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Annales Geophysicae Discussions

Interactive comment on "Outer Van Allen belt trapped and precipitating electron flux responses to two interplanetary magnetic clouds of opposite polarity" *by* Harriet George et al.

Harriet George et al.

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General Referee Comment: This manuscript compares observations from the inner magnetosphere during two different CME-driven storms. The storms are of a similar magnitude but driven by CMEs with opposite rotations of the Bz magnetic field component. The manuscript describes differences in the timing and features of the solar wind during the chosen storms and compares them with the observations of wave activity from RBSP and GOES, precipitating electron flux at POES, and source, seed, and radiation belt electron fluxes at RBSP. The manuscript concludes that the location and timing of the southward component of the magnetic field is a key factor in driving the

differences in the timing of trapped and precipitating flux variations during CME-driven storms. The manuscript is very nicely written and provides new insight, but there are comments which should be addressed prior to publication.

Response: We thank the referee for the careful reading of our manuscript and their constructive comments. We have revised the paper accordingly. Please find our responses below.

Main Referee Comment: The manuscript currently needs to take better care addressing the effects of the local time of the spacecraft in their analysis. The RBSP spacecraft have quite different locations in apogee during the two events which are compared. During event 1 RBSP is primarily on the dayside. During event 2 it is near dusk. There is a local time dependency of chorus (e.g. Li et al., 2009; Meredith et al., 2012), source/seed electrons (e.g. Allison et al., 2017; Korth et al., 1999), and potentially a storm phase dependency on the local time of chorus/source electrons (Bingham et al., 2019). As such, one would not necessarily expect to observe the same timings and intensities of lower energy electron flux and chorus wave activity during each storm. While the manuscript has a thorough description of most of the timing of various features observed, this is one part that still needs to be better addressed.

Response: Additional information on the effects of MLT on electron flux response and wave activity has been incorporated throughout the manuscript. A description of the magnetic local time of the Van Allen Probes in these two events has also been incorporated into the text. MLT information for the RBSP have been added to the Wave Activity figure (attached) to show when they are on the dayside and nightside of the Earth. In this figure, a solid line represents that the RBSP is on the dayside of the Earth while a dashed line represents that the satellite is on the nightside.

Referee comment: Chorus and hiss waves are not necessarily going to be the only waves present between 100–10000 Hz over an RBSP orbit. That is not to say that they will not be the dominant ones. Most of the features shown certainly look chorus-like and hiss-like. However, I think a little more care could be used either in describing caveats of the chorus/hiss observations as they are, or using the wave properties to provide greater certainty that the waves shown are in fact chorus/hiss.

Response: The following text has been added to the Data and Methods section: "We have elected to use only the wave frequency and location inside or outside the plasmasphere to categorise these waves as either chorus waves or plasmaspheric hiss for simplicity."

Referee comment: While they will only be from a limited local time, including RBSP observations of the plasmapause location could provide useful context for the events and provide a comparison to the empirical model currently used.

Response: We agree that inclusion of RBSP measurements of plasmapause location would be useful. However, we have elected not to do this. There is some arbitrariness involved with the selection of the electron density threshold for the plasmapause location when using RBSP data (e.g. Goldstein et. al., 10.1002/2014JA020252, 2014), and there is also limited electron density data for the dates in this study. We think that the plasmapause location from the empirical model is sufficient for the purposes of the study.

Referee comment: Additionally, over plotting the empirical and/or observed plasmapause location on the RBSP electron fluxes would help the reader.

Response: We have plotted an overlay of the plasmapause and magnetopause position on the colour maps of precipitating and trapped electron flux, in addition to showing the magnetopause and plasmapause location in the Solar Wind Conditions figure. The plasmapause overlay is magenta and the magnetopause position is shown in orange. This can be seen in the attached figures of electron fluxes during the two events.

Referee comment: Lines 189-190. "The use of two RBSP satellites over a period of multiple days meant that all MLT were encompassed". RBSP is not able to cover all

MLT for all L-shells shown during each event.

Response: The text has been edited to clarify that all MLT were covered at some point in the evaluated time periods, not that every MLT was covered at every L-shell

Referee comment: Line 297-298. "Dst begins to decrease rather steadily soon after the ejecta leading edge arrives at Earth, reaching a minimum value of -102 nT on June 29, 2013, 07:00 UT." How much of the initial decrease in Dst is due to passing of the sheath region and the end of the sudden storm commencement? After an initial decrease, Dst seems to be at a rather constant value, which is pretty comparable to the prestorm value, for the first 8 hours of 28/06/13.

Response: Changed "soon" to "approximately eight hours" and added the sentence "There is a minor decrease in Dst at the ejecta leading edge, but it remains close to pre-event levels." to better explain the evolution of the Dst index throughout the sheath region and early portion of the ejecta

Referee comment: Line 381. Typo: "The source population flux is strongly decreases towards the time of the ejecta trailing edge"

Response: Corrected: decreases -> decreasing

Referee comment: Figures 1-4. Minor tickmarks on the x-axis every few hours would be helpful to the reader.

Response: Additional minor tickmarks have been added to the x-axis in all figures

Referee comment: Similarly, many of the line flux plots with a log y-axis could use more tickmarks on the y-axis for reference.

