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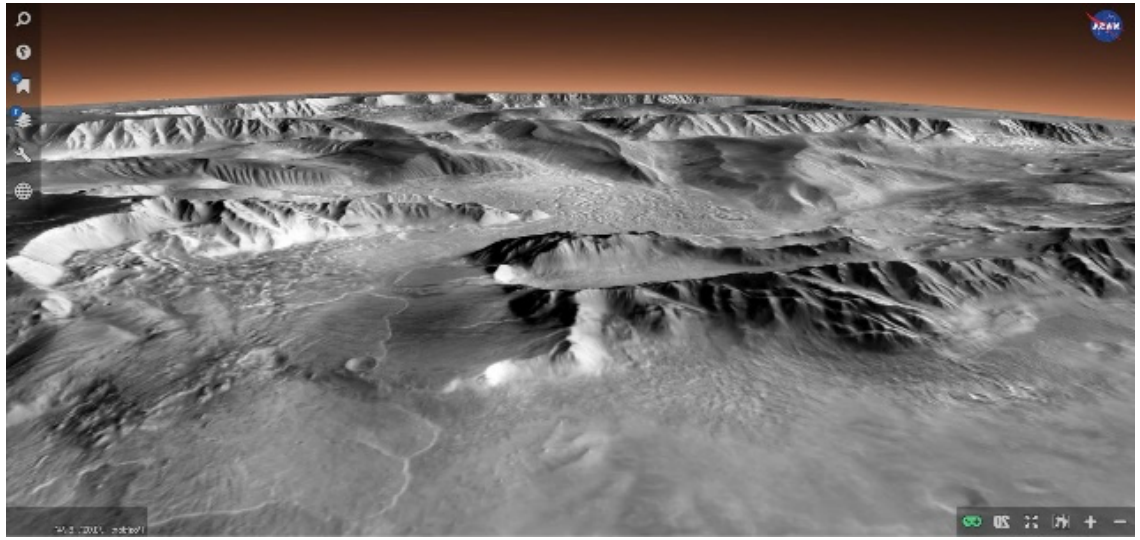
Solar System Treks - GIS that provides interactive visualization and analysis for planetary science and exploration



Emily Law, Brian Day &
Solar System Treks Team

JpGUL
May 30, 2019

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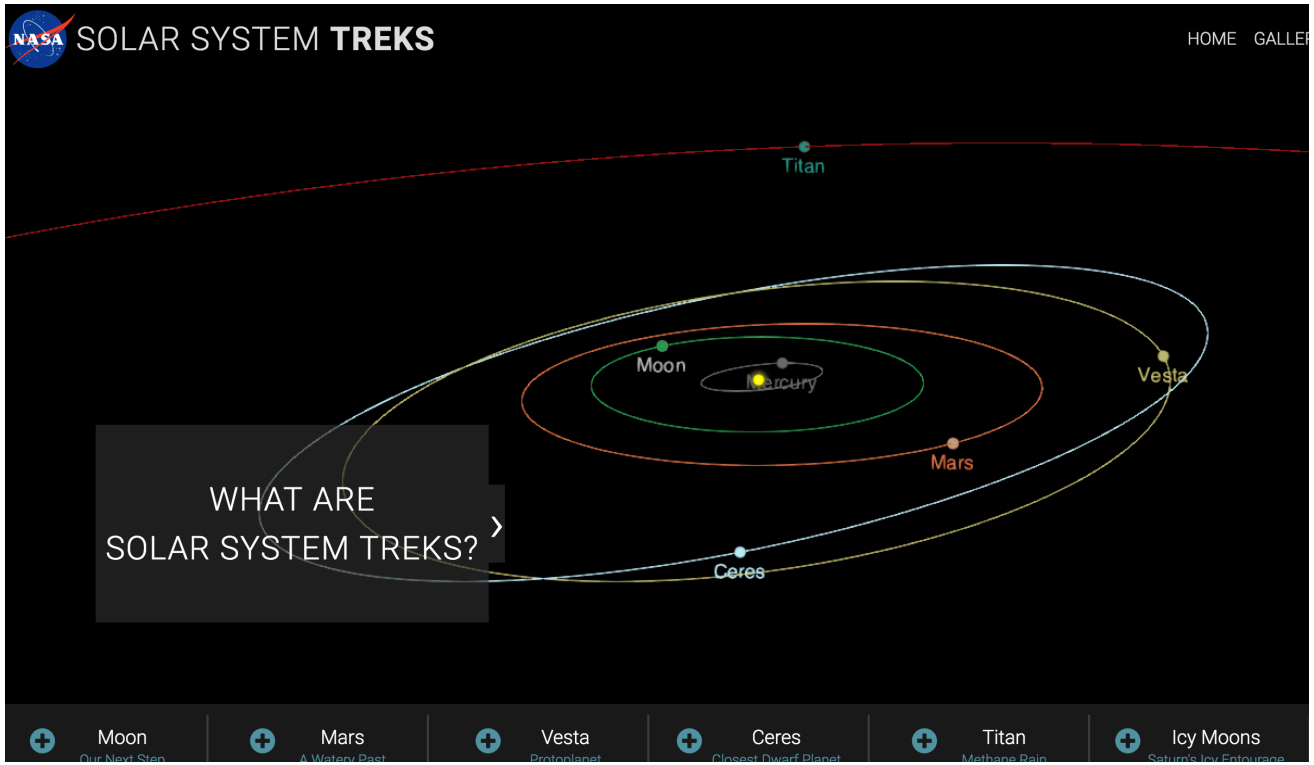
Solar System Treks (SST)

