Site-specific Topographic maps (MRD-115)

These data describe the topography of a local region on Bennu. We will be generating up to 12 of these products to help select sites. A typical example of such a product and associated ancillary files can be found at TRUTHBennuV3.7-products.html (username:uaspoc; password:RQ36@bennu)

Data Product Overview

A gridded map and shape model file of the surface of Bennu. To satisfy MRD-115, this map must have a spatial resolution of <5 cm. These maps will be produced by:

Orbital Phase B for SPC derived products

Orbital Phase B for OLA derived products.

They are generated naturally during the global modeling of Bennu at high spatial resolution.

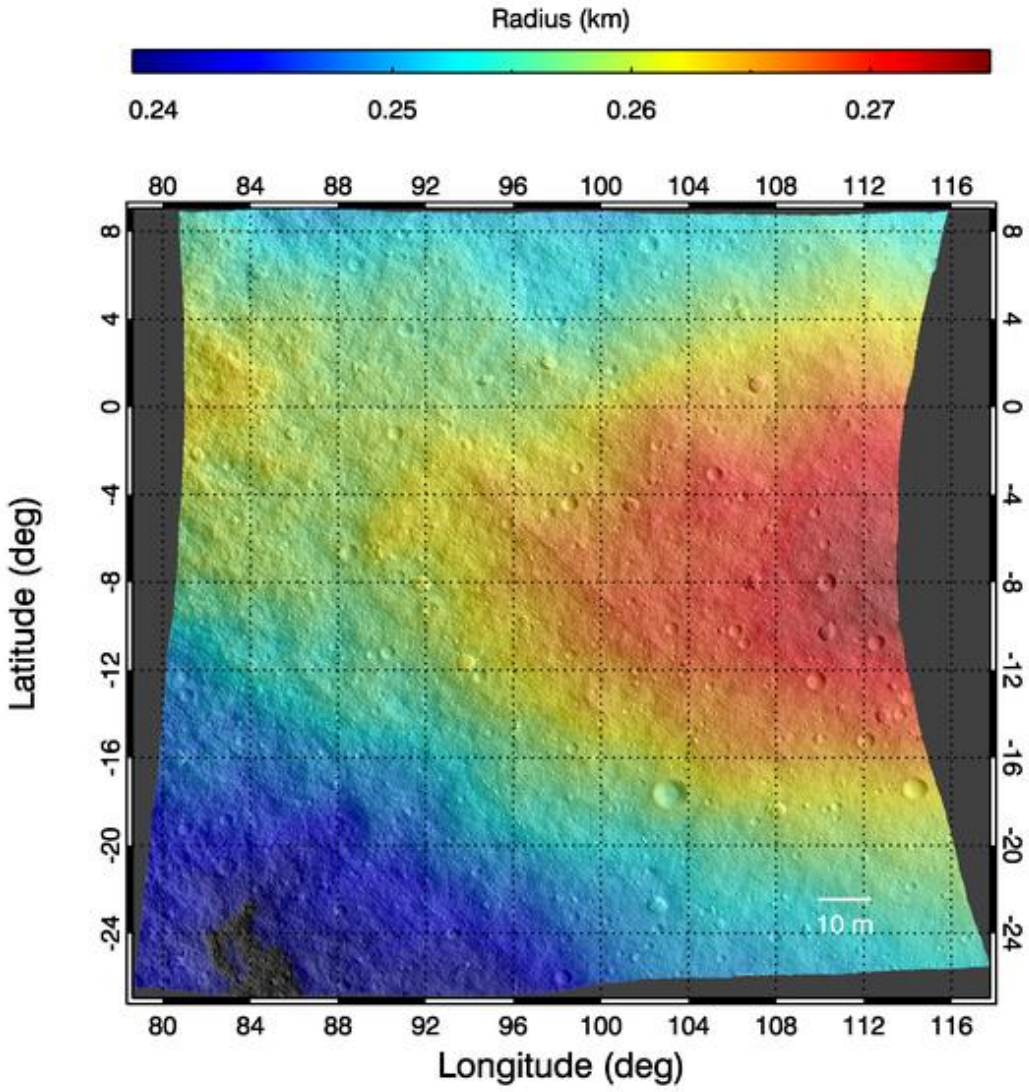


Figure 1. Shaded relief map of a test tag site generated with idealized OLA data collected at 5 cm GSD from simulated shape model 3. Color corresponds to radius from the asteroid center. The entire map spans 150m around the Tag site.

