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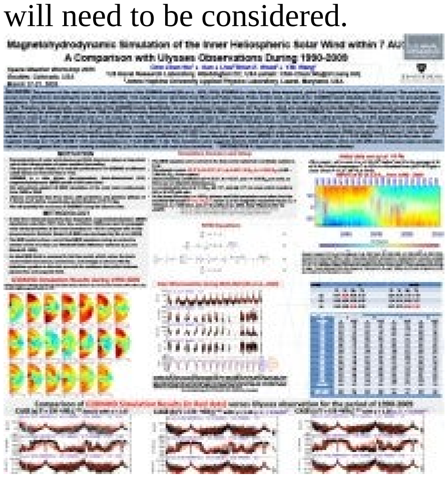
Poster
The purpose of this work is to test the performance of the G3DMHD model [Wu et al., 2020, 2024]. G3DMHD is a data driven, time-dependent, global 3-D magnetohydrodynamic (MHD) model. The model has been proven to be effective in simulating the solar wind at and within 1 AU using the solar wind data from Wind and Parker Space Probe. In this work, we extend the G3DMHD model simulation domain out to 7 AU and perform three simulations. The simulated solar winds are compared with the Ulysses observations. Ulysses was the first (and still the only) spacecraft to orbit the Sun with a high inclination angle (~80º), monitoring the solar wind from pole to pole. Therefore, its data provide a stringent test of the G3DMHD model. Specifically, we use a sequence of source surface (2.5 R?) maps, which are extrapolated from the (Mount Wilson Observatory) photospheric magnetic field maps using the potential field model, from 1990 to 2009 continuously covering two solar minima (1996 & 2008) and one solar maximum (2000), to drive G3DMHD. We consider the following three different inner boundary conditions: Case-A: Vr = 150 +500 fs km/s and ? = 1.67; Case-B: Vr = 150 +650 fs km/s and ? = 1.46; and Case-C: Vr = 150 +650 fs km/s and ? = 1.30, where Vr is the radial speed at 18 R?, ? is the specific heat ratio, and fs is expansion factor. After comparing with the Ulysses observations (density, speed, temperature and magnetic intensity), the following results are found: (a) None of the three cases can lead to a satisfactory result for the four solar wind plasma and field parameters for all region/period being considered; (b) the solar wind speed is under-estimated in the pole region during solar minima for Case-A; (b) the solar wind temperature is under-estimated for Case-A for the entire time period and Case-B in solar minima; is over-estimated during 1997-2001 for Case-C; (c) the solar wind speed is over-estimated in solar maximum (2000) for both Case-B & Case-C; (d) the Case-C results in a better agreement for both solar wind density (Pearson correlation coefficient (cc) = 0.58; mean absolute squared error (MASE) = 0.64) and the solar wind velocity (cc = 0.56; MASE = 0.75) than for the solar wind magnetic intensity (cc = 0.40; MASE = 1.97) and temperature (cc = 0.38; MASE = 1.28). This simulation work suggests that the initial solar wind speed at the inner boundary, which is still difficult to measured, plays an important role. It is also suggested that a proper heating (controlled by ?) in the solar wind will need to be considered.



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