はやぶさ２着陸地点選定訓練：LIDARおよびTIR

TIR 岡田 達明[1,11], 福原 哲哉[2], 田中 智[1], 田口 真[2], 荒井 武彦[3], 千秋 博紀[4], 出村 裕英[5], 小川 佳子[5], 神山 徹[6], 関口 朋彦[7], 坂谷 尚哉[8], 滝田 隼[9,1]
LIDAR 松本 晃治[10], 山本 圭香[10], 野田 寛大[10], 山田 竜平[5], 荒木 博志[10], 水野 貴秀[1], 尾川 順子[1], 並木 則行[10]

1: ISAS/JAXA, 2: 立教大学, 3: 国立環境研究所, 4: 千葉工業大学, 5: 会津大学, 6: 産業技術総合研究所, 7:北海道教育大学, 8: 明治大学, 9: 北海道北見北斗高校, 10: NAOJ, 11: 東京大学

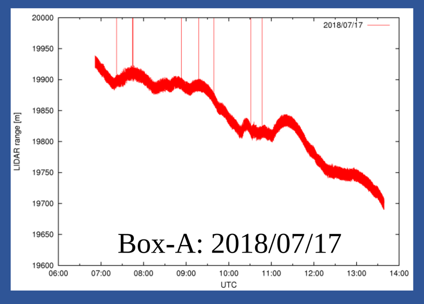
Current Status of Hayabusa2 LIDAR

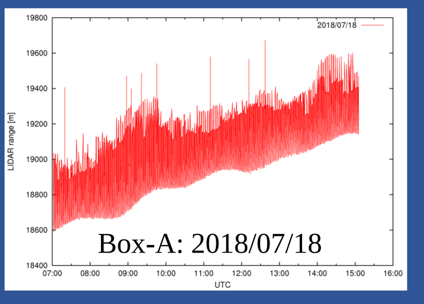
- Hayabusa-2 LIDAR has been halted during cruising phase.
- Team activities
  - Dry Run for Landing Site Selection
    Data analysis tools revised and improved
  - Ancillary documents for PDS4 archives
  - Simulation study for crossover orbit analysis (w/ Astrodynamics team)
    Identification of cross-over points from expected footprints
    Their spatial distribution and temporal occurrence
  - Albedo measurement experiment of C-type chondrite
    Characterization of receiver response to various forms of return pulse (on-going calibration)

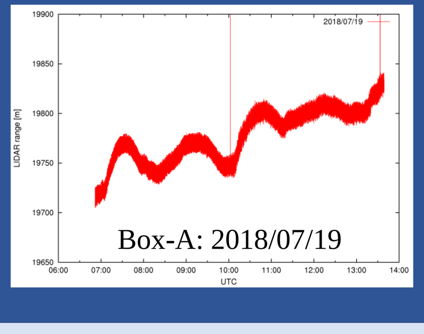
Summary of LIDAR in LSS

- We will provide three types of time series data for LSS;
  i. LIDAR range measurements,
  ii. LIDAR-derived "topography" expressed in the asteroid-centered body-fixed rotating frame, which is dependent on the LIDAR range measurements, spacecraft ephemeris, spacecraft attitude, and asteroid rotation information.
  iii. Corrected spacecraft positions for Box-A & C, which are estimated by comparing the LIDAR-derived topography with one of the shape models.
- ◆ The range product will be processed by the pipeline.
- ◆ The topography product will be generated soon after the necessary input information become ready.
- ◆ The corrected spacecraft positions will be available within a few days after a shape model is provided.

