

We wish to express our appreciation for your significant and useful comments. We believe the quality of the article has improved by addressing the comments and hope our revisions are acceptable to the reviewer. We have responded to individual comments raised by the reviewer in the attached document.

CC1: 'Comment on amt-2020-481', Nobuhiro Matsumoto, 26 Feb 2021

I'd like to have a request on addition of the following two papers.

Matsumoto, N., Watanabe T., Maruyama, M., Horimoto Y., T. Maeda, T., Kato, K. : Development of mass measurement equipment using an electronic mass-comparator for the gravimetric preparation of reference gas mixtures, *Metrologia*, 41, 178-188, <https://doi.org/10.1088/0026-1394/41/3/011>, 2004.

Matsumoto, N., Shimosaka, T., Watanabe, T., Kato, K. : Evaluation of error sources in a gravimetric technique for preparation of a reference gas mixture (carbon dioxide in synthetic air), *Anal. Bioanal. Chem.*, 391, 2061-2069, <https://doi.org/10.1007/s00216-008-2107-8>, 2008.

The preparation of gravimetric standard mixtures in this preprint used the revised equipment of home-made equipment described in the above references.

**Response:** we cited the two papers according to your comment

RC1: 'Comment on amt-2020-481', Anonymous Referee #1, 21 Mar 2021

**General comments:**

Language: in some places the English writing could be improved, I have listed some suggestions in the detailed comments below.

Abstract: the abstract would benefit for having a number to represent the differences in precision between the laboratories, next to the offsets. The span offsets given in % are not directly clear, and it would be helpful if they could be expressed differently. It is also not clear from the abstract how this span offsets leads to a value of 0.29 PgC/yr in the carbon budget, and in which direction the shift is. It would be good to elaborate on this. It would be helpful to specify what the term zero offsets represents, so that the abstract is easier to read without reading the manuscript first. It would be good to include a quantification of the comparison of the 2 records at HAT in the final sentence. The “temporal drift” in line 21 could also be further explained, e.g. with details on the time period.

**Response:** The description about the offsets was revised in overall to be able to understand what the value is (p1, L25-L28). We simply described how to estimate a value of 0.29 PgC/yr. But this value was update and revised to 0.30PgC/yr. The words of “zero offsets” was revised to “deviations in the measured  $\delta$  (O<sub>2</sub>/N<sub>2</sub>) values on laboratories’ scales” (p1, L28). A result of the comparison of the 2 records at HAT was added in the final sentence(p2, L1-L2). Time period was added to the “temporal drift”(p1, L23).

Page 3, lines 25-28: it is not fully clear to me how the correction for the expansion rates are applied and how these are measured.

**Response:** We cleared how the correction for the expansion rates are applied and how the rates are measured. (p4, L8-L12)

Page 4, line 10: it would be good to add information on the choice of the range, it seems quite a large range in comparison to observed values.

**Response:** We selected a large range in comparison to observed values in order to evaluate the difference of the respective span sensitivities accurately. We added the information on the choice of range. (p4, L24-L25)

Page 5, line 3: how are these values determined? (5000, 1000, 500 times).

**Response:** The values were calculated based on the abundances of <sup>17</sup>O<sup>17</sup>O and <sup>17</sup>O<sup>16</sup>O, <sup>18</sup>O<sup>18</sup>O and <sup>18</sup>O<sup>16</sup>O, and <sup>15</sup>N<sup>15</sup>N and <sup>15</sup>N<sup>14</sup>N. We added to the sentence about the calculation. (P5,

L21)

Page 5, line 28: what is sufficiently small?

**Response:** We revised the sentence to “sufficiently smaller than those of  $^{17}\text{O}^{16}\text{O}$ ,  $^{18}\text{O}^{16}\text{O}$ , and  $^{15}\text{N}^{15}\text{N}$ ”. (P6, L20-21)

Page 6, line 13: why are these values constant?

