

PDS Data Review –Tony Farnham

Shape model products generated from
the Double Asteroid Redirection Test
(DART) Mission

May 13, 2022

Data Set

- Example data representing the Dimorphos shape model and ancillary data products
 - Dummy global shape model of Dimorphos
 - Dummy DTM of the impact site on Dimorphos
 - 3D data cube containing maps, tilt measurements, etc. as a function of lat/long
 - FITS formatted tables containing the information in the 3D cube
 - Associated XML labels
- Documentation is in a separate collection, but is necessary to understand what is in this collection

Documentation and XML Labels

- I didn't see any specific references to the documentation dataset in any of the labels or documents included here
 - Need to include a pointer to that data set
 - Logical place would be in the Overview.txt file
- All of the XML labels contain
 - "... global [or local] UNKNOWN shape model generated by SPC"
in the Identification area/Title
 - Pipeline not filling in a value?
- One file is missing the XML label
 - g_08440mm_spc_dtm_dimo_0000n00000_v002.fits

Ancillary files

- Tried to read the tables using IDL FITS reader
- Data tables don't match what is described
 - Supposed to be 6 or 10 columns
 - Actually 24 or 40 columns
 - Can't relate them to the 3D image planes as noted in the SIS

TFIELDS	(6 or 10)	Number of fields in table
TTYPE1	FACET_NUM	Shape Model Facet number
TFORM1	I10	Format
TBCOL1	2	Column offset
TTYPE[2,3,4]	('LAT, LON, RADIUS-coordinate')	The type of value stored in the first (for Latitude, second for Longitude, and third for Radius) column of the file. This will be the Latitude [or Longitude, Radius] coordinate in the body fixed frame of the center to each facet of the OBJ file defined by the MATCHOBJ record keyword. Units are provided in each keyword's associated comment immediately following the forward slash in square brackets (e.g., /[m]). Value is a string.
TFORM[2,3,4]	E16.0	Format
TBCOL[2,3,4]	13, 30, 47	Column offset
TFORM[5; optionally 6,7]	E16.0	Format

```
IDL> for i=0,5 do print ,q1[0:23,i]
0 0 0 0 66 6 136 177 67 8 225 182 61 164 189 32 0 0 0 0 127 192 0 0
0 0 0 1 66 5 159 249 67 12 157 84 61 166 127 59 0 0 0 0 127 192 0 0
0 0 0 2 66 15 121 218 67 14 131 235 61 164 223 66 0 0 0 0 127 192 0 0
0 0 0 3 66 13 74 250 67 18 39 89 61 166 207 41 0 0 0 0 127 192 0 0
0 0 0 4 66 22 245 97 67 20 37 46 61 164 253 195 0 0 0 0 127 192 0 0
0 0 0 5 66 19 151 44 67 23 159 15 61 167 16 223 0 0 0 0 127 192 0 0
IDL> print,q1h
XTENSION= 'BINTABLE' / marks beginning of new HDU
BITPIX = 8 / bits per data value
NAXIS = 2 / number of axes
NAXIS1 = 24 / size of the n'th axis
NAXIS2 = 3072 / size of the n'th axis
PCOUNT = 0 / Required value
GCOUNT = 1 / Required value
TFIELDS = 6 / Number of table fields
TFORM1 = '1J' / column data format
TTYPE1 = 'FACET_NUM'
TFORM2 = '1E' / column data format
TTYPE2 = 'LATITUDE'
TUNIT2 = 'DEGREES'
TFORM3 = '1E' / column data format
TTYPE3 = 'LONGITUDE'
TUNIT3 = 'DEGREES'
TFORM4 = '1E' / column data format
TTYPE4 = 'RADIUS'
TUNIT4 = 'KILOMETERS'
TFORM5 = '1E' / column data format
TTYPE5 = 'TILT DIRECTION VARIATION'
TUNIT5 = 'DEGREES'
TFORM6 = '1E' / column data format
TTYPE6 = 'SIGMA'
TUNIT6 = 'DEGREES'
END
```

g_08440mm_spc_tiv_dimo_0000n00000_v002.fits

Ancillary files

- Tried to read the tables using PDS4 Viewer
- Able to read and view the tables correctly
- Still can't easily compare to the 3D image planes (no way to manipulate the data)
- Odd ordering of the data (presumably due to the methods used to create the shape model)