OLA products are likely to be better fidelity topographically than SPC (with the current version of the DRM), although SPC will possess a better albedo model. A combination of product can be generated in Orb B. Updates to these model of the surface will be improved upon with Recon data. See the ALTWG SIS (ODOCS 9.4.2 -> SISs -> UA-SIS-9.4.4-307) for naming conventions, and associated ancillary files descriptions.

Overview

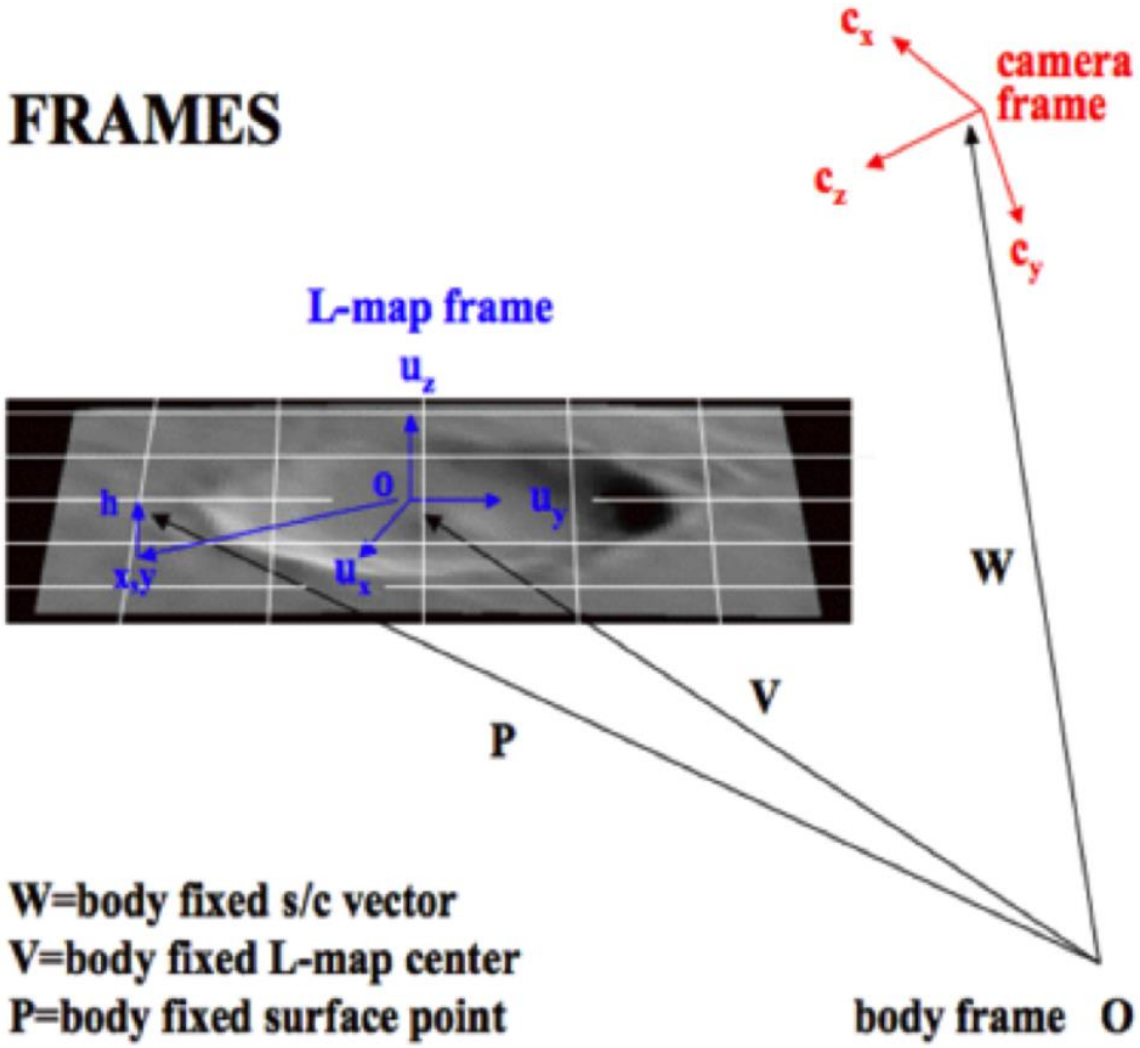


Figure 2. SPC or OLA Maplet format that will be one of the data product provided for science team members only. See ALTHG SIS for more details.

Data type:

OBJ shape file of each region.

SPC Maplet format

Binary multi-layered FITS images with incorporated headers where DTM and all ancillary data produced by ALTWG (see SIS above) are included.

NFT specifc multi-layered fits file (a subset of prior file with only height, albedo and quality information)

Ascii or Binary ancillary FITS tables where each number corresponds to a facet in the original OBJ file.

(See ALTWG and NFT SIS for further details

Measurement:

OCAM images acquired from approach, preliminary approach, and detailed survey.

OLA observations from Preliminary Survey, Orb A, Detailed Survey and Orb B.

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. Only current (March 2016) detailed survey plan needs some modification to satisfy the observation needs (and is already being worked by Boyton et al).

For OLA: Need at least global coverage of Bennu during Orb B. 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 days returned. OLA is unlikely to return meaningful data for emission angles in excess of 45 degrees. While OLA processing of the tag site benefits tremendously from prior OLA data sets (taken in the detailed survey phase), it is essentially that all the OLA datasets from Orbital Phase