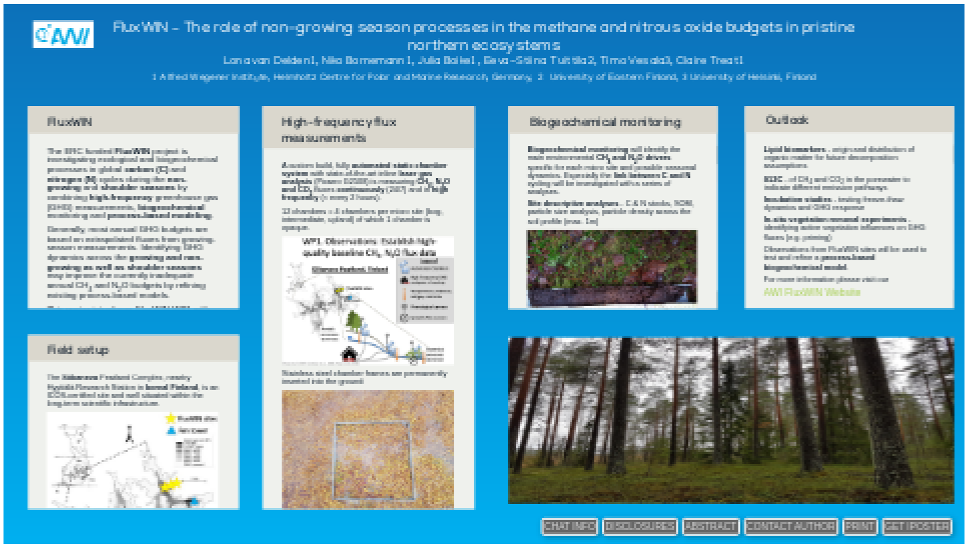
FluxWIN – The role of non-growing season processes in the methane and nitrous oxide budgets in pristine northern ecosystems



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PRESENTED AT:

AGU FALL MEETING
Online Everywhere | 1–17 December 2020

FLUXWIN

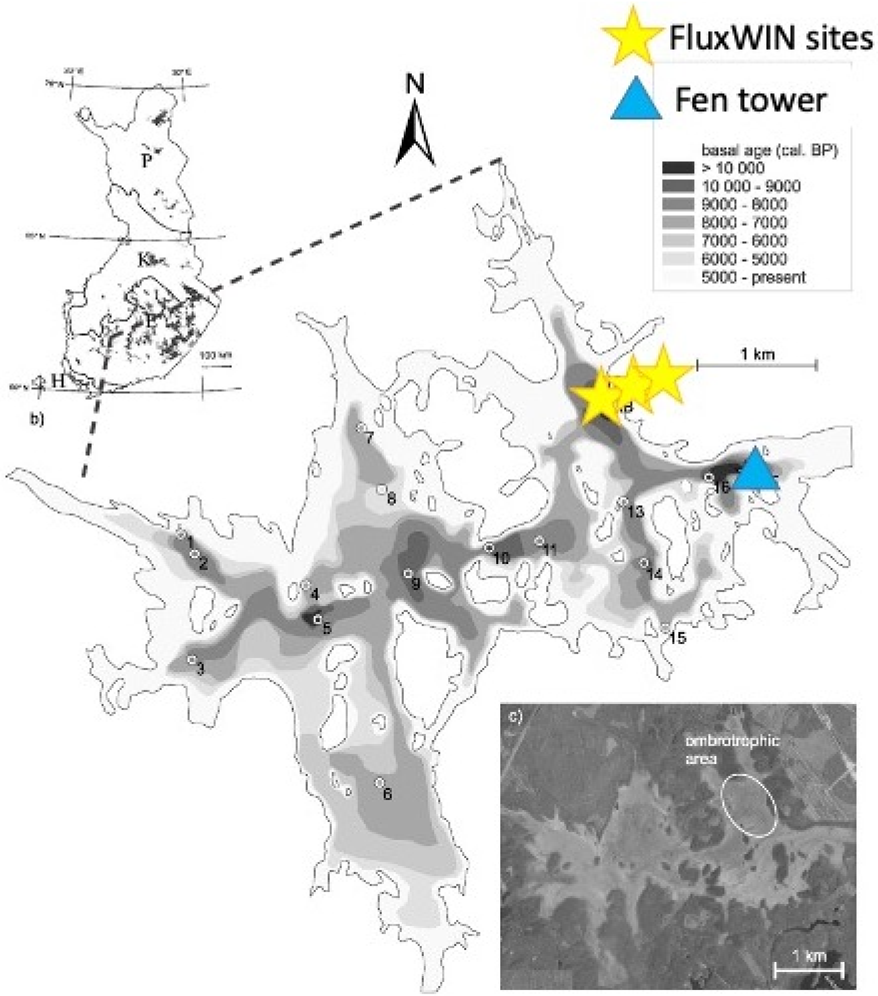
The ERC funded **FluxWIN** project is investigating ecological and biogeochemical processes in global **carbon (C)** and **nitrogen (N)** cycles during the **non-growing** and **shoulder seasons** by combining **high-frequency** greenhouse gas (GHG) measurements, **biogeochemical** monitoring and **process-based modeling**.

