

Interactive comment on “Influence of the spatial distribution of gravity wave activity on the middle atmospheric circulation and transport” by Petr Šácha et al.

Anonymous Referee #1

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In their ACPD paper *“Influence of the spatial distribution of gravity wave activity on the middle atmospheric circulation and transport”*, Sacha et al. discuss a set of model experiments to analyse the influence of spatial variations of gravity wave activity on various aspects of the middle atmospheric circulation. The study raises some interesting aspects on the impact of localized gravity wave enhancements and their uncertainties, however, there are a number of issues concerning structure, method and presentation of the study. Before publication, please see below for a list of issues as well as technical corrections that should be considered by the authors.

- P1L31: Please specify “and other global datasets”

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- P1L38: Specify "changes of the middle atmosphere"
- P2L25: What other phenomena cause abrupt changes of MA circulation? If not relevant, please rephrase.
- P2L32: Explain here (shortly) again why. Mention again PW generation by IGW if relevant.
- P2L39: processes such as e.g. ...? List shortly.
- P4L2: What do you mean with "introduce"? Do you mean prescribe? Nudge?
- P4L8: How long is the spin-up period?
- P4L10: Mean January conditions? Of what period? Or a specific January? In this context, take into account the comments of referee #3
- P4L25-26: Can this abrupt change lead to dynamic instabilities during the transition?
- P4L22-28: Should this GWD modification be understood as rather a change in orographic or non-orographic GWs or as a mixture? Can you estimate that from the observations in Sacha et al. 2015?
- P4L37: Please explain why you are not smoothing the boundaries and if that could have any effect.
- Table 1: Please explain better the systematic behind these experiments. Many values of the table cannot be found in the text. Are these values random guessing (trial and error) or is there a particular science question behind every combination of values?
Caption: Note that the gcu ...

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- Sect. 2.2: It should be made a lot clearer in this section what can be compared here. The model does not seem to calculate interactive chemistry for ozone and methane, and these tracer distributions do not reflect purely dynamical effects (which is mentioned). At this point I do not see how 30 day model simulations (with only January conditions) are supposed to be compared with 30 year annual climatologies of satellite observations. Moreover, are these satellite observations in well enough resolution (temporal and spatial) to hold for comparisons with the effects studied in the model?
- P6L6: Explain why you analyse the 6.25hPa level.
- P6L13: The SSW simulations have not been explained before (only in the table). There should be information in the main text about those.
- P6L21-33: This paragraph should be revised comprehensively. Fig. 2 should be split into two or three figures, in the print-out version, the wind vectors are hardly visible and also the other features are not clear. The meaning of the mentioned results are not clear (particularly line 24-26) and the sentence from line 27-30 should be split to make the points one by one. Also, the word “quite“ in line 28 should be removed or specified.
- P7L26-28: This mechanism should be explained better and/or citations included.
- P7L30-32: This should be in the discussion and outlook section, maybe the entire paragraph.
- P8L5: over how much time is that strengthening and shift taking place?
- P8L11-12: This statement should be constrained further in such way that the robustness of this behaviour has not been tested in other vortex situations.
- P8L15: How can I see that this vortex displacement is more rapid?

- In general: At many places, line breaks should be used instead of blank lines everywhere. This would help to divide the respective sections into individual units of meaning.
- Fig 4: You do not discuss Fig. 4d in the text here, instead you mention one "not shown" figure and one figure from the Supplement. You should consider to restructure this. Also, I would appreciate the contoured lines for the box of enhanced GW drag, as in 4f, in all panels. However, why are there 3 lines, is it not always the same box?
- P10L12: This (rather abstract) figure should be introduced with some motivation why you plot this and/or what you expect to learn from plotting this.
- P10L34: Explain why you choose a level slightly above.
- P12L18: What else can it be? And what does that mean for the simulations?
- P13L13-21: This comparison does not seem sensible to me. CH_4 is influenced by much more than only vertical velocity (chemistry, advection, diffusion) and thus the comparison does not hold. Also, the patterns you describe in the plots are hardly visible and the motivation for this comparison is not clear to me either. I am not sure if the comparison is crucial for your results anyway, since you do not conclude any vital points here, but if so, the comparison should be made much more carefully.
- Section 4: I think this section should be revised comprehensively. Now, it is some mishmash of discussion, outlook (partly irrelevant like P16L36), conclusions and literature review (partly with only little relation to the results of this study, e.g. P17L8-12). It should be structured more thoroughly around the results of this study and link the findings more clearly to the literature (e.g. P15L26-32: It feels like there lacks a (half) sentence at the end that integrates your results into the

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ones from the references mentioned). The second paragraph is a literature review without any clear connection to the results, rather, it raises questions that cannot be answered with this setup; that seems out of place. The second paragraph discusses some insufficiencies of the idealistic modelling approach. This is indeed very important, but it is not made clear, what that means for the conclusions that can be drawn from the model experiments (what can/could still be learned out of the vortex displacement simulation even though it is not reliable?). The connection of your results with the PDO should be discussed more thoroughly because from your model setup (mean January) you cannot compare different PDO phases. Moreover, the PDO had never been mentioned before in the paper.

