STUDIES OF BASIC GEODETIC PARAMETERS AND MAPPING OF GALILEAN SATELLITES

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ABSTRACT:

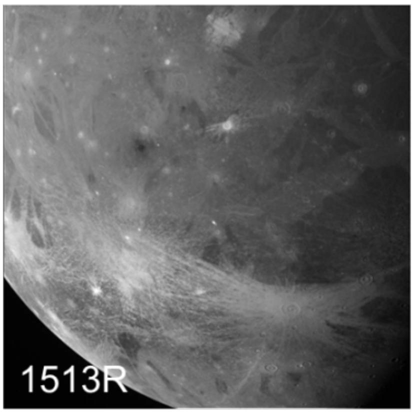
We have developed new methods to produce three-dimensional geodetic control point networks for planetary bodies and tested these on Galilean satellites. The 3D-networks were used to obtain fundamental characteristics and study size, shape, and spin parameters, currently only poorly known for the satellites. Measurements of librations may give critical constraints on internal structures.

1. INTRODUCTION

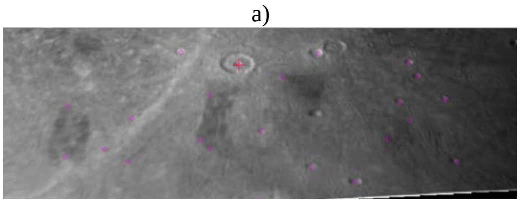
The Galilean satellites are of great interest because of the upcoming JUICE (ESA) and Laplace-P (ROSKOSMOS) missions. Control point networks and basic maps may provide the basic reference and coordinate framework to support the missions (Zubarev et al., 2014.).

2. METHODOLOGY

First, we identify appropriate images and extract associated metadata (image time, resolution, coordinates, camera information and spacecraft position). We use new automated technique for generation of 3D geodetic control networks, suited to deal with images of different resolution (from 0.05-36 km), taken from different perspectives, and taken under different illumination.



a)



b)

Figure 1. Ganymede data (Galileo missions - 1513R): a) original image; b) the orthoimage after rectification

The next step includes orthorectification into the cylindrical projection (Fig. 1) and block layout preparation, tie-point measurements in overlapping regions (Fig. 2), converting of pixel coordinates of tie points from orthorectified to initial images. Then, we carry out the bundle block adjusted, where we repeat all steps beginning from tie-point measurements to eliminate gross errors.
Finally, we compute global 3D control networks and rotation models (rotation axis orientation and libration).

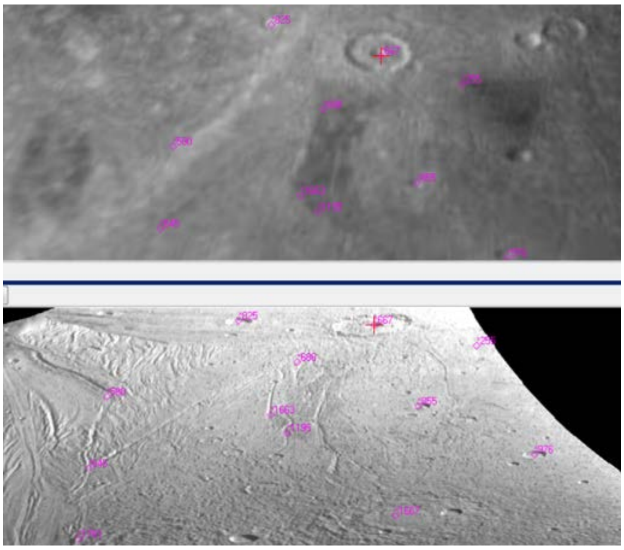


Figure 2. Overlap search and point measurements

3. SUMMARY

For future mission Laplace-P (Zeleniy et al., 2013) we focused on Ganymede where coverage is nearly complete except for polar areas (which includes multispectral data). Following the analysis, we obtained updated elements of exterior orientation, which allow new image processing and accurately referenced mosaics. Using our new techniques we have generated a new control point network in 3D and global orthomosaic for Ganymede, which were used for mapping on various levels of detail (Fig. 3-4).

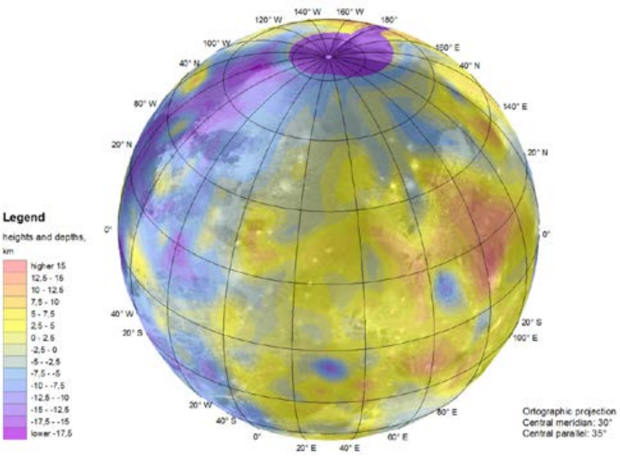


Figure 3. Layout of new Ganymede global hypsometric map.

We used improved orbit data for Galileo based on larger numbers of images than were available before, resulting in a more rigid network for Ganymede (Zubarev et al., 2015). From the obtained results we improved parameters of shape and rotation. Our corrected images will be used for further studying geomorphological phenomena of the surface, for example, distribution of bright and dark surface materials on Ganymede and their correlations with topography and slopes (Oberst et al., 2013). We will use the proposed methods for careful evaluation of geodetic control point and rotation models for other Galilean satellites – Calisto and Europe.

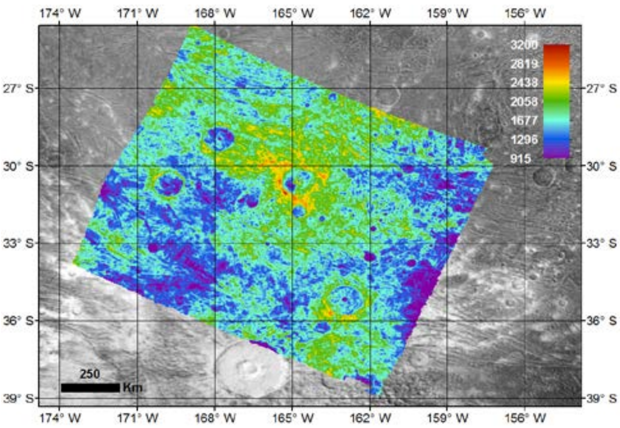


Figure 4. Local Ganymede hypsometric map based on detail DTM using Voyager-2 stereo images

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