The authors thank the reviewers for the constructive comments which have helped to improve the paper.

Answer to Reviewer #1.

This paper investigates the typical variability of atmospheric trace gas species using model simulations, with the aim to provide a user-friendly tool to be used in validation studies. The motivations and the theoretical framework are well introduced and the critical discussion of the results is well argumented.
This paper fits the scope of AMT, and it is logically written. From my side, I have some comments on specific aspects and a few technical corrections. A whole revision of the paper for typos is needed.
Please find our replies below.

1. *The theoretical framework in Sect. 3.1 is well introduced and justified. However, the statement about the stationary increments at lines 58-59 is taken as granted; wouldn't it be better to say that the authors assume that the distribution of the differences does not depend on t, based on literature?*
   Thank you for the suggestion, the text was changed accordingly.

2. *Symbols and used variable names. I find the mathematical symbols used in the paper sometimes confusing and inconsistent. I would suggest to introduce a symbol/name also for the quantities introduced in Eqs. 4,5,8 and for the atmospheric variability, which can then be referred to in the text and in the figures.*
   We deliberately do not introduce the name for the quantities introduced in the equations 4,5,8, because these are just the intermediate blocks, single elements of the samples, out of which the estimator of natural variability is constructed. While the figures show the values of final estimator, constructed out of these quantities.

   The amount of trace gas is referred to as X in Sect. 3.1 and as VMR in other equations.
   This is also done deliberately: in Section 3.1 we are talking about a random variable while VMR refers to its statistical counterpart, VMR being an estimator of X.

   In addition, I find the usage of 'x' for the mismatch in Sect.5 not optimal, especially because τ was already introduced in Sect.3.1, where t was also assumed to indicate time or space.
   We presume you are talking about the section 4.2 because there is no x or τ in the Section 5. Thank you for pointing this out, we have changed x to τ in the Eq. 7.

3. *Regarding the variability values shown, for example, in Fig.1, the authors explained that they increase at northern latitudes due to the presence of the polar vortex: wouldn't it be possible to consider points which have a compatible PV values, as usually done in validation studies?*
   Some validation studies do not consider compatible PV values in the concern to avoid involve the model data in the validation exercise. In principle, we agree, it could have been done, but the obtained values would drastically depend not only from the season, but also from the year. Our choice was hence to stay with the dependence on the mismatch only.

   In this respect, the assumed parameterization at line 135 doesn't not apply for high latitude case at large distances, right? You could point this out in the description of Fig.2.
   This is correct. We have changed the description of the Figure 2 accordingly.

4. *Was the period chosen for the simulations with the BASCOE model arbitrary?*
Almost arbitrary. There were not so many different data sets available that fulfilled all criteria (resolution, number of gases). We had just to use what was available at that time and looked reasonably representative.

5. *It is not so clear to me until line 173 that you used only BASCOE simulations for Figs.1-4, is it right?*
Yes, this is correct. We have added in the captures of Figures 1 – 4 that these are calculated out of BASCOE model data.

6. *Regarding Figs. 6-8, I was wondering if the discrepancies that can be seen for example for H_2O in spring w.r.t. the other seasons, or for O_3 in autumn w.r.t. the other plots are just random or reflect variability in the data set or are related to the restricted chosen time period.*
Examination of plots at other heights /separation distance hints toward the random nature of these discrepancies.
I would also reduce the span of both x and y axis of Fig. 8 to better see the dots.
Done.

7. *Have you seen similar linear dependencies as in Figs. 6-8 when changing the 400 km separation? Possibly, a sentence could be added in this respect.*
Yes, similar linear dependencies were seen at other heights as well. As suggested, we have added a sentence about it in the text.

Technical corrections.
Two frequent incorrent spelling I found are the word 'stationnary' -> 'stationary', and the construct 'as a function of': can you please check its usage in the text? In addition, in Sect. 3.1 please replace 'gase' with 'gas'.
Done.

P1, l14: What does this sentence mean? 'Also different impact of prior information on the result has to be considered'. Do you refer to systematic errors due to the a priori value?
Yes, this is correct.
All text suggestions were incorporated.

Answer to Reviewer #2.

This paper is acceptable for the publication once the issues noted by the other reviewer have been addressed. I apologize that I was unable to provide a thorough review of the paper. However, the time I was able to spend with the manuscript indicated it to be of sufficient quality and significance and therefore deserving of publication.

Done.