SMALL SOLAR SYSTEM BODIES – PRODUCTS AND STANDARDS. M. F. A'Hearn[1], [1]University of Maryland (Dept. of Astronomy, College Park MD 20742-2421; ma@astro.umd.edu).

Introduction: NASA's Planetary Data System is the archive for all planetary data and it is spread among several nodes representing various scientific disciplines. The cartographic products for small bodies, which are archived at the Small Bodies Node (SBN) of PDS, are in some ways similar but in many ways very different from those used for the planets and their large satellites. For this talk we consider small bodies to be primarily asteroids and comets. Dwarf planets are also considered small bodies in PDS, but for cartographic purposes they are closer to the larger planets because they are defined as bodies for which gravity wins over strength, leading to a shape more or less determined by hydrostatic equilibrium and thus reasonably approximated by a sphere or ellipsoid.

Available Data: Only a tiny fraction of small bodies has been studied from any platform other than Earth and a large fraction that have been studied from off the Earth has been studied only from Earth-orbit. Thus data are scarce. *In situ* observations range from fast flybys (*e.g.*, for Ida, Gaspra, Šteins, and Lutetia among the asteroids and comets Halley, Borrelly, Wild 2, Tempel 1, and Hartley 2) to detailed studies over a many-month encounter (e.g. for Vesta, Ceres, and comet Churyumov-Gerasimenko). For a few of the largest asteroids and for a few that approach very close to Earth, some mapping data exist in the archives. As a result, we have partial maps for many bodies, with large gaps for unobserved portions of the surface.

Shape: Small bodies also have very irregular surfaces, such that a reference surface as used for large bodies is not meaningful. Most bodies in our collection at the Small Bodies Node of PDS are represented by triangular-plate models, with a table describing the coordinates of each vertex between plates and a table describing which vertices are connected for each plate. At the SBN we have adopted standard formats for these models such that we can provide versions that are viewable in any VRML viewer in addition to being manipulable by anyone with appropriate software. More recently, we have also been including DSK models (Digital Shape Kernels) of the type being used in developmental versions of the SPICE software that is used for navigation. In general our approach has been to carry a variety of models where possible in order to meet the needs of a variety of users.

Rotation: Whereas the larger bodies of the solar system, at least those for which solid surfaces are observable, have reasonably well understood rotational states, the states of the small bodies are poorly known. For the large bodies, the dominant motion is usually a simple rotation with small variations due to precession and nutation, often including a significant tidal effect from a nearby body, which may include tidal locking to the orbital period (Mercury around the sun, the Galilean satellites around Jupiter). These are often quantified to high-order terms based on a wealth of data. For the small bodies, particularly but not exclusively cometary nuclei, the rotational states vary in a highly non-linear way, whether due to chaotic tumbling or due to torques ranging from the small (YORP) to the large (cometary outgassing).

Surface Coordinates: Because of the unstable rotational states, and particularly large changes in the orientation of the spin axis for some bodies, coordinates are specified always by the right hand rule rather than by the invariant plane supplemented with prograde or retrograde. In many cases, however, the variations in rotational state are not sufficiently well understood to reliably predict the orientation at any time other than at the time of the determination or very close to it.

Because of the unusual shapes, map projections are also sometimes very difficult. For example, radius vectors intersect the surface of comet Churyumov-Gerasimenko multiple times. The Rosetta teams themselves are using separate projections for different portions of the nucleus.

Tools: Tools have been developed by various investigators for morphing images and other 2-D data onto the shape models in order to create valuable data products for research. Selected tools will be discussed.