Geophysical Research Abstracts
Vol. 12, EGU2010-12207, 2010
EGU General Assembly 2010

Endogenic Thermal Emission from Enceladus' South Pole Observed by the Cassini Composite Infrared Spectrometer

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Cassini's Composite Infrared Spectrometer (CIRS) continues to map, and examine spectroscopically, the endogenic emission from the active fractures at Enceladus' south pole, and useful observations have now been obtained on eight flybys of Enceladus. Observations at the shortest wavelengths, 7 – 9 microns, constrain the highest surface temperatures. The highest temperatures inferred directly from blackbody fits to the thermal emission spectra are in the 170 - 200 K range, and these temperatures appear to be tightly confined to the tiger stripes and a few other nearby fractures. The regions heated to these temperatures are typically only tens of meters wide if a linear geometry is assumed. Even warmer temperatures within a few meters of the active fractures are not ruled out by the spectral fits, and of course higher temperatures are likely at depth. Temperatures high enough to allow the presence of liquid water, which has been inferred from other Cassini data, are thus not ruled out by the CIRS data.

At longer wavelengths, endogenic emission from much larger areas at lower temperatures is detected- these areas radiate most of the endogenic heat flow. The first CIRS south polar data, obtained in 2005, covered only the 9 – 16 micron region and thus did not constrain the lowest-temperature emission. Fits to those data, assuming a single best-fit emission temperature of 133 K, resulted in a total heat flow estimate of roughly 6 GW (Spencer et al. 2006). However this was known to be a lower limit because of the likelihood of additional lower-temperature components. More recent south polar data from 2008 include 16 – 500 micron spectra that directly detect the majority of the radiated endogenic heat at all temperatures, and thus allow more robust heat flow estimates. After modeling and subtracting estimated passive thermal emission from the solar-heated surface, which also radiates at these longer wavelengths, we estimate total south polar radiated flux to be in the range 15 – 21 GW, far in excess of what can be generated by steady-state tidal heating.