

Improvement of magnetic cloud interpretation by a torus model: 2. MCs with 20-30 hours durations

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As a result of the fitting analysis of magnetic clouds (MCs) with durations exceeding 30 hours by both a cylinder model and a torus model, we found that there are 4 different cases in the MC events as follows (reported in previous talks).

Case A: MC events in which magnetic fields exhibit rotations through large angles appreciably exceeding 180 degrees that should be interpreted with a torus model. These cases are considered to be observed when the spacecraft traversed deep into the MC near the leg of the MC loop.

Case B: The magnetic field rotation angles within the MCs are less than 180 degrees, but nevertheless a torus model is needed for interpreting the observation. These are considered as cases in which the spacecraft traversed the MC near the leg of the loop where the curvature effects are important, but only through the part near the surface.

Case C: MC events that can be explained equally well both with a torus model and with a cylinder model, and the MC geometries obtained from the two models are similar. These can be taken as cases in which the spacecraft traversed the MC at the portion near the apex of the MC loop.

Case D: MC events that can be explained equally well both with a torus model and with a cylinder model, but the MC geometries obtained from the two models are very much different. For these events, it is impossible only from the fitting analysis to determine which is the right model for the observed MCs. (However, it is suspected that either cases exist in reality.)

The existence of Case D raises an important problem. For example, it imposes a strong impact on the study of the relationship between the MC magnetic fields and the coronal magnetic fields. Besides, we found a tendency that the MC radii obtained from the torus fitting are generally smaller than those obtained from the cylinder fitting. This raises a question about the correctness of the average MC size obtained in the previous studies. It is highly desirable to analyze as many MC examples as possible. Therefore, we extend the analysis by including MC events with shorter durations. In this study, we selected 38 MC events from the ACE solar wind data from 1998 through 2006, the durations of which are in the range of 20-30 hours. The analysis is underway at present, but we confirmed that there are 4 different cases as we noticed for the MC events with durations exceeding 30 hours.