Time series: LIDAR range (Box-A)



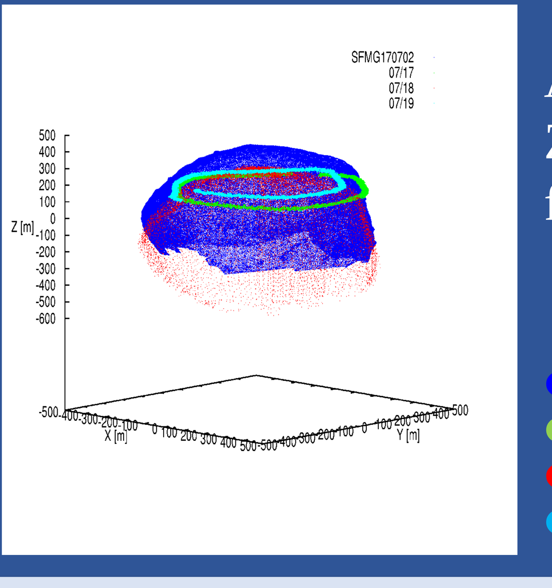




Scan observation

These data will be processed by a pipeline, and to be used to determine the scale of shape models.

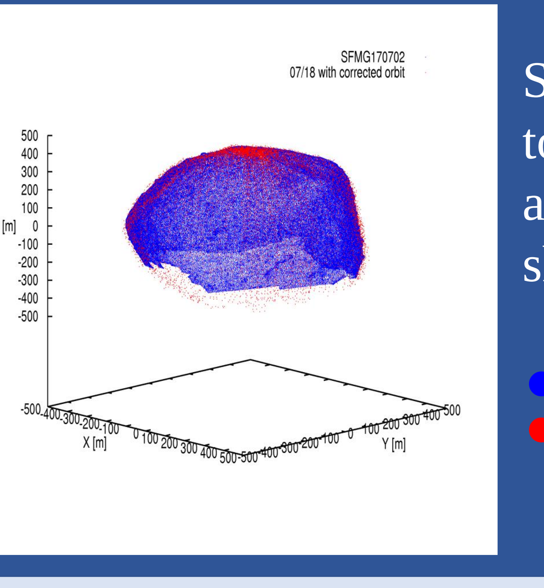
LIDAR footprints (Box-A) with SPC-derived S/C position (ver. 170807)



About -130 m offset in Z-direction @ body-fixed frame.

- ● : Shape model SFMG170702
- ● : 2018/07/17
- ● : 2018/07/18
- ● : 2018/07/19

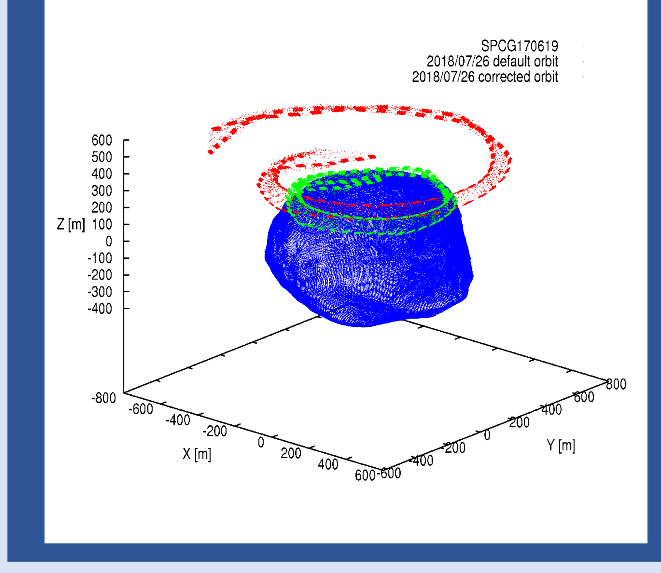
LIDAR footprints (Box-A) with corrected S/C position



S/C position is corrected to remove 130-m offset and footprints match with shape model.

- ● : Shape model SFMG170702
- ● : 2018/07/18

LIDAR footprints (Box-C) with default and corrected S/C position



S/C position again shows significant offset in Box-C.

