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Microwave thermal emission from Iapetus' dark terrains

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Because of its large distance from Saturn and its high inclination, the Cassini spacecraft has made only one close (altitude<25 000 km) flyby (IA49) of Iapetus : on September 10, 2007. During this opportunity, the RADAR instrument scanned the antenna beam in a north-south raster pattern, mostly over the dark terrains (named Cassini Regio) of the leading hemisphere of the moon. During this scan, it collected a unique and concurrent set of passive (radiometry) and active (scatterometry) data at 2.2-cm wavelength and with a footprint size of ∼120 km (∼15% of Iapetus' diameter).

The Cassini radiometer measures the surface microwave thermal emission, which varies with the emissivity (or reflectivity) and physical temperature profile of the near-surface. At such a wavelength, it probes several tens of cm up to a few meters below the surface, depending on the absorbing properties of Iapetus' regolith. Combined with the concurrent active data, the radiometry data acquired during IA49 can be used to constrain the electrical and thermal properties of Iapetus' dark region thus providing clues on the physical state (roughness, porosity) and composition of these terrains whose nature and origin are still under debate.

In this paper, we will report on the Cassini microwave observations recorded during IA49 in the active and passive modes and describe the radiative transfer model we have developed in order to analyze the radiometry data. Comparison with this model indicates that the thermal inertia sensed by the Cassini radar radiometer at 2.2 cm over Cassini Regio significantly exceeds that measured in the thermal infrared by the Cassini's Composite Infrared Spectrometer (CIRS) instrument (∼10 in Rivera-Valentin et al., 2011). This suggests a gradient in density with depth, which is typical for planetary regoliths. The radiometer also captured the temperature asymmetry around the Equator due to heat buried in ground on seasonal timescales while the different local solar times of the equatorial observations seem to be responsible for a variation of less than 10 K in the brightness temperature recorded over Cassini Regio.