New Horizons: Macroscopic Roughness of Differentiated Terrain on Pluto

Spencer L. Devins
Consortium for Undergraduate Research Experience
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Overview

- Background Information (Pluto, *New Horizons*)
- Motivation and scope of project
- Method
- Results
- Discussion
- Future Research
- Acknowledgements

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An Overview of Pluto

- Discovered February 18th ,1930
- Visited by *New Horizons* July 14th, 2015
- Kuiper Belt Object
- 5 Known Satellites (Charon, Nix, Hydra, Kerberos, and Styx)
- Surface Area: 1.77×10^7 km
- Mass: $(1.303 \pm 0.003) \times 10^{22}$ kg
- Surface composed mainly of Ices of Water, Nitrogen, CO, and Methane.

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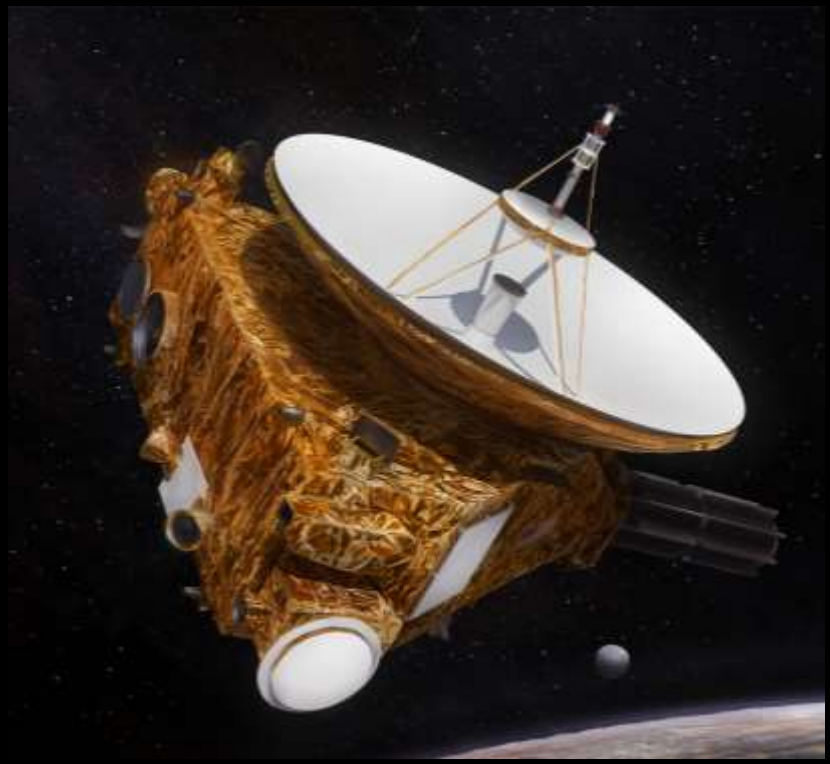
New Horizons Spacecraft Overview

- Built by JHUAPL/SWRI
- Launched on January 19th, 2006
- Visited Jupiter prior to Pluto System
- Made closest approach to Pluto July 14th, 2015 at 12,500 km from the surface of Pluto
- Suite of seven instruments to explore the Pluto system
- Currently in extended mission cruise to another KBO (2014 Mu69)



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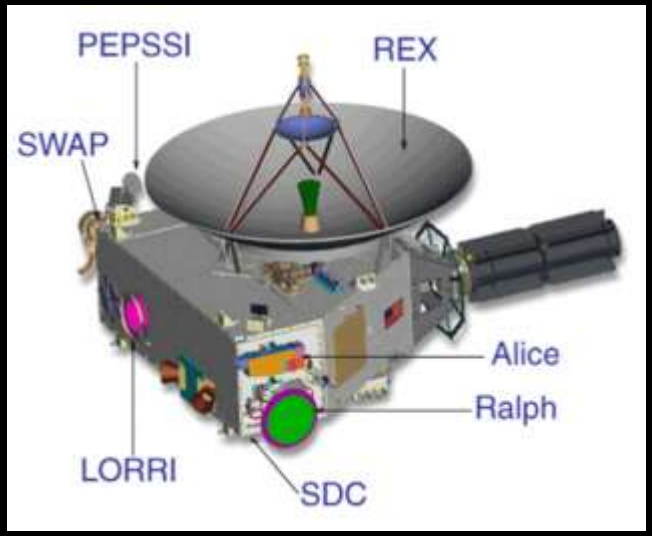
New Horizons Relevant instruments overview