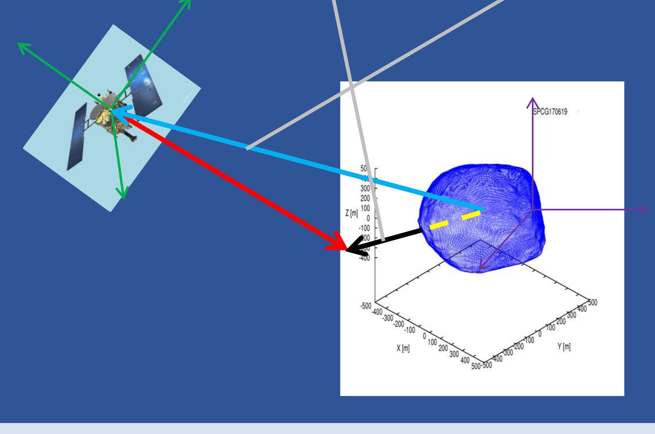
- ● : Shape model SPCG170619
- ● : Before orbit correction
- ● : After orbit correction

Box-C orbit correction

(1) Obtain time series of deviation of LIDAR footprint positions from shape model (SPCG170619) in J2000 frame.

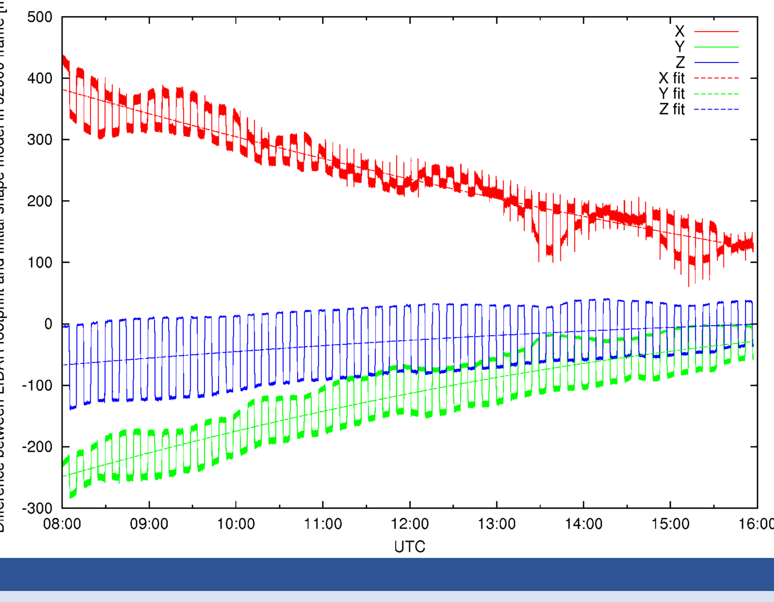
(2) Assume that long-term variation in this deviation is due to error in the default orbit, and get correction time series in each of X, Y, Z components by fitting quadratic functions.

(3) Apply the orbit correction to re-calculate the LIDAR footprints (green dots in previous figure).



If an initial shape model was available from Box-A observation, a rapid orbit correction for Box-C might be provided by fitting the LIDAR footprints to the shape model.

Fitting orbit correction



A simple quadratic fitting sufficiently improves S/C positions and reveals an importance of LIDAR data in orbital determination and shape modeling.

TIR LSS Status

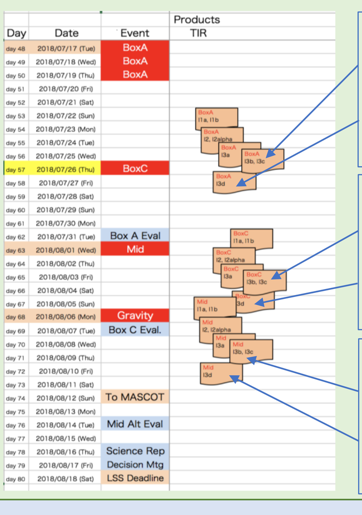
TIR's Roles for LSS

- □ Thermal Inertia Map
  - Porosity, typical grain size distribution
  - Boulder abundance
  - Temperature prediction (safety)
- □ Thermal Radiation
  - Comparison with ground observations
  - Thermal environments

Results of TIR LSS Exercise

- Thermal inertia and the grain size map are well predicted when the accurate SfM asteroid shape model and SPICE Kernels are available.
- Temp. predictions can be also provided for selected dates and local times.
- But, local features (such as boulders) are needed to be treated one by one (not automatically).