Generally, most annual GHG budgets are based on extrapolated fluxes from growing-season measurements. Identifying GHG dynamics across the **growing and non-growing as well as shoulder seasons** may improve the currently inadequate annual CH_4 and N_2O budgets by refining existing process-based models.

This poster introduces FluxWIN-WP1 with the focus to quantify **annual CH_4 and N_2O fluxes** by measuring year-round in high-frequency

FIELD SETUP

The **Siikaneva** Peatland Complex, nearby Hyytiälä Research Station in **boreal Finland**, is an ICOS-certified site and well situated within the long-term scientific infrastructure.

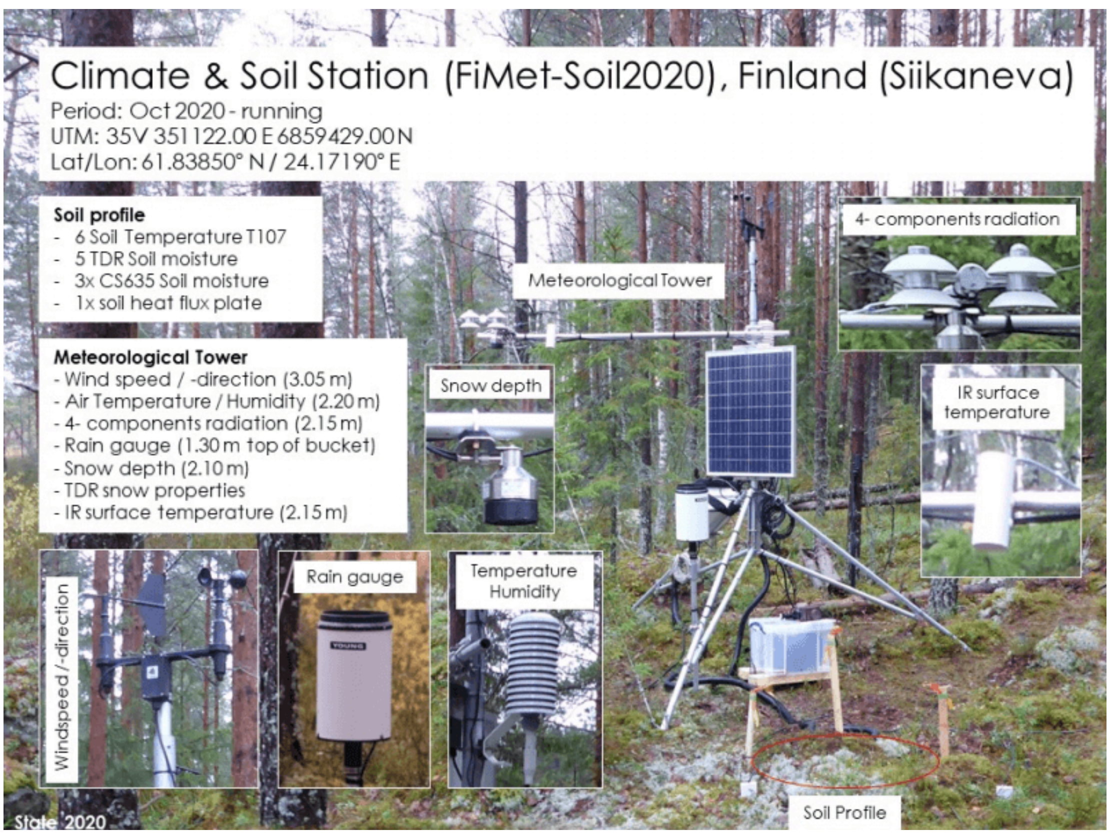


Mathijssen, P. J. H., et al. (2016).

Meteorological monitoring and ecosystem productivity estimates via eddy-covariance are accessible from the close by fen tower (blue triangle in the picture above).

