GIS RESOURCES

Planetary Data Workshop
14 June 2017, Flagstaff, AZ

TRENT HARE

OUTLINE

- Community Examples (state of the art).
- Online GIS Data Resources
- GIS Applications update
  - ArcMap, QGIS, GDAL
- Highlight Foundation Data Examples
- Community Sensor Model (what is it).

MRCTR GIS Lab – What is it

Astrogeology Science Center

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Home > Labs & Facilities > GIS lab

The MRCTR "Mercator" GIS Laboratory

Mapping
Remote-sensing
Cartography
Technology
Research

Expertise and community support for planetary mapping and GIS technologies including:

- GIS Tutorials
- Tool development
- GIS training workshops
- On-site training available
- Remote-sensing data processing and conversion
- Data integration
- 3D Visualization
- Research support
- Mission Support
  - Targeting tools
  - Landing site tools
- Standards
  - Formats
  - On-line web mapping (OGC)
  - Cartography (publication and symbology)
  - Federal Geospatial Data Consortium (FGDC) Metadata

For more information about the MRCTR GIS Lab and to find out about GIS training, contact Trent Hare at thare@usgs.gov

Updated on: Thursday, February 10, 2011

US Department of Interior | US Geological Survey | USA.gov | DOI Inspector | Contact Us

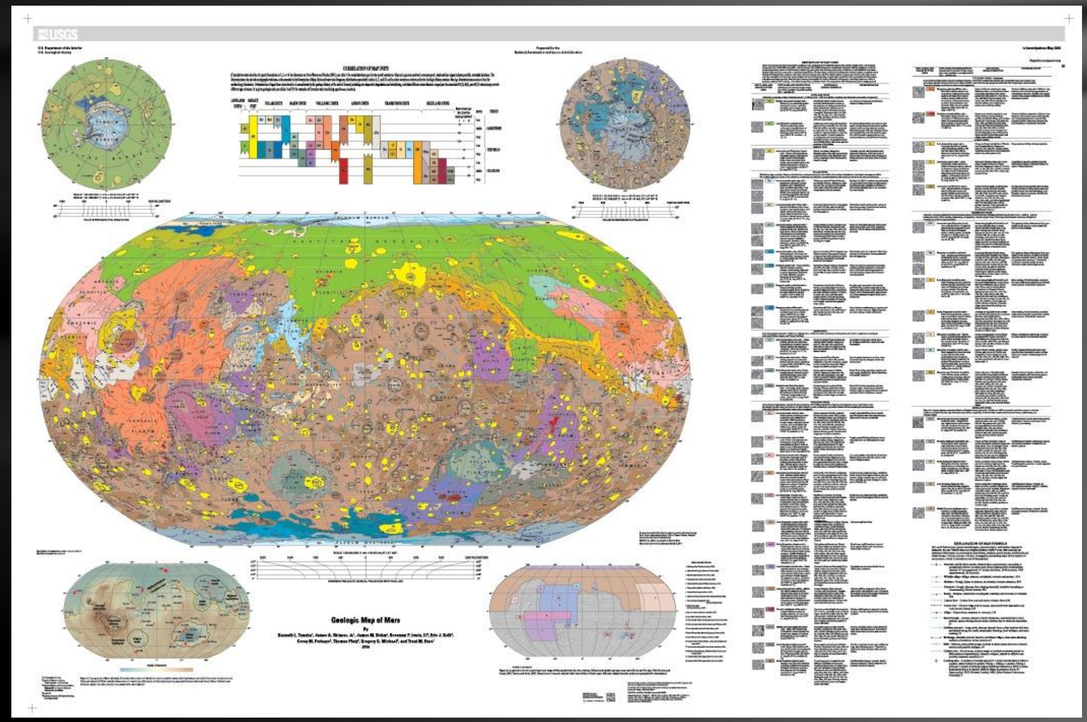
MAPPING REMOTE-SENSING CARTOGRAPHY TECHNOLOGY RESEARCH
MRCTR GIS LAB
USGS
Astrogeology Science Center

Funded by: NASA's "PDSI" Program

Our History of GIS

- GIS Data conversion ~1994
- GIS Geologic map production ~1996
- Mars Pathfinder 1997
- Online mapping 1999

- Data overlay
- Analysis



Geologic Map of Mars (Tanaka et al., 20[illegible])

Planetary GIS Domain

Needs of the planetary community

Same as most any Earth-based mapping community

Need for common projections

Accurate data (to support robotic and human missions)

Support for huge data sets (eg 1TB, 16bt Kaguya mosaic)

- Data portals / Metadata
- Formats

On-line mapping services

Usability / Interoperability

True 3D surfaces (asteroids, in-situ)

PSDI TENET:

Spatial data should just work

1 Label

2 List

3 neural

WHERE ARE WE?

Planetary Web GIS online Resources

State of the Art Summary

- Community has realized several custom WMS/WCS/WCPS implementations
- Examples:
  - PlanetServer, Rasdaman hyperspectral WCS/WCPS server - Jacobs University
  - Lunarserv - Custom WMS/WCS and processing server - Arizona State University
  - MarsTrek, MoonTrek, VestaTrek – WMTS Server (and 3D interface) by JPL
  - JMars (mission planning, data viewer) - Arizona State University

State of the Art Summary

- Community has realized several custom WMS/WCS/WCPS implementations
- Examples:
  - Mars, Moon - Esri (S3) WMTS support – currently under beta
    - Supports optimized WMS and tile server code in GDAL
  - Best-of image bases (as WMS), WFS Nomenclature, ArcGIS Server – USGS
  - German Aerospace Center (Freie University/DLR)
  - Japan Aerospace eXploration Agency (JAXA)
  - More…

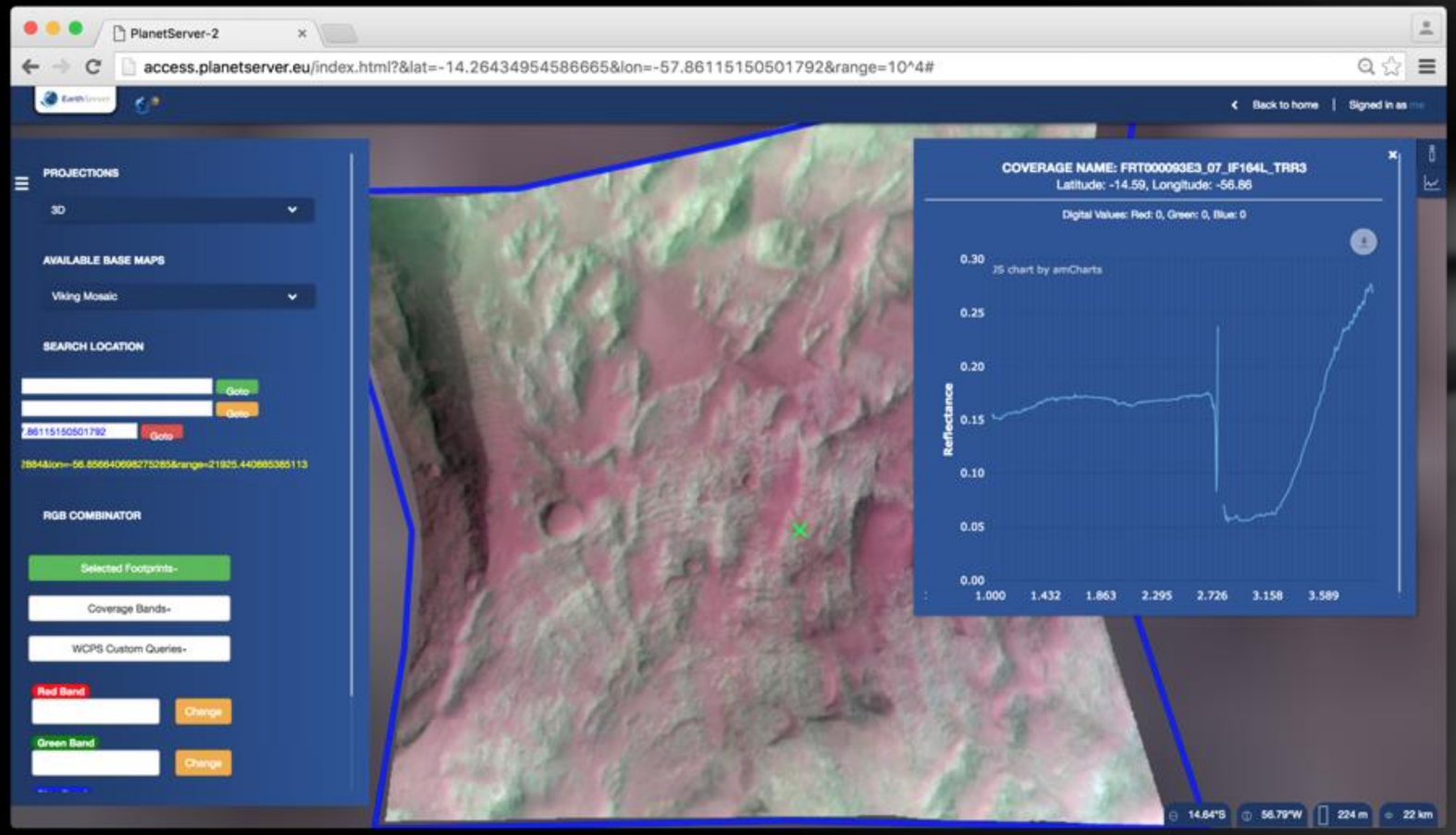
COMMUNITY EXAMPLES

Community Example:

WC(P)S server supported by Jacobs University: access to 10^4 hyperspectral coverages

ESA

(NASA/ESA data)

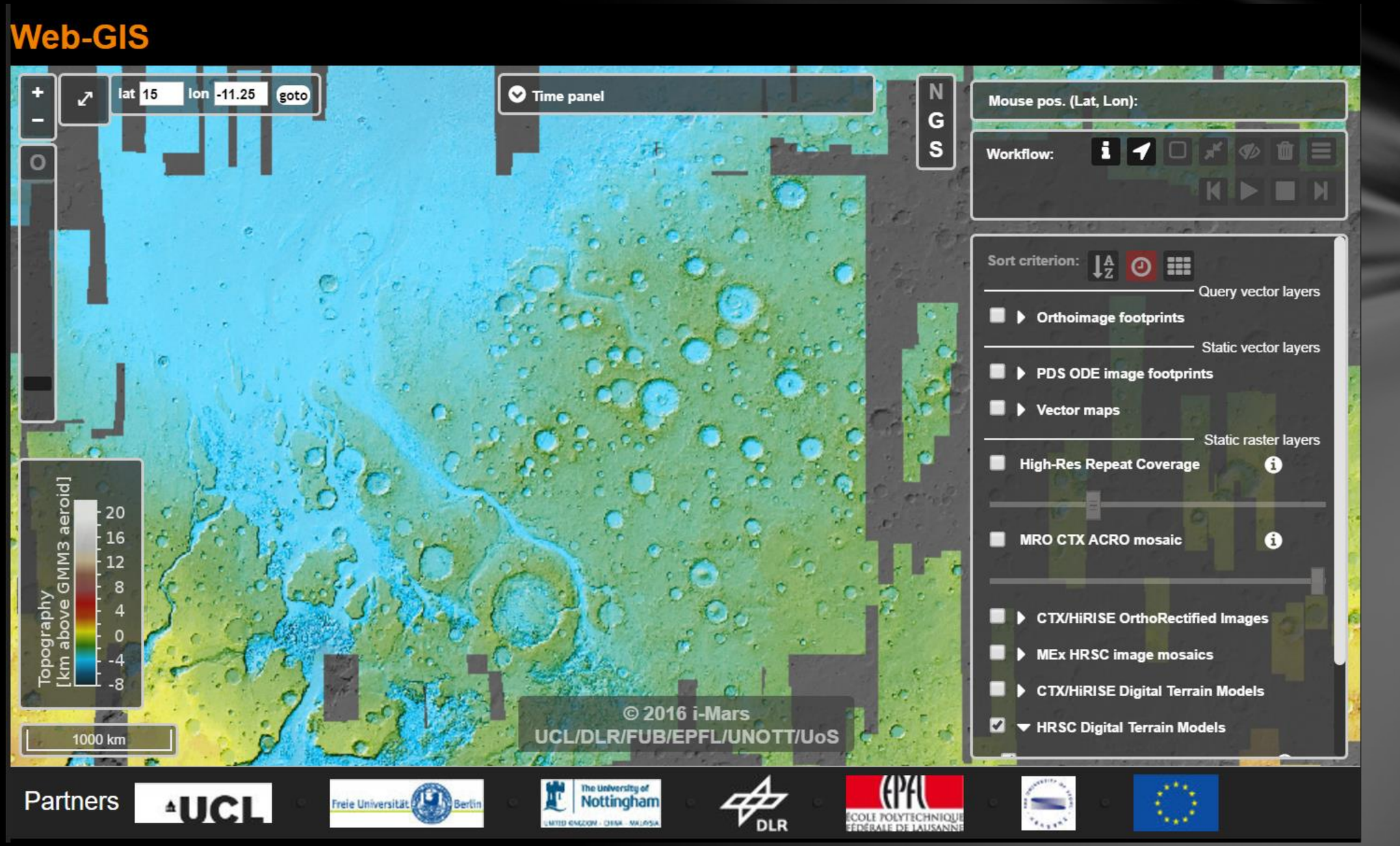


Community Example:

