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Artificial Warming of Arctic Meadow under Pollution Stress: Experimental design

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Boreal and arctic terrestrial ecosystems are central to the climate change debate, notably because future warming is expected to be disproportionate as compared to world averages. Likewise, greenhouse gas (GHG) release from terrestrial ecosystems exposed to climate warming is expected to be the largest in the arctic. Artic agriculture, in the form of cultivated grasslands, is a unique and economically relevant feature of Northern Norway (e.g. Finnmark Province). In Eastern Finnmark, these agro-ecosystems are under the additional stressor of heavy metal and sulfur pollution generated by metal smelters of NW Russia. Warming and its interaction with heavy metal dynamics will influence meadow productivity, species composition and GHG emissions, as mediated by responses of soil microbial communities. Adaptation and mitigation measurements will be needed. Biochar application, which immobilizes heavy metal, is a promising adaptation method to promote positive growth response in arctic meadows exposed to a warming climate. In the MeadoWarm project we conduct an ecosystem warming experiment combined to biochar adaptation treatments in the heavy-metal polluted meadows of Eastern Finnmark. In summary, the general objective of this study is twofold: 1) to determine the response of arctic agricultural ecosystems under environmental stress to increased temperatures, both in terms of plant growth, soil organisms and GHG emissions, and 2) to determine if biochar application can serve as a positive adaptation (plant growth) and mitigation (GHG emission) strategy for these ecosystems under warming conditions.
Here, we present the experimental site and the designed open-field warming facility. The selected site is an arctic meadow located at the Svanhovd Research station less than 10km west from the Russian mining city of Nikel. A splitplot design with 5 replicates for each treatment is used to test the effect of biochar amendment and a 3oC warming on the Arctic meadow. Ten circular split plots (diameter: 3.65 m & surface area: 10.5 m2) composed of one half amended with biochar and one control half not amended were prepared. Five of these plots are equipped with a warming system, while the other five were equipped with dummies. Each warmed plot is collocated with a control plot within one block. While split plots are all oriented in the same direction the position of blocks is randomized to eliminate the effect of the spatial variability. Biochar was incorporated in the first 20 cm of the soil with a rototiller. Warming system is provided by hexagonal arrays of infrared heaters. The temperature of the plots is monitored with infrared cameras. The 3oC increase of temperature is obtained by dynamically monitoring the temperature difference between warmed and control plots within blocks via improved software. Each plot is further equipped with a soil temperature and moisture sensor.