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Interactive comment on "Future Meridional Wind Trends Through the Lens of Subseasonal Teleconnections" *by* Dor Sandler and Nili Harnik

Dor Sandler and Nili Harnik

dor.sandler@gmail.com

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Thank you for your thorough and helpful comments. We will incorporate all of your notes in our revised paper, but in the meanwhile we'll use the discussion platform to shed light on some of the major themes in your comment.

The CTP across scales: An important framework for interpreting our results is analyzing the CTP as a unique bridge between different temporal and spatial scales. Some patterns (like the PNA) only dominate seasonal or interannual timescales. The CTP, however, is an accumulation of quasi-stationary synoptic components which are also clearly manifested on subseasonal scales due to their near-zero phase velocity. That is why we define the CTP as a family of related patterns, as Branstator (2002) did in his

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original paper. This distinction will be better explained and highlighted in the revised paper. All the patterns in the CTP family are number-5 QSWs produced by combinations of the EOFs (global or regional), with possible different phases and locations. This specific family of QSWs is the focus of our study because of its surprising robustness. These patterns are found through various methods (one-point correlation maps, EOF analysis, objective tracking) in observations and models (from dry primitive equation models to fully coupled GCMs), once one looks at monthly means of subseasonal (seasonal means removed) patterns for the EOFs, or seasonal mean variance for one-point time lagged correlations. We therefore consider the regional non-circumglobal patterns to be local manifestations of the CTP. This can also help explain why projection scores on global EOFs are low. The global EOFs capture a combination of related regional patterns. However, as we learn from the regional analysis, separate CTP sectors can have differently phased local waves, so looking at the entire hemisphere is limiting in terms of degrees of freedom. The RWPs themselves are a product of regression onto regional EOFs. Therefore, one often finds localized wave packets that circumscribe the globe, but that is not always the case. For example, one can think of a specific month with a strong northerly flow over North America, corresponding to a positive EOF1. However, as the wave itself is not circumglobal, the flow over Europe and the Mediterranean might have waves with a different phase or even no wave signature. In that case, the projection will be strong for the regional NA EOF1, but poor for the global EOF1.

The CTP as a climate change signal: The CTP is not a phenomenon that is unique to future climate, but its presence is clearly seen in the projected long-term trend. It is tricky to answer the question of whether the CTP will become stronger as a result of climate change. There isn't an amplified monolithic wave that instantaneously spans the entire hemisphere in the future, but we posit that the projected stronger wavenumber-5 signal (seen in subseasonal and climatological data) is related to a frequent excitation of persistent RWPs with specific phases (seen in daily data). This idea has been previously explored in more theoretical terms. Branstator & Selten (2008) found that GHG

forcing is projected to excite various modes of internal variability more frequently, and among them is the synoptic manifestation of the CTP. On a side note, while it is true the resulting global signature is not a pure number-5 wave throughout, we find it convincingly robust. The Fourier analysis performed in Simpson et al (2016) for this exact trend reveals a significant wavenumber 5 component.

Wave response and the mean flow: Due to its timescale-spanning nature, it is hard to disentangle the effects of the mean flow from the CTP itself. It has been previously shown, as you've mentioned, that jet configuration affects teleconnectivity. The main take-away message from our mean flow analysis is that the local mean flow anomaly that relates to CTP phase preference (upstream narrowing of the jet) isn't an artefact of the CTP analysis, but rather an intrinsic characteristic of the models themselves. This is because this feature is seen in the climatological bias of the models in historical data (compared to the MMM historical climatology). Our working hypothesis is that local jet structures might allow for RWPs with specific phases to have greater persistence and reach. We focus mainly on models with a single phase preference in order to isolate this connection clearly and avoid analyzing multiple (sometimes opposing) patterns. We will try to further demonstrate our results for the mean flow in the revised version. Also, incorporating other oscillations is a good idea (especially NAO which is locally very connected to the CTP; Yuan et al., 2011).

Analysis of wind perpendicular to the waveguide: Our work mostly relies on EOF analysis, which unlike RWP tracking, is not limited to the horizontal propagation of the waves. The meandering shape of the zonal waves in the EOFs shows that they capture the climatology of the waveguide. However, this is not to say that the method shown in Wolf & Wirth (2017) won't be useful. In the daily calculations, using perpendicular flow might help us obtain a slightly cleaner picture (better RWP accounting), but we don't expect it to meaningfully alter our conclusion.

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