i-Mars

ESA

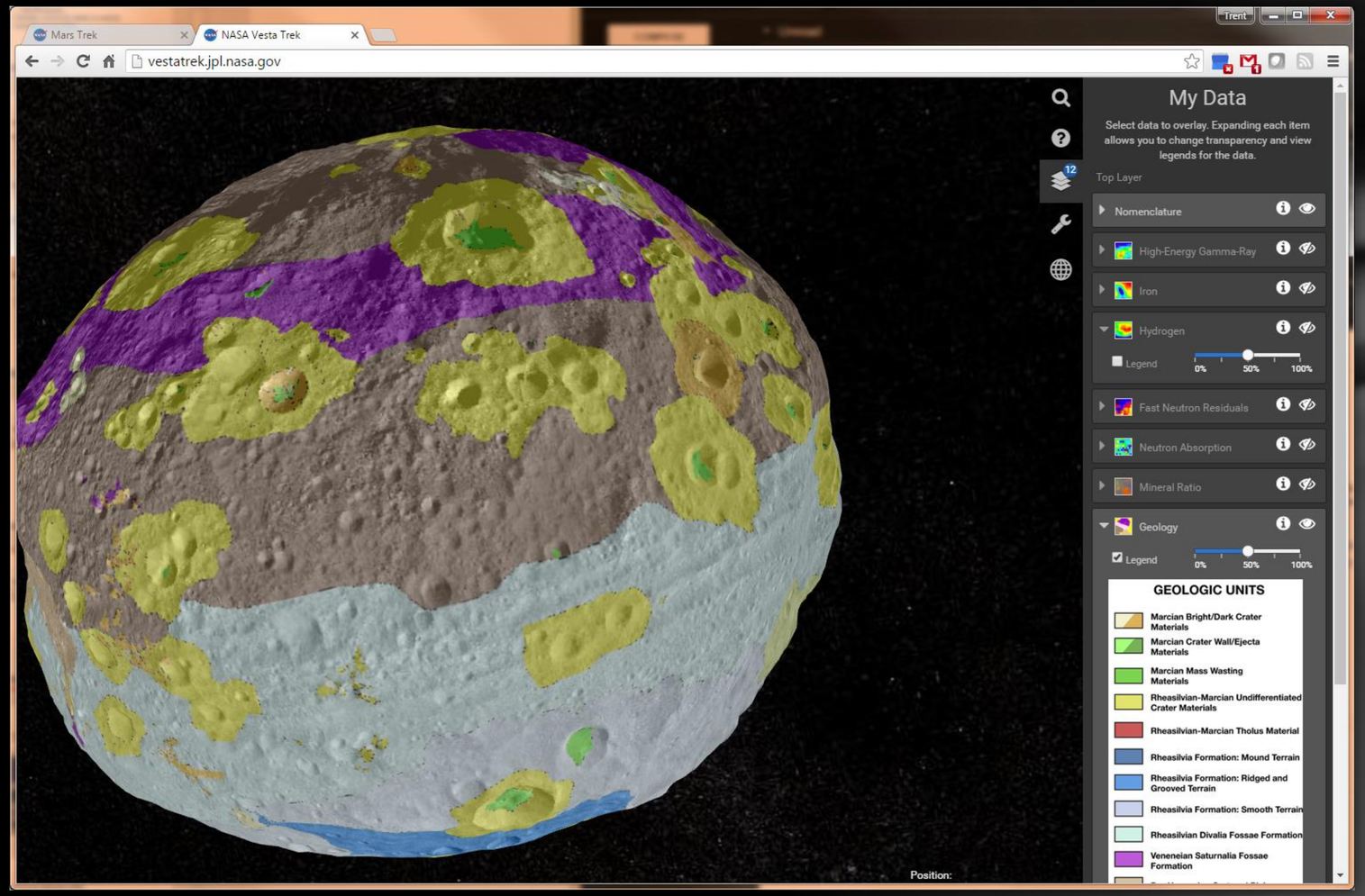
(NASA/ESA data)



Community Example:

VestaTrek (MarsTrek, LunarTrek)

NASA Jet Propulsion Laboratory and AMES



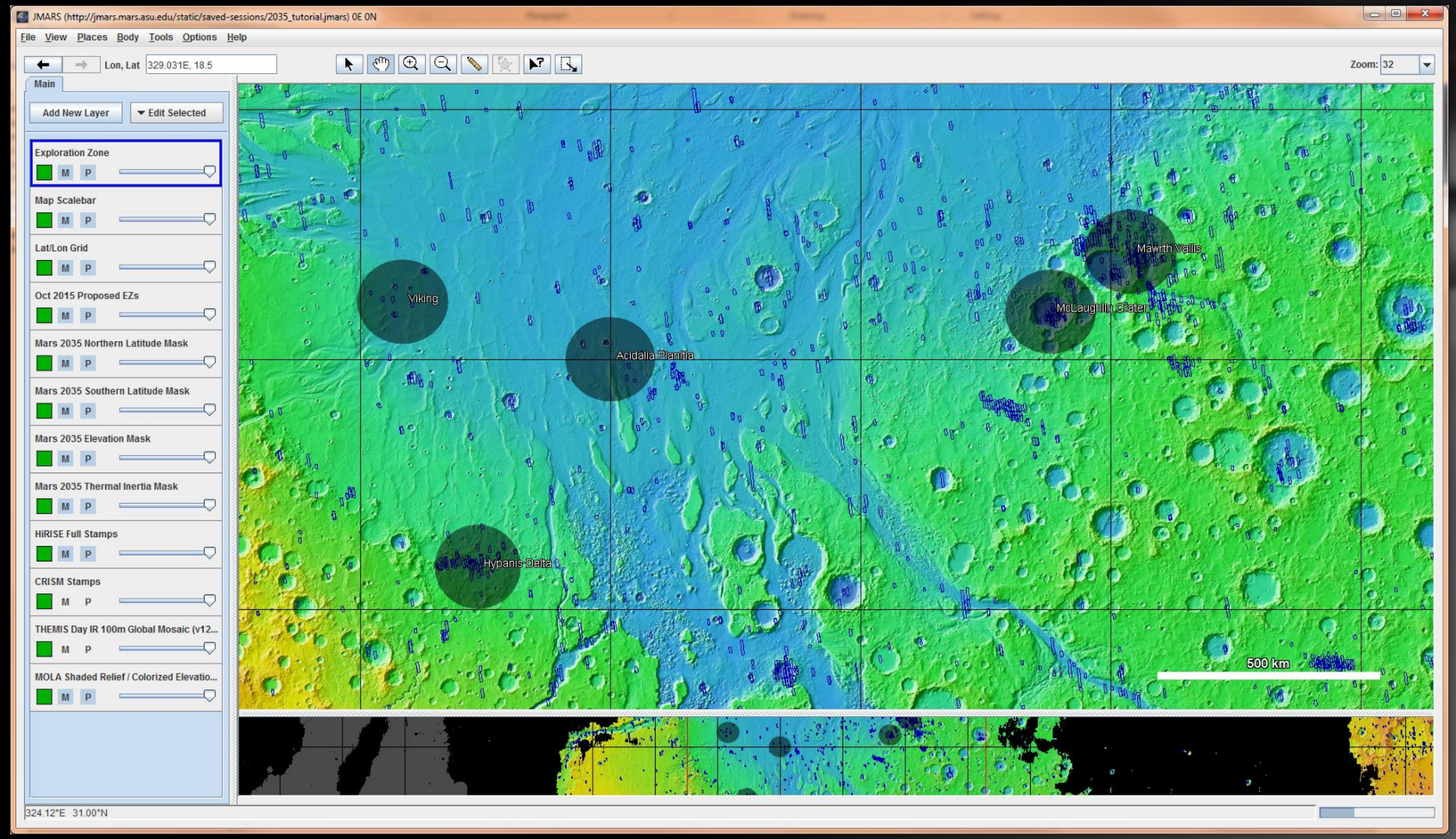
Community Example:

JMARS Mission Planning and GIS Application

Arizona State University

Advanced data streaming techniques

Thick client app.

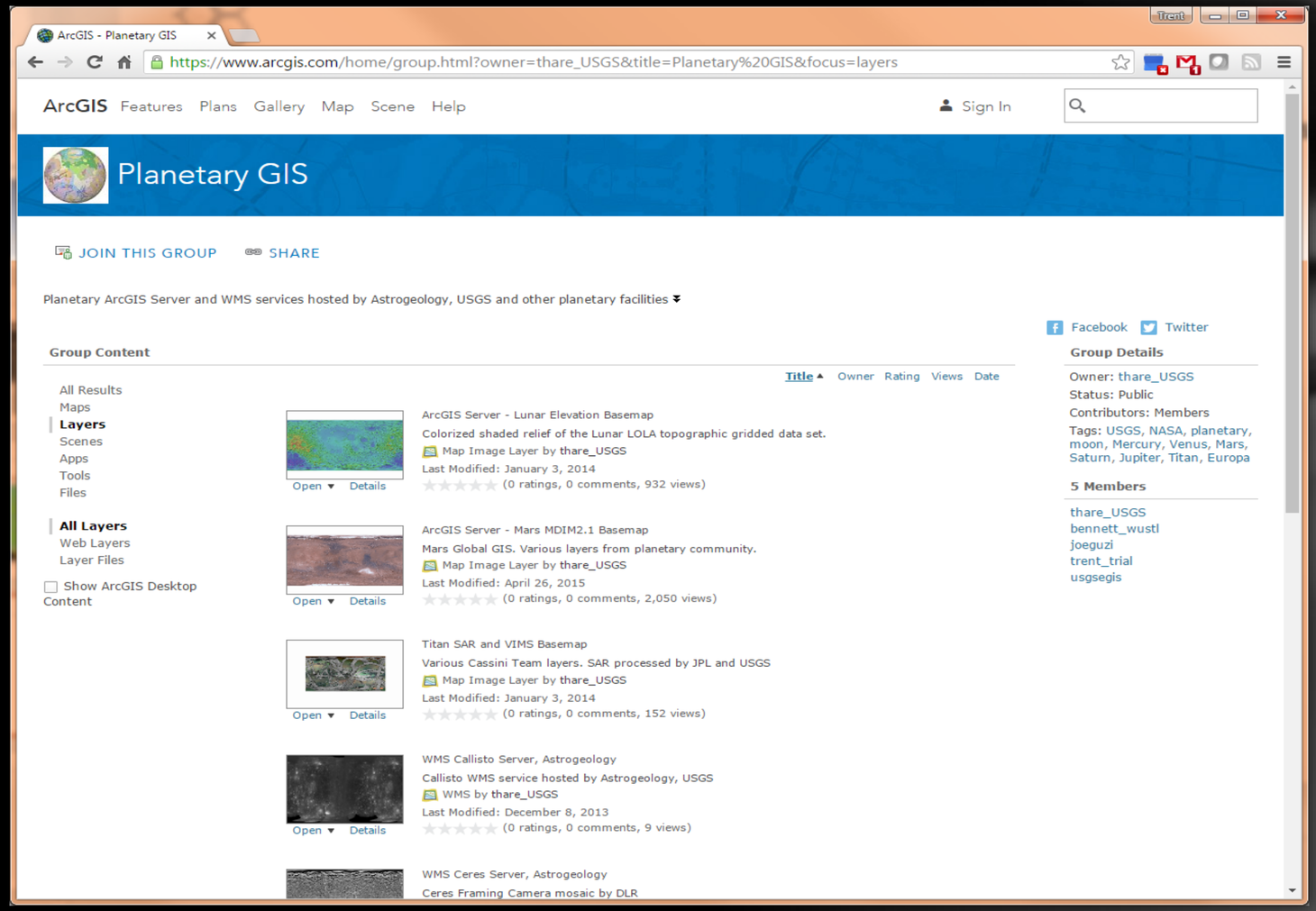


Community Example:

WMS services containing 30+ different planetary bodies with 100+ image layers

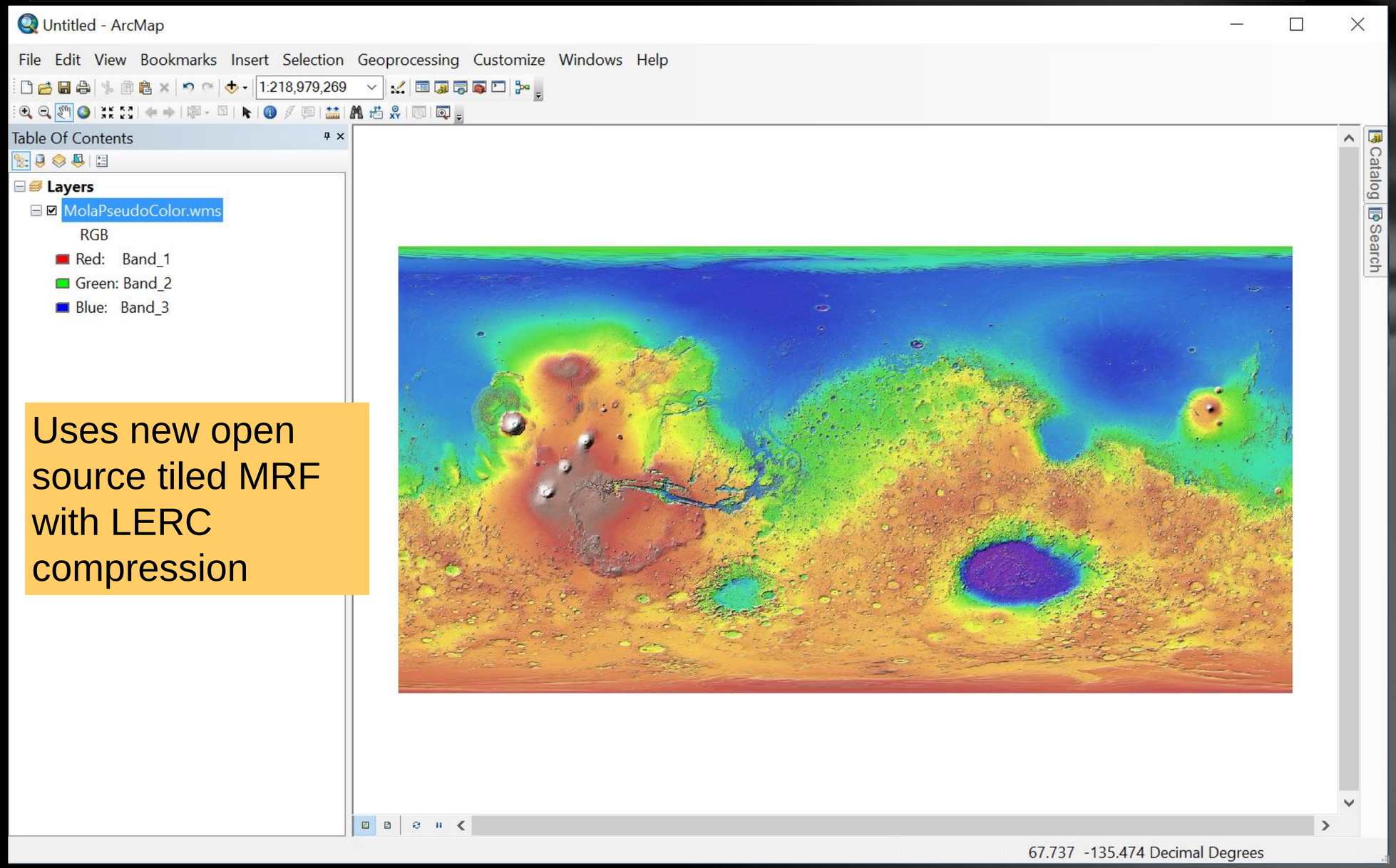
Astrogeology USGS

direct access from ArcMap, QGIS or GDAL (bit.ly/PlantaryGIS)



