IO ECLIPSE OBSERVATIONS: DOES LOKI DOMINATE IO'S INFRARED FLUX? J. A. Rathbun[1] and J. R. Spencer[2], [1]University of Redlands (1200 East Colton Ave., Redlands CA 92373, USA *julie_rathbun@redlands.edu*), [2]Southwest Research Institute (1050 Walnut St., Suite 400, Boulder, CO 80302, USA).

Introduction: For nearly two decades, we have been observing infrared thermal emission from Io's volcanoes using NASA's Infrared Telescope Facility (IRTF). Our observations consist of measuring Io's brightness at 3.5 microns while Io is either entering or leaving occultation by Jupiter (whichever occurs while Io is in eclipse) and at 2.3, 3.5, and 4.7 microns in eclipse. The occultation observations have been used to measure brightnesses of individual volcanoes. Measurements of the brightness of Loki (Figure 1), the largest and most powerful volcano on Io, have indicated that Loki often erupts in a regular and predictable manner (Rathbun et al., 2002). The observations have also been used to constrain models of Loki's eruption behavior (Rathbun and Spencer, 2006; Gregg and Lopes, 2004).

Each occultation can only be observed in a single wavelength while each eclipse can be observed at multiple wavelengths. These eclipse observations have a low spatial resolution so measuring the brightness of individual volcanoes is difficult (Figure 2). Previous groups have hypothesized that Loki will dominate the brightness at these infrared wavelengths so that the eclipse observations can be also be used to constrain models of Loki's behavior (Papapietro et al., 2007).

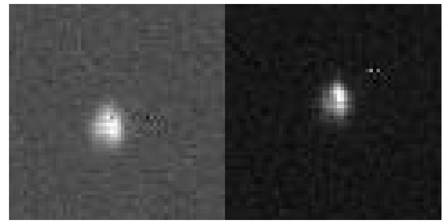

Figure 2: IRTF images of Io in eclipse on October 15, 2001. The left image was taken at 2.2 microns and the right at 3.5 microns. In both cases, Loki is the bright spot in the upper right.

Loki Model: Based on the long history of Loki eruptions measured from occultation observations and the high spatial resolution data taken by the Galileo and Voyager spacecrafts, Rathbun et al. (2002) developed a model of Loki as a periodically overturning