The FluxWIN field site at Siikaneva covers a **moisture gradient** from wet bog over shrubby peat to drained upland forest (slide show pictures to the right).

Another meteorological station has been set up in the upland forest to monitor environmental conditions differing from the open wetland (picture below).

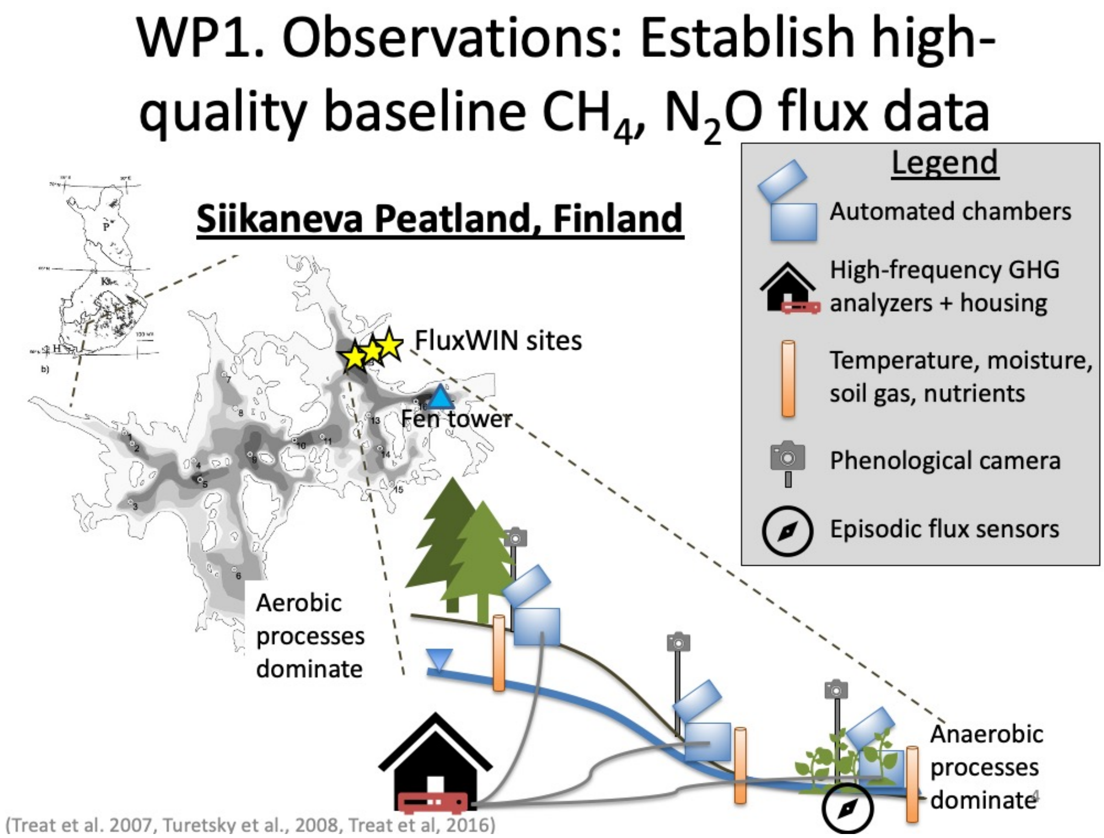


Climate & Soil Station (FiMet-Soil2020), Finland (Siikaneva)
Period: Oct 2020 - running
UTM: 35V 351122.00 E 6859429.00 N
Lat/Lon: 61.83850° N / 24.17190° E
Soil profile
- 6 Soil Temperature T107
- 5 TDR Soil moisture
- 3x CS635 Soil moisture
- 1x soil heat flux plate
Meteorological Tower
- Wind speed / -direction (3.05 m)
- Air Temperature / Humidity (2.20 m)
- 4- components radiation (2.15 m)
- Rain gauge (1.30 m top of bucket)
- Snow depth (2.10 m)
- TDR snow properties
- IR surface temperature (2.15 m)
Meteorological Tower
4- components radiation
Snow depth
IR surface temperature
Windspeed /-direction
Rain gauge
Temperature Humidity
Soil Profile
Stale 2020

