DISTRIBUTION AND MAGMA-TUDE: CONSTRAINING IO'S HEAT FLOW AND VOLCANO DISTRIBUTION USING THE JIRAM INSTRUMENT. M. M. Pettine[1], A. G. Hayes[1] J. A. Rathbun[2], Samara Imbeah[1,3], R. M. C. Lopes[4], A. Mura[5], F. Tosi[3], F. Zambon[5], [1]Cornell University, [2]Planetary Science Institute, [3]Malin Space Science Systems, [4]Jet Propulsion Laboratory, [5]INAF-IAPS Instituto di Astrofisica e Planetrologia

Volcanic activity driven by tidal dissipation was initially predicted on Io, Jupiter's innermost moon, mere months prior to Voyager's flyby in 1979 [1]. Images from Voyager's vidicon camera confirmed the existence of active volcanism and, in the subsequent years, additional spacecraft and ground-based observations have documented extensive silicate-based volcanism, substantive heat flow, and periodic massive eruption events [2]. Io represents the solar system's type-example for tidal heating, and the distribution and character of its volcanic activity presents a window through which to understand how dissipative heat flows from its interior to its surface [3].

Models indicate [4-5] that the depth at which tidal friction deposits heat could have a measurable effect on Io's heat flow and, subsequently, where volcanic hotspots cluster on the surface. The periodicity of volcanoes on Io could also indicate internal behavior and heat flow. Herein, we report on the spatial and temporal behavior of volcanoes on Io using images from the Juno spacecraft. Unlike previous space and ground-based observations, Juno's orbit around Jupiter provides optimal viewing conditions for Io's poles.

The Juno spacecraft, currently in a polar orbit around Jupiter, is able to observe volcanism on Io in the infrared L and M bands using the Jovian InfraRed Auroral Mapper (JIRAM) instrument. We have analyzed JIRAM data to determine the spatial distribution of volcanic hotspots on Io's surface. Our current understanding of Io leads us to believe that most heat flow from Io will be through its volcanic hotspots. Assuming this to be true, we are able to compare the observed volcanic activity on Io as a proxy for the spatial distribution of surface heat delivered from the interior. This allows us to directly compare Ionian volcanic brightnesses with models of tidal heat flow

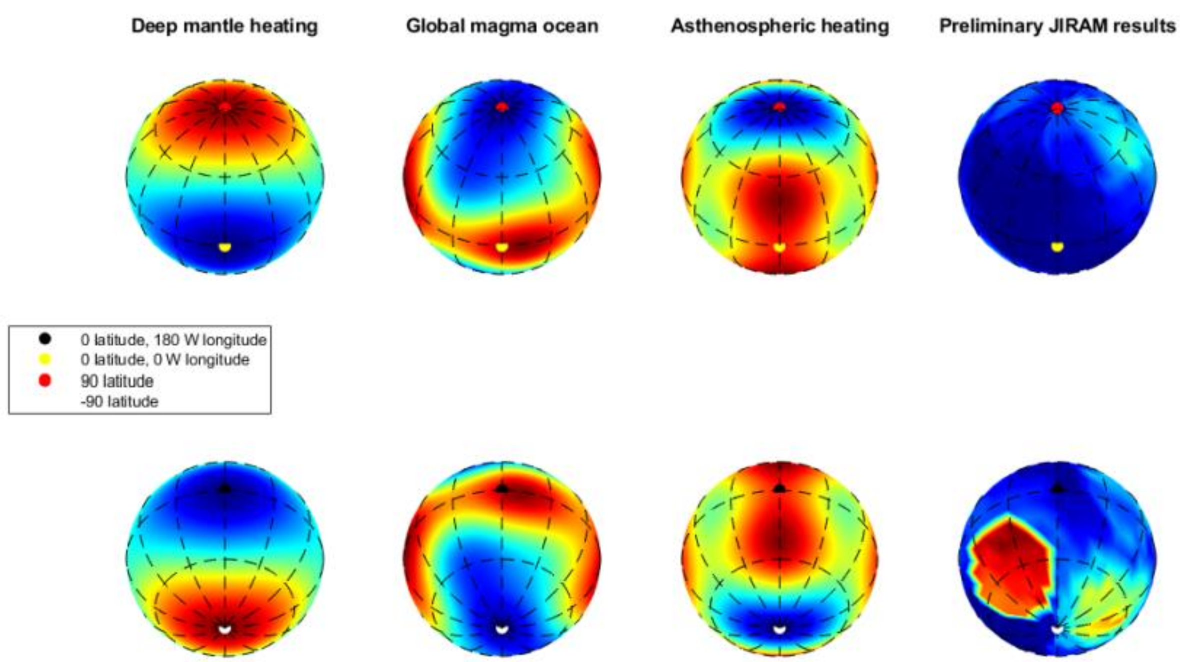

Figure 1: For deep mantle, global magma ocean, and asthenospheric heating, the relative heat flow distribution from the surface of Io is shown using modeling data from the 2019 Final Report for the Keck Institute for Space Studies [6]. Preliminary JIRAM results show the integrated heat flow through the outburst brightness of volcanic hotspots recorded during orbits 17, 20, or 25 of Juno.

within the body. Juno will acquire data of Io at nearly every inner-Jovian orbit during its extended mission, continually expanding the dataset used for our study.

