Review report of "Nonlinear resonant interactions of atmospheric tides with annual oscillation based on meteor radar observation and reanalysis data" by X. Huang et al.

General comment:

This study applied a spectral analysis for long-term horizontal wind data from meteor radar observations to investigate the nonlinear interaction between tides and seasonal variation of zonal-mean state of the atmosphere (AO/SAO). The authors found that the tidal spectral peak was composed of several different peaks including those at the sum and difference frequencies between tides and AO/SO (e.g., 1 day and 1/365 day). They attributed these upper/lower sidebands to the new waves generated through any nonlinear wave-wave interaction.

Although it is interesting to see the upper/lower sidebands for spectral peaks of tides, I cannot agree with the interpretation of the results (please see my major comment) and so I cannot recommend this manuscript for publication.

Major comment:

My major concern is that the secondary peaks may just reflect the seasonal variation of tides. It is well known that the tidal amplitude and phase of diurnal/semidiurnal migrating tides show marked seasonality due to the seasonality of background atmosphere and/or excitation sources and that these physical processes are basically linear (e.g., Hagan et al., 1999; McLandress, 2002; Zhang et al., 2006; Mukhtarov et al., 2009; Sakazaki et al., 2013 and many others). Suppose that the amplitude of diurnal tide (with the frequency of ω_d) exhibits an annual variation (with the frequency of ω_A). We can express this modulation formally as

$$A(1+\epsilon\cos\omega_A t)\cos\omega_d t = A\cos\omega_d t + \frac{A\epsilon}{2}(cos(\omega_A+\omega_d)+cos(\omega_A-\omega_d))$$

where A is annual mean amplitude of diurnal tide, while ϵ is a factor of seasonal modulation. Thus, it is expected that the spectral peaks appear at these upper and lower side-band frequencies (i.e., $(\omega_c+\omega_d)$ and $(\omega_c-\omega_d)$, respectively). So, I do not agree with the authors' view that the spectral peaks at these upper/lower side-band frequencies are the real signals of "third" wave produced by nonlinear wave-wave coupling. I would rather feel that the peaks at $(\omega_c+\omega_d)$ and $(\omega_c-\omega_d)$ are just manifestation of seasonality of tides.

If they want to really suggest that the third waves do really exist and are caused by non-linear processes (i.e., advection terms), more analysis as well as some numerical experiments would be necessary.

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