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## Using mutual information to investigate non-linear correlation between AE index, ULF Pc5 wave activity and electron precipitation

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The Earth's radiation belts are occupied by energetic electrons trapped by the geomagnetic field. The anisotropic electron distribution injected from the magnetotail during substorms drives the very low frequency whistler mode chorus waves in the outer radiation belt. Chorus waves are able to accelerate the electrons as well as cause them to precipitate into the upper atmosphere. The electrons in the radiation belt are also affected by ultra-low frequency (ULF) waves in the Pc5 range, that can be driven internally or by the solar wind-magnetosphere interactions. Using mutual information from information theory, we investigate the nonlinear dependence between the substorm activity indicated by the AE index, global Pc5 ULF wave activity, and electron precipitation at three different energy ranges between L shells from 5 to 7. We find that both the Pearson correlation and mutual information are highest between the AE index and precipitation of 30-100 keV energy electrons between MLTs 6-12, where the electrons are usually precipitated by the chorus waves. The time lag of the maximum correlation between the AE index and electron precipitation increases from 0 to 3h from dawn to dusk, which is consistent with drift period of the electrons in the radiation belt. We compare results from geomagnetically more and less active years and the results indicate that Pearson correlation between AE index and ULF wave activity/electron precipitation is weaker during the more active year while the changes in the mutual information are negligible. This suggests that during quieter magnetospheric conditions the interactions are more linear than during geomagnetically active times.