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Reply on CC1

Manfred Ern et al.

Author comment on "The semiannual oscillation (SAO) in the tropical middle atmosphere and its gravity wave driving in reanalyses and satellite observations" by Manfred Ern et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-190-AC3>, 2021

Thank you very much for your comment and your interest in our work!

The gravity waves that contribute to the driving of the QBO and the SAO are more or less continuously generated in the troposphere and lower stratosphere by several different source processes, such as flow over orography, spontaneous emission of gravity waves by out-of-balance wind jets, and, most prominent in the tropics, deep convection. The long-period tidal forcings that you are mentioning are not directly involved in these processes of gravity wave excitation.

QBO:

For the QBO, there are several model studies showing that the period of the QBO is strongly related to the source strength of gravity waves. See, for example, Sect. 6 in Giorgetta et al. (2006).

Giorgetta, M., Manzini, E., Roeckner, E., Esch, M., and Bengtsson, L.:
Climatology and Forcing of the Quasi-Biennial Oscillation in the MAECHAM5 Model,
J. Atmos. Sci., 19, 3882-3901, 2006.

Still, there are indications that the 11-year solar cycle has some minor effect on the period length of the QBO. See, for example, Salby and Callaghan (2000). However, to my knowledge, this effect is not related to long-period tidal forcings.

Salby, M. L., and Callaghan, P.:
Connection between the Solar Cycle and the QBO: The Missing Link,
J. Climate, 13, 2652-2662, 2000.

SAO:

Different from the QBO, the SAO is more strongly linked to the general global seasonality on Earth:

In addition to the effect of upward propagating gravity waves as described in our study, also horizontal advection and meridional momentum transport of extratropical planetary waves from the respective winter hemisphere contributes significantly to the SAO westward phase and its timing.
(e.g., Delisi and Dunkerton, 1988; Hamilton and Mahlmann, 1988; Ern et al., 2015).

Delisi, D. P. and Dunkerton, T. J.:
Seasonal variation of the semiannual oscillation,
J. Atmos. Sci., 45, 2772-2787, 1988.

Hamilton, K. and Mahlmann, J. D.:
General Circulation Model simulation of the semiannual oscillation of the tropical middle
atmosphere,
J. Atmos. Sci., 45, 3212-3235, 1988.

Ern, M., Preusse, P., and Riese, M.:
Driving of the SAO by gravity waves as observed from satellite,
Ann. Geophys., 33, 483-504, doi:10.5194/angeo-33-483-2015, 2015.