■ TIR Product Preparation

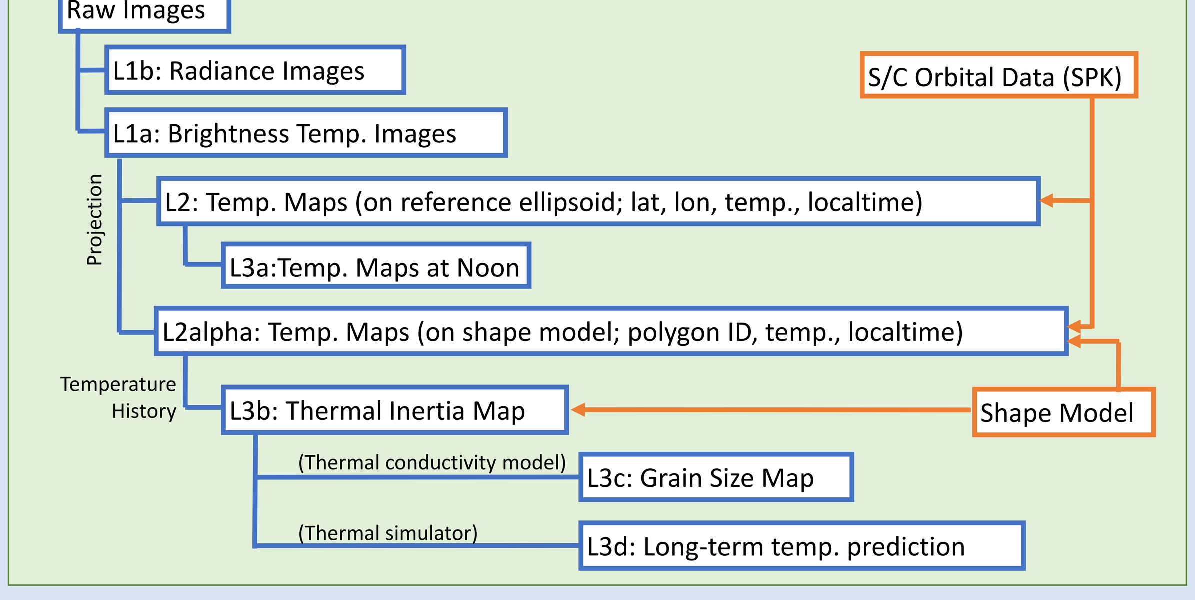


Box-A
7/25 L3b: Thermal inertia map
7/27 L3d: Long-term temp. prediction

Box-C
8/3 L3b: Thermal inertia map
8/5 L3d: Long-term temp. prediction

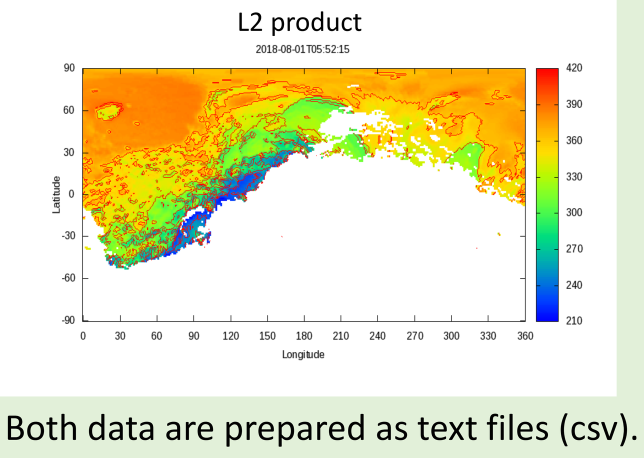
Mid
8/8 L3b: Thermal inertia map
8/10 L3d: Long-term temp. prediction

