§27. Testing Model for Prediction System of 1-AU Arrival Time of CME-associated Interplanetary Shocks

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We investigated influences of solar wind structure on coronal mass ejection (CME), one of macroscopic plasma phenomena, -caused interplanetary shock wave using solar wind and CME models in 3D hydro-dynamical simulation. Slow wind region and CME evolve and their positions change in space and time. We examined whether existence of slow wind regions affected passage of a CME-caused interplanetary shock wave.

Our solar wind models are follows: Solar wind has fast and slow region. Wind velocity input into inner boundary takes minimum on a geodesic line, and smoothly connects to fast wind with *tanh^2* profile. The plane containing the geodesic line ("slow wind line") is tilted to the solar axis and rotates together with solar rotation. It models meandering current sheet. A CME occurs at N15W00.

Figure 1 shows a hierarchical mesh structure used in this study (left) and 10 times magnification at the center (right) at 2 hours after CME occurs. Earth positions at (215,0). The minimum cell size is boxsize/4096 and the maximum one is boxsize/64. Contour represents velocity.

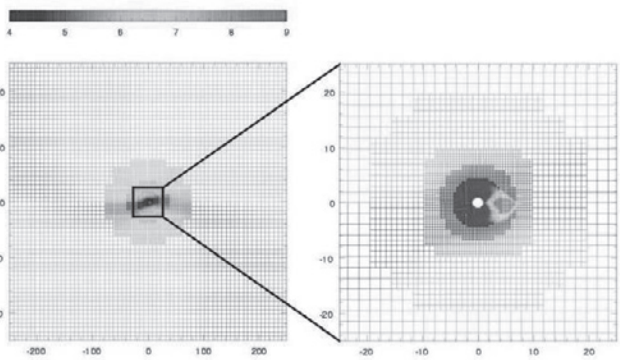

Fig.1 A hierarchical mesh structure with velocity contour.

Figure 2 represents Density profile at the Earth, 4 models with tilting angle of 30 deg and direction angle of 105 deg , 135 deg, 225 deg and 255 deg. Thin lines represent background solar wind. Figure 3 shows that velocity profile at the Earth, 4 models with tilting angle of 30 deg direction angle of 105 deg, 135 deg, 225 deg and 255 deg. Thin lines represent background solar wind.

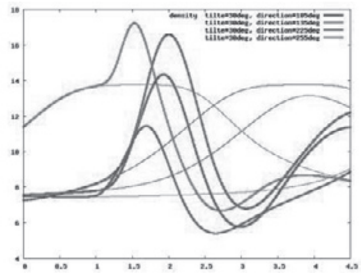

Fig.2 Density profile at the Earth.

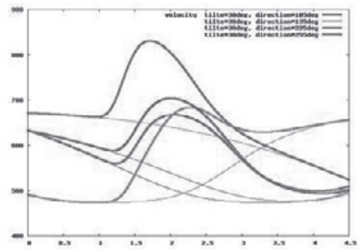

Fig.3 Velocity profile at the Earth.

Models, in which the slow wind line lies from north-west to south-east, show simple results that a CME-caused shock wave which travels in fast wind arrives at Earth in early time and which collides the slow wind or corotating interaction region (CIR) arrives in late time. Models, in which the slow wind line lies from south-west to north-east and a CME occurs on the east side of the slow wind line, density peak is followed by velocity peak. That implies the shock wave pushes CIR and compresses matter. In 30 deg tilting model, the part of CME which has Earth-ward velocity is the south-side of slow wind line, although the center of the CME places on the north-side. So a shock wave is prevented by CIR, then it arrives at Earth in late time. In 60 deg tilting model, the part of CME which has Earth-ward velocity places on the slow wind line. Because slow wind region curves toward east in interplanetary space, the shock wave toward slightly west probably propagates to Earth and arrives in early time. After this, the wave initially toward Earth sweeps slow wind matter and bring density peak.

We showed that slow wind region prevented traveling of CME-caused shock wave. It brought delay of arrival time about half a day. Whether slow wind region went ahead or not affected the arrival time of the shock wave. In addition, tilting angle (or meandering amplitude) of slow wind region also did affect the shock wave propagation.