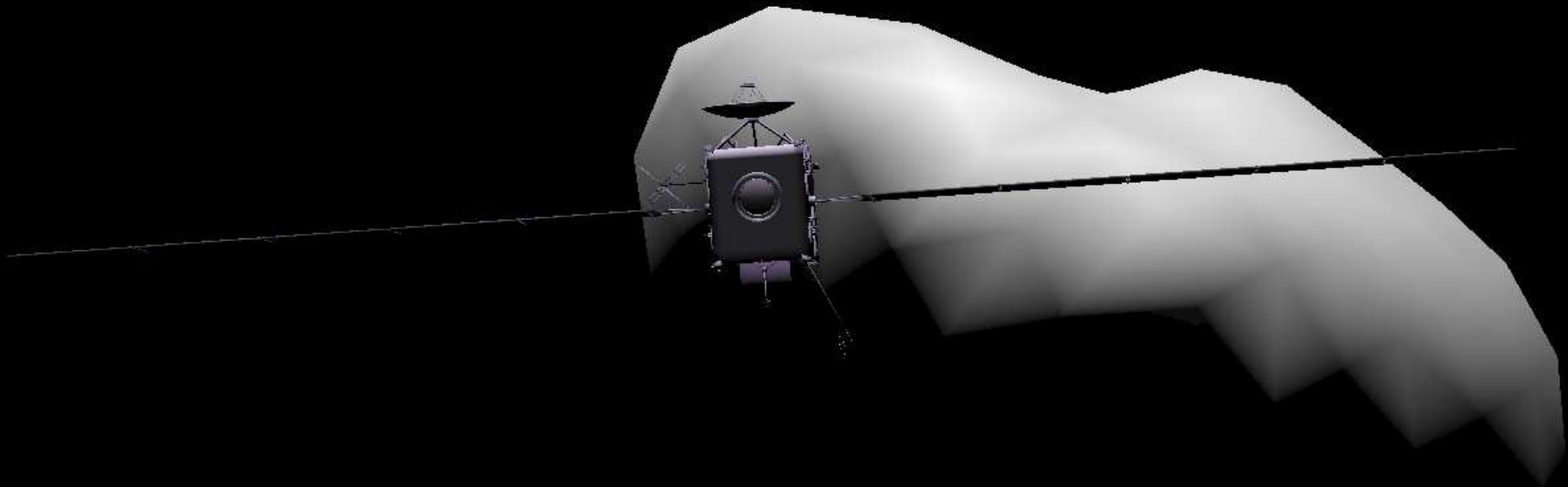


Review of ro-c-multi-5-67p-shape-v2.0



Björn Grieger
Trajectory Planning and Simulation
Aurora Technology B. V. for ESA
ESAC, Madrid, Spain

1. Comparison with NAVCAM images
2. Consistency between plate shape models and provided preview images
3. Consistency between different shape models
4. Quantitative comparison of different shape models
5. Remark on documentation

1

Comparison with NAVCAM images

- 13 images with one hour time step (the same as used for the review of v1.0, hence only northern hemisphere views)
- Images corrected for geometric distortion

OSIRIS imaging periods for SHAP2

Time	Distance	Lat
2014-07-14T14:24	11 500 km	51°
2014-07-15T02:04	10 800 km	51°
2014-07-21T14:34	4 900 km	49°
2014-07-22T00:44	4 600 km	49°
2014-08-01T11:49	820 km	38°
2014-08-01T21:24	700 km	35°
2014-08-03T11:04	290 km	8°
2014-08-03T21:39	220 km	8°

NAVCAM imaging used for comparison

Time	Distance	Lat
2014-07-14T14:24	11 500 km	51°
2014-07-15T02:04	10 800 km	51°
2014-07-21T14:34	4 900 km	49°
2014-07-22T00:44	4 600 km	49°
2014-08-01T11:49	820 km	38°
2014-08-01T21:24	700 km	35°
2014-08-03T11:04	290 km	8°
2014-08-03T21:39	220 km	8°
2014-08-06T23:07	93 km	31°
2014-08-07T11:07	85 km	42°

- Geometry information is taken from respective SPICE kernels or MOC files.
 - The rendered shape is taken from the triplate models.
 - The computation of self-shadowing is based on the DSKs.
- Consistency with real NAVCAM images verifies
- geometry information,
 - triplate models,
 - DSKs.

Available shape models in v2.0

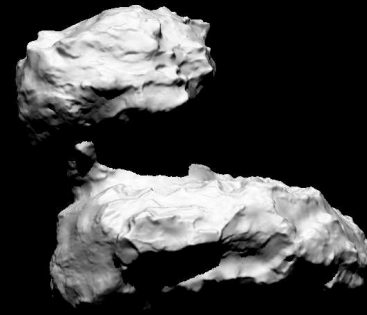
- `m_spcd_lam`
 - `shap2`
- `spc_esa`
 - `mtp009`
 - `mtp019`
- `spc_lam_psi`
 - `shap2`
 - `shap5`
- `spg_dlr`
 - `shap4s`

Available shape models in v2.0

- mspcd_lam
 - shap2
- spc_esa
 - mtp009
 - mtp019*
- spc_lam_psi
 - shap2
 - shap5*
- spg_dlr
 - shap4s*

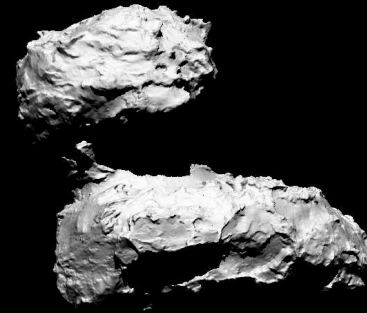
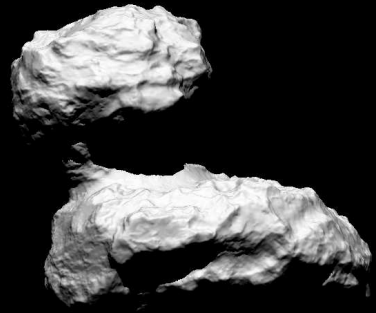
* Only new ones with respect to v1.0 used here.

Real world



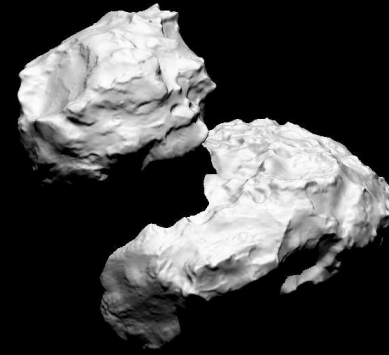
spc_esa

spc_lam_psi



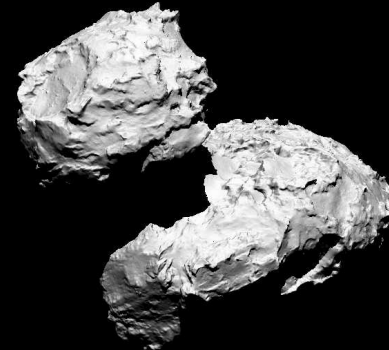
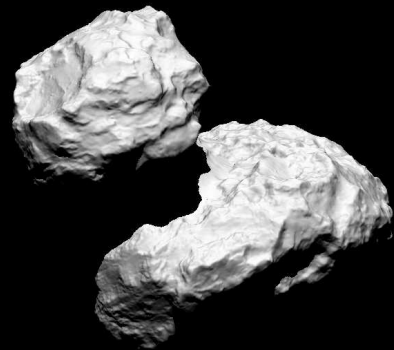
spg_dlr

Real world



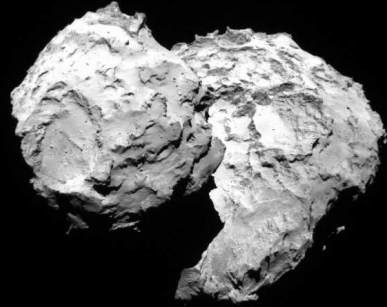
spc_esa

spc_lam_psi



spg_dlr

Real world



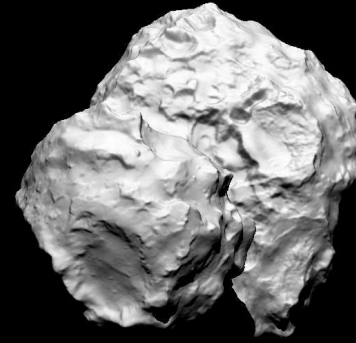
spc_esa

spc_lam_psi



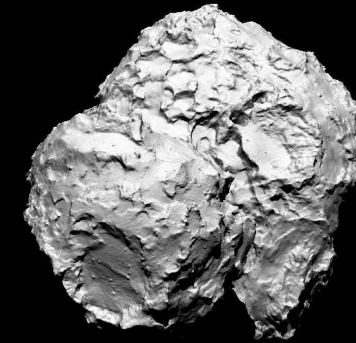
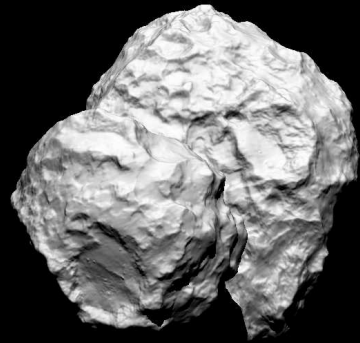
spg_dlr

