Global Topographic Map MRD 122

These data describe the global topography of Bennu. This product is the result of obtaining a suite of local topographic maps and combining them to generate a global map. A typical example of such a global products and associated ancillary files can be found at TRUTHBennuV3.7-products.html (username:uaspoc; password:RQ36@bennu). We will be generating at least 5 differing resolution of global maps and associated products. The origin of the products from Stereo-Photoclinomtery (SPC), OLA (ALT) or combing SPC to OLA (SPO) will only be evident by the name of the files, and three different webpages where the products will be kept (e.g., sample products for shape model 3). See AltWG SIS for clarification on the naming conventions. ODOCS -> 9.4.2 -> SISs -> UA-SIS-9.4.4-307.

Data Product Overview

A global digital terrain map of the surface of Bennu. To satisfy MRD-122, this map must have a spatial resolution of <1m, which is achieved after Detailed Survey Phase when using OLA data. SPC derived maps are going to achieve this resolution by the Preliminary Survey Phase. Initial deliveries of this product will be relative to the center of mass. After the spacecraft enters Orbital Phase A, all these maps will be relative to the center of mass.

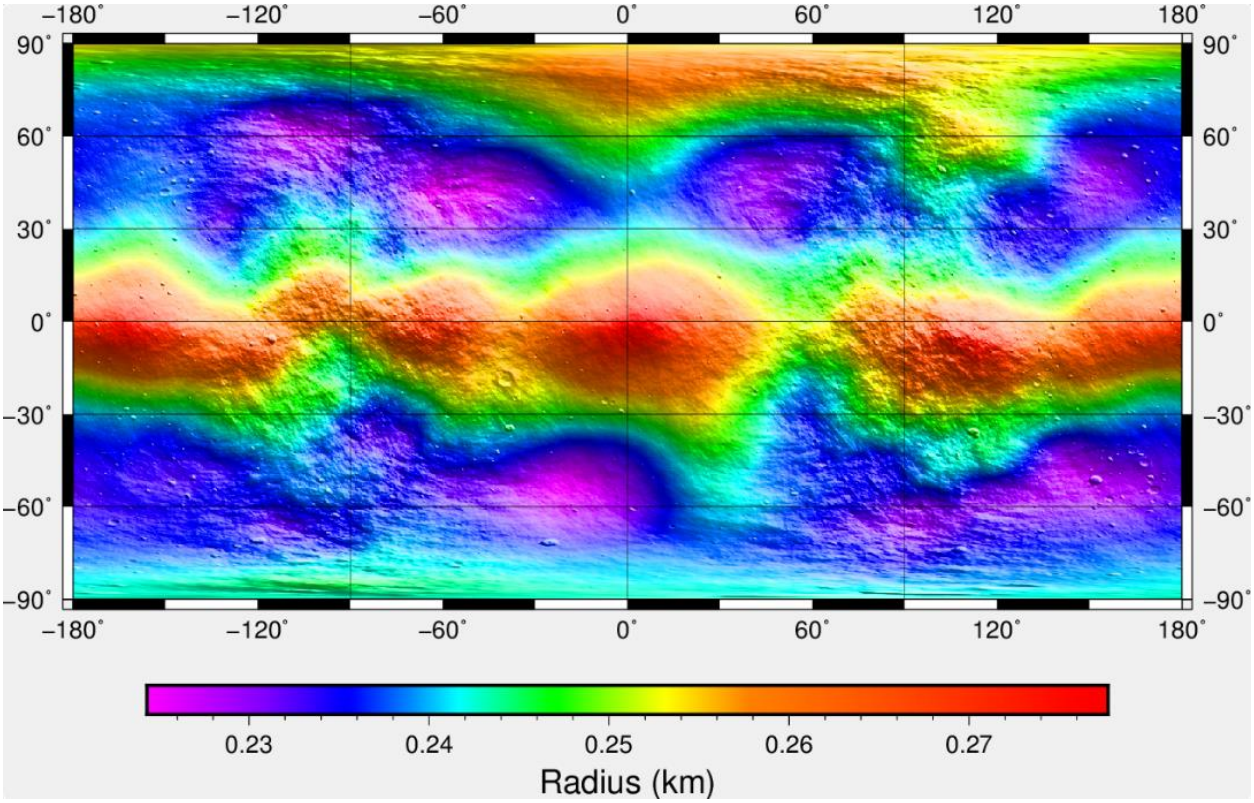

Figure 1. Radial map of the surface of Bennu. This is one of many topographic maps that are generated by ALTWG. Geodetic elevation (elevation relative to a geiod) truly satisfies requirement MRD 122 and is available at TRUTHBennuV3.7-products.html

Overview

Data type:
Global Binary multi-layered FITS images with incorporated headers (five different resolutions). These binary multi-layered FITS images possess with DTM all ancillary data produced by ALTWG (see SIS above).
(See ALTWG and NFT SIS for for further details)

Measurement:

OCAM images acquired from approach, and preliminary approach.

