EGUsphere, author comment AC2
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Reply on RC1

Daniel D. Billett et al.

Author comment on "Mid-latitude neutral wind responses to sub-auroral polarization streams" by Daniel D. Billett et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-593-AC2, 2022

Thank you for your review,

We agree that "no lag" on neutral winds does not make sense physically, assuming that all other forces barring that directly caused by enhanced plasma (in this case, the SAPS) is removed. For Figure 6b, we believe that correlation is highest when the lag=0 due to a limitation of the cross-correlation technique itself. That shortcoming being that a large part of the neutral wind timeseries is being compared to a large part of the plasma velocity timeseries and only a single number (the correlation coefficient) is being produced. Therefore, peaks and troughs in the data are being considered as a whole, which in this case, happens to cause the correlation to be highest when lag=0.

Below is the timeseries' used to perform the cross-correlation in Figure 6, which in a revised manuscript we will add to Figure 6. It is the zonal winds at Millstone Hill which gives high correlation with the fitted convection plasma at zero lag. However, these new panels show that the lag for the very first wind enhancement, beginning around 03:00UT for the Millstone zonal winds, is probably closer to 30 minutes.

The cross-correlation looks at entire windows of data, so peaks and troughs at times other that the first wind enhancement don't correlate as well as at lag=0. This could be for a few different reasons:

- There are uncertainties in the fitted plasma velocity timeseries. The velocity is set to zero at all times before ~03:00 because the convection fit does not expand into the latitude where the average (the box in Figure 5) was taken. This might not truly be the case, but the fit is being constrained by data elsewhere to a higher latitude.
- There is no time history in the convection fitting, causing a certain degree of jumpiness between sequential convection patterns. This is most prominent with the convection velocity spike at ~03:00, which may not be realistic. In reality, the convection velocity would evolve more smoothly.
- We assume that quiet time winds are fully removed to leave the disturbance winds using HWM14, but this is unlikely the case because it is only a climatology. Therefore, there is probably at least a small amount of forcing on the disturbance winds from non-SAPS related sources (e.g. solar heating pressure gradients, Coriolis, etc).

In summary, in a revised manuscript we will add these new timeseries panels to Figure 6. We will also include additional discussion about the caveats surrounding cross-correlation

and the meaning of “zero lag”, as described in our points above. We still use cross-correlation, as it is a good way to give an empirical lag value for the event as a whole, despite its shortcomings.