Community Example:

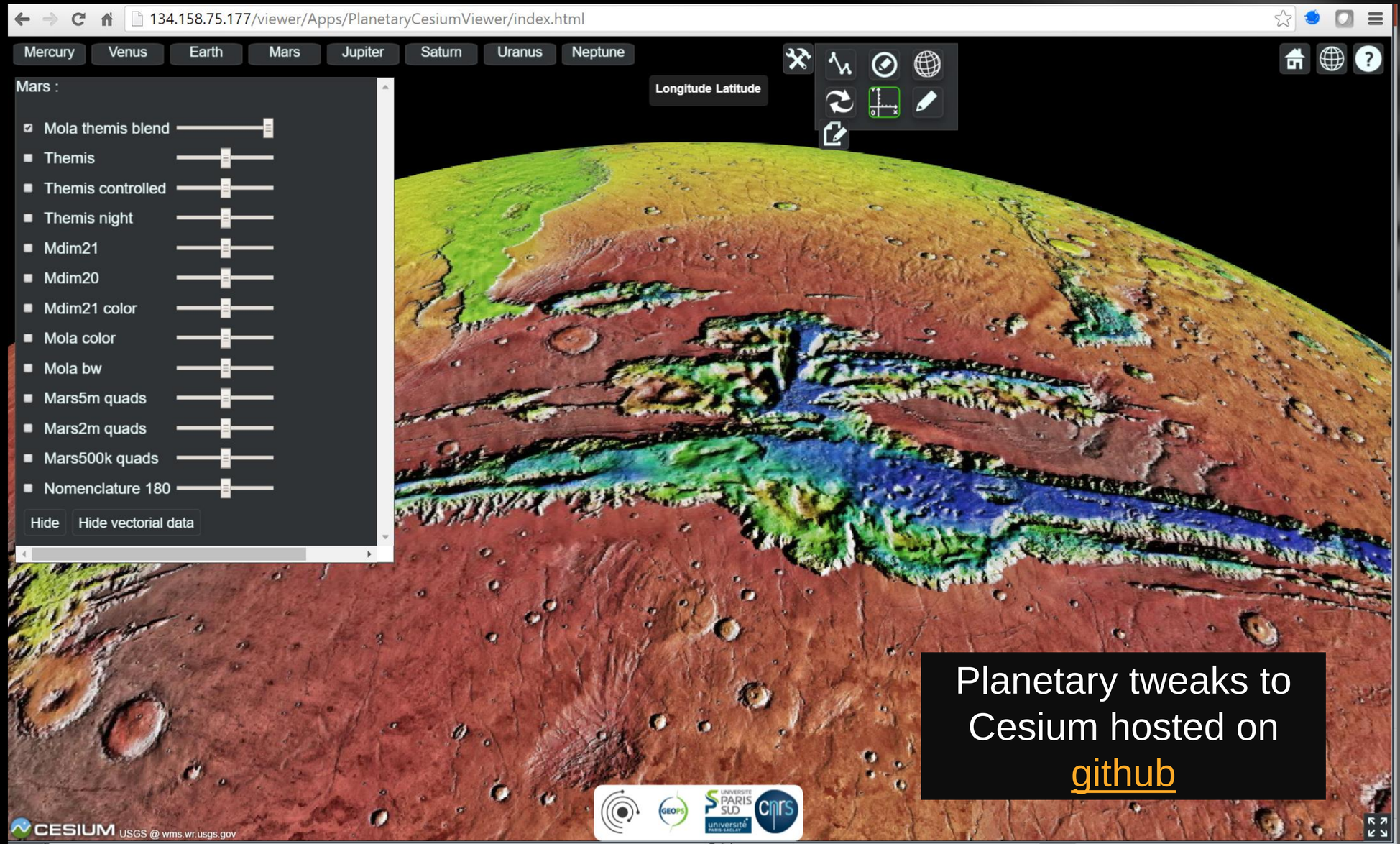
Tiled WMS – in Esri's (Amazon) Cloud



Uses new open source tiled MRF with LERC compression

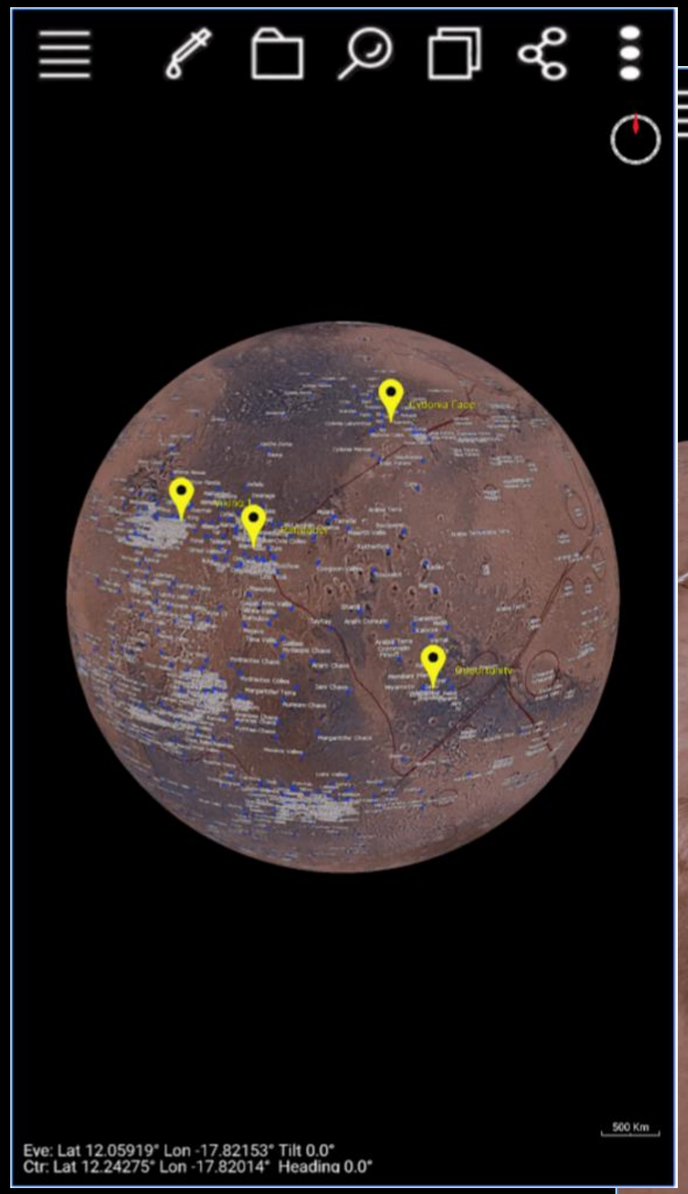
Community Example:

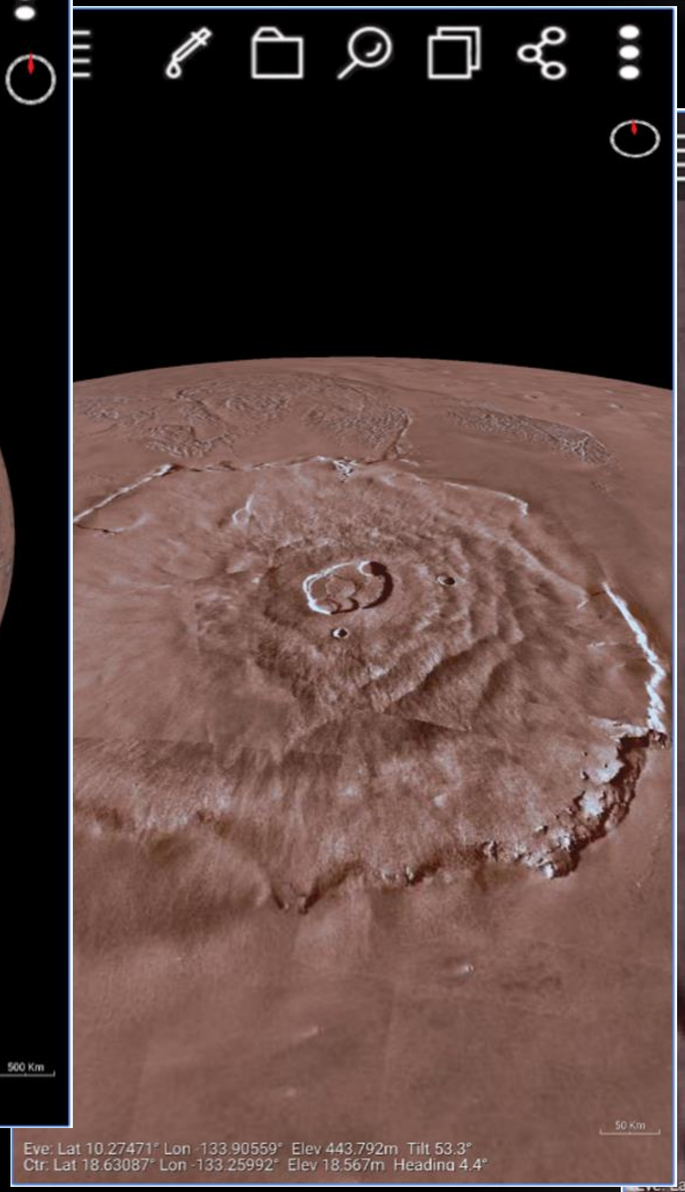
Paris Sud University, Orsay (live WMS layers in Cesium)

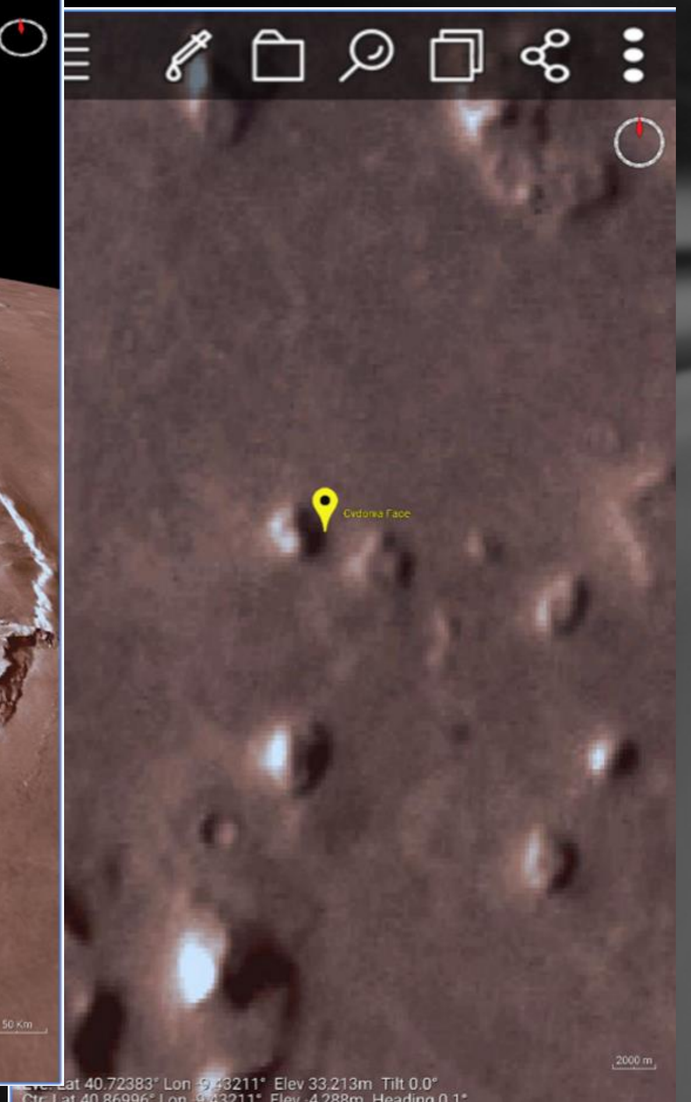


Community Example:

WMS live layers in Android Phone App







Web Streaming Challenges

- WMS projection codes are Earth-based:

- There exist planetary codes (IAU2000)
  - Supported by LunaServ WMS (open source)
  - Supported by JPL server (onMars/onMoon)
  - Support for projection registries (spatialreference.org)

Tiled WMS – still a little fragmented

Bandwidth limited

- WFS (vector streaming) – tiled vector maps
- WCS (data streaming) – compression techniques

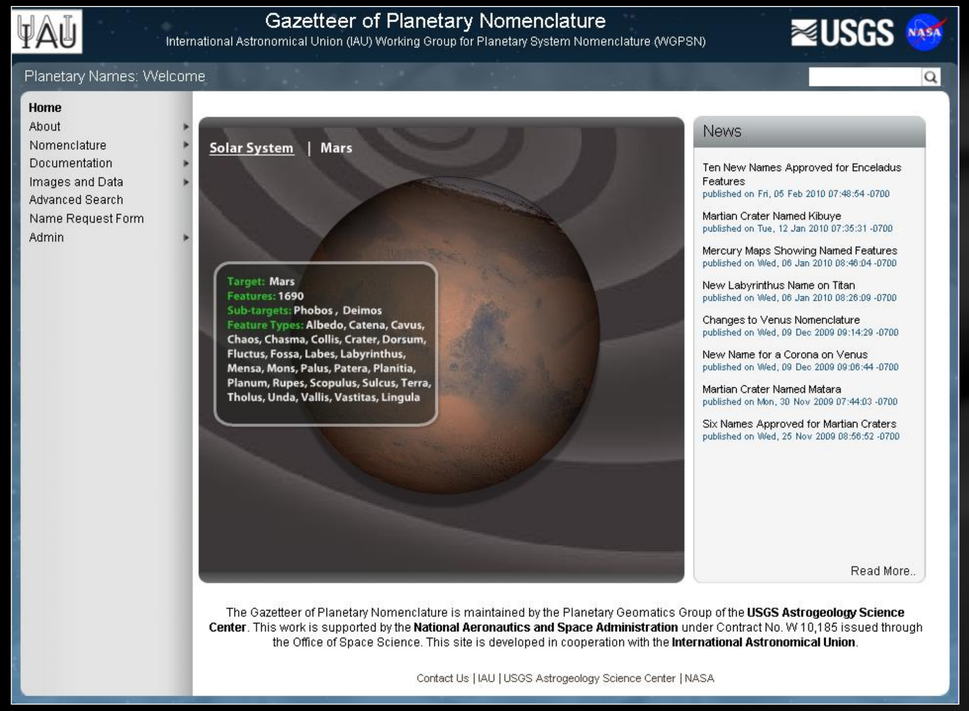
ASTROGEOLOY -- ONLINE “GIS” RESOURCES

Online GIS Resources

IAU Planetary Gazetteer

http://planetarynames.wr.usgs.gov/

Download GIS-ready Shapefiles (point file for each body, approx. bounds)



