Supporting Information for "Evidence of sub-MeV EMIC-driven electron precipitation"

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Introduction

The following supplementary information provides additional information on the steps used to justify assumptions made in the main text of the paper.

Text S1.

In the case study in Section 3 we stated that, at the event time, the Demeter IDP electron flux closely resembled the electron fluxes measured by the NOAA-17 MEPED 90°instrument. A direct comparison between the POES MEPED and Demeter IDP instruments is not possible, due to a difference in the time resolution of their data (2 s resolution for POES, 4 s resolution for Demeter) and because the Demeter IDP fluxes are all differential fluxes, compared to the POES MEPED integral fluxes.

The time resolution difference between the instruments is easy to fix, simply downsampling the POES data to 4 s resolution. Converting the Demeter differential fluxes to a set of integral fluxes comparable to the POES electron channels is done using the same method as described in *Whittaker et al.* [2014]; as with *Whittaker et al.* [2014], we scale the Demeter flux by a small constant factor (2.7, in this case) to account for the difference in altitude of the instruments. The result is a set of integral fluxes that represent an estimate of what the MEPED E1–E4 channels would observe given the electron fluxes observed by Demeter. Figure S1 shows the results of this process, with panels (a), (b), (c), and (d) showing the MEPED measured and Demeter estimated fluxes for the E1, E2, E3, and E4 channels respectively. As was stated in Section 3, there is a close resemblance between the two sets of fluxes in both time variation and magnitude, suggesting they represent the same scattered electrons.

Text S2.

In Section 3 it was stated that strong diffusion was the likely mechanism that allowed us to observe electrons scattered by the EMIC wave in the POES and Demeter trapped flux detectors. Strong diffusion can be caused by strong EMIC waves with amplitudes ≥ 1 nT [*Summers and Thorne*, 2003], however for the presented case study only the electric field data was available from the Demeter ICE instrument (Figure (b)). We estimate the magnetic field amplitude of the EMIC wave using the relation:

$$B_{max} = \frac{E_{max} n}{c} \tag{1}$$

where c is the speed of light, and n is the refractive index. We estimated n as:

$$n^2 \approx \frac{\omega_{pe}^2}{\omega \Omega_e} \tag{2}$$

where ω_{pe} is the electron plasma frequency, ω is the wave frequency, and Ω_e is the electron cyclotron frequency. Using the IGRF magnetic field strength at the satellite and electron density from the Demeter Langmuir probe, we calculate the refractive index to be ~ 600 for a wave at 2.5 Hz. The ICE electric field amplitude at 2.5 Hz is approximately 0.8 mV/m, which gives us an estimated magnetic field amplitude of 1.4 nT. This suggests that the observed EMIC wave is indeed capable of causing strong diffusion.

References

Summers, D., and R. M. Thorne (2003), Relativistic electron pitch-angle scattering by electromagnetic ion cyclotron waves during geomagnetic storms, *Journal of Geophysical Research: Space Physics*, *108*(A4), doi:10.1029/2002JA009489.

Whittaker, I. C., C. J. Rodger, M. A. Clilverd, and J.-A. Sauvaud (2014), The effects and correction of the geometric factor for the POES/MEPED electron flux instrument using a multisatellite comparison, *Journal of Geophysical Research: Space Physics*, *119*(8), 6386–6404.

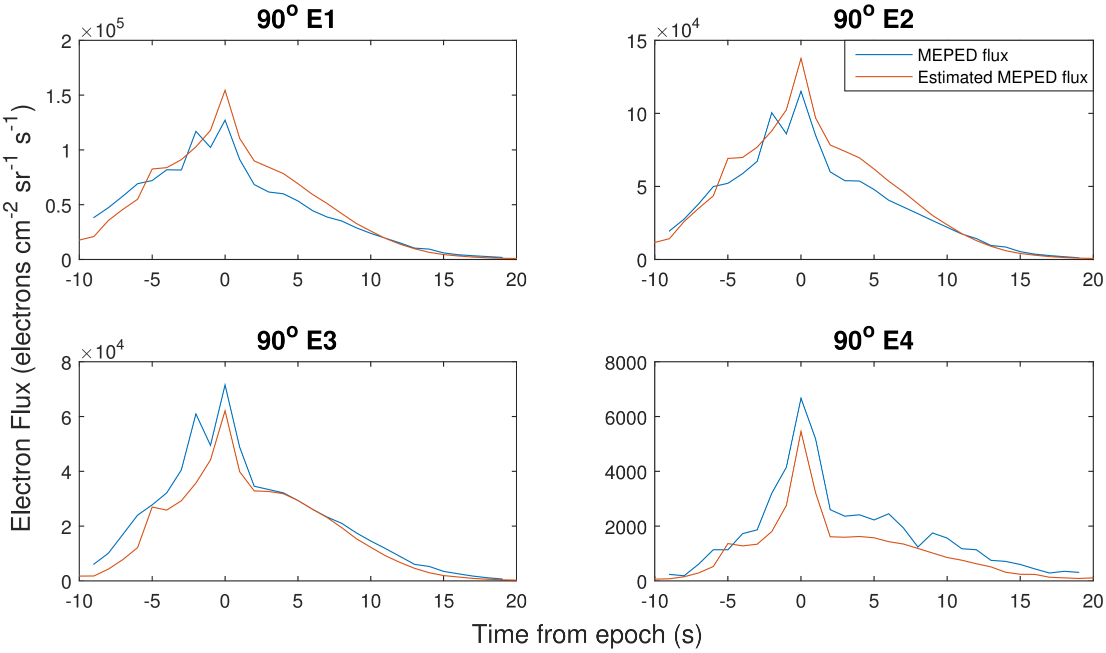

Figure S1. The NOAA-17 MEPED 90°electron flux data, resampled to 4 s resolution (in red), compared to the estimated MEPED flux at the Demeter satellite location, generated from the Demeter IDP data (in blue). Panels (a), (b), (c), and (d) represent the E1, E2, E3, and E4 electron flux channels respectively.