**Response:** We added why these values are constant. (P7, L6-L7)

Page 7, line 2: can the authors also provide the long-term stability for the other labs?

**Response:** Because the long-term stability of NIES and AIST already described, the stability of SIO and TU were added. (TU: P8, L5-L7, SIO: P8, L28-P9,1)

Page 7, line 27: it would be good to explain that the SIO scale is defined to be 0 per meg, because it is used internationally.

**Response:** We added the sentence of “of which scale is defined as  $\delta (\text{O}_2/\text{N}_2) = 0$ ”. (P8, L26)

Page 9, line 11: (and other places in the text): what does the “expanded uncertainty” represent?

**Response:** We explained the expanded uncertainty in text (P10, L14-L16).

Expanded uncertainty (U) was represented using standard uncertainty (u) and coverage factor (k) by the following equation,

$$U=ku$$

We used the coverage factor of 2(k=2) which means  $\approx$  a 95% level of confidence.

Page 9, line 14: this seems a large drift in a couple of years' time, so “slightly” might not be the appropriate word here. The explanations for the drift because of the oxidation inside the cylinders seems to be different for each cylinders, are the corrections made for each cylinder separately? Are these the regular cylinders, also used for maintaining the NMJI/AIST scale? Or is this only used for the round-robins?

**Response:** We removed “slightly” and explained that the corrections for each cylinder were performed separately (P10, L19, L28). We used cylinders having inner wall treated for storing O2 standard gases. NIES and EMRI/AIST also use same type of cylinders.

Page 9, line 32: Where do we see the long-term drift of each laboratory's scale?

**Response:** The sentence about the long-term stabilities of each laboratory's scale were added

in section 2.3 (EMRI/AIST:p6, L8-L9, NIES:p7,L26-L27, TU: p8,L5-L7, SIO: p8, L28-p9, L1).

Page 10, line 10: what do these percentages represent?

**Response:** These percentages represent relative deviation from span sensitivity of the NMIJ/AIST scale. We revised the sentence. (P11, L19-20)

Page 10, line 12: could you elaborate on the filling years?

**Response:** We revised this sentence in overall. (P11, L23-L24)

Page 10, line 16: how are the results consistent with the GOLLUM program? Can this be quantified?

**Response:** Our results were consistent with those of the GOLLIM program within uncertainty. We add the words of “within their uncertainty”. (P11, L28-L29)

Page 10, line 17: could you quantify “slightly bigger”?

**Response:** This sentence was removed. (P11, L29)

Page 10, line 22: can you quantify how this study shows that the labs can be compared?

**Response:** We revised “shows” to “aims”. (P12, L5)

Page 10, line 25: how was it confirmed that the isotope ratios did not differ significantly?

**Response:** We add some sentences to get good understanding of this part. (P12, L8-L12)

Page 10, line 29: why not both against the SIO scale?

**Response:** We understand the SIO scale is internationally used. But purpose of this manuscript is the comparison between individual laboratories' scale values and gravimetric values directly. Therefore, we discussed NIES and EMRI/AIST scales based on NMIJ/AIST scale.

Page 11, line 2: how is the value of -6.6 per meg derived, and should it be compared to the goal of intercompatibility of 5 per meg?

**Response:** We revised the sentence according your comments. (P12, L22-L25)

Page 11, lines 16-20: the GCB paper has been updated in the meantime twice, and it would

be best to use the numbers from Friedlingstein et al. 2020. Line 18 does not seem to be a full sentence and it is not clear to me what the 0.29 PgC/yr correction is (e.g. from land to ocean, or the other way around?). Table 5: it would be good to add the numbers from Friedlingstein et al. 2020 in the table for reference.

**Response:** We updated our data using the numbers from Friedlingstein et al. 2020 and the sentence about the 0.29 PgC/yr correction was revised. (P13, L7-L8)

Page 11, line 30: “first time in the world”: what is the first time in the world? The GOLLUM program is also an intercomparison program between laboratories.