Current work [6] considers three major interior heating models for Io: asthenospheric heating, deep mantle heating, or a global magma ocean model. The first two models consider only the depth of tidal friction dissipation while the global magma ocean considers a case where the entire mantle of Io is melted through continuous gravitational disruption. *Figure 1* shows that deep-mantle heat deposition results in high heat flow through the poles of Io and a lower relative concentration of surface heat at the mid- and low-latitudes while both asthenospheric heat deposition and the global magma ocean result in lower heat flow at the poles than the equator.

Ground-based imaging of Io favors the equator and low-latitude regions since Jupiter, Earth, and Io all lie in very similar orbital planes. Most studies of Io, therefore, have obtained only highly oblique viewing of the poles of Io. In order to compare the relative heat flow through the polar and equatorial regions of Io, viewing geometries that prefer the poles of Io are highly valuable. Juno's polar orbit is excellent for imaging Io's poles which allows us to better compare the measured heat flow from volcanic activity to the expected heat flow predicted by models.

We have analyzed JIRAM images from orbits 17, 20, and 25 and determined the total M-band brightness per unit area for all volcanoes observed (figure 1). From these preliminary results, it appears that Io's volcanic output, and, therefore, heat flow is concentrated at mid-latitudes in the southern atmosphere. However, it is not possible to conclude which model the results best match since the distribution does not resemble any model with any high confidence. However, as more data is taken and reduced, a statistically significant comparison may emerge.

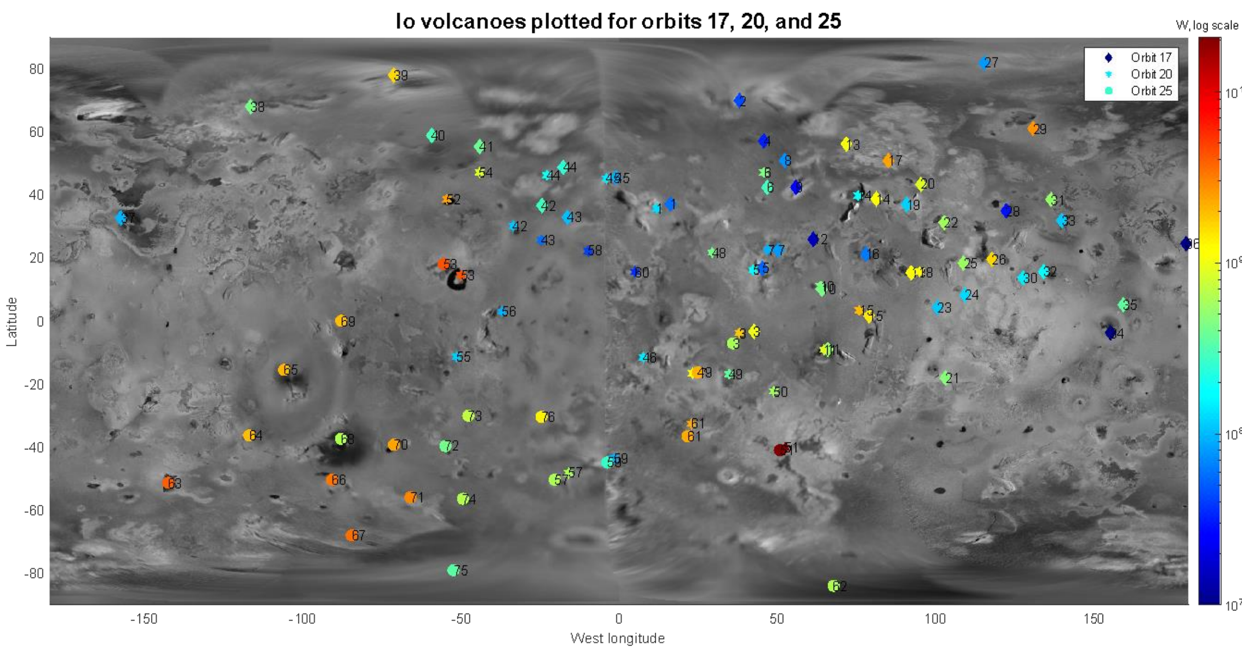

Figure: Volcanic hotspots identified during orbits 17, 20, and 25 of Juno, using data from JIRAM. The symbol denotes which orbits each hotspot was visible during, while the colors denote the brightness of the outburst.

References: [1] Peale, S. J.; et al. (1979). *Science*. 203 (4383): 892–94. [2] Williams, D. A.; Howell, R. R. (2007). *Io after Galileo*. Springer-Praxis. pp. 133–61. [3] Moore, W. B.; et al. (2007). *Io after Galileo*. Springer-Praxis. pp. 133–61. [4] Tyler, R.; Henning, W.; Hamilton, C. (2015) *J Suppl.*. 218:22. [5] Segatz, M.; et al. (1988). *Icarus*. 75 (2) 187-206. [6] de Kleer, et al. *Tidal Heating: Lessons from Io and the Jovian System*, Final Report for the Keck Institute for Space Studies, 2019.