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Four-fluid MHD Simulations of the Plasma and Neutral Gas Environment of Comet 67P/Churyumov-Gerasimenko Near Perihelion

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The neutral and plasma environment is critical in understanding the interaction of the solar wind and comet 67P/Churyumov-Gerasimenko (CG), the target of the European Space Agency's Rosetta mission. In this study, we have developed a 3-D four-fluid model, which is based on BATS-R-US (Block-Adaptive Tree Solarwind Roe-type Upwind Scheme) within SWMF (Space Weather Modeling Framework) that solves the governing multi-fluid MHD equations and the Euler equations for the neutral gas fluid. These equations describe the behavior and interactions of the cometary heavy ions, the solar wind protons, the electrons, and the neutrals. We simulated the plasma and neutral gas environment of comet CG with SHAP5 model near perihelion and we showed that the plasma environment in the inner coma region have some new features: magnetic reconnection in the tail region, a magnetic pile-up region on the nightside, and nucleus directed plasma flow inside the nightside reconnection region.