



## **Accuracy of MHD simulations: Effects of simulation initialization in GUMICS-4**

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We conducted a study aimed at revealing how different global magnetohydrodynamic (MHD) simulation initialization methods affect the dynamics in different parts of the Earth's magnetosphere-ionosphere system. While such magnetosphere-ionosphere coupling codes have been used for more than two decades, their testing still requires significant work to identify the optimal numerical representation of the physical processes. We used the Grand Unified Magnetosphere-Ionosphere Coupling Simulation (GUMICS-4), the only European global MHD simulation being developed by the Finnish Meteorological Institute.

GUMICS-4 was put to a test that included two stages: 1) a 10 day Omni data interval was simulated and the results were validated by comparing both the bow shock and the magnetopause spatial positions predicted by the simulation to actual measurements and 2) the validated 10 day simulation run was used as a reference in a comparison of five 3 + 12 hour (3 hour synthetic initialisation + 12 hour actual simulation) simulation runs.

The 12 hour input was not only identical in each simulation case but it also represented a subset of the 10 day input thus enabling quantifying the effects of different synthetic initialisations on the magnetosphere-ionosphere system. The used synthetic initialisation data sets were created using stepwise, linear and sinusoidal functions. Switching the used input from the synthetic to real Omni data was immediate.

The results show that the magnetosphere forms in each case within an hour after the switch to real data. However, local dissimilarities are found in the magnetospheric dynamics after formation depending on the used initialisation method. This is evident especially in the inner parts of the lobe.