BACKSCATTERING PROPERTIES OF THE DRAGONFLY LANDING SITE IN THE SELK CRATER REGION. L. E. Bonnefoy[1,2], A. G. Hayes[1], A. Lucas[2], S. Rodriguez[2], V. Poggiali[1], D. E. Lalich[1], R. Lorenz[3], and A. Le Gall[4], [1]Department of Astronomy, Cornell University, Ithaca, NY, USA, [2]Université de Paris, Institut de physique du globe de Paris, CNRS, Paris, France, [3]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA, [4]Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS), UVSQ /CNRS/Paris VI, UMR 8190, 78280 Guyancourt, France

Introduction: The Dragonfly mission, selected through NASA's New Frontiers program, will improve our understanding of Titan's chemistry and geology by sending a rotorcraft to its equatorial dune fields in the mid-2030s (expected launch in 2027) [1, 2]. The landing site is in the Shangri-la dune field near the 80-km-wide Selk crater (6.5°N, 161.5°E), which features traces of erosion by both aeolian and fluvial processes [3, 4]. The region has been imaged by the Cassini RADAR (Ku band, 2.2 cm) in Synthetic Aperture Radar (SAR) mode at incidence angles varying from 5° to 72° and polarizations varying from parallel to perpendicular (to the incidence plane). We take advantage of this dataset to fit backscatter models and extract new constraints on the dielectric constant, root-mean-square (rms) slope, and scattering albedo.

Methods: The region of interest around Selk crater, defined by [2], has been imaged by the Cassini RADAR on 9 occasions, brought together in the mosaic shown in Fig. 1a. From this data, we mapped 6 terrain units (Fig. 2b): crater rim, crater ejecta, hummocky terrains, plains, dune fields, and dark terrains (in order of decreasing radar brightness). These terrains are largely the same as those identified and mapped by [2] and [4], with the exception of the “dark terrains”, which we define as very radar-dark regions located near dune fields but without clearly apparent dune structures. Within dune fields, the dunes and interdune regions were separated using the method described in [5], adding two more terrains (which are combined in the dune fields unit). The normalized backscatter cross section (σ^0) values of each unit within a 0.25° grid were averaged and plotted against the incidence angle in order to assemble backscatter curves.

The dominant mechanism contributing to radar backscatter varies with incidence angle: quasi-specular scattering on facets oriented towards the radar dominates at low ($\lesssim$30°) angles, whereas at higher angles diffuse scattering from surface roughness and subsurface structures takes over. The quasi-specular component has the dielectric constant and surface rms slope as parameters, and tests three different scattering laws previously applied to Titan: Hagfors, exponential, and Gaussian [e.g., 6, 7]. For the diffuse component, we used either the empirical $A\cos^n$ model [6, 7] or the simple but physical single-scattering Swift model [8], which can also derive the dielectric constant from the degree of polarization. All six quasi-specular + diffuse model combinations were fit to the data to find the best dielectric constant, rms tilt angle, and scattering albedo. We note that the rms tilt angle is measured at the wavelength scale (centimetric) and could be due for example to coarse gravel. Although absolute values of these parameters are model-dependent, the relative values from one terrain to another indicate real variations in surface properties.

Results and interpretations: The parameters derived for each terrain are represented graphically in Fig. 2. The interpretations of these values are summarized below:

- Dunes and plains exhibit the same microwave scattering properties both inside and outside the crater, indicating likely aeolian infilling and/or crater rim erosion bringing the same materials into the crater as are available elsewhere.
- The crater rim is among the brightest terrains on Titan and exhibits strong diffuse scattering, consistent with an icy (low-loss) subsurface with buried scattering structures, although surface roughness likely also plays a role.
- The dune fields and especially the dunes have a low dielectric constant (between 1.5 and 2.2 median values for all models) consistent with previous work [e.g., 6, 9, 10], a low rms tilt angle, and little diffuse backscatter. These properties all point to organic sand. Meanwhile, the interdune regions have a higher dielectric constant, indicating a likely icier and/or less porous surface.
- The dark regions have a low dielectric constant and little to no diffuse scattering. This is consistent with organic sand over depths thicker than ~1 m, and likely corresponds to a sediment sink due to converging winds or low topography.
- The active radar data can be used to derive the dielectric constant not only from the shape of the quasi-specular component, but also from high-incidence data at different polarization angles, using Fresnel’s equations in a way similar to the method used on passive microwave radiometry [10]. The disparity between dielectric constants derived from backscatter modeling (up to ~4.5 for some terrains) and polarization studies (<2.2 everywhere) suggests either the existence of a depo-

larizing process (surface roughness or multiple scattering, [10]) or that the quasi-specular component inaccurately models Titan's surface.