TFIELDS	(6 or 10)	Number of fields in table
TTYPE1	FACET_NUM	Shape Model Facet number
TFORM1	I10	Format
TBCOL1	2	Column offset
TTYPE[2,3,4]	('LAT, LON, RADIUS-coordinate')	The type of value stored in the first (for Latitude, second for Longitude, and third for Radius) column of the file. This will be the Latitude [or Longitude, Radius] coordinate in the body fixed frame of the center to each facet of the OBJ file defined by the MATCHOBJ record keyword. Units are provided in each keyword's associated comment immediately following the forward slash in square brackets (e.g., /[m]). Value is a string.
TFORM[2,3,4]	E16.0	Format
TBCOL[2,3,4]	13, 30, 47	Column offset
TFORM[5; optionally 6,7]	E16.0	Format
TBCOL[5; optionally 6,7]	64,[81,98]	Column offset
		The type of values stored in the fourth column of this file. In some instances, for vector quantities

PDS4 Viewer - Table 'g_08440mm_spc_tiv_dimo_0000n00000_v002'

Row #	FACET_NUM	LATITUDE	LONGITUDE	RADIUS	TILT VARIATION	SIGMA
0	0	33.6335	136.882	0.0804389	0.0	nan
1	1	33.4062	140.615	0.0812974	0.0	nan
2	2	35.869	142.515	0.080504	0.0	nan
3	3	35.3232	146.154	0.0814498	0.0	nan
4	4	37.7396	148.145	0.0805621	0.0	nan
5	5	36.8976	151.621	0.0815751	0.0	nan
6	6	39.2649	153.773	0.080607	0.0	nan
7	7	38.1548	157.035	0.0816784	0.0	nan
8	8	40.4652	159.407	0.0806437	0.0	nan
9	9	39.1212	162.399	0.0817586	0.0	nan
10	10	41.3567	165.038	0.0806715	0.0	nan
11	11	39.8143	167.72	0.0818157	0.0	nan
12	12	41.9551	170.665	0.0806873	0.0	nan
13	13	40.2553	173.008	0.0818484	0.0	nan
14	14	42.2752	176.29	0.0806956	0.0	nan
15	15	40.4532	178.283	0.0818658	0.0	nan
16	16	40.4532	181.717	0.0818658	0.0	nan
17	17	42.2752	183.71	0.0806956	0.0	nan
18	18	40.2553	186.992	0.0818484	0.0	nan
19	19	41.9551	189.335	0.0806873	0.0	nan
20	20	39.8143	192.28	0.0818157	0.0	nan

g_08440mm_spc_tiv_dimo_0000n00000_v002.fits

Ancillary files

- Format statements in FITS extension headers are invalid
 - Are SIS values correct?
 - Contradictions between FITS (SIS document) and XML header formats?
- **Need to resolve format issues**

TTYPE[2,3,4]	('LAT, LON, RADIUS-coordinate')	The type of value stored in the first (for Latitude, second for Longitude, and third for Radius) column of the file. This will be the Latitude [or Longitude, Radius] coordinate in the body fixed frame of the center to each facet of the OBJ file defined by the MATCHOBJ record keyword. Units are provided in each keyword's associated comment immediately following the forward slash in square brackets (e.g., /[m]). Value is a string.
TFORM[2,3,4]	E16.0	Format
TBCOL[2,3,4]	13, 30, 47	Column offset
TFORM[5; optionally 6,7]	E16.0	Format
TBCOL[5; optionally 6,7]	64,[81,98]	Column offset
TTYPE[5; optionally 7,9]	('SLOPE')	The type of values stored in the fourth column of this file. In some instances, for vector quantities, this will include two additional columns for Y and Z values. The units will be specified in added note.
TFORM[6 or 6,8,10]	E16.0	Format
TBCOL[6 or 6,8,10]	47 or 115,132,149	Column offset
		The type of values stored in fifth (or eighth to tenth) column of data. This value is an estimate of

```

IDL> for i=0,5 do print ,q1[0:23,i]
  0 0 0 0 66 6 136 177 67 8 225 182 61 164 189 32 0 0 0 0 127 192 0 0
  0 0 0 1 66 5 159 249 67 12 157 84 61 166 127 59 0 0 0 0 127 192 0 0
  0 0 0 2 66 15 121 218 67 14 131 235 61 164 223 66 0 0 0 0 127 192 0 0
  0 0 0 3 66 13 74 250 67 18 39 89 61 166 207 41 0 0 0 0 127 192 0 0
  0 0 0 4 66 22 245 97 67 20 37 46 61 164 253 195 0 0 0 0 127 192 0 0
  0 0 0 5 66 19 151 44 67 23 159 15 61 167 16 223 0 0 0 0 127 192 0 0
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TUNIT3 = 'DEGREES'
TFORM4 = '1E' / column data format
TTYPE4 = 'RADIUS'
TUNIT4 = 'KILOMETERS'
TFORM5 = '1E' / column data format
TTYPE5 = 'TILT DIRECTION VARIATION'
TUNIT5 = 'DEGREES'
TFORM6 = '1E' / column data format
TTYPE6 = 'SIGMA'
TUNIT6 = 'DEGREES'
END
    
```

```

<Record_Binary>
  <fields>6</fields>
  <groups>0</groups>
  <record_length unit="byte">24</record_length>
  <Field_Binary>
    <name>FACET_NUM</name>
    <field_location unit="byte">1</field_location>
    <data_type>SignedMSB4</data_type>
    <field_length unit="byte">4</field_length>
    <description>facet number. </description>
  </Field_Binary>
  <Field_Binary>
    <name>LATITUDE</name>
    <field_location unit="byte">5</field_location>
    <data_type>IEEE754MSBSingle</data_type>
    <field_length unit="byte">4</field_length>
    <unit>deg</unit>
    <description>latitude at facet center</description>
  </Field_Binary>
    
```

