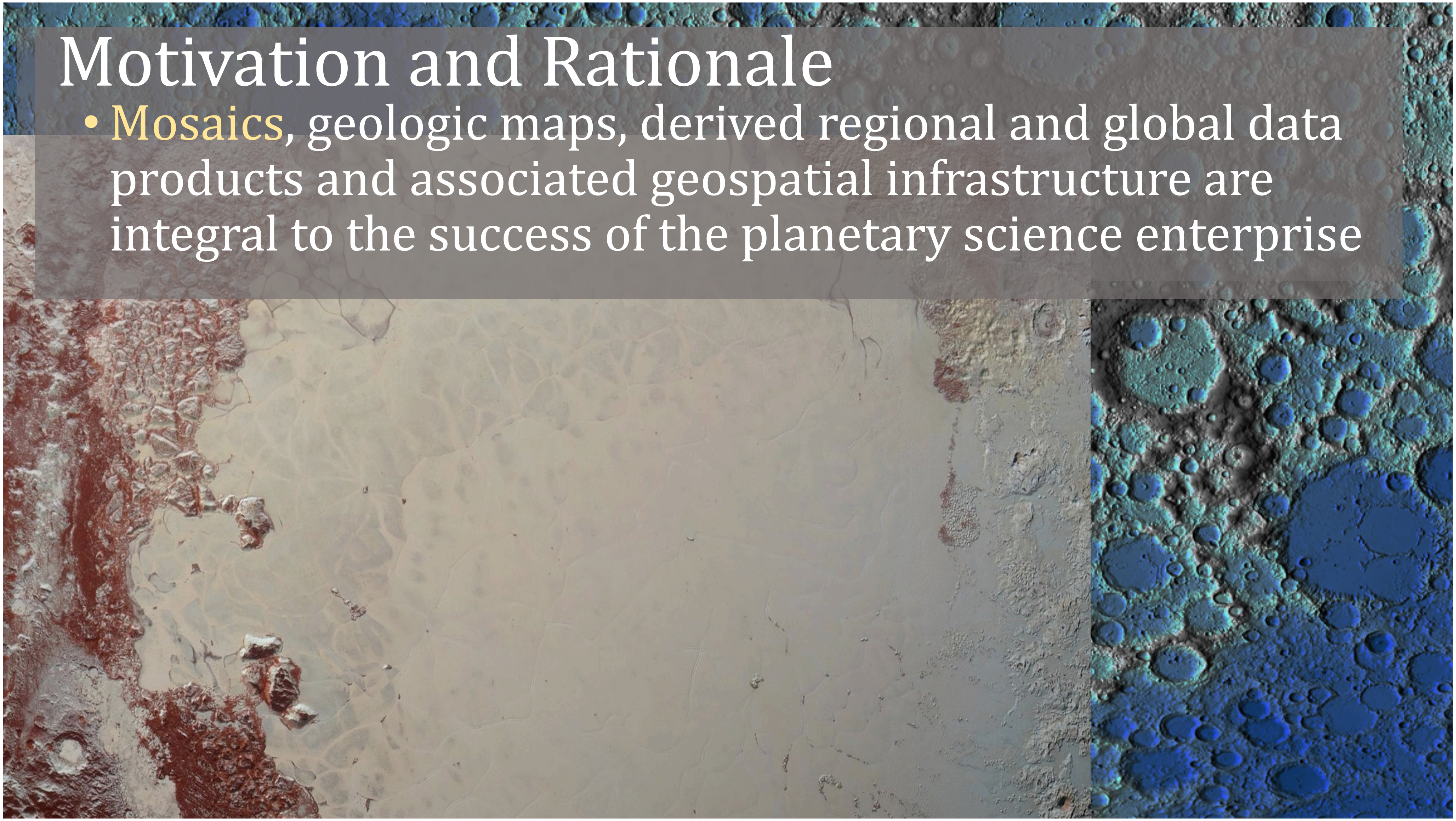
The Importance and Challenge of Building a Planetary Spatial Data Infrastructure

Jani Radebaugh
Chair
Mapping and Planetary
Spatial Infrastructure Team
Planetary Advisory Committee
NASA HQ, Feb. 23, 2018

Motivation and Rationale

- Mosaics, geologic maps, derived regional and global data products and associated geospatial infrastructure are integral to the success of the planetary science enterprise