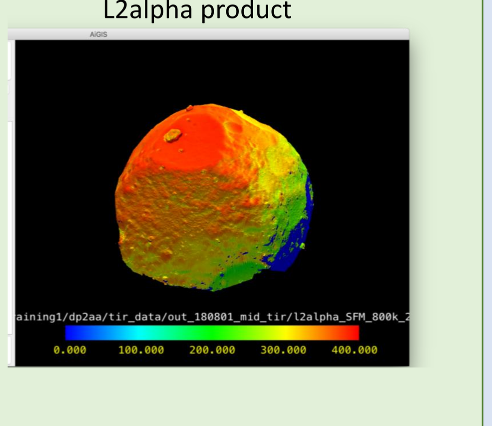
■ TIR Data Products for LSS



■ Brightness temperature map

Two map data will be prepared: one is projected on reference ellipsoid with latitude and longitude coordinate, and the other is on shape models.

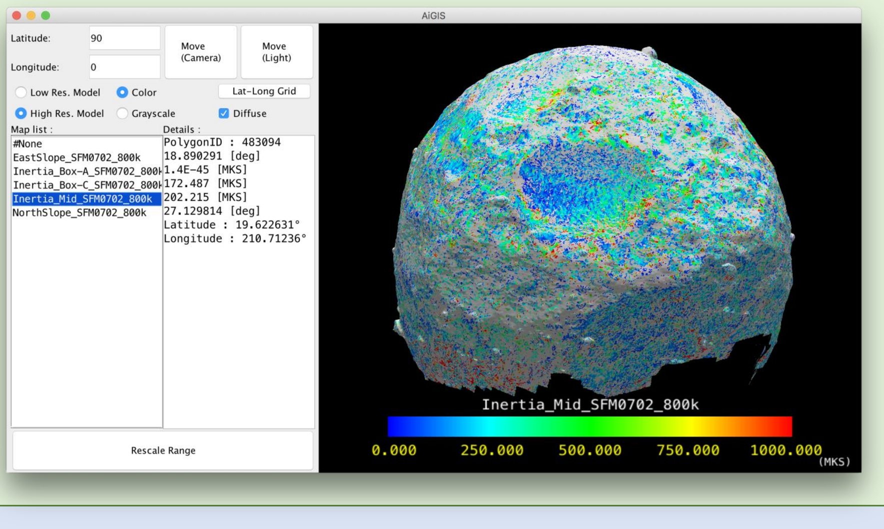




Both data are prepared as text files (csv).
These products will be released after 1 day of SfM shape model release.

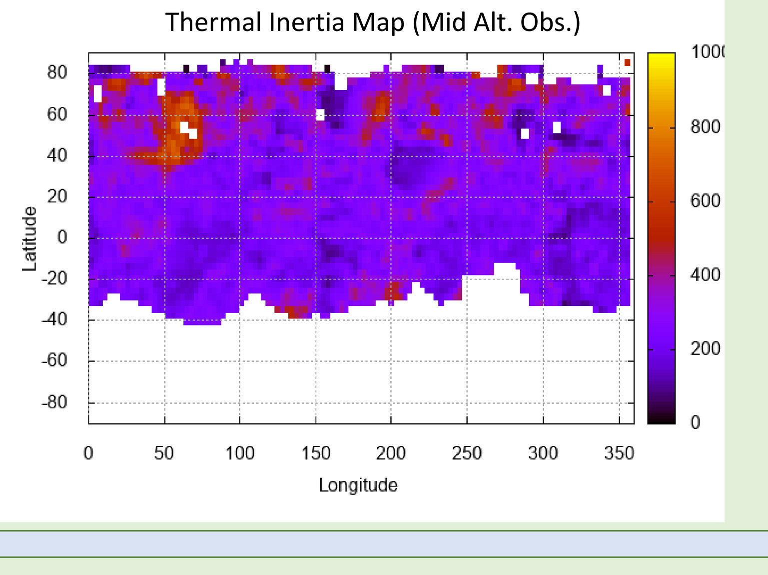
■ Thermal inertia map

The thermal inertia is estimated from the daytime temperature history (peak temperature local time relative to 12:00) from the L2alpha map data.

