DEALING WITH A CHANGING SURFACE: LESSONS LEARNED FROM COMET 67P/CHURYUMOV-GERASIMENKO.

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Introduction: The Rosetta mission [1] obtained a rich set of images showing the changing surface of comet 67P/Churyumov-Gerasimenko through its perihelion passage with the Narrow Angle Camera (NAC) [2]. This dataset allowed us to examine the details of the areas that shows subtle differences in their physical properties and their temporal variations. The photometric properties [3] are generally sensitive to the physical properties of a surface, such as composition, texture, porosity, roughness, and grain size; they can be markers for local alteration processes. With the help of high-resolution shape models, we can investigate the physical properties of various locations on the surface of 67P's nucleus at various perihelion distances through photometric analysis. However, as our analysis has progressed, we have encountered significant challenges in the dataset.

The changes of the surface topography: To de-convolve the regolith's evolution we had to investigate how the surface changed during the perihelion passage of 67P. We devoted to generating a photometric dataset for this study that covers a sufficiently wide range of scattering angles that requires precise registration between images and the shape model [4]. But our previous attempts to control OSIRIS NAC images are problematic. The continuously changing nature of 67P's surface caused bulk registration problems. Our study shows that, for about half images, a single shape model (SHAP7 [5]) is insufficient for a consistent control. The surface changes vary significantly with time and would require numerous shape models.

Control points: When we control all the image of OSIRIS NAC to SHAP7 as ground source [6], we examined the control data quality for each dataset. Showing here RMS of the control points from processing of the PDS archived dataset M15. We found that the most common reason that causing problems in the control is either changes in the surface topography or that the image resolutions are far higher than the resolution of the shape model.

Indexing the irregular surface: The irregular shape of 67P made it counterintuitive to project and map the surface to a regular latitude-longitude projection system. Based on the shape model facets, we made it possible to index all the pixels by its actual location on the surface. This enables us to search and map the surface pixels directly without any ambiguous for location caused by the irregular shape.

Mapping the photometric properties: We will also report our method of generating the photometric datasets and the results of our detailed photometric analysis for a few different geomorphological sites.

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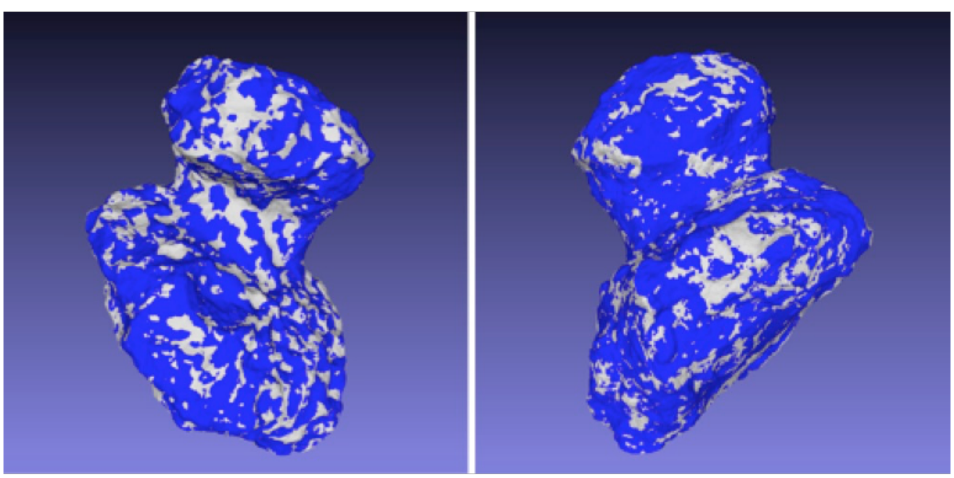

Figure 1 Global change from pre- to post-perihelion mapped on a SPC shape model. Blue color marks where pre-perihelion surfaces are above the post-perihelion surfaces and the gray color marks the opposite case. Left and right panels are the +Z axis and –Z axis view of the shape model, respectively.

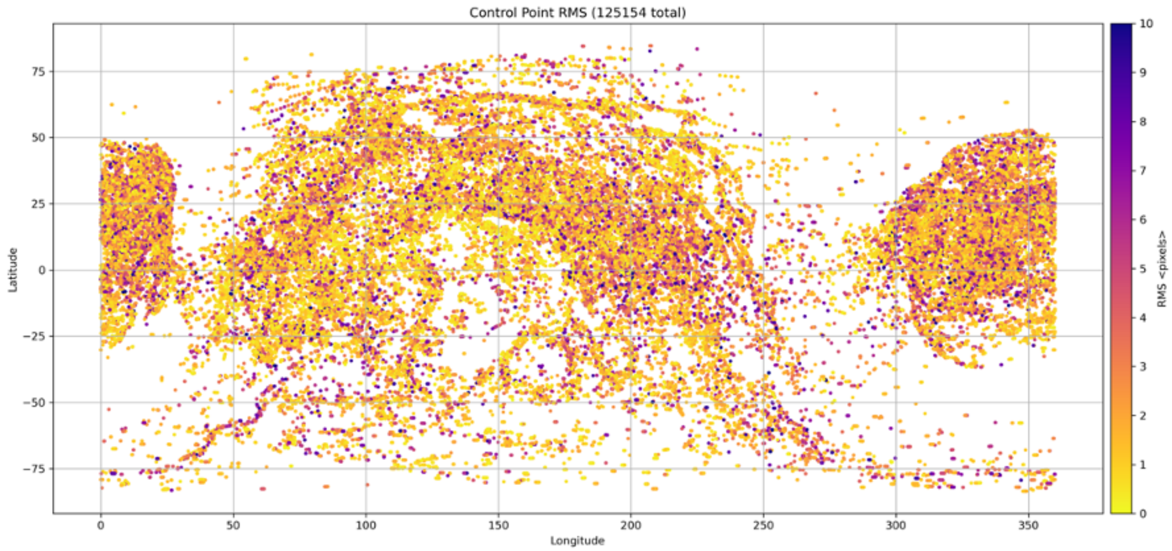

Figure 2 The control points RMS for OSIRIS_NAC_M15 dataset. The mean RMS is 2.25 pixels (which is indicative of our control issues), ~35% are < 1.0 RMS with a 2.0 pixel RMS standard deviation. The highest RMS is 12.3 but 90% are less than 5.5 pixels.

References: [1] Glassmeier K. H. et al. (2007) Space Science Reviews 128(1), pp.1-21. [2] Keller H. U. et al. (2007) Space science reviews 128(1), pp.433-506. [3] Hapke B. (2012) Cambridge university press. [4] Zou X.-D. et al. (2021) AGU Fall Meeting 2021. [5] Preusker F. et al. (2017) Astronomy & Astrophysics 607, p.L1. [6] Zou X.-D., et al. (2020) LPSC # 2326.