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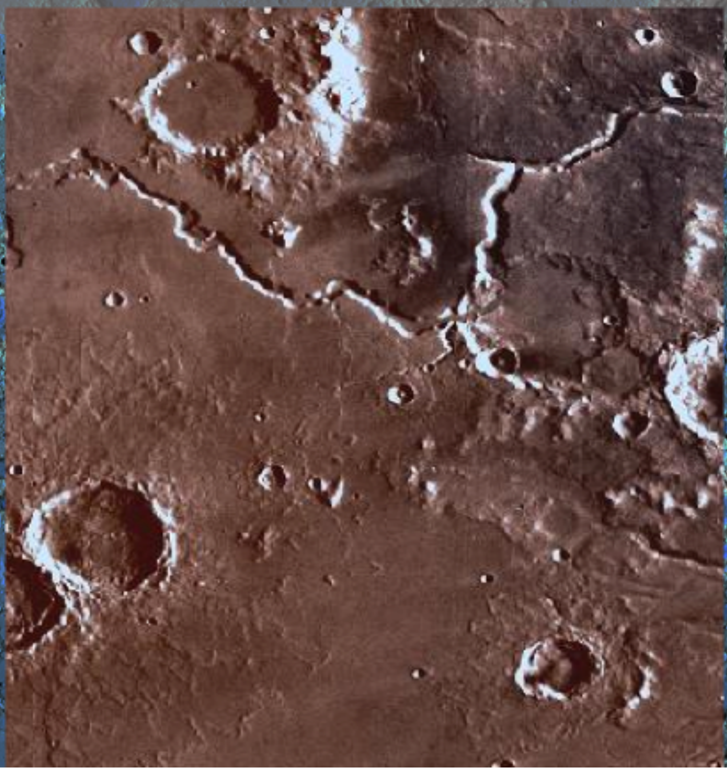

