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Extreme 3D reconstruction of the final ROSETTA/PHILAE landing site

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The Philae lander aboard the Rosetta spacecraft successfully landed at the surface of comet 67P/Churyumov-Gerasimenko (hereafter 67P/C-G) after two rebounds on November 12, 2014. The final landing site, now known as « Abydos », has been identified on images acquired by the OSIRIS imaging system onboard the Rosetta orbiter[1]. The available images of Abydos are very limited in number and reveal a very extreme topography containing cliffs and overhangs. Furthermore, the surface is only observed under very high incidence angles of 60° on average, which implies that the images also exhibit lots of cast shadows. This makes it very difficult to reconstruct the 3D topography with standard methods such as photogrammetry or standard clinometry. We apply a new method called "Multiresolution PhotoClinometry by Deformation" (MPCD, [2]) to retrieve the 3D topography of the area around Abydos. The method works in two main steps: (i) a DTM of this region is extracted from a low resolution MPCD global shape model of comet 67P/C-G, and (ii) the resulting triangular mesh is progressively deformed at increasing spatial sampling down to 0.25 m in order to match a set of 14 images of Abydos with projected pixel scales between 1 and 8 m. The method used to perform the image matching is a quasi-Newton non-linear optimization method called L-BFGS-b[3] especially suited to large-scale problems. Finally, we also checked the compatibility of the final MPCD digital terrain model with a set of five panoramic images obtained by the CIVA-P instrument aboard Philae[4].

[1] Lamy et al., 2016, submitted.
[2] Capanna et al., Three dimensional reconstruction using multiresoluton photoclinometry by deformation, The visual Computer, v. 29(6-8) pp. 825-835, 2013.
[3] Morales et al., Remark on "Algorithm 778: L-BFGS-B: Fortran subroutines for large-scale bound constrained optimization", v.38(1) pp.1-4, ACM Trans. Math. Softw., 2011
[4] Bibring et al., 67P/Churyumov-Gerasimenko surface properties as derived from CIVA panoramic images, Science, v. 349(6247), 2015