MRD 132- Asteroid Volume

Data Product Overview

The asteroid volume with less than 0.9% uncertainty. A shape model is required where the vertical resolution of the shape is better than 0.3m. This is only achieved after Orbital Phase B for a shape model derived from OLA alone, but is produced after the Detailed Survey Phase when combining OLA to SPC data. The volume of the asteroid is determined by a integrating over the volume of Bennu, regardless of how the shape model produced. The following table shows which shape models will satisfy this requirement which is much more stringent than any of the other requirements listed with shape, COM-COF offset and so on.

Overview

Simple text file with volume of the asteroid. This is achieved in a straightforward manner through volumetric integration. This will be made with any shape model produced by ALTWG including those generated by SPC. These data will also be part of the header of any global OBJ file provided by the ALTWG as shown in red below.

The only data required is a shape model for the asteroid. This requirement is achieved when the accuracy of the shape model is better than 0.3 m usually after Orb B for OLA, and detailed survey for SPC.

#Model of the surface of Bennu. File consists of vertices and facets. Facets are triangular and
#connected by the right hand rule. The x, y, and z components of the vertices precede the
#letter 'v' in the first part of the file. The number of each vertex is defined by the position
#of the vertex in the list defined by the letter 'v', where the first line in this list is the first vertex.
#In the second half of the file, the three numbers following the letter 'f' are the vertex numbers
#that make up each facet.
#PRODVERS = 1.0.0 \ Product version number
#MISSION = OSIRIS-REx
#TARGET = 101955 BENNU
#ORIGIN = OREXSPOC
#MPHASE = preflight ground test
#DATASRC = TRUTH
#DATASRCV = BENNUV3.7
#DATASRCD = 2015-09-12T17:02:03Z
#DATEPRD = 2015-11-09T08:24:56Z
#PRODNAME = g_1278cm_tru_obj_99900s-63900_v100.fits
#PRODVERS = 1.0.0 \ Product version number
#DATASRCV = BENNUV3.7
#CREATOR = Barnouin
#CLON = -999.0 \ [deg] longitude at center of image
#CLAT = -999.0 \ [deg] latitude at center of image
#Number of Plates = 12288
#Number of Vertices = 6534
#Number of Edges = 18432
#Euler Polyhedron Formula = 390
#Surface Area = 0.8090023859015390 km^2

#Plate Area Mean = 6.583678270683086e-05 km^2
#Plate Area Min = 3.998804125133503e-05 km^2
#Plate Area Standard Dev = 1.019094101334709e-05 km^2
#Edge Length Mean = 0.01278014956259093 km
#Edge Length Max = 0.02069469922150901 km
#Edge Length Variance = 4.850112744396241e-06 km^2
#Surface Closed? = Yes
#Volume = 0.06272496564911250 km^3
#Centroid:
 # [9.636659810963896E-4, -2.9035454395760866E-4, -6.436673871849306E-4] km
#Moment of Inertia Tensor Relative To Origin:
 # [0.0014745808961473246, -1.3105159233112575E-5, -4.491049522943029E-6]
 # [-1.3105159233112575E-5, 0.0015008758395474594, -6.626885868098366E-6]
 # [-4.491049522943029E-6, -6.626885868098366E-6, 0.001652418910218759]
#Moment of Inertia Tensor Relative To Centroid:
 # [0.0014745496206347648, -1.3122709979359531E-5, -4.529956587478493E-6]
 # [-1.3122709979359531E-5, 0.0015007916024383518, -6.6151630894577095E-6]
 # [-4.529956587478493E-6, -6.6151630894577095E-6, 0.0016523553724702611]
#Extent:
 # X: [-0.2697600126266 4795, 0.27915000915527344] km
 # Y: [-0.26078999042510986, 0.262800008058548] km
 # Z: [-0.2510699927806854, 0.25655999779701233] km
#Warning: The polyhedron is closed, but the Euler polyhedron formula, V-E+F,
#(see https://en.wikipedia.org/wiki/Euler_characteristic*)*
#does not equal 2, as would be expected. This is usually caused by duplicate
#vertices in the shape model. Please contact the creator of
#the shape model to see if this can be corrected.

Data Product Structure and Organization
A simple ASCII file of one number: volume of the asteroid.

Data Format Descriptions
An attached XML label file describing the vintage of the shape model, and what other SPC or AL data were used to make the shape model used for computing the volume.

Detailed Description of data format
Data Type – ASCII file with one number.

Field:

Volume of asteroid in cubic-kms.

Also part of comment section in OBJ file.

Purpose of data product
Needed to assess density of asteroid. But this value is not required for sampling.

Data Product Generation
This product is generated after each shape model is produced by the ALTWG. This information will be output automatically after a shape model is produced. The spatial requirement of MRD-132 are achieved with a shape model whose vertical resolution is less than 0.3 m. This is only

achieved after Orbital Phase B for a shape model derived from OLA alone, but is produced after the Detailed Survey Phase when combining OLA to SPC data. SPC data achieves this only after Orbital Phase B.

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.