Ann. Geophys. Discuss.,
https://doi.org/10.5194/angeo-2018-64-RC1, 2018

Annales Geophysicae Discussions
Open Access

Interactive comment on "Dynamics Geomagnetic Storm on 7–10 September 2015 as Observed by TWINS and Simulated by CIMI" *by* Joseph D. Perez et al.

Anonymous Referee #1

Received and published: 11 July 2018

[GENERAL COMMENTS]

This paper presents the equatorial plasma pressure distributions obtained by the TWINS observation and by the drift kinetic simulation CIMI for the moderate storms of 7-10 September 2015. The general features of the plasma pressure in the inner magnetosphere are similar to each other, whereas some differences are found in terms of peak location, anisotropy, and spatial distribution. The authors attributed the differences to the shielding effect and spatially-localized, short-duration injections of hot plasma.

The direct comparison between a sophisticated observation and an advanced drift ki-

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netic equation is highly valuable, and is promising to overcome the difficulties arising from in-situ satellite observations. The provided data is basically very interesting, and I admire the authors' efforts to derive the pressure and anisotropy. However, I have 3 major concerns as follows. First, the physical interpretations made by the authors are unclear. Because of the lack of proper interpretations, I cannot catch new scientific knowledge, or insights in the current version of the manuscript. Secondly, the reliability of the plasma pressure obtained by TWINS is also unclear. The spectral shape of the ion flux is almost the same at 4 different points, which seems unlikely to occur. Thirdly, the plasma pressure mentioned in this paper is "partial" so that the "true" distribution of the plasma pressure would be different. Careful description is needed when the authors intend to say the distribution of the pressure.

[SPECIFIC COMMENTS]

(1) On the interpretations. The authors concluded that the difference between the observation and the simulation can be best explained by enhanced electric and magnetic shielding and/or spatially-localized, short-duration injections. First of all, please explain the meaning of the electric and magnetic shielding in more detail. Most of the readers may not understand the meaning of it. The electric shielding is supposed to result from the ionospheric electric field redistributed by the Region 2 field-aligned current. What is the magnetic shielding? What is the expected effect of the shielding on the pressure distribution and pressure anisotropy? CIMI/RCM takes into account the shielding. What physical processes or parameters does CIMI/RCM need to consider properly to explain the observations? Have the authors tested CIMI/RCM with different conditions/parameters to explain the observations? Secondly, please explain the expected effect of spatially-localized, short-duration injections on the pressure and anisotropy. Have the authors modeled spatially-localized, short-duration injections to explain the observations? Thirdly, please explain the reason why the CIMI result always shows parallel anisotropy of the plasma pressure in the dawn-midnight-dusk region. The pressure anisotropy is largely different from the observations. Detailed explanation is needed.

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(2) On reliability of the plasma pressure. In Figure 10, the differential fluxes of the ions are shown as a function of energy at 4 points. The intensity of the flux is different, but the spectral shape is almost the same with each other. Why is the spectral shape of the flux almost the same at the 4 points? According to in-situ observations, the spectral shape of the flux depends on L-value and magnetic local time (e.g., Milillo et al., 2001, 10.1029/2000JA900158), so that it seems kquite unlikely to be the same spectral shape at 4 points. Please explain the validity of the spectral shape of the flux and the plasma pressure distribution presented in this paper.

(3) On the plasma pressure. I suppose that the plasma pressure was calculated from integration of the differential flux over the energy range from 2.5 keV to 97.5 keV. The energy range is probably insufficient to cover all the ions trapped in the inner magnetosphere because the ions with energy greater than 100 keV is also known to contribute to the plasma pressure (energy density) largely (e.g., Smith and Hoffman, 1973, 10.1029/JA078i022p04731; Williams, 1983, 10.1016/0032-0633(81)90124-0). If the high energy ions remained during these storms, there would be another peak of the pressure, which may stay at L $\sim$ 2.5 – 3.0. I recommend discussing possible impacts of the high energy ions (>100 keV) on the conclusion. I also recommend emphasizing that the plasma pressure distribution is "partial" so that the pressure distribution is incomplete.

[MINOR COMMENTS]

Introduction: I recommend citing papers related to plasma pressure distribution and anisotropy observed by satellites, for example, De Michelis et al. (1999, 10.1029/1999JA900310), Ebihara et al. (2002, 10.1029/2002GL015430), and Lui (2003, 10.1029/2003GL017596).

Line 47-57: Simulation results with different electric field and/or magnetic field models have been conducted by Angelopoulos et al. (2002, 10.1029/2001JA900174) and Ebihara et al. (2004, 10.5194/angeo-22-1297-2004).

Line 58-63: This paragraph seems not to provide information. What key spatial features do Wang et al. (2011) find?

Line 311: The equatorial pressure p_eq is difficult to understand. Please explain how to derive p_eq.

Line 489-496: Ebihara et al. (2009) also showed multiple peaks of the plasma pressure distribution in the inner magnetosphere by introducing temporal changes in the distribution function at the outer boundary of CRCM. It would be worth mentioning that the rapid changes in the distribution function in the plasma sheet could result in the multiple peaks of the plasma pressure.

Line 499 "But they do not provide incontrovertible evidence for the effects of spatially and temporally dependent injections into the inner magnetosphere." This sentence is difficult to understand.

Figure 10, caption: Please indicate the unit of the color bar (probably in keV), and pitch angle of the particle. What is the meaning of "Minimum – Maximum Energy for Each Path"?

Line 520, "Peak 5" Does it mean "Peak 4"?

Line 497-527: The spectral shape of the differential flux of the ions is almost the same at the 4 points. Please explain the validity of the differential flux derived from TWINS? At Peak 3, the ion is inaccessible from the outer boundary. I recommend tracing the ion trajectory backward in time by starting at slightly different points.

Line 546-548: "This is not unexpected as the ions are being injected into regions of higher magnetic field, and conservation of the first adiabatic invariant would predict the enhancement of parallel pitch angles." I cannot understand this meaning. Please explain the reason why the conservation of the first adiabatic invariant results in the pressure anisotropy dominated by the parallel component?

Line 548-550: "Nevertheless the parallel anisotropy is seen in the observations only during the main phase of the first storm. This is also an indication of stronger electric and magnetic shielding." Please explain the reason why the stronger shielding results in the parallel anisotropy?

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