HOW WIDESPREAD ARE THE BLADED TERRAINS ON PLUTO?

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Introduction: New Horizons observed fields or landscapes of roughly evenly spaced, often sub-parallel sets of steep ridges situated on high ground (Fig. 1). These landscapes have been labeled as 'Bladed Terrain' and consist of deposits of massive CH_4, which are observed to occur within latitudes 30° of the equator and are found almost exclusively at the highest elevations [1]. These blades are analogous to penitentes on terrestrial, low-latitude, high-elevation ice fields [2], and thought to be formed by partial erosion of CH_4 deposits over many climate cycles on Pluto. Thus Bladed Terrain represents an active response of Pluto's landscape to current and past climates, and very likely a major terrain type on Pluto.

Research problem: Bladed Terrain forms the eastward end of a sequence of landforms extending from Sputnik Planitia (Figure 2). Work by [1] shows a good correlation between low latitude, high-standing topography where Bladed Terrain is located (Fig. 2), and broad-width CH_4 absorption (centered on the 890 nm absorption band). There are hints that the observed Bladed Terrain continues eastward beyond the high resolution coverage of New Horizons, into the poorly resolved hemisphere that shows patches with high CH_4 absorption.

In absence of high resolution images, a key way to answer the question of whether the Bladed Terrain extends to the poorly resolved regions of Pluto is to compare the photometric properties, particularly surface macroscopic roughness, of the well resolved Bladed Terrain regions of Pluto's encounter hemisphere to regions in the poorly resolved hemisphere that show spectroscopic hints of Bladed Terrain.

Data and Methodology: We are using New Horizons LORRI images to create reflectance profiles as a function of incidence and emergence angles of selected regions (see Figure 3 for example). We will compare these reflectance profiles to reflectance models by Buratti et al. that depend on the roughness of surface [3], henceforth referred to as B85. B85 calculates the total reflection of a surface covered with parabolic craters as a function of the observation geometry and the ratio of the depth to the radius of the craters. The depth-to-radius ratio parameter is what we are interested in, as higher values of this parameter would imply a rougher Bladed Terrain like surface. We will employ a Bayesian framework to fit the B85 model to the New Horizons data and retrieve posterior distributions of the surface roughness parameter for selected patches of Pluto. Comparison of the retrieved surface roughness parameter values of the known and hypothesized Bladed Terrain regions will shed light on the extent of this terrain type on Pluto. The surface roughness values of the known Bladed Terrain obtained from this analysis can also be compared to the surface roughness of other icy bodies in the outer solar system, such as Europa, where penitentes-like structures have been hypothesized to exist as well [4].

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References: [1] Moore, J.M. et al. (2018) *Icarus, 300,* 129-144. [2] Moore, J.M. et al. (2016) *Science, 351,* 1284-1293. [3] Buratti, B.J. and Veverka, J. (1985) *Icarus, 64,* 320-328 [4] Hobley, J.M. et al. (2018) *Nature Geoscience, 11,* 901-904.

Figure 1 Pluto's Bladed Terrain near its equator, captured by New Horizons. Credits: NASA/APL/SwRI

