

Ann. Geophys. Discuss., referee comment RC3
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Comment on angeo-2021-47

Anonymous Referee #2

Referee comment on "Quantifying the non-linear dependence of energetic electron fluxes in the Earth's radiation belts with radial diffusion drivers" by Adnane Osmane et al., Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2021-47-RC3>, 2021

The manuscript presents an interesting study of the dependence of the radiation belt energetic electron fluxes on ULF waves. The study uses mutual information and Pearson correlation to compute the correlations between (1.2 MeV and 130 keV) electron fluxes and (Sgr, Sgeo) ULF power indices. The study derives an expression that relates mutual information to Pearson correlation coefficient. Their equation is very useful for comparing measures of linear and nonlinear correlations and for determining nonlinearities in the system.

Overall, the manuscript is well written and the study is well executed. It should be published. This reviewer only has minor comments and suggestions, as listed below.

- Line 19, "Their study are..." --> "Their studies are..."
- Line 61, the Balikhin et al. citation is missing the publication year

- Lines 99-100, it is easy to think of scenarios where one can gain information about the likelihood of event X, given Y. However, it is not so easy to think of scenarios where one can lose information. If X and Y are unrelated then no information is gained about X given Y. Can the authors elaborate on this?

- Lines 168-169, the sentence is a bit awkward. The authors probably want to say ...mutual information and Pearson correlation is an indication that the correlation should not be interpreted linearly (or something like that).

- Line 210, there should be a coma between "radial diffusion" and "is a leading".

- Line 238, there should be a description that SOPA is an instrument on board of Los Alamos National Laboratory (LANL) spacecraft.

- Line 256, "... and positive vice-versa". Should this be "...negative vice-versa"?

- Line 261, should the value above the shaded area represents a mutual information that has least three (not six) sigma significance?

- Lines 260-270 and Figures 4 and 5. One of the main differences between mutual information and correlation in Figures 4 and 5 is that mutual informations consistently have very pronounced secondary peaks at time offset around -100 h whereas the secondary peaks in the Pearson correlations appear to be less pronounced or less significant. Can the authors discuss this? The authors did not plot the absolute values of the correlation coefficients r , but one can sort of see this in the plots.

In mutual information plots, Figures 4a, 4c, 5a, and 5c, the secondary peaks probably correspond to negative correlations, as inferred from their Pearson correlation counterparts. The anti-correlations can also be seen in Figures 6 and 7. Can the authors explain this anti-correlation between F1.2 and Sgr and Sgeo at time offset -100 h? The anti-correlations between F130 and Sgr and Sge can also be seen in Figure 11 at about the same time offset.

- Lines 345-346, the authors claim that their results show that quantitatively the dependence is modest. This claim is repeated on line 386 and elsewhere in the manuscript. Table 1 shows adjusted correlations of 0.6 to 0.8. In many studies of space science, correlations of 0.7-0.8 would be considered strong or very good. "modest" is probably a subjective term. Can the authors comment on what they would quantitatively consider modest or strong or weak correlations?