B are collected and that they overlap to maximize the efficacy of the OLA strip-adjustment process. Example of plans to get those observations, and which have been generated by ALTWG using realistic mission trajectories and navigation uncertainties can be seen at http://osiris-rex.jhuapl.edu/ola/scibox/reports/. Please speak directly to Dr. Barnouin or Dr Daly about further observation implementation questions.

When in the DRM are the observations collected:

Prior to and during Orbital Phase B

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, sample safety assessments, general science and long-term science.

Data Product Structure and Organization

Products will be organized in a webpage as shown at: http://osiris-rex.jhuapl.edu/altwg/outputdata/bennu_altwg/truth_products/bennuv3/TRUTHBennuV3-products.html. Testing suggests that SPC products derived will be produced with a few weeks of collecting the images. Likewise, OLA products will take a week or so. 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.

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 for details on how products will be produced.

For more information on OLA process:

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 on SPC:

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:

(NOTE: ALTWG software already handles all this; generation of products will be within ALTWG and delivered to SPOC. Once scientist have okayed generation of SPC or OLA products; data products are produced and delivered)

For OLA derived products: Take OLA data collected throughout mission. Turn these into Mapolas and SHAPE.TXT files that were produced during the shape model process.

For SPC-derived products: Take all OCAM images, and preliminary SPICE data. All SPC Maplets; and a global model in SHAPE.TXT format produced during the shape model process.

Output:

