Characteristics of dayside magnetospheric flows during solar wind dynamic pressure pulse

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Abstract

The response scenario of dayside magnetospheric plasma flows to the sudden increase of solar wind dynamic pressures was studied with 5 events from THEMIS observation. In all events we observed bipolar Vx(-/+) signatures as a response. The inferred flow vortices presented to be rotating clockwise and counterclockwise in the morning and afternoon side, respectively, as see from the north. Moreover, the pre and after noon flow vortices move toward –y and +y direction. The in situ observation of dayside plasmasheet flow vortices may provide a new possible mechanism for the solar wind dynamic impulse associated dayside ionospheric convection vortices.

1. Introduction

An observational feature of flow vortices is the bipolar-like Vx/Vy (GSM/GSE) signatures [1,2]. Some plasma sheet flow vortices may be associated with the sudden solar wind dynamic pressure variations [3-5]. It is well known that the solar wind dynamic pressure could cause 'magnetic impulsive events' in the high latitude dayside ground [6]. It has been interpreted as the effects of the ionosphere convection flow vortices. However, due to the lack of simultaneously magnetosphere and solar wind observations, few study have been done on the responses of dayside magnetospheric plasma flow to the solarwind pressure pulse. In this study, 5 events from THEMIS observations are chosen to describe the response scenario of magnetospheric plasma flows to the sudden increase of solar wind dynamic pressures.

2. Observations

For our events, there are solar wind dynamic pressure impulse observations and at least one THEMIS satellite located in the dayside magnetosphere simultaneously. The impulse amplitude(Δp/p) range from 0.5 to 5.3. Figure 1 presents a superposed epoch analysis of the ion

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velocity perturbations. The time domain is ±15min and the coming time of sudden solar wind dynamic pressure enhancement was taken as the zero epoch. The order numbers (1)-(5) with different colors denote the 5 different events. Disturbance occurred mainly in the XY plane. All events observed bipolar Vx(-/+) signatures after the zero epoch. However the duration of this signal ranges is not the same. It ranges from 7 to 14 min. The major change in Vy of event (1)-(4) also showed the bipolar signature directly after the zero epoch with certain phase difference with the Vx. It shows to be -/+ for event (1)-(3) and +/- for event (4). While event 5 just showed a negative unipolar disturbance.

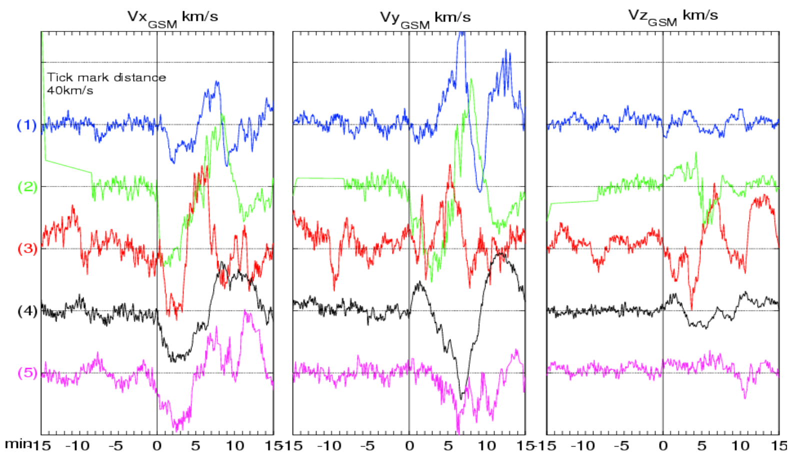

Figure1. Superposed epoch analysis of the ion velocity perturbations. The vertical line represents the arrival time of the solar wind dynamic pressure pulse to the magenetosphere.