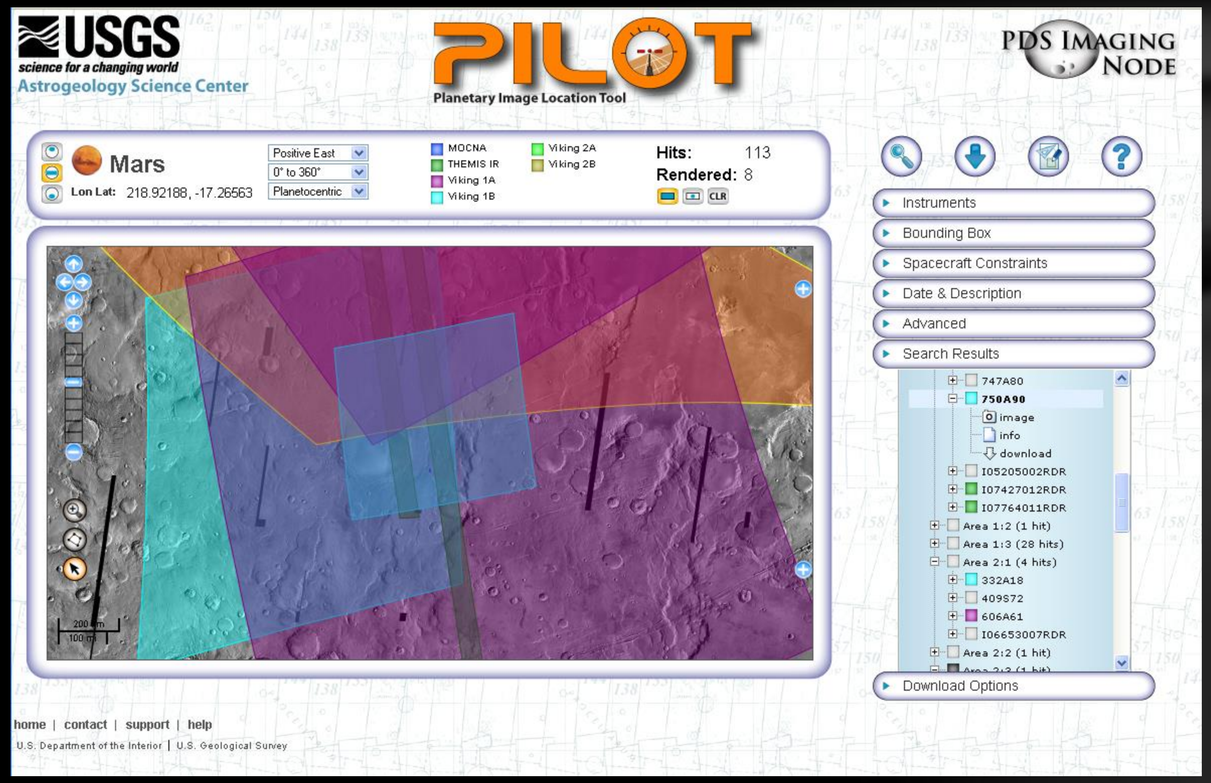
USGS, NASA, and IAU work collaboratively to uniquely identify planetary nomenclature for features on terrestrial bodies.

Online GIS Resources

UPC / PILOT – Planetary Image Location Tool

http://pilot.wr.usgs.gov/

Find images and now stereo coverage,
download GIS shapefiles for each supported instrument



Geospatially search a subset of the PDS Imaging Node EDR archives

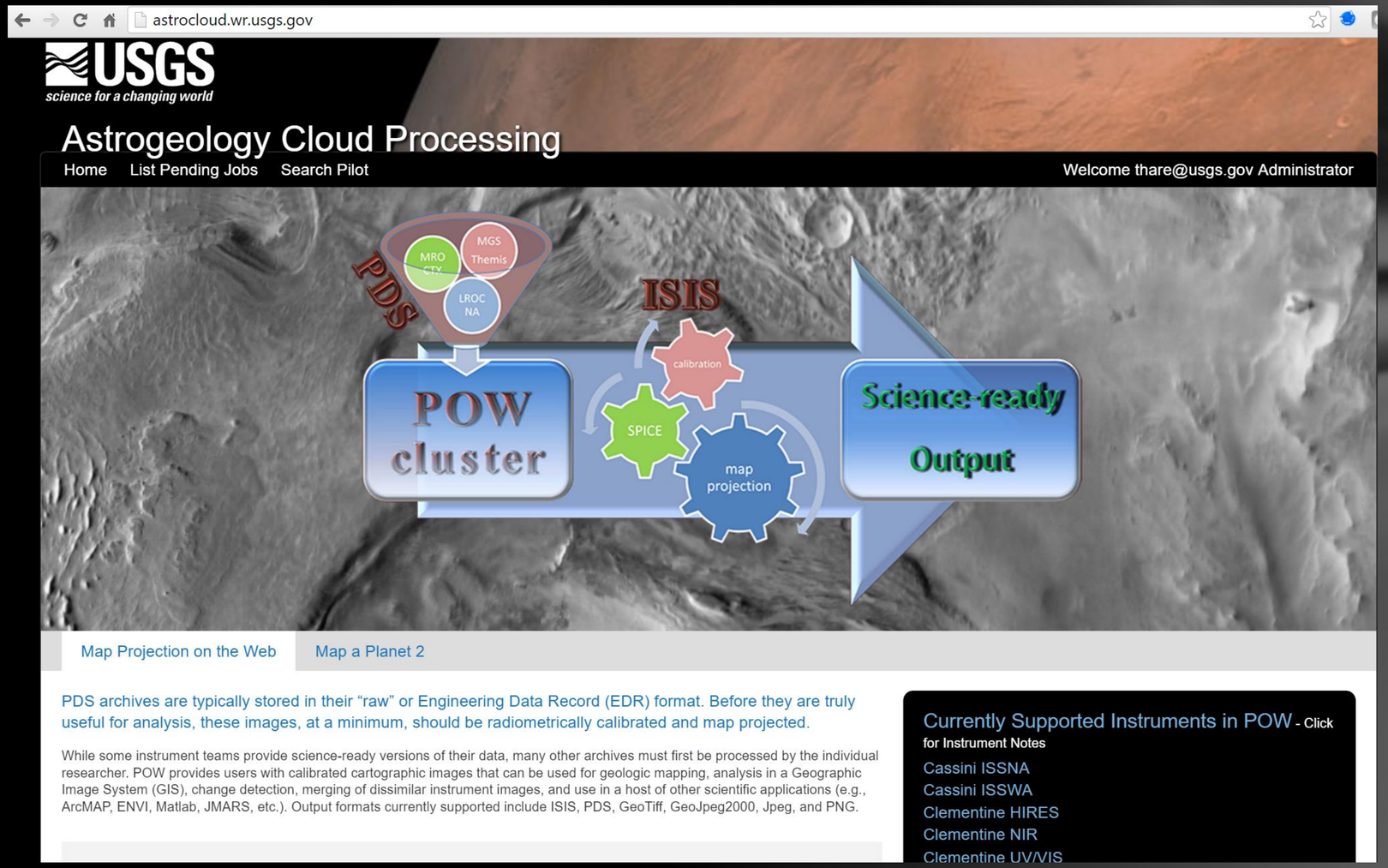
Data sets include

- Cassini, MGS, MRO
- Odyssey, Viking,
- Messenger,
- Clementine, …

ability to process images in POW (ISIS cluster), returns GIS-ready images

Online GIS Resources

POW – Map Projection on the Web



ability to send order to POW, returns GIS-ready images

Online GIS Resources

PDS MAP-A-PLANET "v2"

Download full-res mosaics

Or

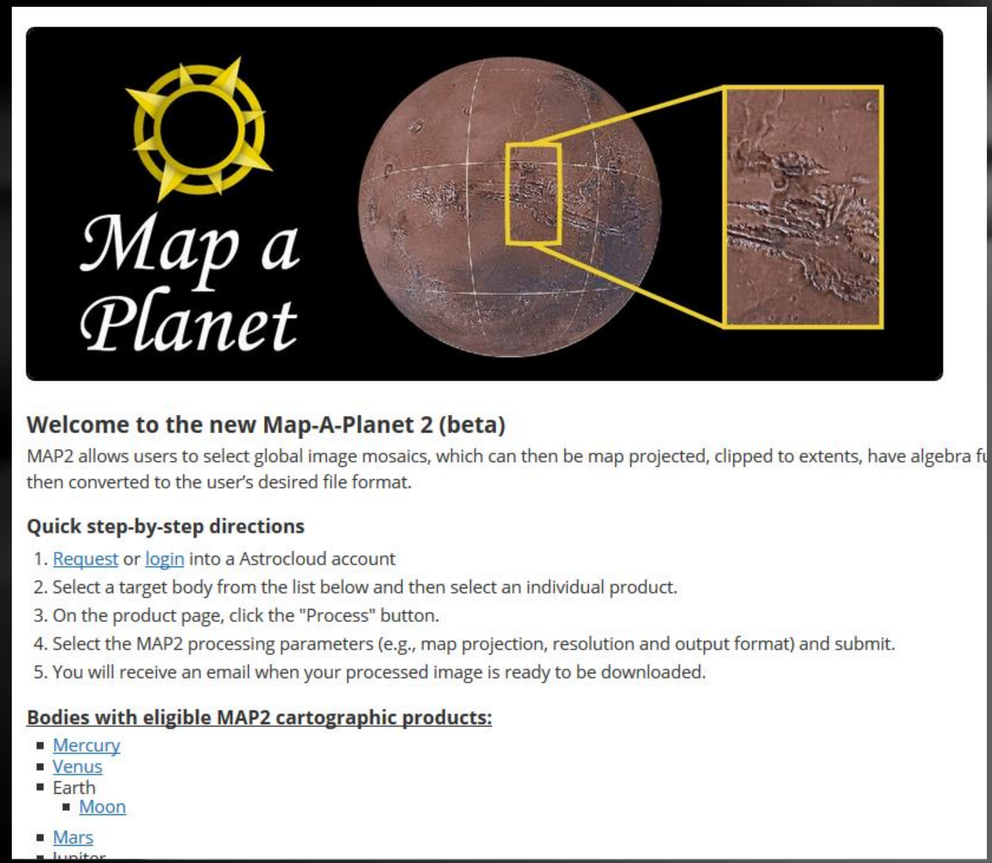
Extract and order areas of interest from existing community created mosaics

Targets include

- Mars, Mercury, Moon, Venus
- Galilean and Saturian satellites, Vesta

GIS-ready formats (GeoTIff, GeoJp2), "soft" image size limit~20GB, ISIS/PDS images, graphical formats

http://astrogeology.usgs.gov/tools/map

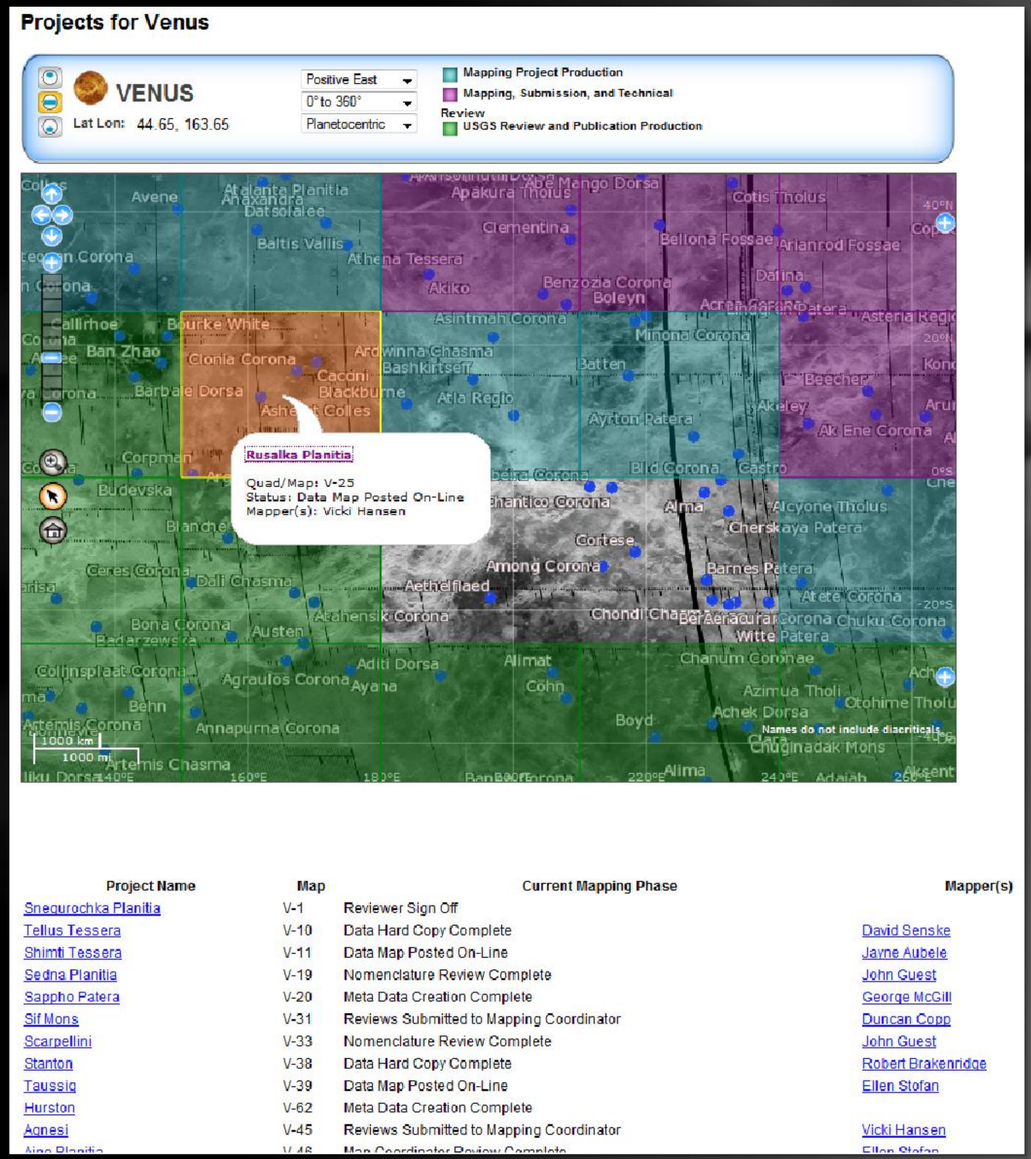


Online GIS Resources

Open Layers (w/ *Planetary Extensions*)