**Response:** Because the span sensitivities of the respective laboratories are not compared in the GOLLUM program, quantifying respective span sensitivities is performed the first time in the world in this study.

Page 11, line 31: rewrite the 0.29 PgC/yr, to be more specific what the number means. See comment above.

**Response:** We revised the sentence in overall. (P13, L24-L25)

Page 12, line 3: what does “other four” mean in comparison to the GOLLUM program?

**Response:** We used five round-robin cylinders and “other four” mean four cylinders in the five cylinders. (P13, L27-L28)

Page 12, lines 4-6: it would be good to be more specific here on the implications, rather than repeating the causes for the decrease.

**Response:** We described the implications in the sentence according to your comment. (P13, L29-p14,L1)

Page 12, line 11: can you quantify the bias?

**Response:** We add the value of the bias. (P14, L6)

Page 12, lines 11-12: how do the results improve the carbon budget and OHC increase?

**Response:** We added the sentence about improvement of the carbon budget and OHC increase. (P14, L7-L8)

Conclusions: it would be useful to include an outlook. Will this intercomparison continue in the future? Will other laboratories be invited to participate?

**Response:** We added an outlook in end of the conclusions. (P14, L8-L11)

Table 1: can the authors add more information about the expansion rates? What is meant with the standard uncertainty?

**Response:** We add more information about the expansion rate. We explained that the standard uncertainty was calculated according to the law of propagation of uncertainties.

Figure 2: what is on the x axis?

**Response:** We revised the x axis which represent gravimetric values.

Table 3: how is the standard uncertainty determined?

**Response:** We added how the standard uncertainty is determined.

Figure 3: should the y-axis in panel a read NMJI/AIST instead of grav? Maybe also include the average residuals to compare lab precisions?

**Response:** This figure represents the relation of the gravimetric values and the measured values. We revised the caption.

Figure 4: maybe add a panel with the differences/bias? Why not on the Scripps scale? It would be good to include in the caption that these are duplicate samples, not measurements of the same flasks.

**Response:** The difference values were added in figure 4. We described that these are duplicate samples. We explained why not on the Scripps scale in previous part.

Table 5: change to Friedlingstein et al. 2020 (see comment above), and add numbers for comparison. Which numbers are Tohjima et al. 2019? Rewrite “changing rate”.

**Response:** We changed values of fossil fuel and atmospheric CO<sub>2</sub> to Friedlingstein et al. 2020 and revised the footnotes.

Detailed comments:

Page 2

Line 2: “molar fraction” could be changed to “mole fraction”, which is more commonly used in the field, throughout the text.

**Response:** We understand that “mole fraction” is more commonly used in the field. But we should use “molar fraction” because derived quantities should be defined by quantities and not by units (mole is a unit). Angles can be defined as ‘length ratios’ and not as ‘meter ratios’. A mass fraction is not called gram fraction either.

Line 3: explain “some” stoichiometric ratios.

**Response:** We revised from “some” to “distinct”. (P2, L7)

Lines 2-5: references to earlier studies would be appropriate here.

**Response:** We added references of earlier studies. (P2, L6-L8)

Line 6: “changes” should be “measurements”.

**Response:** ”change in” was revised to “measurements of ”. (P2, L10)

Line 11: rewrite “the ocean uptakes”

**Response:** We revised to “the ocean uptakes takes in more than 90% of the Earth's excess energy evaluated based on ocean temperature measurements using Argo floats” (P2, L15-17)

Line 14: “precision” -> “precise” and rewrite micro-mole-per-mole

**Response:** “precision” -> “precise” (P2, L18)

Line 27: “per meg” instead of “per meg units”

**Response:** we revised from “per meg” to “per meg units” (P3, L2)

Page 3

Line 6: “remain”?

**Response:** We revised the sentence. (P3, L16)

Line 22: explain “round-robin”

**Response:** We add the explanation of round-robin in introduction. (P3, L25-26)

Page 4

Line 6: “hereafter the” -> “hereafter called the”

**Response:** we revised from “hereafter the” to “hereafter called the” (P4, L20-L21)

Line 24: why are the Ar values much more variable compared to tropospheric air?