- An element of NASA's Solar System Exploration Research Virtual Institute (SSERVI)
- Software development and operations done at JPL
- A family of GIS-based interactive web-based Trek portals
  - Mission Planning
  - Scientific Research
  - Public Outreach/STEM

https://trek.nasa.gov



Trek Portals

- Trek portals support NASA missions and NASA collaborations with partnering agencies
  - Currently supporting lunar & Mars landing sites selection, Cassini science, Dawn outreach
  - Supporting NASA partnerships with JAXA, ESA, KARI, INFN, IRAP
- Visualization of data products from many instruments aboard many missions
  - 2D & 3D viewing, interactive fly-overs, virtual reality path viewing, 3D printing of terrain
- Analysis tools
  - Lighting, Slope, Crater and Boulder Hazards, Elevation Profile, Sun Angle, Surface Potential

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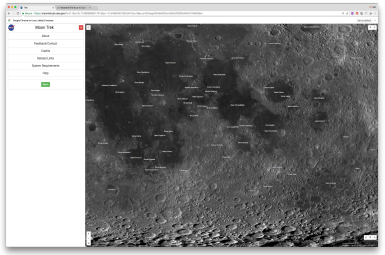
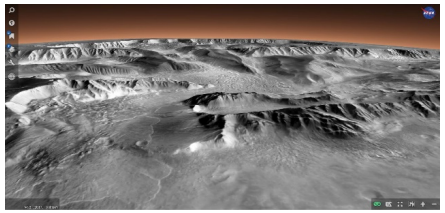
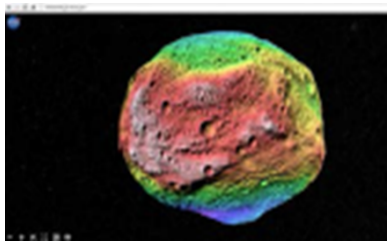
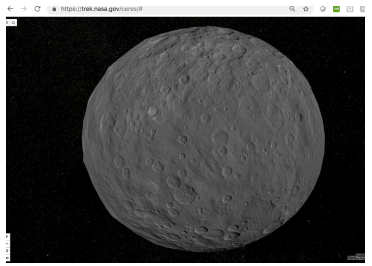
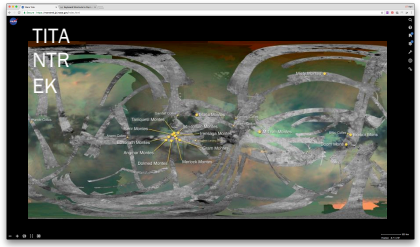
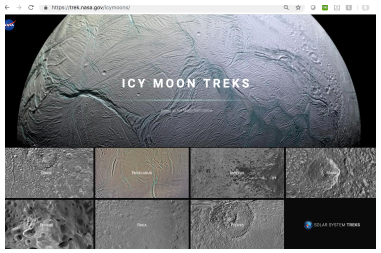
Various Trek Portals

Publicly Available

- Moon Trek – https://trek.nasa.gov/moon
- Mars Trek – https://trek.nasa.gov/mars
- Vesta Trek – https://trek.nasa.gov/vesta
- Ceres Trek - https://trek.nasa.gov/ceres
- Titan Trek – https://trek.nasa.gov/titan
- IcyMoons Trek – https://trek.nasa.gov/icymoons



In Work

- Ryugu, Mercury, Phobos, Bennu, 67P/C-G

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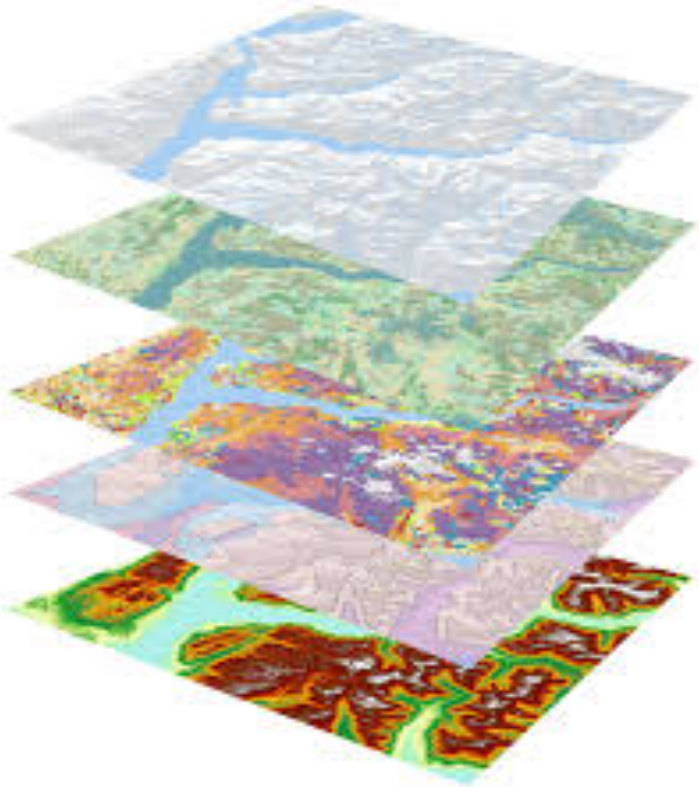
Foundation of SST: GIS

- GIS is in wide use across the planetary science community
- GIS provides structure for
  - Organizing volumes of maps and image data
  - Applying powerful tools for data modeling and analysis
- GIS data processing and analysis support
  - Complex data search
  - Data fusion
  - Time series analysis
  - 2D &3D rendering, 3D fly over
- GIS data products provides insight into
  - Landforms and their relationships
  - Decision making



SST GIS technologies

- Standardized in coordination systems and reference frames
  - Image Georeferencing
  - Image Co-registration to a known geodetic accuracy
- Interactive analysis and visualization
  - 2D, 3D surface analysis (e.g. elevation profile, machine learning feature detection)
  - 2D, 3D fast rendering and interactive visualization (e.g., fly over, VR)
- Standardized data and interface formats
  - Metadata, GeoTIFF, API (e.g. OGC)

