EUROPA'S THERMAL SURFACE FROM GALILEO PPR. N. J. Rodriguez[1] , 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: The Galileo Photopolarimeter-Radiometer (PPR) instrument, which mapped thermal infrared radiation from Jupiter and the Galilean satellites, has been used extensively to study endogenic activity on Io (Spencer et al., 2000; Rathbun et al., 2004). While no current endogenic activity has been conclusively detected on Europa, the likely presence of a global ocean beneath the ice crust suggests that activity could be present. We are using the PPR observations of Europa to determine thermal properties of Europa's surface, namely bolometric albedo and thermal inertia. We will then determine the detection limit for endogenic activity from the PPR data.

PPR data: At Europa, the PPR instrument was primarily used in radiometry mode in which it measures the average brightness of thermal radiation within the field of view, which can be used to determine surface temperature on the assumption of blackbody emission. Observations were made using one of three filters: the open filter (sensitive to radiation from visible up to 100 microns); the 27 micron filter (24.1-32.3 microns), or the 17 micron filter (14.7-18.9 microns). Daytime images generally used the 27 micron filter while nighttime images used the more sensitive open filter.

Since the PPR instrument is a single pixel bolometer, images are constructed by raster scanning across the surface and averaging the fluxes at each to produce a map of brightness temperatures (figure 1). Each observation covers a different portion of the surface with a different range of local times and at a different resolution. For the daytime data, the measured temperatures range from 95 K to 130 K and drop away from the sub-solar point as expected. In the nighttime data, the temperatures at low latitudes range from 80 K to 95 K and temperatures at many longitudes tend to be higher in the north than corresponding latitudes in the south (figure 1). Furthermore, at some longitudes the equator is cooler than surrounding higher latitudes (Spencer et al., 1999).

Determining thermal properties: The bolometric albedo and thermal inertia of a surface, along with the distance from the sun and rotation period, determine the variation of surface temperature as a function of time of day. So, to determine these quantities we must find areas of the surface where we have observations at well-separated times of day.

Time-of-day graphs. We divided the surface of Europa into 10 degree by 10 degree bins. For each bin, we searched all PPR maps for data obtained within that bin. For each map with relevant data we calculated the average temperature within the bin and the time of day of that bin during the

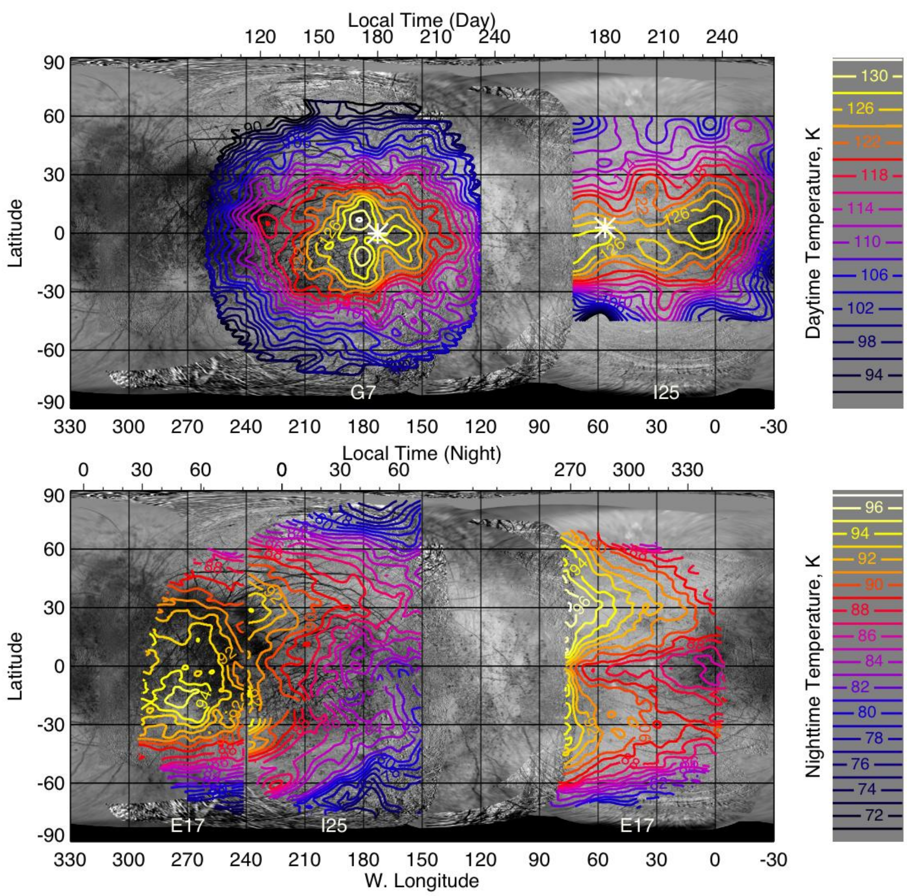

Figure 1: Daytime (top) and nighttime (bottom) brightness temperature maps of Europa obtained by Galileo PPR on multiple orbits, as labeled. The stars indicate the location of the subsolar point in each daytime map.

