Ann. Geophys. Discuss.,
https://doi.org/10.5194/angeo-2019-5-RC2, 2019

Annales Geophysicae Discussions

Interactive comment on "Energetic electron enhancements under radiation belt (L < 1.2) during nonstorm interval on August 1, 2008" *by* Alla V. Suvorova et al.

Anonymous Referee #2

Received and published: 25 February 2019

General Comments

This paper reports energetic (>30 keV) electron flux enhancement at L<1.2 measured by the NOAA/POES satellites and relate it to the transient injection of magnetosheath plasma into the dayside magnetopause region, which is measured by the THEMIS satellite, and global geomagnetic pulses, which are measured by ground INTERMAGNET magnetometers and GOES satellites. The authors propose a scenario of possible association between these dayside magnetopause phenomena with the deep injection of >30keV electrons at L<1.2 by the penetration of localized electric field.

The electron flux enhancement at L<1.2 is well described including its research history

Printer-friendly version

Discussion paper

which is very interesting. Looking through this paper, however, I think the connection between the observed phenomena occurring in the dayside magnetosheath / magnetopause region and the electron flux enhancement at L<1.2 is weak and not well validated by the observations reported in this paper. These two phenomena occur in the same half day of 12-24 UT on August 1, 2008. But there is a significant possibility that they occur in the same day “by chance”. I think it is necessary to provide some more concrete evidence including some quantitative estimation that can explain the observed L<1.2 electron enhancement.

Specific Comments

1. The descriptions of OMTI, THEMIS, GOES and ground magnetometers are fair and easy to understand, although they can be shorter. The authors propose a scenario that dayside magnetopause phenomena cause magnetosphere compression, and associated magnetosheath / magnetospheric plasma precipitation to the dayside ionosphere at high latitudes that result in a local increase of the ionospheric conductivity. This in turn promotes generation of transient localized electric fields, which are able to penetrate from high latitudes to very low latitudes to accelerate energetic electrons at L<1.2. However, in the nightside auroral zone we have normal aurora and associated ionospheric conductivity change which can be much larger than those in the dayside aurora. If the scenario proposed by the authors works, why we do not have L<1.2 acceleration during ordinary (non-storm time) substorms which occur almost every day and cause strong aurora and associated conductivity change in the nightside high latitudes? If L<1.2 electron flux enhancement does not occur during ordinary substorms, I think it indicates that the proposed scenario does not work in the actual magnetosphere.

2. As shown in Figures 7 and 8 the THEMIS satellites shows repeating motion in and out from the magnetosphere to the magnetosheath. Such in and out features are very often seen when THEMIS is approaching to the magnetopause region, because the magnetopause location is not fixed and changes due to dynamic pressure change in

the magnetosheath and/or surface waves caused by Kelvin-Helmholz instability in the magnetopause. In the present case, since compressional wave signatures are seen in GOES and ground magnetometers, it is likely that the dynamic pressure variation outside the magnetosphere is the cause of this motion of THEMIS in/out from the magnetosphere. But I think such compressional wave with an amplitude of a few nano-tesla is not unusual and occur frequently. Then how often does the authors find L<1.2 electron acceleration? Is this a frequent phenomenon occurring associated with the frequently-occurring compression of the magnetosphere with the amplitude of a few nano-tesla on the ground magnetometers? How the authors can prove that these two phenomena occurs in the same time not by chance? Maybe the authors can check correspondence of timing between each magnetospheric compression and the electron flux enhancement at L<1.2.

3. The authors show magnetic field pulses observed by GOES and ground magnetometers. If the penetrating electric field is propagating in the magnetosphere, it should be related to the observed magnetic field variations by the Maxwell's equation of dB/dt = -rot E. One can argue that the observed magnetic field variation (dB/dt) can be used to estimate electric field by taking only one component of the rotation, e.g., dB/dt = dEx/dy (dEx = dB/dt * dy). The GOES magnetic field amplitude is $\sim$5 nT and the time scale was $\sim$500 s. If we take a localized scale size of dy = 1000 km, it gives the electric field intensity of 0.01 mV/m (=1000 x 10ˆ3 x 5 x 10ˆ-9 / 500). This value seems to be too small to cause the electron flux enhancement at L<1.2, because this value is two orders smaller than the prevailing electric field in the ionosphere by the thermospheric neutral wind through F-region dynamo. Thus, electric field associated with the observed magnetospheric compression seems not to work for the present case.

4. In Figure 2b, I noticed that not only the electron flux at L<1.2, but also the electron flux at high latitudes above +-60 degree increases, particularly at negative longitudes in the norther hemisphere and positive longitudes in the southern hemisphere. Thus the electron acceleration seems to be not confined at L<1.2. Why the authors neglect this

clear enhancement of electron flux about +-60 degrees? It is not clear whether the flux at middle latitudes increased or not in this color scale. If possible, it would be better to show the latitudinal profile of electron flux changes at some particular longitudes (e.g., at -120 degree) in a separated figure. Such figure may be useful to discuss how the electric field penetration suggested by the authors affect from high to low latitudes.

5. Sorbo et al. (GRL, 2006) indicated the >30keV electron flux enhancement in the NOAA/POES data at the equator caused by precipitation of energetic neutral atoms (ENAs). Although their events are mainly during magnetic storms, we can expect some amount of ENA flux even during quiet times, because ring current is a persistent feature in the magnetosphere. Is there any possibility that the present L<1.2 electron flux enhancement is related to the ENAs from the magnetosphere?

Sørbø, M., F. Søraas, K. Aarsnes, K. Oksavik, and D. S. Evans (2006), Latitude distribution of vertically precipitating energetic neutral atoms observed at low altitudes, Geophys. Res. Lett., 33, L06108, doi:10.1029/2005GL025240.

Technical Corrections

6. line 120-122: Please provide the values of the electric field suggested by these references.

7. line 182 (kept at the enhanced level for several hours): Readers cannot understand how the authors obtain the information “several hours” from Figure 1b. Please explain.

8. line 349-350 and line 462: I think we cannot exclude the possibility of solar wind dynamic pressure variations, since the OMNI solar wind dynamic pressure in Figure 3a shows small variations with time scales well less than 1 hour throughout the plotted interval.

9. lines 528-529: Why the authors focus only on night injections occurring occasionally from ∼1300 to ∼1700UT at 2-5 LT in Figure 2? There is a continuous injection at nearby 06 LT.

ANGEOD

10. Figure 3: I cannot see shaded box at 13-23 UT, which is mentioned in the figure caption.

Interactive comment on Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2019-5, 2019.