Reviewer #2 comments to 'Technical Note: Reanalysis of Aura MLS Chemical Observations' by Errera et al.

This paper documents a new reanalysis data set of atmospheric chemical composition data (called BRAM2) covering the upper troposphere to the lower mesosphere produced by assimilating observation from the Microwave Limb Sounder (MLS) into the BASCOE system. The paper will make a useful reference paper for users of the BRAMH2 data set. It is well written and the authors thoroughly validate the BRAM2 reanalysis against a range of independent observations. I recommend the paper to be published as ACP Technical Note once my general comments and minor specific comments below have been addressed.

General Comments

Section 5 of the paper is very long. I suggest to shorten the text and to present some of the information in tables. This will make it easier for the reader, who will mainly use this report as a reference paper for the data set, to find the relevant information. In particular:

- Section 5.1, description on pages 22-27: Include a table that has the same layout as Figure 6 but contains mean bias +/- uncertainty calculated over the whole period in each box. This should then allow you to shorten the text.
- Section 5.2, description on pages 32-34: As above, include a table that has the same layout as Figure 8 but contains mean bias +/- uncertainty calculated over the whole period in each box. This should then allow you to shorten the text.
- Section 5.4, description on pages 41-44: As above, include a table that has the same layout as Figure 13 but contains mean bias +/- uncertainty calculated over the whole period in each box. This should then allow you to shorten the text.

Please add a comment in the paper on how the not assimilated species are affected by the assimilation. In particular, how does running several streams affect the not assimilated long-lived species? Do you see jumps in those fields? And if you do is this something that has an impact?

Specific Comments

p1, l12: Change '(SMILES), N2O' to '(SMILES) and N2O'

p3. l1: Change 'Atmospheric reanalysis is' to 'An atmospheric reanalysis is'

p3, l14: Change 'but also limited' to 'but again limited to'

p3, l15: Add a reference paper to 'The second generation of MLS'.

p3, l15: Change 'is operating since' to 'has been operating since'

p3, l18: change 'constituents are assimilated' toe 'constituents have been assimilated'

p3, l19: Add a reference paper for BASCOE here already.

p4, l7: change 'the data assimilation system' to 'the BASCOE data assimilation system'

p4, l20: change 'has been released' to 'was released' and add the year it was released in.

p5, l2: add a reference paper for MLS in the first sentence.

p5, l20: Why does the BASCOE CTM suffer from this o3 deficit? Please add a sentence that explains why.

p6, l22: Please spell out the acronym SMILES

p7, l1-2: change '(Waymark et al, 2013)' to 'Waymark et al. (2013)'

p7-8, Section 2.2.1: Please add some uncertainty ranges from the validation studies you refer to give some more concrete information about the quality of the ACE-FTS data, like you do for ozone sondes.

p8-9, Section 2.2.2: Please add some uncertainty ranges from the validation studies you refer to give some more concrete information about the quality of the MIPAS data, like you do for ozone sondes.

p9-10, Section 2.2.4: Please add some uncertainty ranges from the validation studies you refer to give some more concrete information about the quality of the SMILES data, like you do for ozone sondes.

p9, l6: change 'are quite similar between the two instruments' to 'were quite similar…'. Also, this statement is pretty vague. Can you give some numbers?

p9, l7: Change 'Those of CLO are..' to 'Those of CLO were..'

p10, l8: Change 'the CTM' to 'the BASCOE CTM'

p10, l11: change 'Huijnen et al.'s' to ' Huijnen et al. (2016)'

p10, l16: Change 'CTM results' to 'BASCOE CTM results'

p.11, l 10: see my general comment about the impact of the streams on the not assimilated species, especially long-lived'. Please add a sentence here mentioning how the not assimilated species link up.

p11, l10: change 'The three next' to 'The next three'

p12, l2; change 'BRAM2 have shown' to 'BRAM2 had shown'

p13, l20: You state 'The cause of this drift has not been identified…'. Are you sure it does not come from running several streams?

p18, l12: 'Note that BRAM2 will not be discussed in the extratrocial UTLS.' Please add a sentence to clarify why? Is it no good there, do you not have validation data,…?

p19, caption of Fig.4 : Change 'Daily zonal mean mean' to 'Daily zonal mean'

p21, Caption of Fig. 5. Please mention in the caption the data sets where the period isn't 2005-2017. Also, I noticed you are using American English spellings (e.g. color, gray). Should this be british English from an ACP report?