Real world



spc_esa

spc_lam_psi



spg_dlr

Real world



spc_esa



spc_lam_psi



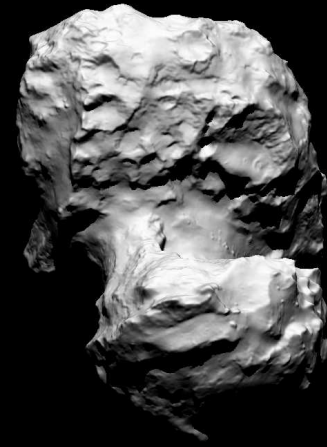
spg_dlr



Real world



spc_esa



spc_lam_psi



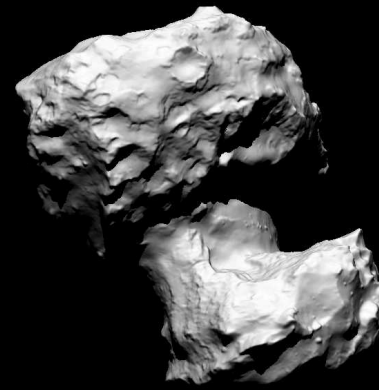
spg_dlr



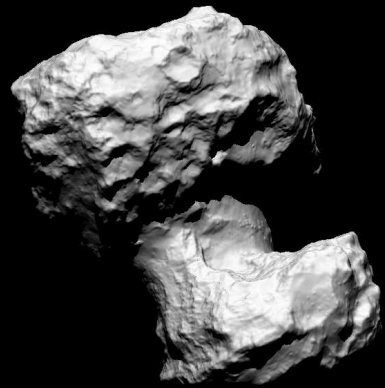
Real world



spc_esa



spc_lam_psi



spg_dlr



Real world



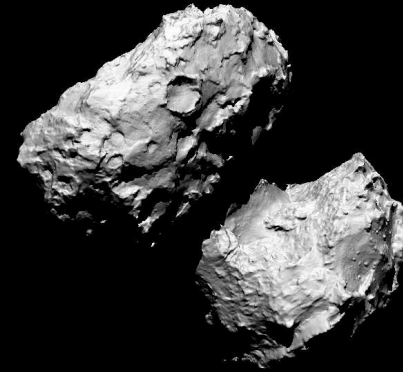
spc_esa



spc_lam_psi



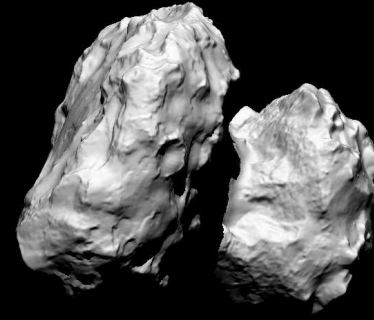
spg_dlr



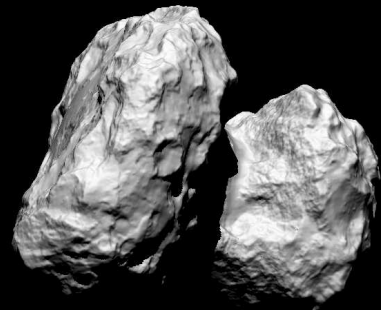
Real world



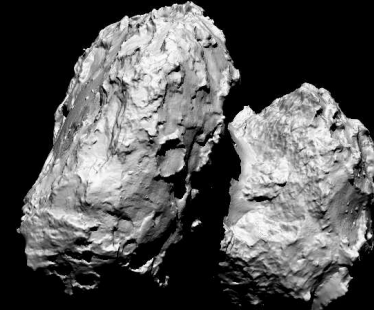
spc_esa



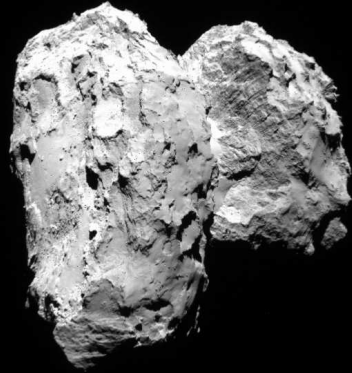
spc_lam_psi



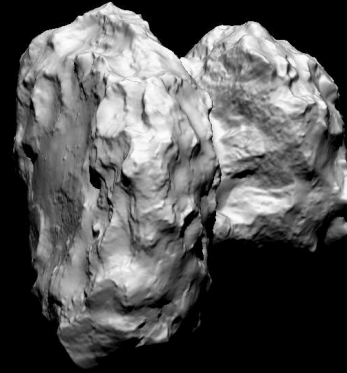
spg_dlr



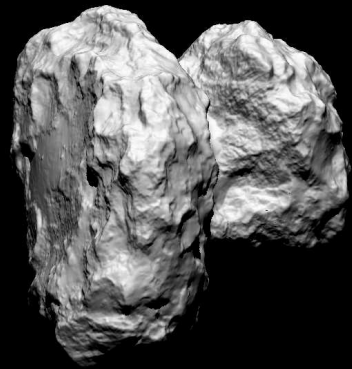
Real world



spc_esa



spc_lam_psi



spg_dlr

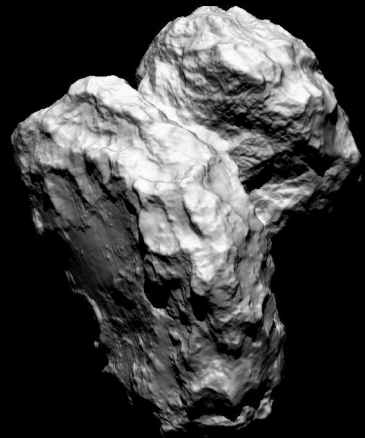


Real world



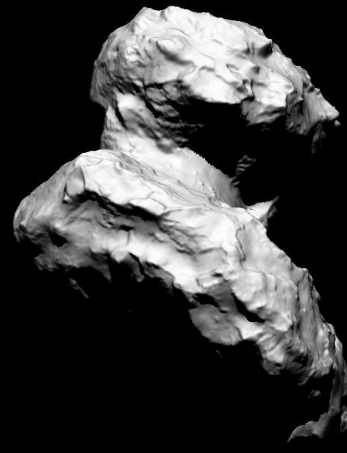
spc_esa

spc_lam_psi



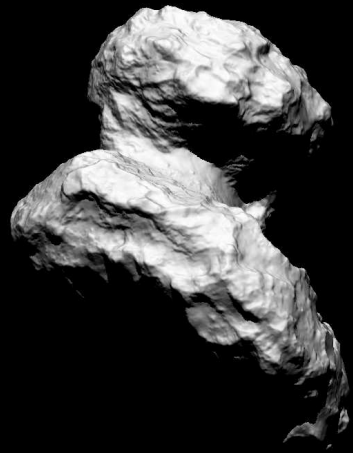
spg_dlr

Real world



spc_esa

spc_lam_psi



spg_dlr

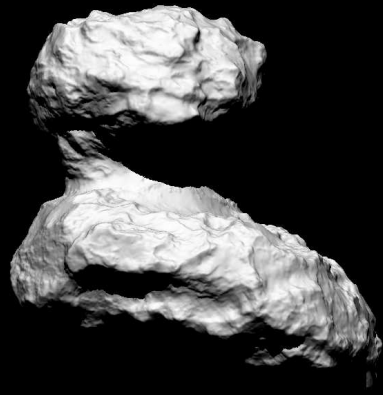
Real world



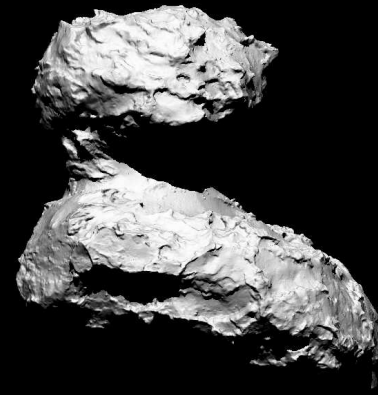
spc_esa



spc_lam_psi



spg_dlr



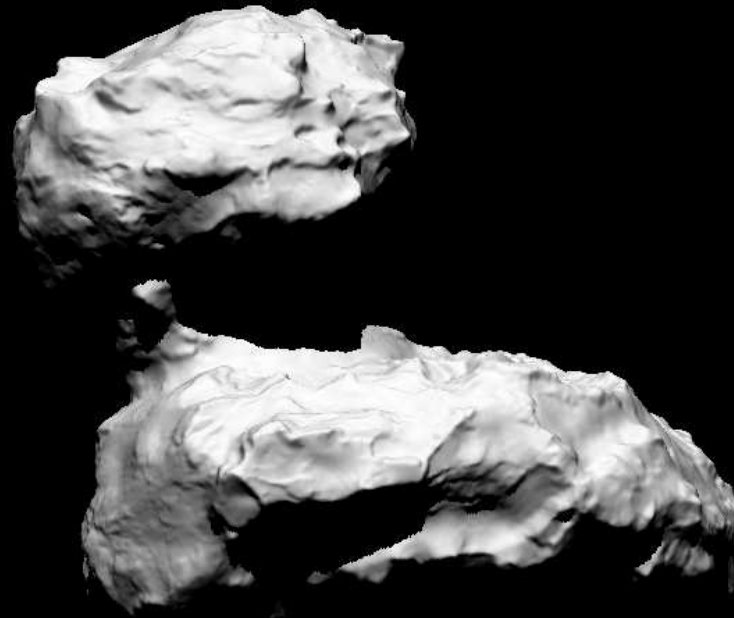
2014-08-06T23:07:18

Real world



2014-08-06T23:07:18

spc_esa



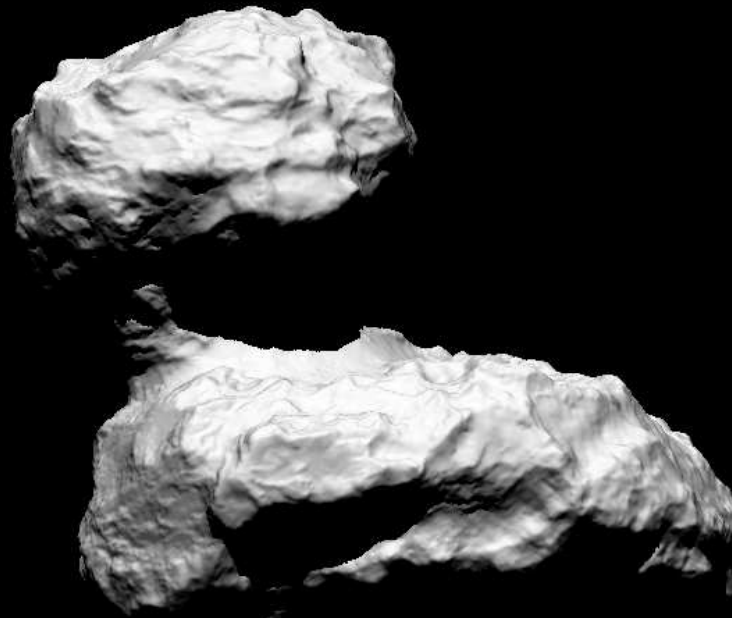
2014-08-06T23:07:18

Real world



2014-08-06T23:07:18

spc_lam_psi



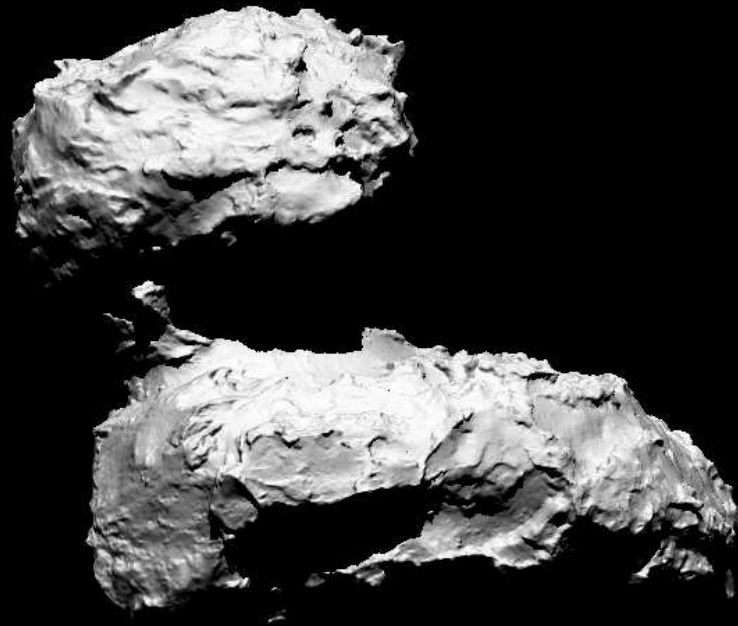
2014-08-06T23:07:18

Real world



2014-08-06T23:07:18

spg_dlr



2014-08-06T23:07:18

Real world



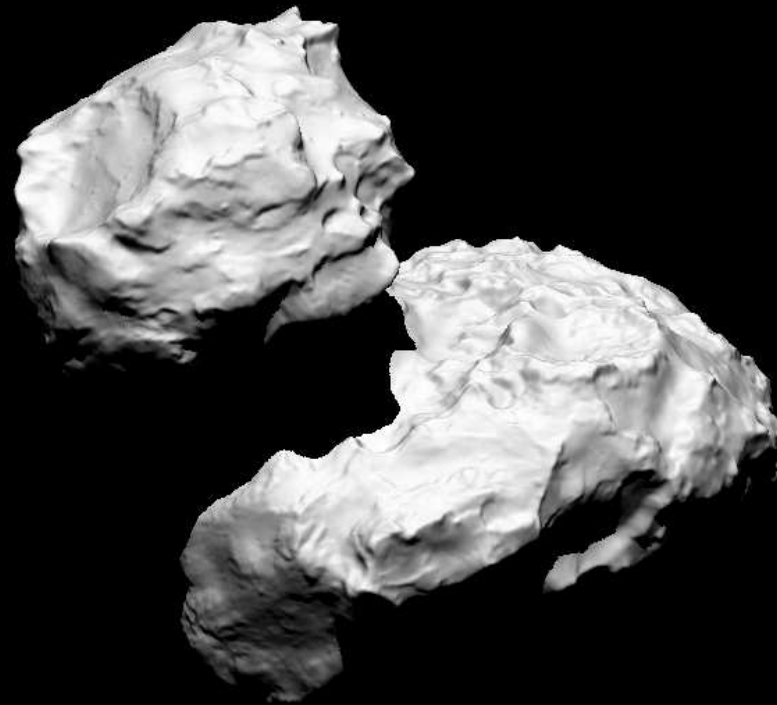
2014-08-07T00:07:18

Real world



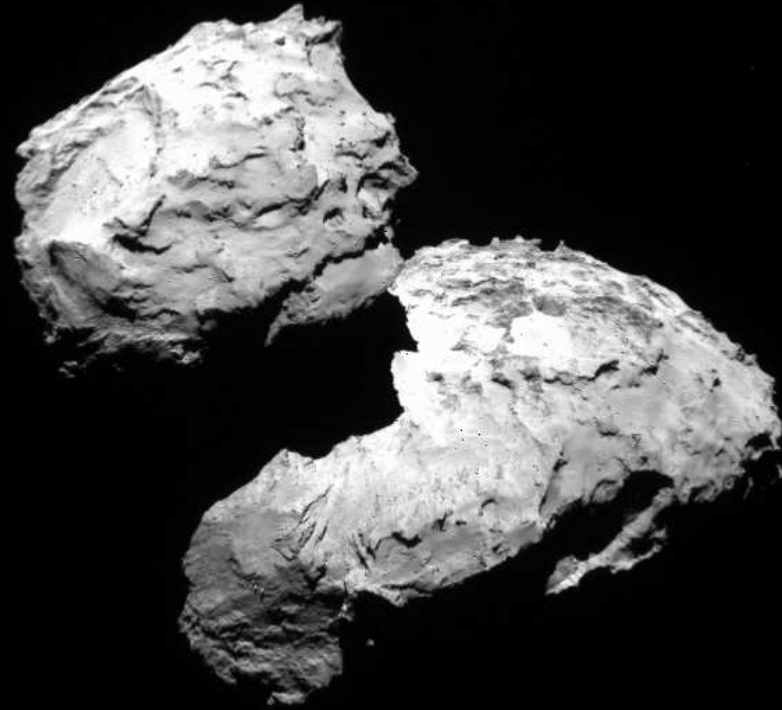
2014-08-07T00:07:18

spc_esa



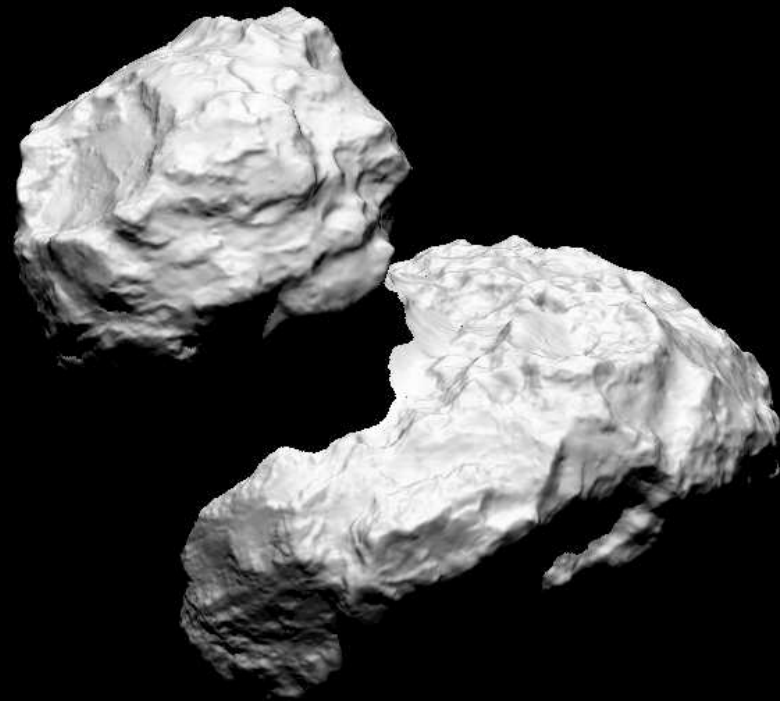
2014-08-07T00:07:18

Real world



2014-08-07T00:07:18

spc_lam_psi



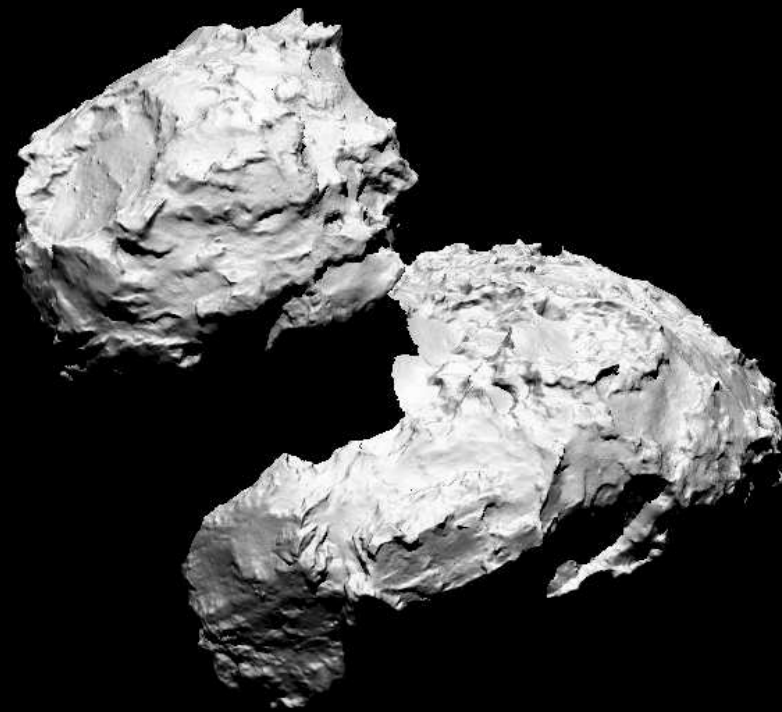
2014-08-07T00:07:18

Real world



2014-08-07T00:07:18

spg_dlr



2014-08-07T00:07:18

Real world



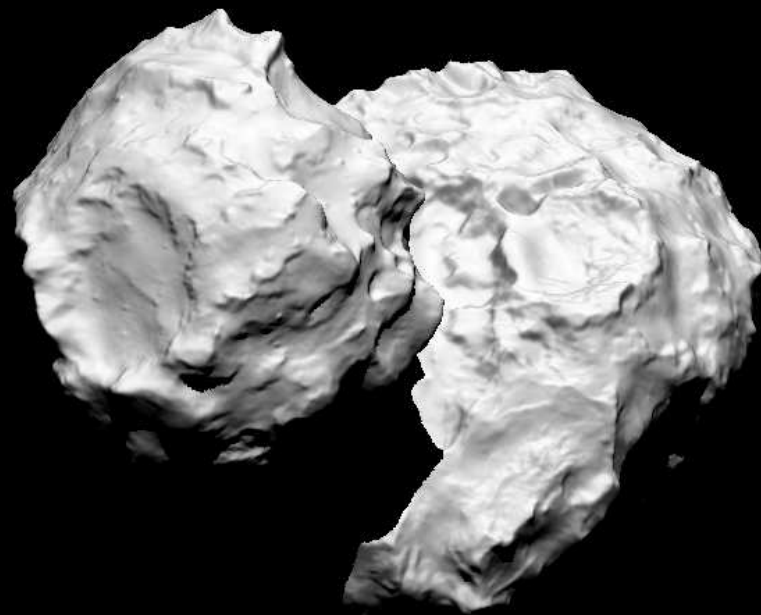
2014-08-07T01:07:18

Real world



2014-08-07T01:07:18

spc_esa



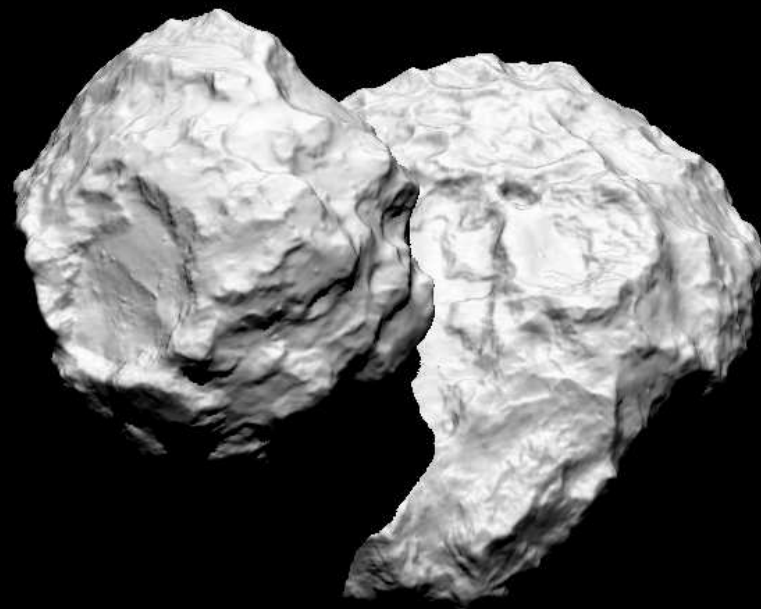
2014-08-07T01:07:18

Real world



2014-08-07T01:07:18

spc_lam_psi



2014-08-07T01:07:18

Real world



2014-08-07T01:07:18

spg_dlr



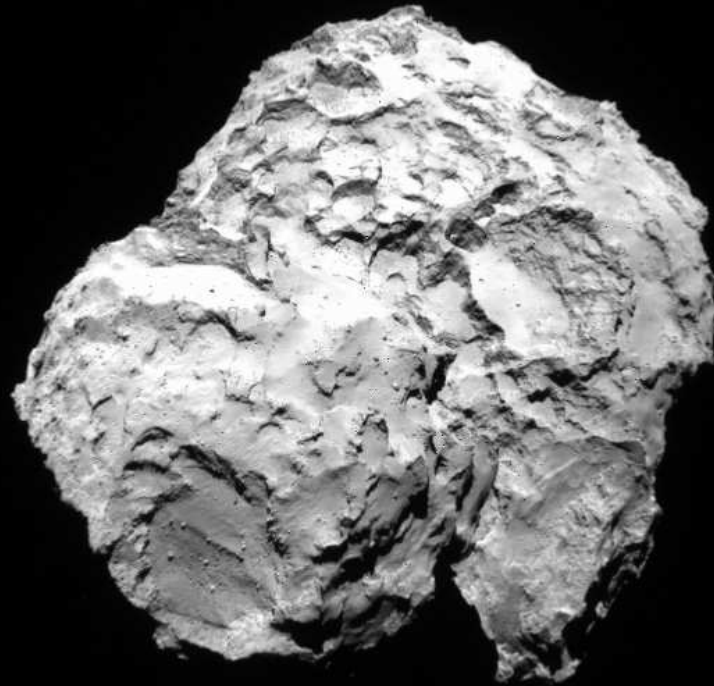
2014-08-07T01:07:18

Real world



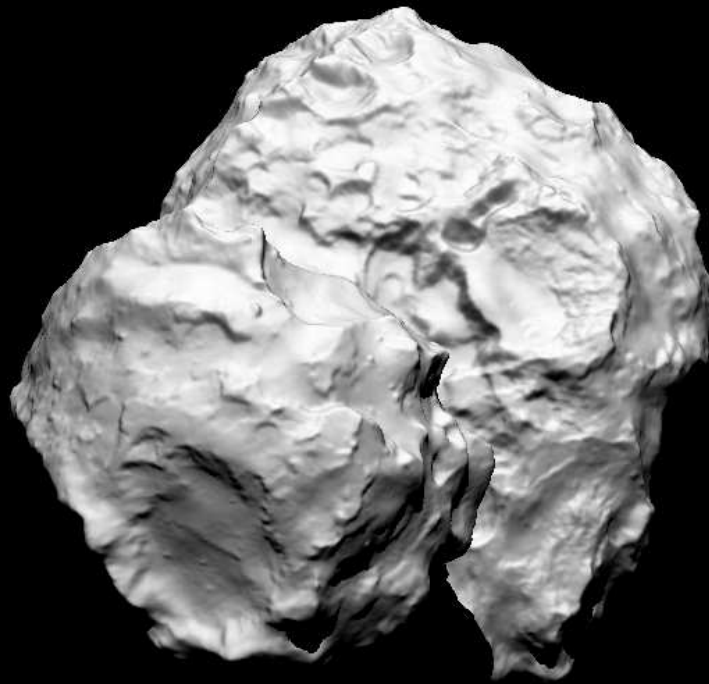
2014-08-07T02:07:18

Real world



2014-08-07T02:07:18

spc_esa



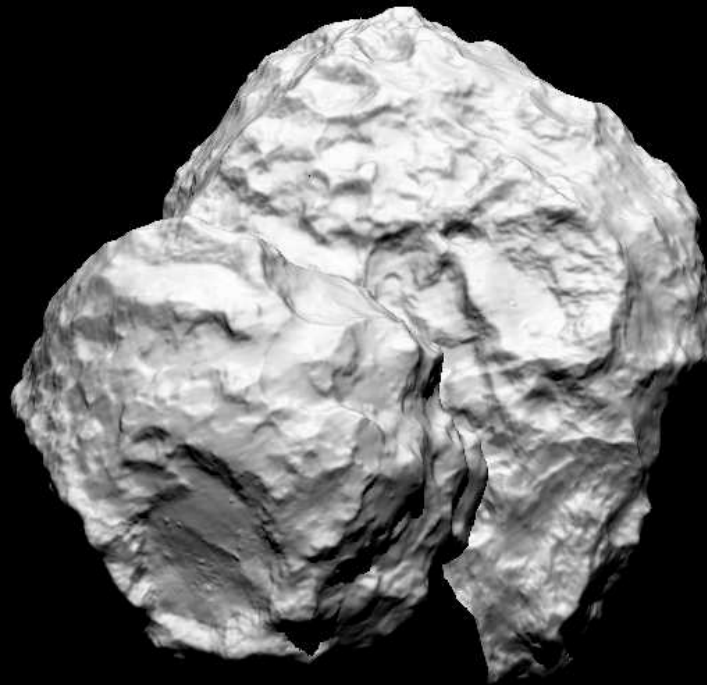
2014-08-07T02:07:18

Real world



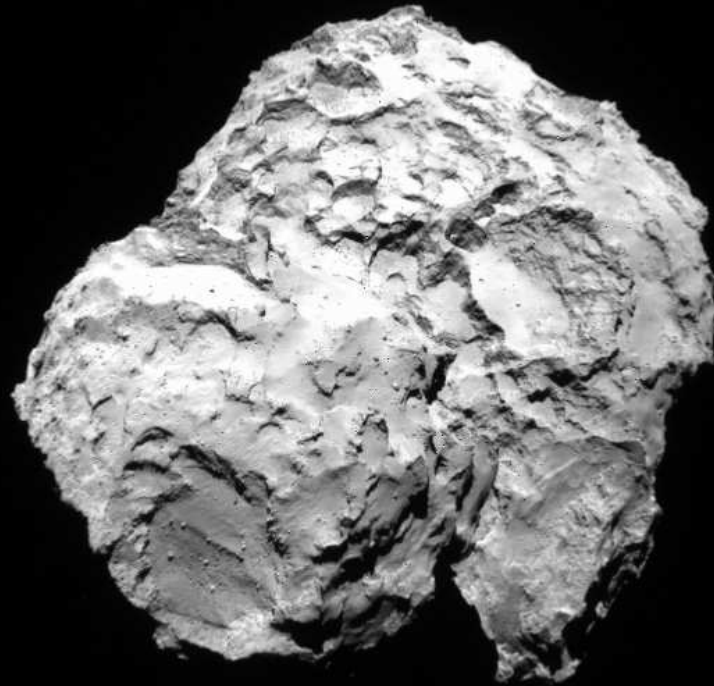
2014-08-07T02:07:18

spc_lam_psi



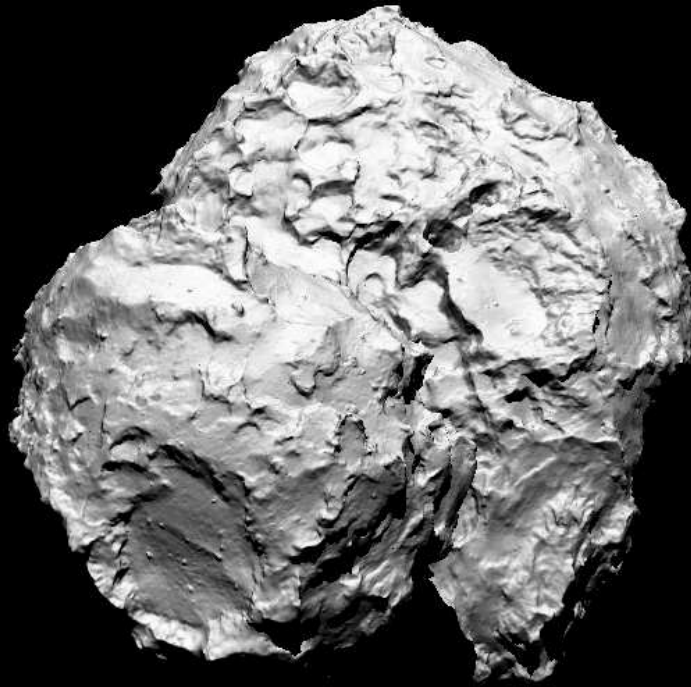
2014-08-07T02:07:18

Real world



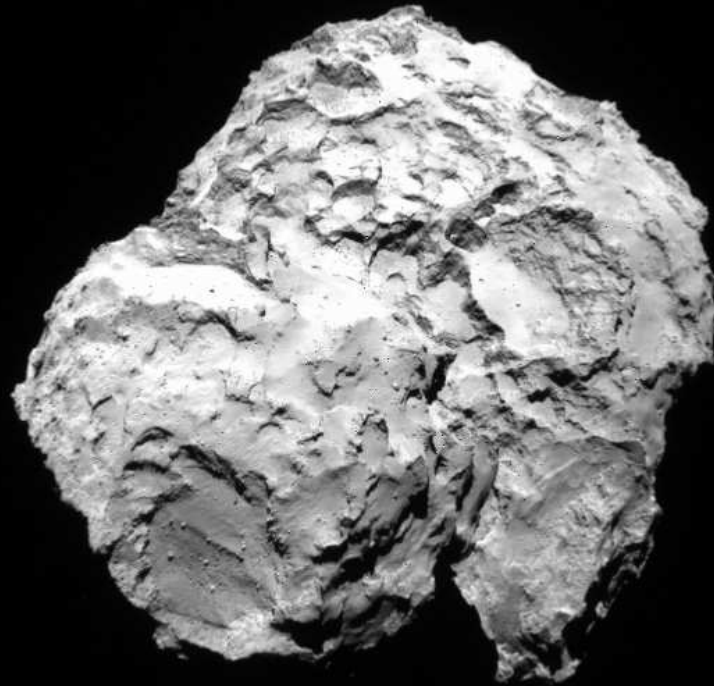
2014-08-07T02:07:18

spg_dlr



2014-08-07T02:07:18

Real world



2014-08-07T03:07:18

Real world



2014-08-07T03:07:18

spc_esa



2014-08-07T03:07:18

Real world



2014-08-07T03:07:18

spc_lam_psi



2014-08-07T03:07:18

Real world



2014-08-07T03:07:18

spg_dlr



2014-08-07T03:07:18

Real world



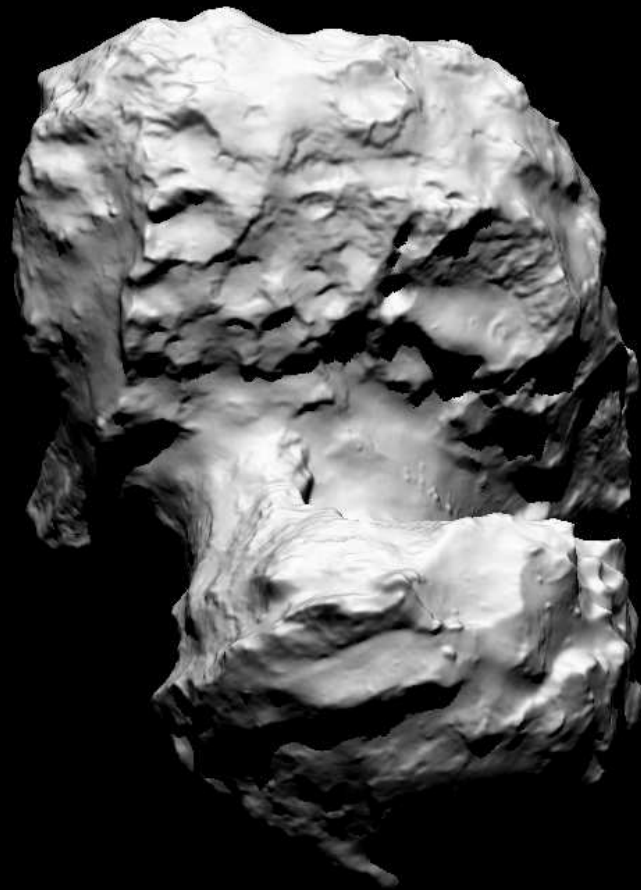
2014-08-07T04:07:18

Real world



2014-08-07T04:07:18

spc_esa



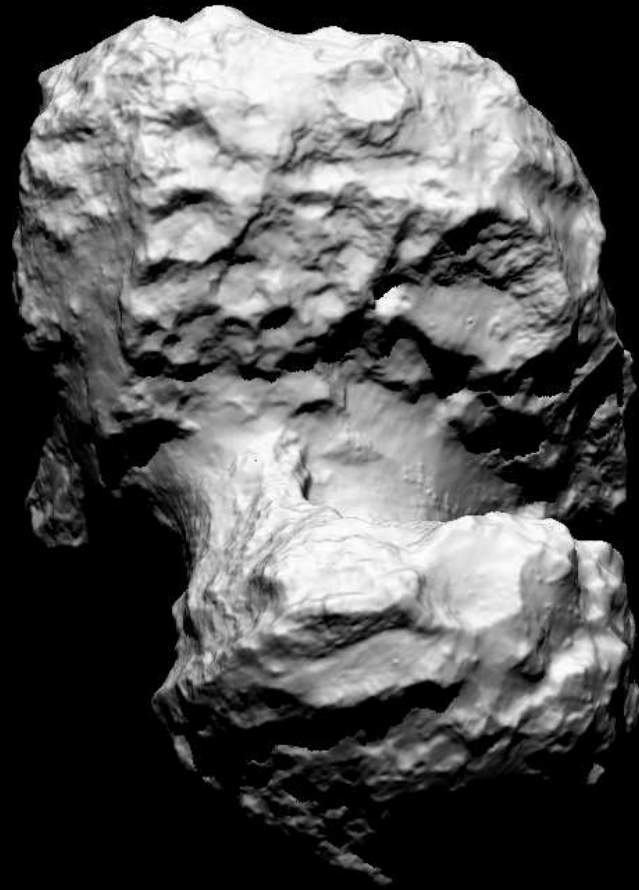
2014-08-07T04:07:18

Real world



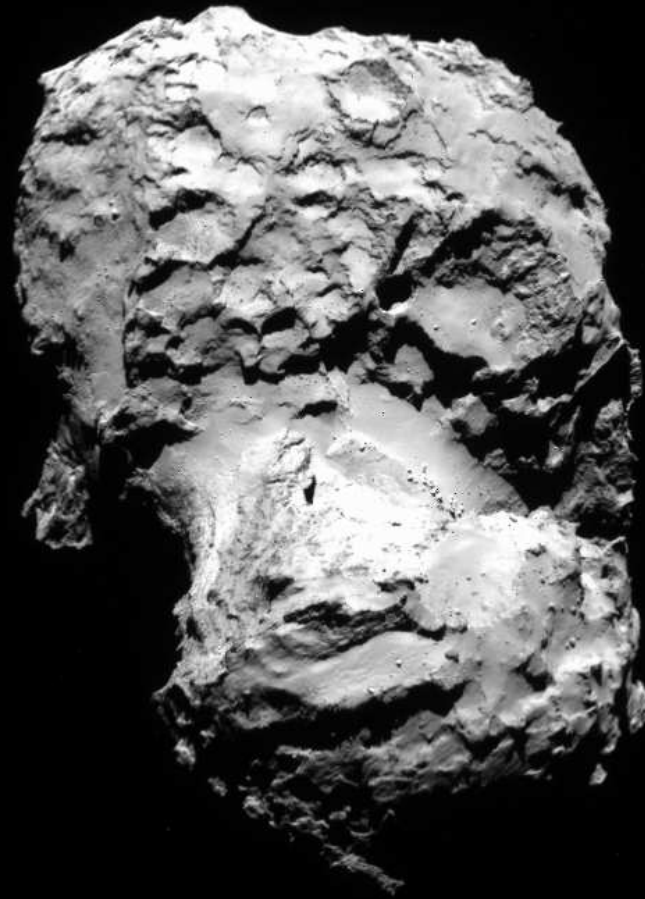
2014-08-07T04:07:18

spc_lam_psi



2014-08-07T04:07:18

Real world



2014-08-07T04:07:18

spg_dlr



2014-08-07T04:07:18

Real world



