Determination of flux rope axis orientations and search of causative coronal mass ejections for MC events during 2006 and 2007

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The magnetic cloud (MC) is a transient structure of the solar wind which is often associated with a specific type of the magnetic field, called the flux rope. The magnetic structure of the flux rope is characterized by helical magnetic field lines around the central axis. The work presented here intend to elucidate the evolution of the axis direction of MCs during the propagation through interplanetary space. This is an important subject for obtaining better understanding of the propagation process of MCs in interplanetary space as well as for improving accuracy of space weather forecasting since the axis direction is one of the controlling factor for the geo-effectiveness of MCs. A recent study showed that the axis orientation of MCs only slightly changes during its propagation from the Sun to 1AU (Marubashi et al., 2015). However, another researches suggested that the axis of MCs can rotate during the propagation in interplanetary space (Yurchyshyn, 2008; Isavnin et al., 2012). In this presentation, we report MC structures determined from in situ measurements at 1AU, and identification of causative coronal mass ejections (CMEs) associated with MCs observed at 1AU. We analyze five MC events during 2006 and 2007. The MC structures are determined from in situ observations by the Advanced Composition Explorer (ACE) using two kinds of the flux rope model: the cylinder model and the torus model (Marubashi and Lepping, 2007). As a result, the torus model yields the axis orientation similar to (less than 11 deg) that of the cylinder model for two MC events, a little different (near 30 deg) for one event, and largely different (greater than 90 deg) for one event and the remaining event can be fitted well by only the torus model. To identify the causative CMEs for these MC events, we check all CMEs in the Large Angle Spectroscopic Coronagraph (LASCO) catalog (cdaw.gsfc.nasa.gov/CME_list/; Yashiro et al., 2004) that occurred 0.5 to 5 days prior to the MC arrival time at 1AU and select candidate CMEs whose first appearance time and initial velocity are consistent with the MC arrival time and velocity at 1AU. Several candidate CMEs are usually found. To examine whether these CMEs are back side or front side, we determine the propagation direction for eight CMEs during 2007 from Solar Terrestrial Relations Observatory (STEREO) coronagraph data using Graduated Cylindrical Shell (GCS) model. Unfortunately, we cannot determine the propagation direction for seven CMEs since CME shape is not clear or not detected. We need to examine some signatures of CME eruption on the solar disk in the future study.