p22, l2: Is the variability in MLS larger than ACE because there are more MLS observations?

p23, Figure 6: CH3Cl at 46 hPa. Why is there the spike in 2010/11? Is this a data problem? Please comment on this when you discuss the Figure (p. 27 at the moment)

p25, l4: Change 'similar agreement is found' to 'Similar drifts are found'

p25, l16: You say ‘These values are stable over time at 4.6 and 46 Pa’, but there is a lot of variability, so I don’t think you can call them stable. I would suggest to change the sentence to ‘These values display significant seasonal oscillations….’. Also, please explain what is causing those seasonal differences.

p26, l5: Please add the year to the reference: Froidevaux et al. (2008)

p 26, l14: Please explain why there is the seasonal change in the bias.

p28, l3: Please change ‘between 10 and 100 hPa’ to ‘between 100 and 10 hPa’

p29, Figure 7: Please add a row with CTRL-MLS and a row for STD(CTRL-ML) because it should show nicely the impact of the assimilation and the improvement of BRAM2 over CTRL.

p29, Caption Fig 7: Please change ‘the mean differences between’ to ‘the mean relative differences in % between’ and also mention in the caption that the standard deviation is in %.

p30,l10: Change ‘to a reasonable extent’ to ‘to a reasonable magnitude’

p30, l12: Please explicitly spell out again what the ‘above mentioned regions’ are.

p32, l18: The sentence ‘ which is small given the relatively low amount of N2O’ doesn’t make sense as those error values are large relative to the low N2O values, perhaps change it to simply ‘ which is small’

p34, l13/14: Change ‘On the other hand’ to ‘Nevertheless’

p34, l20: Change ‘and between 60N-90N’ to ‘and averaged between 60N-90N)

p35, Caption Fig 9: Please change ‘the mean differences between’ to ‘the mean relative differences in % between’ and also mention in the caption that the standard deviation is in %.

p36, l3: Change ‘the mean and standard deviation’ to ‘the mean relative difference and standard deviation’

p36, l14: Change ‘(see Sect. 5.1)’ to ‘(see Figure 5, Sect 5.1)’

p36, l15: Please change ‘The major difference is the smaller bias found’ to ‘The major difference is the smaller bias found in USPV’

p37, l1: Please change ‘The standard deviations against MLS’ to ‘The standard deviations of CO against MLS’

p39, l14/15: The sentence ‘To highlight the differences… are shown at 100 hPa.’ doesn’t make sense, unless you really mean that the reason for showing O3 on theta levels and the others on pressure levels is to high light the different?? I would sugget to remove the first part of the sentence and only say ‘O3 is shown at 390K… while the other species are shown at 100 hPa.

p39, l17: Please add a sentence about the control here (e.g. you could move the sentence from p40, l2-3 here) and explain why the control has those large differences in the West Pacific. Is it because of the missing troposphere?

p39, l19: Change ‘In Fig. 11’ to ‘In BRAM2 in Fig. 11’

p39, l21: Remove ‘which is not the case for CTRL’ as you already say ‘In contrast to CTRL’

p39, l22; Please add at the end of the sentence ‘around the eastern flank of the anticyclone.’

p40, l4: '…for the 2005-2017 period'. Please add that the MIPAS dataset ends in 2012.

p.44, Section 5.5: I think it is good to have a summary section, but at the moment it just seems to repeat a lot what is said in details in the earlier sections. However, if you include the tables I suggest above and shorten Section 5.1, 5.2, 5.4 it will make more sense to have such a summary section.

p45, l4: Change 'In the TTL, MLS profiles' to 'In the TTL, MLS O3 profiles'

p46, l1: Please add a reference paper for the CFH observations here.

p47, l21: Change 'the Aura satellite, of O3..' to 'the Aura satellite, namely O3…'

p47, l22: Add after 2004-2017 'and will be extended in the future.'

p48, l14: Please add the reference papers for the published validation studies.

p48, l19: Please add that the control run has been run for several months in 2009 and 2010

p19, l6: The sentence '.. to derive a bias correction scheme for future versions of BRAM2.' Would that be for the validation data sets or in case you wanted to assimilate datasets other than MLS? you say that BRAM2 is usually not biased against MLS so it can't be for MLS?