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Particle size and formative wind speed of transverse dunes at Sputnik Planitia, Pluto

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Images sent back to Earth by New Horizons revealed that the surface of Pluto is far more dynamic and geologically diverse than had been expected. However, the role of the tenuous atmosphere for landscape morphodynamics is still uncertain.

Dunes, which require a supply of granular particles at the surface and a boundary layer of sufficient efficacy to enable direct entrainment of these particles by fluid forces, have been detected in surprising locations of our solar system. In particular, the equatorial regions of Saturn's moon Titan display a broad belt of linear dunes, while aeolian landforms also occur on the comet 67P Churyumov-Gerasimenko despite the lack of a persistent atmosphere on this comet.

Here we describe regularly spaced, linear ridges on Pluto that have a morphology, orientation and distribution consistent with an interpretation as transverse dunes. The dunes occur proximal to mountainous regions in Sputnik Planitia, a plain of N_2, CO and CH_4 ice that extends across Pluto's tropics and covers 30° of longitude at its maximum. The transverse dunes are orthogonal to nearby wind streaks and display a crest-to-crest distance (wavelength) of $\sim$ 400 m – 1 km.

We develop a model to approximately constrain average particle size (d) and formative wind speed (U) from the average crest-to-crest distance (wavelength λ) of the transverse dunes. The relevant length-scale controlling this wavelength is the saturation length (L_{sat}) of the sediment flux, i.e. the distance needed by the sediment flux to adapt to a change in local flow conditions. By combining a mathematical model for λ as a function of L_{sat} and U with theory that predicts L_{sat} as a function of wind speed and attributes of sediment and atmosphere, we obtain the values of U and d that are consistent with λ.

We find that the observed wavelength of Pluto transverse dunes is consistent with moderate winds ($<$10 m/s) and grain size that does not exceed $\sim$370 μm and is most probably within the range between 210 and 310 μm. This range of particle size is consistent with results from the spectral response of the MVIC CH4 filter, which predicts a granular medium of $\sim$200-300 μm at Sputnik Planitia. From the lack of deformation of the dunes, as well as the relationships with the underlying convective glacial ice, we conclude that the dunes must have formed in the recent geological past.