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Comparing the Global MHD simulations of the terrestrial magnetosphere with Cluster measurements

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We use Grand Unified Magnetosphere Ionosphere Coupling Simulation (GUMICS-4), a 3-D magnetohydrodynamic (MHD) code, to simulate one full year (155 Cluster orbits) of the solar wind's interaction with the Earth's magnetosphere. We input real solar wind measurements to the code to create the longest-lasting global MHD simulation to date. The applicability of the simulation results depends critically on the input parameters used in the model. Therefore, the validity and the variance of the OMNI data are first investigated thoroughly using Cluster measurements close to the bow shock. The OMNI and the Cluster data were found to correlate very well. The solar wind magnetic field and plasma parameters do not change significantly from the L1 Lagrange point to the foreshock; therefore, the OMNIWeb data are appropriate input to the GUMICS-4.

The simulation results were saved along Cluster reference (SC3) orbits in simulation space. The solar wind plasma density, velocity along the Sun-Earth line, and north/south component of the interplanetary magnetic field are correlated with Cluster SC3 measurements in the solar wind, the magnetosheath, the dayside and the nightside magnetosphere. GUMICS-4 simulation output agree with the measurements very well in the solar wind and the magnetosheath. However, the modelled magnetosphere significantly differs from the measured one. In the magnetotail, magnetic fields and velocities agree well, but temperatures and densities differ greatly. GUMICS-4 predicts a very short magnetotail. This might result from the simple magnetosphere model and the missing ring current in the simulation.