Reply on RC2

Christos Katsavrias et al.

Author comment on "On the semi-annual variation of relativistic electrons in the outer radiation belt" by Christos Katsavrias et al., Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2020-90-AC2, 2021

This paper shows new statistical results about the semi-annual variation (SAV) of electron fluxes during solar cycle 24. The authors show that the SAV is mainly explained by the Russel-McPherron effect, and is well correlated with high HSS occurrences. They show that most findings from solar cycles 22 and 23 also apply to solar cycle 24.

These results are of great interest for the radiation belt modelling community. The paper is clear and well written. The figures are mostly clear and appropriate.

I recommend this article for publication, subject to the following minor remarks and questions:

Eq 1,2,3 : some notations are not explained (the star in \phy^* in eq. 1, and what is W_n in eq. 2 and 3). Section 2.2.3 is not very clear, in particular the first sentence. Later in the article the WTC seems to be used as an indicator for the confidence in the XWT phase. It could help to rephrase this section a bit more clearly, and explicit how this metric is used in this study.

Response: ψ is the mother wavelet (here Morlet) and * denotes its conjugate. $W_{n}(f)$ is the amplitude of the wavelet at a specific frequency f at the time-stamp with order number n. These are already included in the text. Moreover, we have modified Section 2.2.3 as follows:

"The wavelet coherence (hence forward WTC) is an estimator of the confidence level of consistent phase relationship, between the two time-series, even if the common power is low. The measure of wavelet coherence closely resembles a localized correlation coefficient in time–frequency space and varies between 0 and 1, corresponding to non-coherent and highly coherent phase relationship, respectively. It is used alongside the XWT as the latter appears to be unsuitable for significance testing the interrelation between two processes [Maraun, 2004]. Thus, in our analysis, we are searching for common periodicities which are accompanied by high levels of coherence."

Line 114: How was averaging done (linear or logarithmic average), and how were the data gaps accounted for?

Response: The averaging corresponds to a daily binning and from each bin the linear mean of the fluxes is calculated. For each L-shell bin, in case the data-gaps were less than

30% of the time-series length, we have used a linear interpolation process to fill them. Note that in all cases the maximum consecutive data gaps were 5. In case the data gaps were more than 30% of the time-series length, the corresponding time-series was excluded from further analysis.

Line 140: How statistically significant is this analysis for the 2009-2014 period?

Response: The statistical significance of the 2009-2014 time-period does not differ from the 2015-2019 or the 2009-2019 time-period. All the aforementioned years include measurements from only one GOES satellite (G15) and, moreover, we have followed the previously described procedure for the data-gaps. This means that in every time-period the amount of gaps is less than 30% of the corresponding length and the maximum consecutive data gaps were 5.

Figure 4-7: An horizontal line or indicator at 175 days would help illustrate the discussions. Since all discussions focus on the SAV, why not present only the 175 days horizontal cuts (or a small band around there) of these plots?

Response: A line has been added to guide the reader's eye to the 175 days periodicity.

Line 167: I think there is part of the sentence missing there, do they show that this number correlated with SAV?

Response: We intended to say that these authors displayed, in their work, the number of occurrence of Interplanetary Coronal Mass Ejections (ICMEs) and HSSs with solar wind speed larger than 500 km/s. The sentence is removed to avoid any confusion.

Line 194: "The phase relationship [...] is only significant during the descending phase of SC24". Why is that? Is it because the Wavelet coherence is above 95%?

Response: The reviewer is right. Nevertheless we note that the wavelet coherence (which resembles a correlation coefficient as explained in the first comment's response) takes values between 0 and 1, corresponding to non-coherent and highly coherent phase relationship, respectively. In the case of the aforementioned figure, the wavelet coherence is higher than 0.7.

Line 271: While SAV could in principle be integrated in specification models, it should be noted that these relatively short-scaled dynamics are only of interest for very specific missions (for instance EOR or short-lived nanosats).

Response: The reviewer is right. A sentence is added at the end of the conclusions section.