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Geoscientific Model Development Discussions

Interactive comment on "Interaction of Small-Scale Gravity Waves with the Terdiurnal Solar Tide in the Mesosphere and Lower Thermosphere" *by* Friederike Lilienthal et al.

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Dear anonymous Referee2,

we wish to thank you very much for your valuable comments and ideas to help improve our mauscript. Below, we are addressing each of your comments.

1) Comparison: In the text you mention some changes in dynamics which are due to the change from the former Lindzen-type to the new MedvedevKlaasen-type gravity wave parameterization. I think, there are some important circulation patterns which can only be properly treated with the new scheme. However, for the setup you mention some

simplifications, such as no eddy diffusivity, which should also be further documented. So I suggest to add a detailed comparison between the two schemes.

GW dissipation occurs due to a combination of various dissipation processes, such as eddy viscosity, nonlinear wave-wave interactions, molecular diffusion and thermal conduction, and ion drag (Yiğit et al. 2008, 2009; Yiğit and Medvedev 2010). In the mesosphere and lower thermosphere, the most dominant dissipation mechanism is due to the nonlinear interactions among the different GW harmonics (Yiğit et al. 2008). Eddy viscosity plays a relatively minor role in this context. Also, there is a significant degree of uncertainty in eddy viscosity in the MLT, so we chose to exclude this minor effect in our study. Moreover, Yiğit et al. (2008)'s study extensively compared the nonlinear whole atmosphere scheme to the Lindzen scheme (section 7) and demonstrated the unphysical nature of the linear scheme. Without artificially reducing the GW drag, Lindzen scheme produces very large GW drag, which is rather unrealistic and would destabilize the model. Lindzen scheme works fine provided that an extensive amount of tuning is performed. Therefore, we updated our modeling framework with a state-of-the-art nonlinear whole atmosphere GW parameterization, whose physics and application have been discussed and tested in a number of papers.

We agree with the reviewer that certain features of GWs, and thus circulation patterns, can only be treated with the nonlinear scheme. The vast majority of those properties have been discussed in previous publications cited in our manuscript. Therefore, we have not addressed them here in detail. For example, in comparison with Lindzen scheme, the nonlinear wave-wave interactions in our scheme lead to breaking levels lower in the atmosphere with smaller GW drag, which is more realistic. No artificial tuning factors have been used in our scheme and GW momentum deposition occurs naturally over a range of altitudes and not just at a single breaking level, to name some of the features of the nonlinear scheme and differences to the Lindzen scheme.

2) Validation: These different circulation and tidal patterns should be related to available observations and simulations. Some of those are mentioned in the text, but I think

the paper requires substantially more information in terms of text and figures. A detailed discussion of relevant publications (for example Becker, 2017 or Liu et al., 2018) in this field is expected.

We will extend our discussion and validation. We plan to compare our results, e.g., with model outputs of the WACCM-X, HWM and NRL-MSIS and with URAP data.

Technical Comments We strongly appreciate the formal and technical comments to improve the writing. They will certainly be implemented in the next version.

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