EPSC Abstracts
Vol. 12, EPSC2018-912-3, 2018
European Planetary Science Congress 2018

The Roles that HRSC Digital Terrain Models Have in Supporting Martian Polar Science

Alfiah R. D. Putri(1), Jan-Peter Muller (1), Panagiotis Sidiropoulos (1,2), Sebastian H. G. Walter(3), & Greg G. Michael(3) (1) Imaging Group, Mullard Space Science Laboratory (MSSL), University College London, Department of Space & Climate Physics, Holmbury St Mary, Dorking, Surrey, RH5 6NT, United Kingdom (2) Cortexica Vision System, 30 Stamford Street, WeWork South Bank Central, London, SE1 9LQ (3) Freie Universität Berlin, Department of Geosciences, Institute for Geological Sciences, Planetary Sciences and Remote Sensing, Malteserstr. 74-100, 12249 Berlin, Germany (alfiah.putri.15@ucl.ac.uk)

Abstract

Thirty-three (33) single-strip High Resolution Stereo Camera (HRSC) Digital Terrain Models (DTMs) over the Martian South Pole have been processed and used to produce ORIs (orthorectified images). This paper describes the DTM production and some applications in Martian Polar Science.

1. Introduction

The Martian polar regions have generated a lot of research interest because of numerous changes appearing around their ice layers. There is a lack of coverage of high-resolution DTMs in this region and corresponding ORIs, hindering possibilities of further scientific analysis. We describe the DTM production method and some applications.

2. Method

The full resolution DTMs are produced using a NASA-VICAR-based pipeline developed by the German Aerospace Centre, with modifications from Kim and Muller [1] through replacement of the image matching based on the (Gruen-Otto-Chau, aka Gotcha) algorithm [2], modified for the polar region. Other than products in MOLA sphere height reference (DT), we have also published products using an areoid height reference (DA) by differencing DTM products with the Mars geopotential surface data. Striping artefacts occur in these areoid products because of resolution limitations in the geopotential surface data in the polar region and integration of values to 16bit integer. A Gaussian filter is used to reduce these striping effects.

3. Results

We have produced 33 single-strip HRSC DTMs over the south pole [3] to fill the gaps between Mars Orbiter Laser Altimeter (MOLA) DTMs with higher resolution images such as CTX, MOC-NA, and HiRISE. The HRSC DTMs have an uniform grid-spacing of 50 m/pixel and have been assessed against the MOLA South Polar MEGDR and MOLA PEDR.

The resultant south polar HRSC DTMs have then been used to orthorectify the corresponding HRSC images. Figure 1 shows a Mosaic of the produced ORIs after de-shading using the method described in [3].

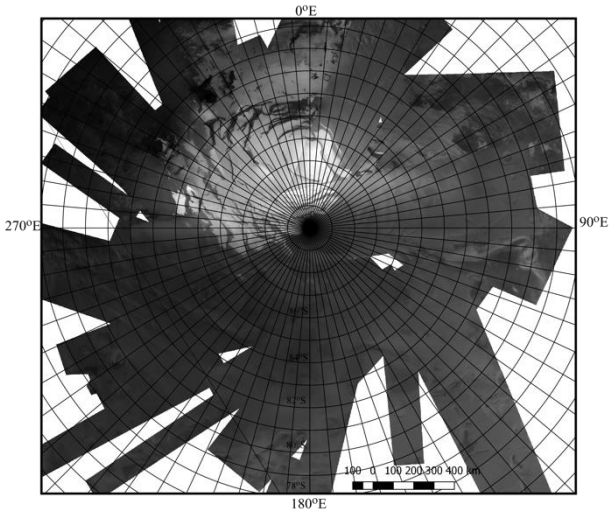

Figure 1: Mosaic of HRSC Orthorectified Images over the South Pole [3]

The HRSC products, both the DTMs and the ORIs have then been employed in several polar research areas. The ORIs have been used as base images for co-registering thousands of high-resolution Martian images [4] around South Polar Residual Cap (SPRC). Figure 2 shows a map of distribution of co-registered

CTX images around the south pole, with high concentration near the SPRC. Co-registered images are an important prerequisite for change detection research to ensure that the changes obtained are not related to misregistration errors [5].

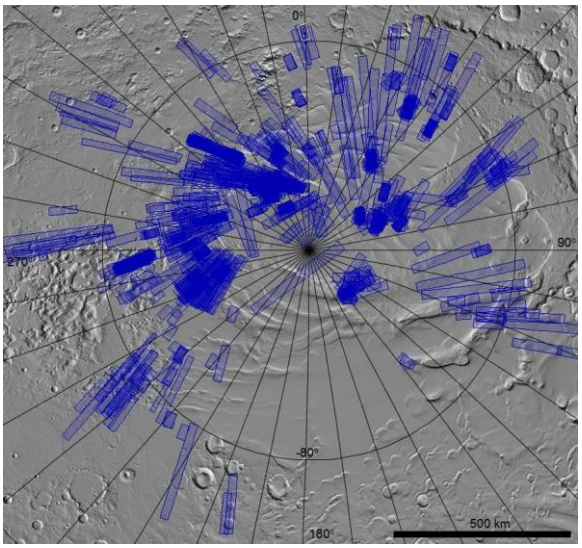

Figure 2: Co-registered CTX image maps around SPRC

The DTMs have also been used to help geological research over the Cavi Angusti region and have also utilized in subsurface layer reconstruction in the Promethei Lingula region [6].

The same HRSC DTM production method is also being applied to produce north polar DTMs, opening up wider possibilities for Martian Polar Research.

4. Conclusions

In this paper, we have presented some highlights of our production of HRSC orbital strip DTMs in MOLA and areoid reference and their corresponding ORIs for SPRC and the South Polar region of Mars (82°S-90°S). We also mention some of the roles of the produced HRSC DTMs and ORIs in related Martian Polar Science research which will be further elaborated at the conference.

Acknowledgements

Part of the research leading to these results has received partial funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under iMars grant agreement n° 607379; MSSL STFC Consolidated grant no. ST/K000977/1; and from DLR Bonn, grant 50QM1702. The first author is supported by the Indonesian Endowment Fund for Education.

We also express gratitude to the HRSC team and the MOLA team for the usage of HRSC and MOLA data, Marita Wählisch for kind assistance with the areoid conversion and Alexander Dumke for the exterior orientation processing results used within this research.

References

[1] Kim and J.-P. Muller; Multi-resolution topographic data extraction from Martian stereo imagery. Planetary and Space Science, 57(14-15):2095 2112, 2009.

[2] D. Shin and J.-P. Muller; Progressively weighted adaptive correlation matching for quasi-dense 3d reconstruction. Pattern Recognition, 45(10):3795{3809, 2012.

[3] Putri, A. R. D. et. al.: A New South Polar Digital Terrain Model of Mars from the High Resolution Stereo Camera (HRSC) onboard of the ESA Mars Express for Tracking Changes over the SPRC. Planetary and Space Science, under-review, 2018.

[4] Putri, A. R. D,. et. al.; Coregistration of Mars South Polar CTX Images to HRSC Base Images. EPSC Vol. 11, EPSC2017-937-2, 2017.

[5] Putri, A. R. D., et. al.: Deep Learning-Based Anomaly Detection to Find Changes over the Martian South Pole. This Conference.

[6] Xiong, S. and Muller, J.-P.: Automated Reconstruction of Subsurfaces in Promethei Lingula over the Martian South Pole by using SHARAD Data, Planetary and Space Science, under-review, 2018.