OLA observations from Preliminary and Detailed Survey.

Observations required:

For SPC: Ideally want each spot on the surface to be imaged with a minimum of three 90 degree stereo separation angles; nadir views; and at least 2 to 4 Sun angles. Ask Dr. Palmer or Dr. Barnouin for additional details. All these data are easily obtained with the current DRM rev C during Approach and Preliminary Survey Phase.

For OLA: Need to collect at least all the data from the detailed survey, or replace some of the detailed survey observations with pole observations from Orb A. A global data set from Orb A that mimic what is being planned for Orb B is better still. All OLA data need to be acquired as close as possible to nadir to minimize the spread of the OLA footprint on the surface and maximize the quality of the data returned. OLA is unlikely to return very meaningful data for emission angles in excess of 45 degrees.

When in the DRM are the observations collected:
Prior to and during During Survey for OLA; and Preliminary Survey for SPC derived products.

Time to produce data:
Testing suggests that SPC products derived will be produced within a few weeks of collecting the images. Likewise, OLA products will take a week or so to produce. Testing is ongoing to further refine the time of production. Once OLA strip adjustments are complete, SPC-OLA products should take little time, similar to the time it takes to make OLA alone products.

Product use:
Needed for sample site selection, general science and long-term science.

Data Product Structure and Organization
Products will be organized in webpage as shown at: TRUTHBennuV3.7-products.html. ALTWG will deliver these products to the SPOC who will then make them available to the rest of the team Depending on the source of the products, each will have a different webpage - SPC will have its set of products; OLA its set; and SPC-OLA (SPO) will have its set. The names of the product indicate what type of product it is. Highest fidelity products are likely to be SPO ones. OLA and SPC products will globally be similar for global products. Site specific maps and shape models may vary in quality.

Detailed Description of data format.
See ALTWG and NFT SIS for details of data format. The only format not described in the SIS, but that will be provided to the OSIRIS-REx team is the Gaskell .MAP format. This product is of small size and useful for decimating data to those who have access the the ALTWG toolkits, or who are SPC users.

Data Product Generation
See ALTWG SIS above for details on how products will be produced.

Additional information can be on OLA processing from:

Kahn, E.G. et al., 2015. Reconstruction of the Eros Shape Model Using NEAR Laser Rangefinder Data. *46th Lunar and Planetary Science Conference*, 46, p.2874. (ALTWG manuscript is also in the works).

For more information is available about SPC at:

Gaskell, R.W., 2011. Optical Navigation Near Small Bodies. *Proceedings of the 21st AAS/AIAA Space Flight Mechancis Meeting*, 140(11-220), p.13pp.

Gaskell, R.W. et al., 2008. Characterizing and navigating small bodies with imaging data. *Meteoritics and Planetary Science*, 43(6), pp.1049–1061.

Inputs:
ALTWG and SPC software generates all the products needed to ultimately create the necessary global models that will be delivered to SPOC. Once ALTWG scientist have okayed generation of SPC, OLA or SPO products, these data products are produced and delivered.

For OLA derived products: All OLA derived Mapolas that were produced from OLA level 2 during the shape model process.

For SPC-derived products: All SPC Maplets that were produced during the shape model process from SPICE and OCAMs imagery.

For SPC-OLA derived products: All SPC Maplets and OLA Mapolas that were produced during the shape model process from OCAMs and OLA data.

Output:
Global digital terrain maps and binary file of surface, with all associated ancillary products (see ALTWG SIS for details) will be placed on website similar to the one shown above for easy access by the science team.

Data Product Validation

SPC and OLA process has been validated by using imagery and altimetry data from past mission such Dawn, Hayabusa and MESSENGER, and simulated OSIRIS-REx imagery and altimetry. These latter data were generated during SPC/OLA thread tests. The algorithms employed have heritage from Dawn, Hayabusa and MESSENGER.

Data Flow

For SPC, imagery, spacecraft attitude and trajectories are combined to determine through stereo and photoclinometry the shape of celestial object. This is achieved via a least squares inversion approach, where the topography at each pixel is modeled to match observations. When using OLA data, OLA level 2 data, where the x, y, z position of each return has been derived from OLA ranges, and spacecraft attitude and trajectory are combined together and minimized via least square to make the asteroid shape model, and regional high resolution terrain maps smooth and continuous. The following schematic provides the overall flow of this process.