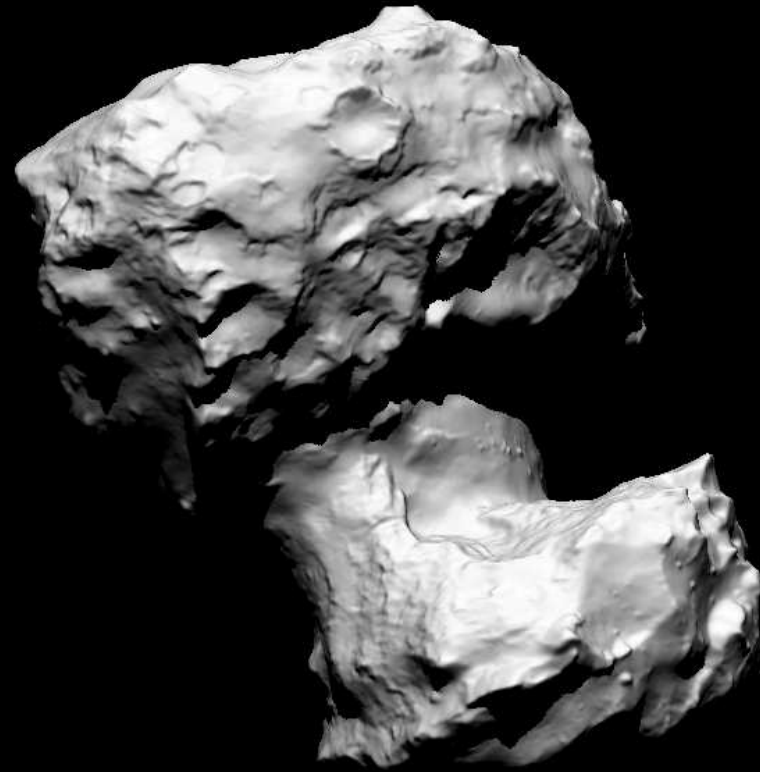
2014-08-07T05:07:18

Real world



2014-08-07T05:07:18

spc_esa



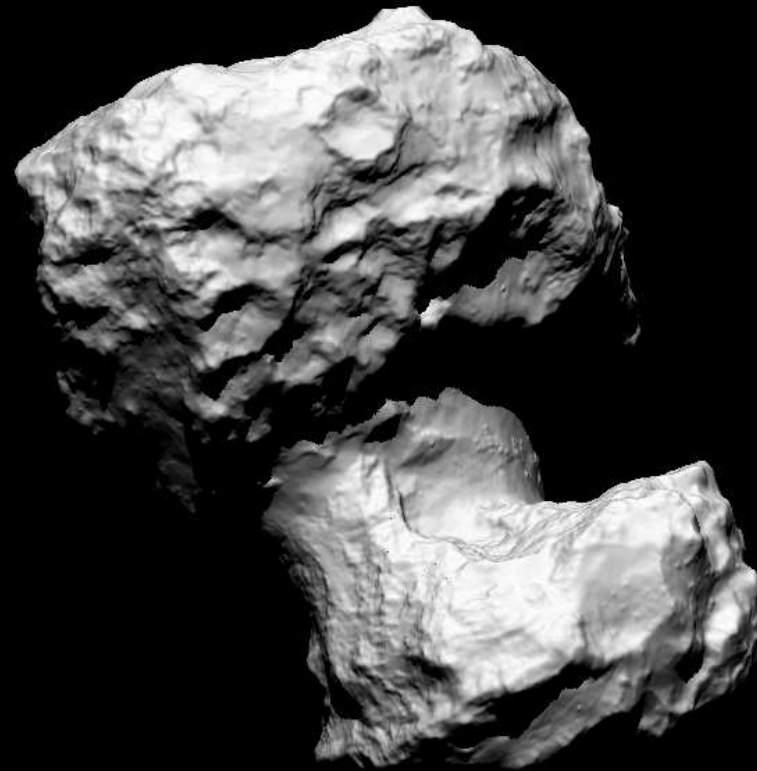
2014-08-07T05:07:18

Real world



2014-08-07T05:07:18

spc_lam_psi



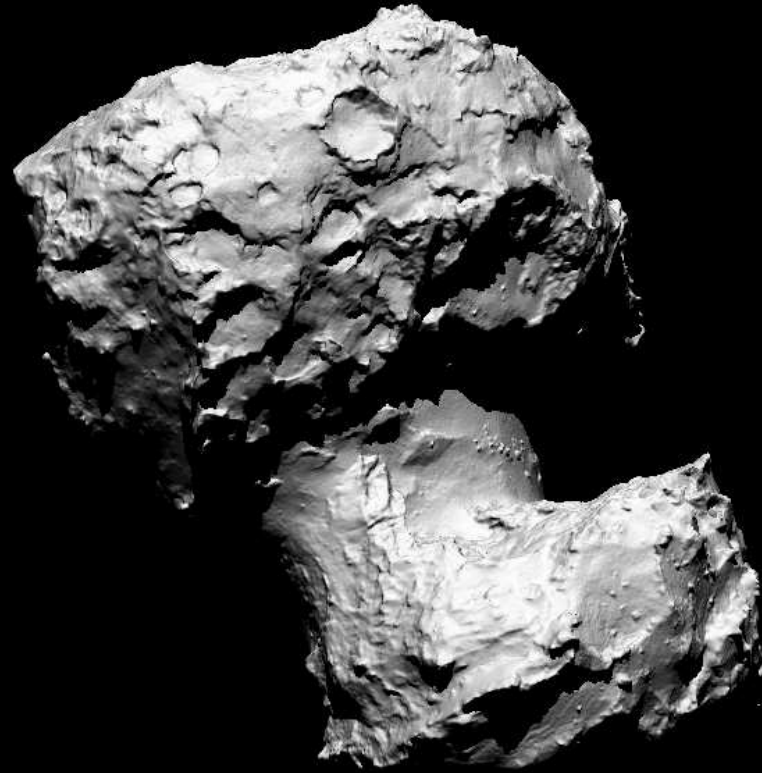
2014-08-07T05:07:18

Real world



2014-08-07T05:07:18

spg_dlr



2014-08-07T05:07:18

Real world



2014-08-07T06:07:18

Real world



2014-08-07T06:07:18

spc_esa



2014-08-07T06:07:18

Real world



2014-08-07T06:07:18

spc_lam_psi



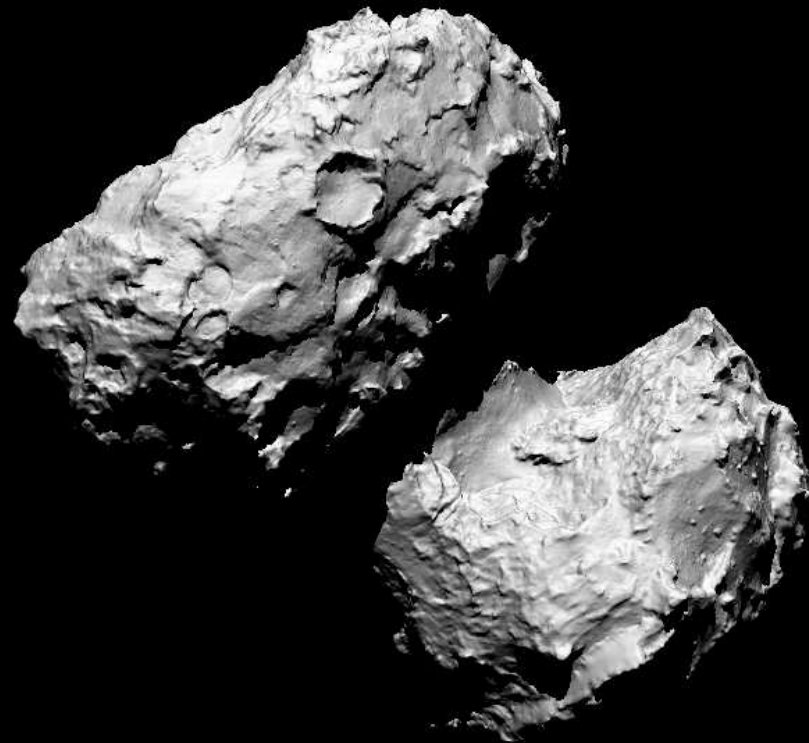
2014-08-07T06:07:18

Real world



2014-08-07T06:07:18

spg_dlr



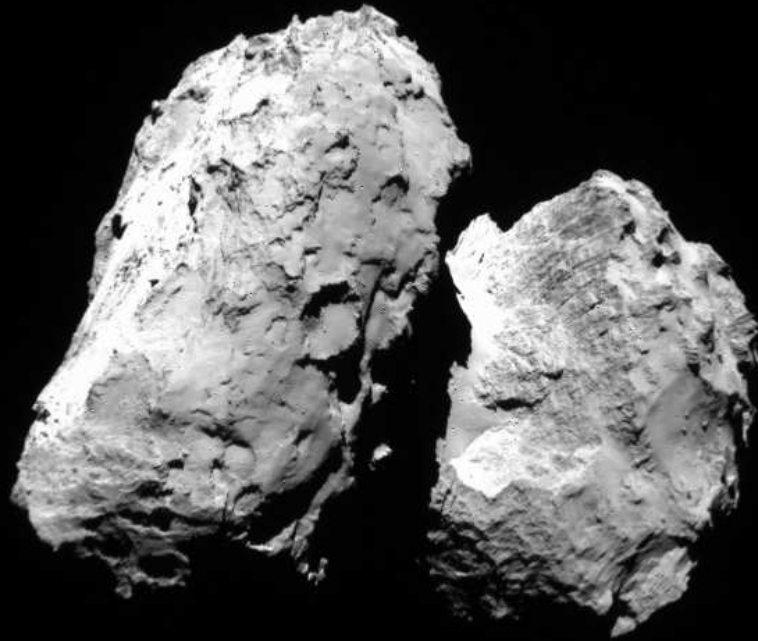
2014-08-07T06:07:18

Real world



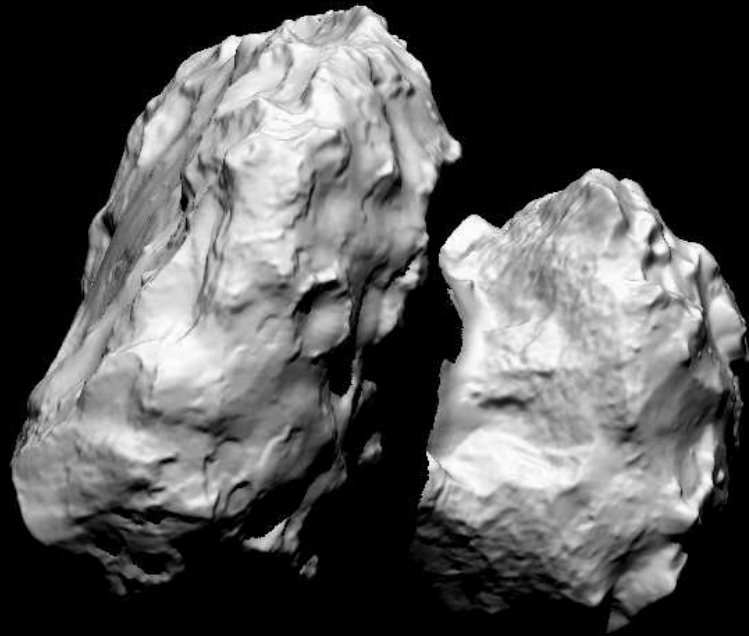
2014-08-07T07:07:18

Real world



2014-08-07T07:07:18

spc_esa



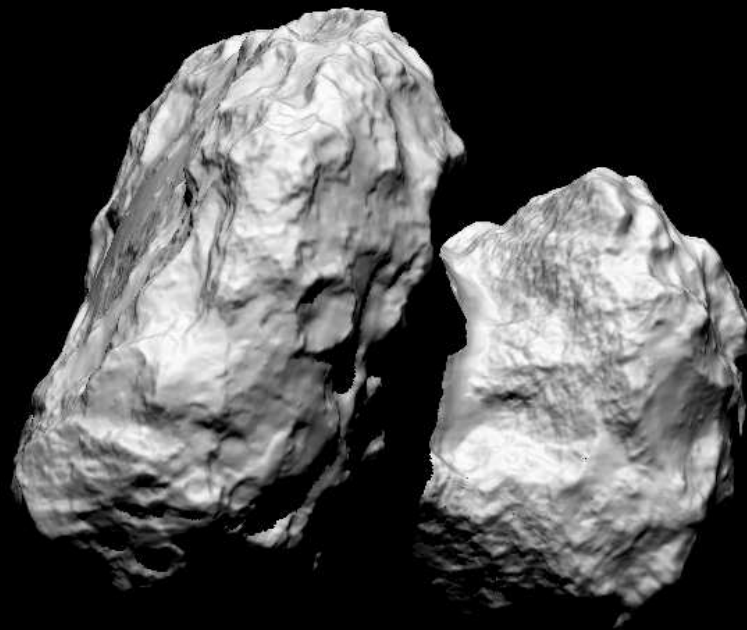
2014-08-07T07:07:18

Real world



2014-08-07T07:07:18

spc_lam_psi



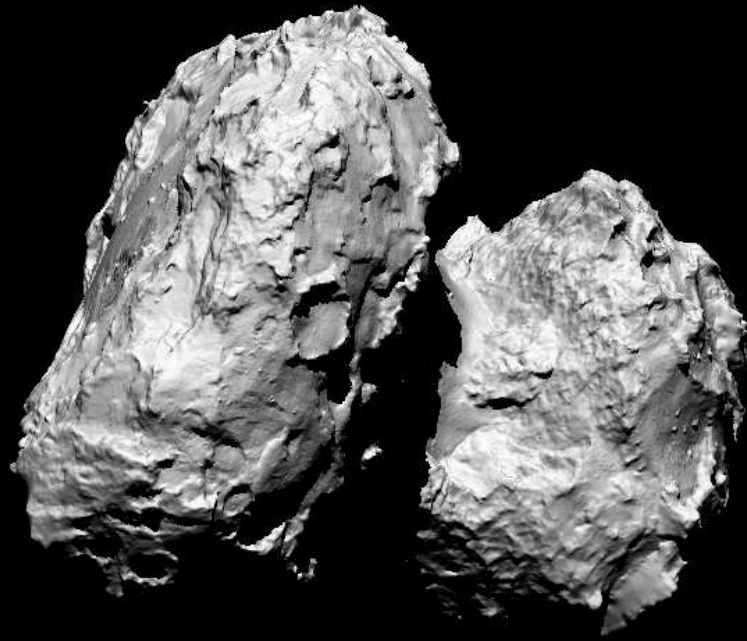
2014-08-07T07:07:18

Real world



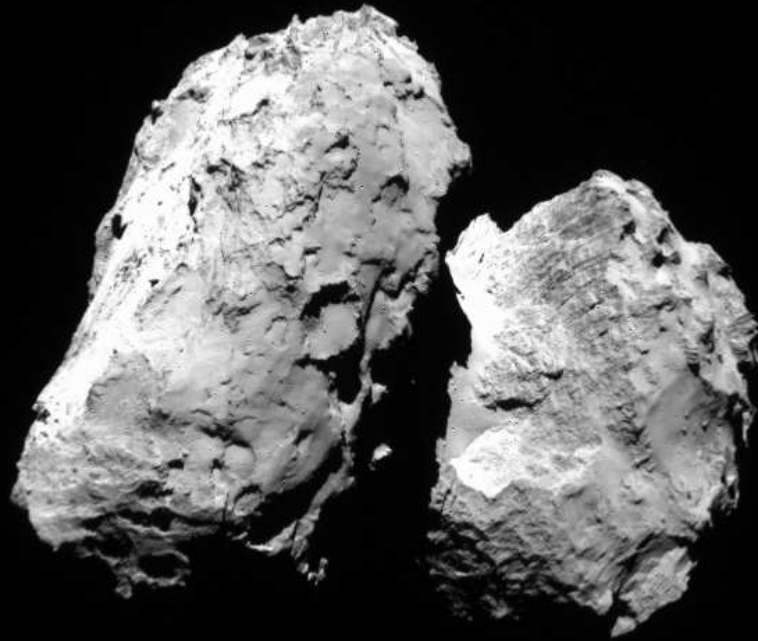
2014-08-07T07:07:18

spg_dlr



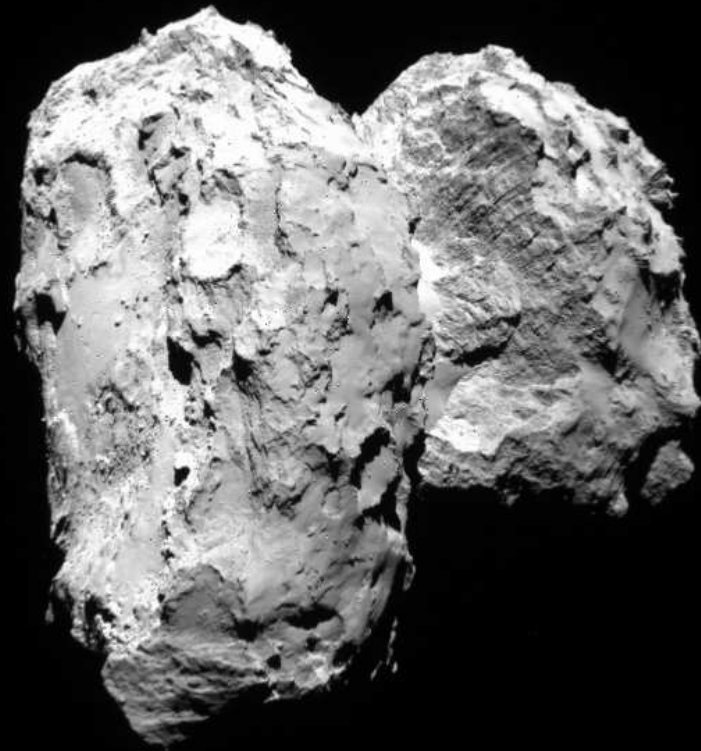
2014-08-07T07:07:18

Real world



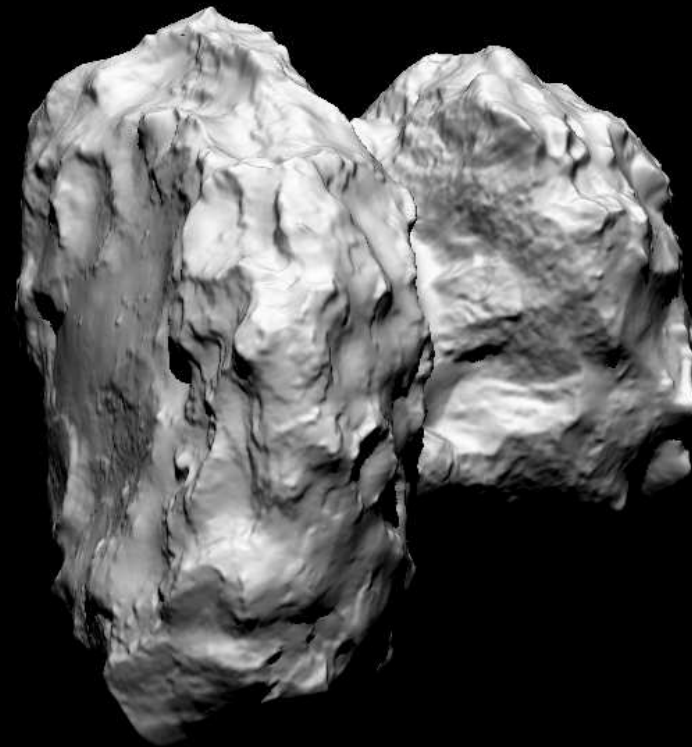
2014-08-07T08:07:18

Real world



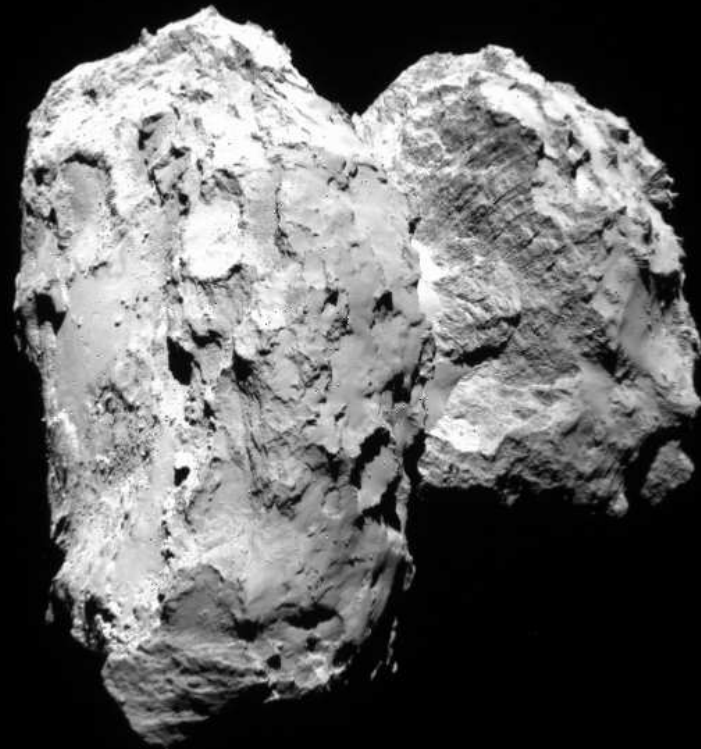
2014-08-07T08:07:18

spc_esa



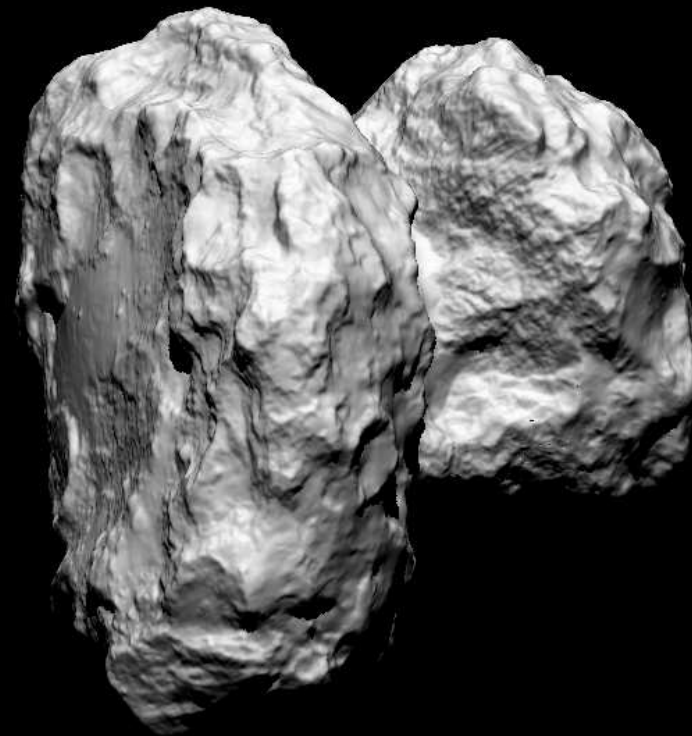
2014-08-07T08:07:18

Real world



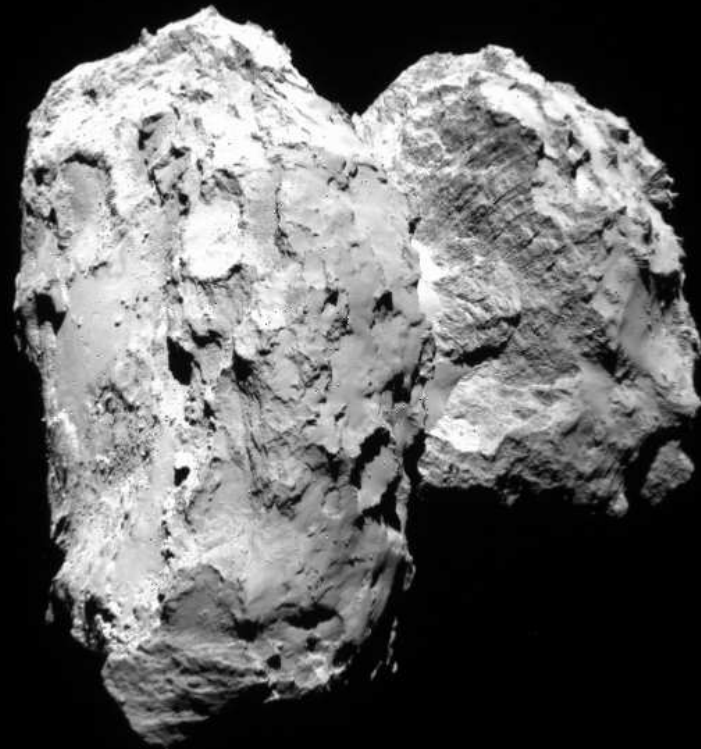
2014-08-07T08:07:18

spc_lam_psi



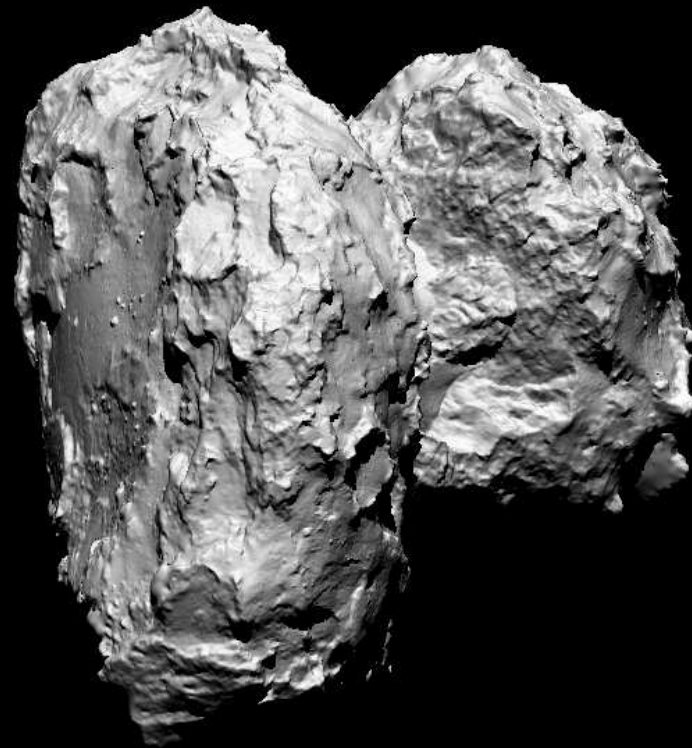
2014-08-07T08:07:18

Real world



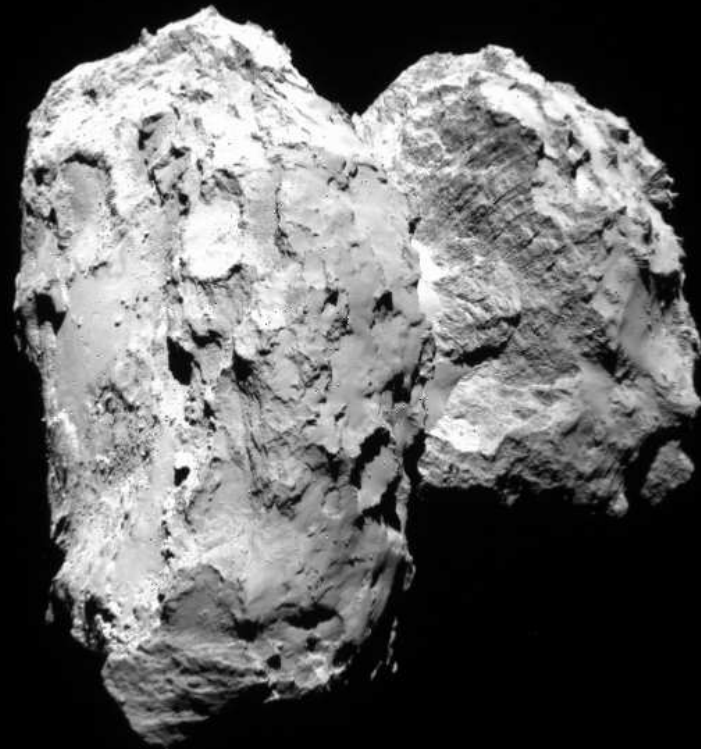
2014-08-07T08:07:18

spg_dlr



2014-08-07T08:07:18

Real world



2014-08-07T09:07:18

Real world



2014-08-07T09:07:18

spc_esa



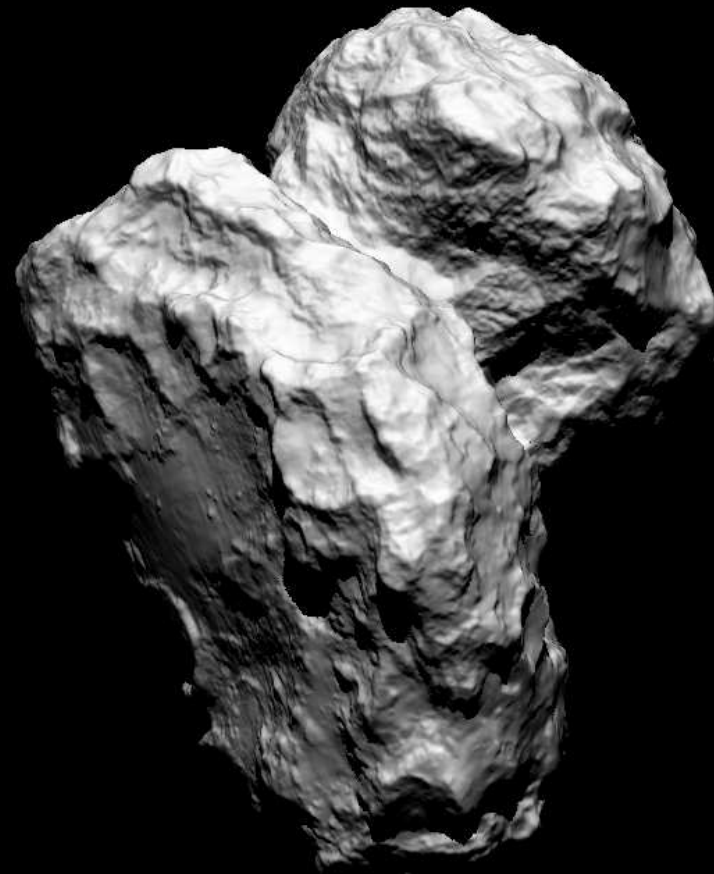
2014-08-07T09:07:18

Real world



2014-08-07T09:07:18

spc_lam_psi



2014-08-07T09:07:18

Real world



2014-08-07T09:07:18

spg_dlr



2014-08-07T09:07:18

Real world



2014-08-07T10:07:18

Real world



2014-08-07T10:07:18

spc_esa



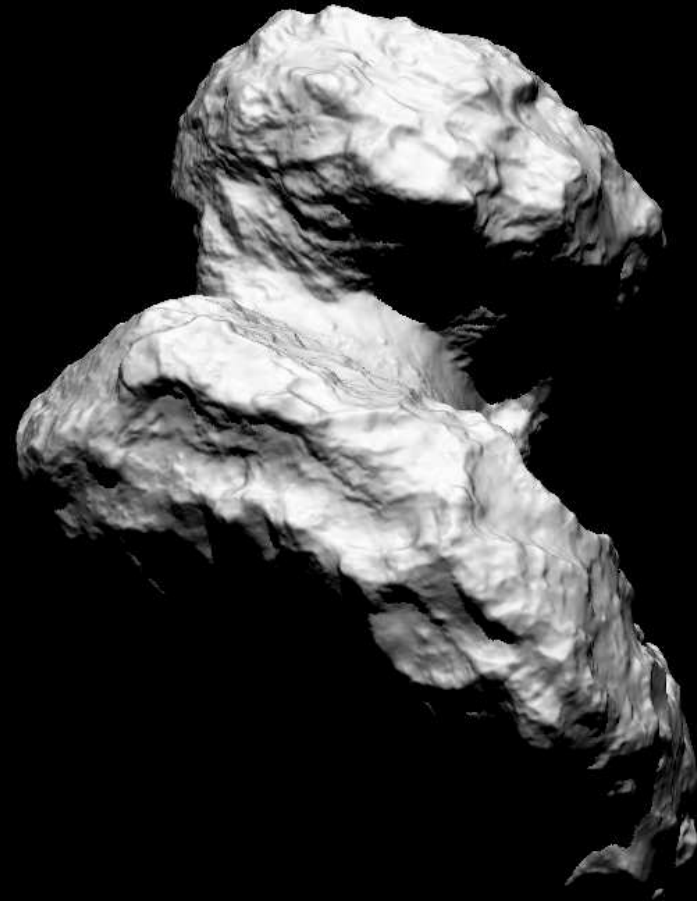
2014-08-07T10:07:18

Real world



2014-08-07T10:07:18

spc_lam_psi



2014-08-07T10:07:18

Real world



2014-08-07T10:07:18

spg_dlr



2014-08-07T10:07:18

Real world



2014-08-07T11:07:18

Real world



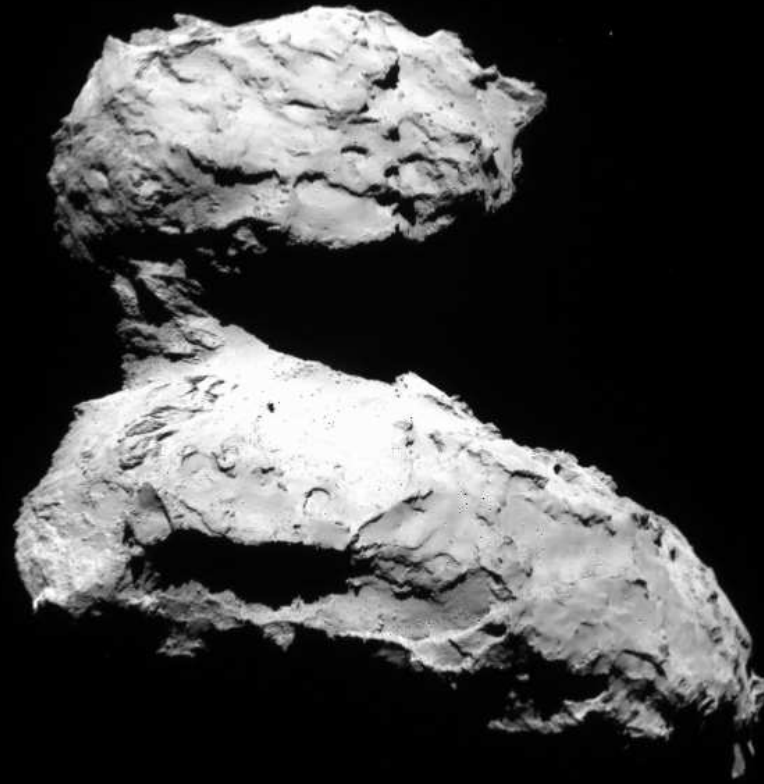
2014-08-07T11:07:18

spc_esa



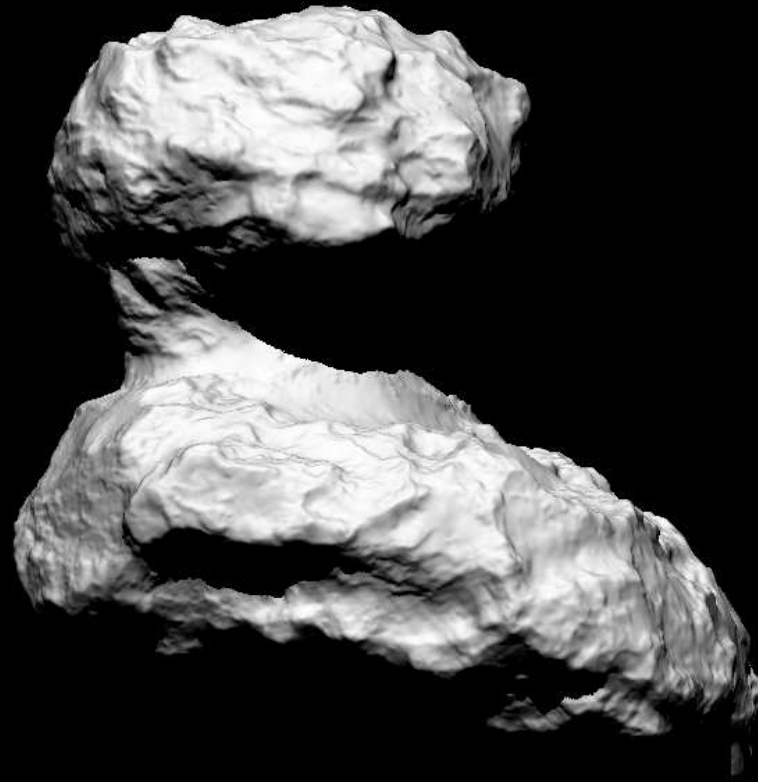
2014-08-07T11:07:18

Real world



2014-08-07T11:07:18

spc_lam_psi



2014-08-07T11:07:18

Real world



2014-08-07T11:07:18

spg_dlr



2014-08-07T11:07:18

Real world



Conclusion of comparison

Within the accuracy obtainable by visual comparison, all shape models (triplane models and DSKs) are consistent with real NAVCAM images (only highest resolution version of each group checked).

(Same as for v1.0)

2

Consistency between plate
shape models and provided
preview images

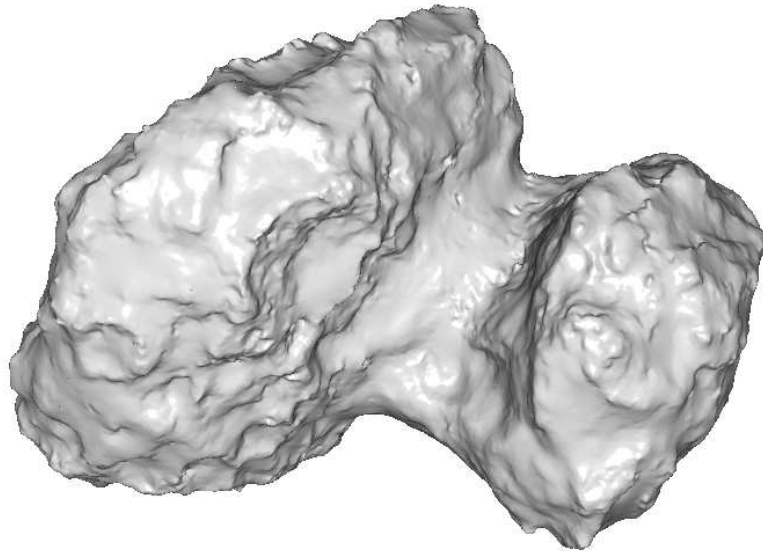
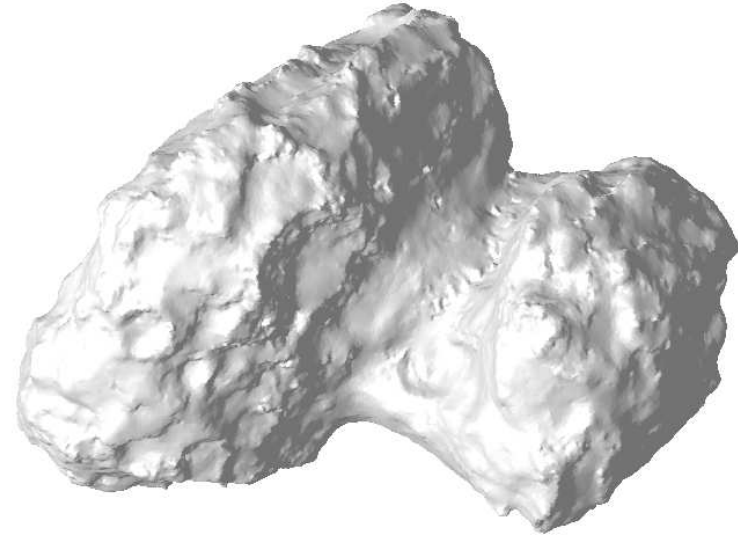


Image from data set

ro-c-osinac_osiwac-5-67p-shape-v1.0



Rendered

orthographic projection

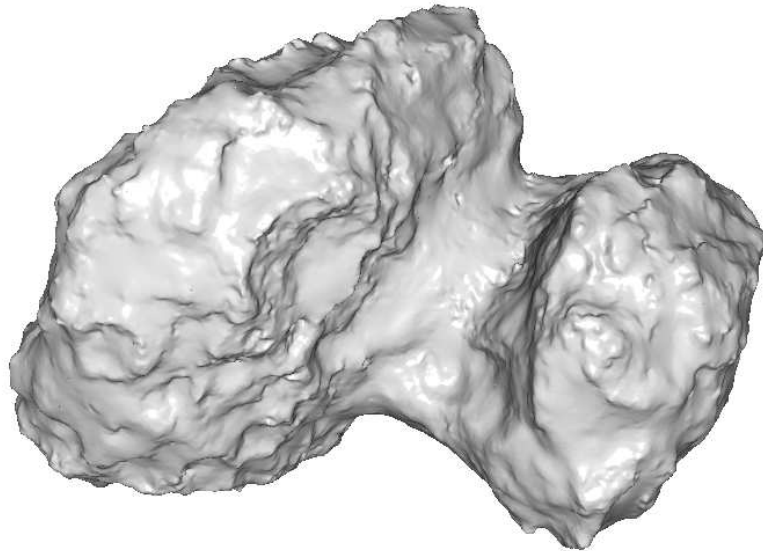
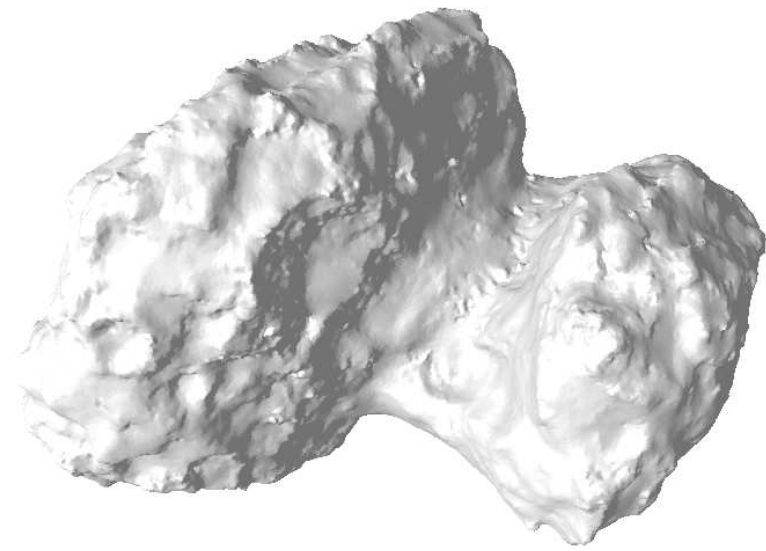


Image from data set

ro-c-osinac_osiwac-5-67p-shape-v1.0



Rendered

perspective projection

Distance 7.5 km

FOV 50°

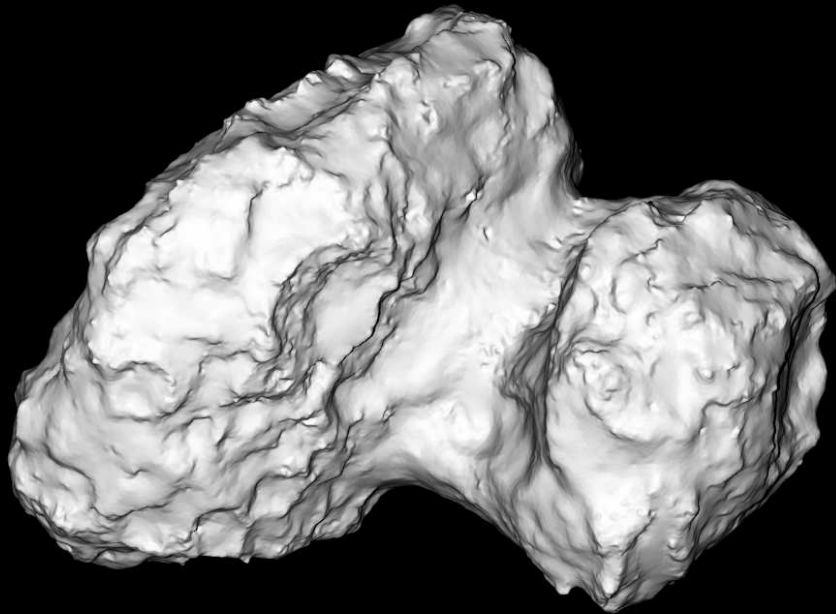
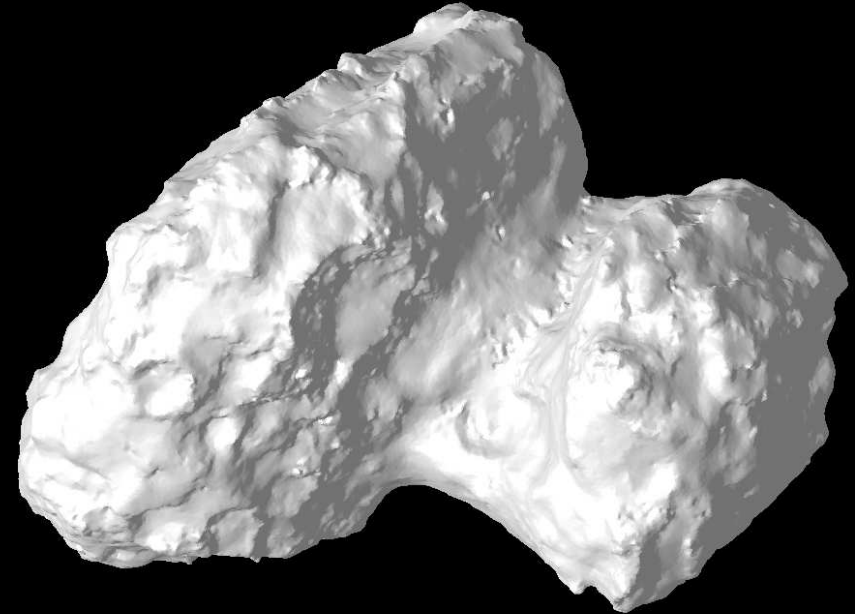


