

# ***Interactive comment on “Ecosystem feedbacks from subarctic wetlands: vegetative and atmospheric CO<sub>2</sub> controls on greenhouse gas emissions” by Matthew J. Bridgman et al.***

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We have added the response to the reviewers comments in order below:

1. In response to this point we have plotted the biomass data (currently in table 1) as barcharts which mirrors the format for the figures showing the CH<sub>4</sub> and CO<sub>2</sub> fluxes and well as the CH<sub>4</sub> treatment responses making the link between biomass and CH<sub>4</sub> flux more obvious. We will add SEDs to the figures to aid the readers to compare treatments as requested by the reviewer. We have also run additional statistics as suggested by the reviewer and we propose to include a set of scatter figures illustrating the positive relationship between the biomass parameters and the CH<sub>4</sub> fluxes. We can show a significant positive regression between total biomass as well as root biomass

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and CH<sub>4</sub> fluxes ( $R^2 > 0.5$ ). 2. This comment chimes with reviewer 1's comment about adding more detail about the different ways in which plants affect CH<sub>4</sub> emissions (discussion 1252-258). We will add further detail to include wider factors and mechanisms like conduit transport, although we dismiss this as a major influence on gas transport due to our field results. We can include more background on species specific factors affecting these relevant mechanisms 3. Add further detail to experimental method, we have given the additional detail requested by the reviewer below and will include this information in the revised ms. a) paired plots were 1-2 meters apart with sampling blocks spaced ca 100 m apart. b) chambers were floating both for vegetated and open water plots. All plots had standing water. c) measurements were taken between 10 am and 5 pm. Note that sampling coincided with the period of midnight sun at this latitude. Plots were blocked (one block consisted of six plots, plots with the three target species and adjoined paired open water areas, total of 30 plots) to account for changes in weather conditions and plant activities over time. All plots were sampled twice over a 5 day periods, with the first set taking two and a half days and the second sampling occasion also taking two and a half days. d) in a few instances measurements were rejected due to non-linearity e) the dimensions of chambers are detailed in the experimental design section f) the number of replicates are per treatment g) water level in pots were less than 2-3 cm above peat surface. We used tapwater water to adjust the water levels through-out the experiment. We used the same volume of the peat in the pots. Peat was taken as bulk samples, and separated into pots around the plant roots to good contact between the plant roots and surrounding peat. We acknowledge this process disturbed the peat structure. Indeed also the plants received a transplant shock as leaves and roots needed to be trimmed back before transport from the wetland site. However, the plant-soil pots for all species and CO<sub>2</sub> treatments were prepared in the same way to allow comparisons among treatment. Peat was taken one metre below water surface without plants. Due to the disturbance and other experimental artefacts (e.g. relating to plant densities as pointed out by reviewer 1) care needs to be taken when interpreting the data and our laboratory fluxes cannot be directly translated to the

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field conditions. We suggest outlining these limitations more explicitly in the discussion whilst improving the connection between the field and laboratory data. h) Thank you we will amend this. i) all measurements were taken under 'daytime' conditions j) this was a compromise to allow for all of the gas samples from the 62 pots in the two growth rooms to be collected over two days. We did not see any signs of ebullition events during sampling (i.e. no gas samples with very high CH<sub>4</sub> values) likely because most of built up bubbles were release from the low density peat both due to the slight disturbance of the peat during watering and because the sample pots were moved around in the growth rooms prior to fitting the head spaces. It is possible that there was some bubble release during sampling in the laboratory experiment resulting in an over estimation of the fluxes. Note that we allowed the mesocosms settle for ca 10 min before the head space was fitted on the plant-soil pots and after the head space was gently fitted on the pots they were left for another 10 min before the first samples were drawn. k) we will add this information to the revised manuscript. l) we will clarify that biomass was not equal at the start of the study. To account for the different sized plants at the start of the experiment we paired them according to size (within each species) and allocated the treatment (400 or 800 ppm) randomly between the plants in each pair to ensure difference in initial starting biomass was accounted for in the experimental design. We will specify more clearly the differences in plant densities in the field and laboratory measurements in the methods section. To aid comaparison between field and lab measurements the field flux measurements these were made over individual shoots for *E. angustifolium* and *C. acuta* (as their growth form allowed this) while the for the tussock forming *E. vaginatum* the field measurements were made over small hummock, aiming to replicate the size of the clumps of *E. vaginatum* used in the lab. 4. We will add in the extension growth biomass data to the paper to support the treatment effects: The impact of the treatments on extension growth is significant with consistently lower extensions growth in the 800 ppm treatment (it is worth noting that the extension growth data is more consistent than the above ground biomass with respect to treatment effects probably due to the issues linked to "starting " biomass,

