AUTOMATED CRATER DETECTION FROM TOPOGRAPHY OF (1) CERES AND CREATION OF GLOBAL CATALOGUE.

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Summary: Automated crater detection has been used to process the digital topography of (1) Ceres, providing a crater candidates. After their manual evaluation, the catalogue with 5614 craters has been created.

Introduction: The catalogues with 132843 [1], 78287 [2], 9224 [3], 967 [4], 24 [5], 6622 [6], and 8749 [7] craters, respectively, have been developed for Mars, the Moon, Phobos, Venus, Earth, Mercury, and Vesta. Thanks to the Dawn mission [8], in addition to Vestan topography, Cererian topography has become available as well. Using these topographies, the best-fit biaxial ellipsoid shapes of Vesta (r_e=278.624 km, r_p=220.872 km) [7] and Ceres (r_e=481.582 km, r_p=444.662 km) [9] have been determined, similarly to the results from [10] (r_e=482 km, r_p=446 km). The topography of Ceres was first available only in lower resolution [11]. Recently, it has become available in considerably higher resolution [12]. Both topographies, in lower [11] and higher [12] resolutions, after conversion to an appropriate format and resolution, can be used as an input for the topography-based crater detection algorithm (CDA) [13, 1, 14]. This is an opportunity to evaluate a CDA's performance for topographies of considerably different resolutions [15]. The CDA's image processing of topography provides a list of crater candidates. Subsequently, their manual verification is necessary using optical images as well, in order to separate true detections of craters from the false ones.

Datasets and Methods: Datasets used and methods developed are as follows:

The initial topography of Ceres in low resolution. The shape file with 1579014 vertices and 3145728 plate-vertex mappings was used [11]. The selected resolution for the resulting topography was 1/8°.

The latest topography of Ceres in high resolution. This topography is based on the Dawn High Altitude Mapping Orbit (HAMO) Framing Camera 2 images and derived by using the stereo photogrammetry method [12]. In order to prepare it for the CDA, it was resampled to the first higher $1/2^{n}$° resolution, the 1/64°.

The initial image of Ceres in low resolution. The initially available resolution of 8192x4096 pixels (~1/22.75°) was used [16]. The global optical image mosaic was resampled to the 1/32° resolution.

The latest image of Ceres in high resolution. The highest available resolution of 21093x10546 pixels (~1/58.59°) was used, from the same source as the topography in high resolution [12]. The global optical image mosaic was resampled to the 1/64° resolution.

Crater detection algorithm. A topography-based CDA was developed [13] and improved using a Crater Shape-based interpolation method [1], in the previous work [14]. This makes the CDA suitable for the detection of craters from even low resolution topographies.

Manual verification of detections. Each crater-candidate proposed by the CDA was manually verified using global optical image mosaic in order to ensure that each crater from the resulting catalogue has double confirmation that it really is an actual crater. Only true detections were added to the crater catalogue. Their coordinates and radius were additionally corrected within ±1 pixel accuracy.

Results: The preliminary results are as follows:

Assembled catalogue from initial datasets of Ceres. The used topography is an inferior Ceres-shaped model used for navigation purposes. For this reason, crater detections are expected to be inaccurate. Optical image is also in inferior resolution/quality in comparison to the recent one. From these initial datasets, it was possible to catalogue only 1262 craters. A part of this intermediate catalogue is shown in Fig. 1.

Assembled catalogue from latest datasets of Ceres. Firstly, the previous 1262 craters were reviewed: their location, and in some cases their diameter. Then, the catalogue was extended with 4352 additional craters, after their manual evaluation. A part of the resulting catalogue with 5614 craters is shown in Fig. 2. The main phases of the work on the new catalogue of Cererian craters are shown in Fig. 3.

Conclusion: Using the topography and accompanying global image mosaics, the catalogue of 5614 Cererian craters was created. The most recent datasets were much more useful, both for the CDA and for the manual evaluation. In future work the catalogue can be: (1) additionally extended; and (2) used to compare topographic-cross-profiles of Cererian craters with Martian, Mercurian, Lunar and Vestan craters.

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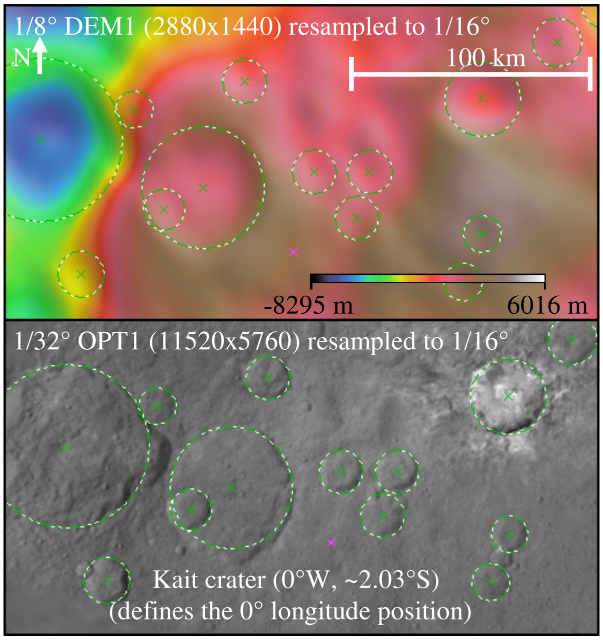

Figure 1: A part of the initial CERES1262GT catalogue assembled using the initial datasets of Ceres.

