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Interactive comment on "On the intermittency of orographic gravity wave hotspots and its importance for middle atmosphere dynamics" *by* Ales Kuchar et al.

Anonymous Referee #1

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Based on model output of the GCM CMAM-sd for the years 1979-2010 the authors introduce a novel method to investigate the intermittent nature of parameterized orographic gravity wave forcing (OGWD). Three hotspot regions are investigated, the Himalayas, the Rocky Mountains, and East Asia. It is found that OGWD in the hotspot regions is very intermittent, as expected from previous simulations and observations. By means of a peak-detecting algorithm, a set of strong peak events is identified and investigated in more detail. Composite analysis shows that during peak events the effect on the upper stratosphere and mesosphere differs strongly between the different hotspot regions, and effects can even have opposite sign.

In summary, this is an interesting paper that provides new and unique information which is of interest to the readership of WCD. The paper is well written and the figures are of good quality. Therefore the paper should be published in WCD after addressing my major comment and my detailed comments.

Major comment:

My major concern is more of technical than of scientific nature. Part of the work has been published before in the first author's PhD thesis, and figures or parts of them are just reproduced. The PhD thesis, however, is not even listed among the references.

This concern can easily be resolved by referring properly to the first author's PhD thesis, see the "specific comments".

Further, I want to state clearly that the scientific value of the paper is not affected because the duplications occur mainly in the "Data and methodology" part of the paper, and the figures are definitively needed as an introduction to the intermittency analysis that is new and not contained in the PhD thesis.

Link to the PhD thesis:

https://dspace.cuni.cz/bitstream/handle/20.500.11956/102077/140068896.pdf

Detailed comments:

(1) p.2, l.30/31: This statement is too specific! Perhaps because also the reference Hoffmann et al., 2013 is too specific as it covers only orographic and convective hotspots and is very limited by the observational filter of the AIRS satellite instrument. In addition to the hotspots, there is also considerable background gravity wave activity, as can be seen from other gravity wave climatologies (for example, Ern et al., 2018), and also gravity waves emitted from other sources like jets and fronts (almost invisible for AIRS) can exhibit spatial asymmetries and can occur as hotspots. This becomes most obvious, for example, during sudden stratospheric warmings (see, for example Ern et al., 2016)

Ern, M., Trinh, Q. T., Kaufmann, M., Krisch, I., Preusse, P., Ungermann, J., Zhu, Y., Gille, J. C., Mlynczak, M. G., Russell III, J. M., Schwartz, M. J., and Riese, M.: Satellite observations of middle atmosphere gravity wave absolute momentum flux and of its vertical gradient during recent stratospheric warmings, Atmos. Chem. Phys., 16, 9983-10019, 2016.

Therefore I would suggest to modify the statement in l.30/31 as follows:

"From observations, GWs are known to be distributed spatially asymmetric around the globe in so-called hotspots (e.g. Hoffmann et al., 2013)."

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"From observations, it is known that, in addition to relatively uniform background gravity wave activity, specific gravity sources like orography, convection, or jets and fronts, can occur as so-called hotspots and introduce strong spatial asymmetries around the globe (e.g. Hoffmann et al., 2013, Ern et al., 2016, 2018)."

(2) p.2, l.31/32: This statement is too unspecific! The statement may hold also for other models that do not use specified non-orographic gravity wave sources like convection, or jets and fronts. However, here and in Sacha et al. (2018) only CMAM-sd is investigated. Further, the step from the real observations that show also multiple features of non-orographic gravity waves to the parameterized gravity waves in CMAM-sd with a simple non-orographic source is too large. Suggestion:

resulting from the two parameterizations is well represented by the OGW parameterizations

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resulting from the two parameterizations in CMAM-sd is mainly introduced by the OGW parameterization

(3) p5, l.113/114 How is area weighting performed? In terms of square-km areas

assigned to each grid point? (This information is important because grid points at lower latitudes would be weighted more strongly.)

(4) p.5, l.121: Not clear what "with minimum distance of 20 days" means. Has a detected peak event to be separated by more than 20 days from the next peak event? Please clarify!

(5) p.7, l.153: In Geller et al. (2013) CMAM-sd is not mentioned, but the main statement still holds. Perhaps just rewrite the first part of the sentence: "Comparison with Fig.2 in Geller et al. (2013) reveals that CMAM-sd ..."

(6) p.8, l.183: Considering the changed shape seen in Fig. S2 after revision, why would you think that it is rather missing OGWD, and not NGWD, if the shape changes from a double-peak to a single peak?

(7) About p.10, l.118/119 onward, and the supplement: please add some explanation! Strong intermittency in summer, in non-mountainous regions, or at higher altitudes does not necessarily indicate "strong OGWD", but could be the effect that OGWD occurs only very sporadically. In these cases, compared to the total GWD, OGWD could be just negligible.

(8) p.11, l.229/230 Intermittency lost by zonal averaging could also happen if other GW sources are more dominant than the OGWs in the hot spots.

(9) p.11, l.232: Please state more clearly that during winter OGWs can permanently find favorable propagation conditions and act more continuously. Therefore OGW intermittency is reduced in winter, but probably OGWD more relevant.

(10) p.11, l.234: About multiple mountain ranges - what do you think is the mechanism? Could it be that if multiple mountain ranges are present (and have different orientations) there are more often favorable OGW propagation conditions for at least one of the ranges, with the effect of OGWs acting more continuously than in other regions with only a single mountain range?

(11) p.12, l.269 please repeat the information that the considered peak events are mainly in the winter season when winds are usually eastward (positive) throughout the stratosphere and lower mesosphere.

(12) p.12, l.276: Would this correspond to positive zonal wind anomalies on zonal average?

(13) Fig.6 If you want to make the statement that the OGWD pdf distributions are log-normal, please add theoretical curves (the corresponding fits of log-normal distributions).

(14) In the caption of Fig.8, "p-values" are mentioned, but not explained. Please clarify: are these values significance values arising from t-tests?

(15) p.15, l.322: Please clarify that "minima" means "strong negative values".

(16) p.4, Fig.1 contains 3 panels that were published before in the PhD thesis Kuchar (2018), Fig. 3.4 there. At least a reference to the thesis should be included. Perhaps something like "Adapted from Kuchar (2018)."

(17) p.6, Fig.3 is almost exactly the same as in the PhD thesis Kuchar (2018), Fig. 3.7 there. Again, at least a reference to the thesis should be included.

(18) p.13, also Fig.8 is similar to one of the figures in the thesis (Fig. 3.12)

Technical comments:

p.2, l.51: CMAM simulation -> CMAM

p.5, l.121: beneath -> beyond

p.6, l142: satelite -> satellite

p.9, l.205: 6 -> -6

p.14, l.283: hotspot composites can have an impact -> hotspot composites indicate potential impacts

p14, l.288: have been -> has been

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