**Response:** We revised the sentence because the “variable” is wrong. (P5, L10)

Page 7

Line 10: what is meant with “unequal to”?

**Response:** We revised it to “not equivalent to”. (P8, L9)

Page 8

Lines 5-8: the sensitivity factor and interference factors could be further explained to be clearer.

**Response:** We explained the sensitivity factor and interference. (P9, L11-12)

Page 9

Line 1: what are “changing rates”?

**Response:** The changing rates represent change speed of  $\delta$  ( $O_2/N_2$ ). We revised the sentence a little. (P10, L7-8)

Lines 29-30: what is meant here by selecting mixtures from the round-robins?

**Response:** We removed the sentence. (P11, L5)

Page 10:

Line 5: rewrite “Figure 3a plots”

**Response:** We revised to “Figure 3a represents”. (P11, L14)

Page 11

Line 10: “corrected” -> “improved”?

**Response:** We revised from “corrected” to “improved”. (P12, L29)

Line 13: rewrite “secular changing rate”

**Response:** We revised to the average changing rate of atmospheric  $O_2/N_2$  ratio and  $CO_2$  molar fraction reported on the NIES scale. (P13, L3)



RC2: ['Comment on amt-2020-481'](#), Britton Stephens, 24 May 2021

## Page: 1

Number: 1 Subject: Highlight, intercomparison is a word on its own (no hyphen needed)

**Response:** We removed hyphen from "inter-comparison" through the text.

Number: 2 Subject: Highlight, "on a Round-Robin Exercise" might be more informative / grammatically correct

**Response:** We revised the sentence according to your comment. (P1, L2)

Number: 3 Subject: Cross-Out, a

**Response:** We revised the sentence according to your comment. (P1,L26)

Number: 4 Subject: Inserted Text, global

**Response:** We revised the sentence according to your comment. (P1,L27)

Number: 5 Subject: Cross-Out, based on trends in atmospheric CO<sub>2</sub> and  $\delta(O_2/N_2)$

**Response:** We added "based on trends in atmospheric CO<sub>2</sub> and  $\delta(O_2/N_2)$ " (P1, L27)

## Page: 2

Number: 1 Subject: Inserted Text distinct

**Response:** We revised the sentence according to your comment. (P2, L7)

Number: 2 Subject: Inserted Text, measurements of

**Response:** We revised the sentence according to your comment. (P2, L10)

Number: 3 Subject: Inserted Text, E

**Response:** We revised the sentence according to your comment. (P2, L15)

Number: 4 Subject: Inserted Text, as

**Response:** We revised the word from "and is" to "as" (P2, L15)

Number: 5 Subject: Inserted Text, s

**Response:** We revised the sentence according to your comment. (P2, L16)

Number: 6 Subject: Inserted Text, e

**Response:** We revised the sentence according to your comment. (P2, L18)

Number: 7 Subject: Inserted Text, a

**Response:** We revised the sentence according to your comment. (P2, L24)

Number: 8 Subject: Highlight, cite Aoki et al., AMT 2019 instead / also

Author: stephens Subject: Sticky Note Date:

given global trends, it would also be helpful to give a year (1967-70?) corresponding to this mole fraction estimate

**Response:** We cited "Aoki et al., AMT 2019" and added a year corresponding to the molar fractions. (P3, L2-3)

Number: 9 Subject: Highlight, previous sentence says this is calibrated, so "calibrated" or "measured" would be better there than "assumed"

**Response:** We revised the sentence according to your comment. (P3, L8)

Number: 10 Subject: Inserted Text, of

**Response:** We revised the sentence according to your comment. (P3, L8)

Number: 11 Subject: Cross-Out, a span stability

**Response:** We revised the sentence according to your comment. (P3, L9)

## Page: 3

Number: 1 Subject: Inserted Text, stability

**Response:** We revised the sentence according to your comment. (P3, L10)

Number: 2 Subject: Inserted Text, in absolute terms

Author: Subject: Sticky Note, a bit tricky to talk about absolute uncertainty in per meg (a relative unit) - perhaps give in mole fraction instead?

