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Interactive comment on "Tropical temperature variability and Kelvin wave activity in the UTLS from GPS RO measurements" *by* Barbara Scherllin-Pirscher et al.

Anonymous Referee #1

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Scherllin-Pirscher et al. use GPS radio occultation data to examine temperature variability in the tropical UTLS. Using spectral analysis, the authors identify contributions of temperature variability from quasi-stationary and sub-seasonal (<100 days) scales to the total variance. This study particularly focuses on Kelvin waves and their relationship with the QBO and convective forcing. The paper is nicely organized and easy to follow. It is interesting that their analysis on Kelvin wave activity in the tropopause does not show a QBO signal. I wonder if the result is affected by the calculation method to get Kelvin wave variance. Therefore, I recommend that the authors check the following points before publication in ACP.

My major concern is their definition of Kelvin waves. Although their definition of Kelvin waves (zonal wavenumber 1-2 and frequency 7-30 days from the zonal space and time FFT) looks reasonable based on previous studies, I am not sure if the simple FFT filtering properly captures Kelvin wave variability quantitatively near the tropopause because amplitudes of tropopause waves strongly vary at different tropical regions. I agree that the inverse FFT of a filtered spectrum is a useful tool to construct characteristics of general zonal and vertical structure of Kelvin waves. This method, however, might not be a best way to quantify temperature variance associated with Kelvin waves, particularly for localized ones. If waves are nearly equally distributed over the tropics, the simple FFT should be sufficient to calculate time series of Kelvin wave variance. This will be the case for the stratosphere, but not for the tropopause layer.

I will use Figure 2 as an example. The authors explain that Kelvin wave variance in the tropopause is much smaller than the resolved total variance in Figure 2. To me, however, this figure demonstrates the simple 2D FFT Kelvin filter is not a proper way to calculate variance near the tropopause. For this event, it looks like Kelvin waves dominantly affect temperature anomalies above ∼15 km. The waves freely propagate over the whole tropics (non-localized) at ∼20-30 km, but they show localized distribution with a zonal wavenumber about 1.5 at 15-20 km. The localized amplitude in real space results in spread of a power spectrum, which will subsequently result in reduction of the amplitude after filtered inverse FFT. The exact same thing is shown in Figure 2b at 15-20 km. The smaller amplitude between 0-240E at 15-20 km in filtered anomalies (b) than in total anomalies (a) does not necessarily mean Kelvin wave variance is much smaller than the total variance; it would be just the localized signal cannot be captured in their method. Therefore, the whole conclusion about Kelvin wave variance near the tropopause over time is questionable. This includes the wavelet results since the wavelet method was applied after 2D Kelvin filtering.

My second concern is the use of a fixed altitude range for the tropopause layer. The tropopause is not a fixed level and varies with a seasonal cycle, QBO, etc. A fixed range includes mostly tropospheric characteristics when the tropopause is high. When the tropopause is low, the fixed range more represents the stratosphere. Since temperature variability greatly changes from the troposphere to stratosphere, the variance calculation could be significantly affected by varying tropopause heights. It will be more reasonable to use a moving tropopause layer to calculate variance. For example, the authors can use relative heights to the monthly mean tropopause.

Minor comments: Term of “high-frequency”: This term is not appropriate for disturbances shorter than 100 days. “Sub-seasonal” could be a replacement.

P4 L3: Add latitude resolution of gridded data

P4 L4: Add a statement like “This gridded data can only resolve waves with zonal wavenumbers up to 6.” Also state the limitation of vertical scales that the dataset can resolve.

P4 L18: Gaussian filter filter → Gaussian filter

P4 L29: I assume only positive wavenumbers were included. To clarify this I suggest: “by selecting wavenumbers k=1 and 2 . . .” → “by selecting wavenumbers k=+1 and +2..” or explain only eastward signals were included. Alternatively a small box for Kelvin waves can be added in Figure 1.

P6 L21: “.. larger temperature variability before 2006 compared to after 2006.” I think this implies that sub-grid scale variability (<1 day, < 60 degrees) is significant. Mention that.

Figure 1: The spectrum is too discrete between 10-50 days at zonal wavenumber 1. If my understanding is right, the whole time record was put to calculate the spectrum. Then, I think the spectrum will be more continuous than Figure 1. Why does the spectrum have separate peaks along the vertical axis?

“zonal anomalies” : The term is a bit confusing. I will rather use “anomalies,” and describe the definition of anomalies. I presume anomalies are deviation from the time-mean zonal-mean.

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Discussion paper

Figure 10: Green, red, and blue lines are distracting. Those color lines seem subjective. If they are objectively decided, explain them. Otherwise I suggest deleting the color lines. Also Kelvin wave filters are for 7-30 days in (a), but OLR variance is for < 100 days in (b). Explain why they use different filter ranges.

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