EGU24-6280, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-6280
EGU General Assembly 2024

Full-cycle greenhouse gas balance of a *Sphagnum* paludiculture site on formerbog grassland in Germany

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The cultivation of peat mosses on rewetted peatlands (= *Sphagnum* paludiculture) is a promising alternative to drainage-based land use, as the production function is maintained while greenhouse gas (GHG) emissions are reduced. However, to date, GHG exchange studies that cover the entire production system and a complete production cycle are missing. Therefore, we combined data from the establishment phase (2011-2013) with data from the production phase (2017-2018) of a seven-year *Sphagnum* paludiculture in northwestern Germany including export by harvest. GHG exchange was recorded on all elements of the production system (*Sphagnum* production fields, ditches, causeways) with closed chamber measurements. Over the entire production cycle, *Sphagnum* production fields represented net GHG sinks of -3.2 ± 4.2 t ha^{-1} a^{-1} (in CO_2-eq), while ditches and causeways were GHG sources of 13.8 ± 11.5 and 29.3 ± 9.8 t ha^{-1} a^{-1}, respectively. Corrected for the percentage of area of each element of the production system and including partial harvest of peat moss (in dry matter) of ~13.8 ± 0.6 t ha^{-1}, *Sphagnum* paludiculture was a net GHG source of 10.7 ± 4.6 t ha^{-1} a^{-1}, reducing net GHG emissions by ~20 t ha^{-1} a^{-1} compared to grassland on drained organic soils. Per ton of dry biomass harvested, *Sphagnum* paludiculture emitted 9.9 ± 4.6 t CO_2-eq. Because of their high area share, causeways contributed the most to net warming, suggesting a reduction in causeway area in future *Sphagnum* paludiculture. Therefore, a realistic future "best practice" approach features area percentages of 80% *Sphagnum* production fields, 5% ditches, 15% causeways, and a full biomass harvest, with the top 5 cm of harvested peat moss lawn used on-site for reseeding *Sphagnum* production fields. This approach reduces CO_2 equivalent emissions from *Sphagnum* paludiculture to up to 4.3 ± 1.9 t ha^{-1} a^{-1} or 0.9 ± 2.1 t per ton of dry matter harvested.