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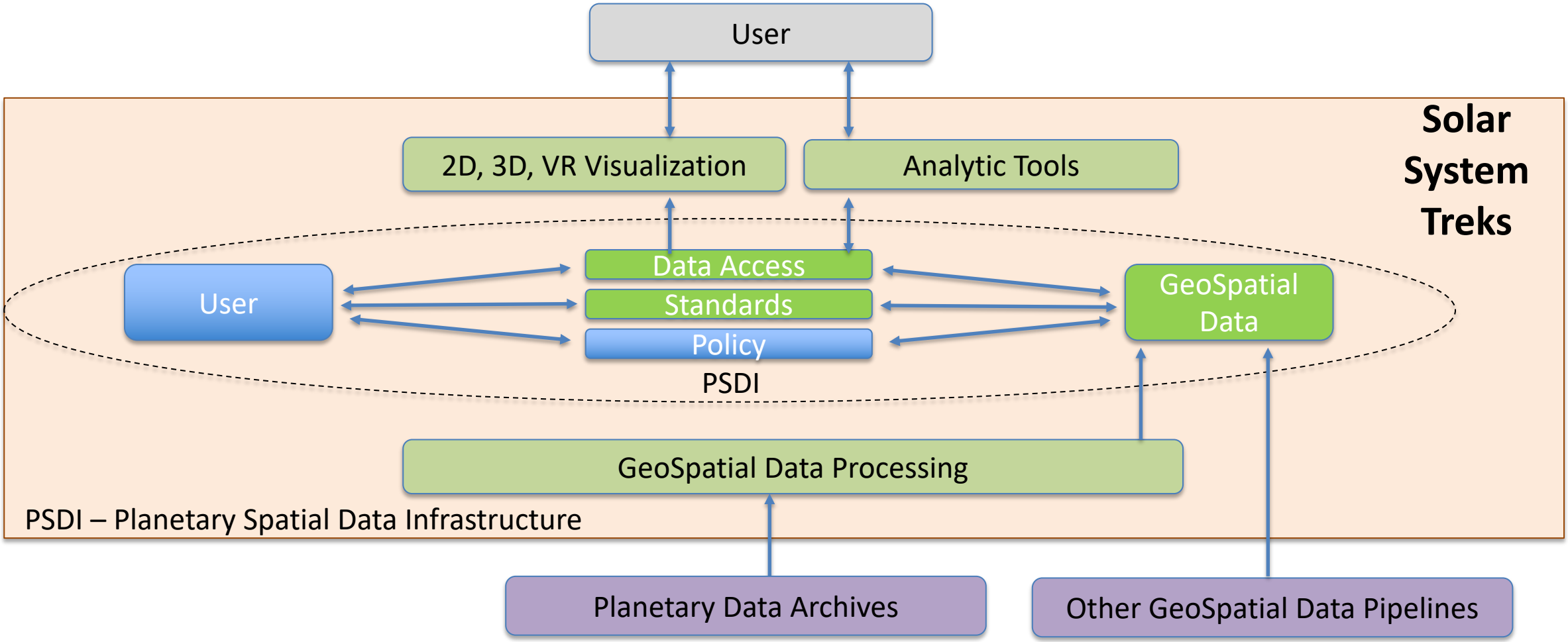
SST Architecture



