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The non-linearity of the cross-polar cap potential during high solar wind driving: GUMICS-4 results

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We study the influence of the solar wind driving on the cross-polar cap potential (CPCP) using the Grand Unified Magnetosphere-Ionosphere Coupling Simulation (GUMICS-4), the only European global MHD simulation developed by the Finnish Meteorological Institute. The CPCP is a key parameter in describing the energy input from the solar wind to the magnetosphere as it couples directly the solar wind to the ionosphere. While it is generally accepted that the response of the CPCP to the solar wind electric field Y component is nonlinear, the process associated with the nonlinearity of the coupling remains an open issue.

We use artificial solar wind data in order to mimic weak and strong solar wind driving in GUMICS-4 by combining high and low IMF magnitudes with high and low Mach number values by means of varying IMF By and Bz and solar wind plasma flow speed. The duration of every simulation run was 5 hours containing a stepwise changing plasma flow speed every one hour from 350 km/s to 750 km/s in 100 km/s steps. The magnitude of the IMF magnitude remained constant in every simulation run, however five different values (3.5 nT, 7 nT, 10 nT, 20 nT, 30 nT) were used thus making it a total of five simulation runs.

This study contributes to explaining processes leading to the CPCP non-linear response to the solar wind electric field Y component and, most importantly, in which part of the system the nonlinearity arises.