INFRARED THERMAL EMISSION LIGHTCURVE FOR HOT SPOTS ON IO. G. J. Veeder[1], A. G. Davies[2], D. L. Matson[1] and T. V. Johnson[2], [1]Bear Fight Institute, 22 Fiddler's Rd., Winthrop, WA, 98862, [2]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA, 91109.

Introduction: The observed strong global heat flow on Io is the result of several types of surface volcanic activity. Many volcanic features on Io have been catalogued and mapped [1-4]. Hot spots are well correlated with dark paterae and large dark flow fields. We have previously analyzed 242, recently active and (mostly) dark, volcanic features identified during the *Voyager* and *Galileo* spacecraft era to individually quantify their volcanic thermal power and estimate Io's total heat flow [5-8]. Loki Patera is most prominent in our "snapshot" of Io's thermal state. The 242 sources considered (down to the level of detection) provide only approximately 56×10^{12}W (or 54%) [8] of Io's total thermal power observed at the Infrared Telescope Facility (IRTF) of $\approx 1.05 \times 10^{14}$W [9]. Our ground-based IRTF data include many hemispheric samples of Io's thermal emission at several infrared wavelengths (i.e., 4.7, 8.7 and 20 µm) covering all longitudes for ten apparitions.

The strong thermal source within Loki Patera as well as some of the other (non-outburst) thermal sources on Io are known to be variable [3,10,11]. Inspection of our IRTF observations shows significant variations in Io's thermal infrared lightcurves among apparitions. Detailed comparison of the expected infrared emission from volcanic sources and our hemispheric observations is needed to further constrain the average total heat flow on Io.

Methodology: Our input data set includes both spacecraft and ground-based telescope observations [5-8]. We have previously produced maps for the heat flow on the surface of Io [12]. Here we utilize estimated temperatures, areas and locations for the 242 volcanic hot spots from our analysis to synthesize the thermal infrared emission from each hemisphere of Io that would be visible to a remote (e.g., ground-based) observer (but excluding ephemeral "outburst" eruptions).

We consider as an example the 8.7 µm radiant intensity for each hot spot on a series of hemispheres facing an observer at each degree of longitude. The emission angle is used to reduce the radiant intensity according to the cosine rule for each hot spot. The sum of the thermal emission from all of the visible hot spots yields the observed disk-integrated radiance due to volcanic activity on Io. The resulting synthesized lightcurve is shown in Figure 1.

The overall shape of this synthesized lightcurve agrees well with the suite of our IRTF observations over ten apparitions. However, there is significant variation among the ten 8.7 µm IRTF lightcurves [9]. Loki Pater at 308° W is the source of the most prominent feature in Figure 1. Loki Patera is Io's most powerful and persistent volcano whose thermal emission typically varies [3,10]. Its total power ranges between 6 and 16 TW with an average value of ~10 TW [11]. The calculations for the contribution from Loki Pater in Figure 1 utilize a temperature of 298 K assigned to an area of 21500 km^2 that yield an 8.7 µm radiance of 630 GW/µm. Although disk integration tends to smooth out the significant aggregate contribution from the many smaller hot spots over the surface of Io, the lack of any other source as strong as Loki Patera has previously been noted [5-9,12]. In addition, the variation in the synthesized 8.7 µm lightcurve between longitudes 210 and 60° W is consistent with our two dimensional maps of the heat flow [12]. However, the dip near 30° W is at least partly due to poor spacecraft coverage over this region [1,2].

Conclusions: We expect some differences among apparitions between lightcurves synthesized from our current global model of volcanic hot spots and our IRTF observations of Io. In particular, note that the IRTF infrared observations include the daytime 'background' thermal emission from the rest of Io's surface outside of hot spots as well as a contribution from the 'pedestal effect' [9] on dark hot spots themselves (i.e., the re-emission of absorbed solar insolation). A finite thermal inertia may effect our synthesis of lightcurves at longer infrared wavelengths. Also, the dependence of the hemispheric 'background' emission itself upon the albedo variation across the surface of Io seen in visual images and maps [1-4] is expected to affect more detailed model calculations.

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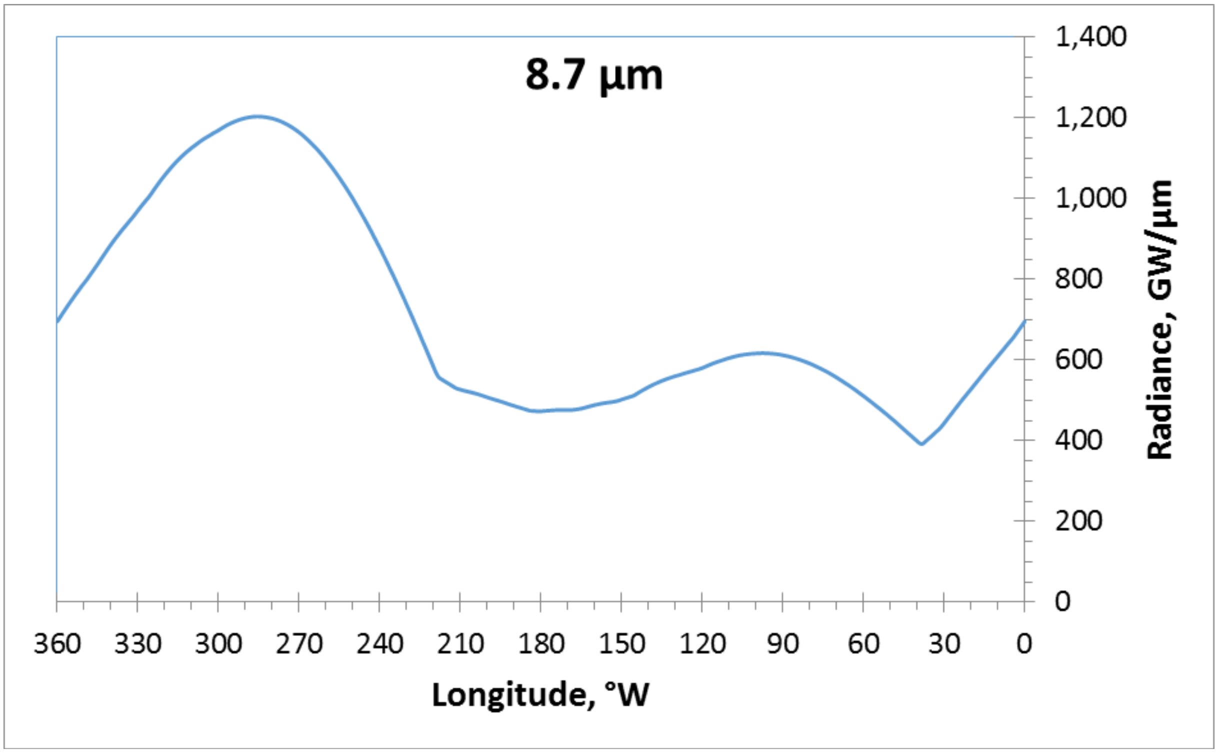

Figure 1. A synthesized lightcurve for thermal emission from Io's volcanic centers at 8.7 µm derived from hot spot model temperatures, areas and locations [7,8,12]. The longitude of Loki Patera is 308°W.