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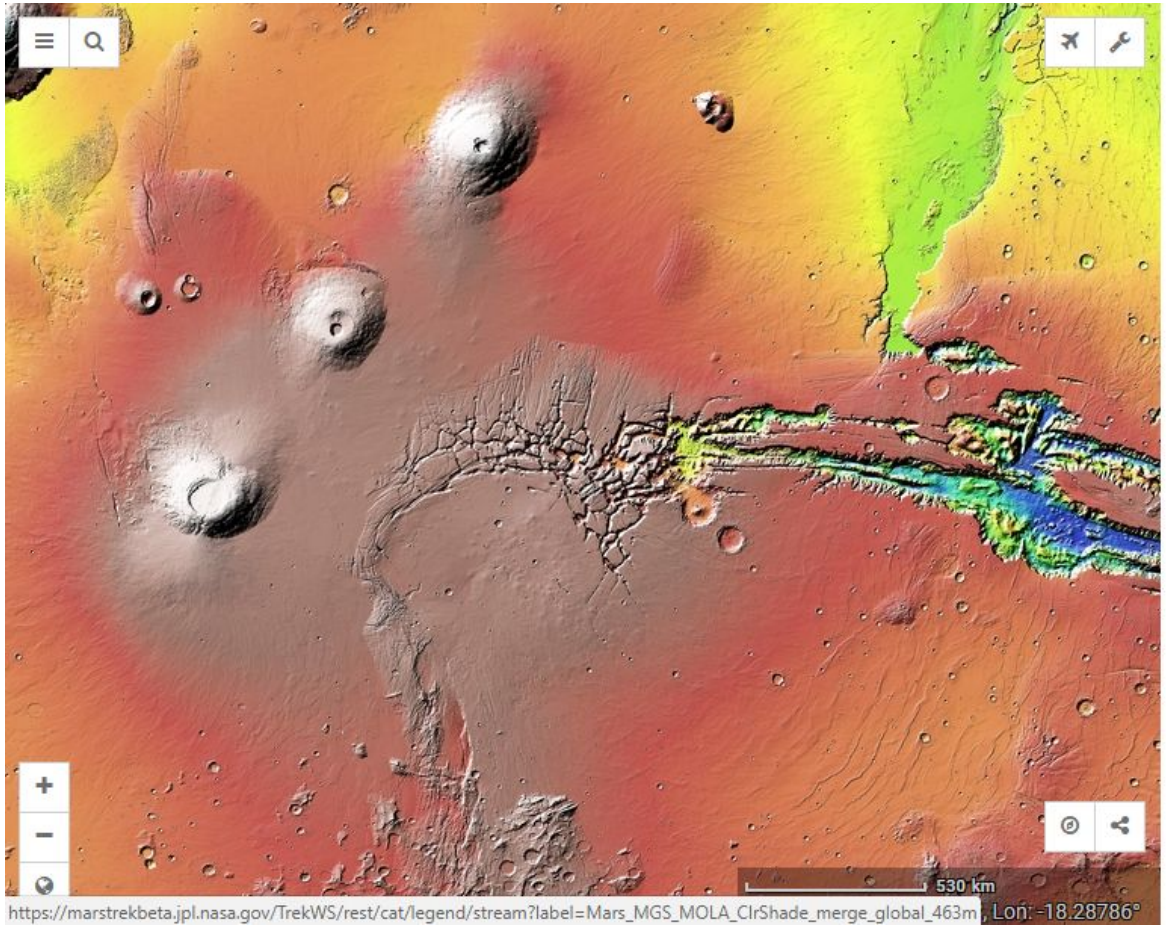
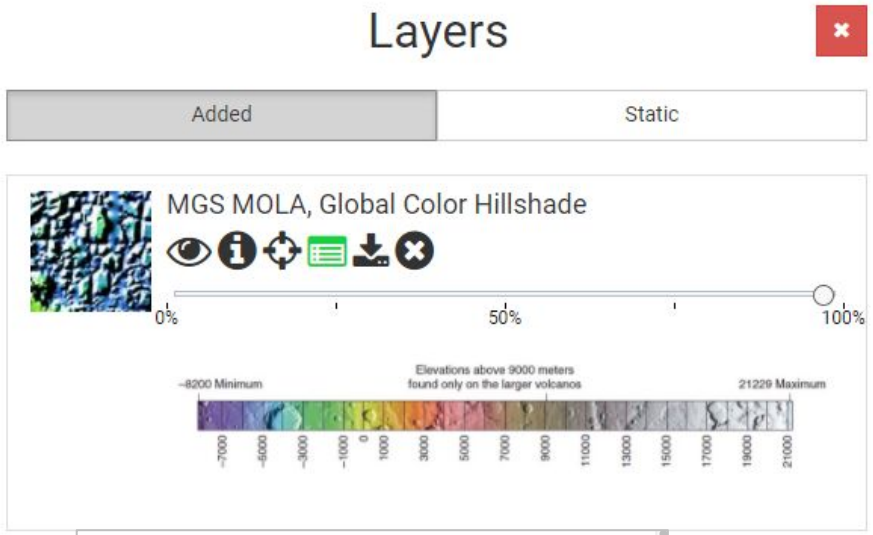
Visualization





MRO CTX, Mosaic InSight

Metadata also available as

Metadata:

- Identification_Information
- Spatial_Data_Organization_Information
- Spatial_Reference_Information
- Metadata_Reference_Information

Identification_Information:

Citation:

Citation_Information:

Originator: NASA-JPL
Originator: USGS
Originator:
Advanced Laboratory for Landing Site Terrain Analysis and Reconnaisance
Publication_Date: 20171129
Title: MRO CTX, Mosaic InSight
Geospatial_Data_Presentation_Form: raster digital data
Other_Citation_Details:
Golombek, M., Kipp, D., Warner, N. et al. Space Sci Rev (2017) 211: 5.
Online_Linkage: https://doi.org/10.1007/s11214-016-0321-9

Description:

Abstract:
This is a 5m/px CTX orthophoto mosaic of the InSight Landing Site. After being transformed using a spline transformation, each image had the exterior 100m of pixels removed and was detrended by fitting a third order polynomial and subtracting it from each image. All of the detrended images were then mosaiced into a single image and color balanced using Distributed Gradient-Domain processing.