**Response:** The sentence was revised as expressed as the mole fraction to understand it in absolute terms. But we also add corresponding value in per meg unit. (P3, L14)

Number: 3 Subject: Inserted Text

**Response:** We didn't know where to revise. (P3, L15)

Number: 4 Subject: Cross-Out:

**Response:** We revised the sentence according to your comment. (P3, L22)

Number: 5 Subject: Highlight

Here, it would be good to point out (as you do below) that by comparing to gravimetric mixtures prepared over time, the trend uncertainty can be addressed. Just checking against them once can fix span biases, but not necessarily zero drift over time.

**Response:** How to evaluate span bias and zero drift is different. We described separately advantages with respect to span bias and zero drift obtained by comparing the scales with gravimetric mixtures. (P3, L20-22)

Number: 6 Subject: Inserted Text, the

**Response:** We revised the sentence according to your comment. (P3, L23)

Number: 7 Subject: Highlight, give materials?

**Response:** We revised the sentence according to your comment. (P4, L6)

Number: 8 Subject: Inserted Text, . They

**Response:** We revised the sentence according to your comment. (P4 L6)

Number: 9 Subject: Inserted Text

**Response:** We revised it in the overall because the sentence was difficult to understand. (P4 L9)

## Page: 4

Number: 1 Subject: Highlight, Why not use a more modern O<sub>2</sub> mole fraction estimate? If it does not matter, consider saying so. Since you have gravimetric determinations, I'm guessing the assignment of zero on the scale is arbitrary, so it might help to say "we arbitrarily assign zero on the NMIJ/AIST scale to correspond to a ratio of 0.26825" and also maybe that this corresponds to the late 1960s.

**Response:** We adopted a more modern O<sub>2</sub> mole fraction estimate according to your comment. (P4, L22-23)

Number: 2 Subject: Cross-Out Date:

**Response:** We revised the sentence according to your comment. (P4 L27)

Number: 3 Subject: Cross-Out Date:

**Response:** We revised the sentence according to your comment. (P4 L28)

Number: 4 Subject: Inserted Text, as

**Response:** We revised the sentence according to your comment. (P5 L1)

Number: 5 Subject: Highlight, this is unclear - does it refer to the standard, the true value of the standard, or the reported values by the labs? Is the "round-robin" subscript necessary or could it be removed throughout?

**Response:** The  $\delta(\text{O}_2/\text{N}_2)$  round-robin represent the measured values by the labs. We adopted the subscript to distinguish the round-robin values and other values clearly. This sentence was revised according your comment. (P5 L2)

Number: 6 Subject: Inserted Text, m

**Response:** We didn't know where to revise. (P5 L4)

Number: 7 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P5 L9)

Number: 8 Subject: Highlight, considering giving values on established reference scales

**Response:** We added the sentence according to your comment. (P5 L11-14)

## Page: 5

Number: 1 Subject: Highlight, might be helpful to start by saying why these corrections are needed - dilution, peak overlap, etc.

**Response:** we explained the reason that these corrections are needed. (P5 L22-24)

Number: 2 Subject: Inserted Text, for (first sentence says these are O<sub>2</sub>/N<sub>2</sub> corrections, not Ar corrections)

**Response:** Because we corrected O<sub>2</sub>/N<sub>2</sub> using the deviation in Ar molar fraction from atmospheric value, the sentence was revised. (P5 L29)

Number: 3 Subject: Inserted Text, for (first sentence says thesea are O<sub>2</sub>/N<sub>2</sub> corrections, not Ar corrections)

**Response:** because we corrected O<sub>2</sub>/N<sub>2</sub> using the deviation in Ar molar fraction from atmospheric value, the sentence was revised. (P6 L1)

Number: 4 Subject: Highlight, say 'corrected' here instead? (first sentence already says 'calculated based on' 16/14)

**Response:** We revised the sentence according to your comment. (P6 L15)

## Page: 6

Number: 1 Subject: Inserted Text, nearly (?)

