENPERM highlights of 2018 include examples of intensive fieldwork and laboratory incubations and how these two components can be integrated in process modelling. The three papers highlight the benefits of plot level based studies of volatile organic compound (VOC) production, multi-year measurements of root growth combined with ecosystem manipulations, and the application of such data in a biogeochemical process model in which ecosystem functioning is investigated.

1. Permafrost thaw allows biological activity in previously frozen ground, leading to a potential production and release of climate-relevant gases. This has been shown for carbon dioxide, methane and nitrous oxide. Now a new study published by Kramshøj et al. in *Nature Communications* (2018) shows that microorganisms in thawing permafrost play an important role in the production of a high amount and diversity of VOCs. VOCs are known to be released from plants to cope with stress and to communicate with other organisms, but less is known about their release from sediments. The new study demonstrates that substantial amounts of ethanol and methanol and more than 300 other organic compounds can be produced and released from Greenlandic permafrost samples upon thaw. Even more surprisingly, VOCs from thawing permafrost may not be released to the atmosphere, as the results also show that unfrozen soil layers above the permafrost zone can consume the VOCs as fast as VOCs are released from the thawing permafrost. Therefore, the actual release of VOCs from thawing permafrost to the atmosphere is closely linked to processes occurring on the way from the deeper permafrost layers through top soil to the atmosphere.

2. In wet tundra ecosystems, covering vast areas of the Arctic, the belowground plant biomass exceeds the aboveground, making root dynamics a crucial component of the nutrient cycling and the carbon budget. In *Frontiers in Plant Science*, D'Imperio et al. (2018) quantify the single and combined effects of increased winter snow deposition by snow fences and summer warming by open top chambers (OTCs) on root dynamics in a wetland on Disko Island (West Greenland). Over the 2014 growing season, minirhizotron observations show that root growth continues beyond the main growing season, and that plots exposed to experimental warming show a significant increase in both root number and root length. In addition, plots with increased snow accumulation show a significant reduction of root diameter. These results indicate a fast response by the ecosystem to changes in air temperature and precipitation. Hence, in the short-term, summer warming may lead to increased root depth and belowground C allocation, whereas increased winter snow precipitation may reduce root production or favor specific plant species by means of reduced growing season length or increased nutrient cycling.

3. Terrestrial carbon cycling in the high Arctic tundra depends on ecosystem responses to climatic warming and associated changes in environmental conditions. However, only a few studies aim to quantify long-term carbon budget in the high Arctic tundra, simply due to lack of sufficient measurements. In the *Journal of Geophysical Research: Biogeosciences*, Wenxin et al. (2018) are the first to use a long time series of CO_2 flux measurements in Northeast Greenland to calibrate and validate a process-oriented model (CoupModel). This allows a unique quantification of various components of the carbon budget for a typical and wide-spread heathland-type ecosystem in Greenland. Two main results can be highlighted: (1) more than 13% of the carbon turnover measured as respiration occurs during the non-growing season, (2) the ecosystem is overall a weak C sink without any significant changes to be noted based on the entire study period 2000-2014. It is worth noting that significant but contrasting changes in the overall carbon budget are noted for the two sub periods 2000–2008 and 2008–2014. This shows the value of using long-term time series and emphasizes the risk for biased extrapolation if models are based on shorter time series.

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