All code available

e.g. Geologic Mapping Tracking Site



Project Name	Map	Current Mapping Phase	Mapper(s)
Snegurochka Planitia	V-1	Reviewer Sign Off	
Tellus Tessera	V-10	Data Hard Copy Complete	David Senske
Shimti Tessera	V-11	Data Map Posted On-Line	Jayne Aubele
Sedna Planitia	V-19	Nomenclature Review Complete	John Guest
Sappho Patera	V-20	Meta Data Creation Complete	George McGill
Sif Mons	V-31	Reviews Submitted to Mapping Coordinator	Duncan Copp
Scarpellini	V-33	Nomenclature Review Complete	John Guest
Stanton	V-38	Data Hard Copy Complete	Robert Brakenridge
Taussig	V-39	Data Map Posted On-Line	Ellen Stofan
Hurston	V-62	Meta Data Creation Complete	
Agnesi	V-45	Reviews Submitted to Mapping Coordinator	Vicki Hansen

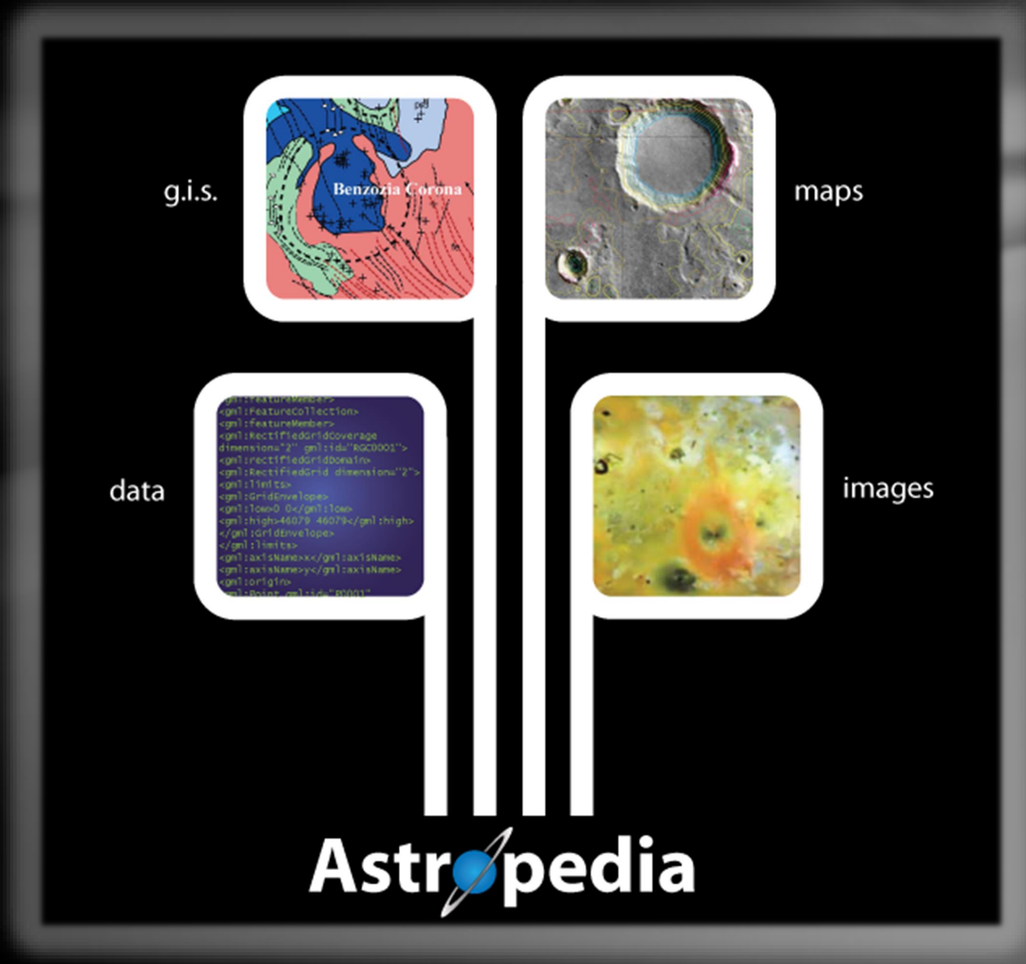
Online GIS Resources

PDS Annex **Data Portal**

PDS Annex is a project at the Astrogeology Science Center to provide a PDS-equivalent archive for GIS layers, geologic maps, and other finished products which might not be accepted as a PDS product.

Needs standardized OGC API called Catalog Service

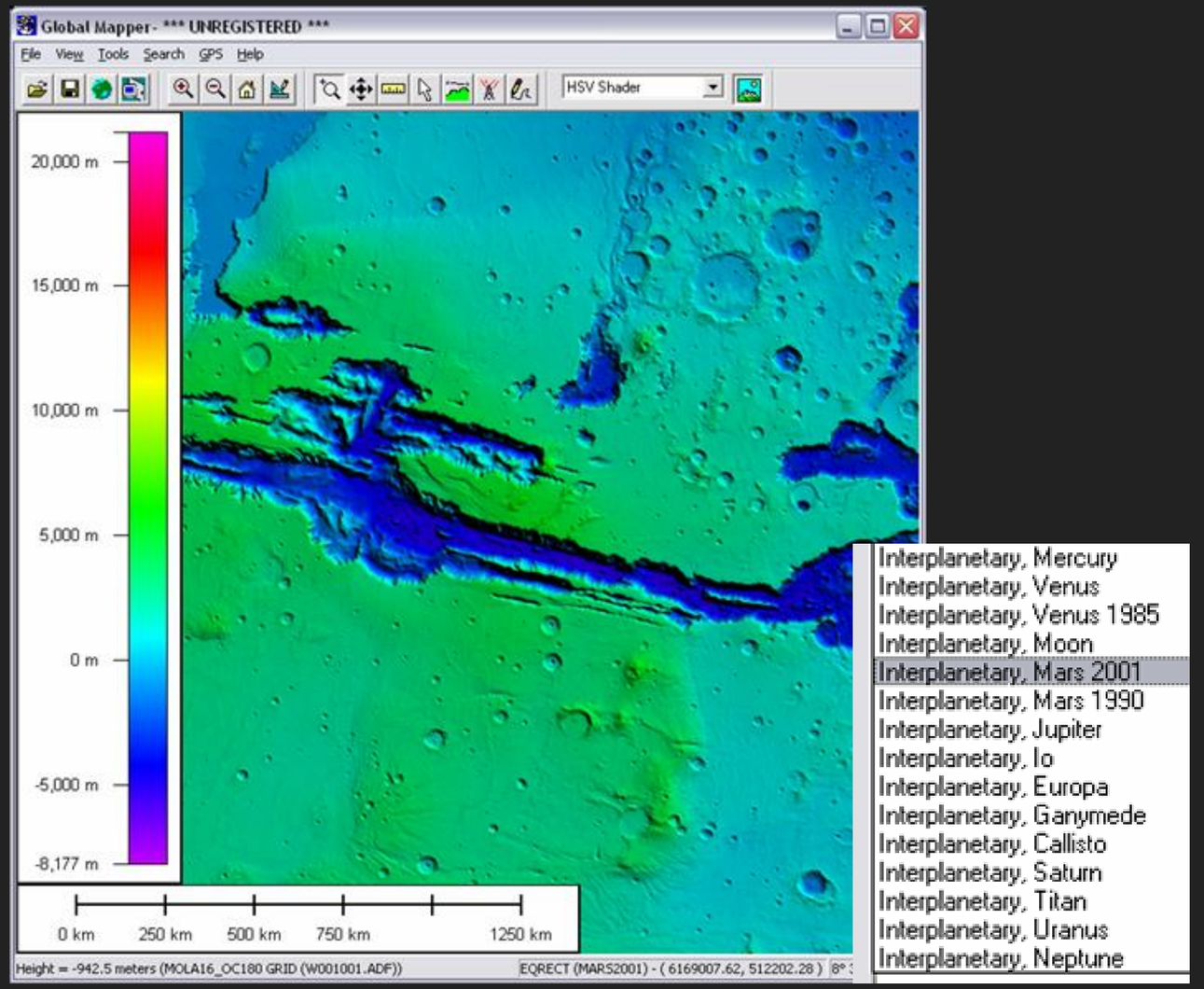
http://astrogeology.usgs.gov/pds/annex



GIS APPLICATION UPDATES

GIS DESKTOP SUPPORT FOR PLANETARY

- Commercial
  - Esri’s ArcMap GIS / ArcGIS Pro
  - Global Mapper
  - ENVI (latest version – Esri’s proj. engine)
- Open Source
  - **QGIS**
  - UDIG GIS
  - SAGA GIS
  - Generic Mapping Tools
  - GRASS

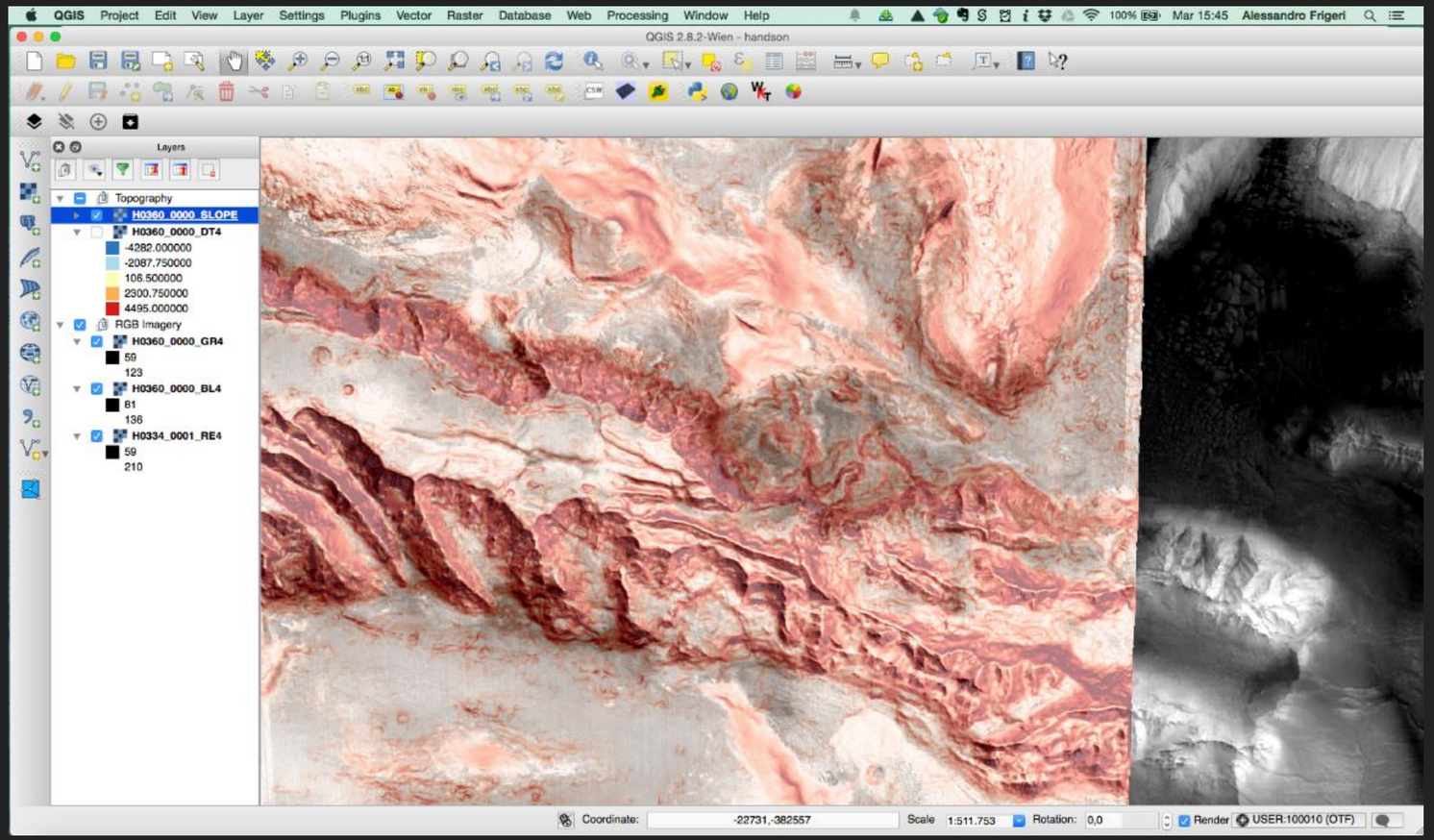


GIS DESKTOP SUPPORT FOR PLANETARY

- QGIS
  - SAGA GIS (add-in)
  - GRASS (add-in)

Today (David Mayer):

QGIS Demo 11:30 Agassiz



QGIS DESKTOP SUPPORT FOR PLANETARY

- Current Version: 2.18.6 ‘Las Palmas’ (April 7th 2017)
- Tons of continued improvements
- Long Term Release (LTR): 2.14.x