**Response:** We revised the sentence in overall. (P7 L6-7)

Number: 2 Subject: Highlight, consider rewording for clarity - if you already have gravimetric Ar and N<sub>2</sub>, why do you need (O<sub>2</sub>+Ar)/N<sub>2</sub> and CO<sub>2</sub> to get (Ar/N<sub>2</sub>)? Also, change "in this study" to "For NIES" or equivalent.

**Response:** We changed the values to gravimetric Ar and N<sub>2</sub>. NIES's  $\delta(O_2/N_2)$  values was recalculated using the gravimetric values. (P7,L24-25)

## Page: 7

Number: 1 Subject: Inserted Text, cylinders

**Response:** We revised the sentence according to your comment. (P7 L26)

Number: 2 Subject: Inserted Text, with respect to these cylinders (primaries could still drift right?)

**Response:** We revised the sentence according to your comment. (P7 L27)

Number: 3 Subject: Highlight, might be of interest to say why 15N14N is used instead of 14N14N

Subject: Sticky Note Date: 5/24/2021 11:21:18 AM

more specifically, 2 sentences later says mass spec measures 28 - why is it not used?

**Response:** We used mass 29 because the spread of both ion beams for mass 28 and 32 was too wide to measure simultaneously. This sentence was revised according your comment. (P8, L7-9)

Number: 4 Subject: Highlight, this is of course true because they are on different scales - did you instead mean d(O<sub>2</sub>/N<sub>2</sub>)round-robin here?

**Response:** The word "unequal" was wrong. We revised it to "not equivalent"(P8, L9).

Number: 5 Subject: Highlight, Table 2 mentions mass-spec measurements of 40Ar and 14N14N - discuss here?

**Response:** Mass-spec measurements of 40Ar and 14N14N were removed from Table 2 because SIO used gravimetric values instead of mass-spec measurements of 40Ar and 14N14N.

## Page: 8

Number: 1 Subject: Cross-Out, SIO applies

**Response:** We revised the sentence according to your comment. (P9, L12)

Number: 2 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P9, L15)

Number: 3 Subject: Highlight, consider moving up immediately after So<sub>2</sub>, Xo<sub>2</sub>, and Ico<sub>2</sub> are defined.

**Response:** We moved up it immediately after So<sub>2</sub>, Xo<sub>2</sub>, and Ico<sub>2</sub> are defined. (P9, L11-12)

Number: 4 Subject: Cross-Out,

**Response:** We revised the sentence according to your comment. (P10, L2)

## Page: 9

Number: 1 Subject: Cross-Out, (unclear what is averaged)

**Response:** We revised the sentence in overall. (P10, L7-8)

Number: 2 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P10, L16)

Number: 3 Subject: Inserted Text, '

**Response:** We revised the sentence according to your comment. (P10, L16)

Number: 4 Subject: Highlight, this would increase d(O<sub>2</sub>/N<sub>2</sub>), no?

**Response:** Because this sentence was wrong, we revised it. (P10, L24-25)

Number: 5 Subject: Cross-Out, EMRI/AIST

**Response:** This word is correct, while the words of data is wrong. We revised the word from data to date. (P10, L27)

Number: 6 Subject: Inserted Text, at EMRI/AIST?

**Response:** We revised the sentence according to your comment. (P11, L1)

Number: 7 Subject: Highlight, Not sure what this means - selected for what?

