Electrical Properties of Titan Surface from Cassini Scatterometer and Radiometer Measurements

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We observe Titan, Saturn's largest moon, using active and passive microwave instruments carried on board the Cassini spacecraft. The 2.2-cm wavelength penetrates the thick atmosphere and provides measurements at resolutions from 10-200 km over much of the moon surface. Here we seek to explain Titan's simultaneous high reflectivity and high emissivity, using a layered model in which a gray body emissive material is overlain by a nearly lossless but complex icy layer. The lossless layer is required to produce the high radar returns through coherent backscattering, while the absorptive substrate is needed to produce high radiative temperatures. We use angle diversity to separate a Hagfors? like surface scattering term from a diffuse volume scattering term in the radar echo, and retrieve dielectric constants ranging 1.5 to greater than 3 for much of the surface. The specular term also yields surface slope distributions from a few degrees rms to greater than 15 degrees in different regions. The reduction of the radiometry data also gives dielectric constants over the same range, but the average properties of Titan favor the lower values. Dielectric constants of 1.7 are indicative of frozen hydrocarbon materials such as methane or ethane, while water ice has a dielectric constant of 3.2. If the surface is composed largely of water ice, it would have to be unconsolidated material such as snow where the bulk electrical properties are reduced by the fractional volume of material. Many small scale features are seen and differ both in emissivity and reflectivity from the average values, and likely give clues to the nature of geologic processes occurring on the surface.