THE IO GIS DATABASE, V. 1.0: A PROTO- IO PLANETARY SPATIAL DATA INFRASTRUCTURE

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Introduction: We were funded by NASA's Planetary Data Archiving, Restoration, and Tools (PDART) program to collect a set of published, higher-order data products of Jupiter's volcanic moon Io, and assembled them into an Io-focused planetary spatial data infrastructure (PSDI) [1]. We call it the Io GIS Database, version 1.0, which is downloadable as an ArcGIS™ database, and is also available in ASU's JMARS software. The contents of this Database include image, topographic, geologic, and thermal emission data of Io in a geospatially-registered format (**Table 1**). The goals in the generation of this Database are: 1) to make higher-order data products of Io more accessible and usable to the broader planetary science community, particularly to new scientists that were not associated with the projects that obtained the data; 2) to enable new scientific studies with the data; and 3) to create a tool to support observation planning for future Io-focused planetary missions. In this poster we will describe the motivation behind our project, discuss the datasets included for this first version of the Database, and demonstrate how they can be used.

Motivation: Over the last decade there has been great interest within NASA's Planetary Science Division regarding the long-term accessibility and usability of planetary data, particularly geospatial image data of planetary surfaces, and particularly the higher-order data products (e.g., regional to global image mosaics, digital terrain models (DTMs), geologic maps, etc.) derived from NASA's robotic planetary missions. NASA's desire to maximize its investment in its planetary missions and their accumulated data is motivated by the desire to enable future generations of planetary scientists to utilize the data for research projects, long after the creators of those data are gone. Likewise, NASA wants to ensure that data from past missions are usable in tools that will support planning of future missions. This is particularly desirable for geologically active worlds, such as Jupiter's volcanic moon Io, where multiple, ongoing volcanic eruptions produce thermal anomalies related to its interior processes, and where active eruptions emplace effusive and explosive volcanic materials and gases that regularly modify its surface at timescales of weeks to months [2,3].

Data & Methods: Our concept was to collect a subset of the accessible and usable, higher-order image-based data products of Io that have been peer-reviewed and published over the last two decades, and assemble them in a geospatially-registered format to enable future research. The primary software we chose to use is ArcGIS™, but the data are also available through ASU's JMARS software. The image basemaps on which the Williams et al. [4] global geologic map of Io was produced are available in ArcGIS™. These include a set of four combined *Galileo-Voyager* global mosaics (Becker and Geissler, 2005 [5]), in which mosaicked images were geodetically-controlled using a triaxial ellipsoid shape model and best available *Galileo* control point network [6]. Reported horizontal accuracy is nominally 1 pixel, translating to 1 kilometer in low latitude regions with good coverage. Thus, these mosaics serve as the *foundational data products* of our Database. **Table 1** lists the published Io data sets included in this first version of the Database.

Results: Data are presented using a Simple Cylindrical projection centered on the antijovian point (0˚, 180˚W), as the *Galileo* mission obtained its best imaging over the antijovian hemisphere. We included the latest named surface features from the USGS Planetary Nomenclature website, as well as a graticule displaying a 30˚ latitude-longitude grid. Having Io data from the 1970s, 1990s, 2000s, and 2010s in this Database enable comparisons and show the evolution in interpretation of Io's geologic features, particularly between the *Voyager* and *Galileo* eras. Importantly, the thermal hot spot datasets include attribute tables, which contain details on recorded thermal activity at every location on Io, covering a time period between 1996-2018. By checking the power, area, and temperature variations at hot spots of interest, it is possible to investigate the waxing and waning of volcanic activity over this twenty-year time period.

We hope to collect new Io datasets as they are published and update the Database every few years.

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References: [1] Williams, et al., 2021. *Planet. Sci. Jour., 2:148,* Open Access, https://doi.org/10.3847/PSJ/ac097f; [2] Lopes and Williams, 2005. *Rep. Prog. Phys., 68*, 303-340; [3] Lopes and Spencer, 2007; [4] Williams et al., 2011. USGS SIM 3168; [5] Becker & Geissler, 2005. *LPSC XXXVI*, Abstract #1862; [6] Archinal, et al., 2001. *LPSC XXXII*, Abstract #1746.