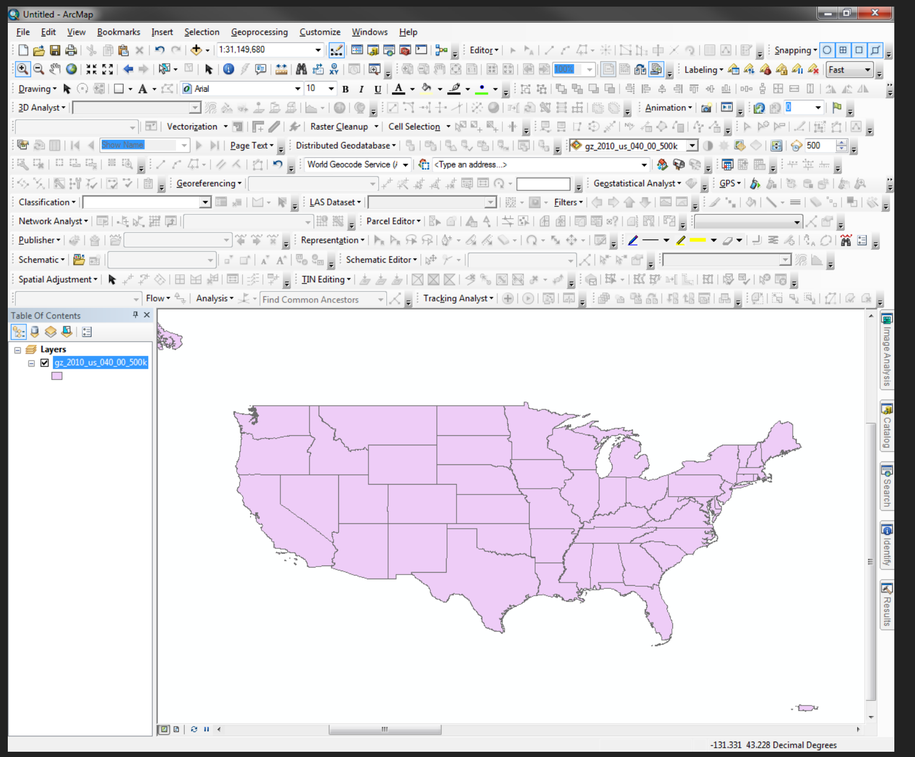
- Upcoming releases: QGIS 3.0

- QT5 and Python 3

  - June 2017: retire 2.14, then 2.18 becomes LTR from June 2017 to 2018
  - July 2017: 3.0 feature freeze
  - Sept 2017: release 3.0 and release 3.2 as next LTR in release 3.0 + 4 Months (eta June 2018)

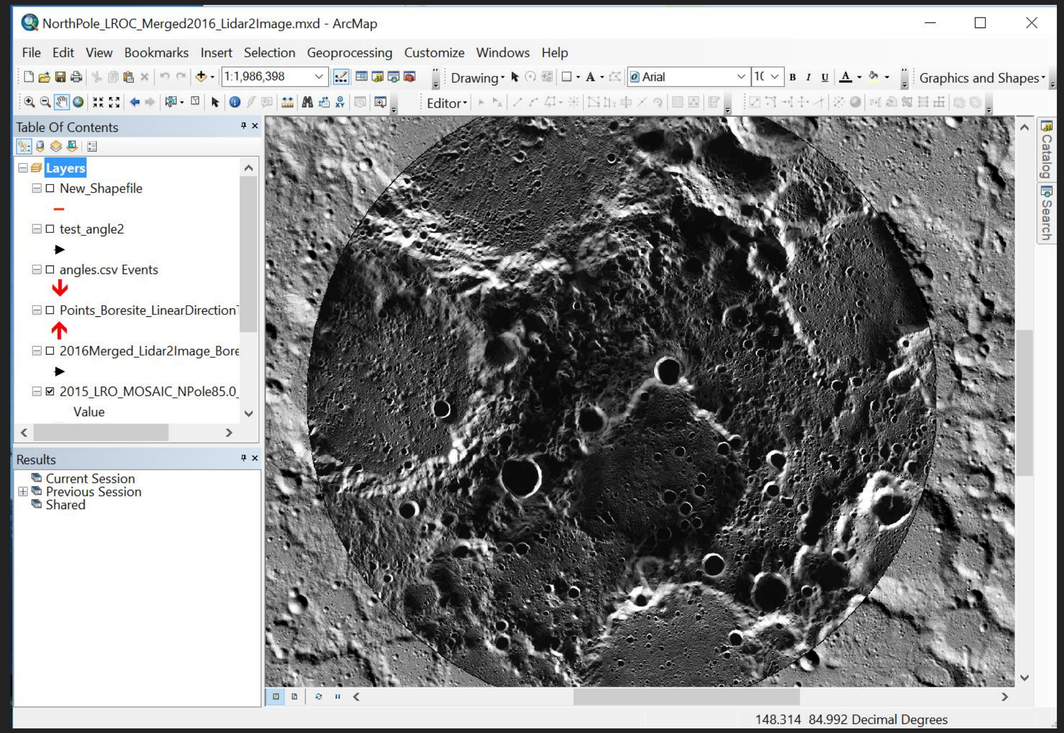
ARCMAP

- Esri added more bodies for 10.5.1?
  - E.g. Mars Sphere (3396190.0), Vesta, Ceres
- Esri supporting server for Mars and Moon.L. Plesea)
  - not yet public (tile cache)
- Esri just added planetary support for ArcGIS Online
- USGS upgrading ArcGIS (tile cache) Server to 10.5
- Willing to support PDS4…



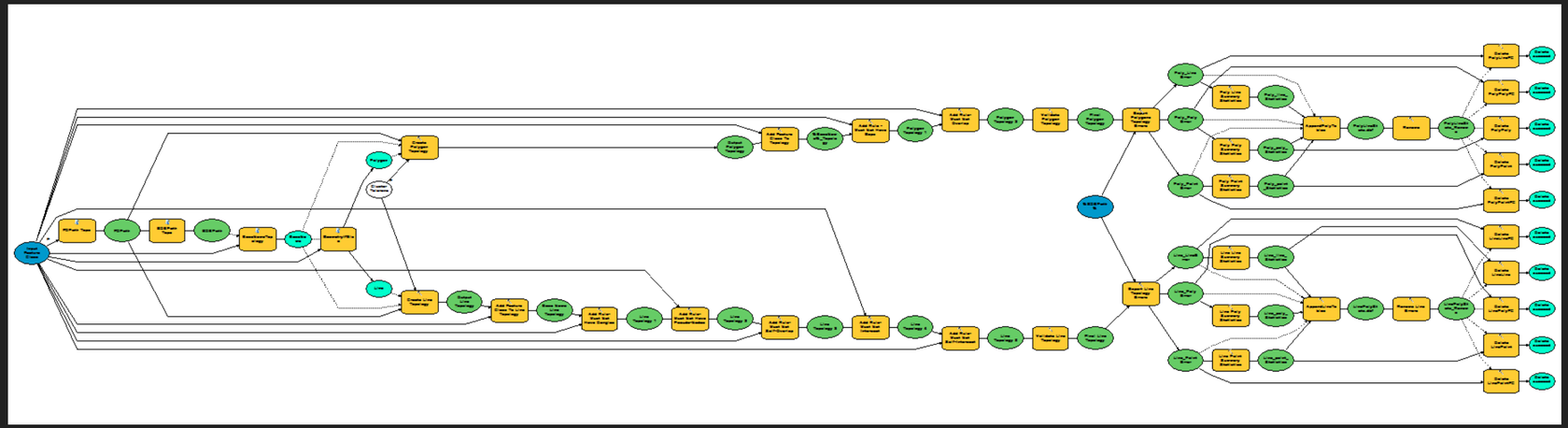
ARCMAP

- Topology Check tool
- Build Polygons tool
- Simple WKT geometry writer
- Zonal Stats cumulative slopes graph (rover)



Demo

1:30 Agassiz



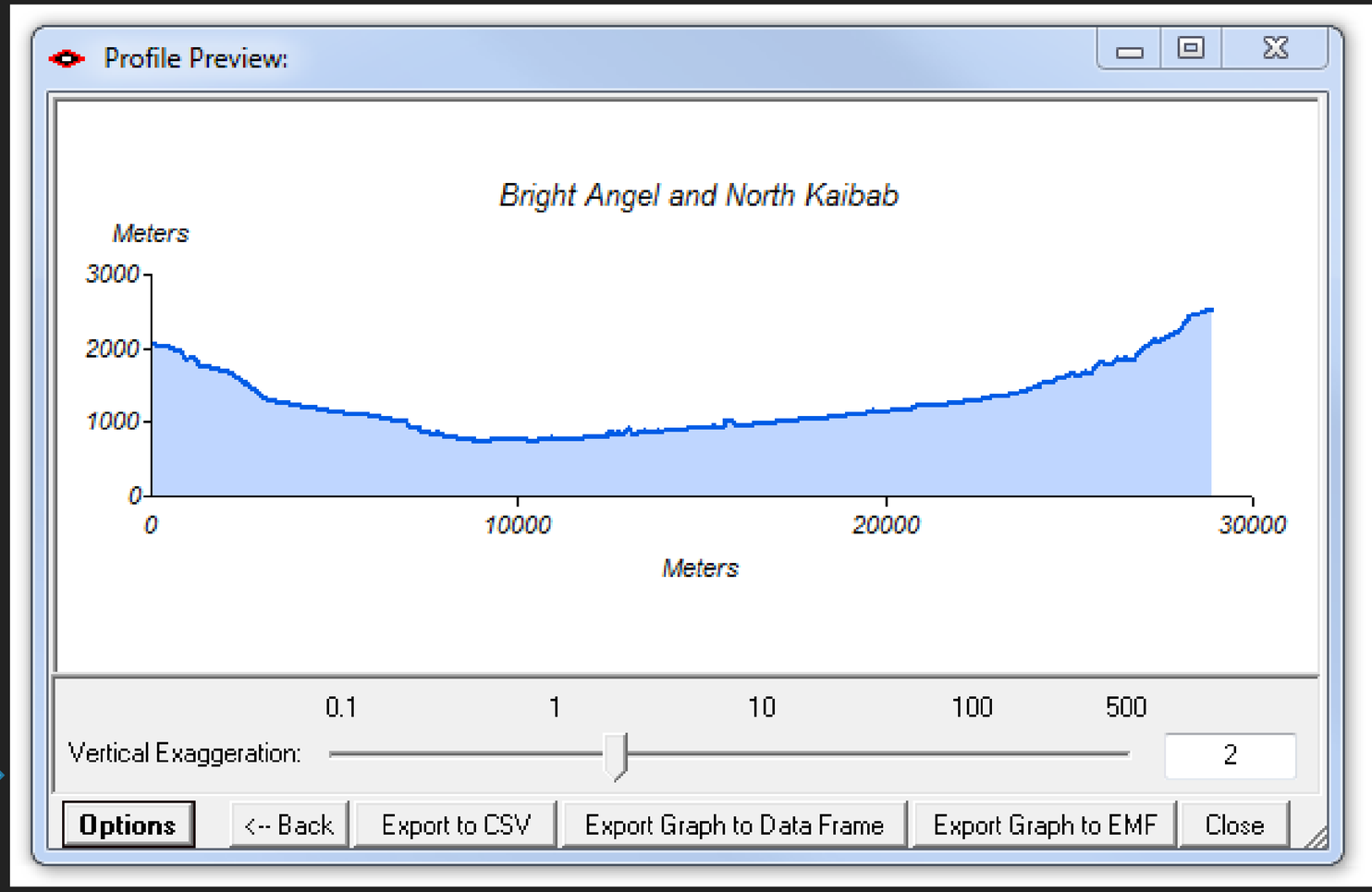
ARCMAP -- TOOLS YOU MIGHT NOT KNEW EXISTED BUT SHOULD

- Tools for Graphics and Shapes – Calculates geodesic areas, lengths and angles
  - By Jeff Jenness (partial USGS contract), http://www.jennessent.com/
- Geodesic Profiler – Calculates accurate profiles over large area
  - Still in beta testing (under USGS contract) – Newly available at Astro's MRCTR GIS
- LayerTools - Strike/Dip tool from high-resolution DEMs
  - By Thomas Kneissl (Freie Universität, Berlin), abstract. http://www.lpi.usra.edu/meetings/lpsc2010/pdf/1640.pdf
  - Slope & Aspect Test tool GUI (by USGS)
- CraterTools – crater collection and plotting tool also by Thomas Kneissl (Freie Universität, Berlin)
- Block Adjustment Tool - built-in since ArcMap 10.4

GEODESIC PROFILER

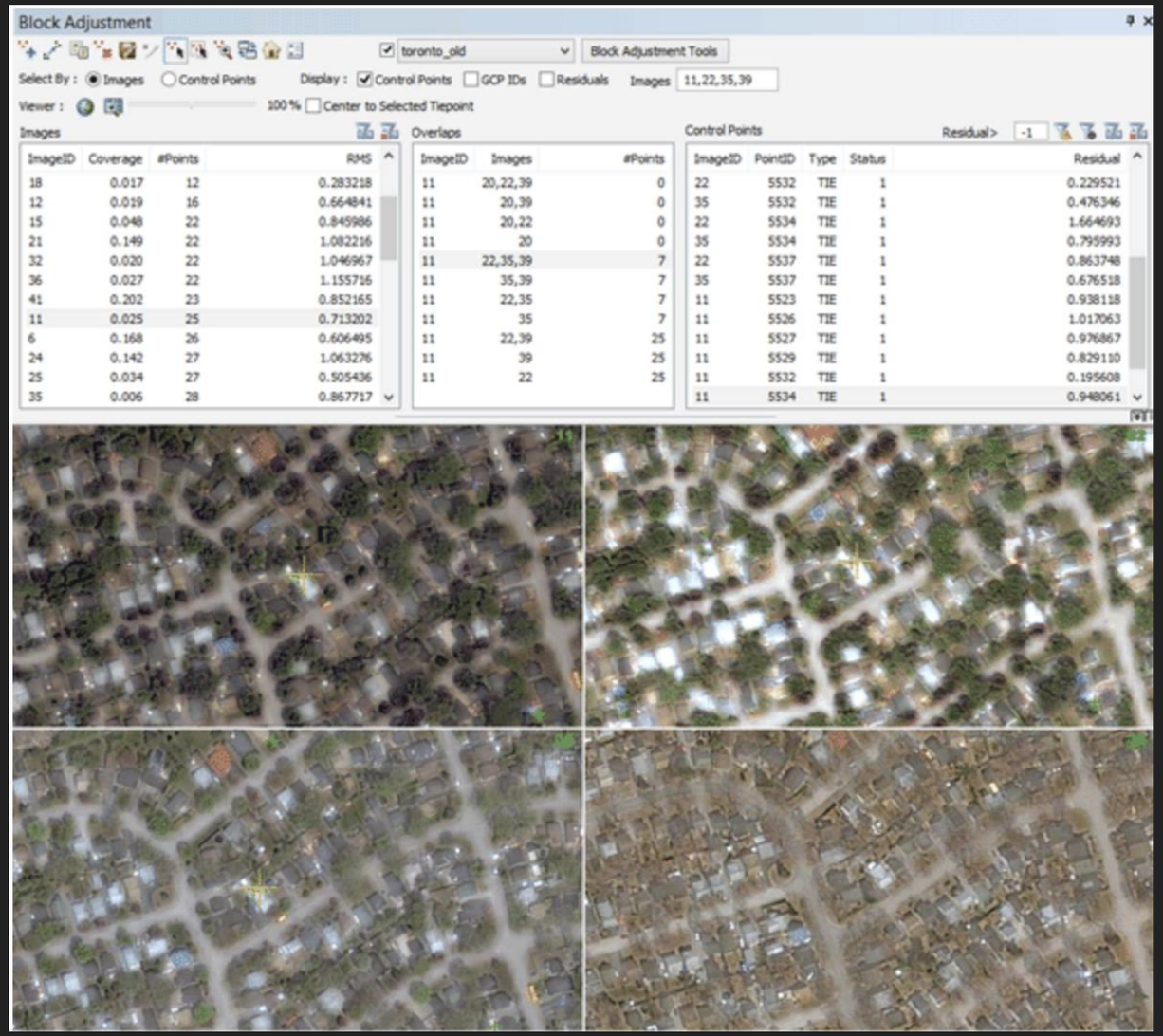
Elevation Profile of Polyline

Finally Exaggeration!!!