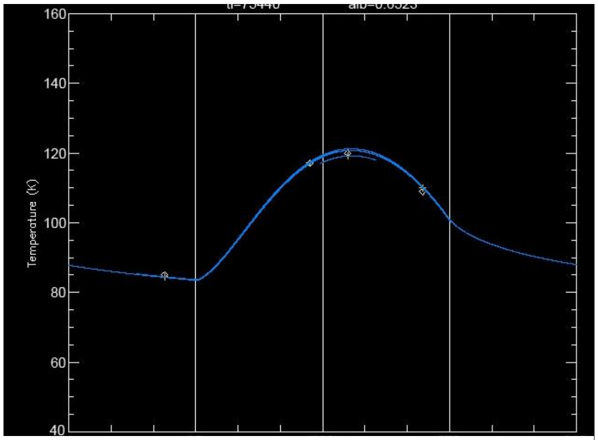

Figure 3: Temperature as a function of time of day for the bin at 10-20 degrees latitude, 150-160 degrees longitude. The blue line is the model fit and the diamonds are the observations. Time of day is defined in terms of angle with midnight at 0° and noon at 180°.

observation. In this way, we constructed a temperature vs. time of day plot for each of the 10 degree bins (figure 2).

Thermal model. We sorted through the 10 degree bins to find areas of the surface with observations near noon (10 am – 2 pm) and at night (6 pm – 6 am), as comparison of these times provides the most robut constraint on thermal properties. For each of these bins, we fit a thermal model to determine the thermal inertia and bolometric albedo of that bin (figure 2). Resulting maps of albedo and thermal inertia for Europa's surface are shown in figure 3. Our maps cover only the subset of the surface where sufficient data was obtained. As a check, we compared our albedo map to the SSI basemap of Europa. Given the current low resolution of our maps, our thermally-derived albedos appear to correlate with the albedo features observed in the basemap. Our thermal inertia maps provide a unique probe of the cm-scale properties of Europa's surface, and thus constrain surface processes and the detectability of endogenic hot spots. The improved knowledge of Europa's surface temperature distribution provided by these temperature maps and derived thermophysical prperties will also aid in the design of thermal instrumentation to search for endogenic activity on future Europa missions.

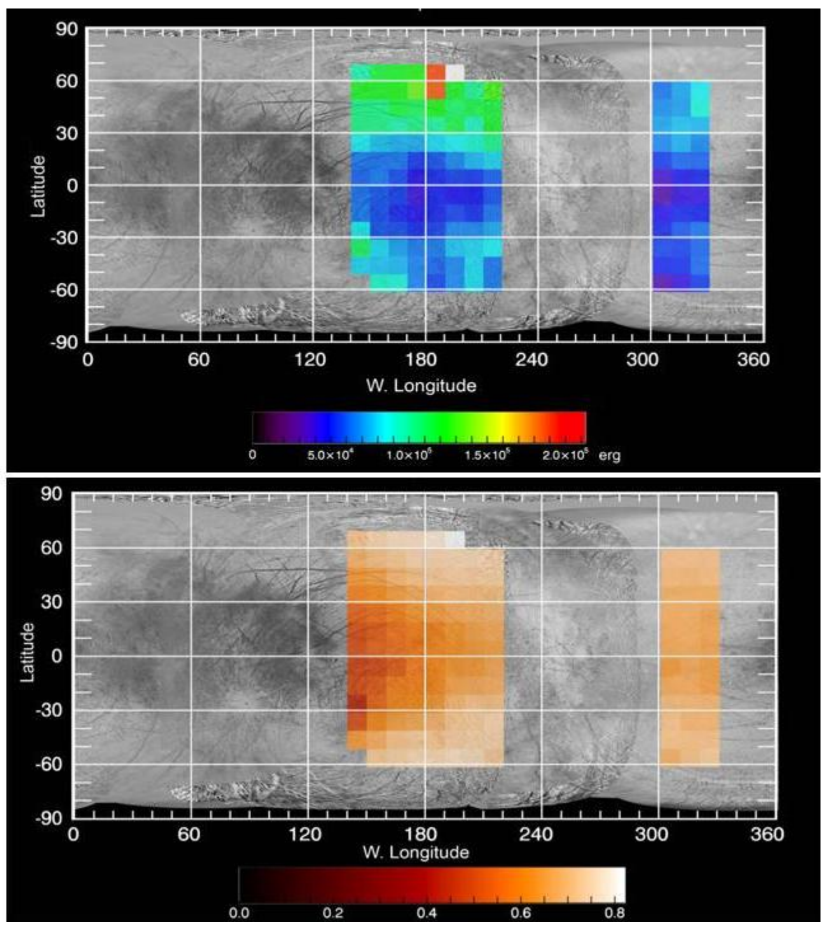

Figure 2: Maps of Europa's thermal inertia (top) and bolometric albedo (bottom) determined from thermal model fits to PPR data overlaid on SSI basemap. Scal for each is shown. Thermal ineratia is in units of erg cm^{-2} s$^{-1/2}$ K^{-1}.

Determining an upper limit for endogenic activity: Preliminary upper limits for endogenic point sources were determined using a subset of these data by Spencer et al. (1999). We will exend this analysis to obtain limits to endogenic activity from the full data set by adding synthetic point sources to the temperature maps to determine visibility thresholds. We will then compare these to numerical models of hot spot cooling by Abramov et al. (2008) to place limits on current endogenic activity on Europa.

References:

Abramov and Spencer (2008) *Icarus*, 195: 378-385.
Rathbun et al. (2004) *Icarus*, 169:127-139.
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Spencer et al. (2000) *Science*, 281:87-91.