A Search for Temporal Changes on Pluto and Charon (224.11)

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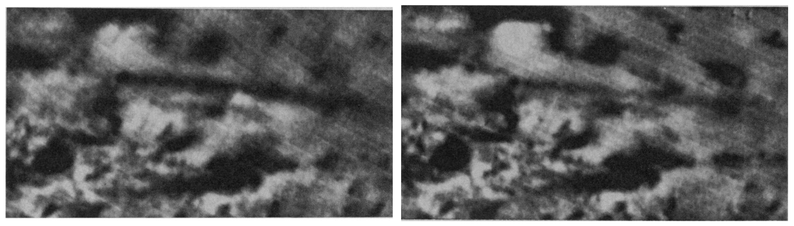
1. Summary

A search for short-term temporal changes on the surfaces of Pluto and Charon was conducted using high-resolution New Horizons encounter images. To accomplish this, different images of the same region were overlaid and blinked; at least two researchers searched each image set for evidence of temporal changes. The longest change detection search interval was about 4 hours. Variability between images was observed, but is attributed to the variable image resolutions, photometric angles, and instrument artifacts. No definitive variability that is indicative of a temporal change on either Pluto or Charon was found. In contrast, plumes on Triton were observed to be variable in images of similar resolution over intervals of less than 45 minutes (L. Soderblom et al., Science 250, 410, (1990)). This search for temporal changes will be extended to include lower-resolution, full-disk images such that all illuminated regions of both Pluto and Charon will be investigated.

2. Motivation: Plumes on Triton

Temporal changes are more likely to be observed between images with longer time intervals. Due to the flyby architecture of the New Horizons mission, the period of high-resolution imaging was relatively short and thus only short-term temporal variability can be constrained using the high-resolution images. Nonetheless, there were 3 reasons for conducting a search for temporal changes:

1. Plumes on Triton were observed to be variable in images with similar resolutions and temporal intervals
2. Detection of a temporal change would be a very exciting discovery as dynamic geologic processes are not typically observed *in action* in the solar system.
3. Completeness.



Voyager 2 images showing the evolution of a geyser-like plume on Triton. The images have a pixel scale of about 1 km and were taken less than 45 minutes apart. The trailing cloud is more than 150 km long. Such features would have been detected on the encounter hemispheres of Pluto and Charon if present. Images from L. Soderblom et al., Science 250, 410, (1990).

3. Methodology

To search for temporal changes, different images of the same region were overlaid and blinked and investigated by eye. Two researchers checked each image set. An automated change detection algorithm is conceivable but was not pursued because of the drastic variability in imaging parameters and broad phase space of possible temporal changes.

The systematic search was divided into three parts:

1. Highest resolution LORRI image sequences of the encounter hemispheres of Pluto and Charon
2. Lower-resolution, full-disk LORRI images such that all illuminated regions of Pluto and Charon are investigated
3. MVIC images with information about temporal variability that is not encompassed in 1. and 2. above

Part 1 is complete, part 3 is in progress and nearly complete, and part 2 is to be completed as future work.

4. Conclusions: No Definitive Temporal Variability

1. No definitive variability that is indicative of a short-term (~4 hours) temporal change on either Pluto or Charon was found.
2. Variability between the images was observed, but is attributed to the variable image resolutions, photometric angles, and instrument artifacts.
3. Geyser-like plumes such as those observed on Triton by Voyager 2 would have been detected had they been present on the encounter hemispheres of Pluto and Charon.

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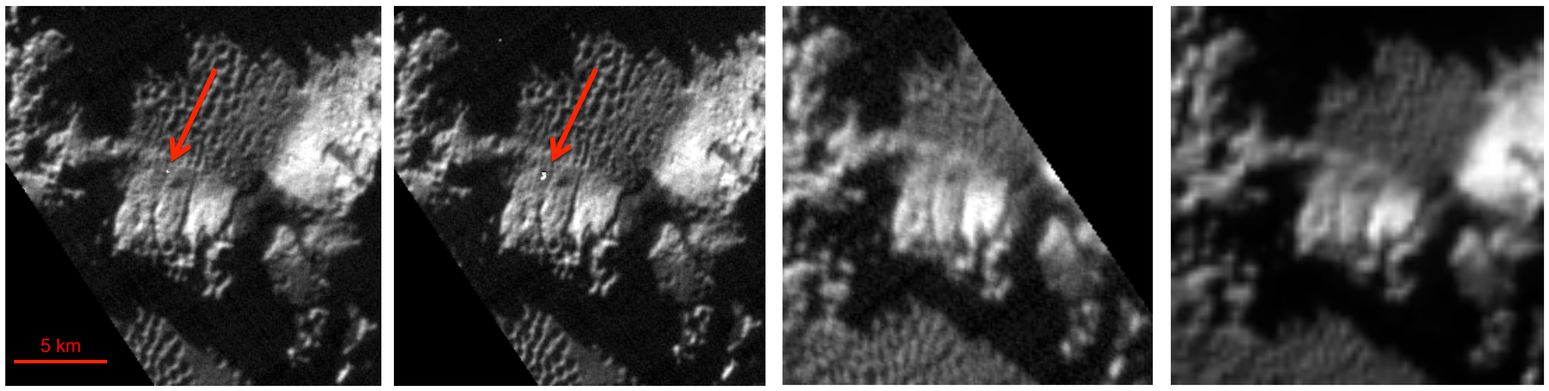
Some Interesting Examples

