EGU23-6104, updated on 19 Apr 2024
https://doi.org/10.5194/egusphere-egu23-6104
EGU General Assembly 2023

Soft X-ray Imaging of Earth's Magnetopause under Different Solar Wind Conditions: Three-Dimensional Global Hybrid Simulations

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Earth's magnetopause is a thin boundary separating the shocked solar wind plasma from the magnetospheric plasmas, and it is also the boundary of the solar wind energy transport to the magnetosphere. Soft X-ray imaging allows investigation of the large-scale magnetopause by providing a two-dimensional (2-D) global view from a satellite. However, it is challenging to derive information about the three-dimensional (3-D) magnetopause from a 2-D X-ray image. By performing 3-D global hybrid simulations, we obtain the soft X-ray imaging of Earth's magnetopause under different solar wind conditions. The soft X-ray images observed by a hypothetical satellite are shown, and the location of the magnetopause, the cusps, and the magnetosheath are all identified in the X-ray images. Although there is a large amplitude fluctuation of the X-ray emissivity in the magnetosheath, the maximum X-ray intensity matches the tangent directions of the magnetopause well, which indicates that the magnetopause location can be identified from the 2-D X-ray images. Moreover, the magnetopause location can be identified with different positions of the satellite. We also find that solar wind conditions have little effect on the magnetopause identification. The Solar wind Magnetosphere Ionosphere Link Explorer (SMILE) mission will provide the X-ray images of the magnetopause for the first time, and our global hybrid simulation results can help better understand the 2-D X-ray images of the magnetopause from a 3-D perspective, with particle kinetic effects considered.