Shape Model

- Dimorphos – Global shape model
 - Checks out as complete model
 - I get the same parameters as those in the header (surface area, etc)
 - Able to display and manipulate it

```
% READCOL: 4610 valid lines read
Shape represents a solid body.
  Number of vertices:      1538
  Number of triangles:    3072

  Minimum Radius:         0.067
  Maximum Radius:         0.104

  Surface Area:           0.087
  Volume:                  0.002

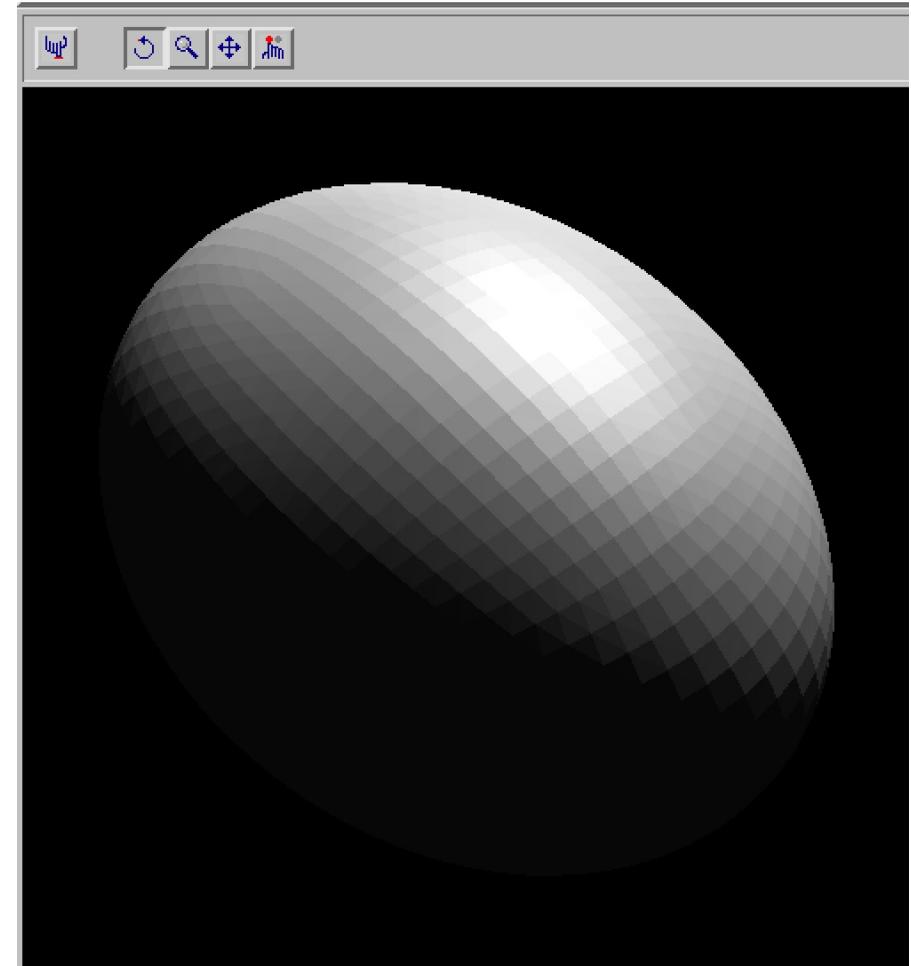
  Straight average of all radii:      0.083
  Radius of equiv. volume sphere:     0.082
  Average Radius (weighted by area):  0.083

All triangular plates are oriented with their surface normals facing outward

The CG of the body is at approximately:
  X =      0.00000
  Y =      0.00000
  Z =      0.00000

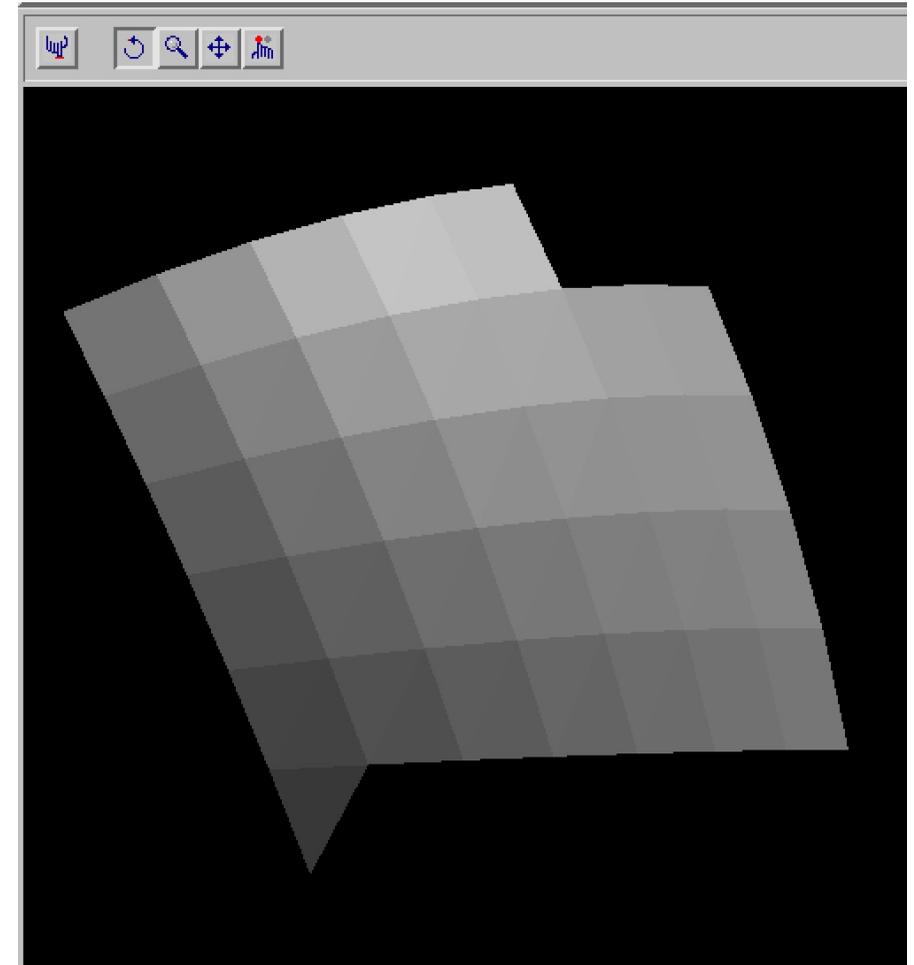
  Offset =      0.00000

IDL> █
```