- Ralph Telescope:
- 6cm aperture
- MVIC Channel (Multispectral Visible Imaging Camera) with multiple filters (CH4, NIR, Red, Blue,Pan)
- LEISA Channel (NIR Imaing Spectrometer)

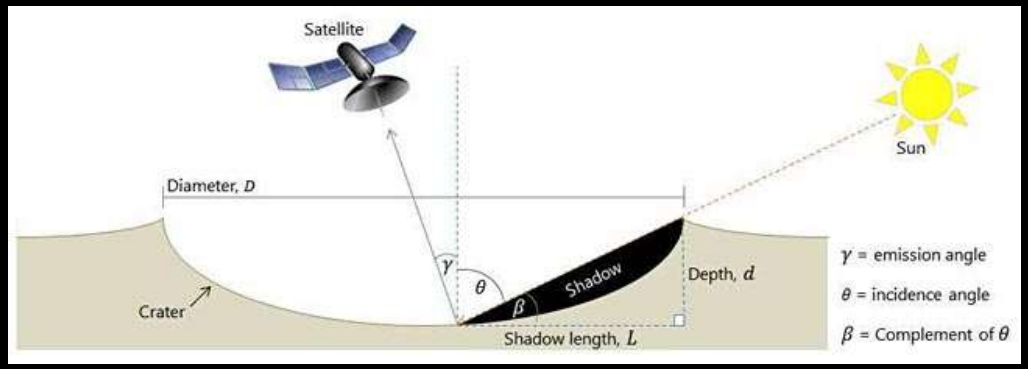


- LORRI
- Long Range Reconnaissance Imager
- 21cm Aperture
- Monochromatic (approx. to MVIC Red)

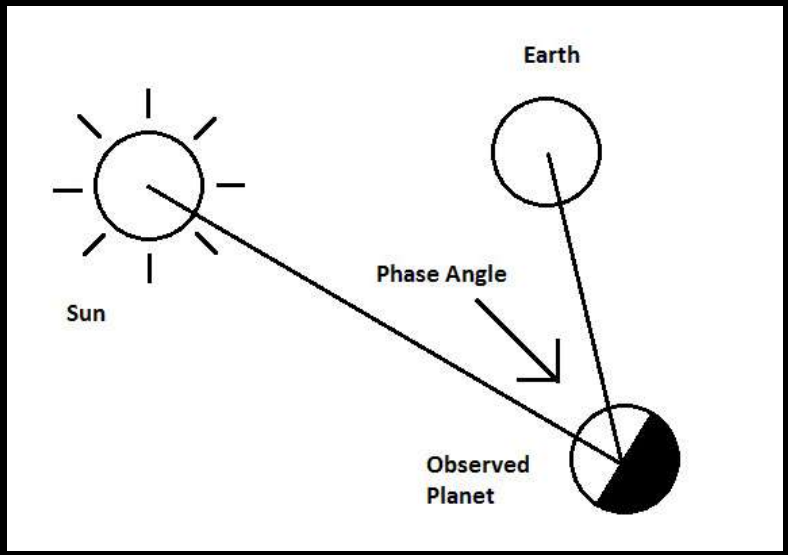
Photometry

- I/F – dimensionless value (0-1) of specific intensity for Irradiance/Solar Flux
- Phase Angle (**α**) – The angle between the observer, the target, and the sun
- Emission Angle – The angle between the observer and the surface normal
  Incidence Angle – The angle between the surface normal and the sun
- A – Scattering Coefficient (1= Lunar like (Purely single scattering) 0=Lambert (Difuse Scattering))
- f(**α**) – Surface Phase Function

- f(**α**) = (I/F-(1-A)*cos(Inc))/A * ((cos(Emis)+cos(Inc))/cos(Inc)

