NEW INVESTIGATION ON THE LOCAL TOPOGRAPHY AT THE HUYGENS LANDING SITE: IMPLICATIONS FOR LANDSCAPE FORMATION ON TITAN. C. Daudon[1], A. Lucas[1], S. Rodriguez[1], S. Jacquemoud[1], B. Grieger[2], E. Howington-Kraus[3], E. Karkoschka[4], R. Kirk[3], T. Perron[5] . [1]Institut de physique du globe de Paris, France (daudon@ipgp.fr), [2]European Space Astronomy Centre, Madrid, Spain, [3] US Geological Survey, Flagstaff, Arizona, USA, [4]Lunar and Planetary Lab, Univ. of Arizona, Tucson, Arizona, [5]Department of Earth, Atmospheric and Planetary Science, Massachusetts Institute of Technology, Cambridge, USA.

Introduction: Landscapes of Titan, the largest moon of Saturn, were observed during nearly 13 years in the frame of the Cassini-Huygens mission. The wide variety of morphologies observed (dunes, mountains, seas, lakes, rivers...) testifies to the geological richness that Titan shares with the Earth.

In order to better understand the processes at work that sculpt these formations, landscape evolution models have been developed [1]. We aim to compare 3D morphologies obtained by numerical simulation with those derived from photogrammetric observations (DEM). This study is focused on the Huygens landing site where hills supposedly incised by river valleys have been observed.

The only existing DEMs of this site was produced by [2] with the first version of the images acquired by the DISR camera and using the SOCET SET photogrammetric software. They build two DEMs from two different regions, one showing dendritic networks and the other covering an area in the plains; we focused here on the first region [2]. Due to the poor quality of the images, automated matching was unsuccessful so that the DEM was manually derived before being interpolated onto a regular grid. This was the best achievable DEM considering the information available at that time. But the problem is that such an approach cannot be reproduced and that the topographic features observed in the resulting DEM are assigned a low confidence rating. It consequently limits its use to understand the geomorphic processes that shape this area.

We investigate the same dataset as [2] with a different approach to improve the accuracy of the DEM of the Huygens landing site released in 2005: first we benefit from a new calibration of the DISR images that have been reprocessed to correct both the radiometric and geometric distortions [3,4]. The SPICE kernels have been also updated following the work of [3]. Second we based the photogrammetric analysis on an automatic open-source shape-from-motion algorithm [5].

Method: For the 3D reconstruction, we selected 8 DISR images acquired by the MRI and HRI sensor and reprocessed by [3,4], and we used recalculated navigation data (SPICE) [3].

The generation of the DEM was performed using MicMac, an open-source photogrammetric suite developed by IGN (National Institute of Geographic and Forestry Information) and the National School of Geographic Sciences (ENSG) [5]. MicMac offers a large degree of freedom on the sensor models and 3D reconstruction strategies.

First, we took into account the sensor model of DISR for the internal calibration. Then we computed the absolute orientation and position of the Huygens probe, thanks to the updated SPICE navigation data [3]. A bundle adjustment is then performed, in order to refine the global orientation.

Finally, an automatic dense pixel matching was used to derive a 3D point cloud that was hence interpolated to generate a regular DEM. All the parameters have been intensively benchmarked in order to test the sensitivity and robustness of our solutions.

Results: Our method was able to generate a DEM at a resolution of 15 m (as compared to 50 m for the DEM of [2]).

The resulting DEM has been analyzed and compared to that released by [2]. We first looked at the maximum amplitude of the elevation and found similar values (170 m in this study vs 190 m in [2]). This provides an overall agreement of the whole sensor orientation.

Then, we analyzed in detail some geomorphological criteria to validate our DEM and to quantify the improvements over the original DEM, such as:

- the general slope of the DEM that agrees with the shape of the dendritic network;
- the rivers that form valleys and not bump (see Fig.1)
- the flow of a river that follows the slopes (see Fig.1)

Besides, we could also note that there is no cliff on that site which confirm the hypothesis that the hillslope erosion is driven by landslides or raveling of cohesionless grains [6], which has also been shown at the poles [7].