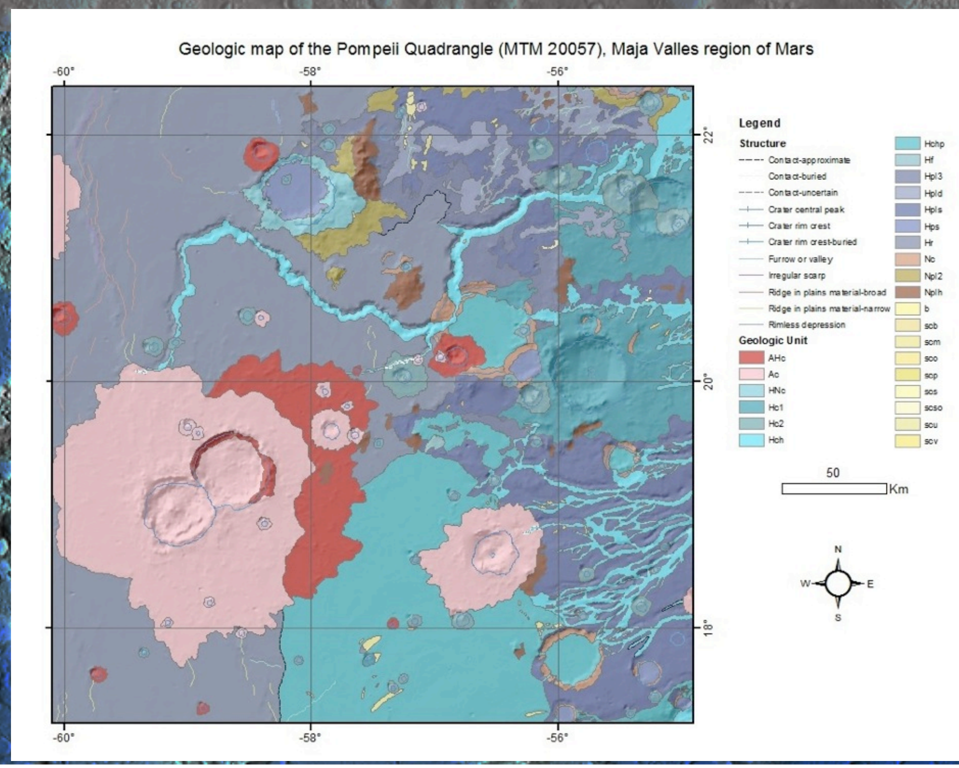

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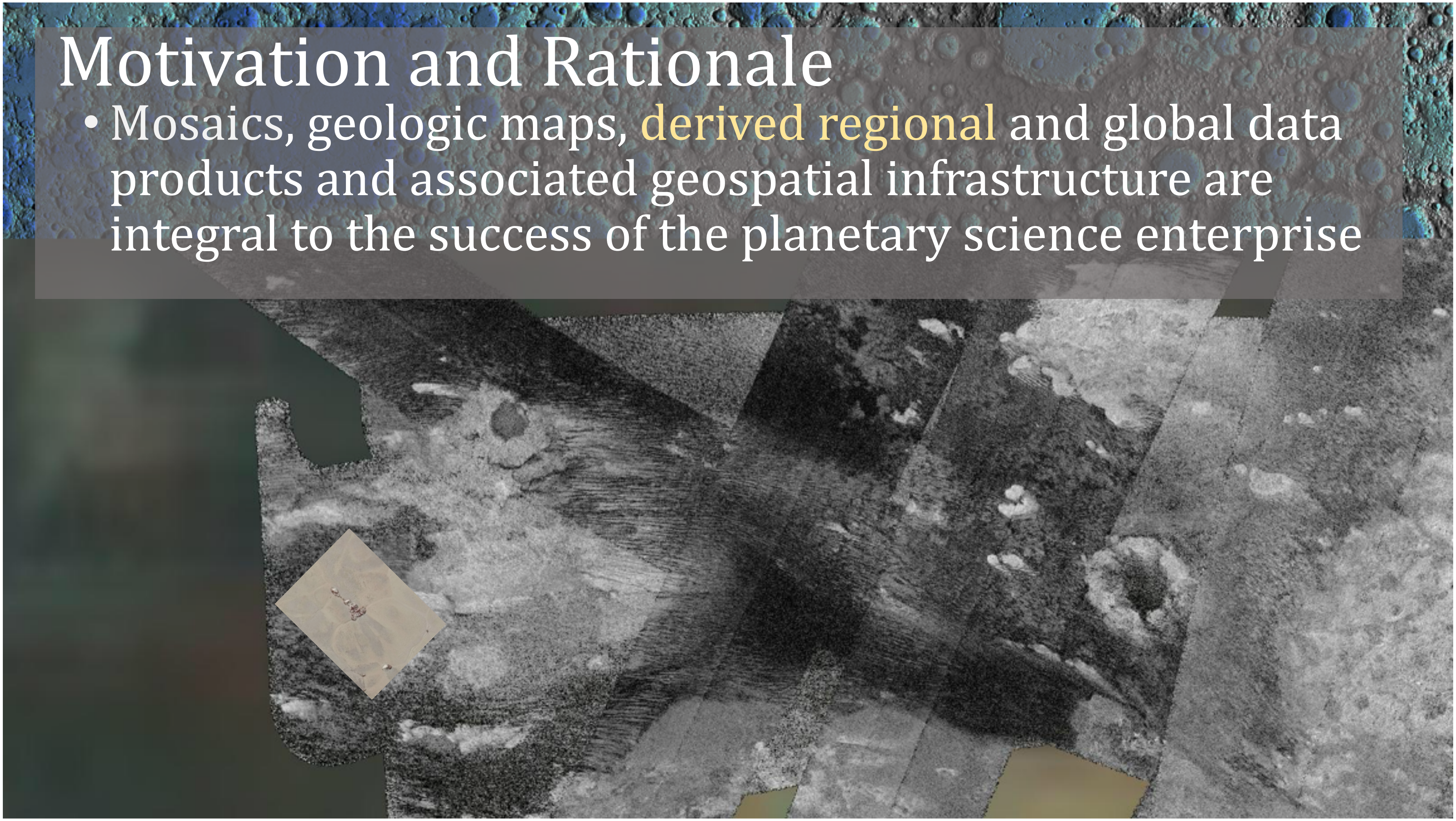