+ Add Layer

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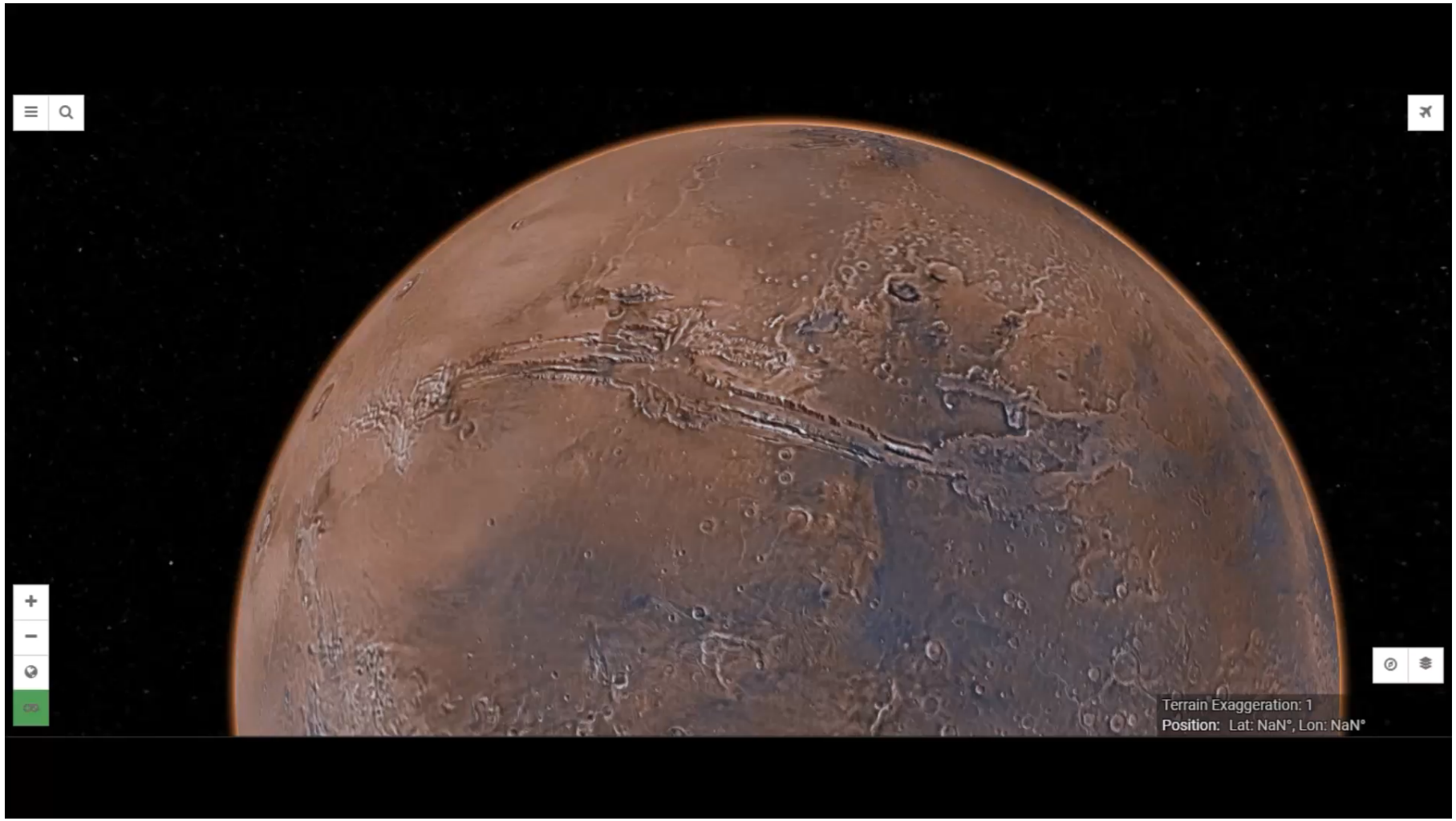
3D Visualization



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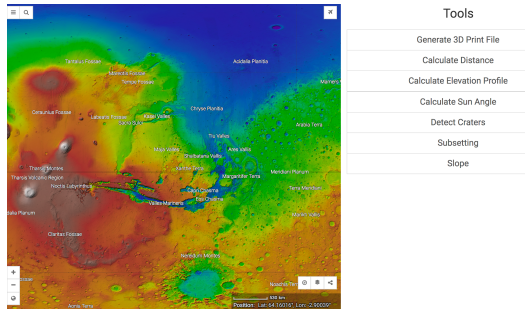
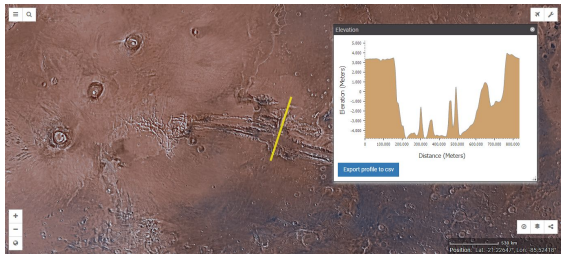
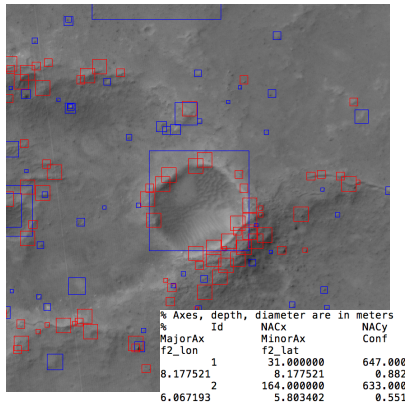
Analytics

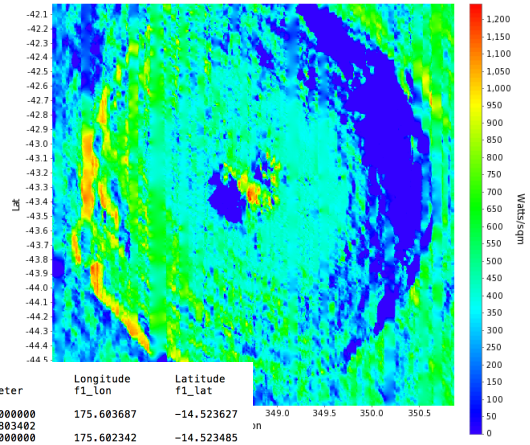
- Basic tools
  - Distance, Elevation, Sun Angle, 3D prints generation





- Advanced tools for exploration and research
  - Lighting, Crater Detection, Rock Detection, Slope, Path, Surface Potential