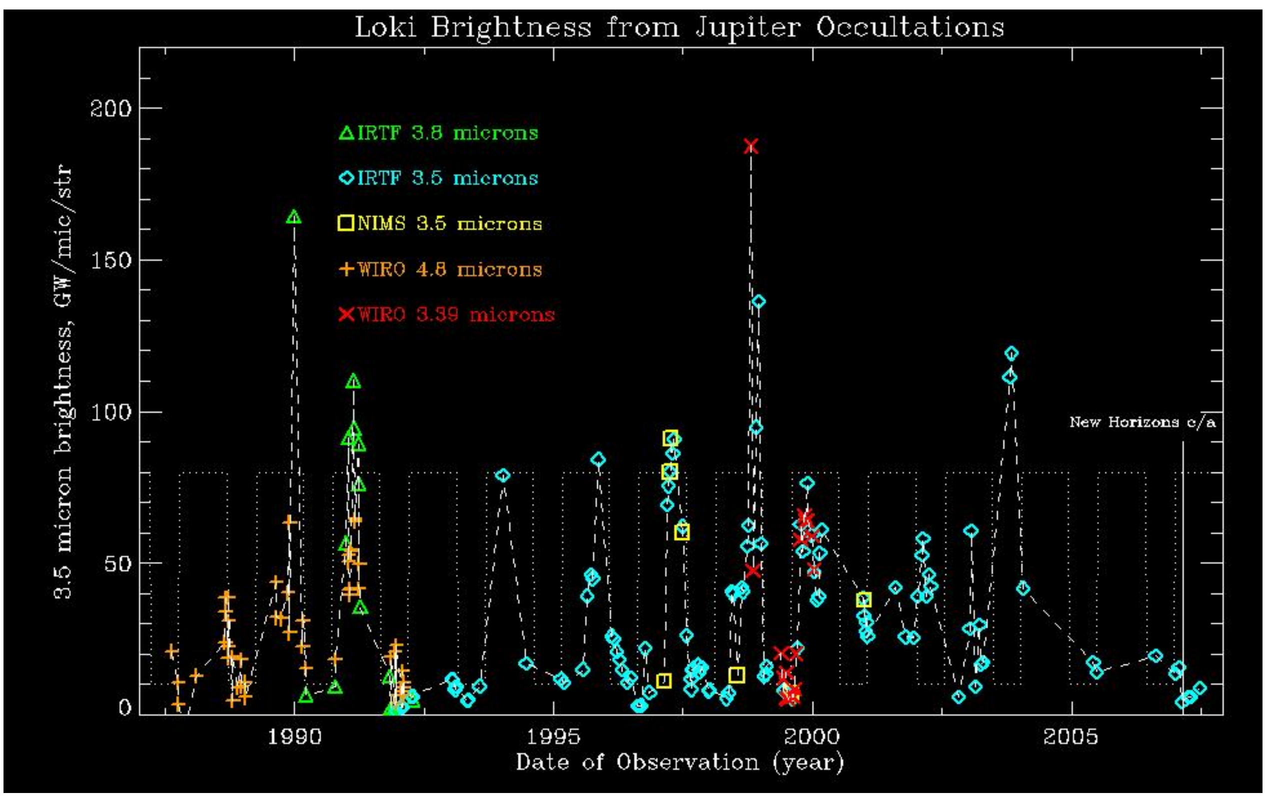

Figure 1: Loki's 3.5 micron brightness as measured primarily from Jupiter occultations.

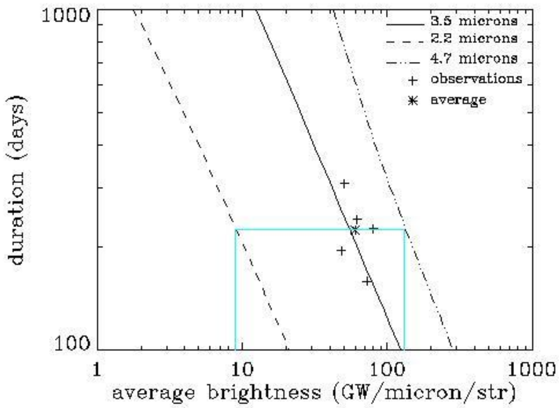

Figure 3: Average brightness of Loki during a brightening from the quantitative lava lake model. Observed brightness and durations from 3.5 micron occultation data are shown. Using the average duration from those observations, the average brightness at 2.26 and 4.68 microns are predicted (teal lines).

lava lake. Rathbun and Spencer (2006) constructed a quantitative version of this model and were able to match it to ground based observations of Loki's brightness taken by a variety of observers at a variety of wavelengths. This includes the 3.5 micron occultation data shown in figure 1, speckle data collected by MacIntosh et al. (2003), and adaptive optics measurements from Marchis et al. (2005). By altering the velocity at which the overturn propagates across the lava lake, the model matches the data from times when Loki was erupting periodically and those from more recent times when Loki was no longer erupting on a regular schedule. This change in velocity could easily be due to small changes in magma density or initial porosity of the solidifying crust.

Model predictions: We use the quantitative model of Rathbun and Spencer (2006) to predict the average brightness of Loki during a brightening at 2.3 and 4.7 microns (Figure 2). In the model, the average brightness and the duration of the brightening event are inversely proportional. The 3.5 micron measurements were shown to match both variables. Using the average duration measured, we predict an average brightness of 9 GW/micron/str at 2.26 microns and 130 GW/micron/str at 4.68 microns.

Observations: Papapietro et al. (2007) found an average 2.2 micron brightness of Loki during a brightening event to be 7.6 GW/micron/str, remarkably similar to the predicted brightness. However, they assumed that all of the 2.2 micron brightness measured was from Loki and corrected these measurements for Loki's position on Io. This assumption is not warranted as several volcanoes were known to be active during many of these observations. Furthermore, their 2.2 micron measurements did not show any correlation with the 3.5 micron measurements of Loki, suggesting that Loki is not always dominating the 2.2 micron brightness of Io. We will look more closely at these observations. For each night's observations we will note how many volcanoes were active (based on the 3.5 micron occultation curves) and compare this to the number of volcanoes that can be distinguished in the eclipse observations, searching for nights when Loki is dominating Io's total flux.

We will measure the brightness of Io in eclipse at 3.5 microns and determine the percentage of this brightness contributed by Loki for each night by comparing it to Loki's brightness measured from the occultation lightcurve. This will give us further evidence as to whether or not Loki is dominating Io's total flux. Finally, we will measure Io's 4.8 micron brightness to determine if Loki is more or less dominant at that wavelength.

References:

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