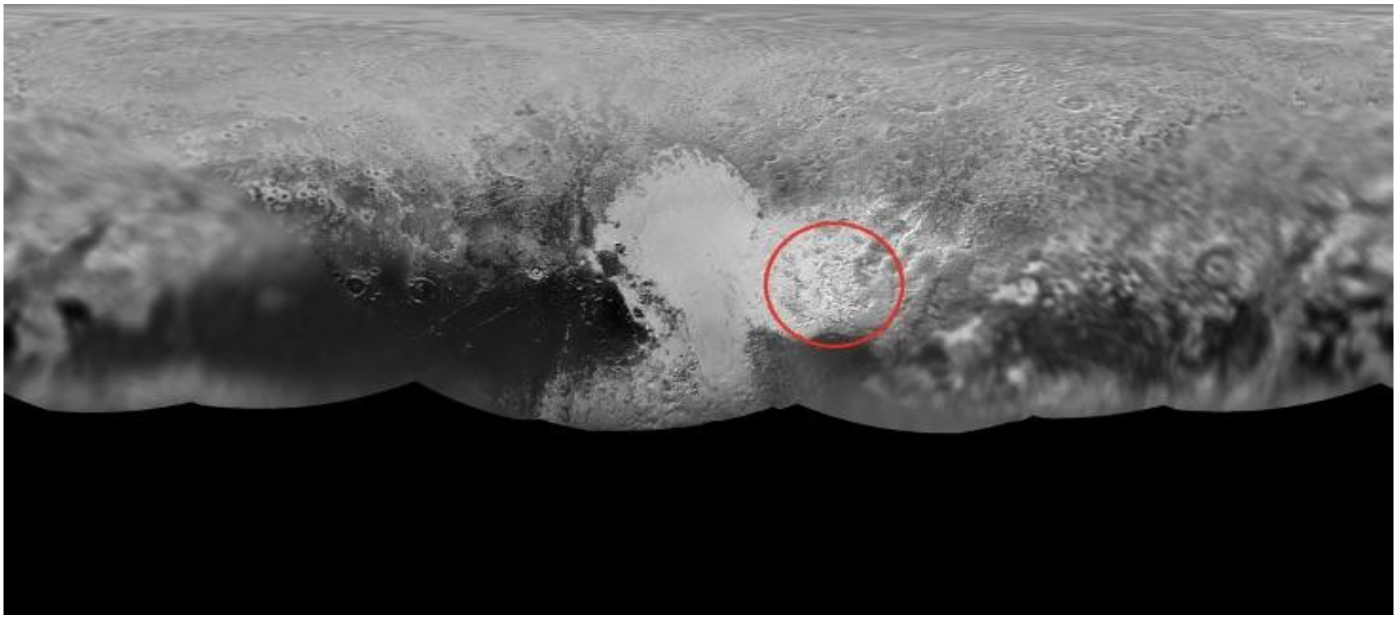

Figure 2 Map of Pluto derived from New Horizons images, with the red circle showing the approximate extent of bladed terrain. Credits: NASA/APL/SwRI

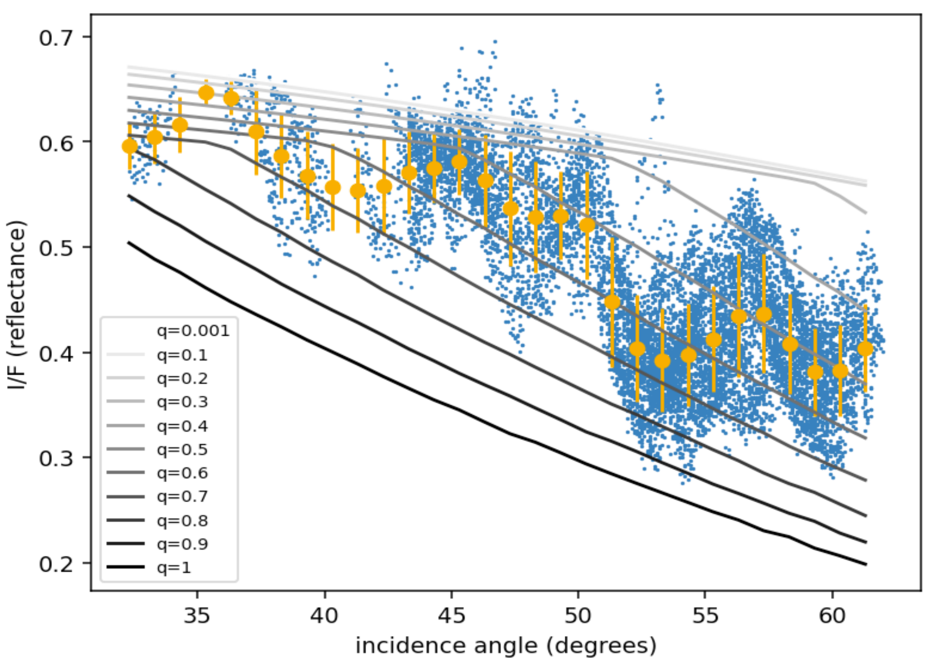

Figure 3 Reflectance of pixels from a Bladed Terrain region of Pluto is shown (blue dots) as a function of incidence angle, for a fixed phase angle of around 16.7° for all observations. The orange dots show the reflectance data binned to intervals of 2°, with the error bars indicating the standard deviation of reflectance values in each bin. The solid-line curves are B85 reflectance models generated for varying surface-roughness parameter 'q', which is the ratio of depth to radius of parabolic craters on the surface. The q parameter controls the inflection point of the reflectance curve, and the inflection in the data seems to match well with the q=0.5 model which is indicative of a rough surface such as the Bladed Terrain.