THE SHAPES AND DISTRIBUTIONS OF DUNES ON PLUTO. J. Radebaugh 1, M.W. Telfer 2, E.J.R. Parteli 3, R.A. Beyer 4 and R.L. Kirk 5. 1Department of Geological Sciences, Brigham Young University, Provo, UT (jani-rad@byu.edu), 2School of Geography, Earth and Environmental Sciences, Plymouth University, Plymouth, UK, 3Department of Geosciences, University of Cologne, Pohligstraße 3, 50969 Cologne, Germany, 4NASA Ames Research Center and SETI, Mountain View, CA, 5USGS Astrogeology Division, Flagstaff, AZ.

Introduction: The surface of Pluto as revealed by New Horizons has many geological features similar to other bodies in the solar system, including mountains, craters, tectonic fractures, cryovolcanic constructs and even a convecting glacier [1,2,3]. Included among the geological landforms are hundreds of sand dunes, stretched across the Sputnik Planitia glacier (Fig. 1) [4]. These features have many morphological similarities to dunes on Earth, Mars, Venus and Titan, such as bifurcations or “y-junctions”, an increase in size towards the center of a given dune patch (or “pattern coarsening”), alignment with wind streaks, and deviation around topography [4]. New Horizons MVIC (Multispectral Visible Imaging Camera) images revealed a concentration of methane ice associated with the dunes, meaning they are made of methane sand (where “sand” means a loose, subround, small particle of any composition) [4,5]. Here we describe their shapes and relative heights, the variations in their patterns, and their distribution across the underlying glacier.

Fig. 1. Dunes on Sputnik Planitia at the base of the Al Idrisi Montes. NASA/New Horizons

Shapes and Heights of Pluto’s Dunes: The features initially described as dunes on Pluto are concentrated in the NW corner of the Sputnik Planitia glacier, near the 5-km-high Al Idrisi Montes. They have regularly spaced [4], elevated and ridge-like morphologies that vary in height and spacing across the terrain. Features in the middle of the heart-shaped feature in Fig. 1 (a convection cell, typical of other cells across Sputnik Planitia, [6]) are straight over distances of several tens of kilometers, are relatively closely spaced (~400 m) and are highly parallel (upper left, Fig. 2) [4]. They have some y-junctions, indicating excursions from the regular pattern, but defects like these are comparatively rare. In many ways, their morphologies are like ripples; in fact, they were modeled as “elementary” transverse dunes, which are the smallest dunes that can be formed by wind on a flat surface [supplemental material in 4]. Features at the bottom of Fig. 1 (upper right, Fig. 2) are generally larger, more widely spaced (~700 m) [4], and based on their shading appear to be taller than those in the north.

Features far to the left in Fig. 1 (bottom of Fig. 2) are more laterally discontinuous and have almost a boxed pattern in planview. These features also appear to have slightly flatter tops than the other dunes (Fig. 3). This may result from a gradual flattening of the crestlines, either through wind- or sublimation-related erosion [7]. That the dunes of Pluto are relatively small is consistent with them being elementary forms, and also makes them analogous to snow dunes on Earth, which tend to have smaller heights.

Fig. 2. Dune shapes discussed from Fig. 1.

Distributions of Pluto’s Dunes: Away from the base of the Al-Idrisi Montes, there are many regularly spaced linear ridges across Sputnik Planitia that have patterns consistent with being dunes [4]. The ridges are perpendicular to wind streaks, appropriate for dunes that form transverse to the winds [4]. Most ridged forms on Sputnik Planitia are oriented roughly NNE-SSW, consistent with a regional wind blowing from Al-Idrisi across Sputnik [4]. Ridged forms at first glance are randomly distributed across Sputnik, covering perhaps 40% of the surface (Fig. 3). They do not favor an upwind or downwind portion of a convection cell; however, they are preferentially found away from the convection cell centers (Fig. 4). No one reason stands out for why this concentration occurs, but potential reasons...
Pluto's dunes must be fairly young, given the rate of the convection thought to be occurring on Sputnik Planitia [6]; however, it is uncertain if they are forming today or when winds were stronger in the past [4,8].

Conclusions: The dunes of Pluto have forms that vary in size and shape across Sputnik Planitia. They display shapes, spacings and heights consistent with shapes of dunes seen on other planets, especially elementary forms and snow dunes on Earth. While stereogrammetry of New Horizons data is insufficient to resolve the morphology of these features, photoclinometry algorithms [9,10] may be able to derive their shape. Paired with regional mapping of their locations and models for wind effects on Pluto’s sands [11], will provide a more conclusive picture of the differences and relative ages of the features and the state of activity on Pluto today.