% Axes, depth, diameter are in meters

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6.067193	2	164.000000 5.803402	633.000000 0.551909	0.000000 0.968166	0.000000 4.220656	175.602342	-14.523485
0.791373	3	185.000000 0.791373	659.000000 0.897428	0.000000 0.424569	0.000000 1.582746	175.602130	-14.523748
1.318955	4	293.000000 1.318955	586.000000 0.515028	0.000000 0.000000	0.000000 2.637910	175.601039	-14.523011
1.055164	5	214.000000 1.055164	624.000000 0.869387	0.000000 0.268521	0.000000 2.110328	175.601837	-14.523395
0.791373	6	29.000000 0.791373	496.000000 0.624331	0.000000 0.569619	0.000000 1.582746	175.603707	-14.522103
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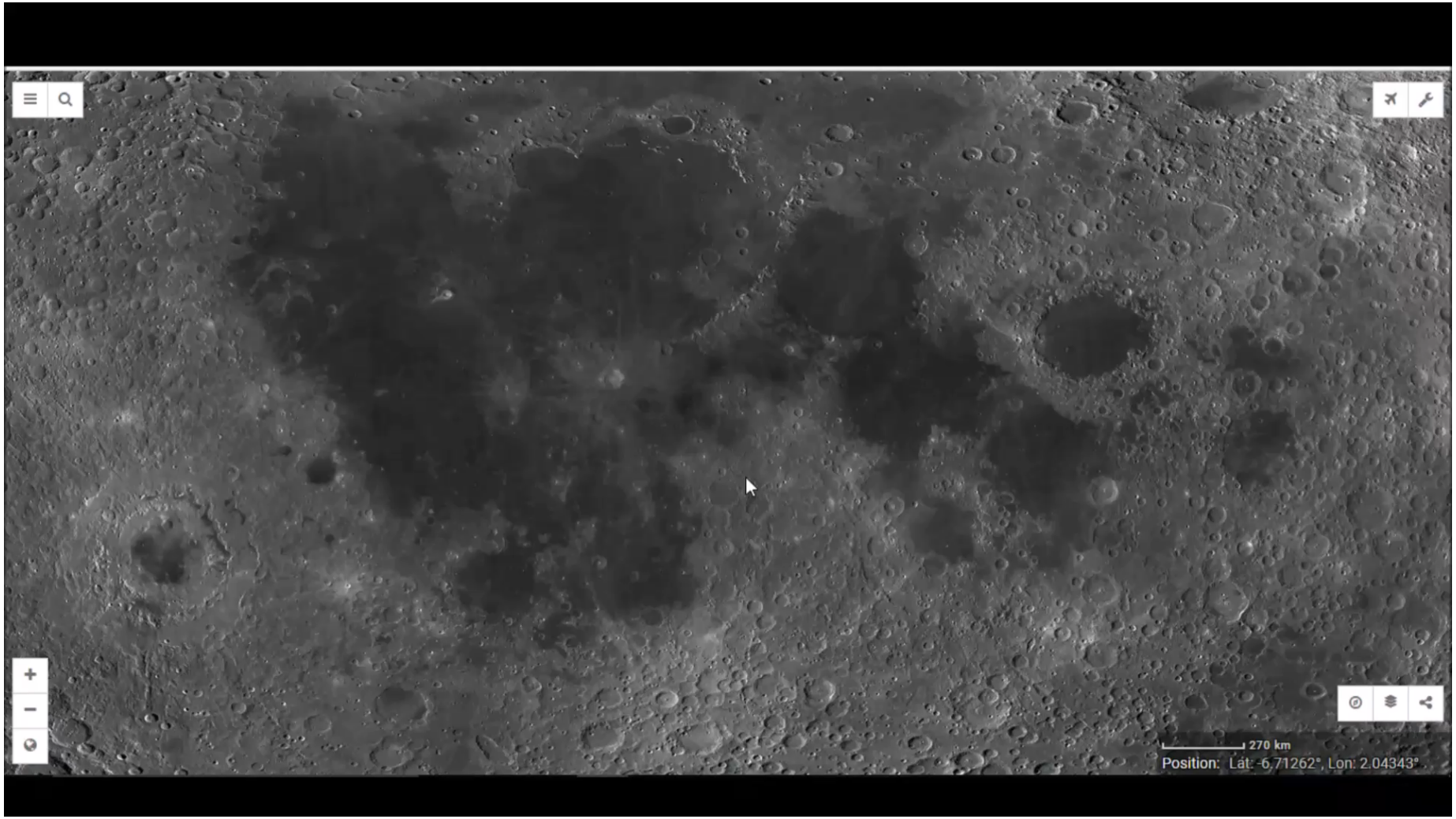
Visualization & Analytics



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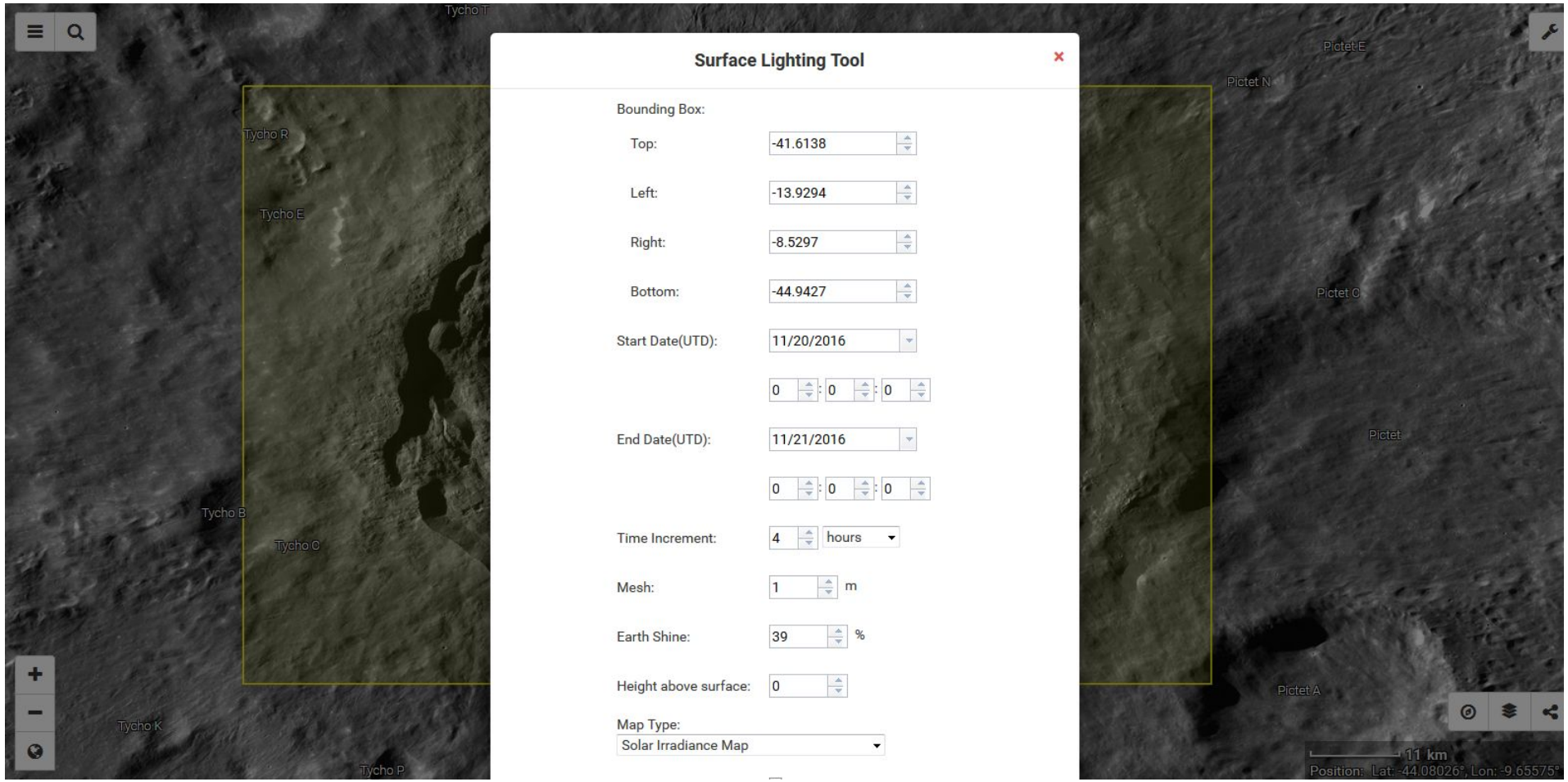
Lighting Analysis