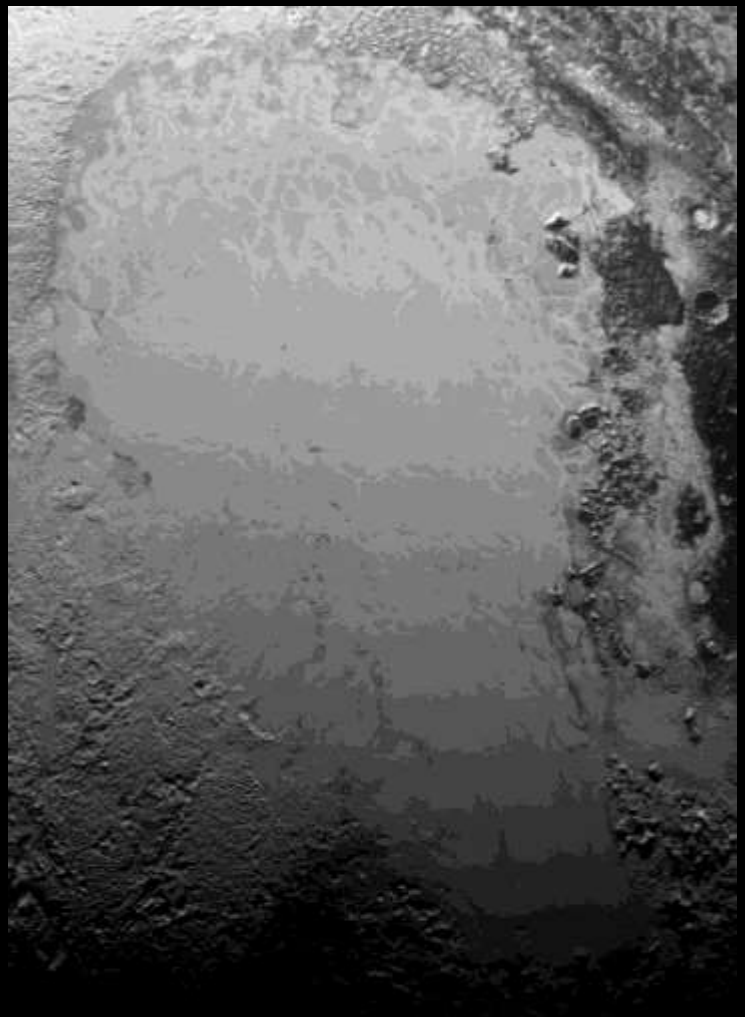


Source: 'Science buddies' + Wikimedia



Macroscopic Roughness

- Varying terrain features will have different macroscopic roughness properties.
- Changes in topography will alter the local incidence and emission angles and cast shadows to change the intensity of scattered light on the surface
- Model developed by past research (Buratti and Veverka 1985) uses ‘cratering’ properties of porous surfaces.
- This model takes into account points along a planetary surface and ensures that they are visible to the observer and illuminated and then takes into account data values from the next slide to compute the above changes.



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Method

- The USGS Integrated Software for Imagers and Spectrometers is an enabler to process *New Horizons* data into ‘cubes’
- Multiple iterations of the same cube are run concurrently to have them toggeled between multiple ‘bands’ and then spatially coordinated to allow accurate measurements for different pixel values along the same geographic areas
- These measurements take into account I/F, Incidence, Emission, Phase, Latitude, and Longitude (per IAU)
- Scan is plotted in MATLAB before entering model to ensure no cosmic ray hits or other abnormalities that would skew roughness
- Scan is ingested into FORTRAN model which parses through the data values for each pixel taken and computes porous surface qualities from variations in I/F versus the geometries included
- Model outputs depth-to-diameter (d/D) and a mean slope of the surface

