Auxiliary online material for:

Competing source and loss mechanisms due to wave-particle interactions in Earth’s outer radiation belt during the 30 Sep. - 03 Oct. 2012 geomagnetic storm


Figure S1: Comparing L-shell (red line with circles) to L* (blue line with stars) for RBSP-B’s outbound trajectory on 30 Sep. – 01 Oct. 2012. Both L and L* shown here were calculated using the TS05 magnetic field model. Note that: L = 4 corresponds to L* ~ 3.6 during this active period; L is consistently higher than L*; and the difference between the two becomes significantly greater at higher L-shells.
Figure S2: L* for RBSP-A (red) and -B (green) from the TS05 model from 00:00 UT on 30 Sep. to 00:00 UT on 02 Oct. 2012. This figure can be used for comparisons with the data shown in Figures 3 and 7 of the paper for clarity and timing on inbound vs. outbound trajectories and satellite conjunctions in phase space coordinates. This is the same as Figure S1 in the auxiliary material from Turner et al. [2014]

Figure S3: SAMPEX observations of >1 MeV (a) and >500 keV (b) electron count rates plotted vs. L-shell. Observations are taken from only those portions of SAMPEX’s orbit when it was in the afternoon/evening MLT sector (15:00 < MLT < 24:00) between 18:00 UT on 30 Sep. and 02:00 UT on 01 Oct. These data support the POES observations that there was enhanced precipitation loss of >1 MeV electrons at L < 4 in the evening MLT sector around and after ~22:00 UT on 30 Sep.
Figure S4: Electron and proton fluxes from the three available GOES spacecraft (g13, g14, and g15). Electron data from the MAGED instruments are shown in the top three plots, and proton data from the MAGPD instruments are shown in the bottom three plots. Each of the instruments’ five differential energy channels are shown in a different color with channel equivalent energies labeled on the side of each plot. Data are shown from the instrument suites’ third telescopes (tele3), which measured pitch angles nearest local 90-degrees throughout the period shown. With these multipoint observations, we were able to differentiate between energetic particle injections and trapping boundary crossings.

Additional model details: Here we simulated the event from 02-12 UT on 01 Oct. 2012 with 2 hour time step at \( L = 5.25 \). Note that although \( L^* = 4.5 \) corresponds to \( L \approx 5.65 \) at \( \sim 2-3 \) UT, it actually changed to a lower value of \( L < 5 \) in the later period of the simulation. Therefore, we used the averaged value of \( L \approx 5.25 \) for the simulation. We used initial conditions observed by the Van Allen Probes and adopted the dynamic global chorus wave model from POES electron measurements (averaged over \( L \) of 4-6). We used the
plasma trough density model from Sheeley et al. [2001], but we confirmed that the adopted density values are consistent with the density values from the Van Allen Probes around the dawn sector. Diffusion coefficients were calculated using those various parameters, and those coefficients were then used to run the 2D diffusion (energy and pitch angle) simulation of the event.

**Figure S5:** 2-dimensional diffusion model results simulating the effects of chorus waves on relativistic electron distributions. This figure shows the evolution of the electron pitch angle distributions for energies ranging from 100 keV to 7.1 MeV (shown in different colors). The different plots show different times, from $t = 0$ hours (the initial condition) to $t = 10$ hours. The simulation was performed at $L = 5.25$, and we compared these results to those observed by the Van Allen Probes, as discussed in the paper.
Figure S6: Relativistic electron energies as a function of L-shell and first adiabatic invariant (Mu) in a dipole field. For each fixed value of Mu, electrons moving across L-shells (radially in or out in the system) while conserving their first adiabatic invariants will be accelerated or decelerated to the corresponding energies, as shown here in color. Results are shown for four different values of equatorial pitch angles ($\alpha_{eq}$): 90, 60, 30, and 15 deg in a), b), c), and d), respectively. For example, an electron with $\alpha_{eq} = 60$ deg (b) and Mu = 700 MeV/G will have an energy of ~405 keV at L = 8 and an energy of ~1.7 MeV at L = 4 assuming it is transported inward while conserving Mu. Note that both the Mu and energy axes are plotted on a logarithmic scale and all four plots are shown over the same ranges in L, Mu, and energy.
Figure S7: Electron equatorial pitch angles ($\alpha_{eq}$) as a function of L-shell and the second adiabatic invariant (K) in a dipole field. For each fixed value of K, electrons moving across L-shells (radially in or out in the system) while conserving their second adiabatic invariants will experience an increase or decrease in $\alpha_{eq}$, as shown here in color. Note that K is plotted on a logarithmic scale and covers the full range of K’s examined in this study.

For the phase space density results from the Van Allen Probes for all $\mu$ and K combinations that were examined for this event, please see the RBSP_PSDs_AllMuAndK_Plots.zip file in the auxiliary online material.