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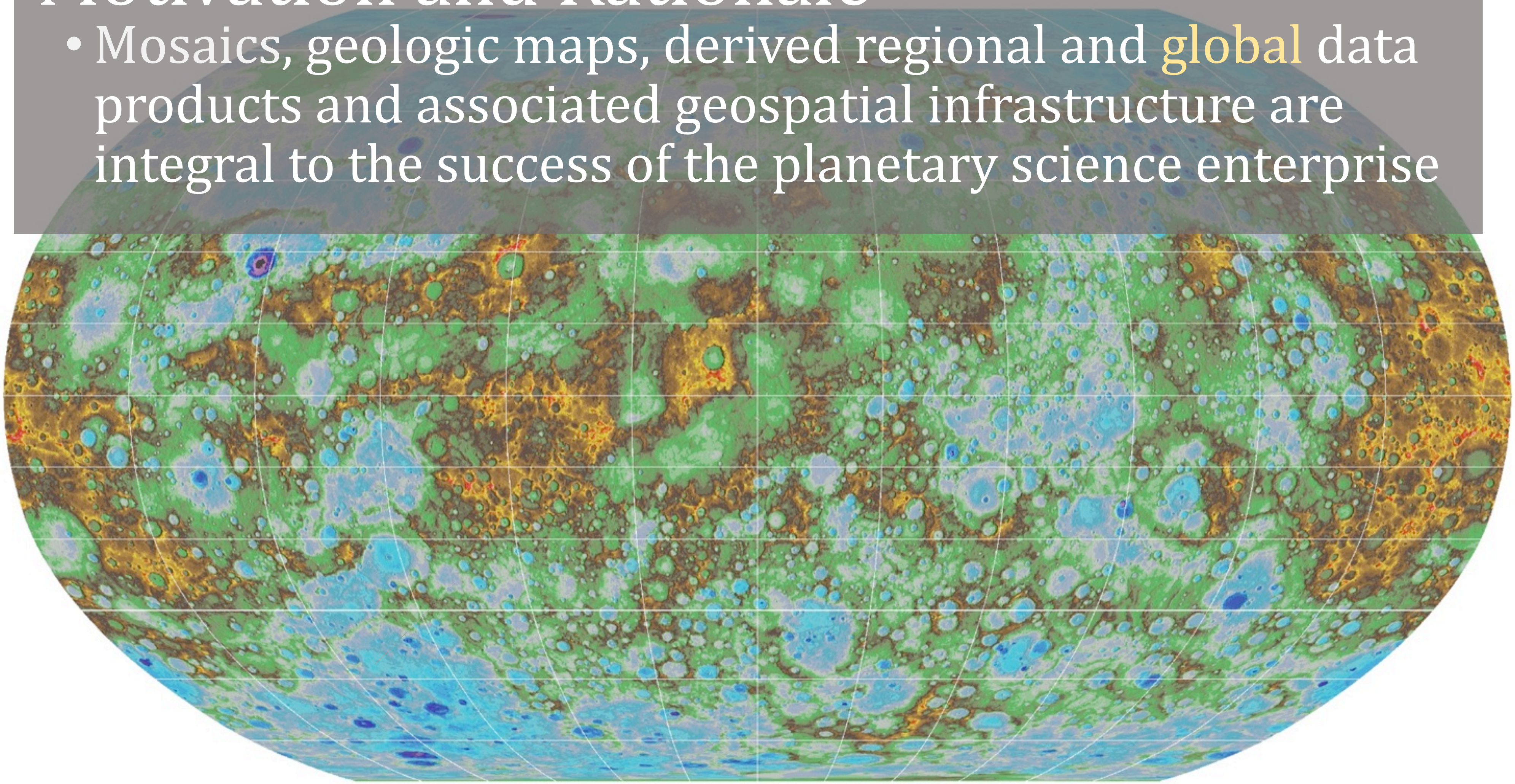
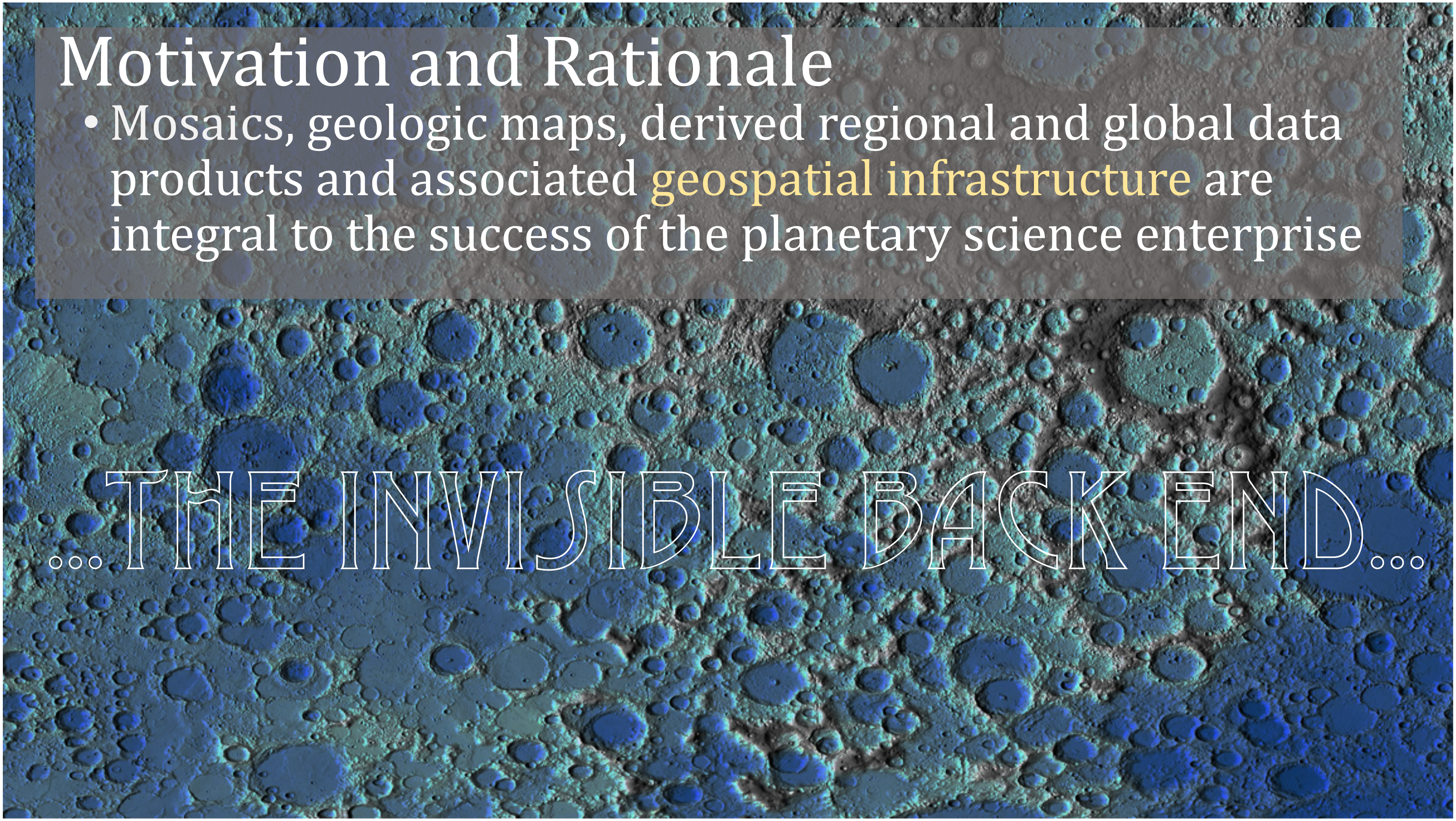
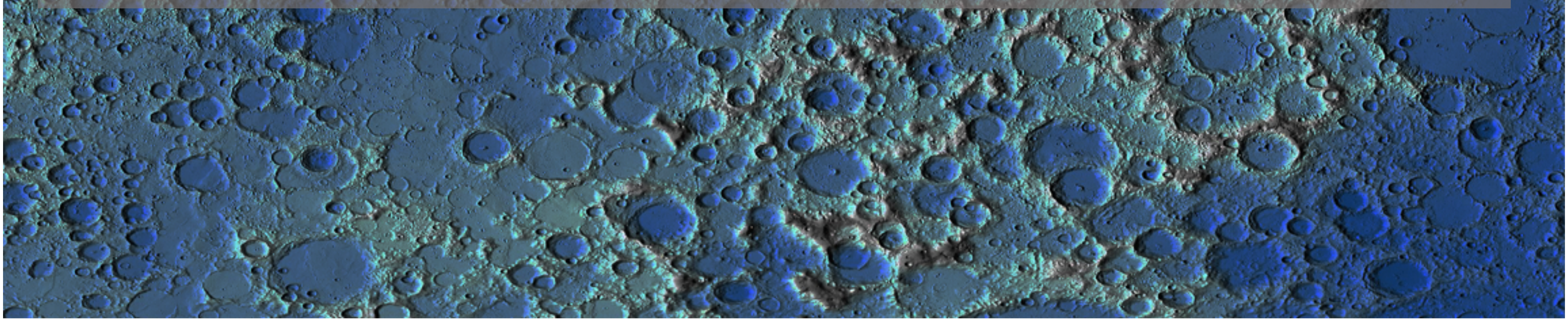



