Supporting Information for the Article *The Dynamics of Earth's Cusp in Response to the Interplanetary Shock*

Contents of this file

Figure S1, Figure S2, Figure S3

Introduction

This supplementary material contains (a) the CODIF time-of-flight spectra from Cluster C4 during the time interval from 22:30-24:00 UT using the level 0 data, which provide more details for interested readers on the data quality of different ion species; (b) the IMF B_Z, auroral electrojet indices, energetic electrons from GOES13 and energy O^+ from Van Allen Probe A, which provide the information of substorm injection onset.

1) Figure S1. We plot the CODIF time-of-flight (TOF) spectra for all energies as function of TOF channel and energy (or energy step) during different time intervals. The TOF spectra in panel a and c shows that H^+, He^+ and O^+ during the time intervals of 22:30-23:00 UT and 23:30-24:00 UT can be well distinguished from each other. The energy of O^+ is around 100 eV. The TOF spectra in panel b indicates that there are O^+ measurements in almost all energies but their counts are very low, which will be further analyzed in Figure S2. It should be noted that the He^{++} data product for CODIF is not valid because most of what is binned as He^{++} is just a tail on the proton distribution.
2) Figure S2. We plot the TOF spectra as function of TOF channel and normalized pulse-height counts in different energy step ranges during 23:00-23:30 UT. The spectrum in panel a and b show that there is a clear O^+ peak in the energy range of 21-40 keV and 10-21 keV, respectively. It is difficult to see a clear O^+ peak in the energy range of 6-10 keV as shown in panel c. In panel d, there is an enhancement in the O^+ range with some randomly distributed counts across all TOF channels. A technique to subtract the H+ "spill" from the CODIF measurements has been developed for the He^+ data product (Mouikis et al. 2014), but there is no one for O^+ data product. So it is difficult to distinguish O^+ from H^+ below 10 keV, but there are true O^+ signatures above 10 keV.
3) Figure S3. We plot the IMF B_Z, auroral electrojet indices (SMU and SML) and energetic particles in the dusk sector of the inner magnetosphere including energetic electrons from GOES13 and energetic O+ from Van Allen Probe A. After the IP shock arrival, the SML index was suddenly decreased and there appears the enhancement of energetic electrons and O^+ due to the substorm injection.

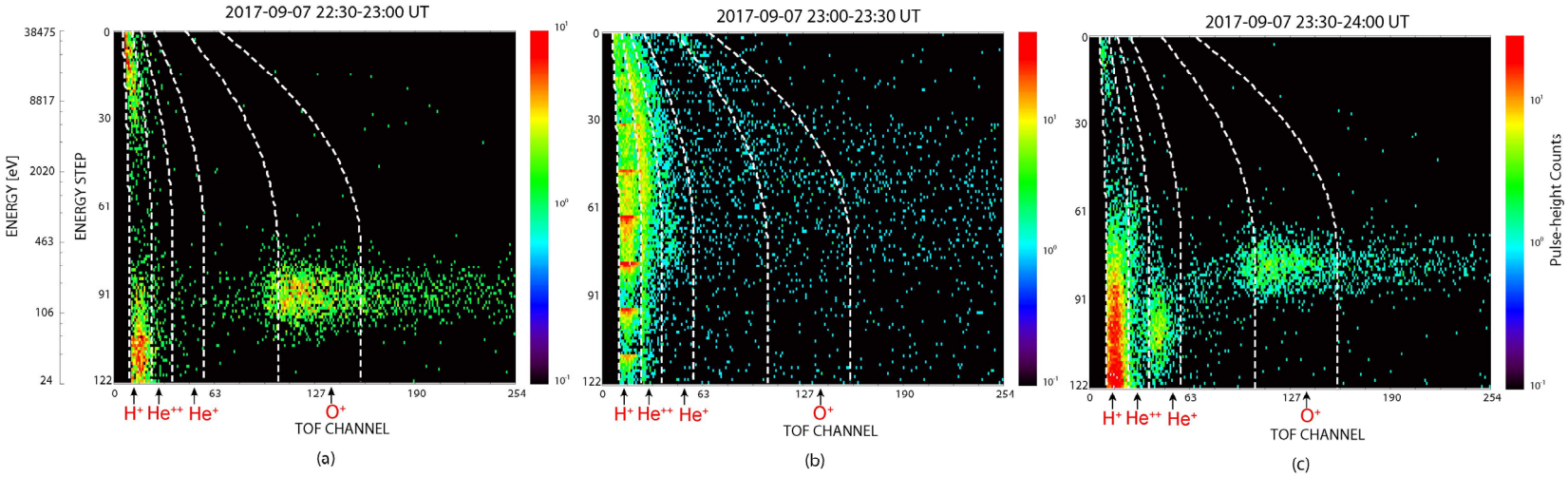

Figure S1. CODIF time-of-flight (TOF) spectra for all energies as function of TOF channel and energy (or energy step) during the time intervals of (a) 22:30-23:00 UT, (b) 23:00-23:30 UT, (c) 23:30-24:00 UT on 7 September 2017. The white dashed lines indicate the TOF windows for the four species, H^+, He^{++}, He^+ and O^+.

