MODELLING IO'S POLAR VOLCANIC THERMAL EMISSION USING *JUNO* JIRAM DATA. A. G. Davies[1], J. Perry[2], D. A. Williams[3] and D. M. Nelson[3]. [1]Jet Propulsion Laboratory-California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, USA (Ashley.Davies@jpl.nasa.gov). [2]University of Arizona, Tucson, AZ 85721, USA. [3]Arizona State University, Tempe, AZ 85287, USA.

Introduction: NASA's *Juno* spacecraft, currently orbiting Jupiter in a high inclination orbit, affords unprecedented observations of the poles of Io. The *Juno* Infrared Auroral Mapper (JIRAM) [1] has been observing Io at a variety of spacecraft altitudes, at 3.5 µm (L-band) and 4.8 µm (M-band), as well as collecting spectra between 2 and 5 µm [2]. The JIRAM data allow examination of the distribution, eruption style and power output from Io's polar volcanoes which have not previously been observed in such detail.

Io's volcanoes: Tidal heating [3] drives Io's volcanism, and Io has hundreds of active volcanoes. The JIRAM data, where not saturated, allow comparison between polar volcanoes (with latitudes >60°) and those at lower latitudes to examine if there are fundamental difference in volcanic activity that might reflect the distribution of tidal heating. Tidal heating models predict that enhanced heat flow at Io's poles would indicate deep mantle heating [4, 5]. Heat flow at lower latitudes and at certain longitudes would be indicative of heating focussed primarily in the asthenosphere. How, then might this affect volcanism at Io's poles? Enhanced volcanic heat flow – increased advection – might lead to more voluminous, hotter eruptions in the polar regions [6], detectable through modelling infrared data from appropriate polar viewpoints. While *Juno* instruments cannot measure endogenic heat flow from non-volcanic areas, JIRAM can, critically, quantify the thermal emission from Io's active polar volcanoes.

Although recent work catalogued the number of hot spots seen on Io by JIRAM [7], our objective is to quantify the integrated thermal emission from hot spots and constrain the likely eruption style (the manner in which volcanoes erupt and emplace lava). We can then relate the thermal emission and distribution of Io's volcanoes to models of tidal heating [8,9].

Workflow: We have examined all of the JIRAM data from 19 orbits up to orbit PJ41 and identified 248 hot spots (Figure 1), in part using a superposition technique also used by [7] that allows identification of faint thermal sources that otherwise would be difficult to spot in individual JIRAM frames. Using Juno mission NAIF SPICE kernels, Io is identified within each JIRAM image frame and each on-moon pixel is assigned a latitude, longitude, spacecraft altitude, and emission angle. Positions are adjusted using limb-fitting and tying hot spots to known stable surface features (the latter if lighting conditions allow). These adjustments improve the alignment of hot spots from image to image, reduce motion blur in the resulting summed images, and make it easier to map hot spots to known surface features. Saturation masks are created where band radiances reach the JIRAM detector saturation threshold [2]. Band radiances are corrected for filter band width, range to target and emission angle, and, assuming Lambertian emission, are then converted to spectral radiances (GW/µm). Correction of spectral radiance for incident sunlight in sunlit data depends on whether the hot spot is resolved. If resolved, then the assumption is made that the pixel is low albedo and the reflected component is negligible. If not, then surrounding pixels are used to estimate a reflected component. Where data are available at two wavelengths, they are fitted with a single temperature, single area thermal model from which the total thermal emission is estimated (Table 1).

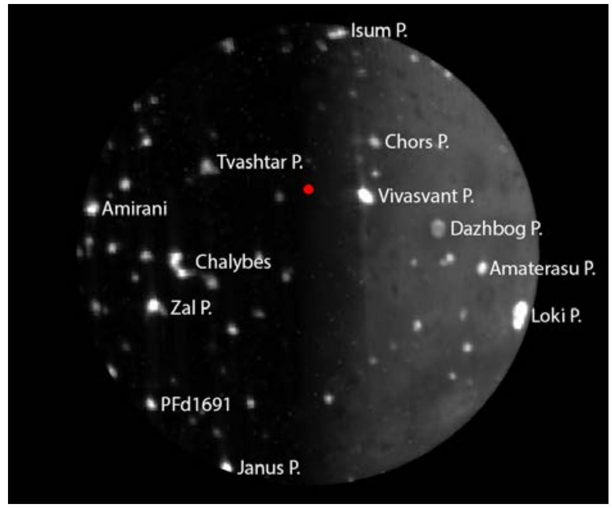

Figure 2. Mosaic of PJ41 JIRAM M-Band observations of Io's northern hemisphere, at a range of ≈110,000 km. Spatial resolution is ~26 km/pixel. Sub-spacecraft point is -18 °W, 73 °N. The red spot is the north pole. Some major hot spots are labelled.

Pele and Janus Patera - active lava lakes: Near-contemporaneous L-band and M-band data of Pele and Janus Patera show near flat spectra between 3.5 µm and 4.8 µm, yielding a L/M ratio close to 1. Previous analyses of low spatial resolution data (e.g., [9]) suggested that these were active, overturning lava lakes and the JIRAM data (Table 1) support the presence of a fixed, high-temperature, persistent source consistent with an active lava lake [e.g., 10].

