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The role of numerical models in data analysis for the Rosetta mission

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Abstract

The Rosetta mission will have collected data for over a year by September 2015, ranging over a wide range of heliocentric distances, latitudes, longitudes and local times. However, both remote sensing and in situ instruments capture very specific features of the cometary system in their respective measurements. Numerical models can help, for example, link these in situ and remote sensing observations which, in turn, inform the numerical models by constraining them. The end result is that much more information is obtained from the mission than possible with observations alone. Here we use simulation outputs from a 3D DSMC, and a 3D hydrodynamic code to link results between different instruments on the Rosetta spacecraft.

1 Models

We present model results for the coma of 67P from two different codes. Both including a detailed shape model of the comet nucleus and realistic illumination conditions. AMPS, which is a Direct Simulation Monte Carlo (DSMC) code, simulates a large but discrete set of particles that are ejected at each surface element of the shape model according to realistic boundary conditions. The code then simulates interactions of the gas molecules based on gaskinetic effects. Macroscopic properties of the coma are obtained by sampling of a subset of particles in different cells within the computational domain. BATS-R-US is a hydrodynamic code that approximates the cometary coma as a fluid, and solves the Euler equations on a 3D block adaptive Cartesian grid. Both codes can be run on multiple CPUs to handle the high computational demands of full 3D models.

2 Method

BATS-R-US and AMPS both produce physical quantities such as number density, bulk velocities and gas temperatures within a three dimensional simulation box. From the SPICE toolkit we can compute exact instrument pointings and the position of Rosetta relative to the comet. By interpolation we are able to reproduce results of both, local measurements or line of sight integrations through the coma, which allows for a comparison between in situ and remote sensing instruments. We provide a sophisticated web interface to these tools to different teams within the Rosetta mission. The generic implementation and the integration of SPICE kernels make these tools extendable to simulations of other missions.

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