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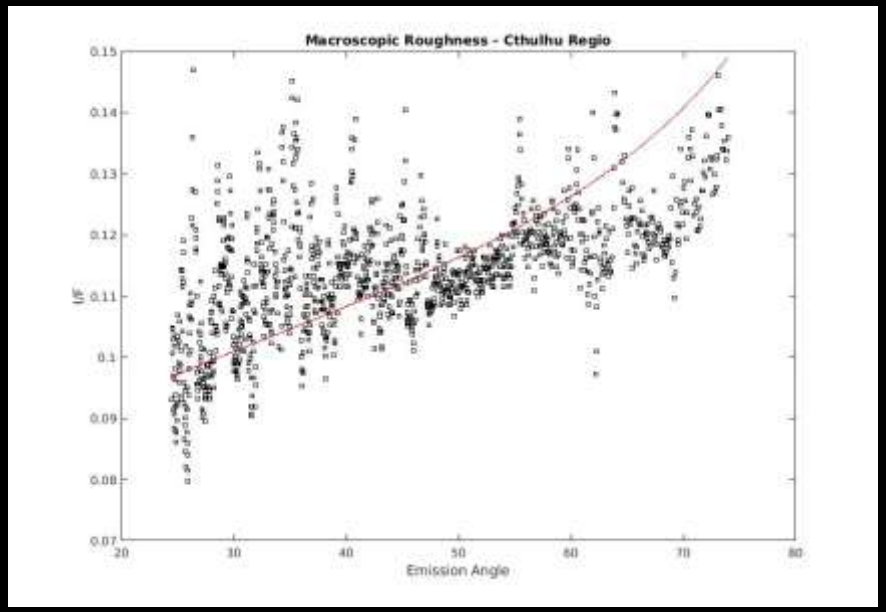
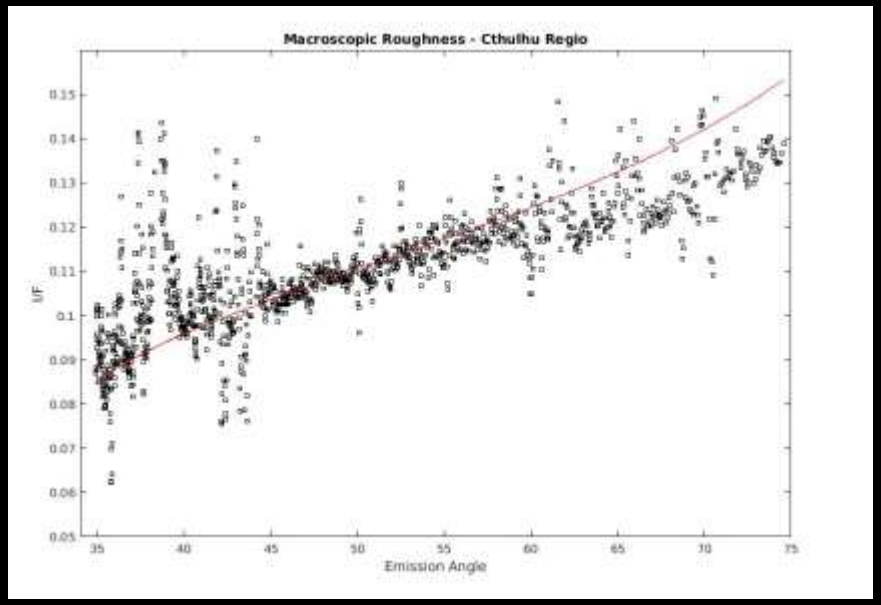
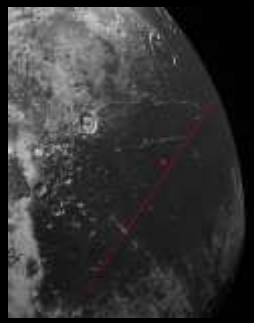
Results – C’thulu Regio