Response: Minor y-axis tickmarks have been added to the Median Flux plots

Suggested citations from referee: Allison et al. (2017). The magnetic local time distribution of energetic electrons in the radiation belt region. JGR. doi: 10.1002/2017JA024084

Bingham et al. (2019). The Storm Time Development of Source Electrons and Chorus Wave Activity During CME and CIR Driven Storms. JGR. DOI:10.1029/2019JA026689

Korth et al. (1999). Plasma sheet access to geosynchronous orbit. JGR. DOI:10.1029/1999JA900292 Li et al. (2009). Global distribution of whistler-mode chorus waves observed on the THEMIS spacecraft. GRL. DOI:10.1029/2009GL037595

Meredith et al. (2012). Global model of lower band and upper band chorus from multiple satellite observations. JGR. DOI:10.1029/2012JA017978

Response: The suggested citations have been incorporated into the Introduction section. A paragraph has been added on MLT dependence of trapped electron fluxes at the energies evaluated in this study. Further information on the impact of MLT and geomagnetic activity on chorus wave activity and distribution has also been added to the paragraph on magnetospheric wave activity.

Interactive comment on Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2020-18, 2020.

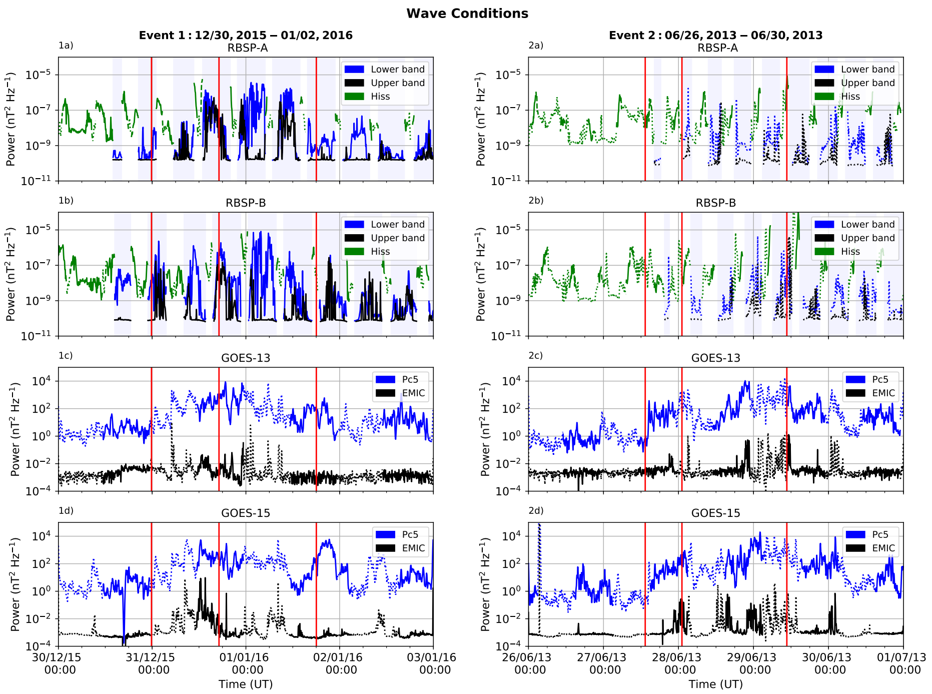

Fig. 1.

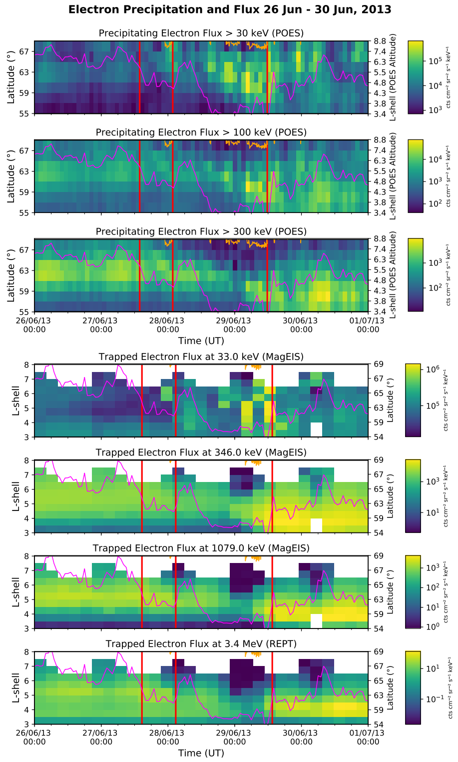

Fig. 2.

C7

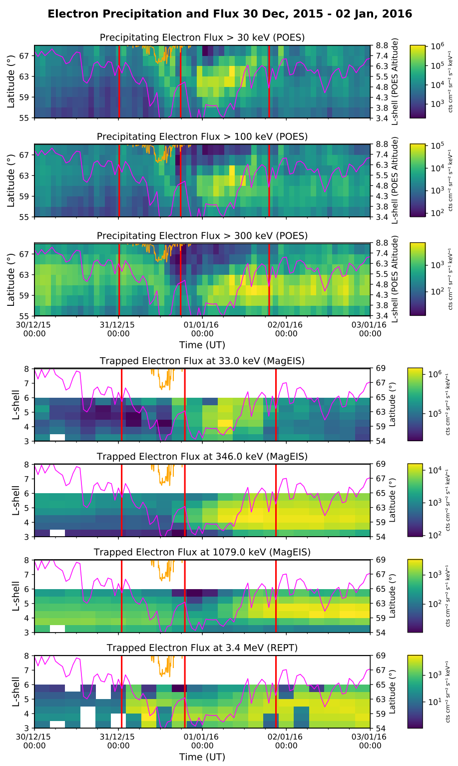

Fig. 3.

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