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

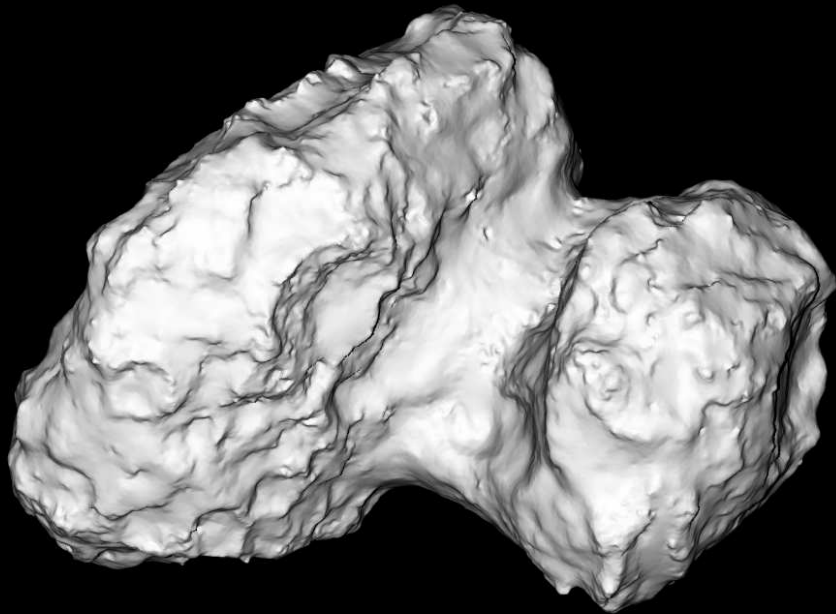
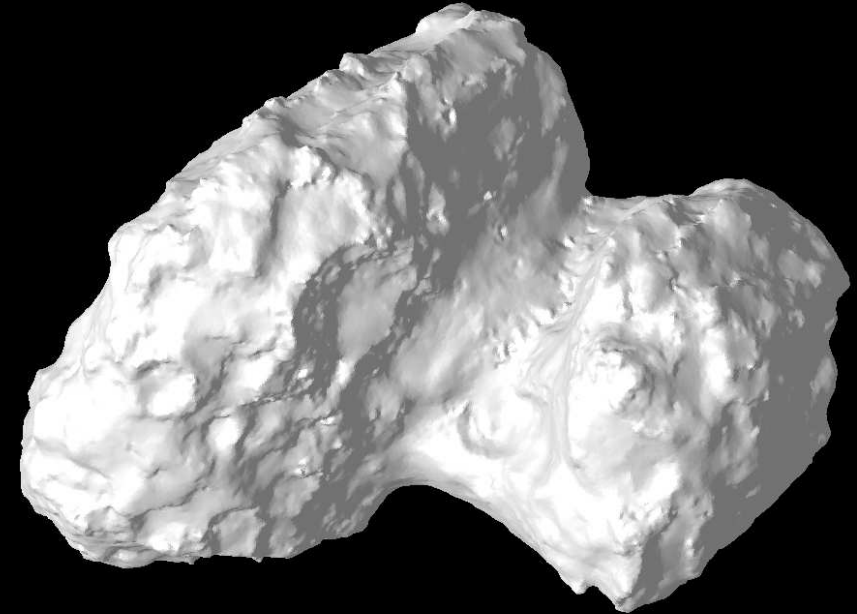


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

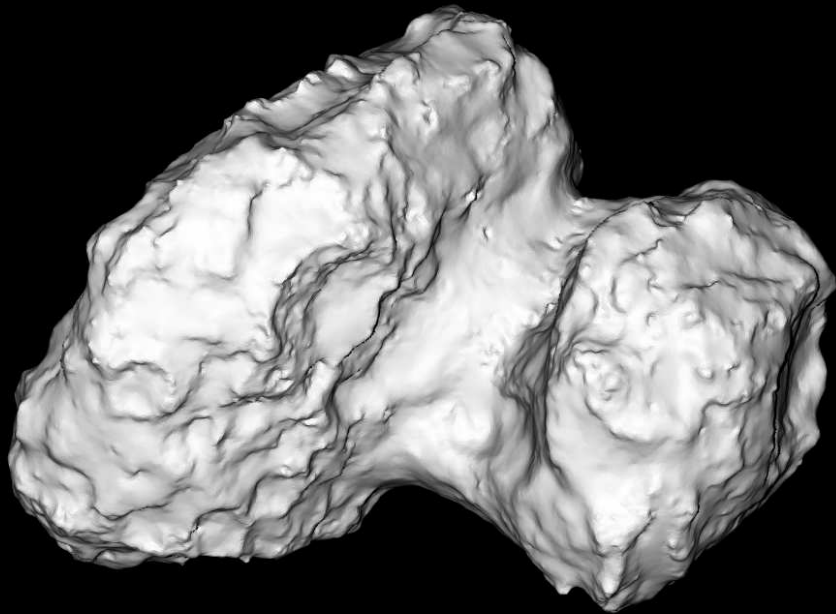
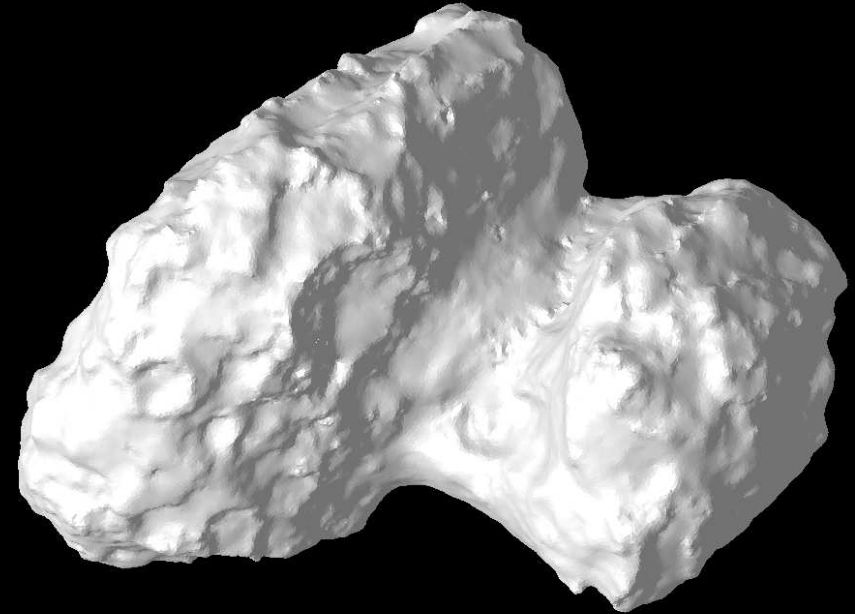


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

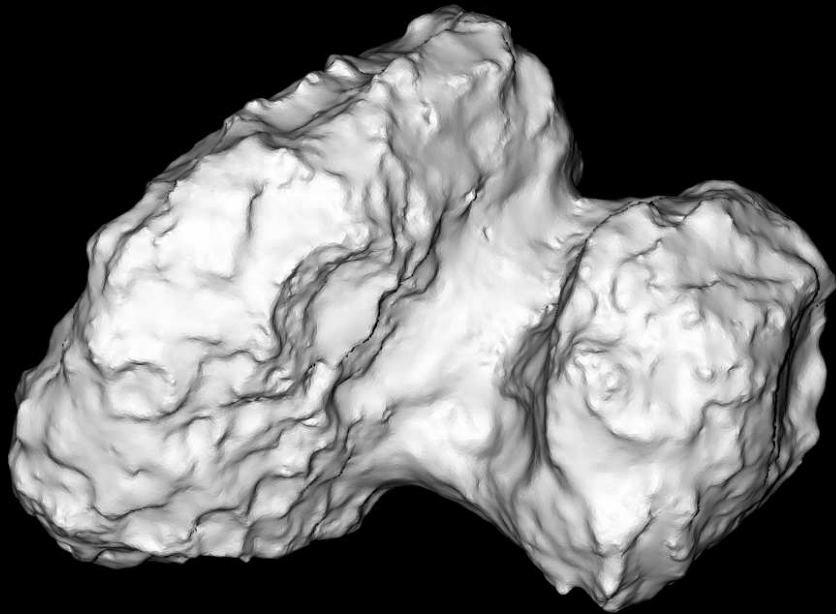
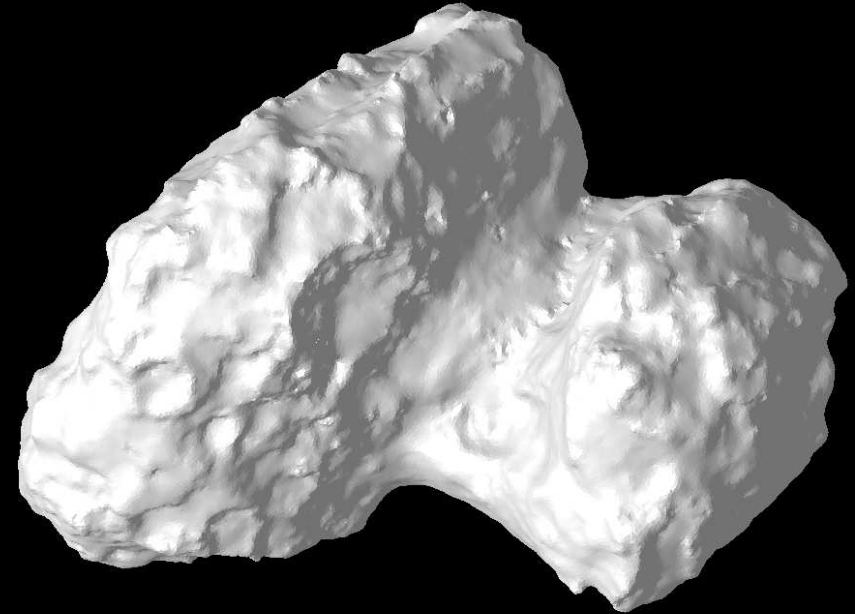


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

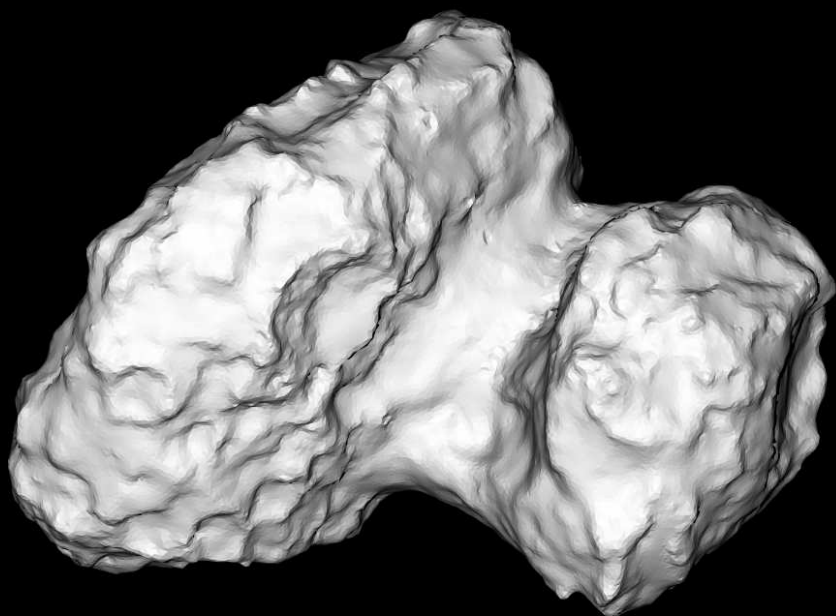
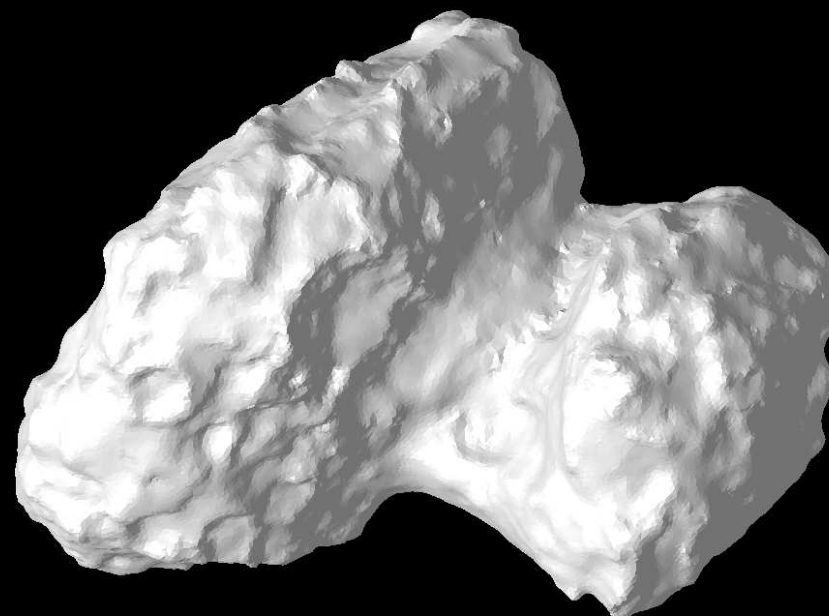


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

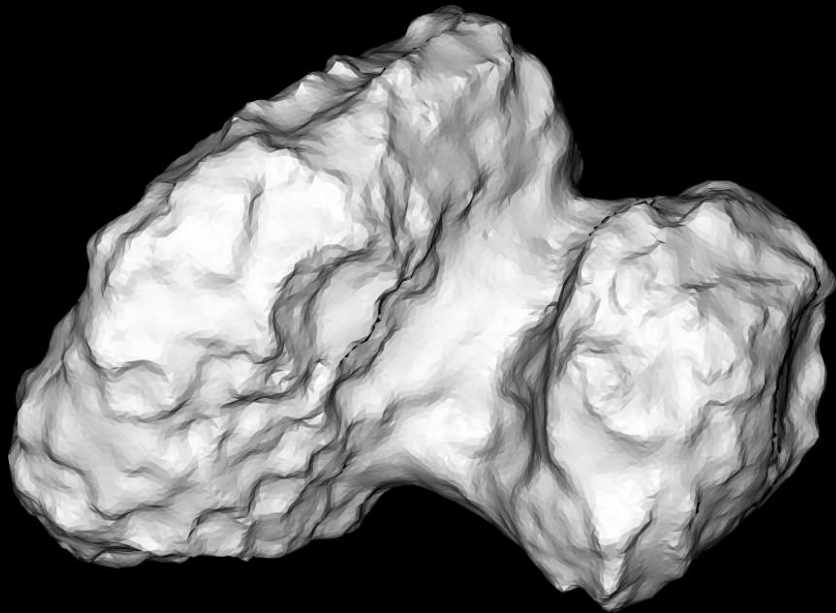
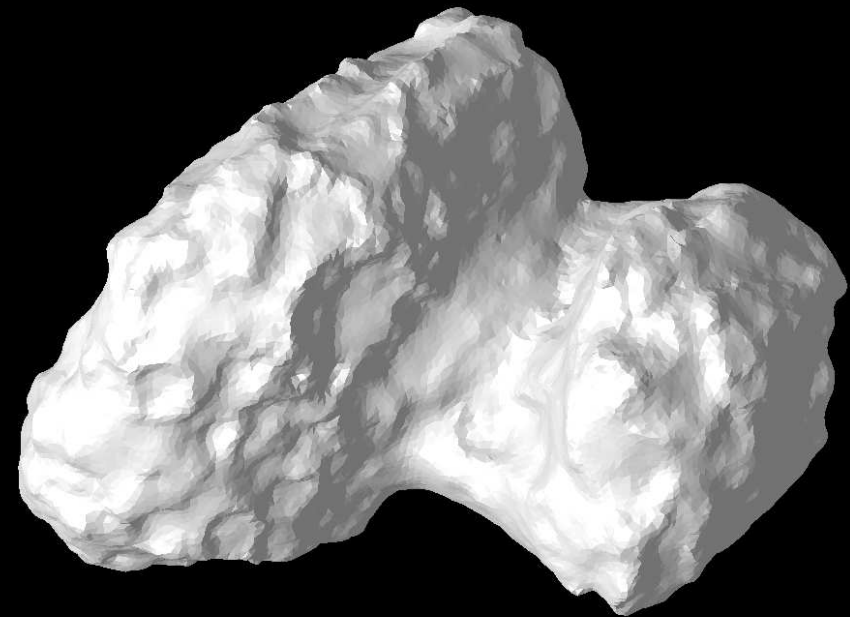


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

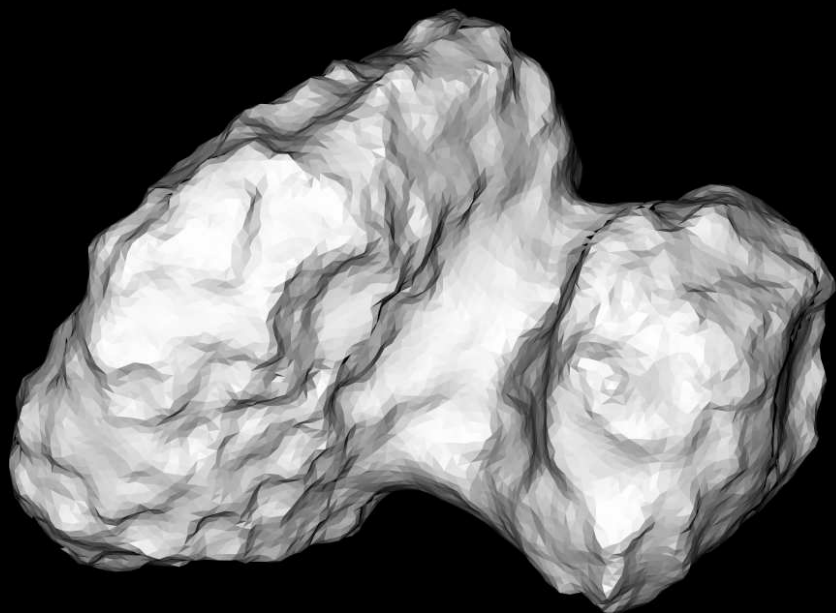
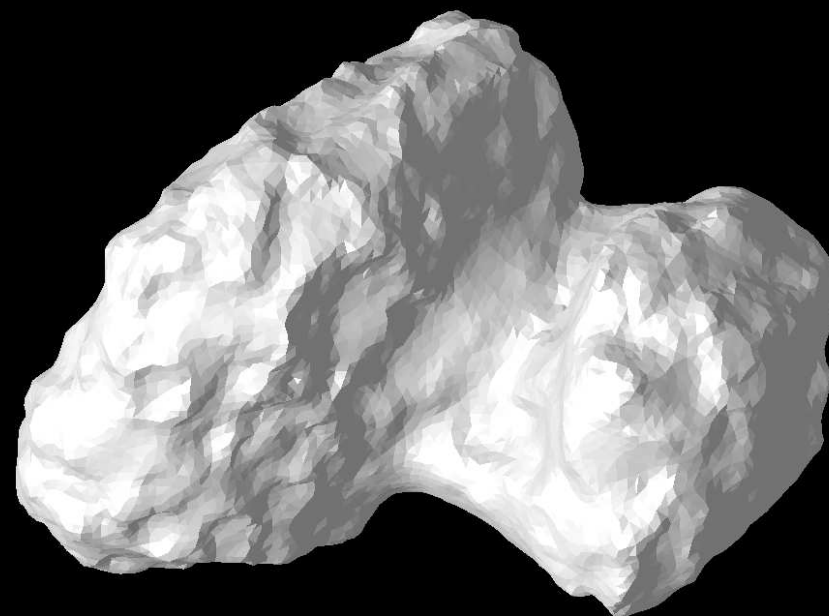


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

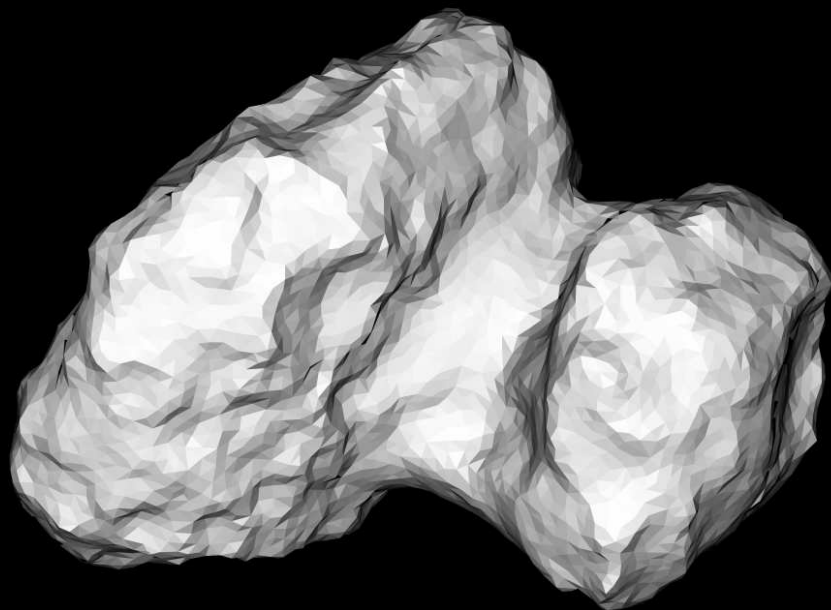
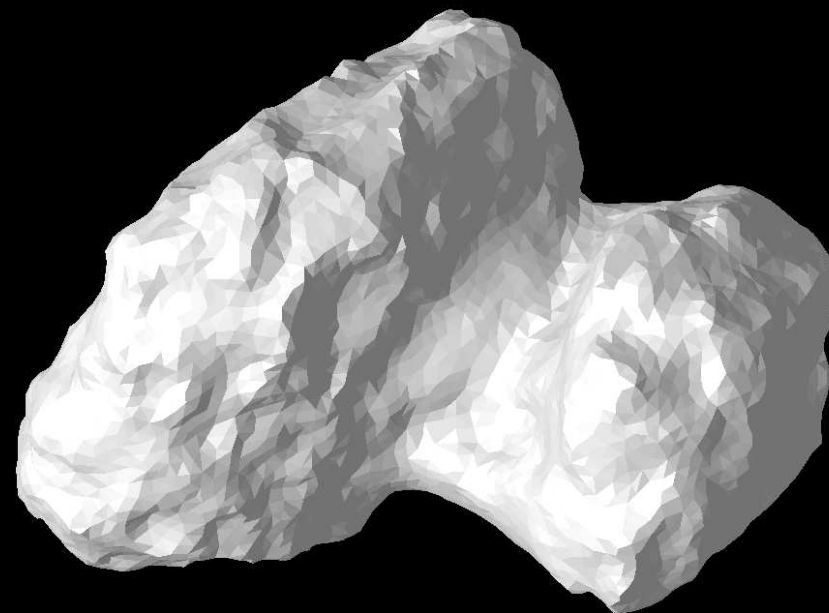


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

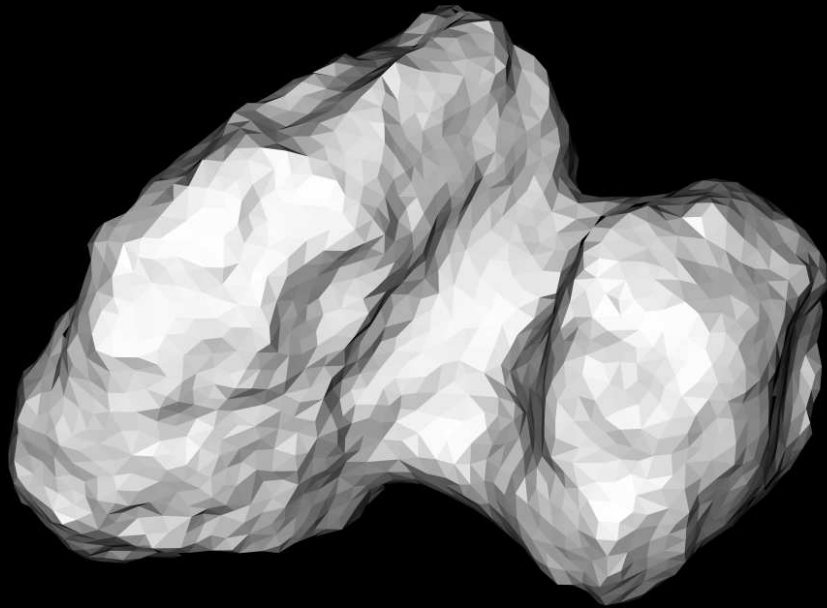
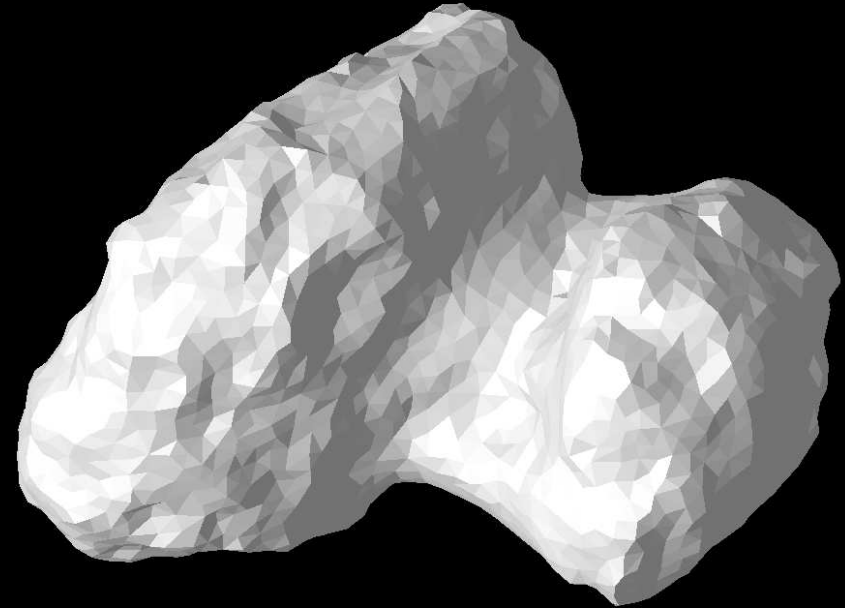


Image from data set

ro-c-multi-5-67p-shape-v2.0



Rendered

orthographic projection

- The preview images for different resolutions are consistent with the plate shape models.

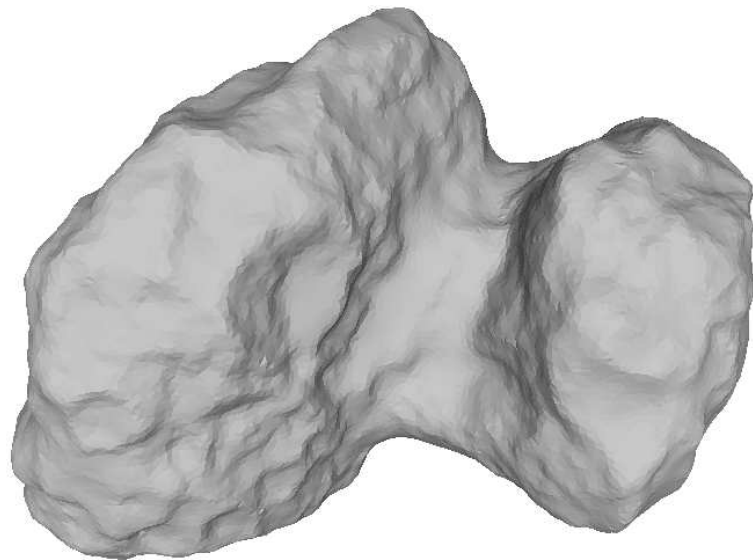
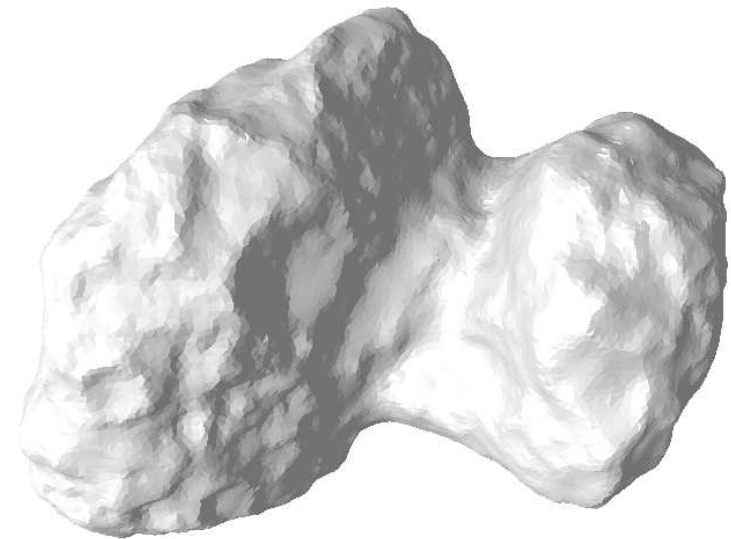


Image from data set

ro-c-osinac_osiwac-5-67p-shape-v1.0



Rendered

Perspective projection

Distance 7.5 km

FOV 50°

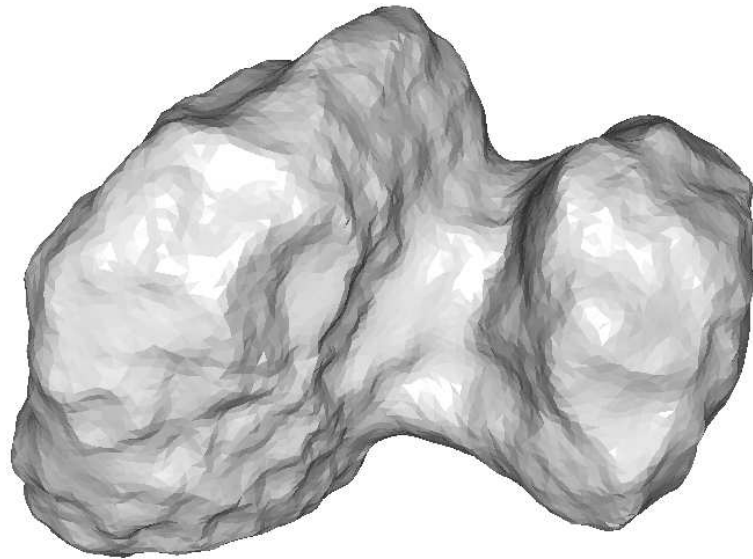
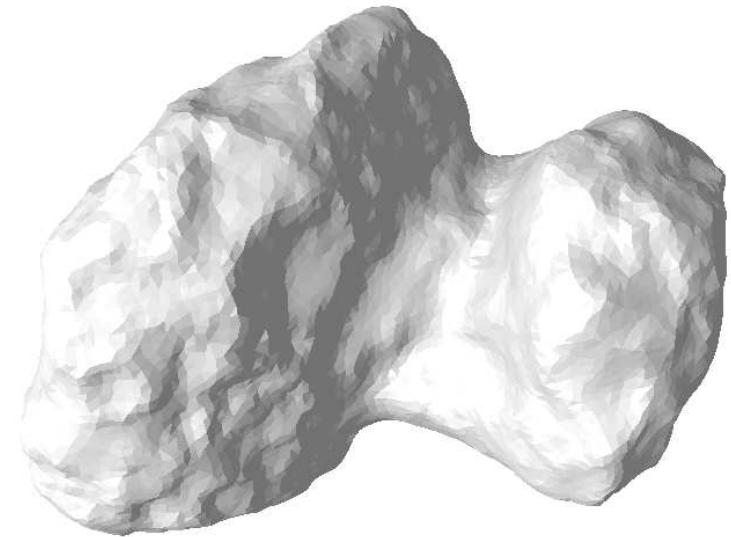


