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Mapping Saturn's thermal emission at 2-cm wavelength using the Cassini RADAR radiometer

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The thermal emission from Saturn's atmosphere was mapped over most of its globe using the passive radiometer that is part of the Cassini RADAR instrument. The radiometer operates at a frequency of 13.78 GHz, or 2.18-cm wavelength, and uses the spacecraft's main communication antenna to form a beam of 0.37º width at half power. An image in cylindrical coordinates was constructed using data obtained from continuous pole-to-pole scans made in each of three time segments during a periapsis pass on September 23-24, 2005. The spacecraft distance to Saturn ranged from 2 to 8 Saturn radii during the observations, and the inclination of the rings as viewed from the spacecraft never exceeded 0.3º. The sensitivity was nearly 0.1 K, and the best spatial resolution in the image achieved after beam deconvolution is 500 km (0.5º) in latitude and 2000 km (2º) in longitude. This represents more than an order of magnitude improvement in both sensitivity and latitude resolution over all previous microwave observations of Saturn, and is the first time a microwave image of an outer planet has been obtained with any resolution in longitude.

At 2-cm wavelength the radiometric weighting function lies at altitudes almost entirely within the ammonia saturation region, and the brightness temperature is therefore primarily sensitive to the cloud-level ammonia concentration. A variety of heretofore-unseen structure attributable to cloud-level ammonia variations is apparent in the image, including strong and stormy warm bands centered around ±4º and ±10º latitude, strong continuous bands at ±30º latitude, and numerous faint, narrow bands at intermediate latitudes. The latter appear regular in the southern hemisphere and irregular in the north, currently shadowed by the rings. The warmest areas show brightness tem-

perature increases up to 15 K relative to the cold areas, consistent with the complete absence of ammonia to altitudes well below the nominal saturation level. The ready interpretation is that the cold areas are regions of upwelling atmosphere that have high relative humidity in the cloud region, while the bright areas are downwelling regions depleted in ammonia. Implications for atmospheric circulations will be discussed.

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