**LIFE CYCLE OF A PLANETARY BODY DEFINITION FOR SCIENTIFIC ANALYSIS**

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**Introduction:** Something as seemingly simple as defining the size of a planetary body is a critical first step required to support the creation of all mapping products and resulting scientific analysis. The life cycle in defining the body size is evolved from the initial Earth-based observations, then refined using acquired data from planetary missions, published in the peer-reviewed literature and adopted by standards-setting working groups, integrated into various libraries and applications, and finally made available for the creation of derived cartographic data products. Here we expose these steps to help users understand the benefits for using standardized definitions to enable data usability and interoperability by looking at the definition for the moon Enceladus.

**Defining the Size:** Enceladus was discovered by William Herschel in 1789. In 1980 and 1981, the NASA Voyager 1 and Voyager 2 missions imaged Enceladus as they flew by Saturn. Starting in 2005, the Cassini spacecraft greatly improved our knowledge based on several Enceladus fly-bys. The assembled data, photogrammetrically controlled in a global context, allows derived solutions to provide body pole position, spin, shape information and accuracies. Photogrammetric control methods for Enceladus were first employed by Davies and Katayama [1] in 1983 and improved by various researchers with the latest solution provided in 2018 by Bland et al. [2].

**International Astronomical Union (IAU):** As the measurements of a body improve, updated size parameters will be reviewed for potential adoption by the Working Group on Cartographic Coordinates and Rotational Elements (WGCCRE) and compiled for publication every 3-5 years. From [3], "The Working Group's mission is to make recommendations that define and relate the coordinate systems of Solar System bodies to their rotational elements to support making cartographic products (i.e., mapping) of such bodies. The working group incorporates any reasonable and peer-reviewed improved determinations that follow previously established conventions...". Their last publication in 2018 included new parameters for Enceladus and further updates are likely in the next WGCRE publication based on [2].

**Navigation and Ancillary Information Facility (NAIF):** The next stage in the life cycle of a body's definition is usually NAIF [4]. NAIF is best known for providing NASA flight projects and researchers the "SPICE" observation geometry information and software. This includes a file for body parameters (known as planetary constants) within their PCK kernel file. This file and the other observational kernel files are first and foremost used by NAIF's own supported SPICE toolkit, which is in turn used by community tools for data processing (e.g., USGS's Integrated Software for Imagers and Spectrometers [ISIS] and JPL's Video Image Communication and Retrieval [VICAR]). Within the NAIF file, *pck00010.tpc*, Enceladus is defined as a triaxial body (in km): *body602_radii = (256.6 251.4 248.3)*. A model defining the orientation of a body as a function of time is also given.

**Open Geospatial Consortium (OGC):** Along with NAIF, but to support to digital mapping applications (e.g., GIS), the newly ratified OGC planetary working group will also support the WGCCRE size definitions. A forthcoming web service will be hosted by working group members to support predefined body and map projection look-ups. These definitions, recently proposed in [5], have also been incorporated in the OSGeo library PROJ [6]. This library is used by several geospatial applications like the Geospatial Data Abstraction Library (GDAL), QGIS and MapServer. While OGC supports triaxial definitions, to better support typical cartographic methods in PROJ, Enceladus will be defined using the WGCCRE best-fit mean radius (*252.1 km*).

**Conclusion:** A typical planetary researcher may not fully appreciate the implications of the complicated life cycle for a body's size definition; however, it is an essential prerequisite for scientific analysis. When products are labelled and applications are released with the same consistent definitions, data providers and end-users will benefit from both data usability and interoperability across applications.

**References:** [1] Davies and Katayama (1983). doi: 10.1016/00191035. [2] Bland et al. (2018). doi: 10.1029/2018EA000399. [3] Archinal, et al., (2018). doi: 10.1007/s10569-017-9805-5. [4] https://naif.jpl.nasa.gov/ [5] Hare, T. M., Malapert, J-C. (2022). LPI No. 2549, id.7012. [6] https://proj.org/.

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