**Response:** We removed the sentence. (P11, L5)

Number: 8 Subject: Inserted Text, which showed

**Response:** We revised the sentence according to your comment. (P11, L6)

## Page: 10

Number: 1 Subject: Inserted Text, Their

**Response:** We revised the sentence according to your comment. (P11, L10)

Number: 2 Subject: Inserted Text,

**Response:** We revised the sentence according to your comment (This overlaps Number: 1?). (P11, L10)

Number: 3 Subject: Inserted Text, values.

**Response:** We revised the sentence according to your comment. (P11, L11)

Number: 4 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P11, L12)

Number: 5 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P11, L12)

Number: 6 Subject: Highlight, Table 4 calls these "standard uncertainties" - say how calculated, and if standard

deviations, say of what.

**Response:** "standard deviations" is wrong and it is "standard uncertainties". We added "the standard uncertainties which were calculated based on the Deming least-square fit". (P11, L22-23)

Number: 7 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P11, L27)

Number: 8 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P11, L27)

Number: 9 Subject: Highlight, see alternate suggestion of how to cite (it is not clear here that "the GOLLUM comparison" is a citation, and some more description is warranted). Should probably also cite: WMO, 2005: Global Atmosphere Watch, 12th WMO/IAEA Meeting of Expert on Carbon Dioxide Concentration and Related Tracers Measurements Techniques (Toronto, Canada, 15-18 September 2003). GAW Report No.161, WMO TD No. 1275, Geneva. and/or A. Manning pers. comm. for the actual values since they are not included in either of these.

**Response:** We revised how to cite according to your suggestion. (P11, L27-29)

Number: 10 Subject: Inserted Text, a

**Response:** We revised the sentence according to your comment. (P11, L27)

Number: 11 Subject: Inserted Text , the GOLLUM exercise coordinated by SIO and the University of East Anglia from 2003-2014 (GOLLUM, 2015),

**Response:** We revised the sentence according to your comment. (P11, L27-29)

Number: 12 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P12, L5)

## Page: 11

Number: 1 Subject: Inserted Text, )

**Response:** We revised the sentence according to your comment. (P12, L15-16)

Number: 2 Subject: Inserted Text, We found a change of

**Response:** We revised the sentence according to your comment. (P13, L9-10)

Number: 3 Subject: Inserted Text, to

**Response:** We revised the sentence according to your comment. (P13, L9)

Number: 4 Subject: Inserted Text,

**Response:** We didn't know where to revise.

Number: 5 Subject: Inserted Text, are

**Response:** We revised the sentence according to your comment. (P13, L11)

Number: 6 Subject: Inserted Text, to

**Response:** We revised the sentence according to your comment. (P13, L11)

Number: 7 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P13, L12)

Number: 8 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P13, L16)

Number: 9 Subject: Highlight, to support this statement, please say what value Resplandy used for their estimate of span uncertainty (2% 1-sigma) and what value(s) you would recommend instead. For example, would you recommend 1.6% (standard deviation of slopes reported here) without any correction, and some smaller uncertainty if a span correction is applied?

**Response:** We added what value they used for their estimate of span uncertainty and what value(s) we recommend instead of their estimate of span uncertainty.(P13,L15-18)

Number: 10 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P13, L20)

Number: 11 Subject: Cross-Out

**Response:** We revised the sentence according to your comment. (P13, L24)

Number: 12 Subject: Inserted Text, changes

**Response:** We revised the sentence in overall. (P13, L24-25)

## Page: 12

Number: 1 Subject: Cross-Out, We speculate that t

**Response:** We revised the sentence in overall. (P13, L28-30)

Number: 2 Subject: Cross-Out

**Response:** We revised the sentence in overall. (P13, L29-P14,L1)

Number: 3 Subject: Highlight, adsorption?

**Response:** We revised the sentence in overall. (P13, L29-P14,L1)

Number: 4 Subject: Inserted Text, ,

**Response:** We revised the sentence in overall. (P13, L29-P14,L1)

Number: 5 Subject: Inserted Text, than t

**Response:** We revised the sentence in overall. (P13, L29-P14,L1)

Number: 6 Subject: Inserted Text, from

**Response:** We revised the sentence in overall. (P13, L29-P14,L1)

Number: 7 Subject: Cross-Out

**Response:** We revised the sentence in overall. (P14, L4-5)

Number: 8 Subject: Highlight, uncertainty? bias was within uncertainty, no?