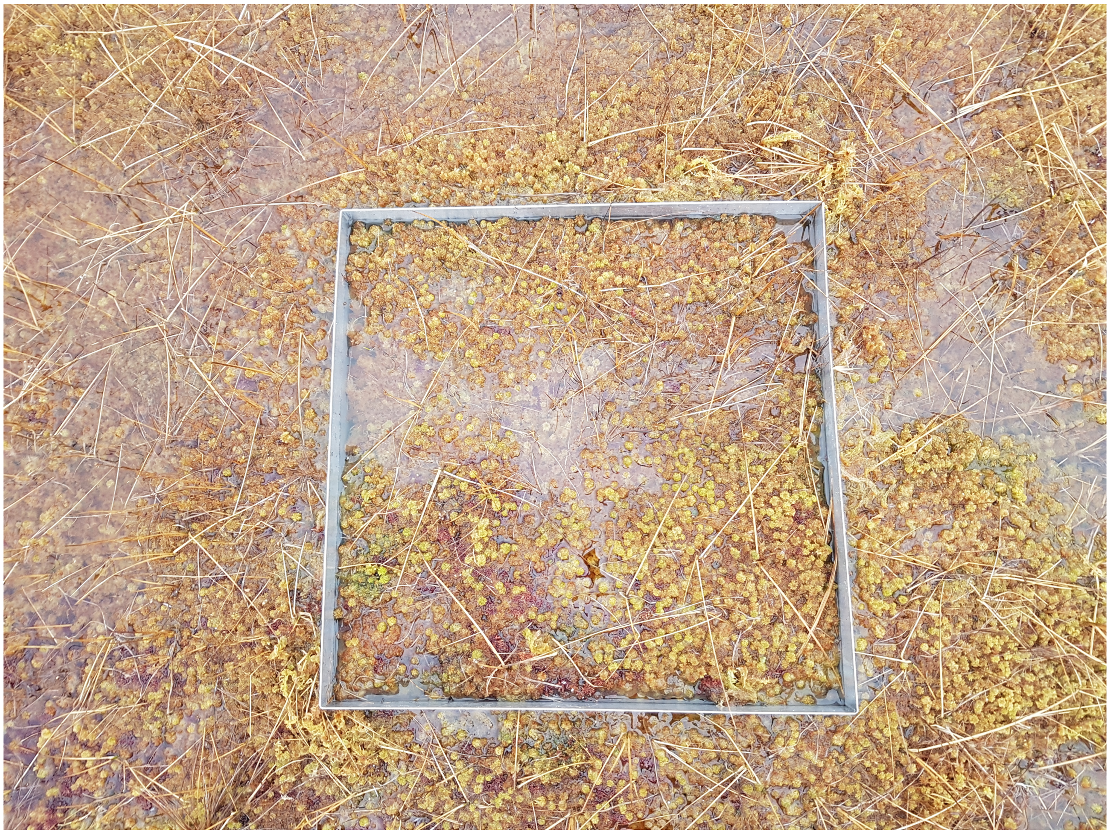
HIGH-FREQUENCY FLUX MEASUREMENTS

A custom build, fully **automated static chamber system** with state-of-the-art inline **laser gas analysis** (Picarro G2508) is measuring **CH_4, N_2O and CO_2** fluxes **continuously** (24/7) and in **high frequency** (≈ every 2 hours).

