

Interactive comment on “Permafrost Nitrous Oxide Emissions Observed on a Landscape Scale Using Airborne Eddy Covariance Method” by Jordan Wilkerson et al.

Anonymous Referee #1

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General comments

The results from studies conducted during last ten years suggest that not only fluxes of carbon dioxide and methane but also nitrous oxide fluxes have to be considered when evaluating the present and future atmospheric impact of permafrost regions. It is well known that nitrous oxide fluxes have generally high spatial variation. The studies by chamber methods have shown that the nitrous oxide emissions from permafrost regions have extremely high spatial variation. Therefore, all different functional surfaces should be included to the measurements done by chambers and high resolution tools are needed for mapping of various surfaces to upscale the nitrous oxide emissions

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from permafrost landscape. Eddy covariance (EC) method integrates gas fluxes for a larger area and offers an alternative tool to determine gas fluxes for landscape/region. However, to set tower based EC instrumentation in remote regions, like permafrost regions, is a demanding task. In the present study airborne eddy covariance method was used first time to measure nitrous oxide fluxes in permafrost region. The study is an important contribution to the ongoing efforts to evaluate the importance of nitrous oxide fluxes in the permafrost regions. The authors have considered in details the methodological aspects of the airborne EC method they applied. The mean nitrous oxide emission for the 310 km² area they report is high when compared to the emission rates obtained by chamber techniques from permafrost soils. Such high emission rates are measured from high-emitting patches in permafrost regions. The footprint analyses here also indicated areas with negligible emissions and areas with high nitrous oxide emissions.

As the authors noted there is a study (Abbott et al. 2015. *Global Change Biology* 21: 4570-4587) showing that permafrost collapse in the study region, North Slope of Alaska, increases nitrous oxide content in soil. To get such a high mean emission rate shown here by the EC, the emissions from the high-emitting areas have to be very high. Would be excellent if the authors could get some published or non-published data on nitrous oxide emissions in the region based on chamber measurements or determined by a gas gradient approach based on nitrous oxide content in soil. This data could then be upscaled by estimating the total coverage of the high emitting areas. If the nitrous emissions from these analyses are in the same range as the mean emission rate here, this could confirm the results obtained by EC.

Some detailed comments

Page 2/line 1 Change the text to “. . .However, recent in situ measurement of permafrost soils in Russian tundra and northern Finland (Repo et al. 2009; Marushchak et al. 2011)”

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Page 2/lines 10-16 The discussion on the flux data generated by chamber method could be modified to state that there are both disadvantages and benefits using chamber method for the gas fluxes. By the chambers e can catch efficiently the various functional surfaces, even very small. So, we can get knowhow on the soil and vegetation related factors affecting gas fluxes. To obtain landscape or regional fluxes by chambers for permafrost regions, accurate distribution of the functional surfaces is required. This can be done using e.g. satellite images (e.g. Treat et al. 2018. Global Change Biology, Doi: 10.1111/gcb14421).

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