Motivation and Rationale
• Mosaics, geologic maps, derived regional and global data products and associated geospatial infrastructure are integral to the success of the planetary science enterprise
…The invisible back end…

Motivation and Rationale

- Mosaics, geologic maps, derived regional and global data products and associated geospatial infrastructure are integral to the success of the planetary science enterprise
  - Ideal is if all users can *access* and *use* NASA planetary spatial data
  - **Should fall to the community to evaluate and anticipate needs**



MAPSIT Mapping and Planetary Spatial Infrastructure Team

- The planetary community and NASA recognized the need for community input on how to help missions obtain useable data, and how to help users access and use data
- This team is the result
- An Analysis/Assessment Group (AG) like *VEXAG* etc., but independent of location in Solar System
  - Point of Contact at NASA HQ is Sarah Noble

MAPSIT – Mapping and Planetary Spatial Infrastructure Team

Steering Committee

- Jani Radebaugh, Brigham Young University [Chair]
- Samuel Lawrence, Arizona State University [Chair Emeritus]
- Brad Thomson, University of Tennessee Knoxville [Vice Chair]
- Brent Archinal, United States Geological Survey
- Daniella DellaGiustina, University of Arizona
- Caleb Fassett, NASA Marshall Spaceflight Center
- Lisa Gaddis, United States Geological Survey
- Justin Hagerty, United States Geological Survey
- Trent Hare, United States Geological Survey
- Jay Laura, United States Geological Survey
- Erwan Mazarico, NASA Goddard Space Flight Center
- Andrea Naß, German Aerospace Center DLR
- Alex Patthoff, Planetary Science Institute
- James Skinner, United States Geological Survey
- Sarah Sutton, University of Arizona
- David Williams, Arizona State University

- Website: http://www.lpi.usra.edu/mapsit

Role of MAPSIT

- We seek to lay out a path forward for establishing frameworks for various needs, Planetary Spatial Data Infrastructure(s), or PSDIs (*What are these again??*)
- PSDI: Framework for correctly obtaining, processing, then laying a set of images and other products correctly on a body, relating these to each other, then making them available and useable through technology and standards
- The vast volumes of *terrestrial* remote sensing data have generated similar discussions, needs, and *Spatial Data Infrastructure* (SDI) frameworks.
- *We are now extending this concept to planetary data*
- Need strategies and priorities

How is this different from the PDS?

- The Planetary Data System (PDS) is tasked with stability, security and long-term preservation of data
- Focuses on formatting, archiving, preservation
- Not tasked with making data useable
  - - What do you use the PDS for? -
- MAPSIT is concerned with immediate user data needs
- Data should be discoverable and useable
- Is community-driven

Planetary Examples

- We must have some?
  - Not really. ☺
- But we have georeferenced coordinate systems, global mosaics, elevation data…
  - These are elements to include in a PSDI
- Has the PDS made any?
  - Data are stored, but not readily useable
  - Some interfaces for accessibility are being created
- What about JMARS?
  - *Not standards compliant* or available to other interfaces
  - Vulnerable to loss of tool
- TREKs at JPL?
  - Getting better – but NO CONTROLLED TITAN MOSAIC now OR planned by JPL…

What is the path ahead?