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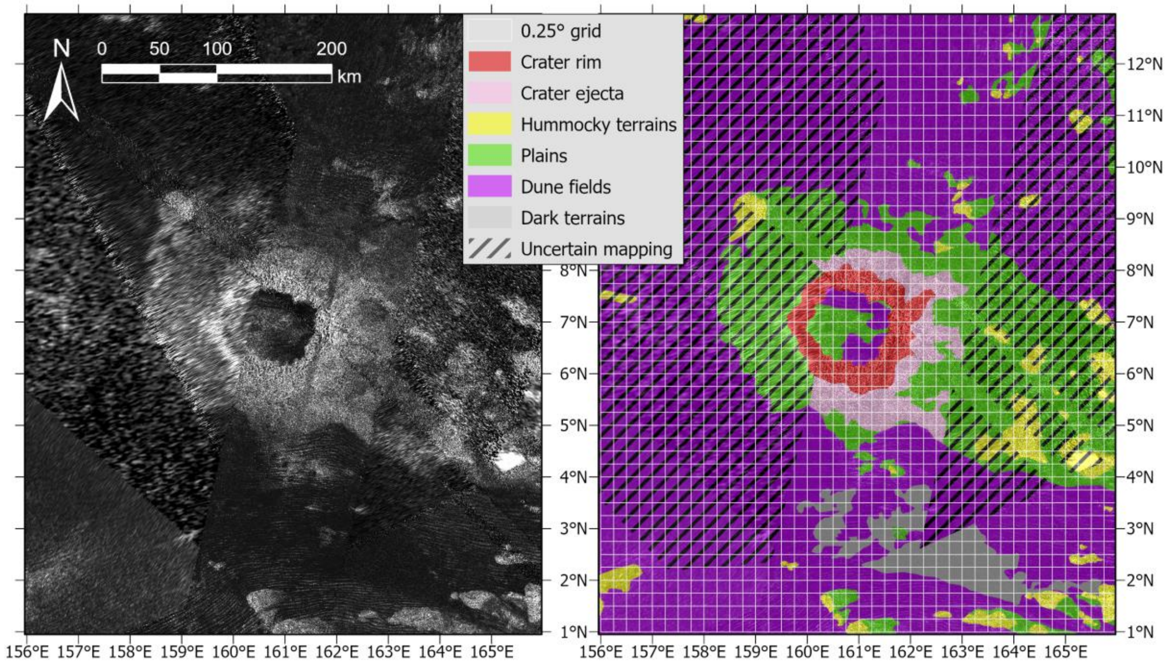

Figure 1: Left: mosaic of the incidence angle corrected SAR swaths within the region of interest. Right: geomorphological map of the region of interest. For easy comparison with previous work, we use a color scheme similar to Malaska et al. (2016).

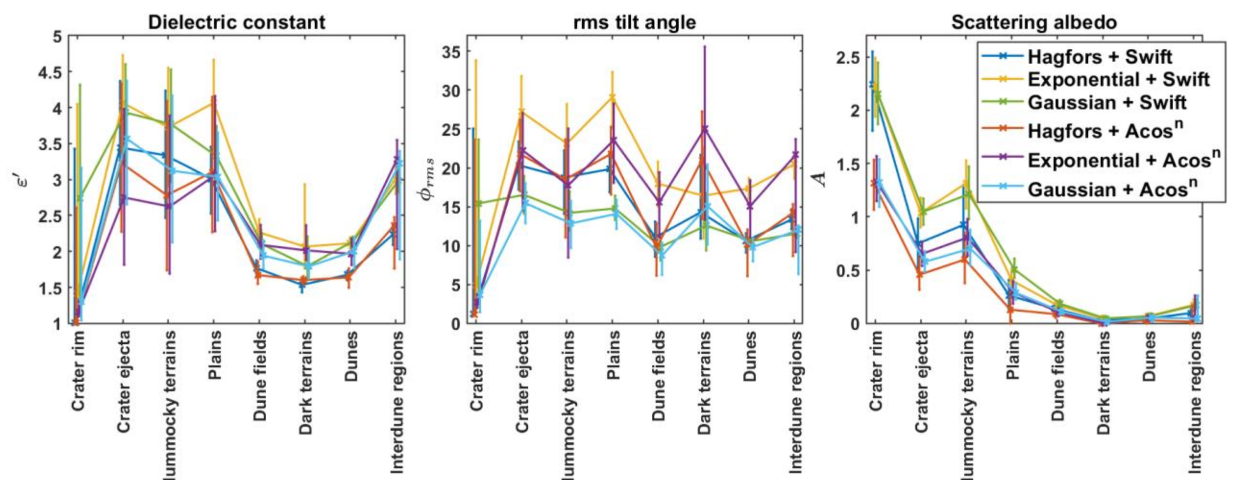

Figure 2: Values of the effective relative dielectric constant (from the quasi-specular component), rms tilt angle at the wavelength scale, and scattering albedo derived for all 8 terrains and for all 6 combinations of quasi-specular and diffuse scattering mode. Note that the dune and interdune regions are mixed together in the dune fields unit.