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Curvilinear coordinate introduction in the HYB hybrid model

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The cosmic plasma interaction with non-magnetized and magnetized planetary objects can be efficiently modeled using hybrid approach. In a hybrid model ions are represented as particles while electrons form a massless, charge neutralizing fluid.

The HYB hybrid model family has been developed in the Finnish Meteorological Institute (FMI) and used successfully to describe how the flowing plasma interacts with such solar system bodies as Mercury, Venus, the Moon, Mars, Kronian moon Titan, comets and asteroids.

The HYB model assumes cube-shaped grid cells. However, taking into account that planetary worlds are not Cartesian, developing a curvilinear (spherical and cylindrical) coordinate version of the model would allow a more precise representation of the real situation.

Important advantages of curvilinear grid compared with a Cartesian grid, are: 1) A good grid resolution, because the grid size decreases automatically near the obstacle (the planetary surface) and 2) A natural boundary condition for the obstacle, because the planetary surface overlaps a constant radial surface of the grid. We represent the first achievements in the grid development project and illustrate the usage of the new model by example test runs. The aim of the project is to create a 3D curvilinear hybrid code, which can be used at different branches of space plasma physics: planetary physics, solar physics, and astrophysics.