GROUNDBASED OBSERVATIONS OF IO IN SUPPORT OF THE NEW HORIZONS FLYBY. J. A. Rathbun[1] and J. R. Spencer[2], [1]University of Redlands (1200 East Colton Ave., Redlands CA 92373, USA *jullie_rathbun@redlands.edu*), [2]Southwest Research Institute (1050 Walnut St., Suite 400, Boulder, CO 80302, USA).

Introduction: Io is the most volcanically active body in the solar system with dozens of volcanoes erupting at any time. Recently, the volcanoes were extensively studied by the remote sensing instruments on the Galileo spacecraft. But, they have been observed from ground-based telescopes for more than two decades (Rathbun et al., 2002). The frequency of these observations and the number of telescopes used increased dramatically during the Galileo era in order to compliment the data being returned by that spacecraft.

The New Horizons spacecraft flew by Jupiter on February 28, 2007 and made observations of Io on its way through the system. Three of New Horizons' remote sensing instruments were trained on Io: the Multispectral Visible Imaging Camera (MVIC) which is sensitive to the visible range in the spectrum; the Long Range Reconnaissance Imager (LORRI) which is sensitive to the near infrared (0.4 – 1.0 μm); and the Linear Etalon Imaging Spectral Array (LEISA) which is sensitive to slightly longer infrared wavelengths (1.2 – 2.5 μm).

As during the Galileo era, we observed Io from the Infrared Telescope Facility (IRTF) in Hawaii in order to compliment the data being taken by New Horizons. Our observations were at longer wavelengths than New Horizons with some overlap (2.2, 3.5, and 4.8 μm). We were also able to observe Io over a longer period of time which can put the New Horizons data into the proper temporal context. We began observing in August 2006 and our last observation will be in June 2007. Because of solar conjunction, we were unable to observe Io from October through December 2006. The highest concentration of observations took place near the flyby.

Observations: We were awarded 28 partial nights total at the IRTF, all but two of which have passed at the time of this writing (table 1). The observations can be categorized into two broad types. In one type, observations are scheduled during Jupiter eclipses, when Io is in Jupiter's shadow and the volcanoes are seen without interference by reflected sunlight. During the associated occultation events, we can obtain one-dimensional spatial resolution across Io by plotting Io's total brightness as a function of time as it passed behind Jupiter. From this, we can determine the brightnesses of individual volcanoes on the Jupiter facing hemisphere of Io. Nineteen of the awarded partial nights were during Jupiter eclipses, included the two remaining dates. During twelve of these nights we were able to successfully observe Io.

The other type of observation takes place while Io is in sunlight. This enables us to observe a variety of longitudes and to look for major eruptions over the entire moon. During these observations Io's brightness is mostly due to reflected sunlight. In 1999, an eruption at Tvashtar (figure 1) was observed by the IRTF before the Galileo spacecraft obtained a higher resolution view (Howell et al., 2001), demonstrating that major eruptions can be seen from the IRTF. Nine of the observations were of this type and seven of those nights were successful for observing. They are spaced in time in order to obtain good coverage of Io at all longitudes.

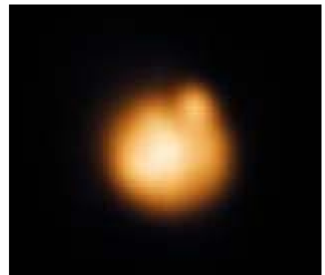

Figure 1: IRTF 3.8 micron image of Io during the November 1999 Tvashtar eruption.

Table 1: Dates of successful and upcoming IRTF observations in 2006 and 2007. Occultation observations are of the in-eclipse occultation and also include eclipse observations.

Date	Observation type
Aug. 15	Occultation reappearance
Aug. 22	Occultation reappearance
Jan. 3	Occultation disappearance
Jan. 18	Sunlit
Jan. 19	Occultation disappearance
Jan. 23	Sunlit
Jan. 24	Sunlit
Jan. 26	Occultation disappearance
Jan. 27	Sunlit
Jan. 29	Sunlit
Feb. 18	Occultation disappearance
Feb. 20	Occultation disappearance
Feb. 25	Occultation disappearance
Feb. 28	Sunlit
Mar. 2	Sunlit
Mar. 15	Occultation disappearance
Mar. 31	Occultation disappearance
Apr. 22	Occultation disappearance
May 7	Occultation disappearance
May 16	Occultation disappearance
Jun. 24	Occultation disappearance

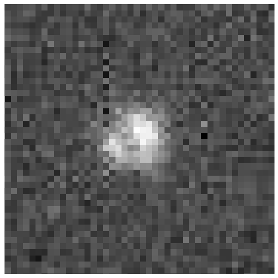

Figure 2: IRTF 3.5 micron image of Io in eclipse on March 6, 2007.