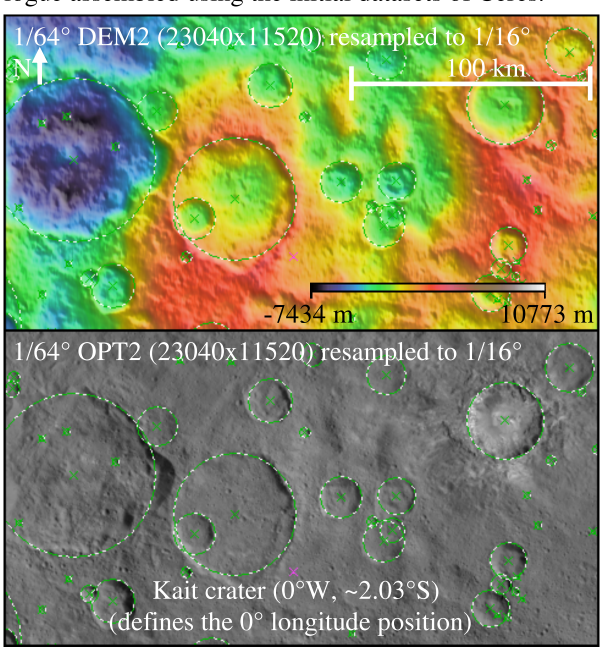

Figure 2: A part of the new CERES5614GT catalogue assembled using the latest advanced datasets of Ceres.

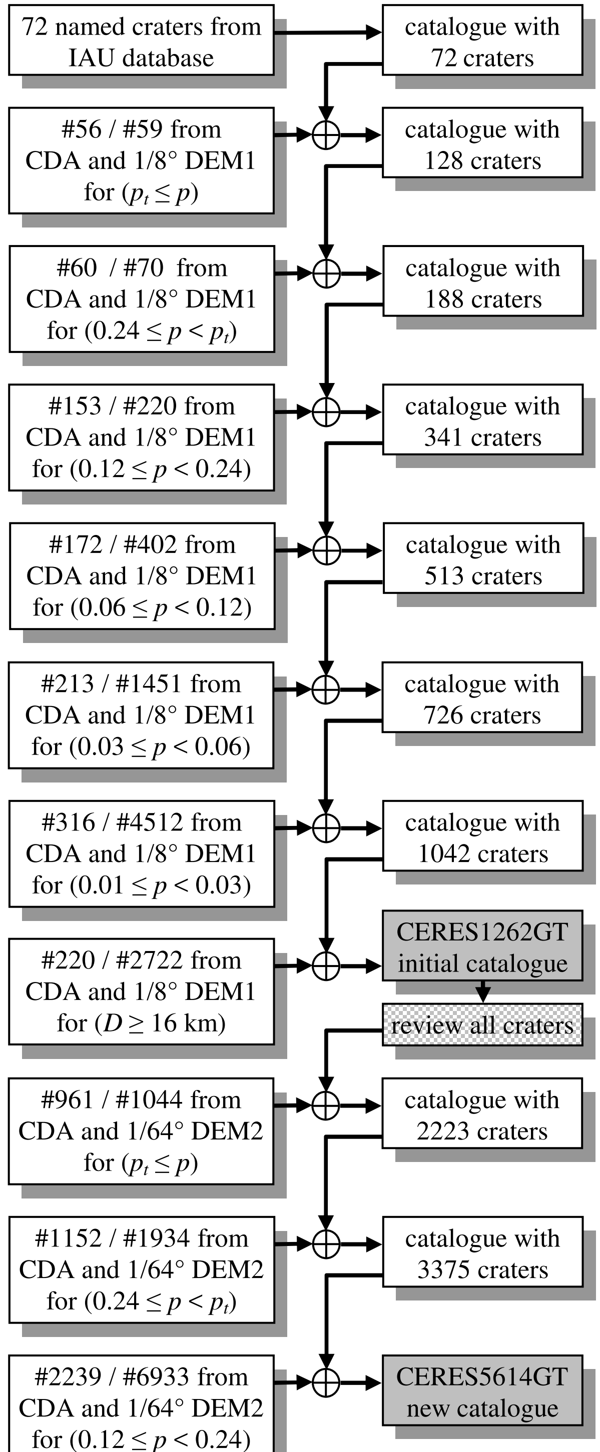

Figure 3: The main phases of the work on the new catalogue of Cererian craters (#*n* / #*m* means *m* candidates and *n* previously uncatalogued craters; $p_t = 0.39068145$ – the maximum of *Q* curve computed using the MARS132843GT catalogue [1]).