Table 1. Hot spot thermal analysis examples

Volcano	Orbit	L/M	Temp. K	Area km^2	Power GW
Chalybes B	PJ41	0.179	337	82	60
Chalybes C	PJ41	0.334	416	38	64
Janus Patera	PJ41	0.952	688	13.5	170
Lei-Kung Fluctus A	PJ24	1.507	980	0.1	6
Kurdalagon	PJ37	0.424	457	110	271
Ot Patera	PJ24	0.228	364	24.2	24
Pele	PJ24	1.004	712	3.4	50
Pele	PJ25	1.002	711	3.4	50
Pele	PJ37	1.068	743	4.8	83
Vivasvant	PJ37	0.363	430	73	141
Zal Patera	PJ25	0.430	460	8	20
Zamama	PJ25	1.644	1070	0.1	9
Zamama	PJ37	1.014	716	0.8	12

The Loki Patera "lava sea": Loki Patera is the most important single contributor to Io's volcanic heat flow. Where spectral radiance is available at only one wavelength, a robust estimate of thermal emission can be made by considering the known emitting area of Loki Patera (21,500 km^2). An unsaturated L-Band Loki Patera observation yields a total thermal emission between 9 and 14 TW, using different methodologies [11], values consistent with previous observations [9].

Other examples: We find a broad spread of temperatures and areas with other volcanoes, a few examples of which are shown in Table 1. For example, at Lei-Kung Fluctus A (40°N, 202.7°W), in one of a number of observations of this hot spot, there is a small but high temperature thermal source we are examining in detail. At Ot Patera, the thermal source temperature is lower, and the emitting area larger. Based on the analysis of other hot spots [10], the eruption style at Ot Patera, as reflected by the implied spectral shape, is more quiescent than at Pele and Janus Patera, indicative of a predominantly cool surface crust on the lava, be it lava flow or lava lake. Temporal change, if any, will further constrain eruption style [9].

Caveat: We note that single temperature/single area fits to near-infrared wavelength thermal emission spectra tend to underestimate total thermal emission from active volcanoes, particularly from lava flows with well-developed, insulating surface crusts [9].

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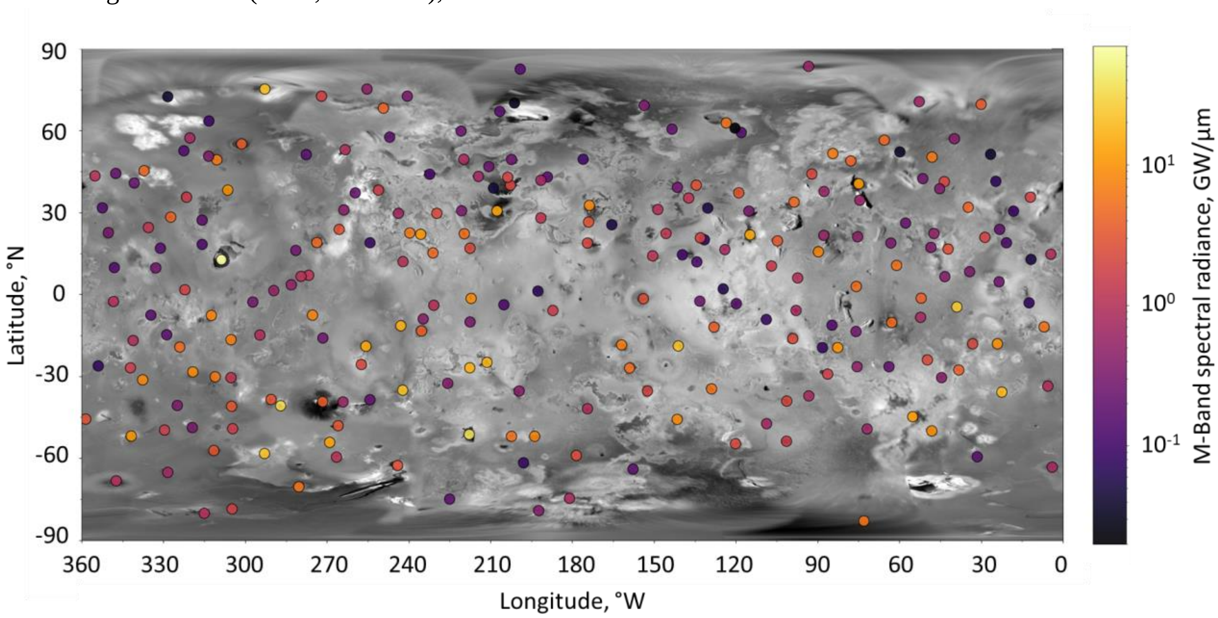

Figure 1. The maximum, unsaturated M-Band spectral radiances from the 248 Io hot spots we identified in Juno *JIRAM data obtained 2017-2022.*