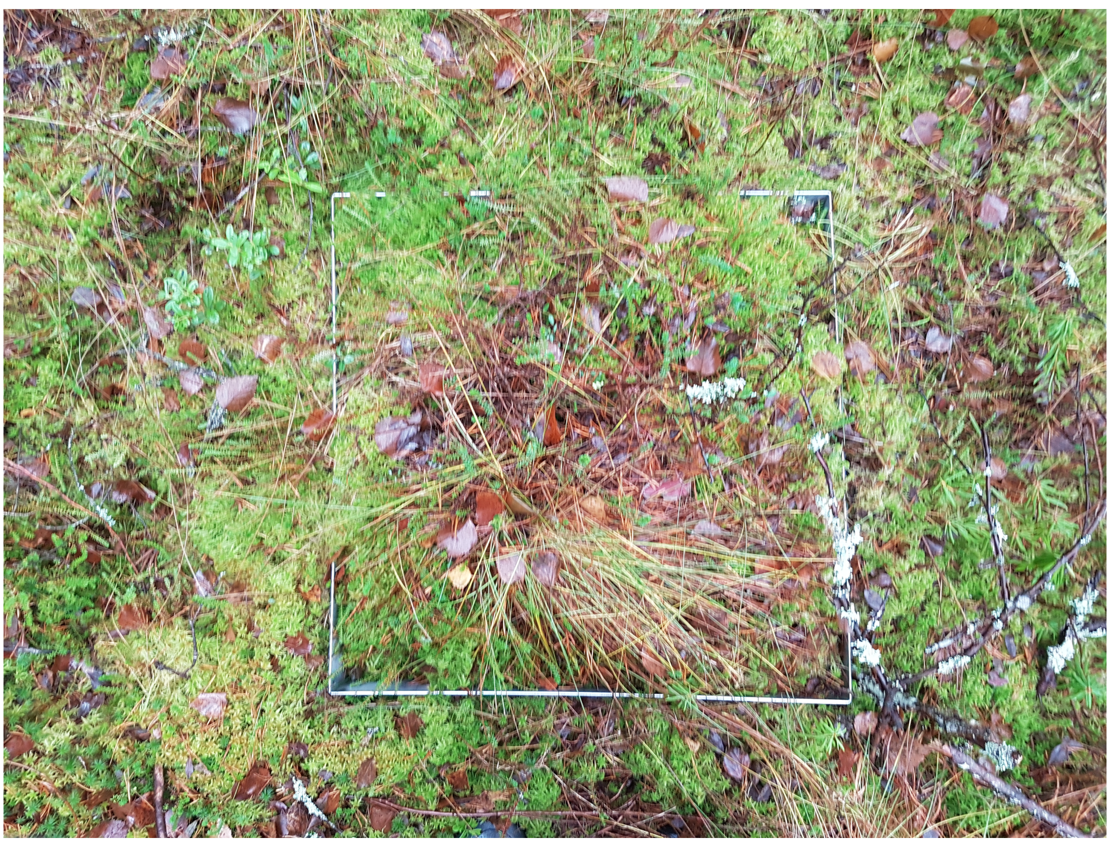
12 chambers = 4 chambers per micro site (bog, intermediate, upland) of which 1 chamber is opaque.



Stainless steel chamber frames are permanently inserted into the ground:



Wet bog



Intermediate shrubby peat

Dry upland forest with moss and lichens

The chamber is placed on top of the frame ensuring an airtight seal. Sample lines are connecting the headspace to the nearby hut containing the laser analyzer. Thanks to the Finnish 4G network, the data can be uploaded regularly remotely.

BIOGEOCHEMICAL MONITORING

Biogeochemical monitoring will identify the main environmental **CH_4 and N_2O drivers** specific for each micro site and possible seasonal dynamics. Especially the **link between C and N** cycling will be investigated with a series of analyses.

Site descriptive analyses - C & N stocks, SOM, particle size analysis, particle density across the soil profile (max. 1m)

Soil gas gradient - gas concentrations will be samples within the soil and/or snow profile to investigate GHG production/release vs. consumption processes

Pore water chemistry - dissolved concentrations of organic C & N (DOC, DON), nitrate, nitrite, ammonium, within the profile depth (max.1m)

Plant Root Simulators (PRS) - ion exchange resin membranes to measure ion supply in situ with minimal disturbance, comparing both spatial and temporal variations in nutrient availability rates for all soil ions (NO_3^-, NH_4^+, $H_2PO_4^-$, SO_4^{2-}, K^+, Ca^{2+}, Mg^{2+}) between micro sites and seasons

Groundwater dynamics - water table sensors

Snow depth - snow sensor and visual monitoring via Phenocams

Soil moisture - moisture sensors for each chamber and along the soil profile of the upland forest

Soil temperature - temperature sensors for each chamber and along the soil profile of the upland forest

OUTLOOK

Lipid biomarkers - origin and distribution of organic matter for future decomposition assumptions