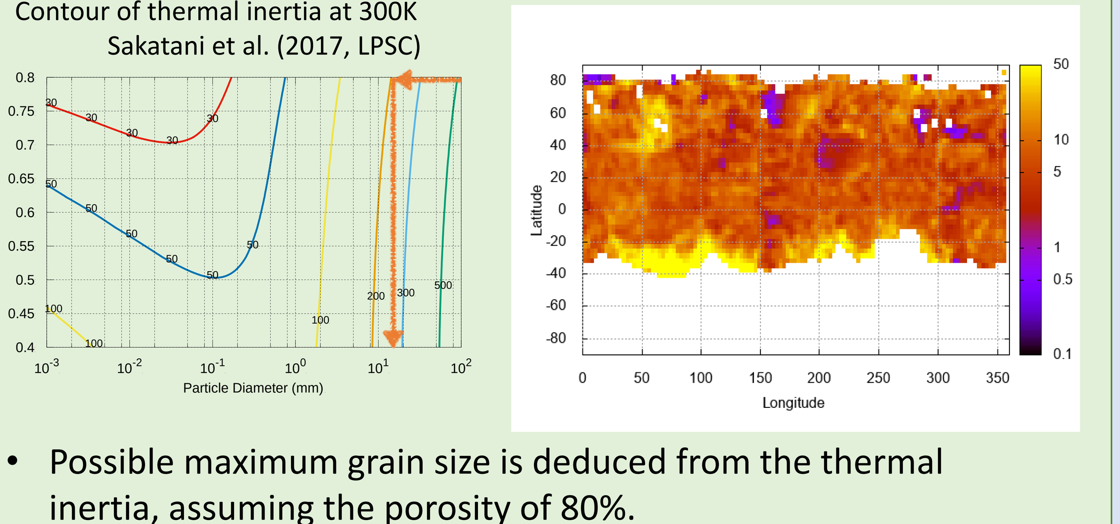


■ Thermal inertia map

A map binned into lat. vs. lon. map will be released as text file and png images, after 1 day of the L2 map data release.