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Lighting Analysis Result

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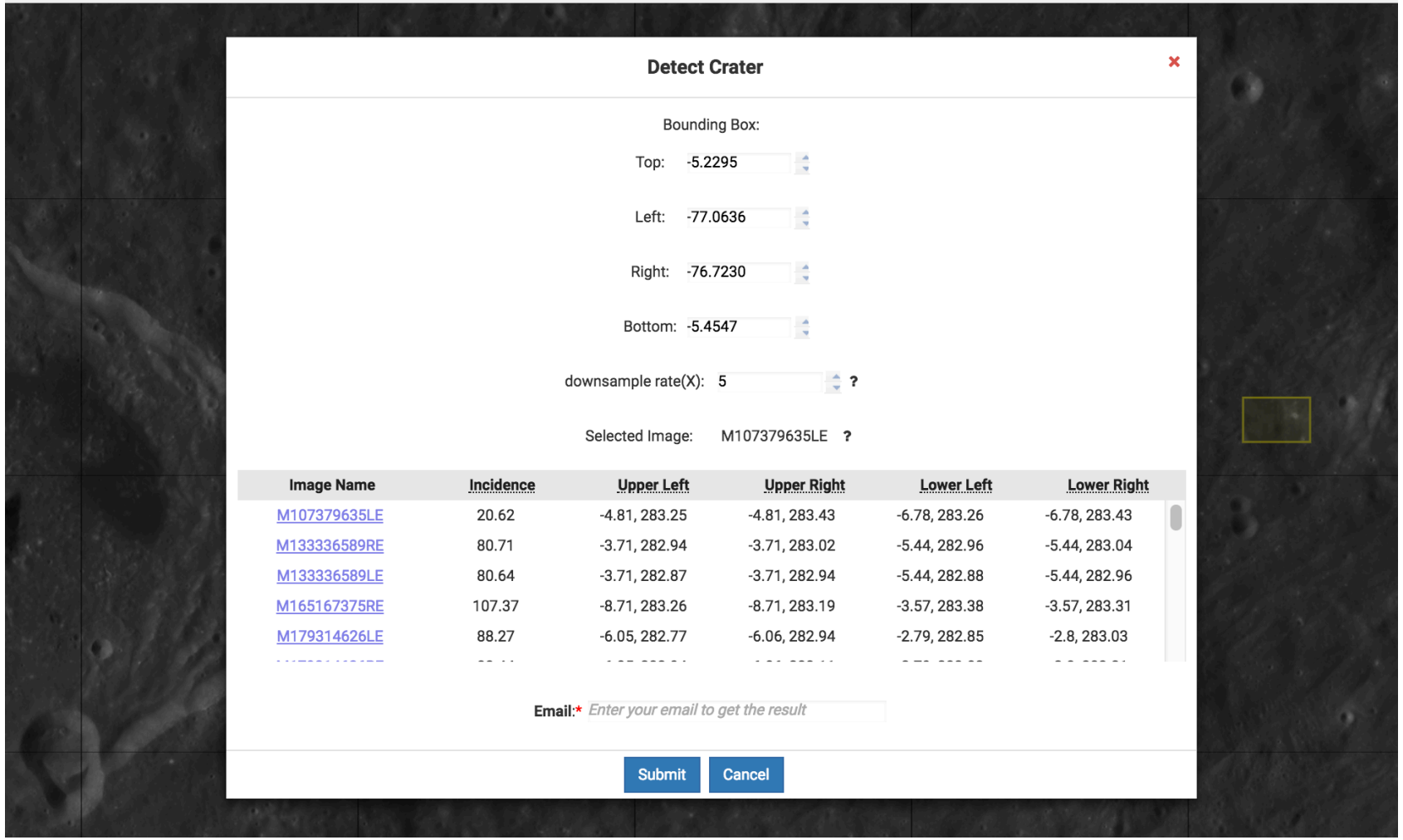
Crater Detection

https://moontrek.jpl.nasa.gov/#v=0.1&x=-79.76623386363772&y=-5.564575091513323&z=7&p=urn%3Aogc%3Adef%3Acrs%3AEPSG...