δ13C - of CH_4 and CO_2 in the porewater to indicate different emission pathways

Incubation studies - testing freeze-thaw dynamics and GHG response

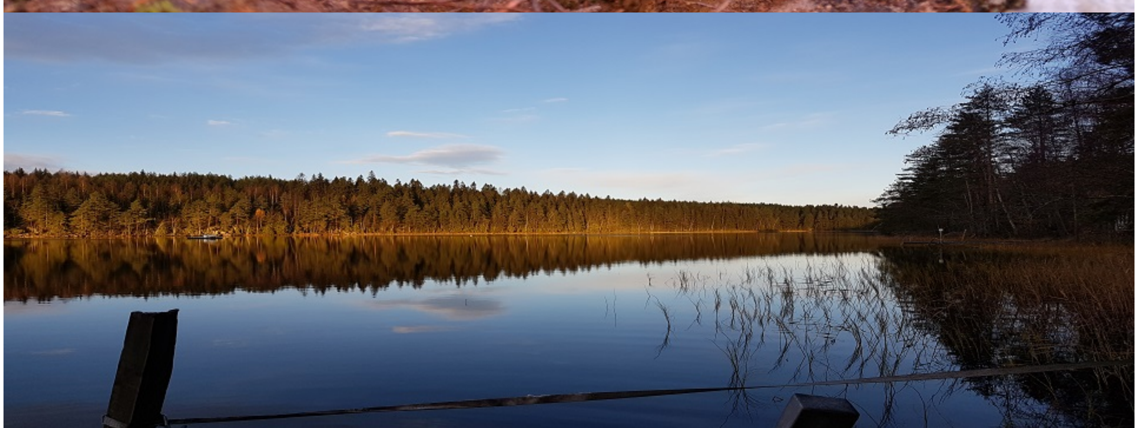
In-situ vegetation removal experiments - identifying active vegetation influences on GHG fluxes (e.g. priming)

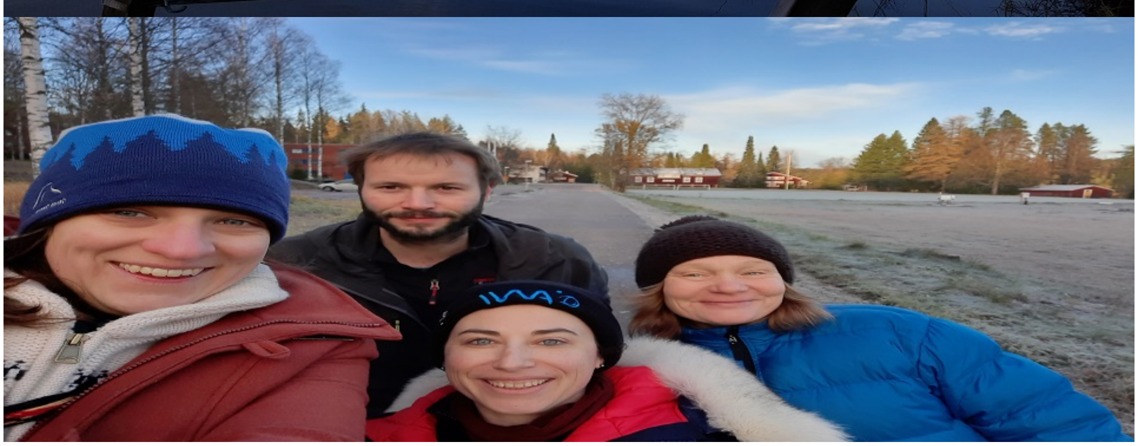
Observations from FluxWIN sites will be used to test and refine a **process-based biogeochemical model**.

For more information please visit our

AWI FluxWIN Website (https://www.awi.de/en/science/junior-groups/fluxwin.html)


10 CM
20 CM





DISCLOSURES

FluxWIN is funded by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programm (Grant agreement No. 851181).

ABSTRACT

The importance of non-growing season greenhouse gas fluxes to annual budgets in pristine northern terrestrial ecosystems is growing in awareness. Greenhouse gas (GHG) fluxes during the non-growing season and freeze-thaw dynamics are still underrepresented and may be a reason why current process-based models predict inadequate annual methane (CH_4) and nitrous oxide (N_2O) budgets. FluxWIN is therefore investigating ecological and biogeochemical processes in global carbon (C) and nitrogen (N) cycles during the non-growing and shoulder seasons by combining high-frequency greenhouse gas measurements, biogeochemical monitoring and process-based modeling. Siikaneva, nearby Hyytiälä Research Station in boreal Finland, is an ICOS-certified site and well situated within long-term scientific infrastructure to compare and combine high-frequency greenhouse gas measurement techniques and investigate freeze-thaw dynamics. An automated static chamber technique is used with inline laser gas analysis to obtain soil-atmosphere CH_4 and N_2O exchange in real time. Additional automated sampling of diffusion tubing will sample soil gas concentrations in the same analytical system. We control for climatic variability and isolate differences in non-growing season emissions by using a moisture gradient from well-drained upland soils to adjacent wetland ecosystems. The use of these automated high-frequency GHG measurements in combination with year-round biogeochemical monitoring maximizes the likelihood of capturing episodic emissions and their drivers, which are particularly important during fall freeze and spring thaw periods. The gained information on ecosystem function and biogeochemical cycles for temperate, boreal, and arctic regions will improve feedback estimates to climate change by including non-growing season processes in global-scale process-based models.