Local Digital Terrain Model

- Dimorphos – Local DTM
- Able to read and display the DTM
- **Has an odd shape**
 - 4 triangles missing in one corner
 - 1 triangle tacked on in the opposite corner
 - Artifact of lat/long selection?
 - Not clear how this connects to the “corner lat/long” positions defined in the header



Typos

- Overview Document
- Abstract
 - geiod --> geoid
 - asteroid's --> asteroids'
- Data Set Overview
 - naming convention has two underscores in a row (“_” + “_”)
- Table of data type identifiers
 - avoid tabs and use spaces to force proper alignment

Parameter	TTYTYPE DATA Column	Des. string	
Relative Albedo	ALBEDO	alb	
Normal vector X	NORMAL VECTOR_X	nvf	
Normal vector Y	NORMAL VECTOR_Y	nvf	
Normal vector Z	NORMAL VECTOR_Z	nvf	
Gravity vector X		GRAVITY VECTOR_X	grv
Gravity vector Y		GRAVITY VECTOR_Y	grv
Gravity vector Z		GRAVITY VECTOR_Z	grv
Gravitational magnitude	GRAVITATIONAL_MAGNITUDE	grm	
Gravitational potential	GRAVITATIONAL_POTENTIAL	pot	
Elevation	ELEVATION	elv	
Slope	SLOPE	slp	
Facet tilt	FACET TILT	fti	
Facet tilt direction	FACET TILT DIRECTION	fdi	