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Geomagnetic effects of solar wind density enhancements

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Geomagnetic effects due to sharp solar wind density enhancements during a solar wind magnetic disturbance observed on 08 June 2000 are examined. Three cases of solar wind density enhancements are investigated in this study. They are measured at 0840 UT, 1224 UT and 1430 UT at the ACE satellite position at about 230 Re upstream in the soar wind. The first one was a shock associated density jump and the other two are large density enhancements observed in a core of the magnetic cloud. The solar wind bulk speed was about 500 km/s before the shock and jumped to 780 km/s drastically with the shock front. The solar wind thereafter, maintained its speed of about 700 km/s through the course of the magnetic cloud. The shock was the density jump of about 10 /cc from 4/cc to 13/cc, which was corresponding to the dynamic pressure change of about 10 nPa from 2 nPa to 12 nPa. Therefore, the dynamic pressure change forced the sharp magnetosphere compression on the dayside magnetosphere and produced the severe magnetic disturbance in the magnetosphere. The other following two density changes were about 13 – 15 /cc, corresponding to the dynamic pressure changes of about 10 – 13 nPa. Therefore, the dynamic pressure changes in the core of the magnetic cloud were large comparable to or rather bigger than that observed at the shock front, suggesting that important geo-effectiveness should be taken into account in the magnetosphere dynamics. The other important point is the accompanied density fluctuations. It is well known that there are a variety of period in the solar wind density fluctuation. The order of magnitude was observed from 1/cc to 10 /cc with a period ranged from 1min to 20 min, which covers a wide period range of magnetic oscillations usually observed in the magnetosphere and on the ground. Therefore, the density fluctuations observed in the solar wind are very important to investigate the magnetosphere physics. The shock did not accompany any clear density oscillations. However, on the ground and in the magnetosphere Psc oscillations were observed. They are clearly intrinsic to the geo-magnetosphere. On the other hand, the following two density enhancements were observed with accompanying clear density oscillations of about 4 - 8 min (2 - 4 mHz) in the solar wind. The temporal variations of the density fluctuations observed in the solar wind density enhancements were different, i.e., the former was a longer period with rather periodic oscillations with a period of about 5 – 8 min. The latter was very sharp increase accompanied a shorter period oscillation less than 5 min. The geo-effectiveness and their oscillations observed in the magnetosphere and at the geosynchronous orbit were different between them. The oscillations were observed much clearly in the former case and not in the latter case. On the ground the oscillations were observed over a wide range of the longitude from the dayside to night. The oscillation period was very similar to those observed in the solar wind. However, in more detail examination the oscillation was not clearly observed in the morning side high latitude ground stations, higher than 60 degrees in the GM latitude. The former case was masked by a substorm activity, which was triggered by the density enhancement and developed in the night side to the early morning side auroral regions. On the other hand, the latter was due to the sharp increase of the dynamic pressure. The synchronous orbit satellite was undergone by the multiple magnetopause crossings. Therefore, the magnetic variations observed at the higher latitude ground stations were similar to those observed by the synchronous satellite at the magnetopause crossing. These observed facts suggest that the density enhancements and their oscillations in the solar wind are very important for the magnetosphere dynamics and the excitation of ULF waves in the magnetosphere.