Results: During all eclipse observations in 2006-2007, Io appears much fainter than observed during earlier periods. The seeing is not often good enough to make out individual volcanoes, but on March 6th, 2007 the eclipse was observed in darkness and at a low airmass, allowing us to see three distinct bright spots at 3.5 μm (figure 2). The upper right spot appears to be Loki, the most powerful volcano on Io. The lower left spot may be either Kanehekili or Janus or some combination of both, and the dim lower right spot is still unidentified.

When the eclipsed Io is occulted by Jupiter, we can derive hotspot brightnesses from the observed light-curves. So far, we have been able to reduce light curves for four nights (August 15, January 3 and 26, and February 20). Only one hotspot had a measurable brightness during these events, Loki. It was measured to have a 3.5 micron brightness below 20 GW/micron/str on all four nights. Typical measurements of Loki's flux during eruption are closer to 50 GW/micron/str, indicating that it was, unfortunately, not actively erupting during the New Horizons flyby. Furthermore, none of the sunlit observations reveal an obvious eruption similar to the Tvashtar eruption in 1999. In conclusion, we observed no major outbursts during our 2006-2007 IRTF observations.

Comparison with New Horizons: Early images from New Horizons show a giant plume at the location of Tvashtar along with smaller plumes at other locations (figure 3). Although no major eruptions were observed at IRTF, several of our observations did include the Tvashtar area (table 2). We will thoroughly analyze all the images to see if Tvashtar can be detected at some lower level. If it can, we will use our multiwavelength measurements to constrain the eruption temperature. If it is not observed, we can put an upper limit on Tvashtar's output at the wavelengths with which we observed. If we are able to observe Tvashtar is some images and not in others, we can constrain the date the eruption began.

We will analyze the eclipse images as a function of date in order to see which volcanoes on the Jupiter-facing hemisphere are erupting and compare this to the eruptions observed by New Horizons and determine how long the eruptions have been occurring. We will further use our multiwavelength data to estimate surface temperatures of the observed eruptions.

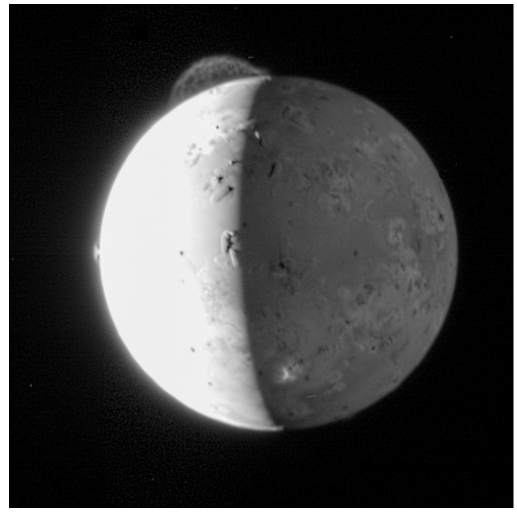

Figure 3: New Horizons image showing Tvashtar's giant plume near the top of the image and several smaller plumes across the disk.

References:

Howell, R. R., et al., Ground-based observations of volcanism on Io in 1999 and early 2000, *J. Geophys. Res.*, **106**, 33,129-22,139, 2001.

Rathbun, J. A., J. R. Spencer, A. G. Davies, R. R. Howell, and L. Wilson, Loki, Io: A periodic volcano, *Geophys. Res. Lett.*, **29**, 10.1029/2002GL014747, 2002.

Table 2: Sunlit observations and the orientation of Io and location of Tvashtar during each.

Date	Central lon.	Location of Tvashtar
Jan 18	130	Near Center
Jan 23	66	On limb
Jan 24	260	Other side
Jan 27	160	Near Center
Jan 29	206	Extreme limb
Feb 28	188	On limb
Mar 2	234	Other side