- We need input from the community on what exists, what is needed now, what will be needed in the future
- Asking AGs to give us a wish list for PSDIs
  - We will comb their Goals Documents to see what they say they need, then confirm
  - OPAG – Europa SDI in prep for Clipper? Titan SDI at end of Cassini?
  - VEXAG – global Magellan basemap with overlain DTM?
  - MEPAG, LEAG – (more complex problem) Some partial examples of SDIs exist. Prioritize Human and robotic landing sites?
  - SBAG – how to deal with irregular bodies? Well fleshed out SDI for OSIRIS-REx already – good template?
- ROADMAP

MAPSIT PSDI Roadmap

- Strategic Plan to lay out options and enable NASA to prioritize decisions
- Plan for fully exploiting planetary data and to meet goals and objectives set by the community
- Help the broad user community of planetary scientists who are not experts in spatial data concepts, but who want *spatial data* ***to just work***
- Plan for and enable performance and technology
- Support NASA science and exploration goals

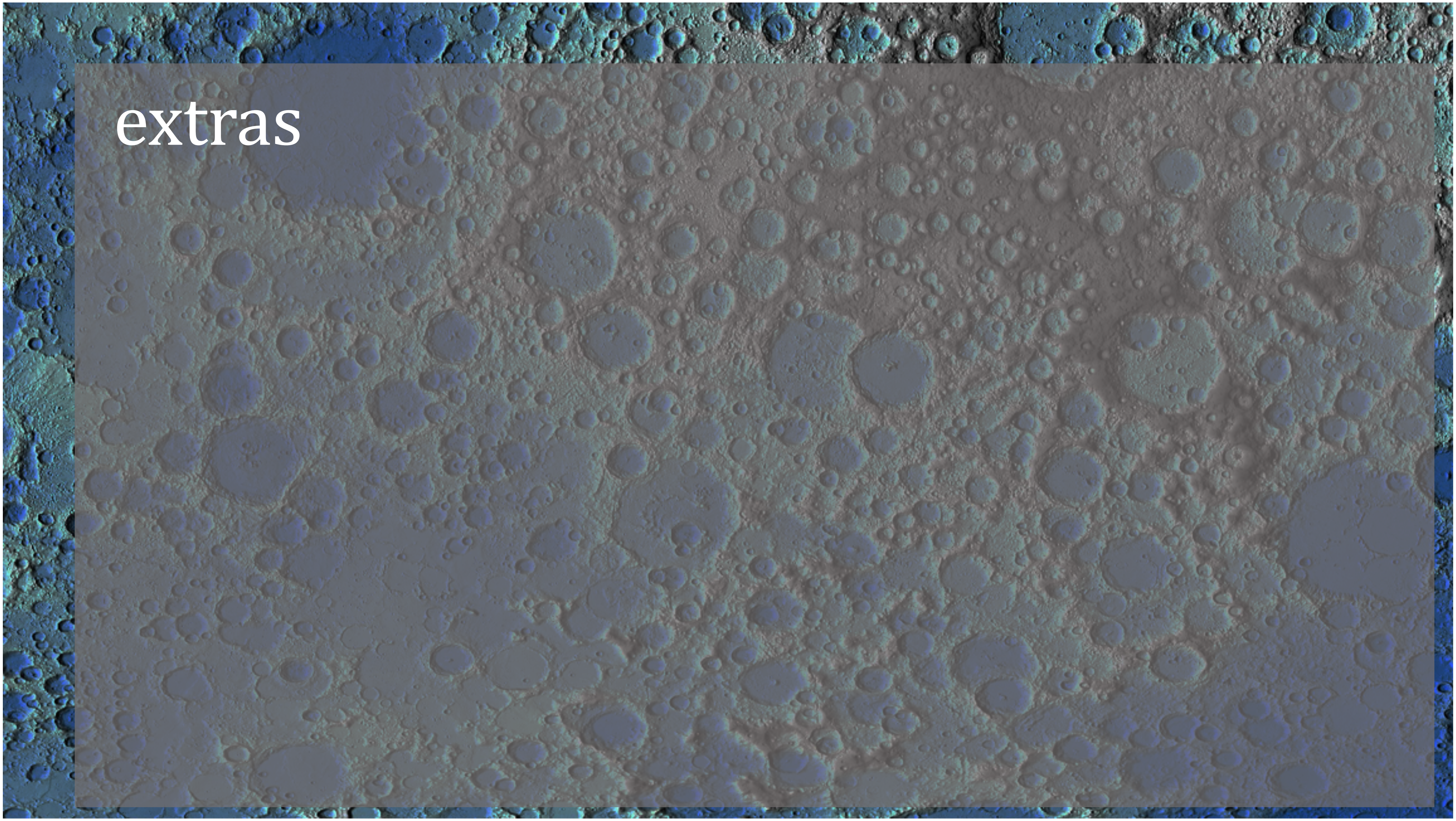

Draft Roadmap Overarching Themes
A. Ensure planetary data are discoverable and useable
B. Strategize for needed expertise, tools, and capability
C. Enable future NASA Science and Exploration Goals

Conclusions

- MAPSIT wants to encourage the creation of Planetary Spatial Data Infrastructures
  - PSDI = data from source to sink
  - Better generation, access and use of planetary data
- Need input and support from AGs and NASA
- What are the priorities for your stakeholders?

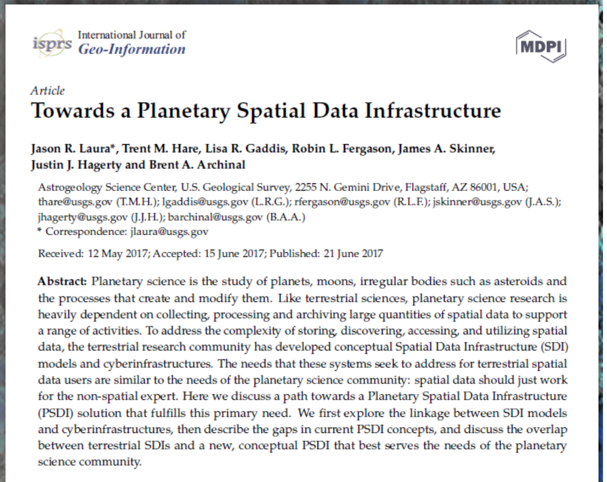
- Website: http://www.lpi.usra.edu/mapsit

extras



What is a Spatial Data Infrastructure?