**Response:** Because values of NIES and AIST by the conversion was consistent within uncertainty. We added "within uncertainty" to the sentence. (P14, L4-L6)

Number: 9 Subject: Highlight, I suggest acknowledging Andrew Manning for the GOLLUM results.

**Response:** We were grateful to Manning for the GOLLUM results in acknowledgments. (P14, L14-15)

## Page: 13

Number: 1 Subject: Highlight, This link does not work. This one does: <https://gollum.uea.ac.uk/apo-2015.shtml>

**Response:** the link was revised to "<https://gollum.uea.ac.uk/apo-2015.shtml>" (P16, L6)

## Page: 17(Table 1)

Number: 1 Subject: Highlight, formatting issue here

**Response:** We revised the sentence according to your comment.

Number: 2 Subject: Inserted Text, dry air?

**Response:** We described that figures are given in the unit of  $\mu\text{mol mol}^{-1}$  in dry air. (P20, L10)

Number: 3 Subject: Highlight, see earlier comments - give reference year and consider using more recent value

**Response:** The sentence was revised according to your comment (P20,L11-L13).

## Page: 18 (Table2)

Number: 1 Subject: Highlight, line spacing in this column could be improved

**Response:** line spacing in this column was improved

## Page: 19 (Figure 1)

Number: 1 Subject: Inserted Text, as

**Response:** We revised the sentence according to your comment.

## Page: 20 (Figure2)

Number: 1 Subject: Highlight, should y-axis label on 2a be the same as on 3a?

**Response:** We revised y-axis label of the Figure 2a according to your comment.

Number: 2 Subject: Inserted Text, at EMRI/AIST

**Response:** We revised the sentence according to your comment.

Number: 3 Subject: Highlight, say what whiskers are here

**Response:** The whiskers were explained according to your comment.

## Page: 21 (Table 3)



Number: 1 Subject: Highlight, specify/remind here or in footnote that these are all reported on different (lab-specific) scales

**Response:** We specified in footnote that these are all reported on own scales

## Page: 22 (Figure3)

Number: 1 Subject: Highlight, say what whiskers are

**Response:** The whiskers were explained according to your comment.

## Page: 23 (Table4)

Number: 1 Subject: Highlight, This term is new here - say what "GOLLUM 15" refers to. I suggest just saying "GOLLUM" as the 15 doesn't really indicate anything about the experiment (which ran 2003-2014) other than the date of the cited presentation.

**Response:** We revised the sentence according to your comment.

Number: 2 Subject: Inserted Text

**Response:** We didn't know where to revise.

Number: 3 Subject: Inserted Text, from the Deming fit. (true?)

**Response:** We revised the sentence according to your comment.

Number: 4 Subject: Inserted Text

**Response:** We didn't know where to revise.

Number: 5 Subject: Inserted Text, the

**Response:** We revised the sentence according to your comment.

Number: 6 Subject: Inserted Text, the individual laboratory

**Response:** We revised the sentence according to your comment.

Number: 7 Subject: Highlight, "provided by Andrew Manning" instead? Or did you internally redo this comparison based on SIO, TU, and NIES results?

**Response:** We revised the sentence according to your comment.

## Page: 25 (Figure5)

Number: 1 Subject: Highlight, panel letters missing

**Response:** We revised the panel letters missing

Number: 2 Subject: Highlight, y-axes in (b) reflect conversion to NMIJ/AIST?

**Response:** The y-axes in (b) was updated because we assigned  $0.2093391 / 0.7808943 = 0.2680761$  as  $\delta$  (O<sub>2</sub>/N<sub>2</sub>)

NMIJ/AIST=0. It reflects conversion to NMIJ/AIST

