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Hybrid simulations of Venus' ionospheric magnetization states

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The solar wind interaction with the plasma environment of Venus is studied with focus on ionospheric magnetization states using a 3D hybrid simulation code.
The plasma environment of Venus was investigated mainly by Pioneer Venus Orbiter (PVO) and the still ongoing Venus Express (VEX) mission. Unlike many other planets, Venus' ionosphere is not shielded by a strong magnetosphere. Hence, data measured by spacecraft like PVO and VEX close to the planet are highly sensitive to solar wind and IMF upstream conditions, which cannot be measured while the spacecraft is inside the magnetosheath region about one hour before and after the closest approach. However, solar wind and IMF are known to change within minutes; ionospheric magnetization states, found by PVO and VEX, are highly dependent on the solar wind upstream pressure and also the magnetic field direction may change rapidly in case of a magnetic sector boundary crossing. When these solar wind induced transition effects occur, the causal change in the solar wind cannot be determined from ionospheric in-situ data. Additionally, with an orbital period of 24 hours, measuring transition timescales of solar wind triggered events is not possible.
Our self-consistent simulations aim to provide a global picture of the solar wind interaction with Venus focusing on the effects of upstream fluctuations to the magnetic field in the vicinity of the planet. We use the A.I.K.E.F. (Adaptive Ion Kinetic Electron Fluid) 3D hybrid simulation code to model the entire Venus plasma environment. The simulation grid is refined within the ionosphere in order to resolve strong small-scale gradients of the magnetic field and ion density, a necessity to describe the magnetic field depletion inside the Venus' ionosphere. In contrast to other simulation studies, we apply no boundary conditions for the magnetic field at the planetary surface. Furthermore, we include varying upstream conditions like solar wind velocity and density as well as IMF strength and direction by adjusting these parameters after a first, quasi-stationary state has been reached. This allows for a simulation of dynamic processes like the transition between the magnetized and unmagnetized ionospheric state and fossil fields.