

Interactive comment on “Methane efflux from an American bison herd” by Paul C. Stoy et al.

Anonymous Referee #2

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Review for “Methane efflux from an American bison herd”

General comments

The manuscript “Methane efflux from an American bison herd” from Stoy et al. presents winter CH₄ fluxes from a bison grazing system combined with a flux footprint analysis to estimate average CH₄ fluxes per animal and day. It addresses the interesting scientific question on the magnitude of bison emissions. The data is presented in a clear structure and easy-to-follow writing style. The manuscript uses methods which have been shown with varying success elsewhere (e.g. Felber et al., 2015; Coates et al., 2017). While other authors used also automatic GPS tracking (e.g. Felber et al 2016 in AEE) the authors manually attributed the animals to a raster. Acknowledging the difficulty to assess a system of wild animals, the method used can be seen as useful first step to quantify bison emissions. A main methodological issue is that the flux uncer-

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tainty is underestimated. Knowing that the different footprint models give very different results on which your approach relies upon – to better depict the uncertainty, it would be useful to analyze sensitivity of the CH₄ flux per animal to different footprint models in order to include this uncertainty in the presented SE. The study lacks conclusiveness regarding the bison emission estimate: If the results were robust - What was the reason for the low CH₄ emissions from bisons compared to average cattle emissions?

Specific comments

L 21 “Emission estimates are subject to spatial uncertainty in bison location measurements and the flux footprint, but from our measurements there is no evidence that bison methane emissions exceed those from cattle. We caution however that our measurements were made during winter and that evening measurements of bison distributions were not possible using our approach.” The sentence does not make sense. “but” indicates a contrast, while no significant differences are exactly a result of high spatio-temporal variability/and considerable measurement uncertainty.

Please rather give the exact numbers \pm SE for both estimates, for so the readers get an idea of what it means that no differences were found.

L 25 Eddy covariance is a promising technique for measuring ruminant methane emissions in conventional and alternate grazing systems and can be used to compare them going forward. RC: The sentence is not really saying much that was not known before. Rather state a concluding sentence from what you found.

Introduction

RC: L43: Add one sentence about: What is known about methane emissions from energy-dense/high-quality versus low-energy/low-quality grass for cattle?

L46: “Methane is a highly potent greenhouse gas and has about 3.7 times the global warming potential of carbon dioxide on a per- mole basis (Lashof and Ahuja, 1990).”

RC: I guess you overlooked some major updates since the nineties – please cite the

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most recent IPCC report (2014). The number(s) there are considerable higher...

L49: Between 30 and 40 percent of anthropogenic methane emissions are due to enteric fermentation in livestock

L60 "The important role of bison to past methane fluxes suggests that current their role in the global methane budget must be understood as their populations increase." The sentence does not make sense, improve spelling/grammar.

L 63: 30 L per kg dry food intake – how does this compare to measurements from cattle? The number is not very meaningful without comparison as a reference

Methods

If you provide hay, how are the feeding values typical for what they would eat otherwise? I would guess the hay represents rather an average, not particularly species selected to be nutrient-rich.

The methodology for deriving bison location is not clearly described. The perspective of the cameras gives a highly skewed picture. From the description the bison attribution to a grid-cell is not comprehensible. Please describe precisely what you did.

How can you justify a shift by a grid-cell of 20 m in each direction is sufficient to represent spatial inaccuracies?

Please explain to the reader the two-dimensional Tikhonov Regularization (& Lagrange multiplier) in a methods paragraph.

The methods section on the flux calculations could be more specific, i.e. state the respective thresholds and parameters used.

The paper would benefit from some numbers indicating: How many datapoints are actually available with e.g. > 20 bisons placed in the area of 60% flux contribution footprint area.

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Results

It necessary to state that winter methane fluxes in the system without bisons are insignificant, as this is a basis for the whole calculation. Still, there are many words spent on this in the results and discussion, I think that this adds not much to the content of the paper.

Fig. 7: include the daily variability of fluxes

L211 negative not positive

In the highly skewed distribution (Fig 11), it is getting obvious that the SE does not represent well the uncertainties. Consider reporting quantiles of the distribution which then reflect the higher uncertainties towards higher CH₄ flux values.

It would be useful and interesting to repeat the measurements with the fodder source placed in the major footprint area.

From Fig 3 and Fig 6 it becomes clear how little overlap there is between bison presence in the footprint. How would the flux estimates look like if you just choose the occasions when the joint presence of many bisons overlaps with the core (i.e. 50% flux contribution) footprint area for a certain time? Such an analysis could enhance the understanding of how robust your estimate is.

Discussion

Give an approximate estimate of the bulk uncertainties inherent to the flux calculations in the discussion section.

It remains unclear if the low CH₄ fluxes for bison fluxes is a result of methodology (spatial distribution, flux footprint uncertainty, non-stationary conditions) and possibly (but probably of much less importance) also other confounding factors (fodder composition).

In the discussion, it is necessary to more specifically elaborate on why bison CH₄ emissions should be that low, what can be reasons/mechanisms behind it?

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The methodological issues seem to dominate the outcome of the paper and I lack of confidence in the estimated uncertainty.

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