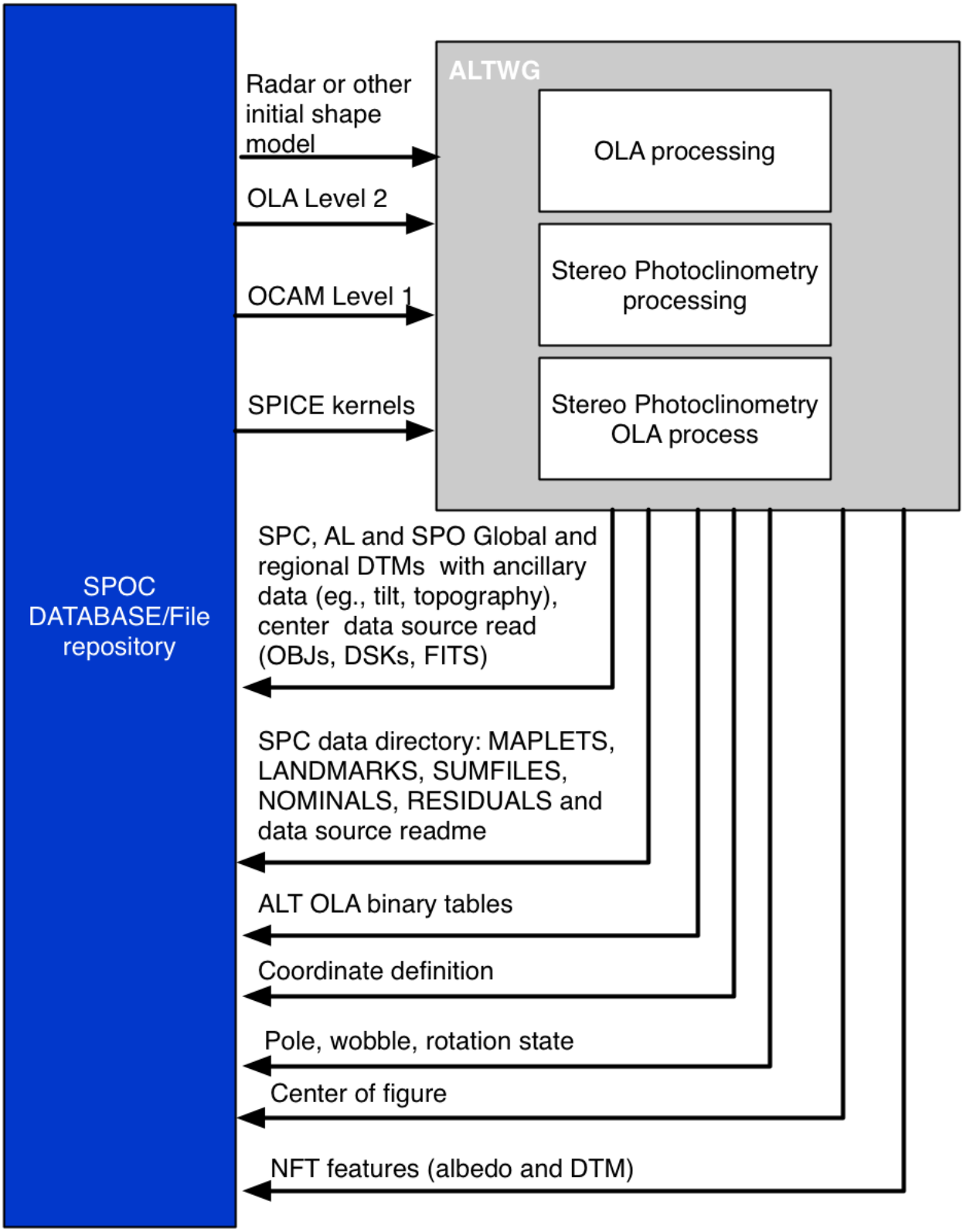
Local map file: Topographic maps of surface, with all associated products (see ALTWG SIS for details). These will be placed on website similar to the one shown above for easy access by the science team.

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. Various thread tests have been undertaken by the OSIRIS-REx projects. More are planned. 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.


SPOC DATABASE/File repository
Radar or other initial shape model
OLA Level 2
OCAM Level 1
SPICE kernels
ALTWG
OLA processing
Stereo Photoclinometry processing
Stereo Photoclinometry OLA process
SPC, AL and SPO Global and regional DTMs with ancillary data (eg., tilt, topography), center data source read (OBJs, DSKs, FITS)
SPC data directory: MAPLETS, LANDMARKS, SUMFILES, NOMINALS, RESIDUALS and data source readme
ALT OLA binary tables
Coordinate definition
Pole, wobble, rotation state
Center of figure
NFT features (albedo and DTM)