Biogeosciences

Discussions

Interactive comment on "Uncertainties in the national inventory of methane emissions from rice cultivation: field measurements and modeling approaches" *by* Wen Zhang et al.

Anonymous Referee #1

Received and published: 9 September 2016

The manuscript provides a comprehensive analysis of the sources of uncertainty in the national inventory of methane (CH4) emissions from rice agriculture in China. Three approaches were used to estimate the inventory and the associated uncertainties (i.e. direct field measurements, two empirical regression models, and the process-based model, CH4MOD). Additionally, the sensitivity of the levels of uncertainty using each approach to various scenarios of data scarcity was assessed. The more complex, process-based model had the lowest total error compared to the two empirical models. All approaches had higher error when average values were used for input data compared to case-specific values, highlighting varying degrees of model instability to insufficiency of supporting data. Interestingly, even when no case-specific input data

were used in the processed-based model CH4MOD, it still had lower total error than the least complex empirical model when all case-specific input data were used (i.e. organic matter input modified by water regime). This in-depth comparison of approaches, their associated errors, and the sensitivity of the errors to input data availability is a significant contribution to the scientific community. It examines very relevant issues and challenges that modelers are faced with when scaling up field-validated models to larger spatial scales. The manuscript nicely quantifies and discusses the trade-offs associated with using the different approaches. It also outlines a method for assessing various sources of uncertainty and distinguishing model structural uncertainty from the uncertainty in input data.

The main criticisms I have of the paper are as follows:

-There is no mention of total estimated national CH4 emissions using each approach in the abstract. I actually I think the estimation of national CH4 emissions using the empirical models is missing from the whole paper. It seems like this is a major comparison to include in the paper and highlight in the abstract. Instead, the average CH4 emissions and 95% confidence intervals of the mean are reported. I think a comparison of the national CH4 emissions and their respective 95% confidence intervals for each approach and data-availability scenario is a very important application of this analysis and should be in the abstract. Similarly, I think it is important to highlight which case-specific data (e.g. organic matter inputs, water regime, or soil properties) mattered the most in terms of its effect on uncertainty when it was omitted.

-Overall the paper is lacking in citations of current research articles. Most articles cited are >10 years old.

-Missing description of model calibration of the two empirical models and CH4MOD. Thus, it's unclear whether data used for model validation (i.e. comparison to measurement-based estimations of fluxes) and uncertainty analyses are independent from data used to calibrate the internal model parameters.

-It's unclear whether the direct measurements used in the analyses are cumulative CH4 emissions or daily CH4 fluxes from the same experimental plots. If it's the latter, then the errors are not independent, and this issue should be explicitly addressed in the paper. The issue of non-independence of errors was discussed, but it was unclear whether this was due to measurements taken in close proximity versus repeatedly from the same location.

Additional comments, questions, and technical corrections:

P 1, Lines 26-29: Revise to account for the exception in which M-S3 performed better than R1-S0 (Table 2).

P 1, Line 33: Do you mean "between-grid variations", i.e. differences among grid cells?

P 2, Line 2: I think a slight rewording should be made, i.e. "Reducing the total uncertainty in the national methane inventory depends on a better understanding of both the complexity of the mechanisms of methane emission and the spatial correlations of the factors that influence methane emissions from rice paddies."

P3, Line 16: Reference needed.

P 6, Line 12: Provide detail on the parameters and assumptions for substrates produced from added organic matter and root exudates.

P 7, Line 9: Can you provide a reference or derivation of equation 4?

P 7, Line 10: Given that the focus of the manuscript is on uncertainty in national inventories, it seems that the methods section should be framed under national-level uncertainties as opposed to regional-level. It's my understanding that national inventories represent an aggregation of multiple regions. Thus, perhaps the section title here should state "national scales" as opposed to "regional scales", and translate this distinction into the text that follows.

P7, Lines 28-33: Please clarify each step of the process in which SAND data were ob-

tained. What method of interpolation was used (e.g. ordinary kriging, inverse distance weighted)? What is meant by "missing spatial variation" in your dataset – how was this determined and quantified? Were some grid cells missing survey data all together?

P 9, Line 1: Please provide a reference or derivation of equation 5.

P 9, Line 9-10: You refer to the "three components of the estimation uncertainties" in equation 5. I assume you are referring to (1) $(Fj \times Br)2$, (2) $(Fj \times CV)2$, (3) σ_DJ^2, which is analogous to the three terms in equation 6. Can you please provide a meaningful definition of what each of these components of uncertainty represent? Later in the discussion you explain that $(Fj \times Br)2 + (Fj \times CV)2$ represents model fallacy, while σ_DJ^2 represents uncertainty due to input data. I think including this type of description in the methods section would be helpful to read leading into the results section.

P 9, Lines 30-31: Explicitly state the water regimes.

P 10, Line 27: What "estimated CH4 flux" are you referring to? Are you referring to an example of a single flux? If so, I would start the sentence with: "For example, in one case the modeled CH4 flux was . . ., while the measured flux was . . ."

P 11, Lines 16-18: Specify which model the simulated fluxes are based on. Please clarify this in Fig. 6 and Table 3 as well.

P 12, Lines 13-14: Didn't the authors also apply the two regression models to the 10 x 10 km grids? A comparison to the other two approaches (direct measurements and process-based model) should be discussed here.

P 12, Lines 26-29. Nice explanation!

P 14, Lines 19-33. See comment above for P 7, Line 10. Reframe conclusions to include national estimates and uncertainties at the broadest level of discussion.