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M133336589LE	80.64	-3.71, 282.87	-3.71, 282.94	-5.44, 282.88	-5.44, 282.96
M165167375RE	107.37	-8.71, 283.26	-8.71, 283.19	-3.57, 283.38	-3.57, 283.31
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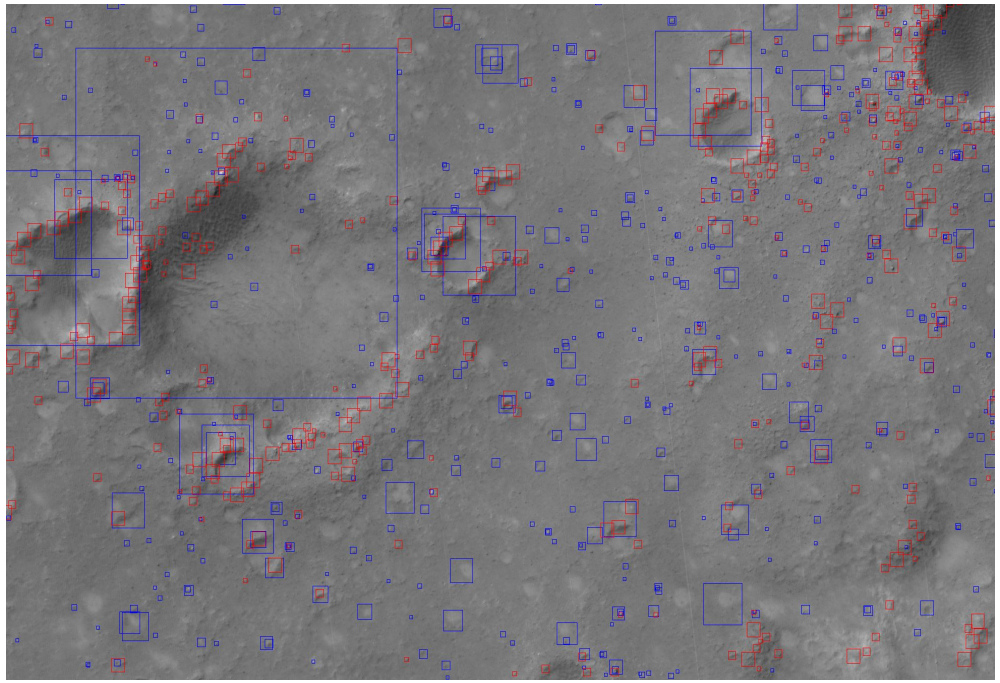
Crater/Rock Detection Result



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MajorAx         MinorAx         Conf            Depth           Diameter        f1_lon          f1_lat
f2_lon          f2_lat
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8.177521          8.177521        0.882696        1.750542        5.803402
        2       164.000000      633.000000        0.000000        0.000000      175.602342      -14.523485
6.067193          5.803402        0.551909        0.968166        4.220656
        3       185.000000      659.000000        0.000000        0.000000      175.602130      -14.523748
0.791373          0.791373        0.897428        0.424569        1.582746
        4       293.000000      586.000000        0.000000        0.000000      175.601039      -14.523011
1.318955          1.318955        0.515028        0.000000        2.637910
        5       214.000000      624.000000        0.000000        0.000000      175.601837      -14.523395
1.055164          1.055164        0.869387        0.268521        2.110328
        6        29.000000      496.000000        0.000000        0.000000      175.603707      -14.522103
0.791373          0.791373        0.624331        0.569619        1.582746
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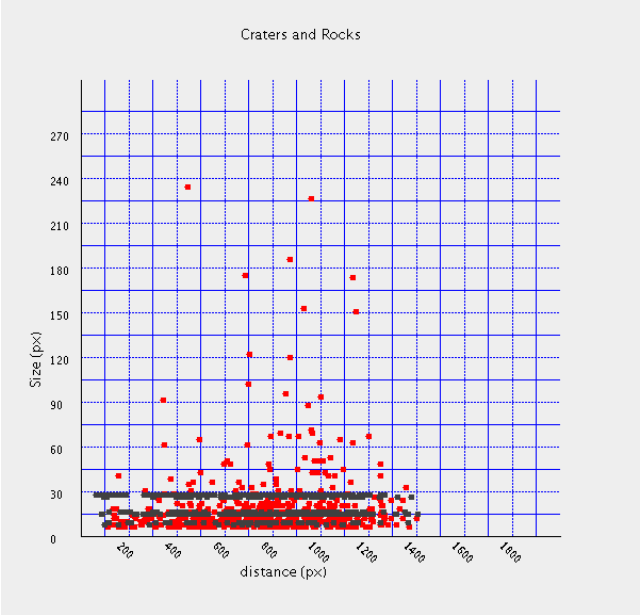

Summary

- Planetary exploration and science are complex
  - Data is difficult to interpret and use
- GIS enabled interactive Visualization and Analytics have major impact
  - Lower barrier of usability, advance science & science communication, inspire public
- GIS technologies and capabilities exist but lacking, more investments needed
  - Visualization and analytics
  - Value added geospatial product generation
- Solar System Treks project continues to advance these fields
  - New portals coming soon: Ryugu, Mercury, Phobos, Bennu, 67P/C-G, etc

Acknowledgements

NASA's Science Mission Directorate (SMD)

Planetary Science Division

Science Engagement and Partnerships Division

NASA's Moon to Mars Directorate (MMD)

We thank them for their support and guidance of the development of Solar System Treks

Thank You

Questions?

https://trek.nasa.gov

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