Geophysical Research Abstracts
Vol. 17, EGU2015-5531, 2015
EGU General Assembly 2015

3D DSMC Modeling of the Inner Gas Coma of Comet 67P/Churyumov-Gerasimenko with an Unstructured Grid

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As the development of ESA's Rosetta mission started, it became clear that the physics of the outflow immediately above the surface needed to be understood. Ice sublimating from nucleus surface into vacuum forms the Knudsen layer, which is a non-equilibrium boundary layer with a scale height of about 20 mean free paths. In Rosetta's orbit around Comet 67P/Churyumov-Gerasimenko (C-G), the mean free path will range from meters to kilometers. Direct Simulation Monte Carlo (DSMC) is a very powerful numerical method to study gas flows inside non-equilibrium regions and has been applied to study cometary outflow by many authors over the past decade. The drawback with 3D DSMC is that it is computationally highly intensive and thus time consuming. Our aim here is to determine the gas flow-field in the innermost coma and to place constraints on the surface outgassing properties from analysis of the flow-field. For a preliminary shape model of C-G, we have identified to what extent modification of parameters influences the gas flow and temperature fields and established the reliability of inferences about the initial conditions from in situ and remote sensing measurements. The boundary conditions are implemented with a publicly available nucleus shape model and thermal models based on the surface heat balance equation. Several assumptions and different parameter sets have been investigated by DSMC runs using the PDSC^{++} (Parallel Direct Simulation Monte Carlo) code on an unstructured tetrahedral grid. In this work, we will present simulations of the flow field and changes resulting from modification of specific variables.