TITAN: 13 CM ARECIBO RADAR OBSERVATIONS AND COMPARISONS WITH CASSINI ISS AND RADAR IMAGERY. D. B. Campbell[1], G. J. Black[2], L. M. Carter[3] and M. C. Nolan[4], [1]Department of Astronomy, Cornell University, Ithaca NY 14853; campbell@astro.cornell.edu, [2]Department of Astronomy, University of Virginia, P.O. Box 3818, Charlottesville, VA 22903, [3]Center for Earth and Planetary Studies, Smithsonian Institution, Box 37012, Washington, D.C. 20013-7012, [4]Arecibo Observatory, HC3 Box 53995, Arecibo, PR 00612.

Introduction: Arecibo 13 cm radar observations of Titan probe the scattering properties of its surface at a scale six times longer than the 2.2 cm Cassini radar. While they are at much lower resolution than the Cassini radar images, the 13 cm observations investigate the normal incidence properties of the surface allowing the determination of surface rms slopes and, assuming a homogeneous surface, the Fresnel reflectivity and surface dielectric constant from the properties of any specular reflections. The Cassini radar operating in both its scatterometer and altimetry modes [1] is capable of investigation the normal incidence properties of Titan's surface at its 2.2 cm wavelength. However, to date only a small quantity of scatterometer data has been reported on [2].

Observations: We have observed Titan with the Arecibo 13 cm wavelength radar during the last five oppositions of the Saturn system with sufficient sensitivity to allow characterization of its scattering properties as a function of sub-earth longitude. Almost all the observations were of the CW type where a monochromatic circularly polarized signal is transmitted and rotationally Doppler broadened spectra in both senses of receive circular polarization are formed from the received echoes (Fig. 1). Using the Arecibo antenna to both transmit and receive the echo, spectra have been obtained for a total of 53 sub-earth longitudes at latitudes between 18S and 26S, close to the maximum southern excursion of the sub-earth track. During the opposition of the Saturn system in early 2007 we expect to obtain spectra for an additional 13 sub-Earth locations at latitudes close to 13S.

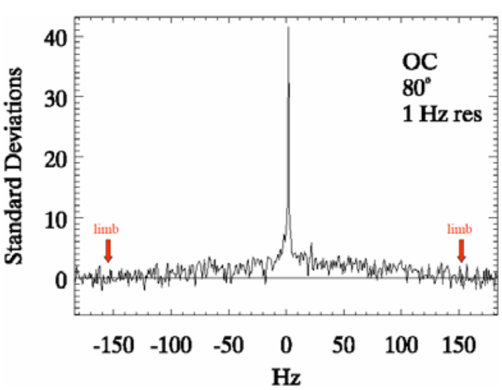

Figure 1: A 13 cm radar spectrum of Titan in the expected sense of received circular polarization for a sub-Earth location near Hopei Arcus in eastern Xanadu. There is very narrow specular echo at 0 Hz corresponding to a surface with an rms slope of 0.13 deg. Most of the echo power is in a broad diffuse component with a bandwidth of ~325 Hz.

Discussion: As reported in [3] and from the subsequent observations we find that: 1) Most of the echo power is in a broad diffuse component; 2) the 13 cm radar reflection properties of Xanadu Regio suggest that its composition is relatively pure water ice; 3) the proportion of spectra showing a specular echo is roughly 60%, somewhat less than the 75% that was reported on the basis of the 2001 observations. The properties of the specular echoes, low cross sections and small rms slopes, are consistent with reflections from very smooth low reflectivity surfaces but the absence of any convincing evidence from the Cassini radar imagery for liquid surfaces in the latitude range covered by the Arecibo observations suggests that the low cross sections arise from higher reflectivity surfaces that are only partially smooth at 13 cm and larger scales.

The large Arecibo data set and the advent of high resolution near-IR Cassini images [4] has allowed an initial correlation of the locations and properties of specular echoes in the Arecibo data with the high and low albedo areas discernable in the Cassini ISS imagery [4]. With one exception, all of the 13 cm spectra from Xanadu exhibit a specular component with over half of them having rms slopes between 0.13^0 and 1.0^0, indicating reflections from surfaces that are extremely smooth at 13 cm and larger scales over spatial scales of 10 to 100 km. Three of the smooth areas are very close to the Hotei Arcus, the "smile" feature in eastern Xanadu. Assuming that the surface of Xanadu is water ice with a Fresnel reflectivity of 0.08, the measured mean 13 cm normalized radar cross section in the specular component for Xanadu of ~0.03 implies that roughly 40% of the surface is contributing to the specular echo and, hence, is very smooth at wavelength and larger scales. To date there has been no common coverage between the Cassini radar imagery and Arecibo sub-Earth locations but the very variegated terrain imaged by the Cassini radar over Xanadu near 10S makes the presence of such a high percentage of "flat" areas somewhat surprising. One alternative possibility that has been suggested is that there are small dune fields within Xanadu. If so, they may be responsible for some of the specular echoes and the low Fresnel reflectivities may be due to low porosity. In this case, the variation in the measured RMS slopes may then be related to the orientation of the dunes with respect to the E-W, the Doppler direction. However, given the ubiquity of specular echoes from Xanadu it is unlikely that they are all due to reflections from dune fields.

Almost all of the well defined low albedo areas discernable in the current Cassini ISS imagery, many of which contain dune fields based on the radar imagery [5], are just north of the 18S to 26S latitudes of the sub-Earth locations observed with Arecibo to date. They are also dark in the 2 cm Cassini radar images implying that they are very smooth at 2 cm scales [5]. The scheduled January/February 2007 Arecibo observations will be at a sub-Earth latitude near 13S. The track crosses several large dark areas including the one that contains the Huygens probe's landing site. We will sample possible dune fields at the western end of the T8 Cassini radar swath in the Senkyo low albedo area and locations in the vicinity of the Huygens landing site and the Shangri-La feature west of Xanadu.

References: [1] Elachi, C. et al. (2005) *Science*, 308, 970-974. [2] Wye, L. C. et al. (2006) *LPS XXXVII* abstract 1473. [3] Campbell, D. B. et al. (2003), *Science*, 302, 431-434. [4] Porco, C. C. et al. (2005) *Nature*, 434, 159-168. Lorenz, R. D. et al. (2006) *Science*, 312, 724-727.