ARCMAP

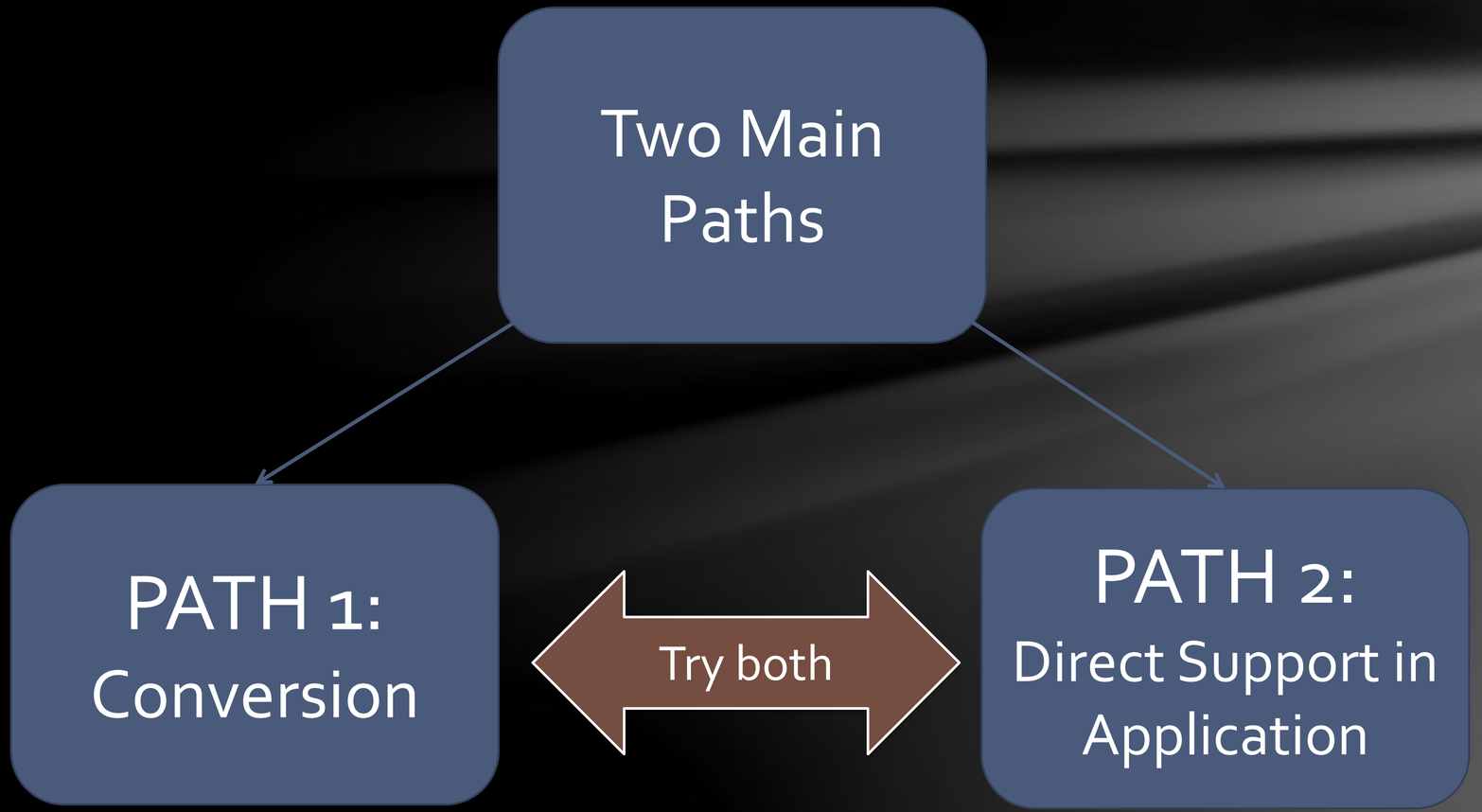
- Block Adjustment Tool
- Use case:
  - CTX Human Landing Sites



Format Resources

Need:

Support of planetary data in GIS / Mapping Apps



Path 1: Format Conversion

2006 - added PDS3 / ISIS2 **read** support to GDAL
2007 – ISIS3 read support added
2014 – VICAR read support added
2017 – ”Geo”FITS to be added (github also fits2vrt script)
2017 – ISIS3 writer,
2107 – plans for PDS4 reader/writers

Goals:

- Convert to GIS/RS formats like GeoTiff, GeoJp2
  Specifically to support:
  - Derived data (not raw PDS)
  - Planetary datums and map projections
  - Large files
  - Ability to use processing / Python tools

What is GDAL?

Geospatial Data Abstraction Library

- GDAL is a "**translator library** for raster geospatial data formats"
- Open source
- Used in many applications
- Can handle many image formats for read and slightly less for writing: PDS3, ISIS, VICAR, **FITS (CFITSIO)**, GeoTiff, JPEG, PNG, NetCDF – plans for PDS4

Path 2: Direct Application Support

Wrap planetary data in supported headers

- To support: Esri, ERDAS, PCI Geomatic, ENVI (raw headers) or use graphical formats with Worldfiles

But as GDAL grew in use so did **direct** planetary support

  - QGIS/UDIG/Mirone
  - Esri's ArcMap
  - MapServer (WMS server)
  - **AMES Stereo-pipeline**
  - …
- More recent
  - Generic Mapping Tools
  - GRASS
  - TuiView

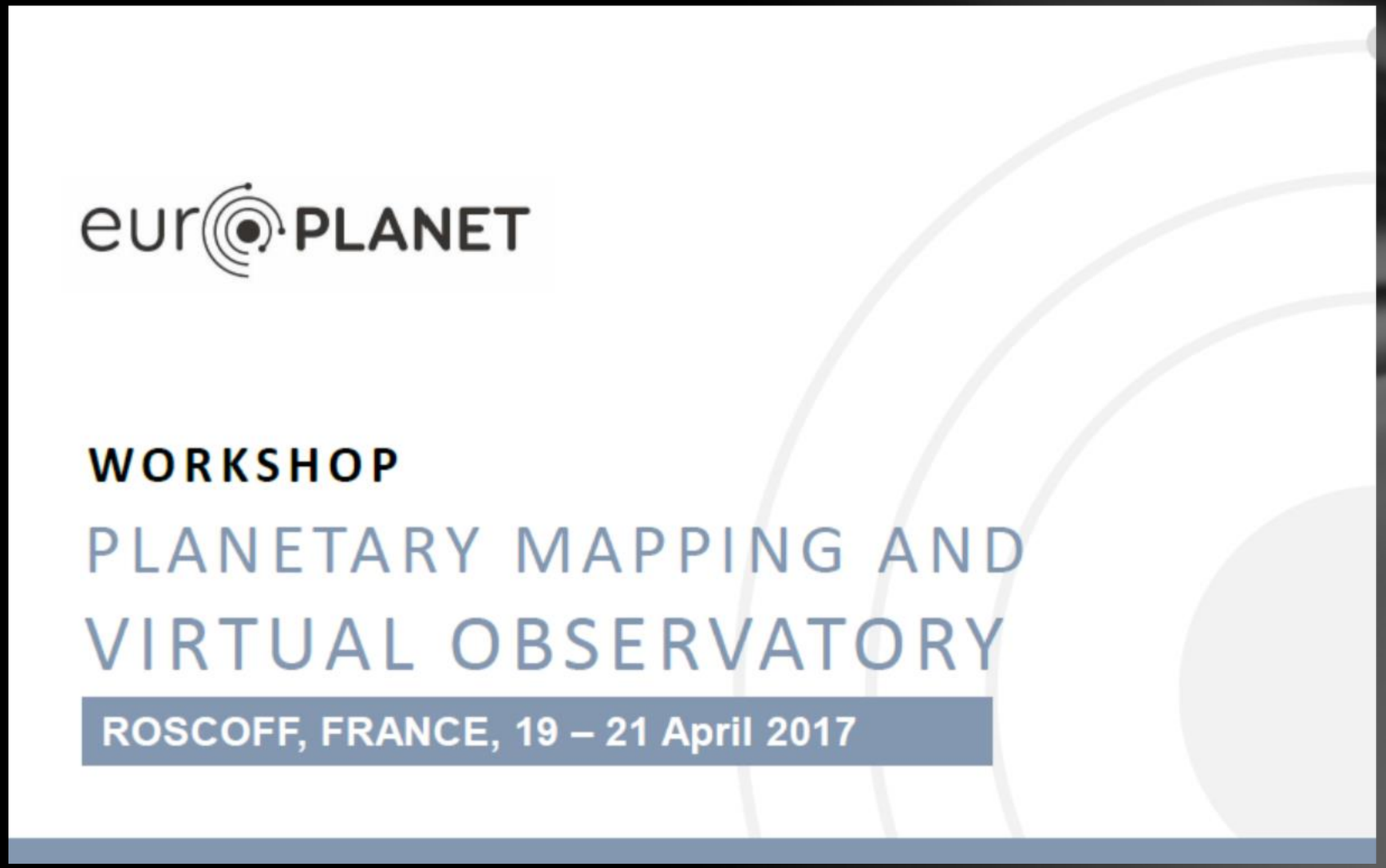
Format Challenges

community improvements to GDAL critical

For example:

- fix / report bugs
- add more writers?
- new formats (e.g. PDS4)
- …

Community Efforts:



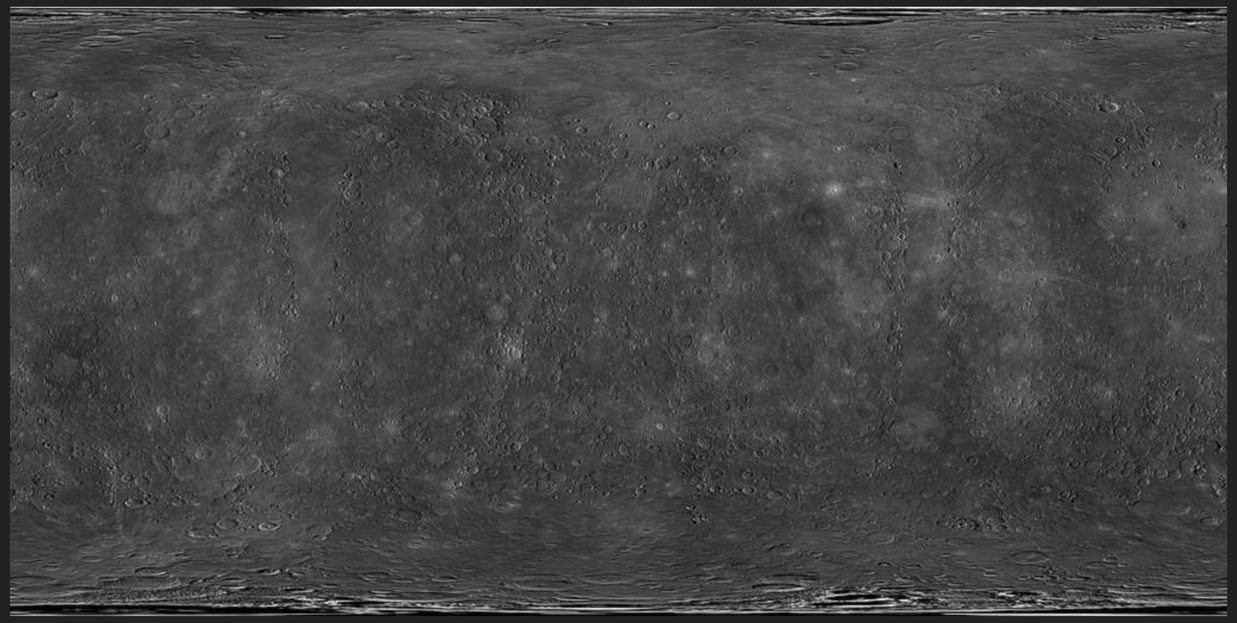
Community Efforts: http://openplanetary.co/

