EUROJOVE CONFERENCE: JUPITER AFTER GALILEO AND CASSINI, LISBON 2002

Io's Heat Flow: Accounting for Unexpected Sources

D. L. Matson, T. V. Johnson, G. J. Veeder, D. L. Blaney, and A. G. Davies Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109. dmatson@jpl.nasa.gov

Io's unusual infrared properties first became appreciated in the 1960's when eclipse measurements and infrared radiometry yielded results that could not be easily explained by lunar-like models. When Voyager observations in 1979 revealed active volcanism and a geologically youthful surface, some of the reasons for these bizarre properties became apparent. The first determination of Io's heat flow resulted from examining the signature of volcanic heat in telescopic observations (Matson et al., JGR, 86, 1664 1981). Since then, numerous telescopic observations and Galileo observations have greatly expanded our understanding of Io's volcanism. However, Io continues to surprise us and significant problems remain. Of particular concern are two unexpected sources: "warm" polar regions (seen in PPR data), and "myriads" of small hot sources (seen in NIMS data). Any successful model for heat flow must reconcile the various observations and constraints on Io's thermal output: 1. small volcanic hot spots; 2. multi-wavelength radiometry at all longitudes; 3. multi-wavelength eclipse observations; and 4. temperature distributions observed by NIMS and PPR on Galileo. Two particularly difficult observational constraints have proved to be the daytime long-wavelength flux (20 microns) from Io, which is actually lower than expected for most passive models despite the obvious presence of volcanic contributions (Veeder et al., JGR, 99, 17095, 1994), and the surprising observation of ubiquitous warm regions at high latitudes in both the day and night (Spencer et al., Sci., 288, 1198, 2000; Rathbun et al., LPSC XXXIII, abs 1371, 2002). This paper presents preliminary results and current status of a self-consistent thermal model that involves small volcanic hot spots, both high and low thermal inertia components on Io's surface, and significant thermal output from cooling lava flows preferentially at high latitudes. The resulting heat flow is ~3 W/m^2, somewhat higher than previous estimates and well below the upper bound of 13.5 W/m^2 derived earlier (Matson et al., JGR, 106, 33021, 2001).

This work was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract to NASA.