Image from data set

ro-c-osinac_osiwac-5-67p-shape-v1.0



Rendered

Perspective projection

Distance 7.5 km

FOV 50°

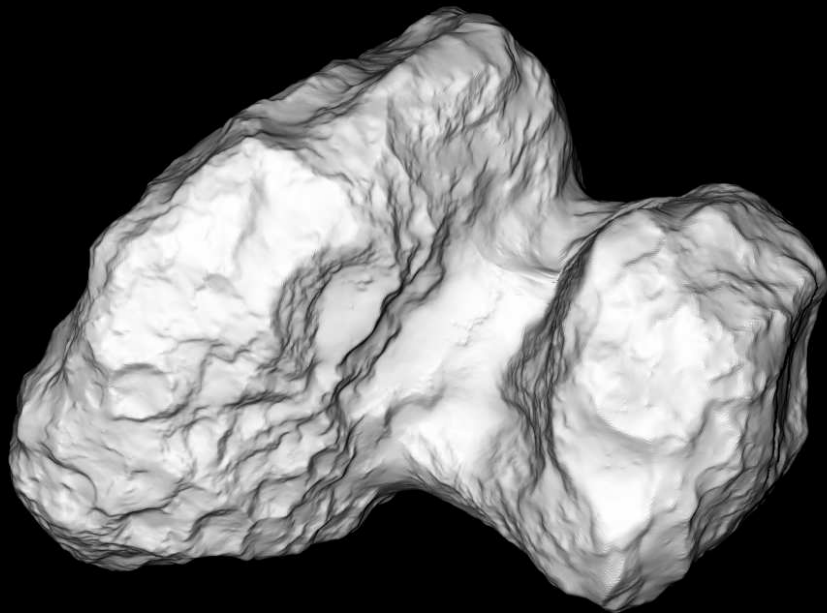
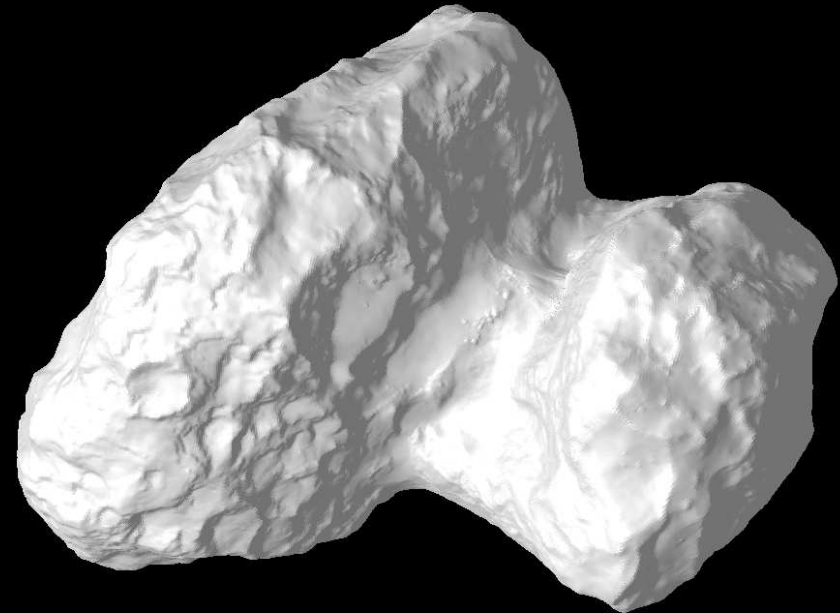


Image from data set

ro-c-multi-5-67p-shape-v2.0



Rendered

orthographic projection

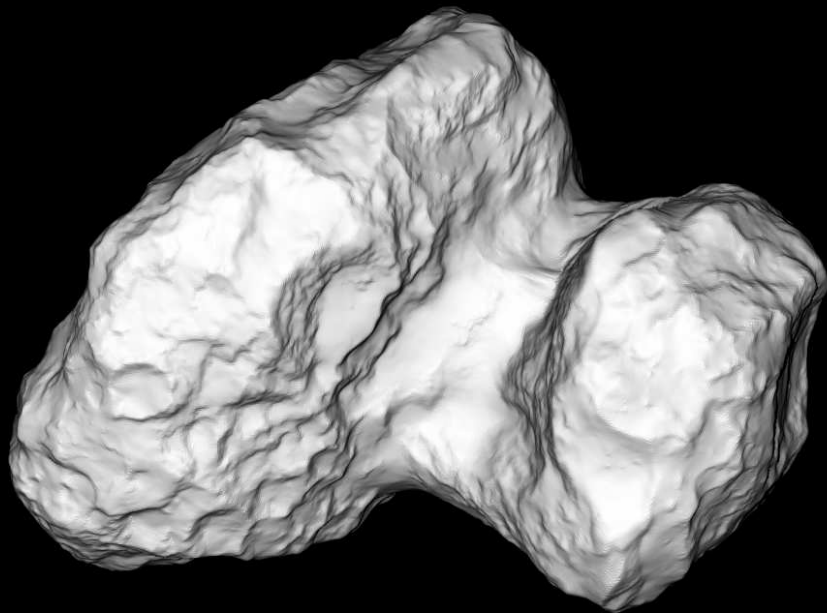
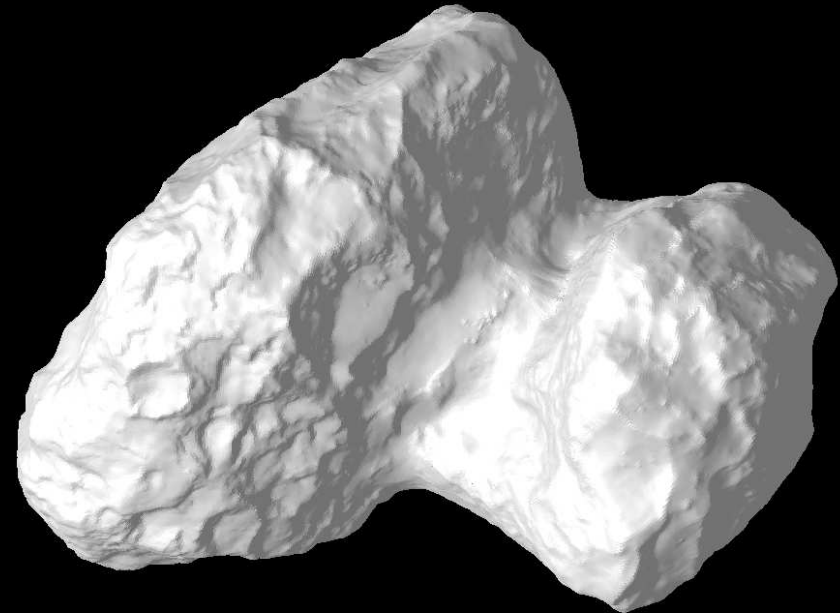


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

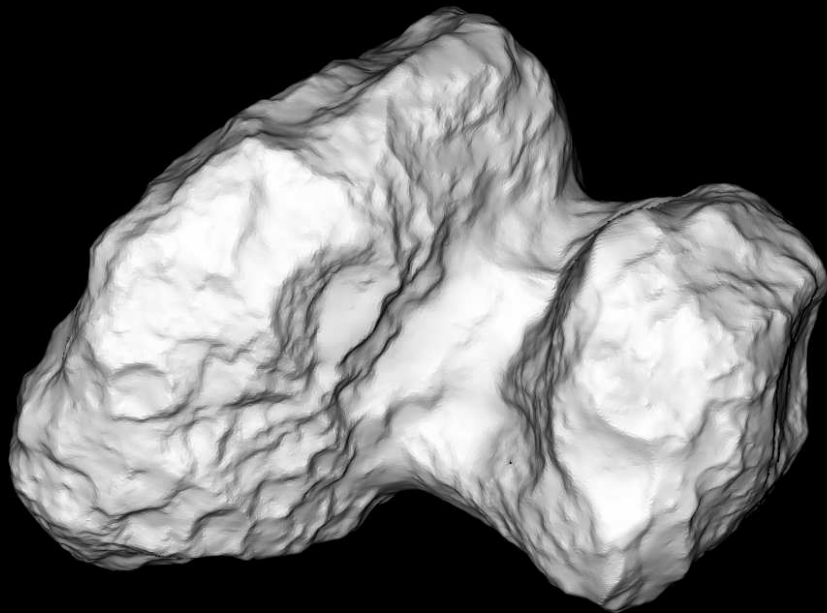
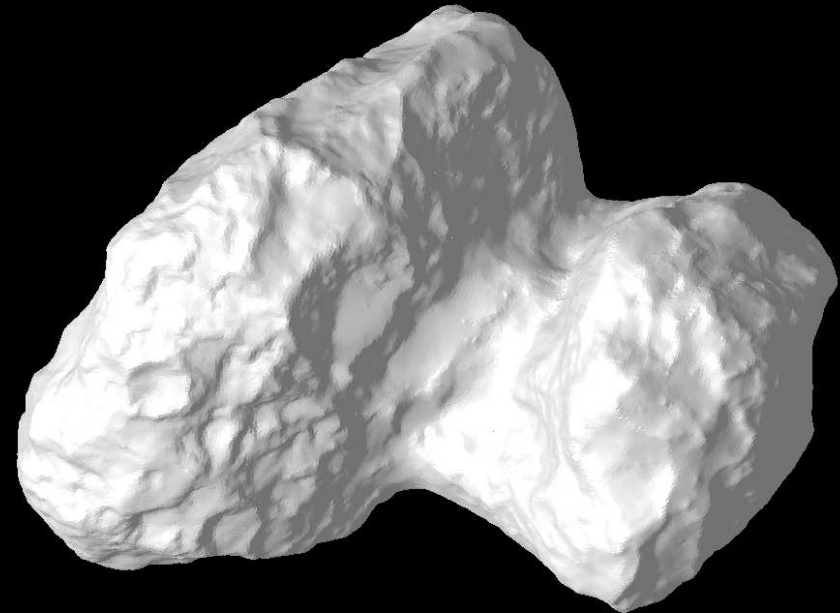


Image from data set

ro-c-multi-5-67p-shape-v2.0



Rendered

orthographic projection

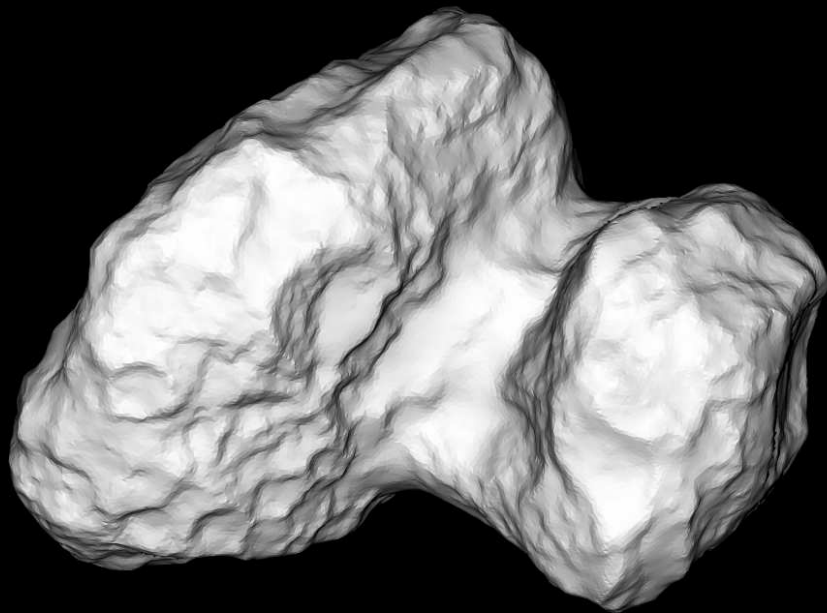
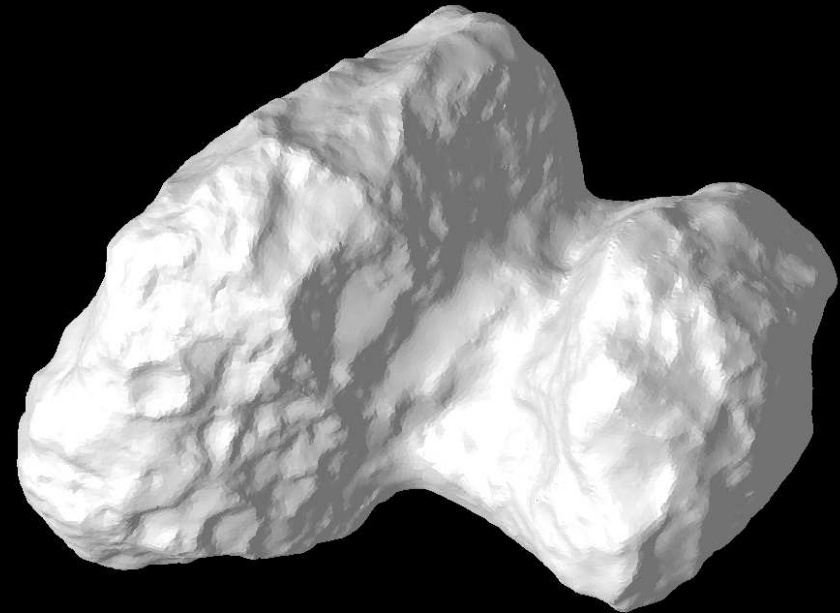


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

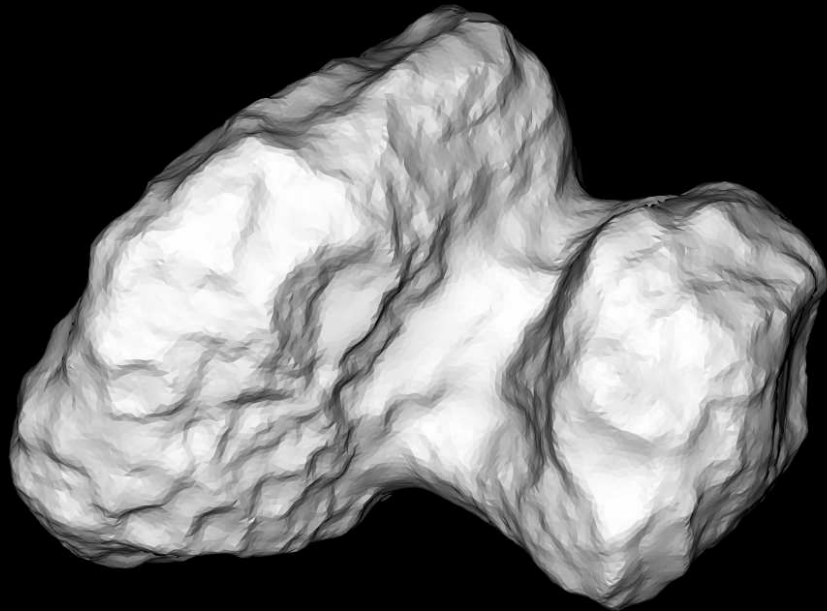
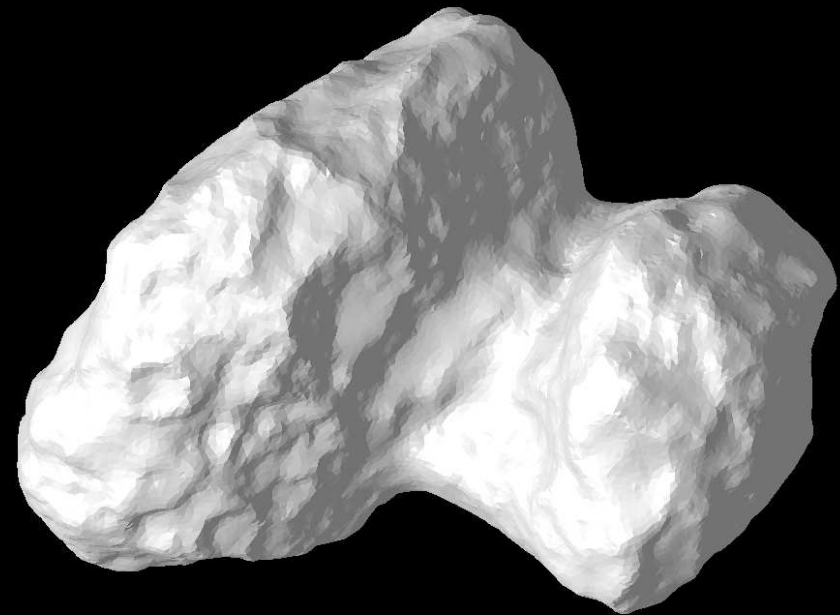


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

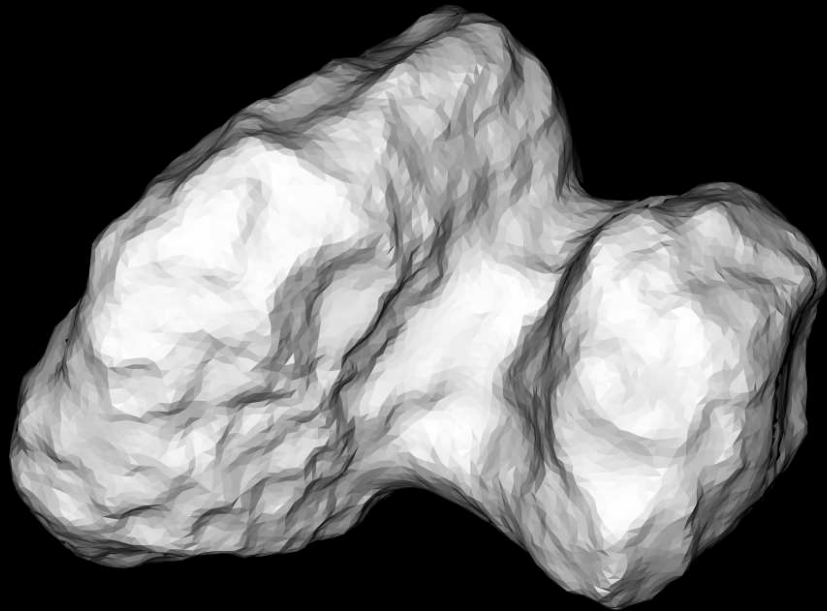
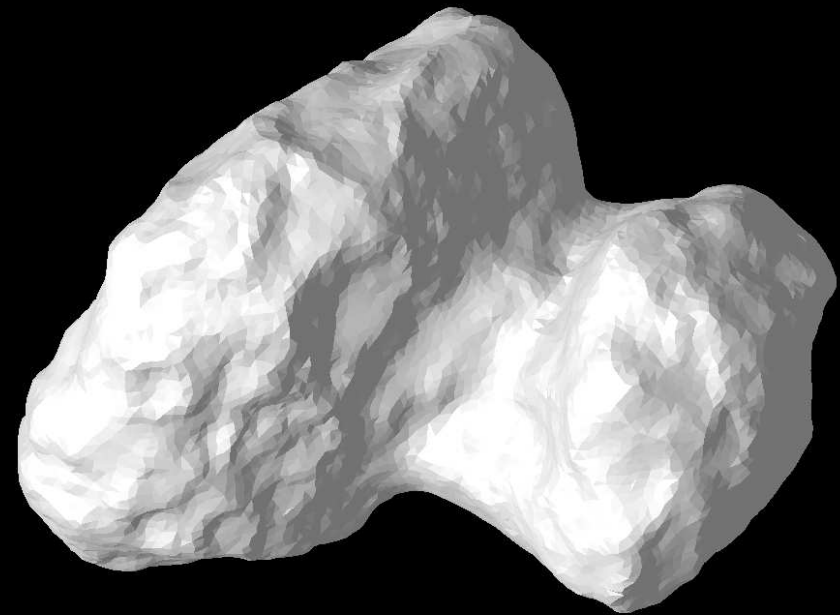


Image from data set

ro-c-multi-5-67p-shape-v2.0



Rendered

orthographic projection

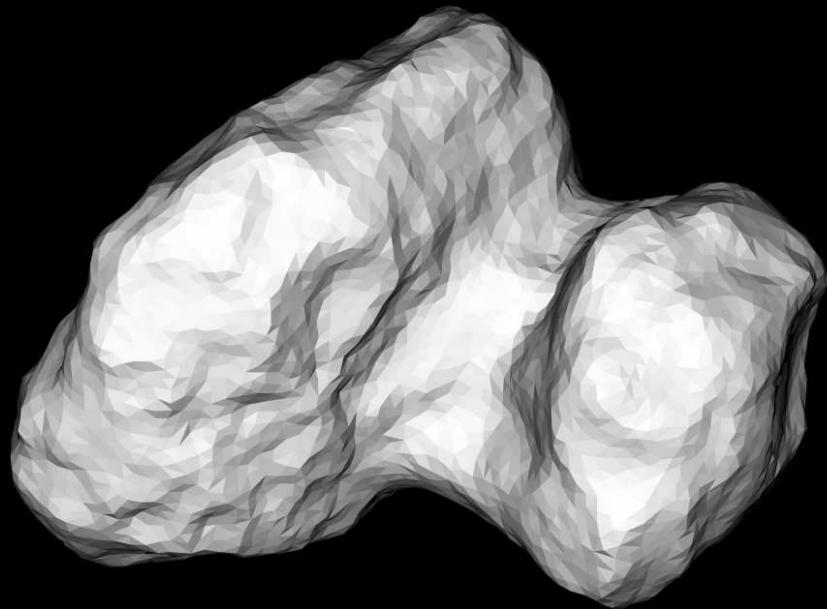
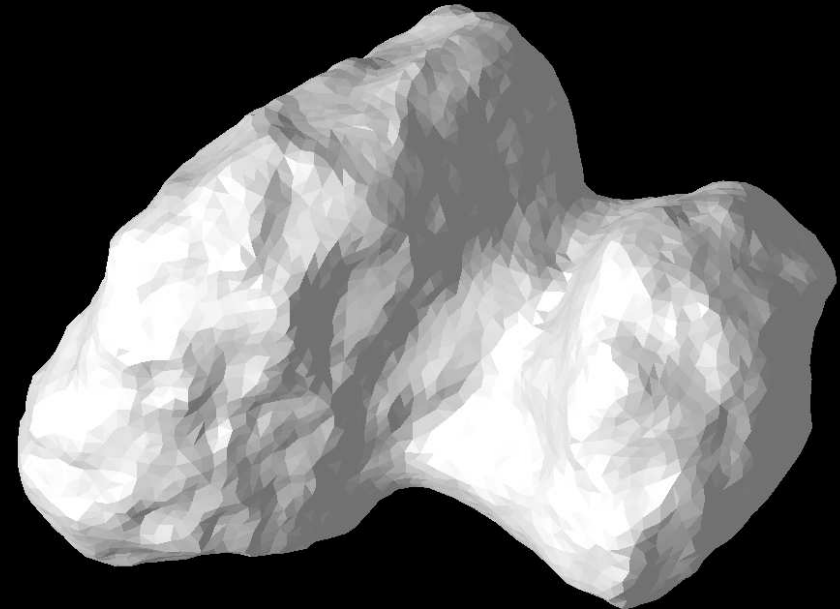


Image from data set
ro-c-multi-5-67p-shape-v2.0



Rendered
orthographic projection

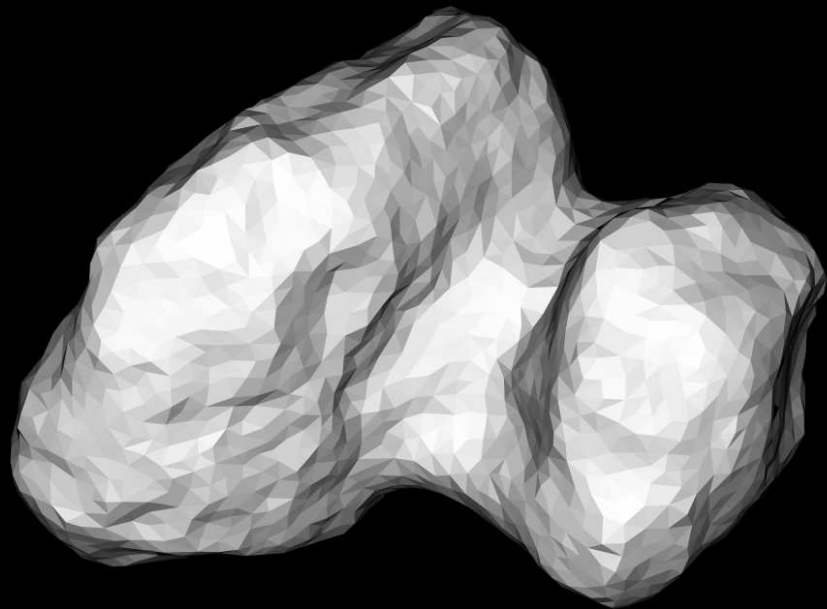
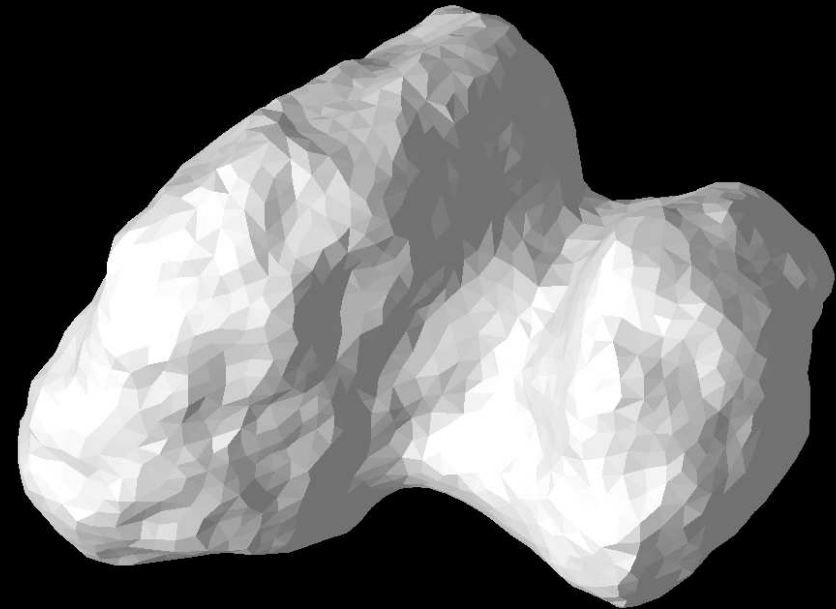


Image from data set

ro-c-multi-5-67p-shape-v2.0



Rendered

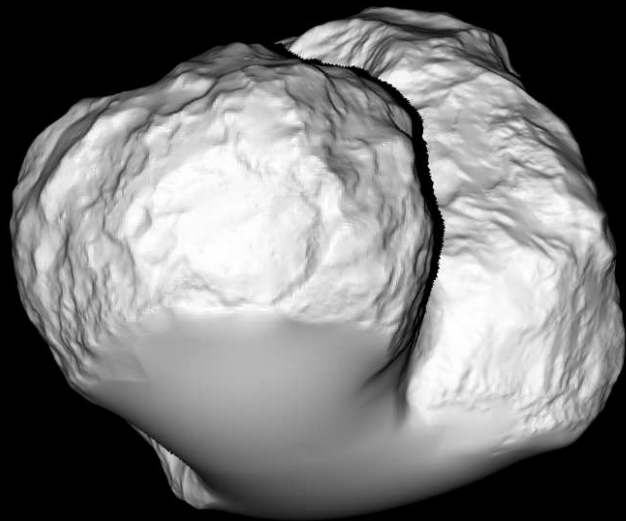
orthographic projection

- The preview images for different resolutions are consistent with the plate shape models.

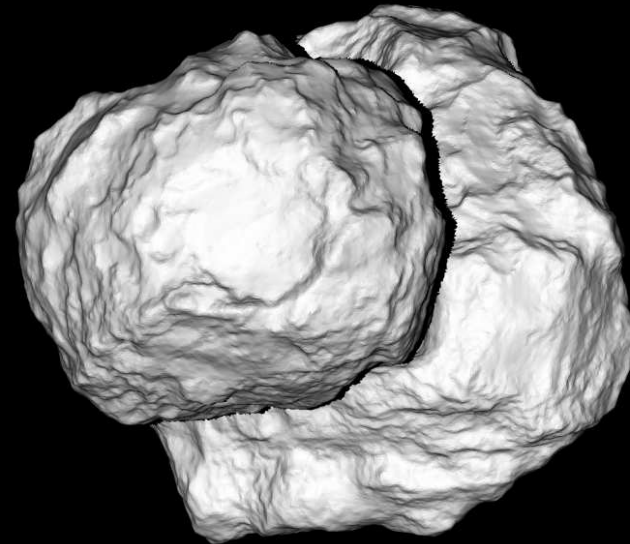
3

Consistency between different shape models

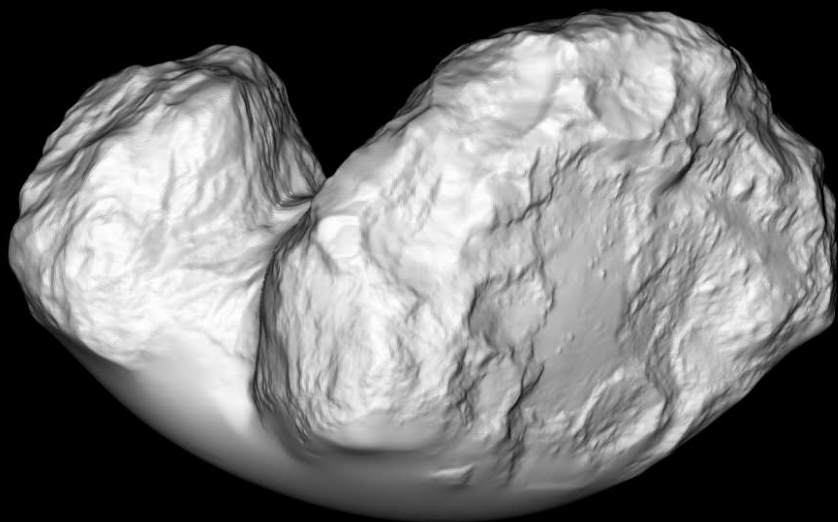
- My comparison with NAVCAM images comprised only northern hemisphere views, now I want to look from all directions.
- I am convinced that the provided preview images are correct, thus here I just use these instead of rendering my own ones.