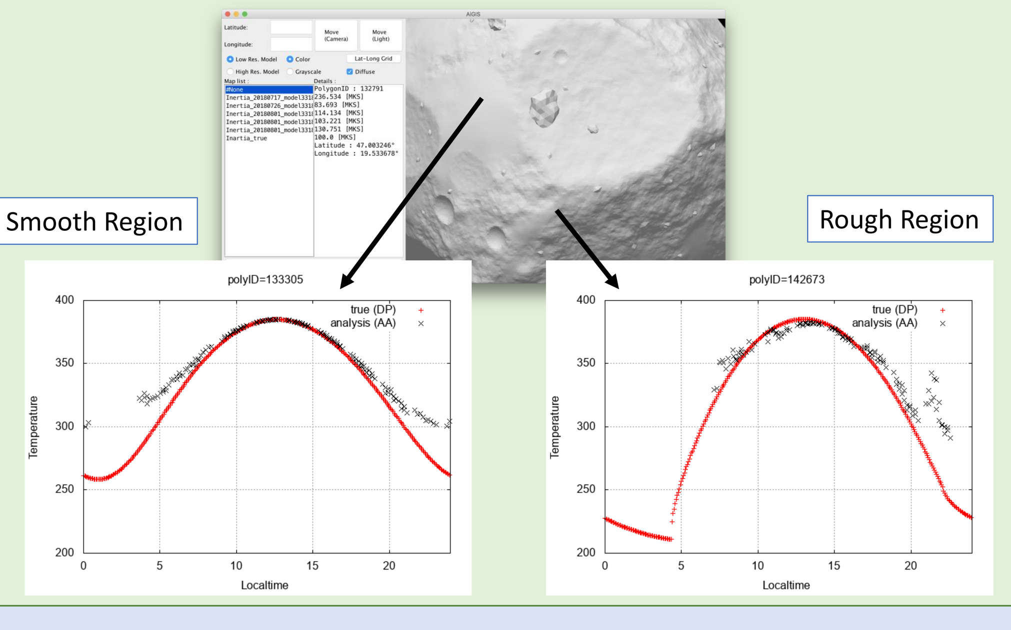
■ Grain size map



- Possible maximum grain size is deduced from the thermal inertia, assuming the porosity of 80%.
- Text map file and PNG image are provided at the same time of the thermal inertia map release.

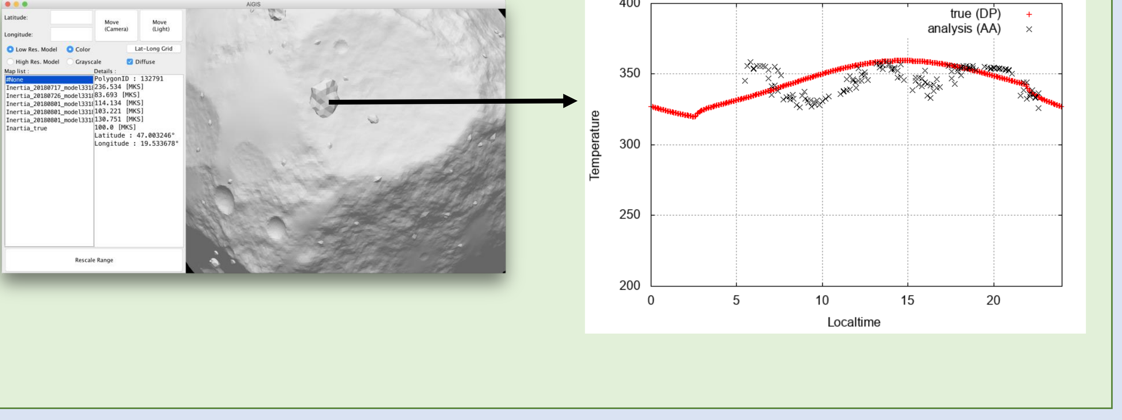
■ Rough regions

Observed temperature profiles of rough regions are not smooth.



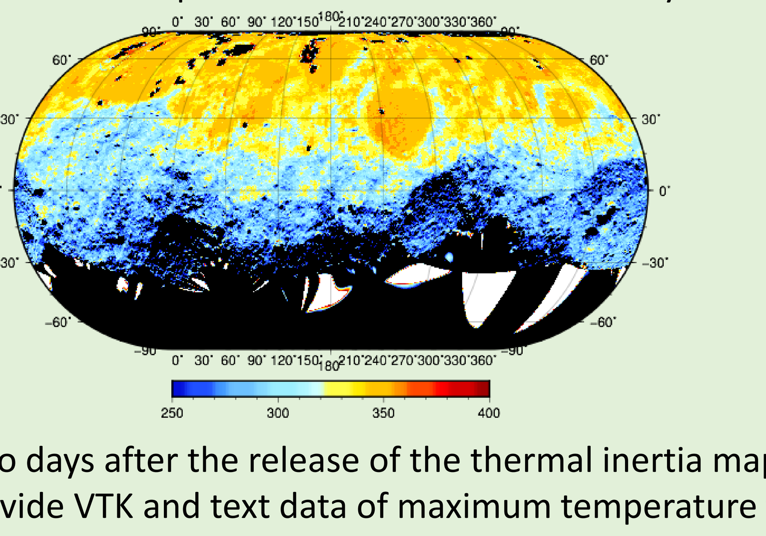
■ Boulders

Temperature profiles of polygons on a boulder are also too complex to well determine the thermal inertia from the phase shift.



■ Long-term temperature prediction

Maximum temperature at MASCOT release day



It needs two days after the release of the thermal inertia map.
We will provide VTK and text data of maximum temperature for each polygons.