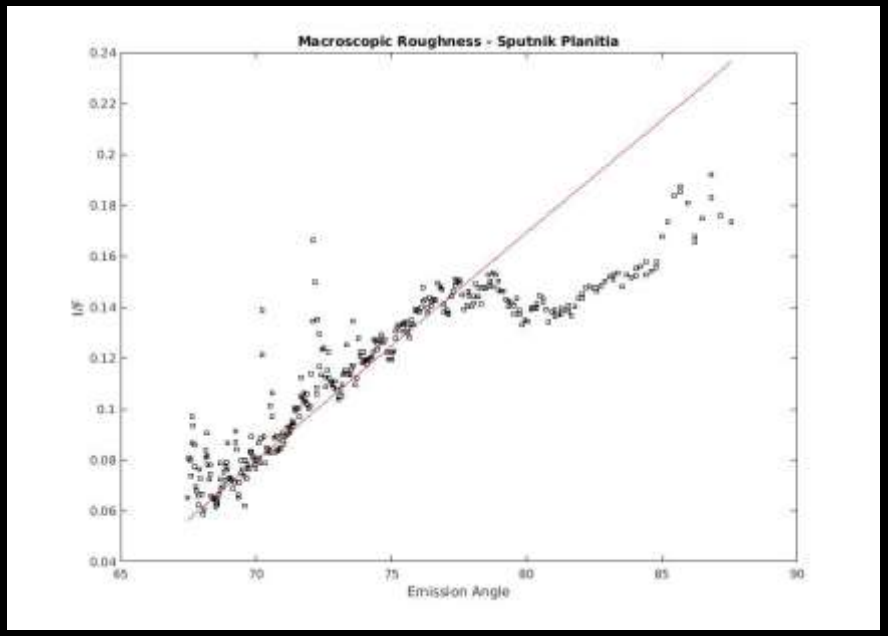


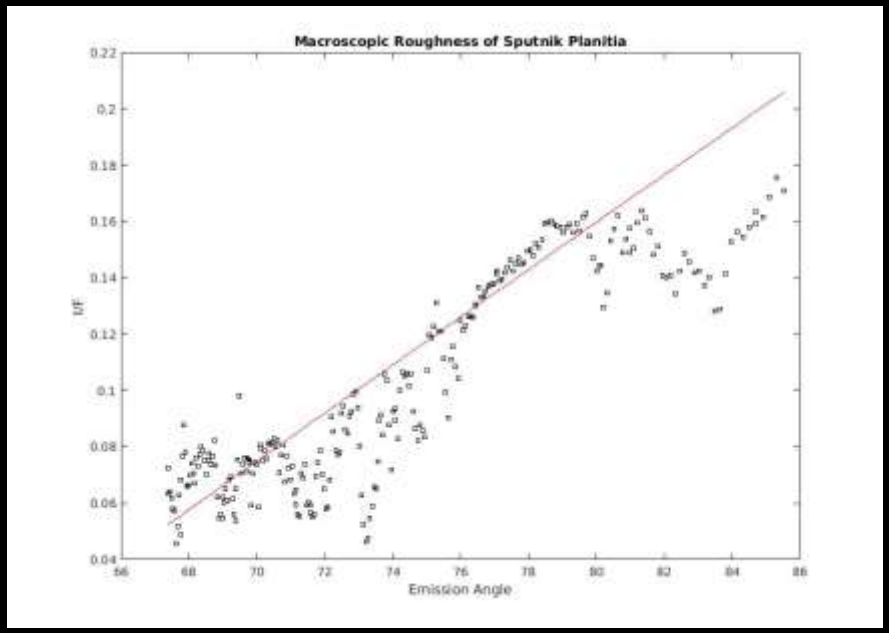


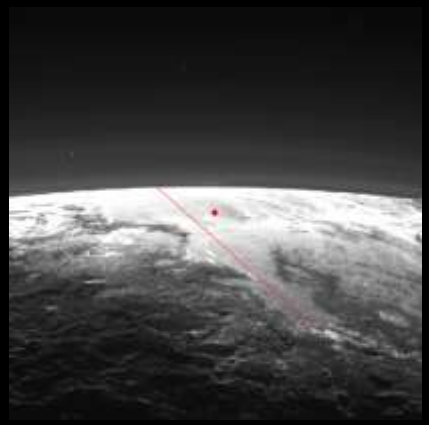
- Average (d/D): 0.043 ± 0.01
- Mean Slope (degrees): 5 ±1



Results – Sputnik Planitia







- Average (d/D): 0.016 ± 0.01
- Mean Slope (degrees): 0.92 ±1

Discussion

- Cthulhu Regio's slopes are roughly inline with that of Iapetus (Lee et al. 2010) which is another dark albedo, icy body which implies an ifilling process from atmospheric dust

- Sputnik Planitia's smoothness represents a young surface that has some sort of infill process of Nitrogen that has been occurring during Pluto's history

- Both are remarkably smooth surfaces when compared to other bodies in the solar system using similar parameters:

Buratti et al. 2006

Body	(d/D)	Mean Slope(degrees)
Titan (bright)	0.50	34
Titan (dark)	0.25	18
Europa	0.30	22

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Future Research

- Applying technique to other *New Horizons* data (Other terrain on Pluto, Sattelites)
- Compare photometry research to other concurrent science being done by the *New Horizons* team to see how this plays into the understanding of Pluto's history and ongoing processes
- Radiative Transfer Model
- Follow up mission

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