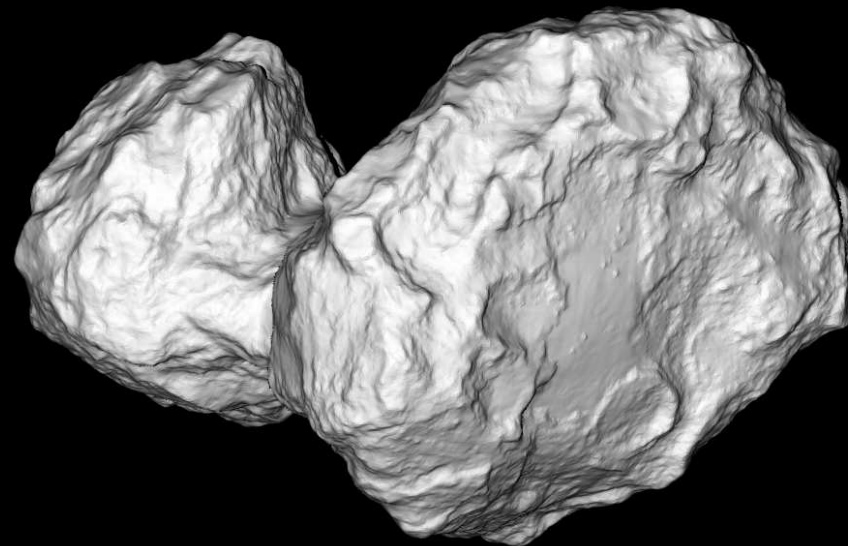
SHAP2



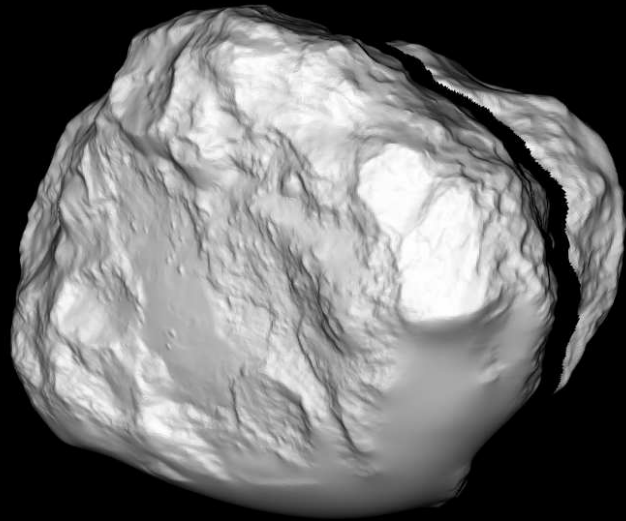
SHAP5



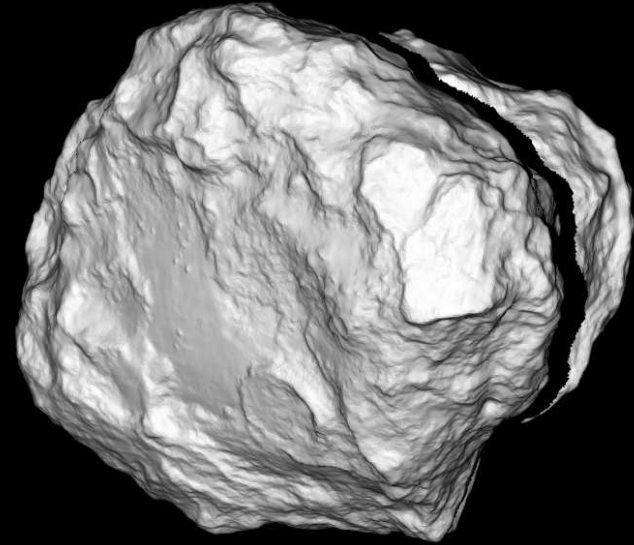
SHAP2



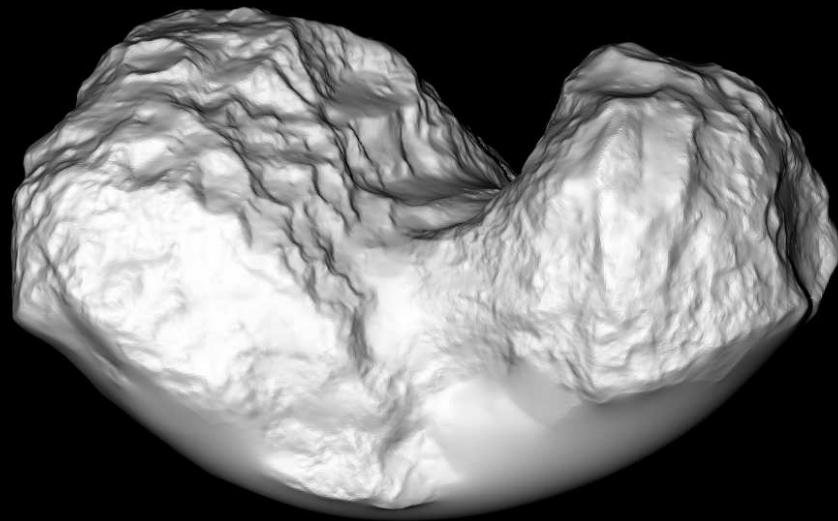
SHAP5



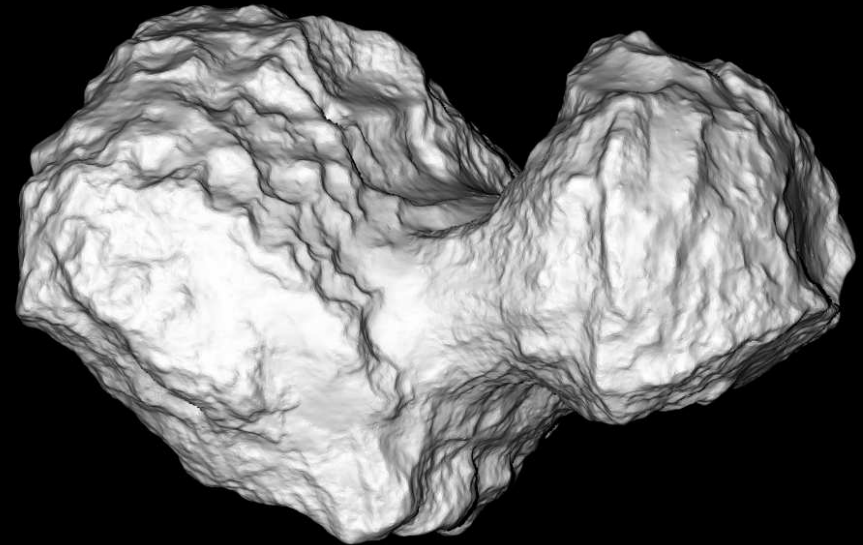
SHAP2



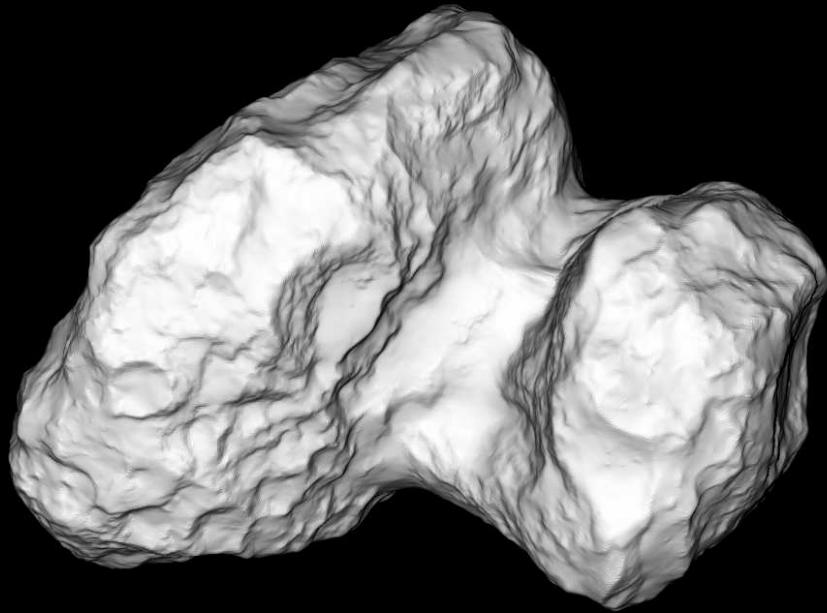
SHAP5



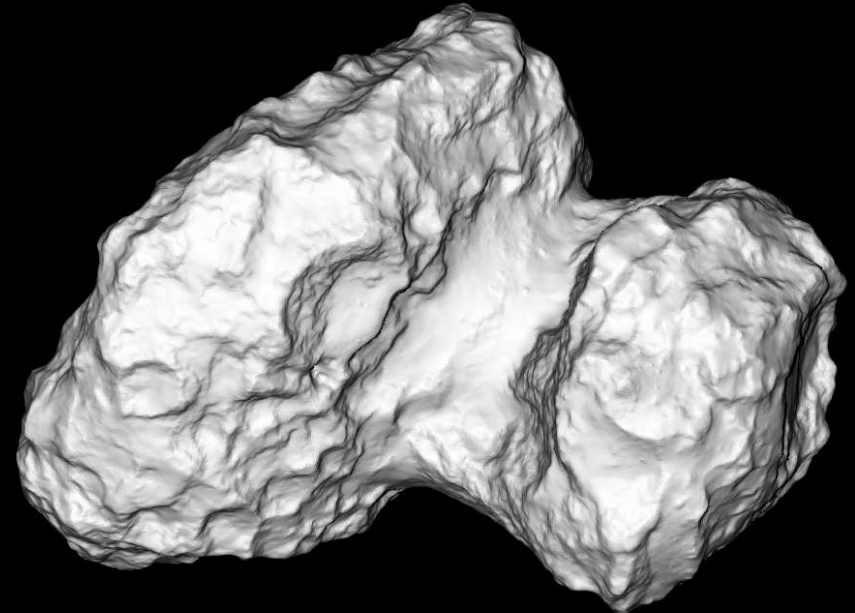
SHAP2



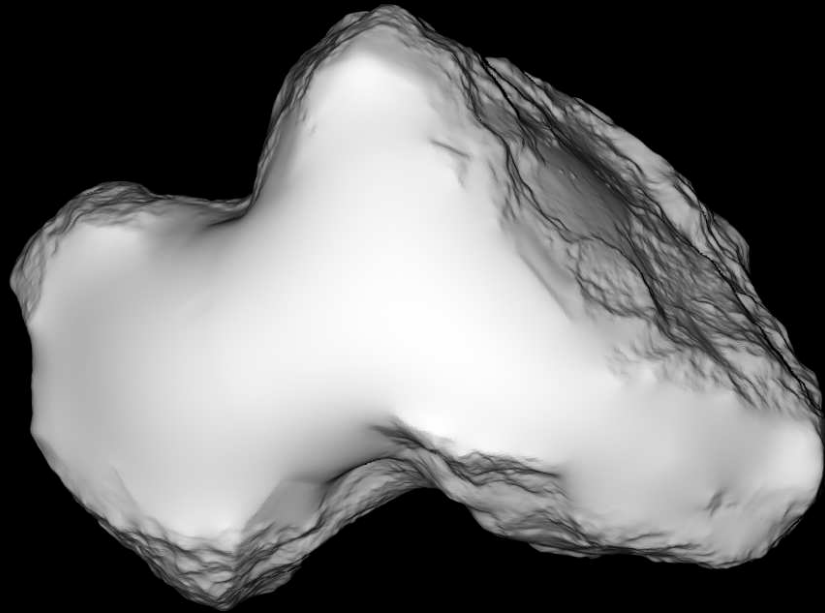
SHAP5



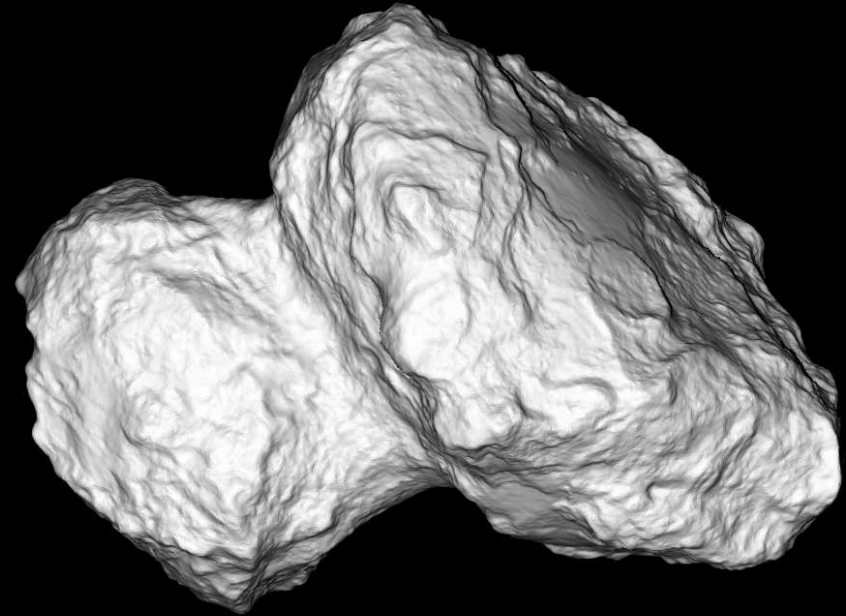
SHAP2



SHAP5

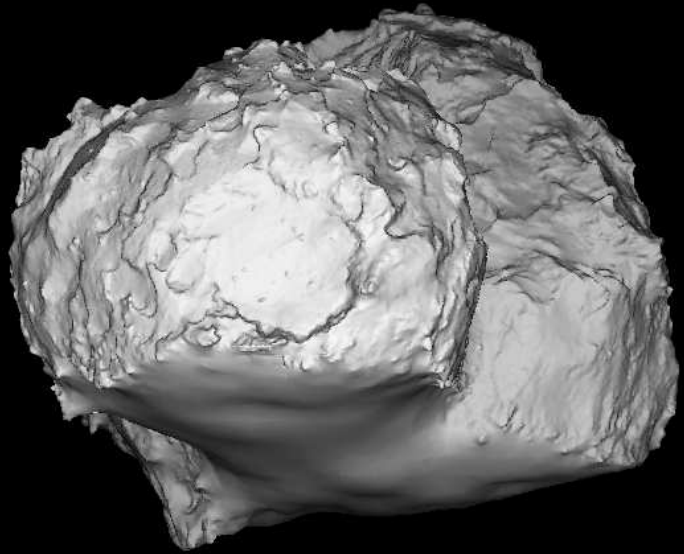


SHAP2

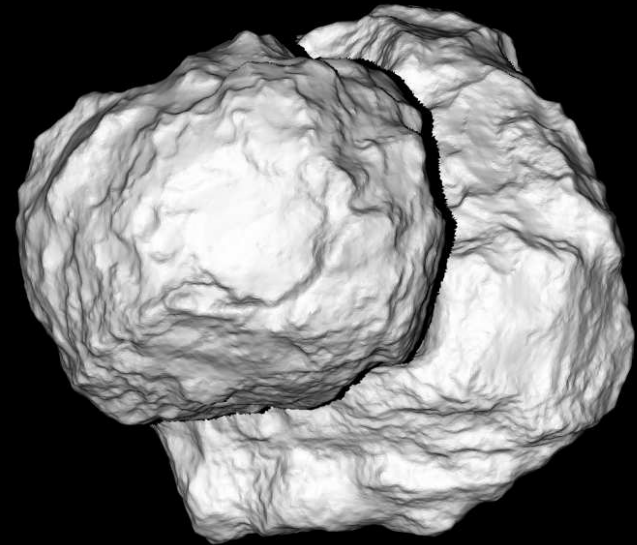


SHAP5

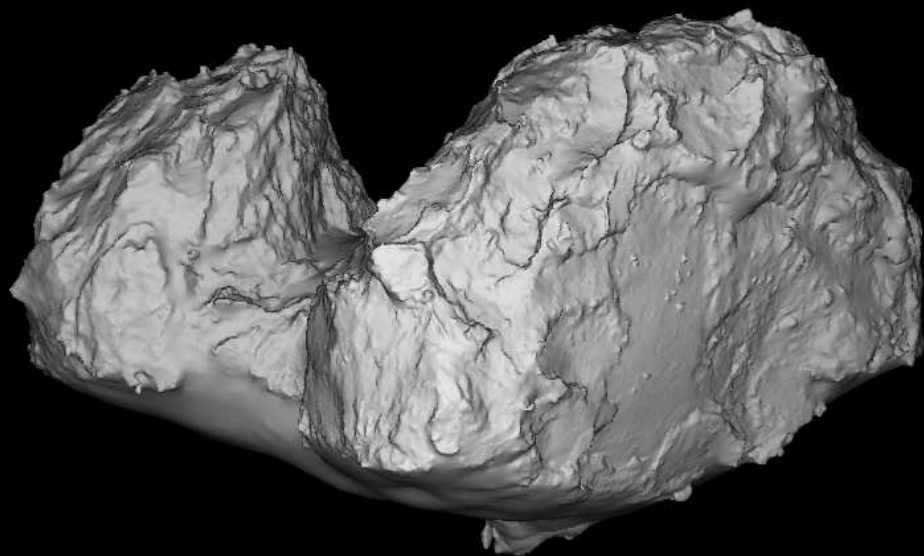
The shape models `spc_lam_psi/shap2` and `shap5` are consistent with each other.



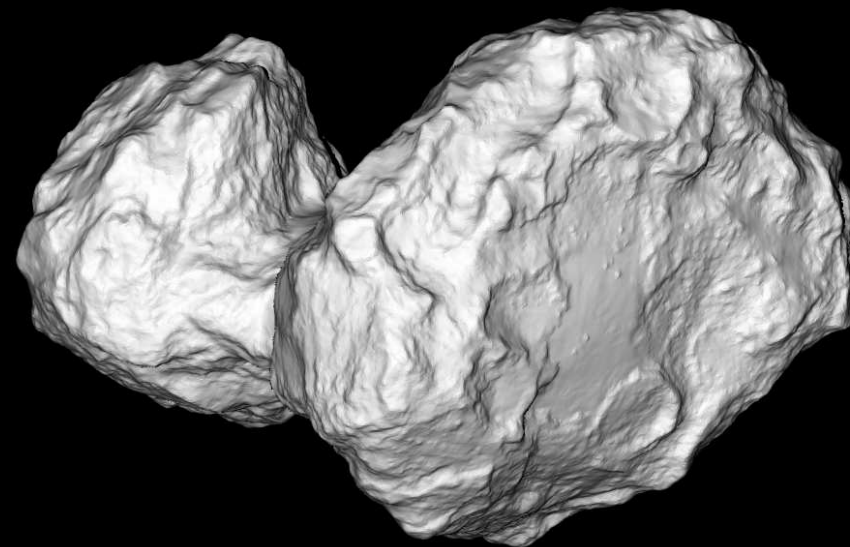
SHAP4s



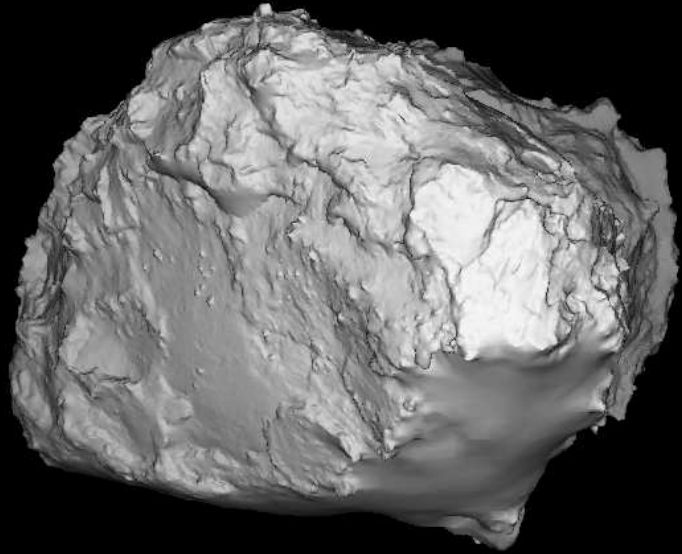
SHAP5



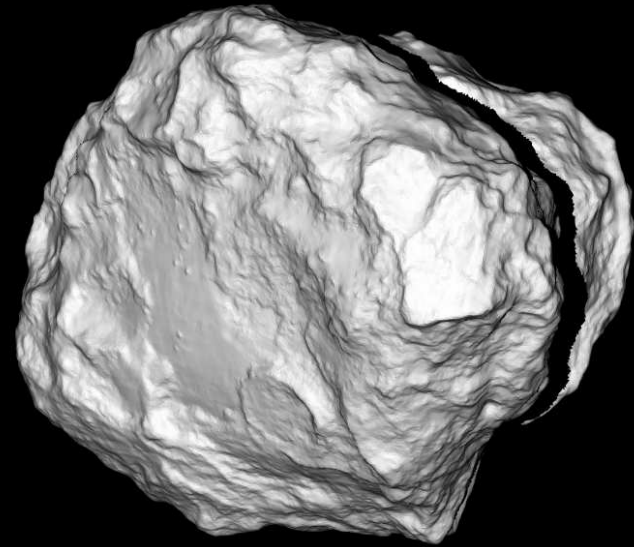
SHAP4s



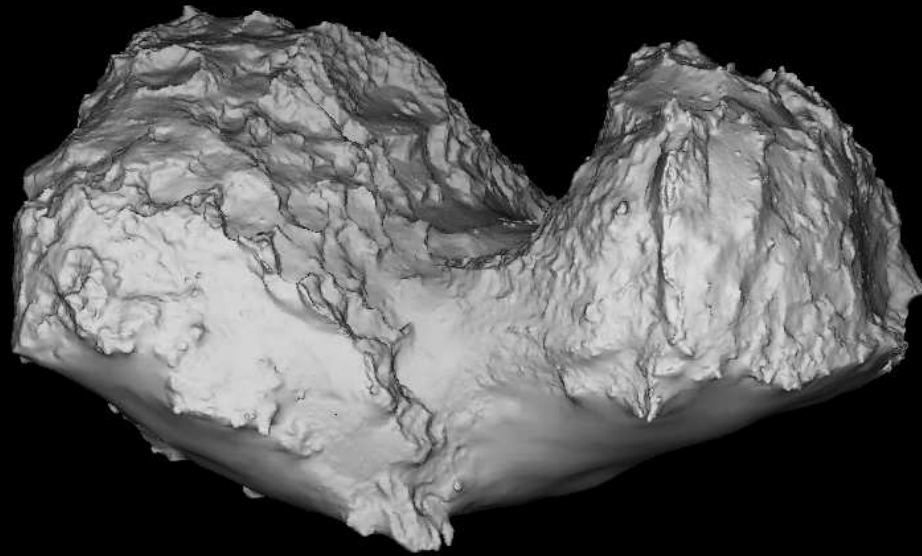
SHAP5



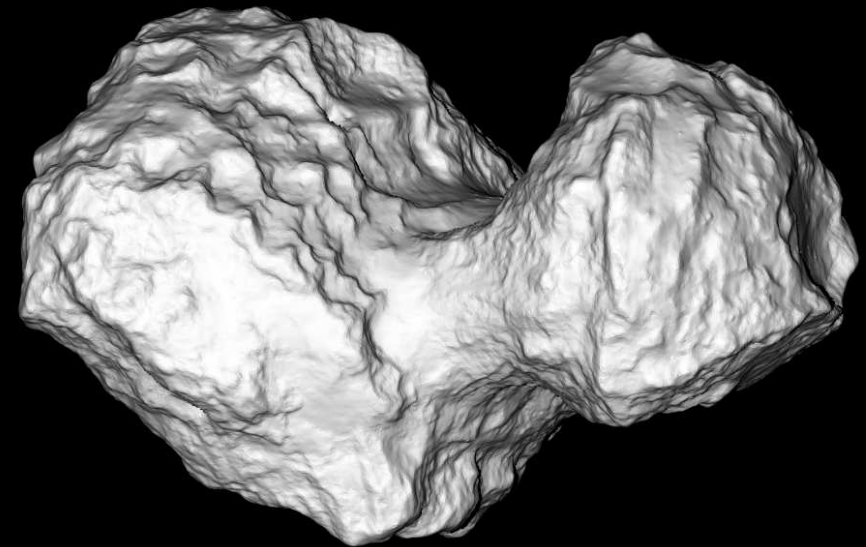
SHAP4s



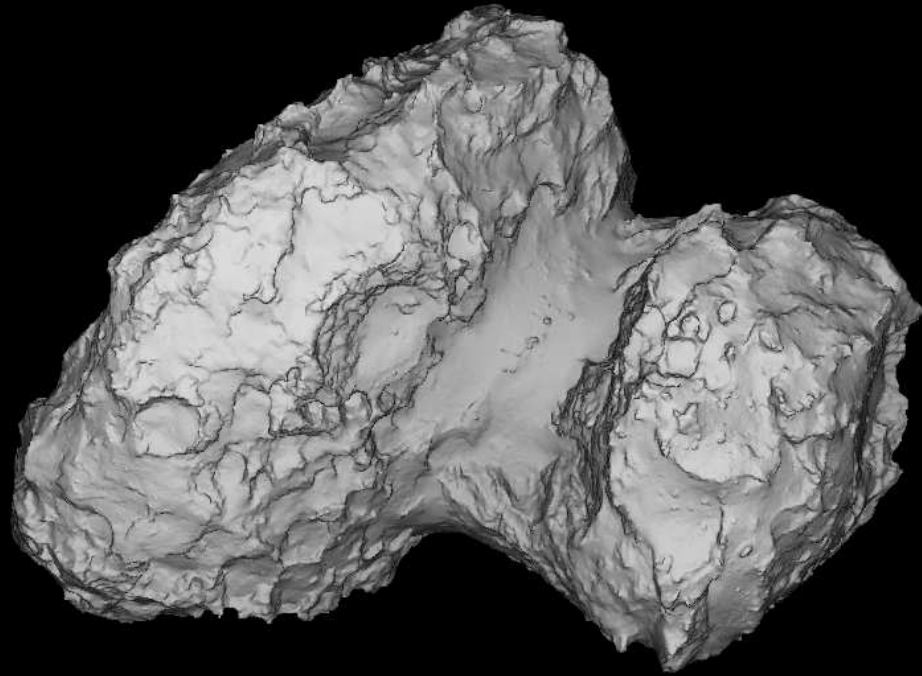
SHAP5



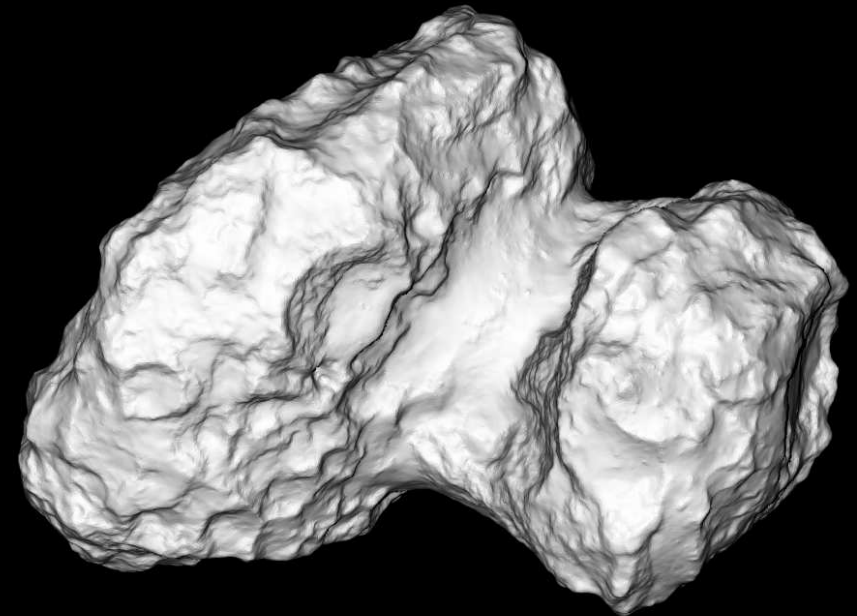
SHAP4s



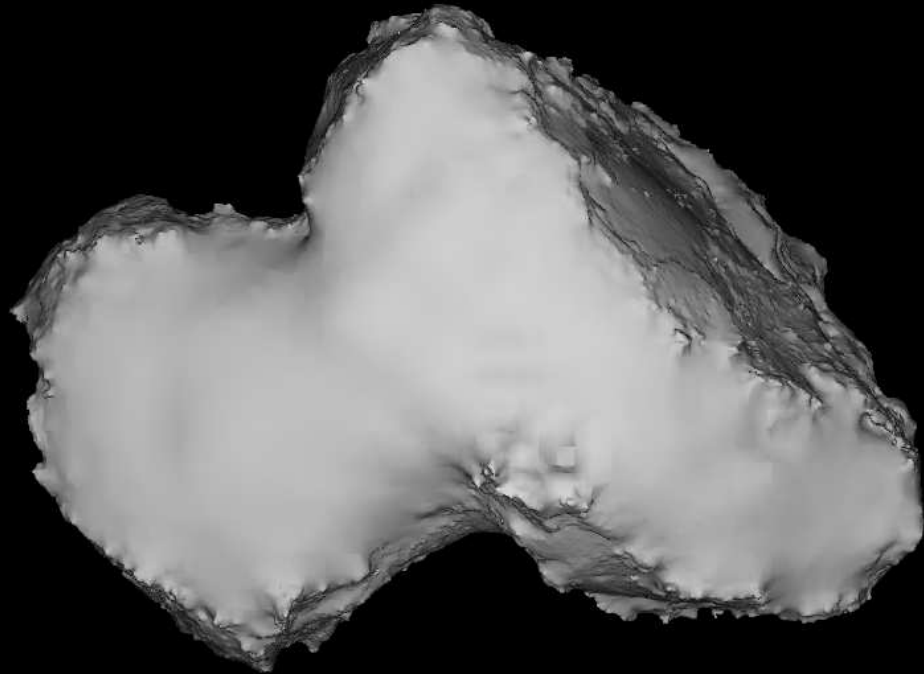
SHAP5



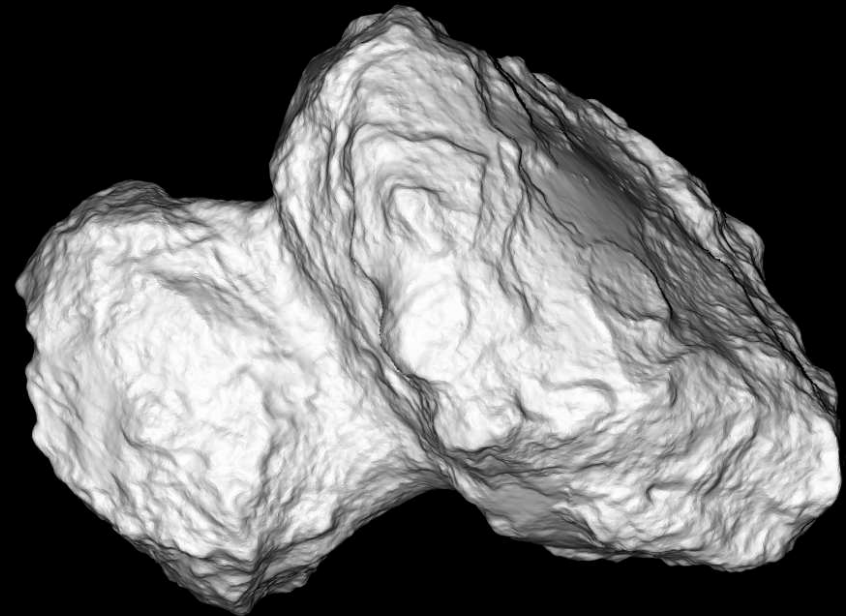
SHAP4s



SHAP5



SHAP4s



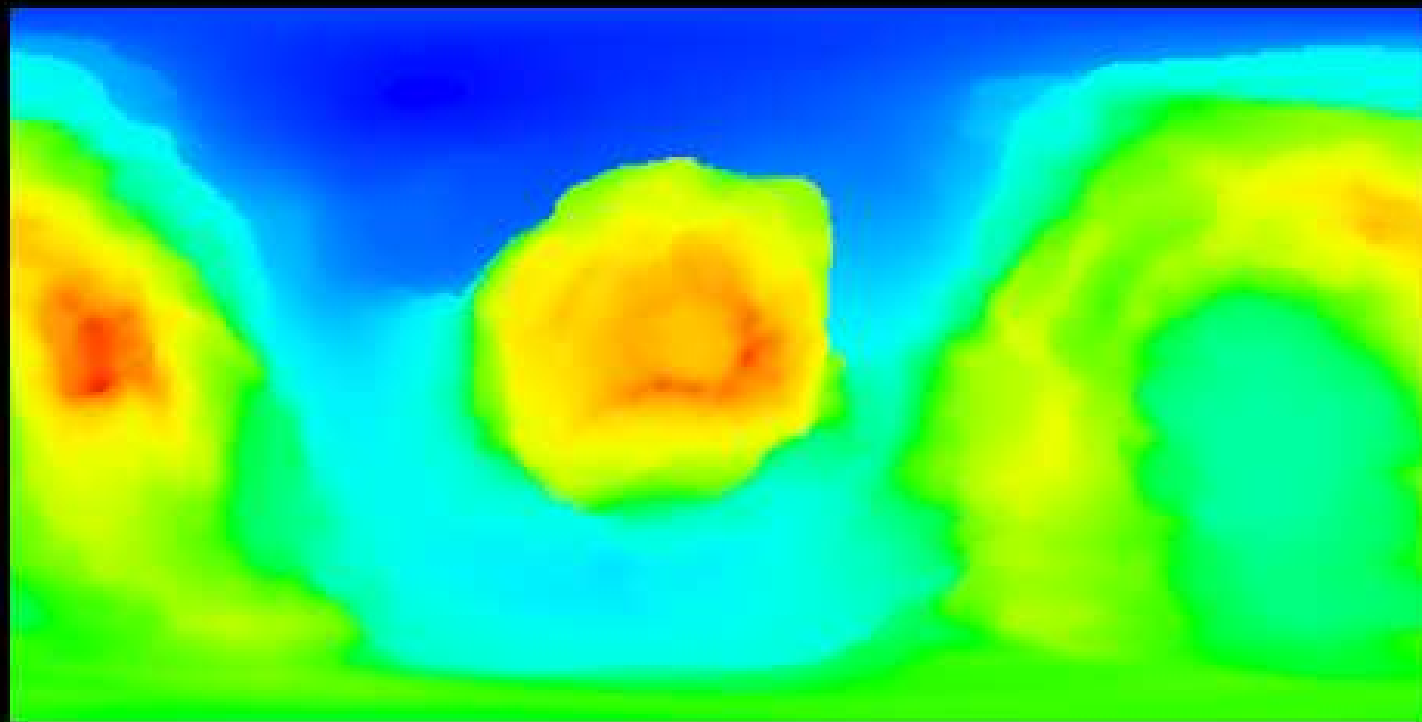
SHAP5

The shape models `spg_dlr/shap4s` and `spc_lam_psi/shap5` are consistent with each other.