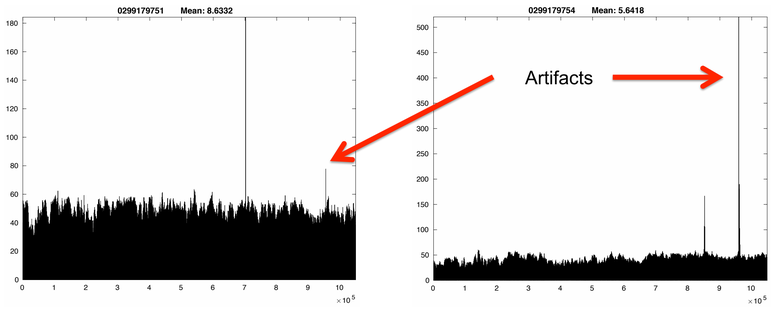
1. Spatially Coincident Cosmic Rays



Cosmic ray artifacts are observed in the above two images, temporally separated by 3 seconds, at nearly the same geographic location.

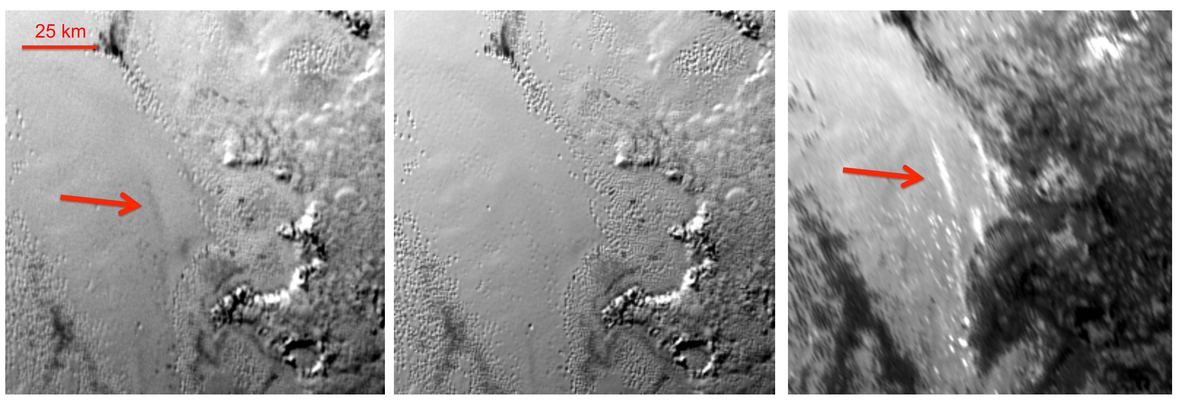
Artifact is not observed in image from about 14 minutes prior (left) or in near coincident image from another instrument (right). Artifact is also not detected in two other images, not shown, that could have detected it.

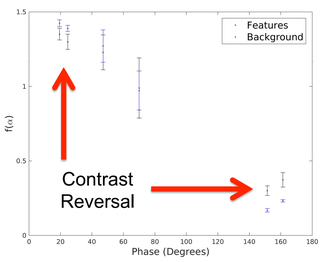
1D plots of all pixel values in image frame suggest the anomalies are artifacts



Spikes are common in 1D plots of all pixel values in the image frame. The spikes are generally not saturated pixels and attributed to cosmic rays. From the frequency of the spikes and the number of image pairs investigated, the expected number of spatially coincident cosmic rays is ~0.05 but 1 is observed.

2. Contrast Reversal Features





Quantitative demonstration of contrast reversal behavior. The photometric model from Buratti, Hofgartner et al., *in review,* was applied to correct for incidence and emission angle.

Contrast reversal features that are dark on a bright background at low phase (α=25^{O}; left), not apparent at intermediate phase (α=47^{O}; middle), and bright on a dark background at high phase (α=150^{O}; right) are observed in the above three images. These contrast reversal features are observed to be stationary for about a 4 hour period.

3. High Phase Bright Features

Bright features in high phase images that are not apparent in lower phase images generally occur in regions with volatile deposits that appear smooth and do not exhibit pits. But not all regions that do not exhibit pits brighten at high phase.

Bright features are observed in high phase images (α=151^{O}; right) that are not observed in any lower phase images (α=19^{O}; left, α=69^{O}; middle, α=25^{O} and α=47^{O}; not shown). These bright features are more likely due to the high phase angle than temporal changes but this remains to be verified.