- A theoretical concept developed in terrestrial community
- For planning, not a canned solution
- Goals are to improve data
  - Discoverability
  - Accessibility
  - Usability
- Broader than just data
  - Data sets and products
  - Technologies (access, processing, use, preservation)
  - Human resources (training and continuity of knowledge, outreach)
  - Standards


International Journal of Geo-Information

Article

Towards a Planetary Spatial Data Infrastructure

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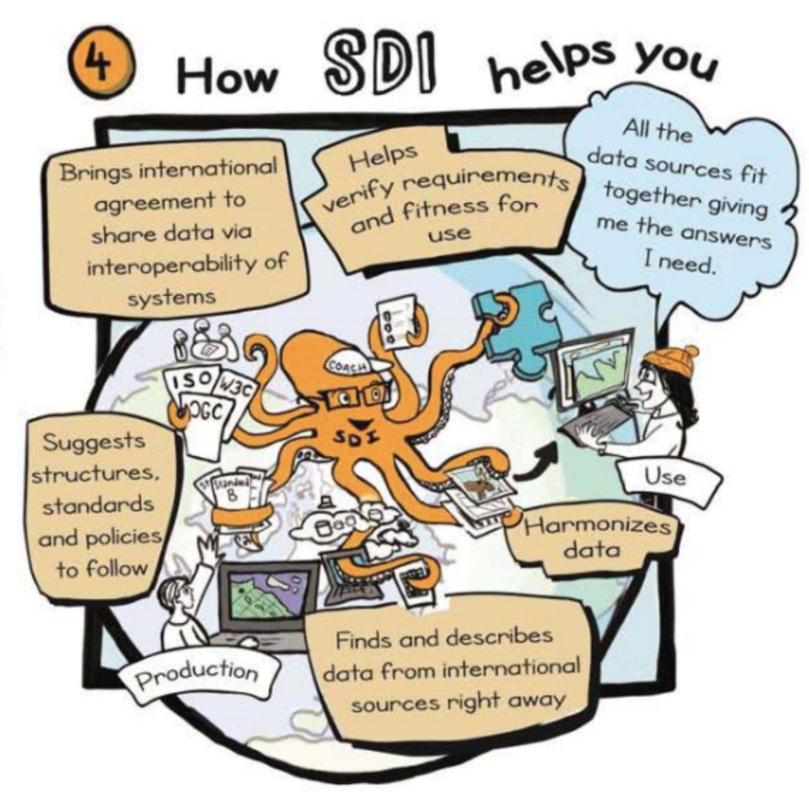
Abstract: Planetary science is the study of planets, moons, irregular bodies such as asteroids and the processes that create and modify them. Like terrestrial sciences, planetary science research is heavily dependent on collecting, processing and archiving large quantities of spatial data to support a range of activities. To address the complexity of storing, discovering, accessing, and utilizing spatial data, the terrestrial research community has developed conceptual Spatial Data Infrastructure (SDI) models and cyberinfrastructures. The needs that these systems seek to address for terrestrial spatial data users are similar to the needs of the planetary science community: spatial data should just work for the non-spatial expert. Here we discuss a path towards a Planetary Spatial Data Infrastructure (PSDI) solution that fulfills this primary need. We first explore the linkage between SDI models and cyberinfrastructures, then describe the gaps in current PSDI concepts, and discuss the overlap between terrestrial SDIs and a new, conceptual PSDI that best serves the needs of the planetary science community.

- *See Laura et al.* (2017) ISPRS Int. J. Geo-Inf., 6, 181, doi:10.3390/ijgi6060181 *for a theoretical framework for a Solar System-wide PSDI*

