Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2022-407

Anonymous Referee #2

Referee comment on "Nonlinear resonant interactions of atmospheric tides with annual oscillation based on meteor radar observation and reanalysis data" by Xiansi Huang et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-407-RC2, 2022

General comments:

This study derived the spectra of the wind observations from a meteor radar and MERRA2 reanalysis data from 2012 to 2021 using the two-dimensional Fourier transform and Lomb-Scargle spectrum analysis. The manuscript showed mainly a spectral analysis of the nonlinear resonant interactions of the diurnal (DT)/semidiurnal (SDT) tides and the annual (AO) / semiannual (SAO) oscillations. The authors concluded that ".. there exist several significant peaks in the upper and lower sidebands of the DT. These spectral peaks are located right at the sum and difference frequencies between the DT and the AO and SAO, meaning that these waves are generated through the nonlinear resonant interactions between the DT and the AO/SAO. The amplitudes of the secondary waves excited through the difference (sum) resonant interactions between the DT and the AO and SAO …"

A contradiction existing in this manuscript is this study analyzing a nonlinear phenomenon with the Fourier-based methods. The summation of sine or cosine functions, which is linear and stationary, makes mathematical sense to fit the data but does not make physical sense of a nonlinear process.

Another problem of this manuscript is the missing investigation of the physical mechanism. The authors showed only the spectra of the wind data with discussion. Accordingly, the reviewer suggests a major revision.

Specific comments:

The realistic atmosphere is a nonlinear system. However, the nonlinearity can induce spurious harmonic components that cause energy spreading and result in the spectra

making little physical sense (Huang et al. (1998), https://doi.org/10.1098/rspa.1998.0193). The summation of the Fourier components fitting the nonlinear and non-stationary nature of data generates artificial harmonics, which misleads the true energy distribution in the frequency or wavenumber domain. In my opinion, the authors mistook the artificial harmonics for the nature signal of the possible nonlinear wave-wave interaction.

The reviewer recommends that the authors should derive the Hilbert and marginal spectra of the wind data and prove the authenticity of the Fourier-based spectra as shown in the manuscript. The HHT is a method for studying the nonlinear wave-wave interaction and energy transfer. The authors should prove if the spectral peaks are natural or not before investigating the physical mechanism.

Note that this study shows only the spectra of the data. Investigation of the physical mechanism is missing. Does the interaction of the tidal modes and the atmospheric background circulation cause the nonlinear process? How's the atmospheric gravity waves dump their momentum energy into the wind flow? Does the QBO driven by tropospheric activities also play a role in the mechanism of the nonlinear interaction? The QBO is highly nonlinear and nonstationary because it varies significantly during the study period from 2012 to 2021. Investigating the mechanism in detail is also required.