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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Constraining N_2O emissions since 1940 using firn air isotope measurements in both hemispheres" *by* M. Prokopiou et al.

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Major comments: RC 1. Box model calculation: The model parameters that kept invarying are not stated clearly. A table that list all time independent parameteres (cross-tropopause exchange fluxes of isotopologues, natural fluxes and their associated isotopic signatures, N2O lifetime, etc) will be helpful. In addition, a comparison with AR5 fluxes is useful. RC 2. Also box model: the derived time dependent variables. A table that summarizes the derived fluxes and isotopic values (average over a certain period) will be helpful, along with comparisons with other independent work by, for example, Park et al. and AR5.

Author's response to major comments 1 and 2: We realise that a more detailed pre-

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Discussion paper

sentation of the parameters used is needed therefore we have substituted Table 3 where only natural and anthropogenic isotopic signature results were presented with a more detailed version including stratospheric loss fluxes and isotopic signatures, N2O lifetime, natural and anthropogenic fluxes as in the two-box model. The values were compared to Park et al. (2012) because they provide results not only for fluxes but also for isotopic signatures. We did not include a comparison with the AR5 for the reason that it provides us only with flux results not isotopic signature ones. Lines 989-995

RC 3. What's the reason(s) behind for the elevated N2O flux in year 2008?

AR: We suspect the referee refers to the very slightly increasing emission strength at the end of the reconstructed record. This apparent upwards trend is likely not significant for our construction and we have not discussed it in more detail. We shortly stated this in the revised manuscript. Lines 478-480

RC 4. What's the reason(s) for the oscillating values in source/anthropogenic delta values in Fig. 4? Moreover, if I understand correctly, natural N2Os are kept constant. I then expect to see the same time variability in anthropogenic as in source in Figure 4, but apparently the two are different. This highlights the usefulness of the major comment #1.

AR: The reason why the oscillations of the total and the anthropogenic source are not the same is that in our mass balance model the total source is regarded as the sum of a constant natural source and a changing anthropogenic source, which was small in the beginning of the record and larger at the end of the record. Therefore, changes in the total source signature in the beginning of the record require a substantially stronger isotope signal in the (small) anthropogenic source at that time compared to the (large) anthropogenic source at the end of the record. This was also stated in the manuscript. To make this more comprehensive we have added in Fig. 3 (bottom panel) the assumed constant, natural source, also. Lines 515-520, Lines 1019-1037

RC 5. In addition to isotopic values, it will be useful and more informative to have isoflux

for each process considered. A plot similar Fig. 4 but for the respective flux (better also break into each process considered is recommended).

AR: We have considered adding isofluxes to the manuscript, but since we only distinguish between a natural and an anthropogenic source this does not seem to add very useful information in our opinion. If – as the referee suggested – we were able to distinguish different processes it would indeed be useful, but since we cannot do that, we prefer not to add a discussion on isofluxes.

Minor comments: RC 1. section 2.5: define all the variables used and no need to define variables not used. For example Fsink defined but not used. Fexch used but not defined. Also is epsilon_L the same as epsilon_app? Please check carefully the variables in this section.

AR: The section has been updated, Fsink is replaced by L, epsilon_L is the same as epsilon_app and we have adopted only the first and Fexch is defined in Table 3. Lines 295-296, Line 314, Lines 317-318, Line 323, Line 324, Line 325, Line 328, Line 672, Line 675, Lines 989-996

RC 2. Line 445: additional decadal variability: raised also above in the major comment #4. What are the underlying mechanisms for the variability? Agricultural activity? Use of fertilizer?

AR: Yes these are the mechanisms we describe and we added some more clarification in the discussion section. Lines 621-637

RC 3. Line 492: d15Nav" is the same notation throughout, in the figure d15N is used.

AR: The notation d15N in the figure was replaced with d15Nav.

RC 4. Line 495: Fig.5, I believed you meant Fig. 4. Do the corrections for the remaining.

AR: Thank you for pointing this out, it has been corrected.

RC 5. Table 3: Is your delta_atm,pi the same as Park et al.? If not, why not compare? If the same then say it.

AR: The delta_atm,pi is the same as Park et al. and it is mention in the footnote denoted with an asterisk located below table 3. Lines 992-995

RC 6. Same table, the last column double asterisk: what is it for?

AR:Thanks for noting this, the double asterisks was removed.

RC 7. Line 604: d15N_sp: not defined. You mentioned in line 36, but the term not defined.

AR:d15N_sp is now defined in line 37.

RC 8. d15N_sp is useful: please also show the time series in Fig. 4

AR: The information has been added in the revised manuscript. Lines 1038-1045

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