There should be a separate and concise conclusions section that lists the main findings of this study (one of which e.g. an extract of the last paragraph of the paper, this is a very important point).

Technical corrections

- Supplement: Please use video formats as in the guidelines for ACP papers (http://www.atmospheric-chemistry-and-physics.net/for_authors/manuscript_preparation.html)
- Supplement: Captions: Use units as suggested by ACP guidelines (e.g. $kg \cdot s^{-2}$)
- Supplement: Please convert the three text files into one with captions on the same pages as figures.
- Supplement: The reference vectors should have max one decimal place and possibly be the same in each panel. As is, the real values are very hard to estimate and to compare.
- P1L21: variability of the Brewer...

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- P2L1: ..., yet...
- P2L2: Change "projections" to "simulations" (projections cannot be compared with observations!)
- P2L6: Hence, better ...
- P2L8: ... equations, Dunkerton ...
- P2L21: ... and later on, e.g. ...
- P2L23: ... preconditioning sudden stratospheric warming (SSW ...) events.
- P2L25: SSWs belong ...
- P2L30: replace "come along" with "correlate"
- P2L31: preconditioning SSWs
- P3L6: ... showed that orographic gravity wave induced drag in the lower stratosphere can significantly affect the development of SSWs ...
- P3L10: orographic gravity wave
- P3L10-11: Please restructure to something like: Recently, McL found changes of ..., through artificially modifying ...
- P3L14: ...to reach an energetically more favorable...
- P3L16: In this study, ...
- P3L21: insert comma after brackets
- P3L24: ...the role of the GWD distribution and of the artificial forcing components ...

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- P3L31: Finally, we show the differences of the BDC due to the geometry of the GWD modulation and ...
- P3L31: ...4, we...
- P4L10: "for all simulations" instead of "here"
- P4L14: As input for the parameterization scheme, we modified the GW ... field of the potential ...
- P4L26: incorporate GWD modifications.
- P4L32: averaged
- P6L1: Why "subjectively"? This should be objectively and/or explained better.
- P6L5: The header sounds confusing. Suggestion: Atmospheric response to variations in GWD
- P6L35: remove "one may see that"
- P6L36: use "large" (or alike) instead of "significant" unless you conducted the statistical test here.
- P7L5: Therefore, ...
- P7L9: remove "which is chosen for ...our results".
- P7L11: ... 1m/s. This is comparable with the ...
- P7L13: ...level, however, we cannot investigate this because our model has an idealistic troposphere. Still, the location of the GW hotspot in this region can be relevant for the ...

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- P7L25: remove “an”
- P7L37: ... in Fig. 2. Therefore, we ...
- P8L3: So you mean right after the spin-up, right? Suggestion: In the SSWbox simulation, immediately after the spin-up period when the GWD is artificially modified, a formation ...
- P8L5-8: Please rephrase: Here, the anomaly is ten times stronger than in ... and hence we can observe ... and the vortex ...
- P8L36: What do you mean with “Putting together”, please rephrase.
- P9L4: ... simulation, the ..
- P9L5: Include (Fig. 4c) after anomalies
- P9L8: ... (Fig 4e), also pronounced anomalous equatorward propagation can be observed.
- P9L10: Move (Fig. 4b) to end of sentence.
- P9L12: Therefore, we ...
- P9L12-16: The sentence is unclear and very long, should be split and restructured.
- P9L22: Here, we ...
- P9L37: ... amplitude, the peak ...
- P10L7-10: The sentence is unclear and very long, should be split and restructured.

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- P10L20: We can find the maximal amplitude anomalies at ...
- P10L26-29: The sentence is unclear and very long, should be split and restructured. (and "one may see" should be replaced)
- P10L37: ... and the wave-1 maxima are descending to altitudes below 30 km over time.
- P11L7: Replace biggest with largest.
- P11L7: ...stratosphere, but these results are not directly comparable. The E-P flux ...
- P11L13: remove "very"
- P11L20: south of the enhancement region
- P11L22: If we take into account the total values (..), we can ...
- P11L31: In the anomalies (...), the ...
- P11L36: Remove "approximately above the GWD enhancement area"
- P12L2: This, together with the previously unexpected fact of a weak upper BDC branch response to the artificial GWD can rather be explained by the effect of the monthly averaging than by the locality of the residual circulation response to the artificial GWD (see Animation 4 in the Supplement). At particular time steps, the magnitude of the anomalies is comparable regardless of the BDC branch, but for the deep BDC branch the anomalies oscillate.
And still I don't think I get the meaning of this paragraph. It should be rephrased with better explanations of the points that you want to make here.
- P12L12: the "other" one

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- P12L16: ... after the start the first signs of anomalies evolve.
- P14L14: At first, we discuss ...
- P15L3: If we consider that the intermittent ...
- P15L33: ... during the “positive phase of the(?)” PDO ...
- P16L1-4: Very long and confusing sentence. Please rephrase.
- Fig. 10: The only numbers in the contours is .0000. Why so many digits? Add other numbers, this way it is impossible to see how much the variation is. Add another number to the colour bar to make counting easier, in this context, think about using $x \cdot 10^{-4}$ Caption: Add the unit to gcu.

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