Conclusion: We applied an automatic and reproducible photogrammetric method of the DISR images acquired during the Huygens probe descent and therefore achieved to a new DEM which shows some improvements compared to [2].

This new product offers new perspectives for our work on landscape evolution on Titan since it will be used as a reference for the comparison with our 3D simulations of river formation and evolution at the equator.

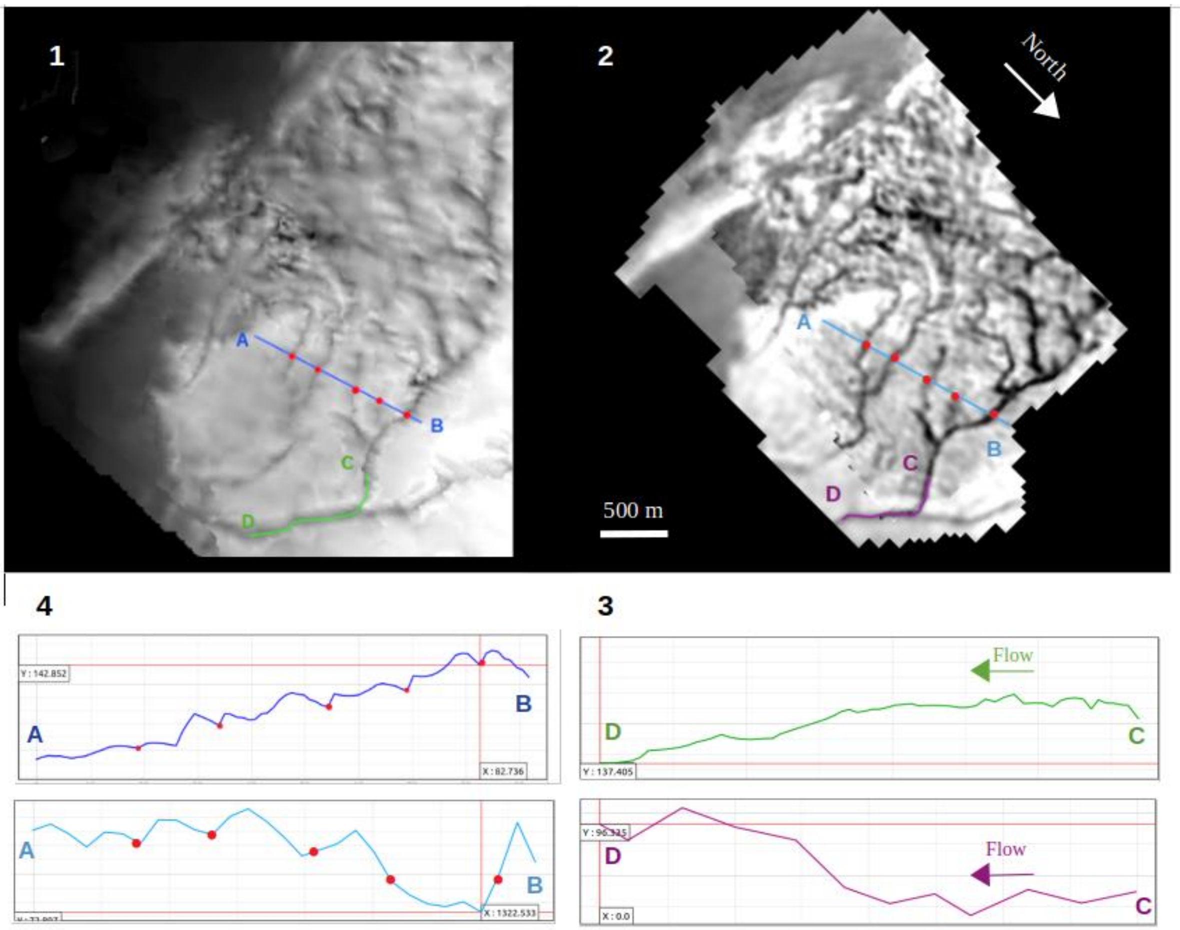

Fig. 1: (1) Orthoimage, from this study, (2) Orthoimage, from [2], (3) transect along a river; the top graphic correspond to our DEM and the other to the DEM of [2], (4) transect across a river (on top : our DEM, bottom : DEM of [2]).

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