Table 1. Directory structure and datasets listing for the ASU Io GIS database, version 1.0. Downloadable Zipped GIS file: https://rgcps.asu.edu/downloads/PDART_Io_DB_GIS_data_1.0_v2.zip

Item Name	Description	Reference
Surface Heat Flux Models	Extracted from figure in journal paper.	Hamilton et al. (2013): https://doi.org/10.1016/j.epsl.2012.10.032
AO Telescopic Observations	2013-2018	de Kleer et al. (2019): https://doi.org/10.3847/1538-3881/ab2380
	2001-2016	Cantrall et al. (2018): https://doi.org/10.1016/j.icarus.2018.04.007
	2010	de Pater et al. (2014): https://doi.org/10.1016/j.icarus.2014.06.019
	2001	Marchis et al. (2005): https://doi.org/10.1016/j.icarus.2004.12.014
Additional Hot Spot Data	*Galileo* NIMS NITED Database**, Part I**	Davies et al. (2015): https://doi.org/10.1016/j.icarus.2015.08.003
	Hot spot locations, 1979-2007	Appendix A.2, Lopes and Spencer (2007), *Io After Galileo*.
Regional Geologic Maps	Chaac-Camaxtli map	Williams et al. (2002): https://doi.org/10.1029/2001JE001821
	Culann-Tohil map	Williams et al. (2004): https://doi.org/10.1016/j.icarus.2003.08.024
	Zamama-Thor map	Williams et al. (2005): https://doi.org/10.1016/j.icarus.2005.03.005
	Amirani-Gish Bar map	Williams et al. (2007): https://doi.org/10.1016/j.icarus.2006.08.023
	Zal region map	Bunte et al (2008): https://doi.org/10.1016/j.icarus.2008.04.013
	Prometheus map	Leone et al. (2009): https://doi.org/10.1016/j.jvolgeores.2009.07.019
	Hi'iaka-Shamshu maps	Bunte et al. (2010): https://doi.org/10.1016/j.icarus.2009.12.006
Global geologic map	USGS I-2209 *Voyager*–based, 1:15M	Crown et al. (1992), USGS map: https://pubs.er.usgs.gov/publication/i2209
Global geologic map	USGS SIM 3168 *Galileo-Voyager* 1:15M	Williams et al. (2011), USGS map: http://pubs.usgs.gov/sim/3168/
Mission Image Data	*New Horizons* 2007 LORRI mosaic	Spencer et al. (2007), Science: https://doi.org/10.1126/science.1147621
	LEISA hotspot images and data	Tsang et al. (2014), JGR-Planets: https://doi.org/10.1002/2014JE004670
	Galileo SSI Digital Elevation Model	White et al. (2014), JGR-Planets: https://doi.org/10.1002/2013JE004591
Galileo SSI Orbit I25 observations	I25ISEMAKNG02, I25ISGIANTS01, I25ISCULANN01, I25ISTERM__01	Keszthelyi et al. (2001), JGR-Planets: https://doi.org/10.1029/2000JE001383
Galileo SSI Orbit I27 observations	I27ISTOHIL_01, I27ISCAMAXT01, I27ISAMRANI01, I27ISTVASHT01, I27ISZALTRM01, I27ISSHMSHU01, I27ISSOPOLE01	Keszthelyi et al. (2001), JGR-Planets: https://doi.org/10.1029/2000JE001383
SSI Orbit I32 observations	I32ISLOKI_01, I32ISTVASHT01, I32GSHBAR01, I32ISTERMIN01, I32ISTERMIN02	Turtle et al. (2004), Icarus: https://doi.org/10.1016/j.icarus.2003.10.014
USGS Galileo-Voyager Global Mosaics	a) SSI only B&W, b) SSI only color, c) SSI-VOY B&W, d) Merged SSI-VOY B&W and SSI color	USGS Astropedia: https://astrogeology.usgs.gov/maps/io-voyager-galileo-global-mosaics. See also: Becker and Geissler (2005), 36th LPSC : https://www.lpi.usra.edu/meetings/lpsc2005/pdf/1862.pdf.
Ancillary data maps	Maps of Emission, Incidence, & Phase angles, & Spatial resolution for c) above	USGS Astropedia: https://astrogeology.usgs.gov/maps/io-voyager-galileo-global-mosaics

NOTES: (1) *Galileo* SSI I24 observations were damaged by radiation exposure to the camera electronics, and were only partially recoverable. There were insufficient resources to include them in this project. (2) Io mosaics better than 200 m/px would require too much time to tie to this database, so they are not included in this first version of the Database.