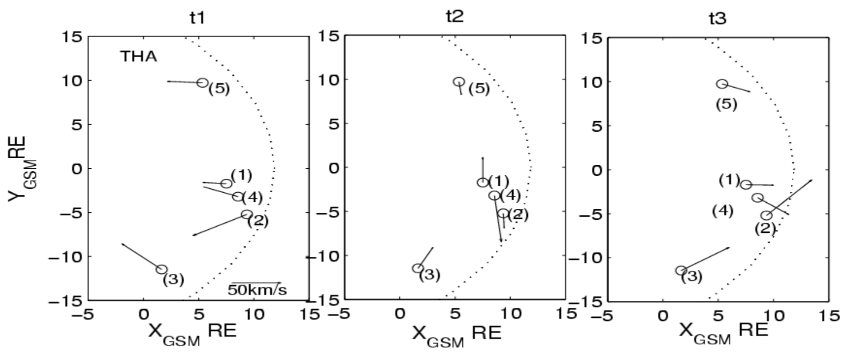

Figure 2 Rotational characteristics of the velocity field (THEMIS-A) in the GSM XY plane. t1 t2 and t3 denotes the times of maximum, reversal point and minimum value of the Vx bipolar signals for each event.

Figure 2 shows the rotational characteristics of the velocity field measured by THEMIS-A satellite in the XY plane. t1 t2 and t3 represent the times of maximum, reversal point and minimum value of the Vx bipolar signals respectively for each event. It can be seen that the dawn (event 1,3) and dusk (event 5) events showed clockwise and counter clockwise rotation, respectively. But the pre-noon events 2 and 4 did not show the clockwise rotation of the law. In fact, the direction of rotation direction of velocity vector from a single satellite is not necessarily equal to the rotation sense of a vortex structure [7]. We will further point out that these signals are from different orbit crossing of the vortex structure by satellites in next section.

3. Interpretations

As shown in figure 3, the distances between the three satellites for event 2 are about 1.5Re. The multi joint observations are useful to confirm the existence and spread of a vortex. t1 t2 and t3 is with the same meaning as in Figure 2. Obviously, the rotation of velocity vectors can be interpreted as a traveling clockwise rotating vortex in the pre noon sector. Its phase velocity is pointing toward the west and outward the magnetopause. Further more, according to figure 2, we infer the direction of rotation and movement characteristics of vortex in the dayside XY plane. It shows that, see from the north, the morning and afternoon side vortex are clockwise and counterclockwise, respectively. Moreover, our examples present a movement direction of –y and +y direction for the pre and after noon flow vortices. As the distance far from the noon , the phase velocity gradually deviated to the tailward. In situ observations of the dayside plasmasheet flow vortex may provide a new possible mechanism for the solar wind dynamic impulse associated ionospheric convection vortices. We will carry out the corresponding study in the next work.

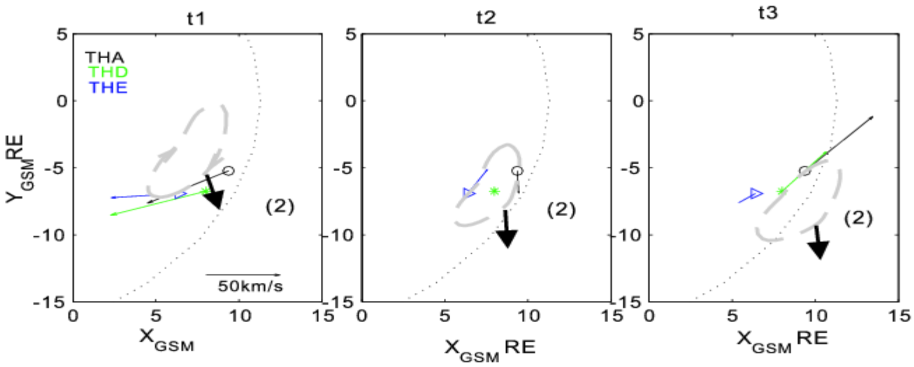

Figure 3 Schematic diagram of motion of the flow vortex for event 2. The gray dashed lines present the vortex flow. Thick black arrows indicate the direction of vortex motion.

4. Acknowledgments

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