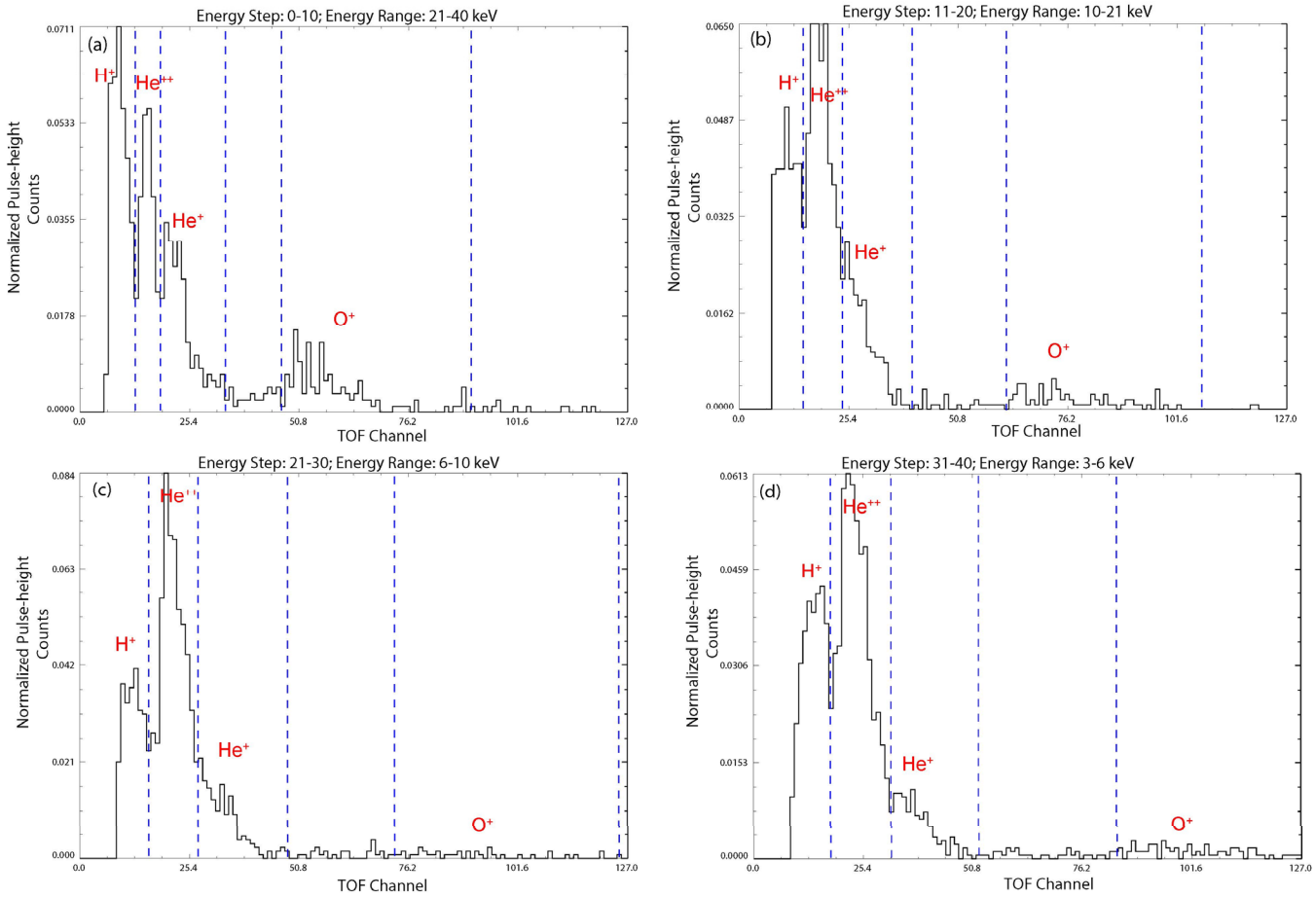

Figure S2. Time-of-flight spectra as function of TOF channel and normalized pulse-height counts in the energy step ranges of (a) 0-10; (b)11-20; (c)21-30; (d)31-40 during 23:00-23:30 UT. The vertical dashed lines show the TOF windows for H^+, He^{++}, He^+ and O^+.