- Foundational Data Products

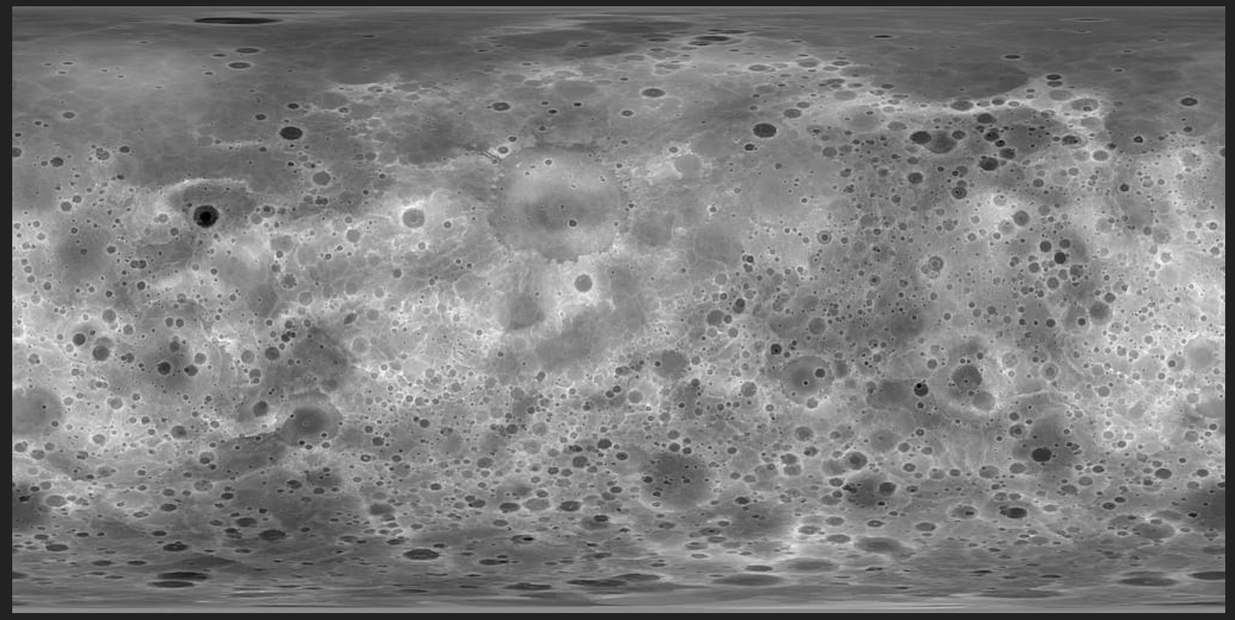
HIGHLIGHT FOUNDATIONAL EXAMPLES

MESSENGER MOSAICS / DEM

- Messenger Team



166 m/p



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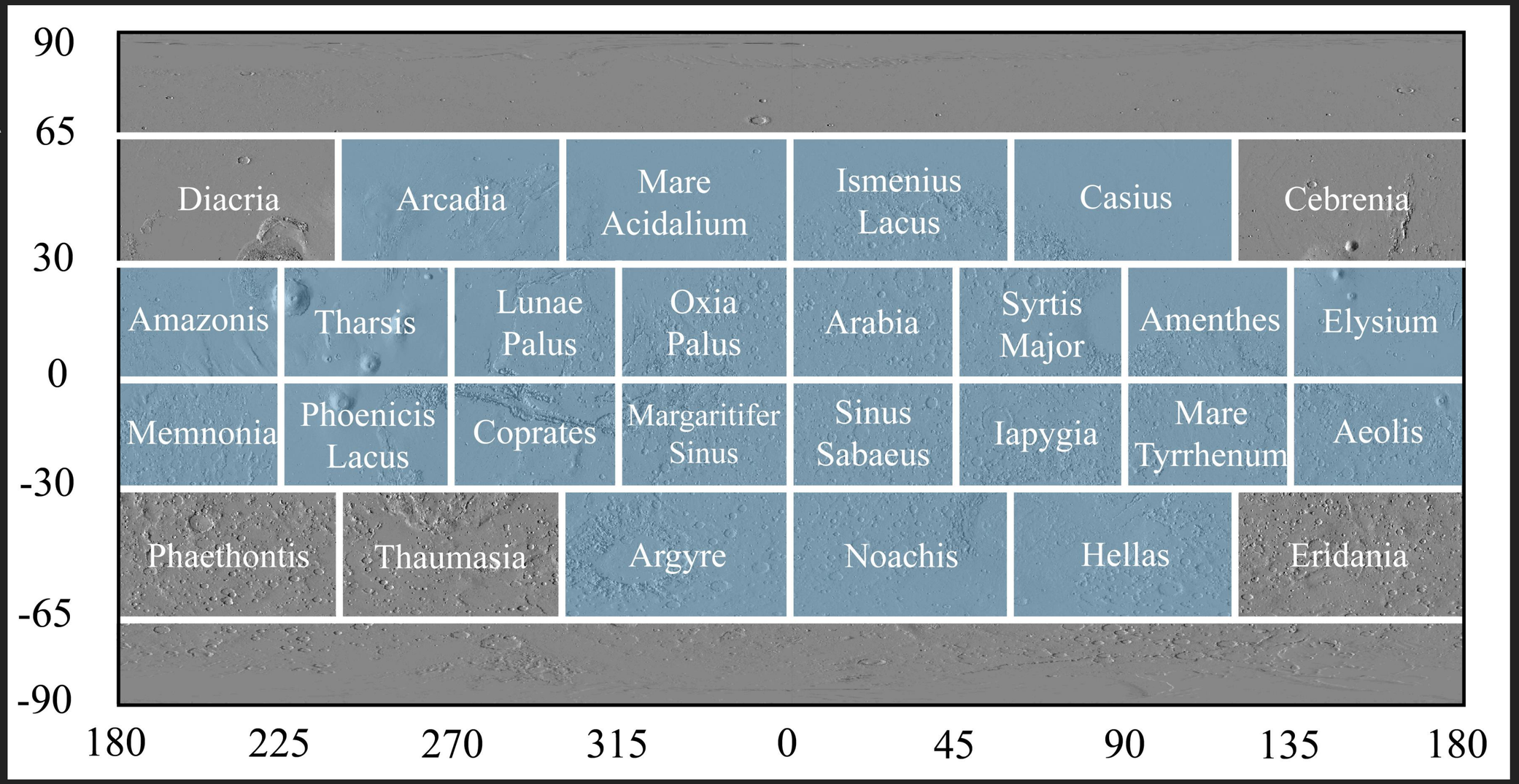
THEMIS IR CONTROLLED MOSAICS

- USGS

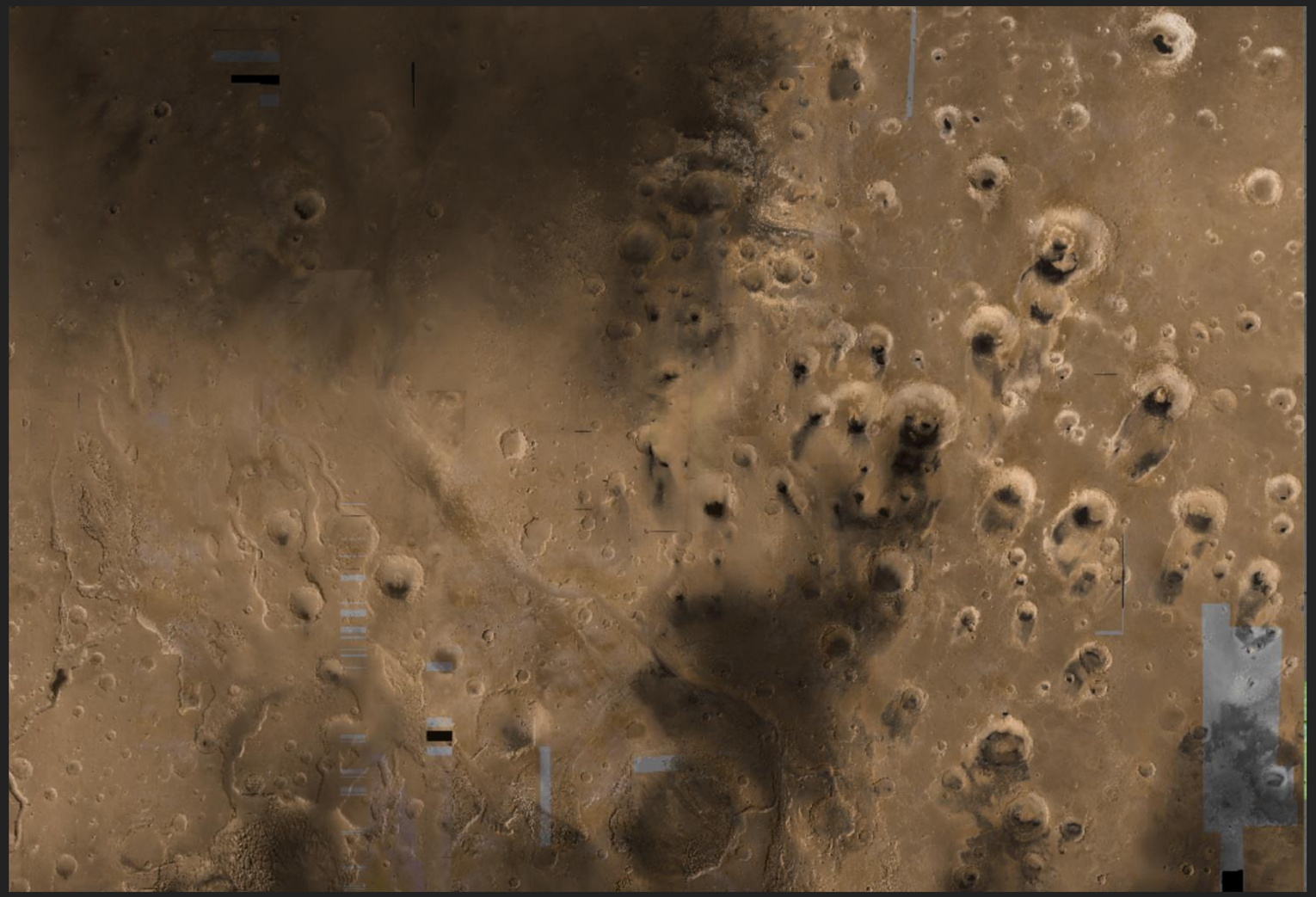
ASU / NASA

100 m/p



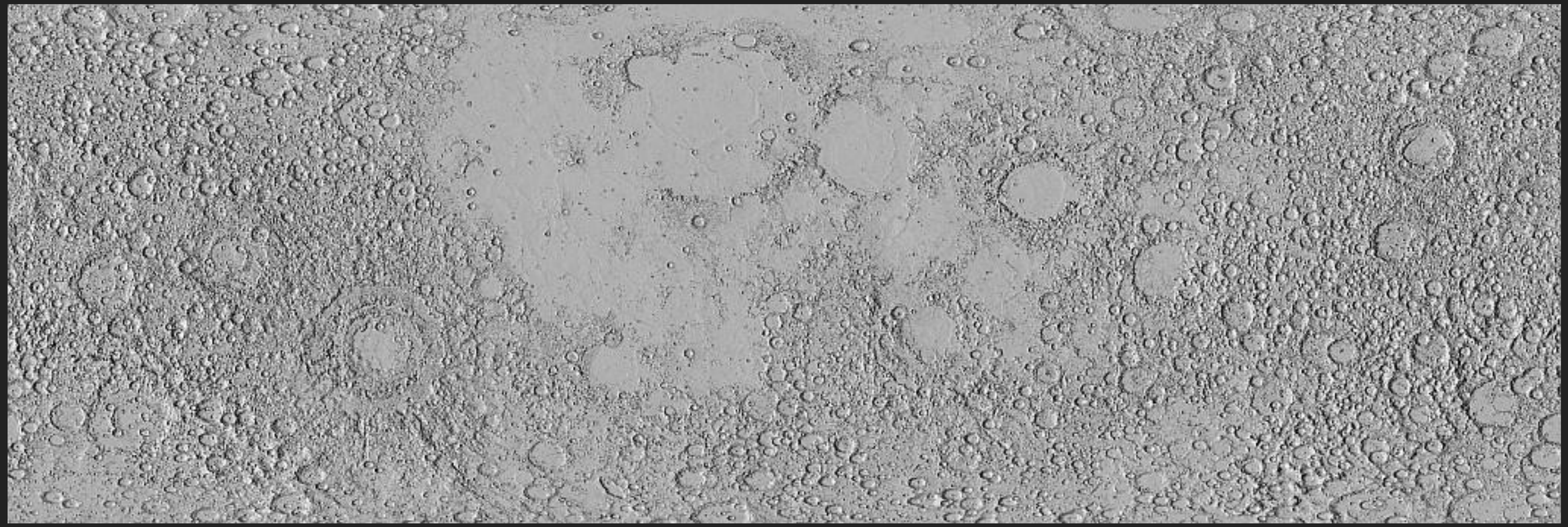
HRSC MOSAICS AND DEMS

- HRSC Team
  - See iMars talk



LOLA / KAGUYA TC STEREO MERGE

- Goddard / JAXA



59 m/p, only 60N to 60S

PLUTO / CHARON

- New Horizon Team
  - Pluto image mosaic (315 m/pixel)
  - Charon image mosaic (400 m/pixel)
  - Pluto DTM (315 m/pixel)
  - Charon DTM (400 m/pixel)
- coming out soon…

COMMUNITY INPUT

- Anything else being produced?
  - Forthcoming
    - Clementine UVVIS re-controlled
    - Europa basemap re-do
    - CTX equatorial mosaic…?
    - Phobos…?

CSM Standard for Planetary

Community Sensor Model

Trent Hare and Randy Kirk

Camera Sensor Model Definition

place data as taken by sensors onto the surface

Planetary Workflow:

SPICE→CAMERA → SHAPE

Why?

PSDI tenet:

support infrastructural **standards**

What standard?

The **Community Sensor Model (CSM)** Working Group was established by the U.S. defense and intelligence community with the goal of **standardizing camera models** for various remote sensor types. The CSM standard, now at version 3.0.2, provides a well-defined application program interface (API) for multiple types of sensors and has been widely adopted by Earth remote sensing software systems.

CSM GOAL

1. **Share** camera software across photogrammetric systems

- ISIS3
- VICAR
- AMES Stereo-pipeline
- Commercial
  - SOCET GXP
  - ArcMap
  - Harris (ENVI)

CSM GOAL

2. Serve as example for future mission instruments

- CSM doesn't make writing the software any easier but the standard provides a thoughtful design for how it can be used.

- Help to make camera model software understandable (not magic).

More Resources

OpenPlanetary Community: http://openplanetary.co

GRASS tutorial: https://grasswiki.osgeo.org/wiki/Planetary_mapping

QGIS Tutorial: https://issues.cosmos.esa.int/psawiki/display/GISWS/Session+2+-+Hands-on

Astrogeology MRCTR GIS Lab

http://astrogeology.usgs.gov/facilities/mrctr-gis-lab

Astrogeology Github:

https://github.com/USGS-Astrogeology

Planetary Data Workshop:

http://astrogeology.usgs.gov/groups/planetary-data-workshop