

## ***Interactive comment on “N<sub>2</sub>O changes from the Last Glacial Maximum to the preindustrial – Part I: Quantitative reconstruction of terrestrial and marine emissions using N<sub>2</sub>O stable isotopes in ice cores” by Hubertus Fischer et al.***

**Anonymous Referee #2**

Received and published: 10 June 2019

Fischer et al. in this manuscript present a compilation of N<sub>2</sub>O and its isotopic (both N and O isotopes) data for the last 12,000 years (28,000 years with less resolution data) from ice-core records from both Greenland and Antarctica by combining new high-resolution analysis with previously available measurements. They then use N<sub>2</sub>O concentration and N isotope data to provide a quantitative reconstruction of terrestrial and marine N<sub>2</sub>O emission history.

They find that N<sub>2</sub>O emissions from land and ocean increased during the last deglaciation, closely linked with climate warming and ocean circulation. Also, land emissions

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responded abruptly to Northern Hemisphere climate warming at the onsets of BOA and the Holocene, in particular to monsoon and ITCZ shifts.

The compilation and interpretation are comprehensive and provides fundamental data sets for understanding carbon-nitrogen cycle processes, especially in Earth system models. The manuscript is well organized, and the writing is clear, despite complex data sets and technical issues involved and required discussions.

I do not have major concerns about the manuscript. I think that the manuscript can be accepted for publication after considering the following specific comments, mostly minor.

Page 1 Line 21: Add “Almost”, or “Up to” or “More than” before “90% of these large step increases”. Do not start a sentence with a number.

L21: change from “within maximum two centuries” to “within two centuries at maximum”?

L25: change to “in reconstructed marine N<sub>2</sub>O emission of 0.4 TgN yr<sup>-1</sup>” L26: change “suggesting” to “suggests”

L27: change “however” to “but”?

L28: change “which” to “that”

Page 2 L5-6: the discussion on land and marine processes is a bit confusing. Or change “where nitrification” to “but nitrification”? The reference of Battaglia and Joo 2017 should be 2018a?

L7: change “in line with” to “similar to”, as the new estimate technically is outside the range in IPCC as cited, 9.5 vs. 9.0. In any case, “in line with” is unclear in wording.

Page 3 L18: change “Two hundred two” to “A total of 202 ice samples” (also delete “core”?)

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L22: change “13 samples” to “A subset of 13 samples”, as not to start a sentence with a number.

Page 7 L3: add “,” before “which does not. . .”

L26: change “Also” to “Also,” L26: delete one “in this interval”. Also, the meaning “this interval” is unclear so maybe just repeat “late Holocene” as this is the first sentence in a new paragraph.

Page 10 L27: delete “,” after “Note”

Page 11 L13: add “;” before “however,”

Page 12 L4: the equation: I don’t think you should add units in the equation. They are awkward and confusing. If for absolute clarity, you could use a, b and c for three coefficients in the equation and then define their values and units, such as “a = 4.3266 per mil” (also, indicate the unit used for MAT and MAP and  $\delta^{15}N$  for completeness).

Page 13 L27: change “between 26-18 ka BP” to “at 26-18 ka BP”, or “between 26 and 19 ka BP” (the former is concise and crisp, so preferable in situation like this).

Page 14 L1: change “deglacial” to “deglaciation”

Page 23 L30: change “, however,” to “; however,”

Page 36 L4: delete “,” after “Rasmussen et al, 2006)”

Page 37 L7: delete “,” after panel E”

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