4

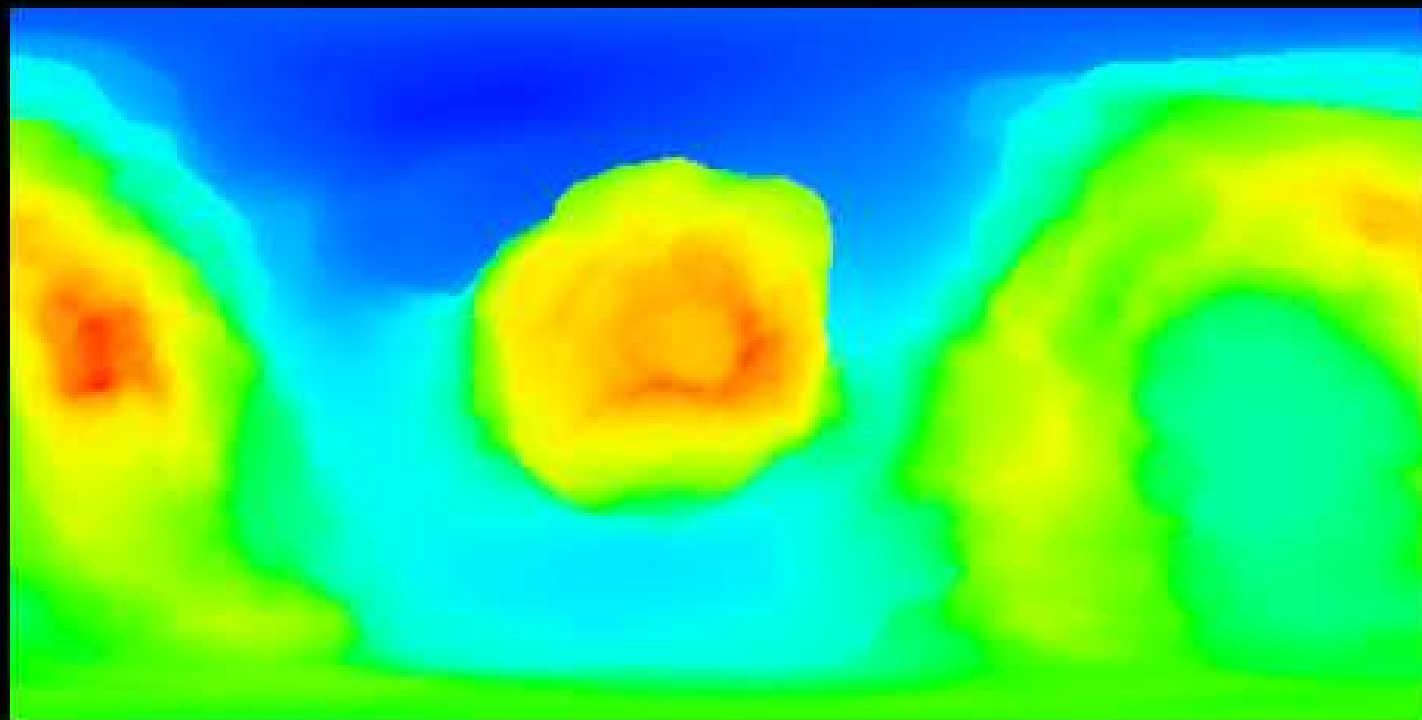
Quantitative comparison of different shape models

Simple Cylindrical projection



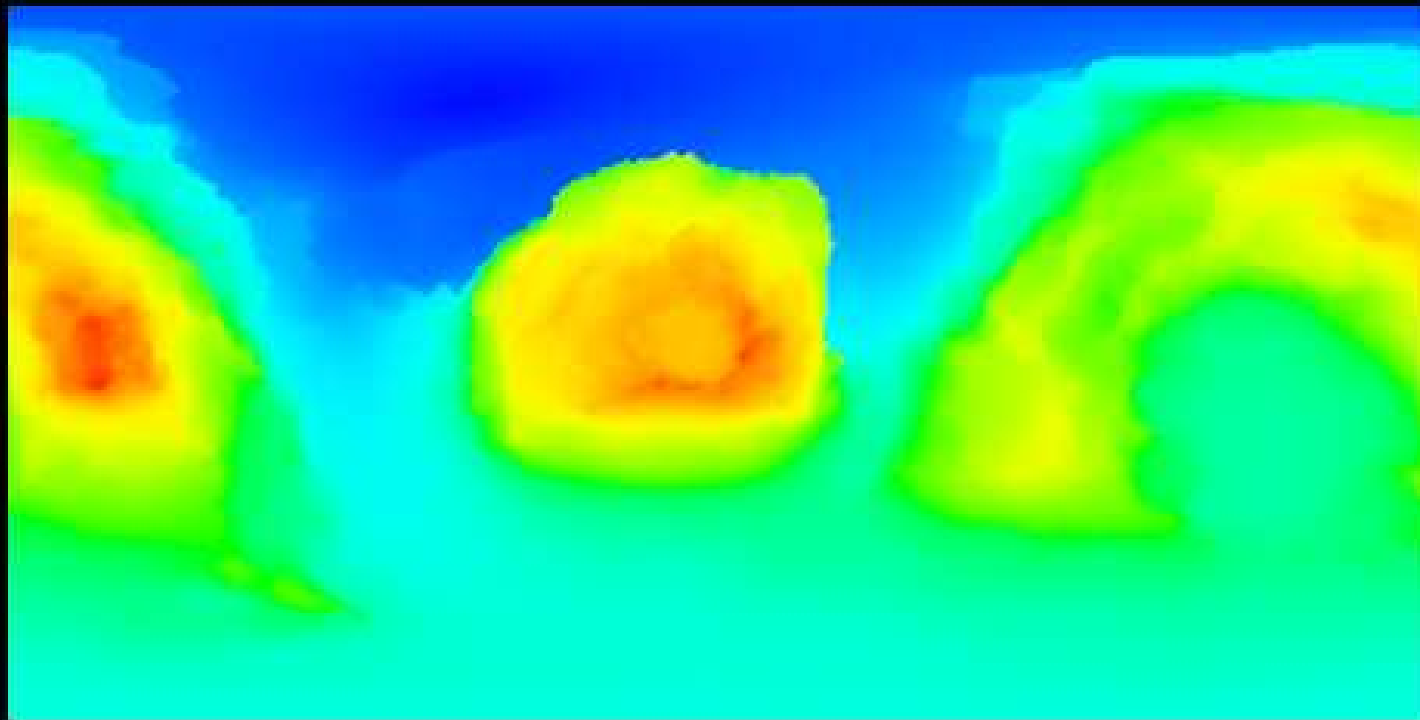
cs hp_dv_130

Simple Cylindrical projection



cg_spc_shap5

Simple Cylindrical projection



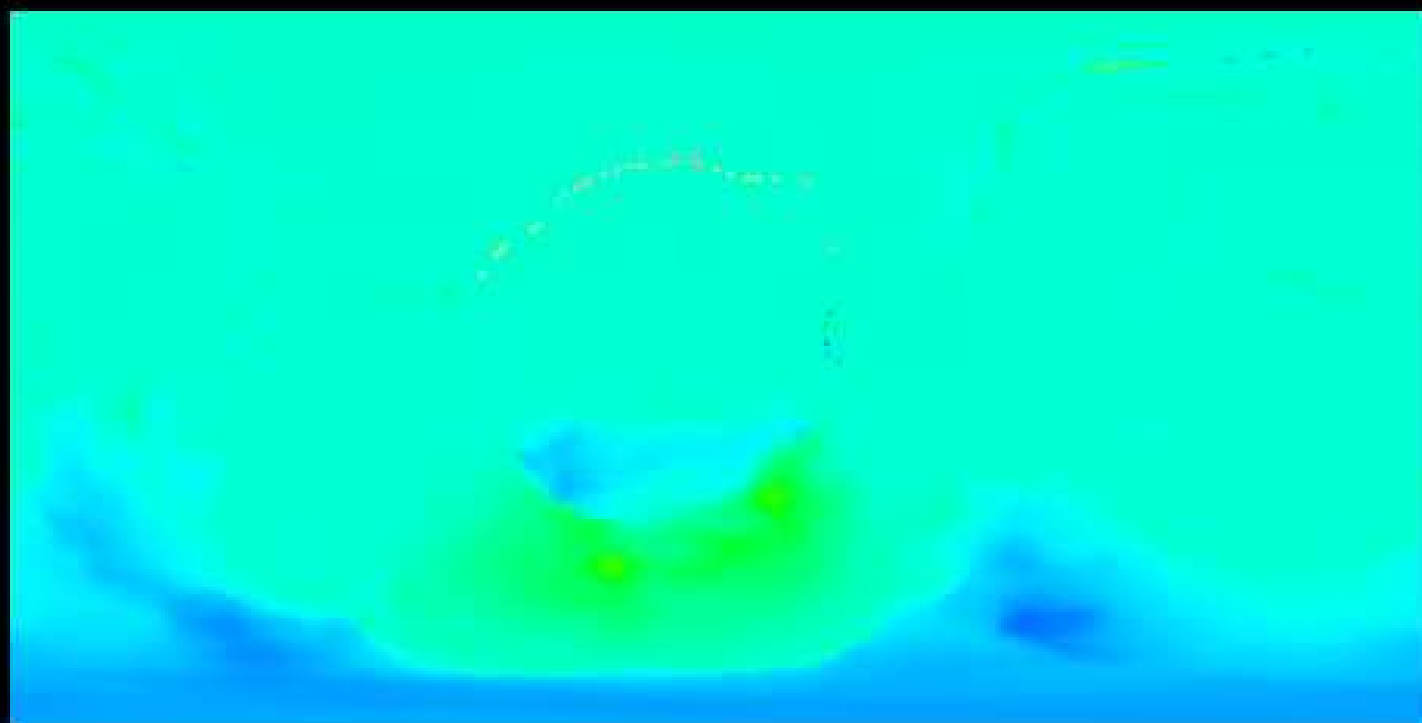
`cg_dlr_spg_shap4s`

Simple Cylindrical projection



cg_spc_shap5 — cshp_dv_130

Simple Cylindrical projection



Radius difference [km]

1.0

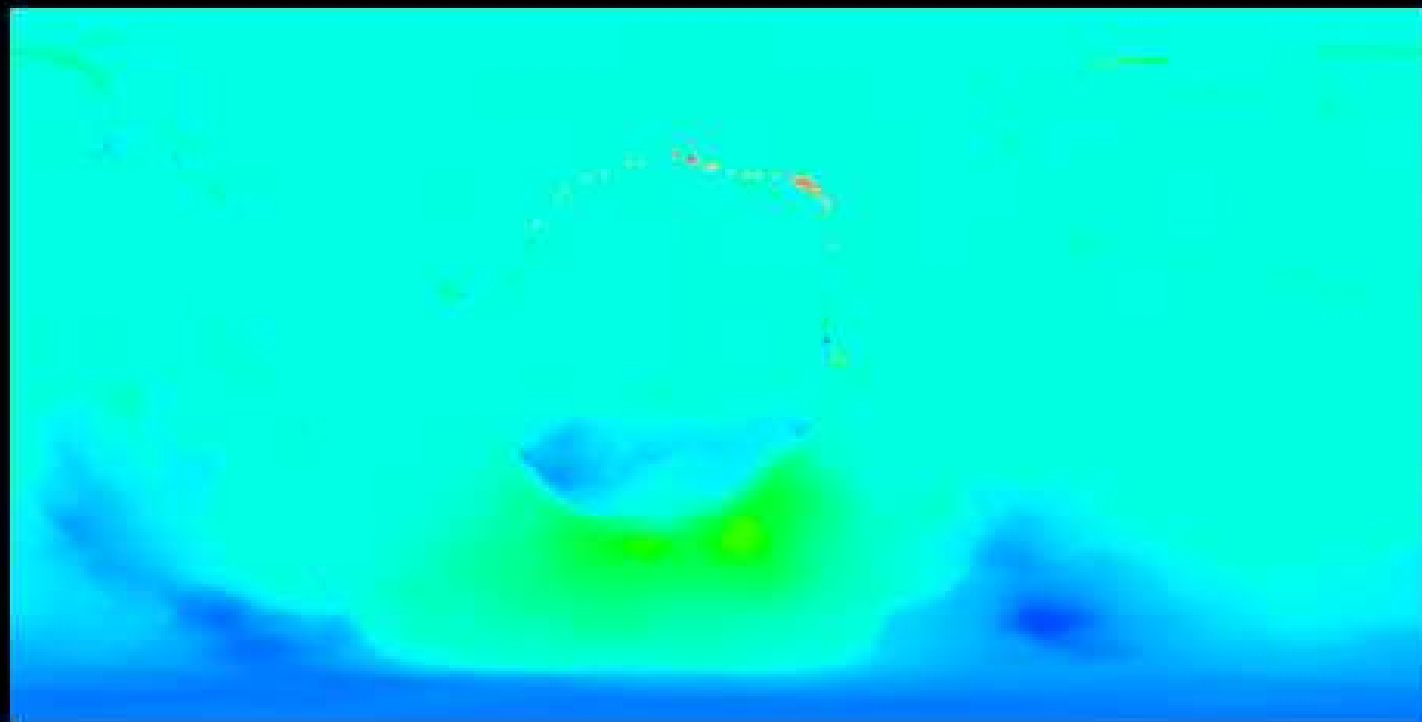
0.5

0.0

-0.5

`cg_dlr_spg_shap4s - cshp_dv_130`

Simple Cylindrical projection



Radius difference [km]

1.0
0.5
0.0
-0.5

`cg_dlr_spg_shap4s - cg_spc_shap5`

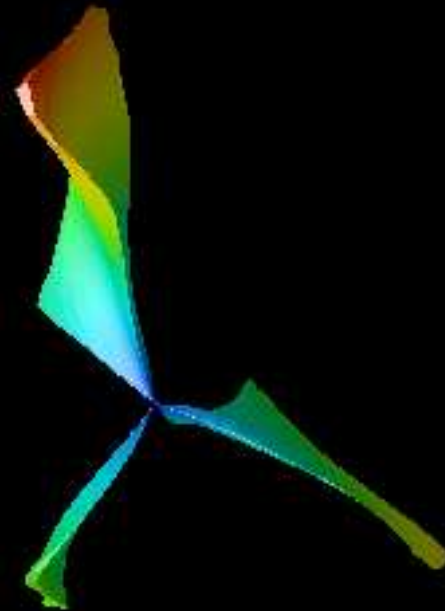
How to deal with overhangs?

- Because of the overhangs, small shape difference can cause large differences in elevation.
- It seems not to be straight forward to access the surface layers below an overhang with DSK functionality.
- Isn't there a better way of mapping such an irregular body?
 - The Kohonen map, a type of self-organizing neural network.

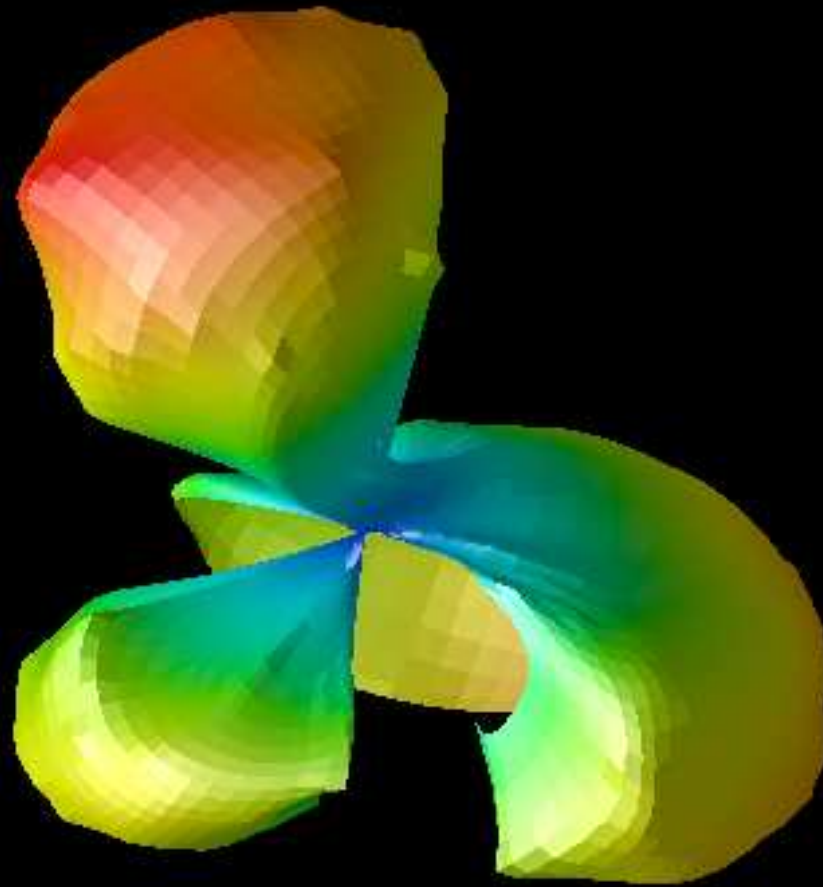
Iterative adaption of the Kohonen map



10 iterations



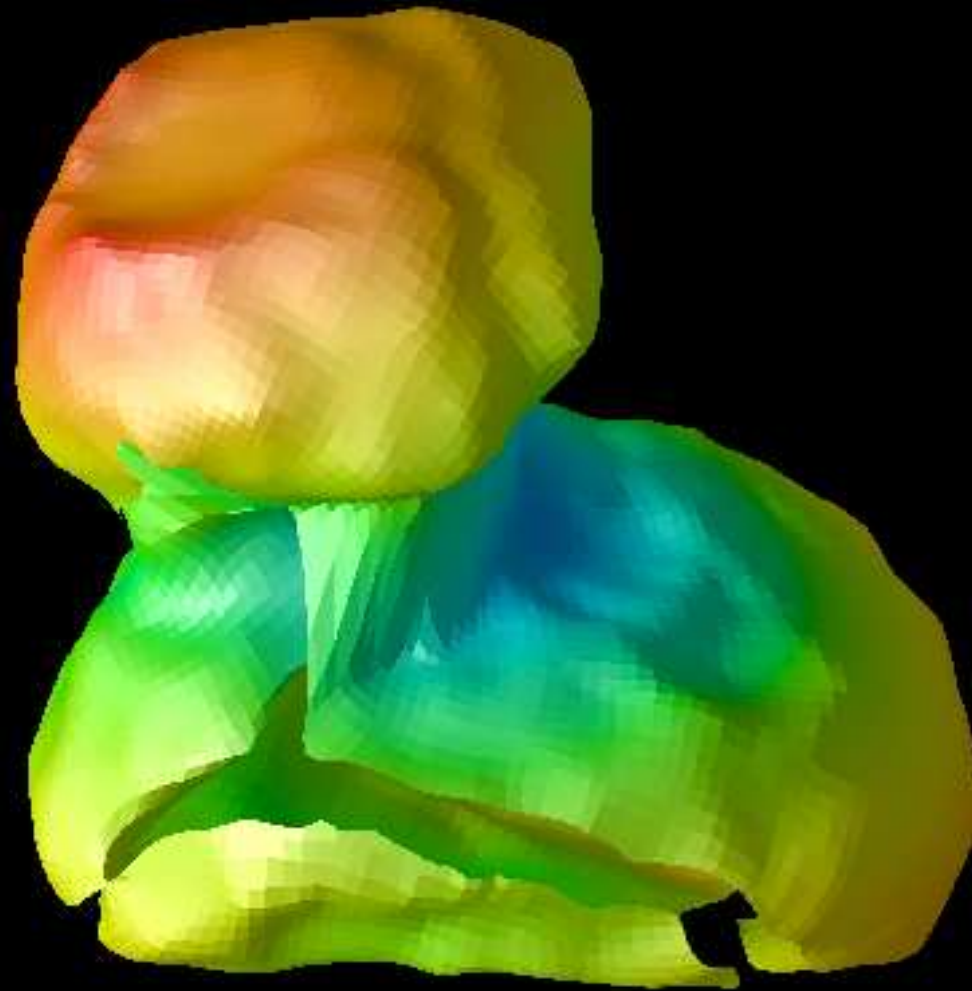
100 iterations



1000 iterations

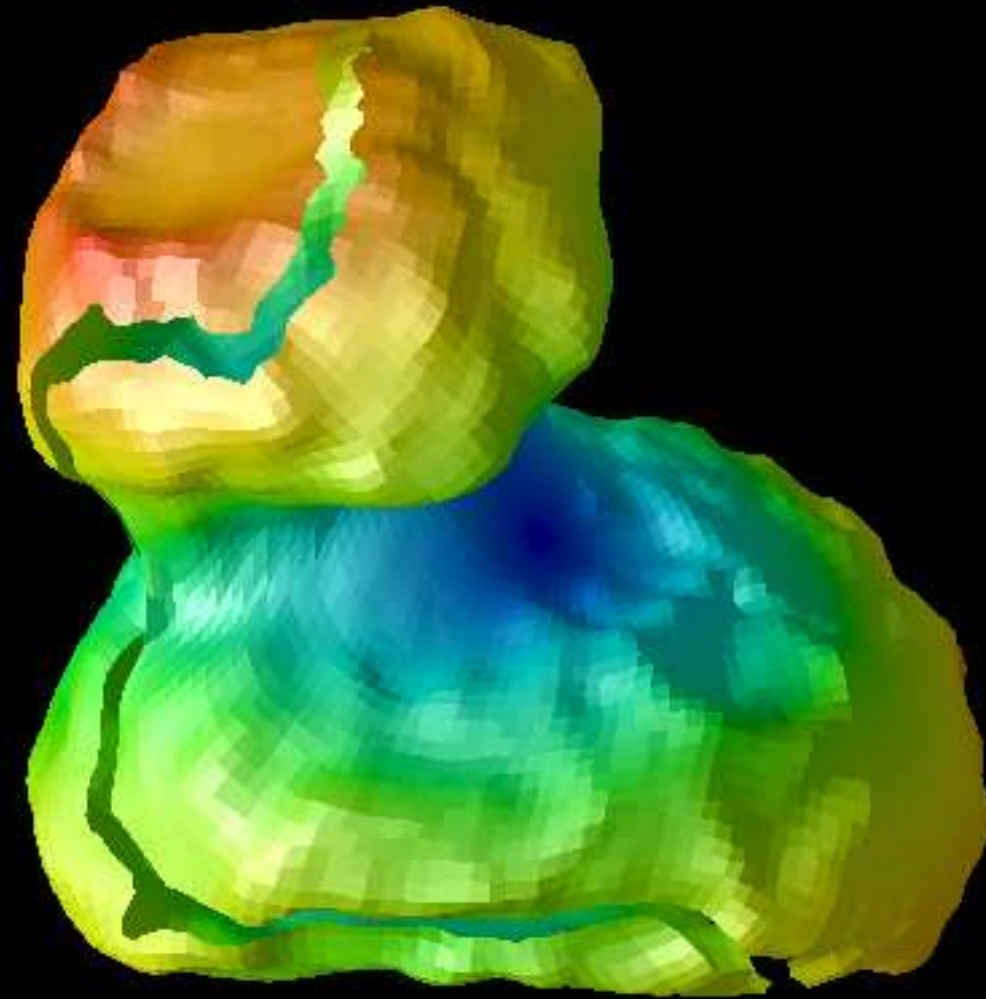


10 000 iterations



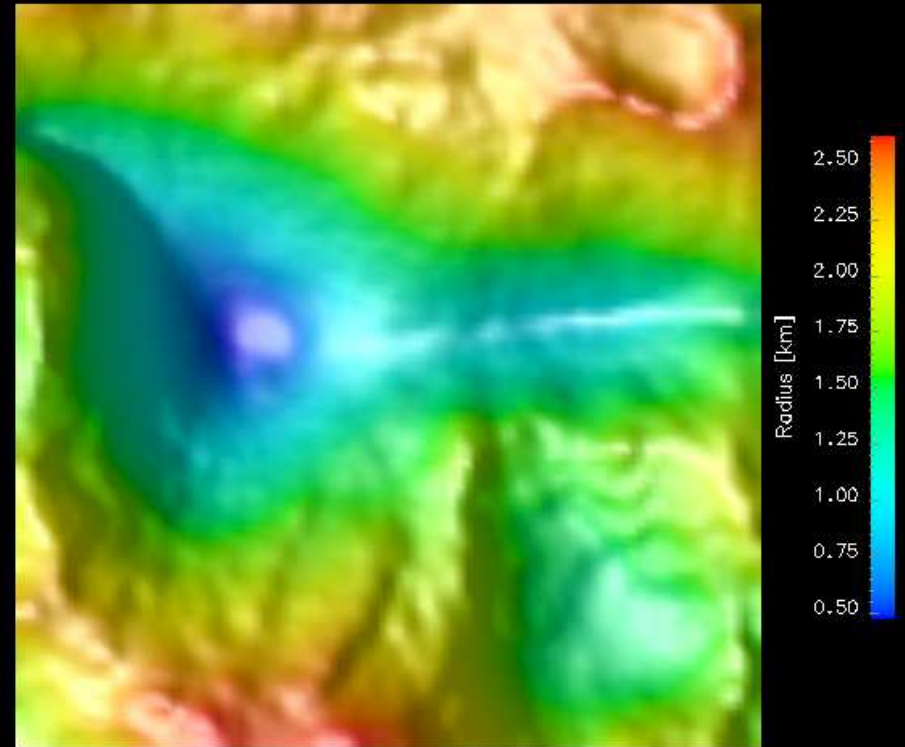
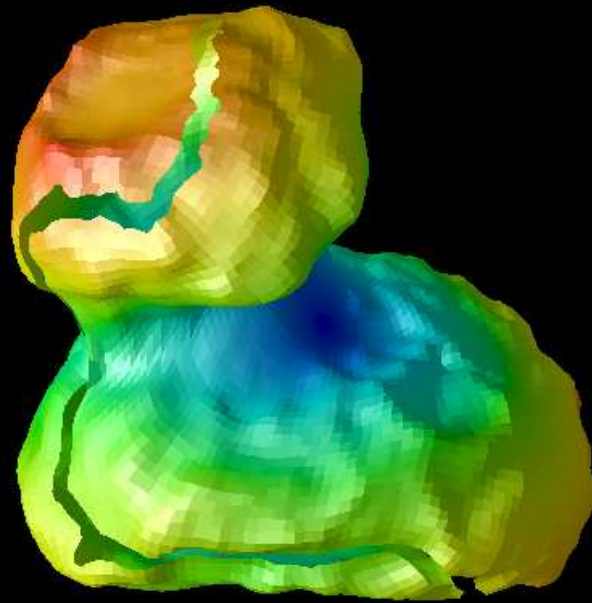
100 000 iterations

Iterative adaption of the Kohonen map



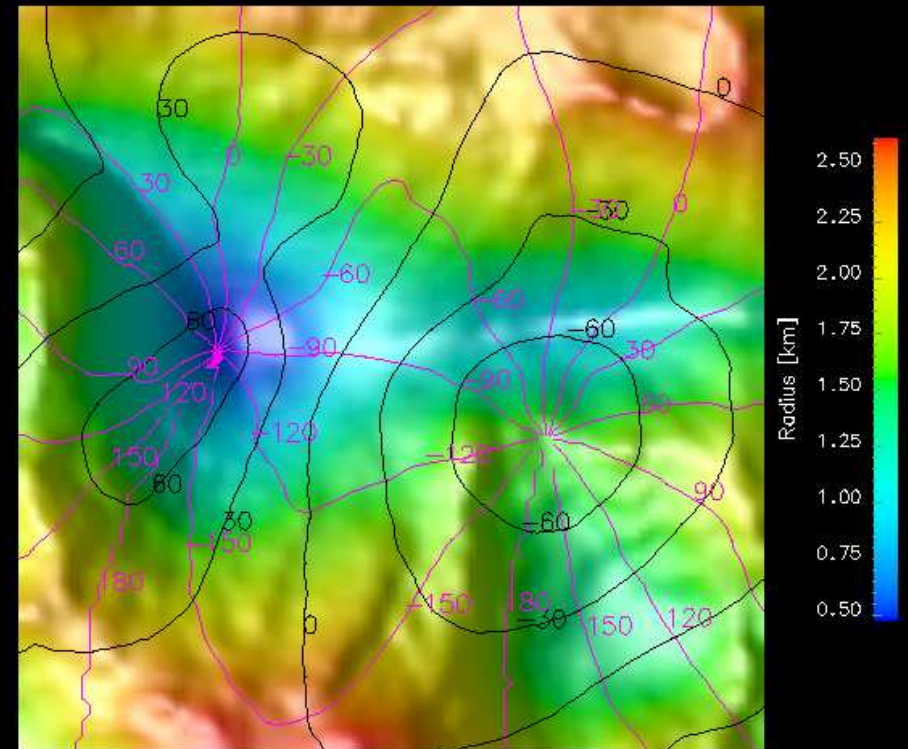
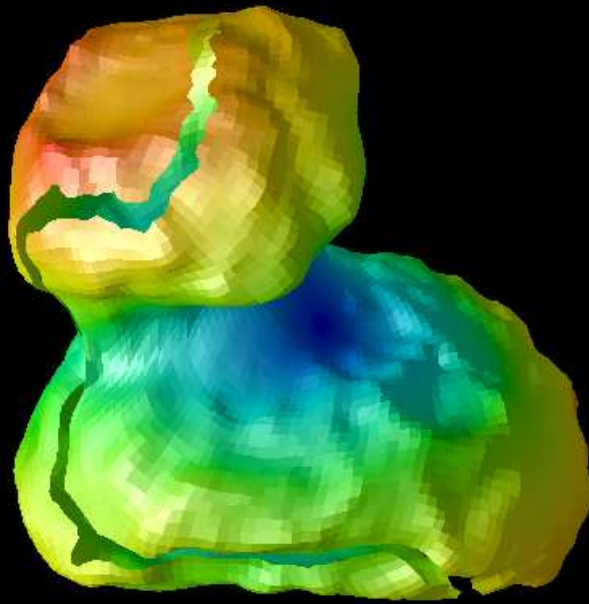
1 000 000 iterations

A map of the whole comet



Input was SHAP5.

