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# A young region on Enceladus revealed by 2 cm radiometry?

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## Abstract

On 5 November 2011, the Cassini spacecraft had a flyby of Enceladus dedicated to its synthetic aperture radar (SAR) instrument. In the course of that flyby, approximately 80% of Enceladus' surface was also observed serendipitously with the microwave radiometer operating concurrently at 2.2 cm. The radiometry data is analyzed and shown to drop sharply in the leading hemisphere's smooth terrain. This drop is also demonstrated in a series of unresolved distant radiometry measurements spread out over the ten years of the Cassini mission. However, the anomaly is absent from distant unresolved RADAR measurements and not visible in SAR imaging. The anomaly is most likely caused by a young surface (<100MYr in age) which has not yet been processed by micrometeoroid impacts below the electromagnetic skin depth (3 m).

## 1. Introduction

Microwave radiometry of moons of the Saturn system probes three properties: temperature, composition, and scattering. On Titan, all three of these have been readily measured [3]. Temperature is the fundamental component of the microwave regime, but it can be modulated by the scattering properties and composition of the surface. Composition is mainly determined via observing the polarization of microwave emission at high emission angles. Scattering can be inferred when the observed brightness temperature is lower than the observed or theoretical temperature. In this data set we study the large scale structure of Enceladus' surface primarily via the scattering properties of the surface. We will only touch on the temperature/thermal properties (as this is being worked on by others) and composition (because the data set is poorly suited to measure it).

## 2. Observations

### 2.1. 5 Nov. 2011

The raw antenna temperature data were unusable due to the fact that Saturn was behind Enceladus for the first half of flyby. The data were corrected by subtracting a model of Saturn with a 0K hole at the location of Enceladus convolved with the radiometer beam from the raw antenna temperature. The second quarter of data were dominted neither by Saturn nor cold space, but rather by Saturn's rings, which are poorly modeled at present. Thus, only the first quarter and second half of the flyby were analyzed.

The corrected antenna temperatures were then compared with various models for the surface. These models were produced by calculating spacecraft orientation and calculating the emission angle, polarization angle, and geographic location of each ray of the beam map on the surface of Enceladus at every observation time. The emission and polarization angles were fed into a model [6] with varying dielectric constant. The surface temperature was determined based on the multiplication of a model of the geographic surface and a model of solar heating relative to the subsolar point. Figure 1 shows three of the most relevant geographic models and Figure 2 shows a comparison between those three models and shows that a "geographic anomaly" is the clear winner.

### 2.2. Distant radiometry and scatterometry

Distant radiometry shows a similar pattern to the mid-resolution observations: a drop in brightness temperature of about 30% coincident on the anomaly region. However, the distant scatterometry (active radar) data from Cassini is approximately flat over the entire rotation period.

## 3. Discussion and Conclusions

The combination of distant and mid-resolution radiometry indicate that the anomaly is a scattering anomaly rather than a thermal inertia anomaly. The anomaly is at a depth of a few m in an ammoniated or

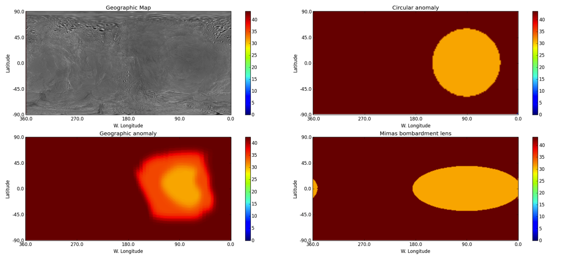


Figure 1: Plot of three different models for Enceladus' surface emission and an optical map of Enceladus with the same orientation and scale. Upper left: ISS mosaic of Enceladus (PIA14937). Upper right: Circular anomaly. Lower Left: Geographic anomaly. Lower Right: bombardment ellipse identical in shape to the one found on Mimas [2].

pure icy surface [5]. The shape is **inconsistent with electron bombardment** such as that seen on Mimas [2] and **most consistent with leading hemisphere geography**. Our interpretation is that this anomaly is caused by the terrain being young enough that it has not been processed by micrometeoroid impacts down to the depth of the observation, since the anomaly is deep enough to be invisible to the 2 cm scatterometry observations. The depth implies it cannot be a near-surface feature like electron bombardment or a few cm of snow. Using a micrometeroid gardening model [1] we estimate the age of the surface to be less than 100 MYr.

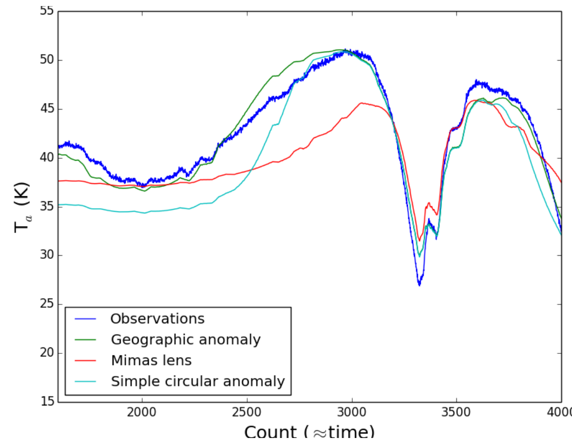


Figure 2: Three models of Enceladus compared to the observations. Modeling the anomaly along the lines of the leading hemisphere smooth terrain ("geographic anomaly") produces by far the best match to the data.

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