Project acronym: BEFLUX

Project title: BEfore the FLUXes – an independent microbial, geospatial and modeling based estimation of methane emissions

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Discipline: Earth Sciences & Environment: Global change & Climate observation

Station(s): Oulanka Research Station (Finland)

During our stay at Oulanka RS in October 2020 we set up and tested several initial process-based model runs. Preliminary outputs from SPA and TECO can be found in Figure 1 and 2, respectively. These model runs have been set using the very same model parameterization applied for Nuuk-Kobbefjord (López-Blanco et al., 2018 | JGR).

Figure 1.Preliminary modelled NEE, GPP and Reco for the 2019-2020 period in Puukkosuo fen.

Figure 2. Preliminary modelled CH4 (including diffusion, ebullition and plant mediated pathways) for the 2019-2020 period in Puukkosuo fen (right figure) and for the 2011-2015 period in Nuuk-Kobbefjord fen (left figure).

Overall, the model suggests that Puukkosuo fen is a year-round net C sink (dominated by photosynthesis over respiration):

Year	NEE (gC m-2 y-1)	GPP (gC m-2 y-1)	Reco (gC m-2 y-1)
2019	-49	-229	180
2020	-31	-216	185

We expect that Puukkosuo stores more carbon and nitrogen (see e.g. Palmer and Horn, 2015) than Kobbefjord, therefore our guess according to these preliminary results is that SPA underestimates both NEE of CO2, but also CH4. In other words, we hypothesize an intensified C sink strength (of NEE) and larger CH4 emissions in Puukkosuo fen. Therefore, an extension of in-situ measurements from the eddy covariance and manual chamber systems deployed in

2020 will help us tackle these uncertainties.

Additionally, multiple key parameters (P) and variables (V) are still missing for proper parameterization and validation of the numerical models:

1. (P) Carbon and Nitrogen stocks (in foliage, litter, stems, roots, SOM, moss) at the peak of the growing season to constraint initial conditions (leaf mass per area, foliar N, C:N ratios...) and ultimately the magnitude of the fluxes.
2. (V) Soil water chemistry data (DOC, DON, Anions, Cations, Conductivity).
3. (V) % of Greenness data from RGB cameras to constraint modelled LAI.
4. (V) Snow cover data to constraint wintertime soil temperatures under the snowpack and subsequently heterotrophic respiration.
5. (V) NEE and CH4 for C flux validation. Great opportunity here to use mode data fusion techniques (e.g. TECO) assimilating in-situ data.

Any implementation of the above described parameters and variables will help us improve our process-based estimates. We therefore now continue the project with an aim to establish measurements and monitoring of the above listed.

In a further visit by TRC and JS in May and June 2021 a manual flux measurement program was established and we plan to develop this into automatic measurements from the autumn of 2021.

The further TA support received for the Before the Fluxes project will see more developed and detailed modeling outputs as seen in the preliminary of above and it will be compared with the data stream in the process of being established.