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see reviewer 2's point 3l and our response above). This reflects the reduced CO<sub>2</sub> sink strength in this treatment. We will develop this link between growth responses and the CO<sub>2</sub> uptake in the result and discussion. 5. With regards to linking laboratory and field data there are some links which we propose to develop in response to the reviewers' comment: First the species which act as CO<sub>2</sub> sinks in the field also acts as CO<sub>2</sub> sinks in 400 ppm treatment the laboratory experiment while the species that is a CO<sub>2</sub> source in the field was also a weak CO<sub>2</sub> source in the 400 ppm treatment in the laboratory suggesting that the laboratory control condition to some extent reflect the field conditions. Second the fact that the plant treatments actually lower peat redox conditions is interesting in the context of the reviewer 1s' point about deep CH<sub>4</sub> oxidation (l252-258) we agree with the reviewer that plant root oxygen release with increase CH<sub>4</sub> oxidation in the rhizosphere. However, the fact that the planted treatments had lower redox than the unplanted peat at the end of the laboratory experiment suggest that stimulations of reducing processes due to the presence of plant roots (e.g. release of labile substrates for decomposition) may actually increase the potential of CH<sub>4</sub> production in the rhizosphere. We propose to bring these points into the discussion. 6. We agree with the reviewer that we can make better use of this data. The points we suggest to bring into the discussion are: The corresponding patterns with lower root biomass, TOC and TN concentrations and lower CH<sub>4</sub> emissions in the 800 ppm C. acuta treatment suggests a link between root biomass, root exudation and CH<sub>4</sub> fluxes. As different plant species (we will specifically refer to graminoids and our study species using information from existing studies) allocate C differently and also differ in the amount and composition of their root exudates. We propose to develop this line of inquiry in the discussion as a potential explanation to the species-specific responses with regards to the CH<sub>4</sub> fluxes to the elevated CO<sub>2</sub> treatment. Additionally the lower redox in the 800 ppm C. brunescens treatment may explain/contribute to the diminished CH<sub>4</sub> sink in the 800 ppm treatment for this species. We speculate that the lower redox in the 800 ppm treatment of this species may be due to stimulation of reducing processes in the rhizosphere due to the greater root biomass in this treatment. In future research it would be interesting

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to explore the role of biomass for producing reducing condition as this contrasts to our current understanding of roots impact on soil redox conditions under water logging. 7. We agree with the reviewer that the differences in the temporal pattern in the laboratory fluxes are interesting. Our interpretation of the data is at the greater initial CH<sub>4</sub> emissions from the *C. acuta* is linked to the more rapid growth of this species at the start of the laboratory experiment (highest extension growth rates and also high CO<sub>2</sub> release at the start suggesting high activity in the rhizosphere). In parallel we speculate that the greater CH<sub>4</sub> release at the end of experiment for *E. angustifolium* reflects the build-up of biomass over time. It is not quite clear us how the reviewer thinks this information should be used to discuss species specific effects on plant-mediated CH<sub>4</sub> transport as in our laboratory experiment we are not able to separate emissions through the plants from other emissions pathways and in the field measurements we did not detect any differences between open water and vegetated areas with regards to CH<sub>4</sub> emissions. We propose to outline the parallel between growth rates and CH<sub>4</sub> emissions in the discussion but refrain from speculating as to how the laboratory study may inform our understanding of species specific plant mediated CH<sub>4</sub> transport in the field as we feel that the data we have is not strong enough to under pin a robust discussion. 8. We will make this section more nuanced and refer to studies exploring different emission pathways and the different way plants may impact emissions of CH<sub>4</sub> to account for this comment by reviewer 2 and also reviewers 1s' point about deep methane oxidation. 9. There are two main questions raised by this research both of which the reivewers has touch upon: First what does our findings mean in the field context and over long time periods? Second is what plant traits is driving the different below ground biomass responses (below ground biomass was a strong predictor of CH<sub>4</sub> emissions) among the plant species? These two questions needs answering before plant mediated impacts on CH<sub>4</sub> emissions in a CO<sub>2</sub> rich world can be predicted. 10. We will ensure the paper is proof read before submission on the revised manuscript.

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