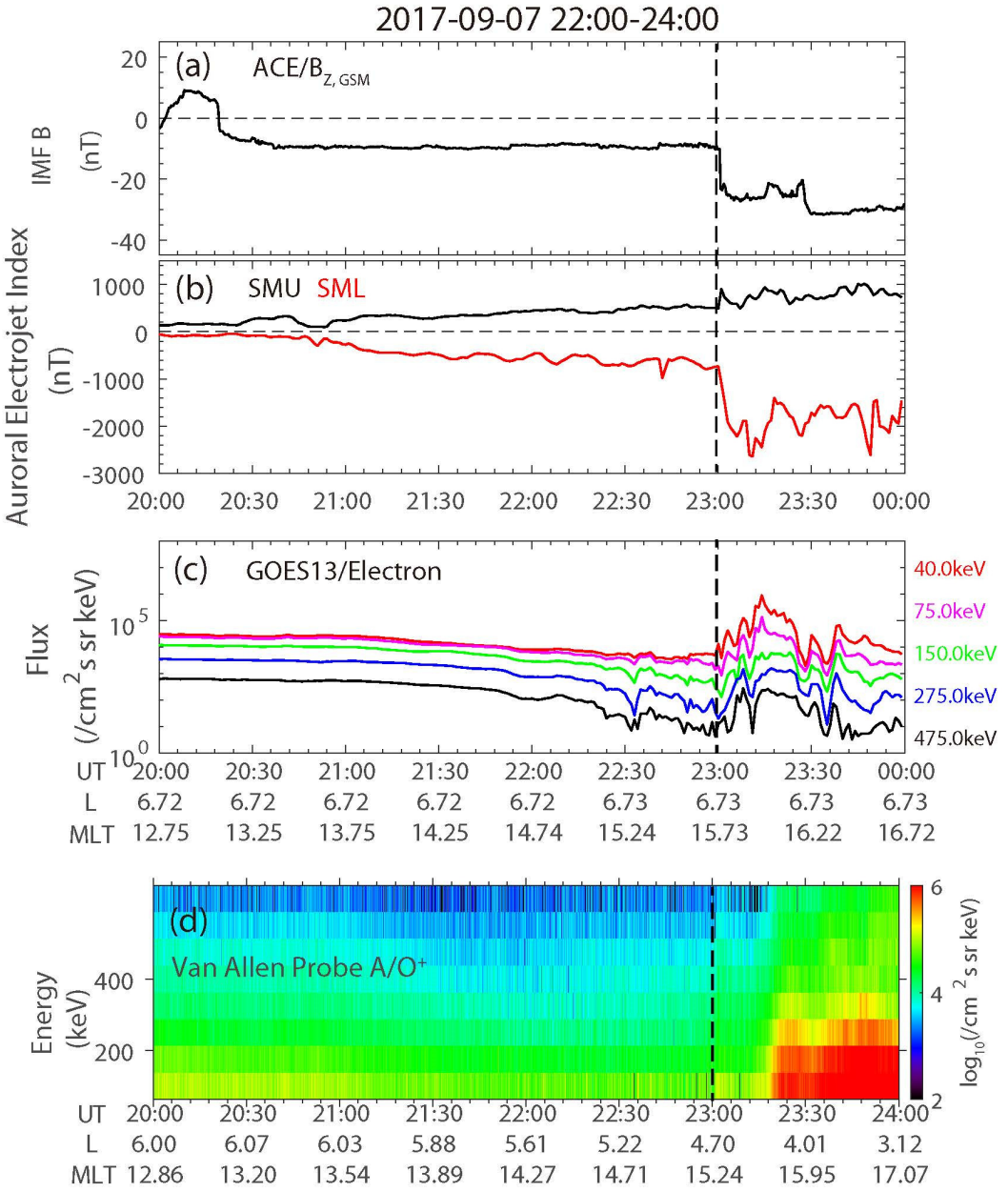

Figure S3. (a) IMF B_Z observed by ACE; (b) Auroral electrojet indices (SMU and SML); (c) Differential flux of energetic electrons observed by GOES13; (d) O^+ spectrum from the RBSPICE instrument onboard Van Allen Probe A. The vertical dashed line represents the shock arrival time (23:00 UT).