A map of the whole comet



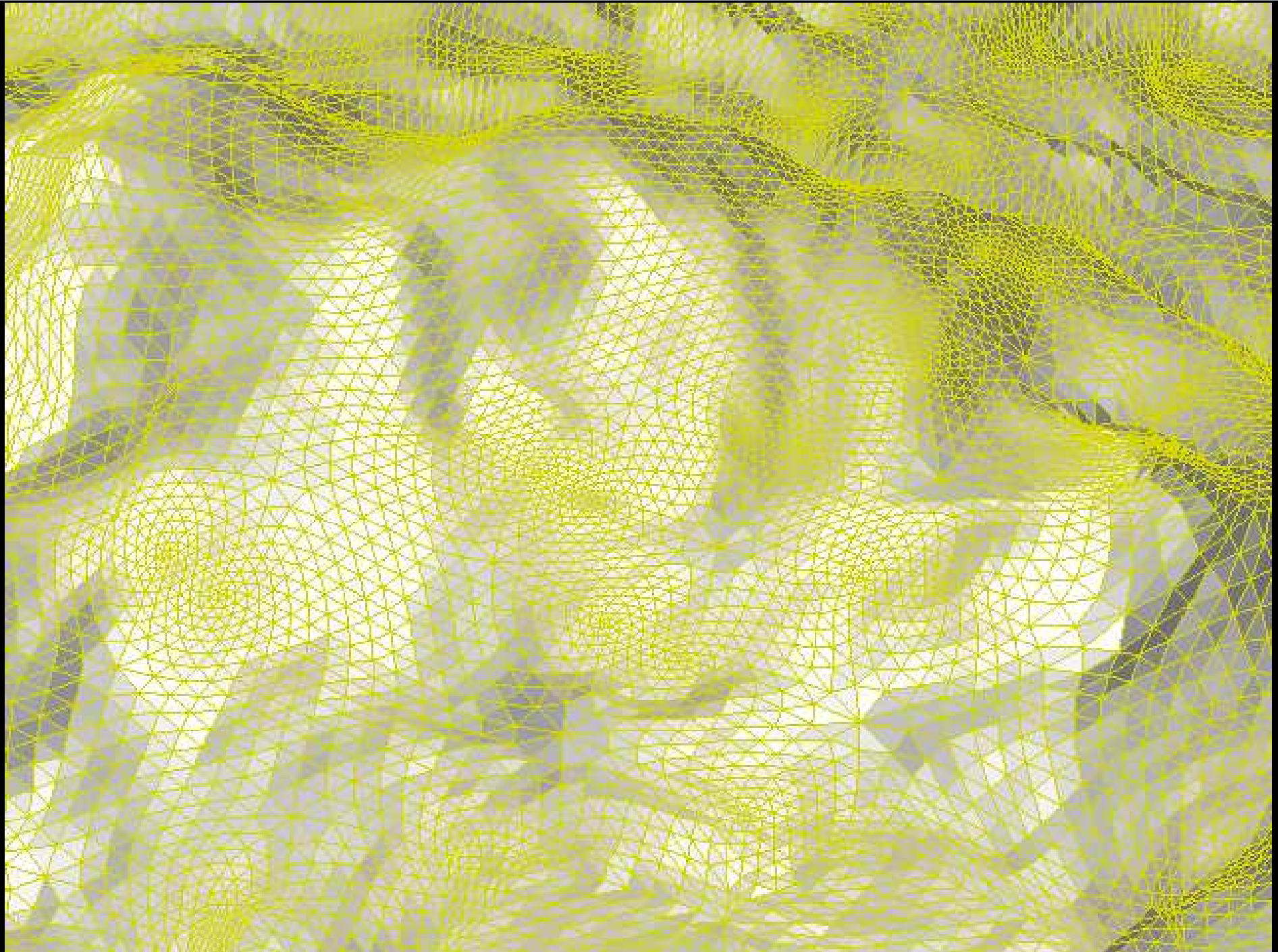
Input was SHAP5.

— Latitudes

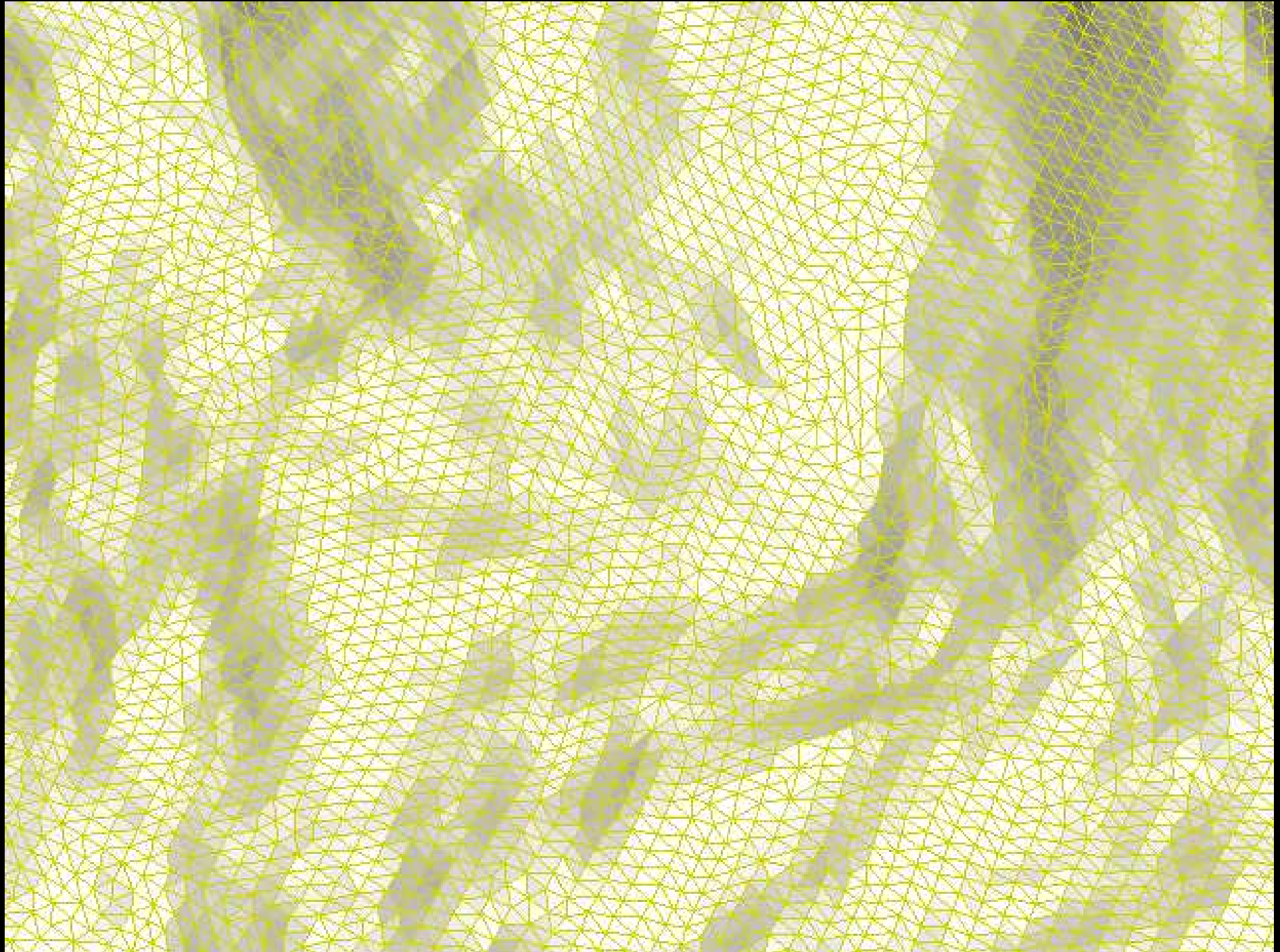
— Longitudes

- The Kohonen map does not strictly fulfill any of the useful projection properties, like being conformal, direction preserving, or area preserving.
- However, the Kohonen map is approximately area preserving if the input positions (the shape model vertices in this case) are evenly distributed in space.
 - The ESA shape model has various “poles” where the density of vertices gets very high.
 - The SHAP5 model seems to have approximately evenly distributed vertices.



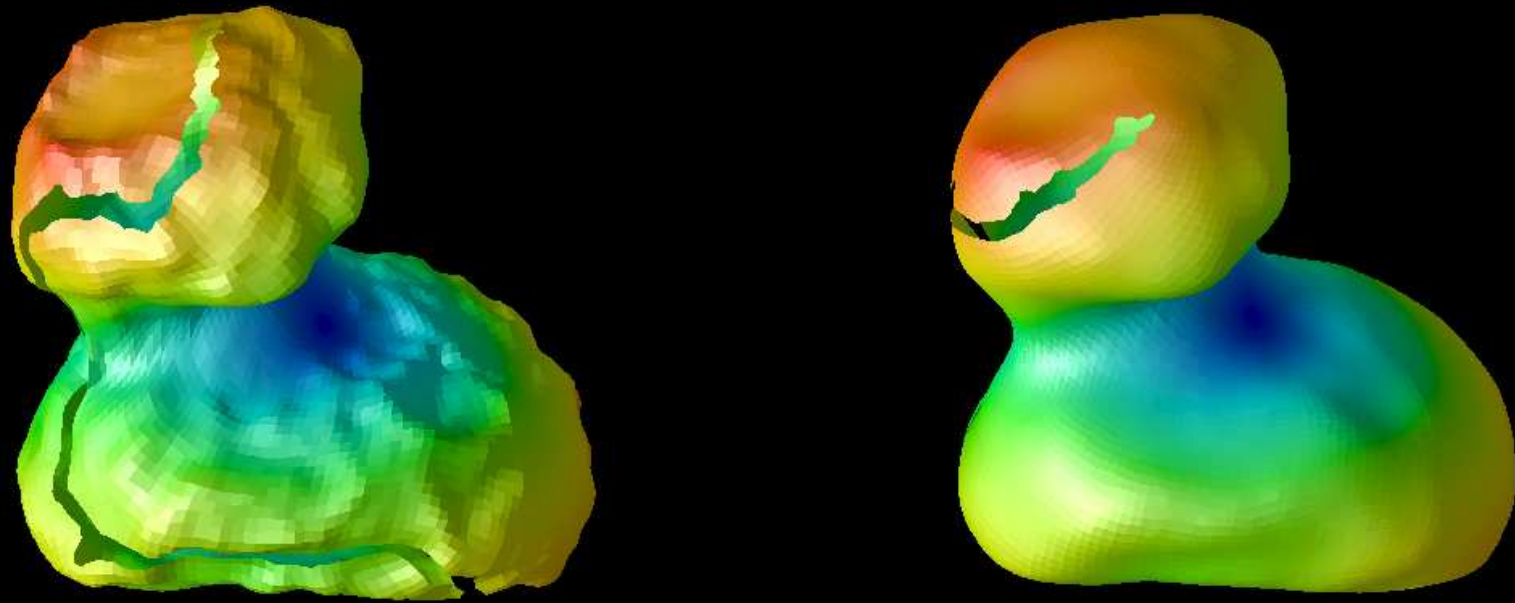




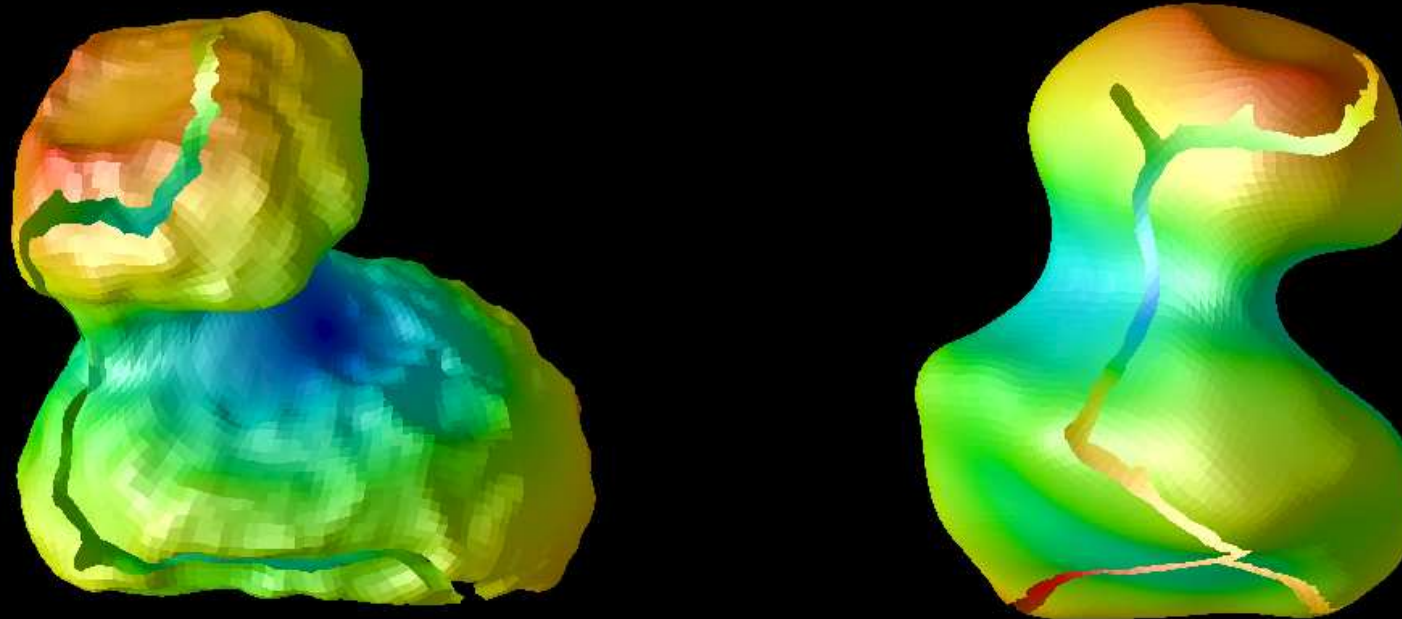


- The strongly varying resolution of the ESA shape model yields a Kohonen map far from area preserving.
 - I want to use a smoothed shape model to create a Kohonen map as reference surface. The varying resolution yields curious results for (naive) smoothing.
- SHAP5 is used.

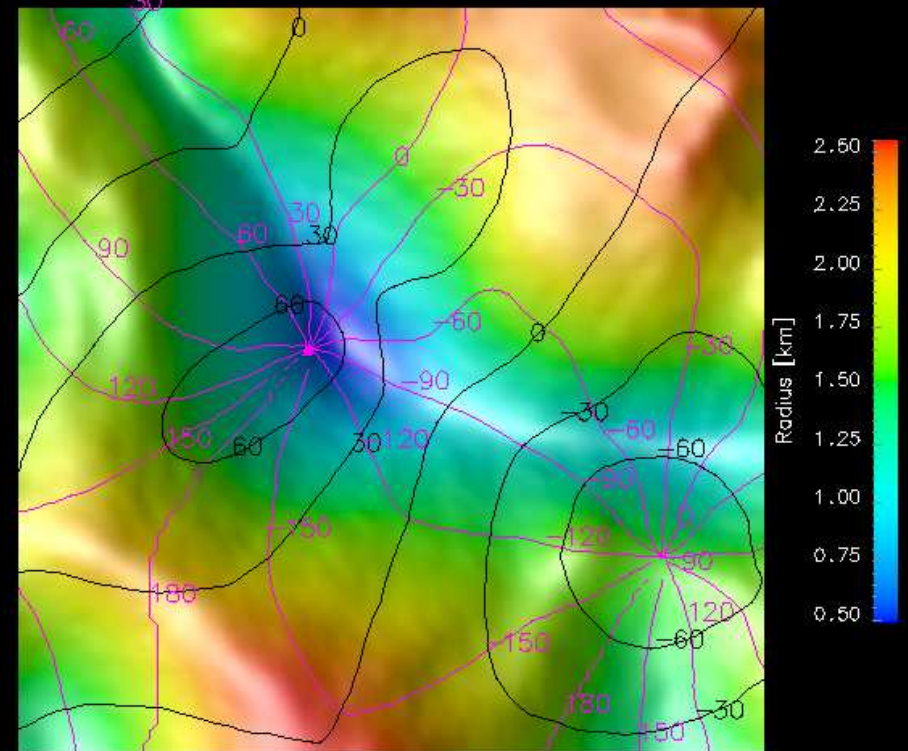
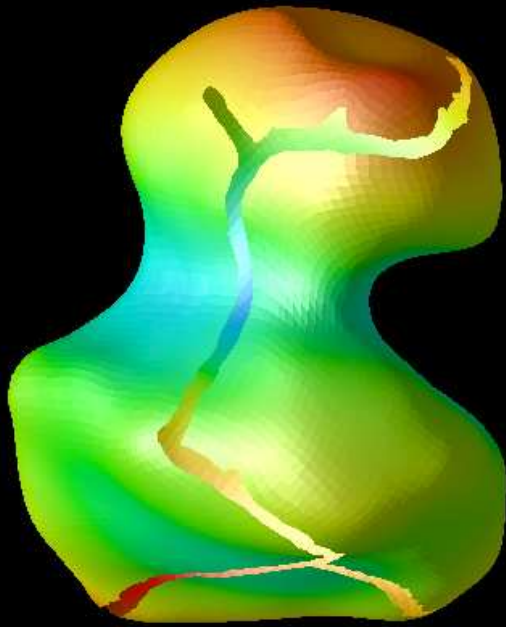
Kohonen map of smoothed SHAP5



Kohonen map of smoothed SHAP5



Kohonen map of smoothed SHAP5

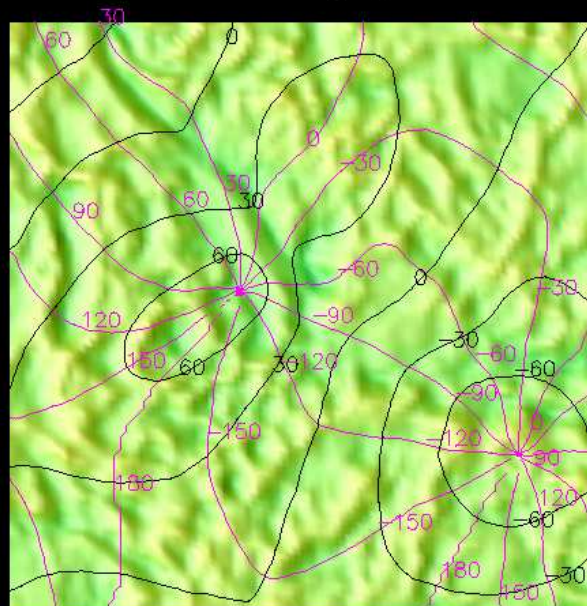


→ Reference surface for shape model comparison

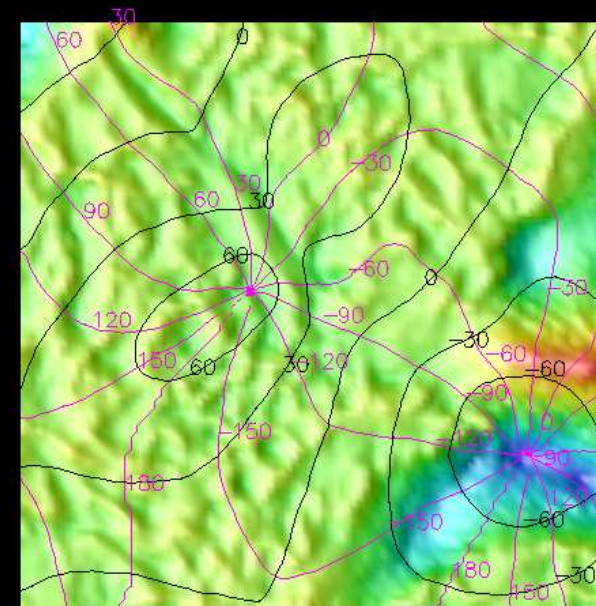
Elevation relative to reference surface



cshp_dv_130



cg_spc_shap5



cg_dlr_spg_shap4s

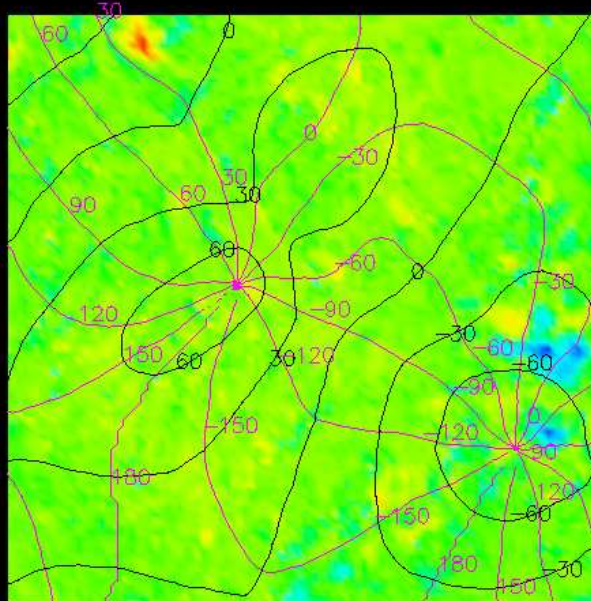
Elevation differences

-0.09 km

+0.07 km



Elevation difference [km]



cg_spc_shap5

—

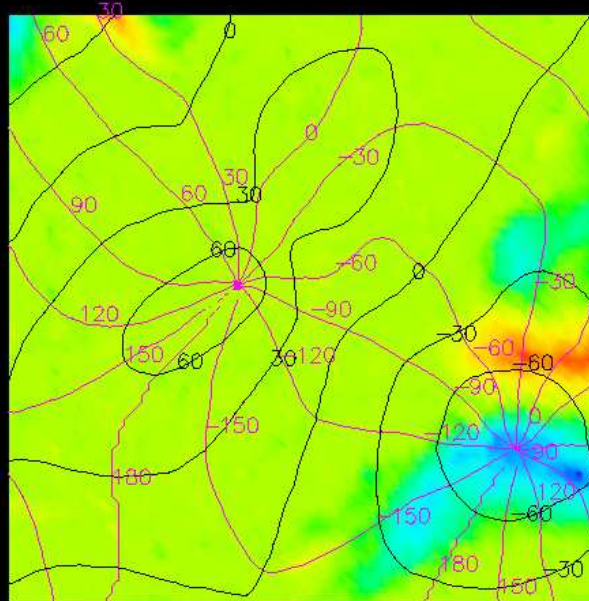
cshp_dv_130

-0.45 km

+0.3 km



Elevation difference [km]



cg_dlr_spg_shap4s

—

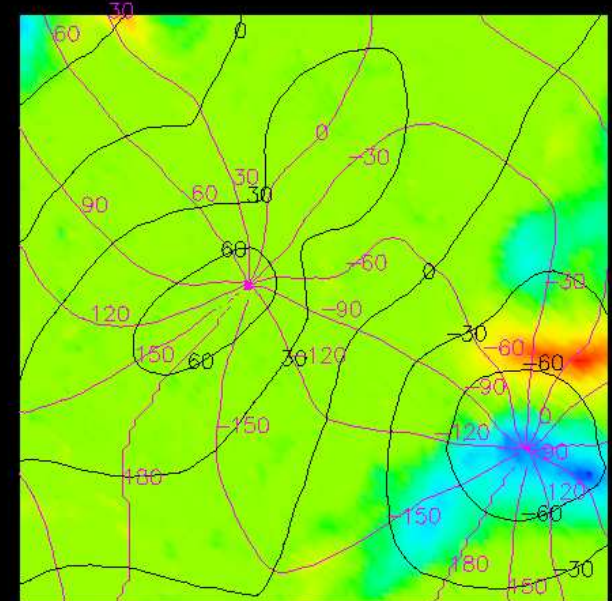
cshp_dv_130

-0.45 km

+0.3 km



Elevation difference [km]

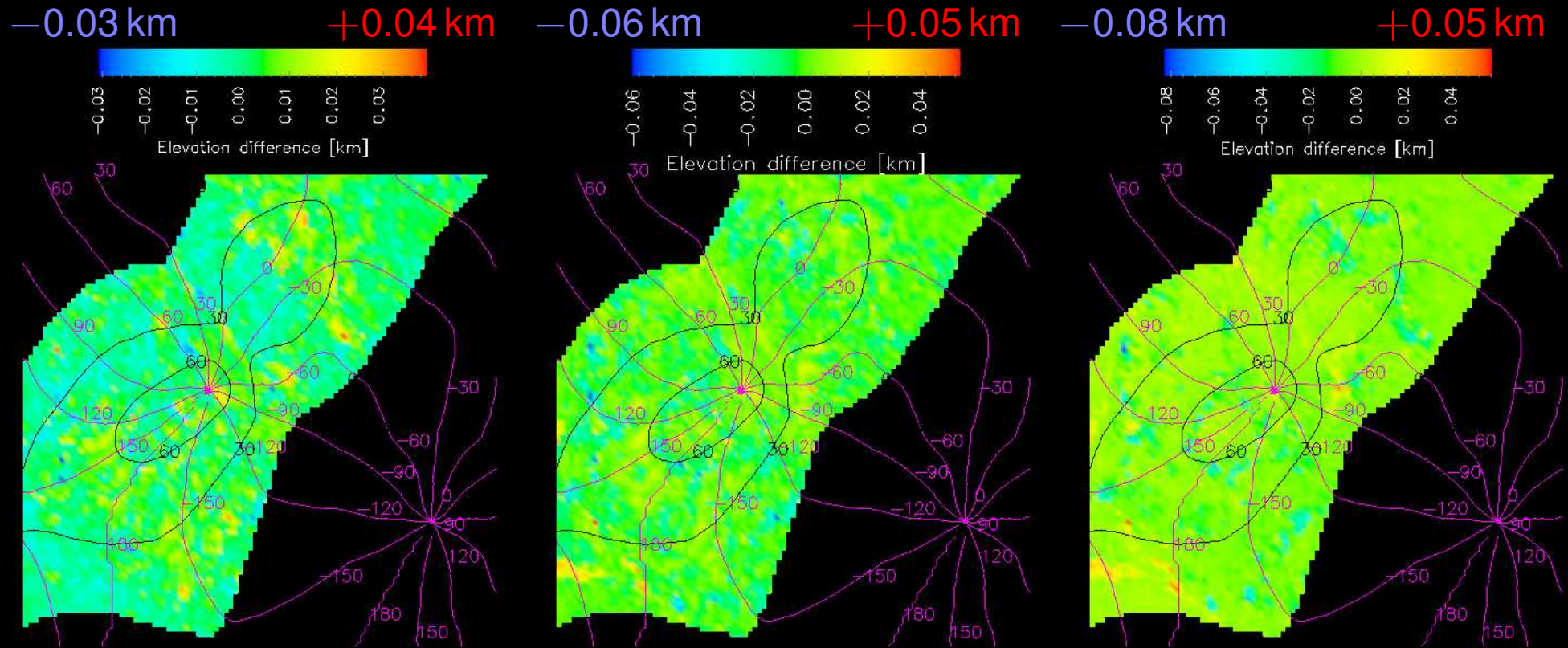


cg_dlr_spg_shap4s

—

cg_spc_shap5

Elevation differences northern hemisphere only



cg_spc_shap5

—
cshp_dv_130

cg_dlr_spg_shap4s

—
cshp_dv_130

cg_dlr_spg_shap4s

—
cg_spc_shap5

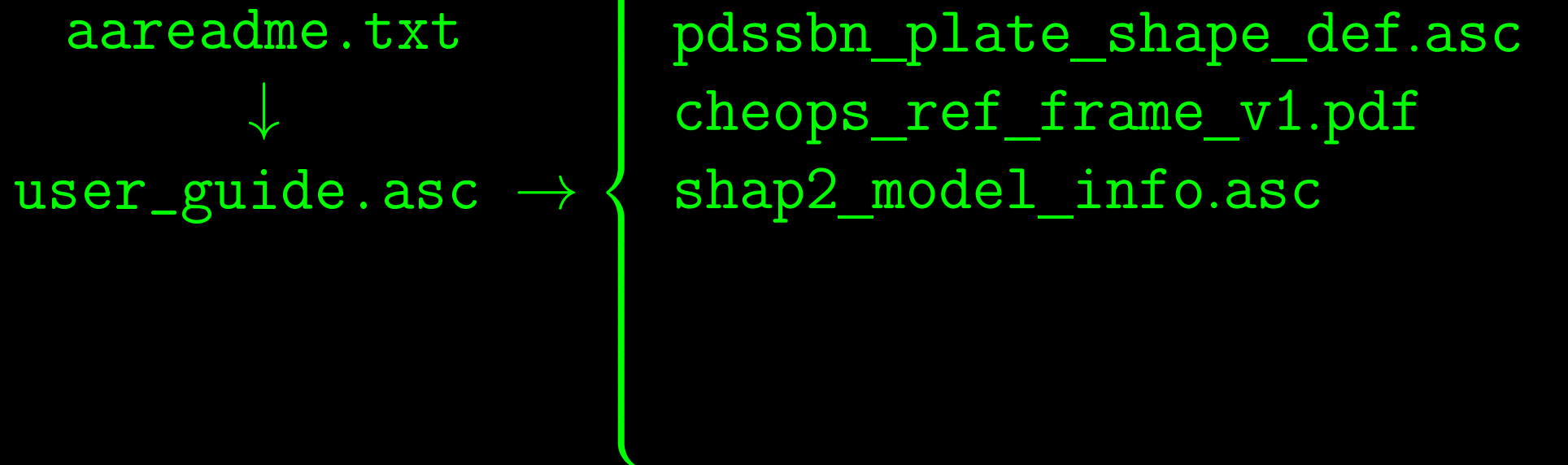
Table of differences [m]

Models		Whole comet		Northern hemisphere	
		mean	max	mean	max
cshp	shap5	10	93	6	39
cshp	shap4s	77	476	8	62
shap5	shap4s	76	470	9	83

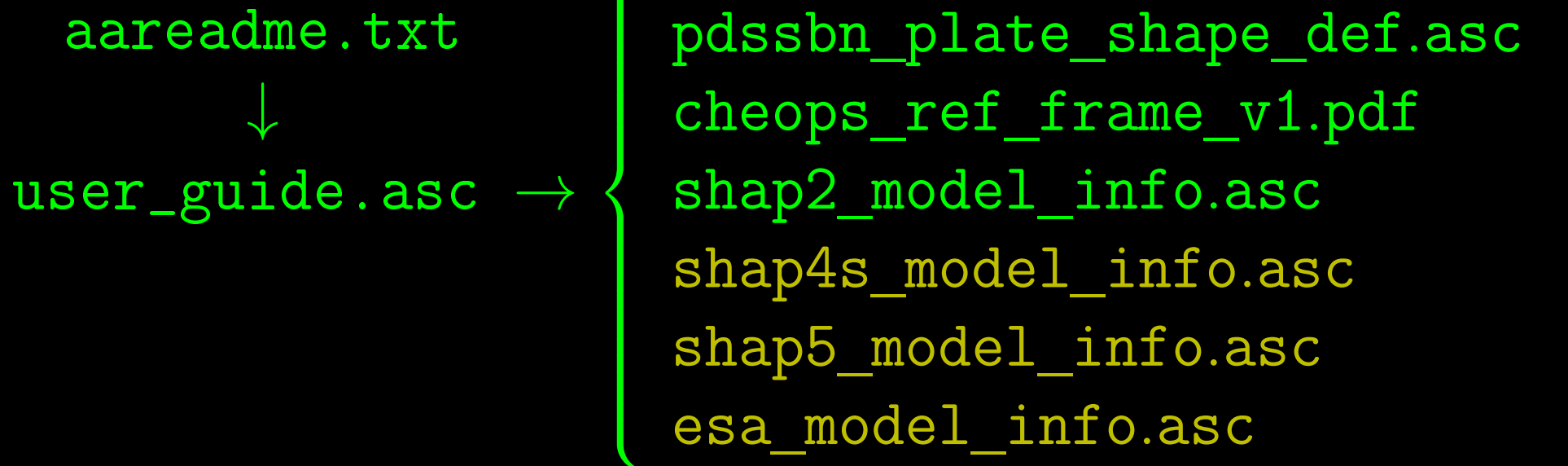
Remark on documentation

- I did not systematically check the documentation.
- However, whenever I was looking for some information, I could seamlessly find it.

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The other model info documents could also be referenced in user_guide.asc.

Very nice and well usable
data set!