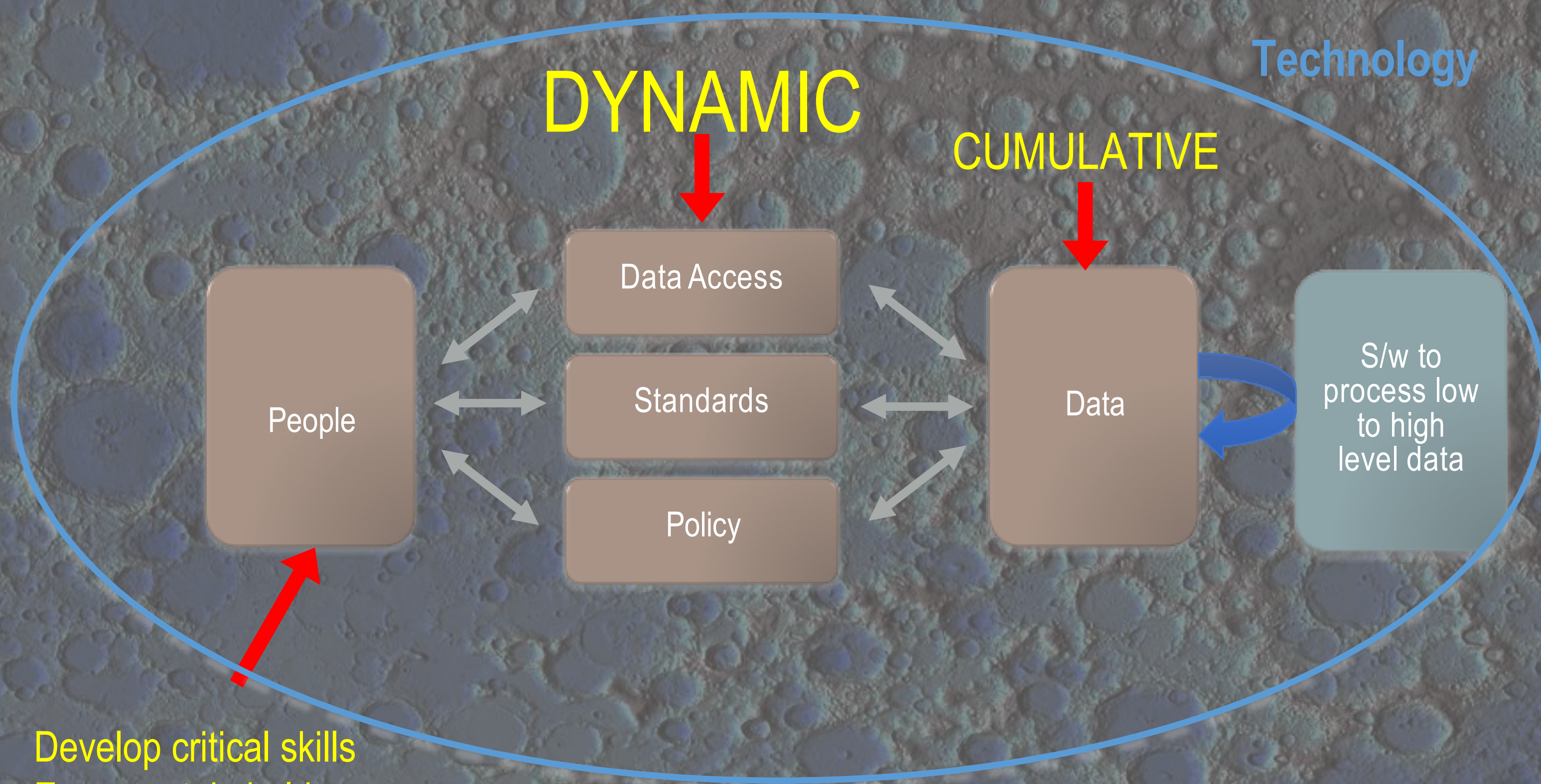
What is a Spatial Data Infrastructure?

- Conceptual tool
- Goals are to improve data...
  - Discoverability
  - Accessibility
  - Usability
- Also include:
  - Data sets and products
  - Technologies (access, processing, use, preservation)
  - Human resources (training, continuity of knowledge, outreach)
  - Standards



- *See Laura et al.* (2017) *Solar System-wide PSDI*

Elements of a Spatial Data Infrastructure



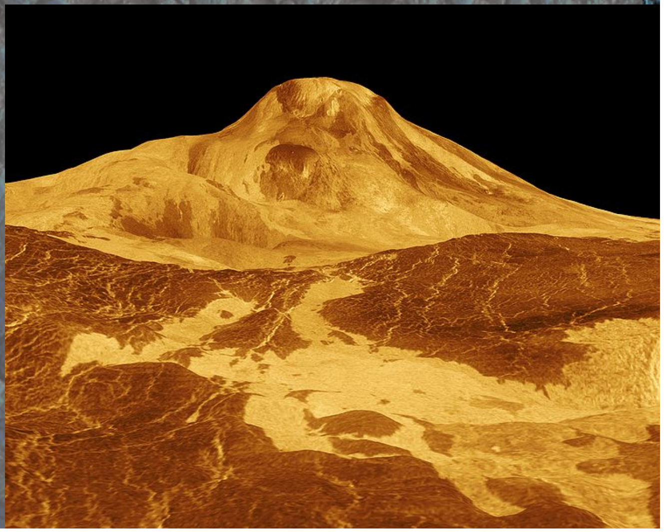
Develop critical skills
Engage stakeholders
Connect with new/non-expert users

Types of Data Products

- Geodetic Coordinate Reference Frame
- Elevation (Topographic) Data
- Orthoimages / Orthomosaics

Planetary Examples

- Geodetic Coordinate Reference Frames
  - IAU defined lat/lon and ephemeris
  - Planetary is special: geodetic coordinate reference frames are iteratively defined as data improves. (laser altimetry (e.g. LOLA) for the Moon)
  - As a non spatial expert - these should just work
- Elevation Data
  - Mars DTM from MOLA, Magellan DEM
  - As a non spatial expert - these should just work
- Orthorectified Orthomosaics
  - Global Io Voyager/Galileo basemap
  - As a non spatial expert - these should just work



Outline

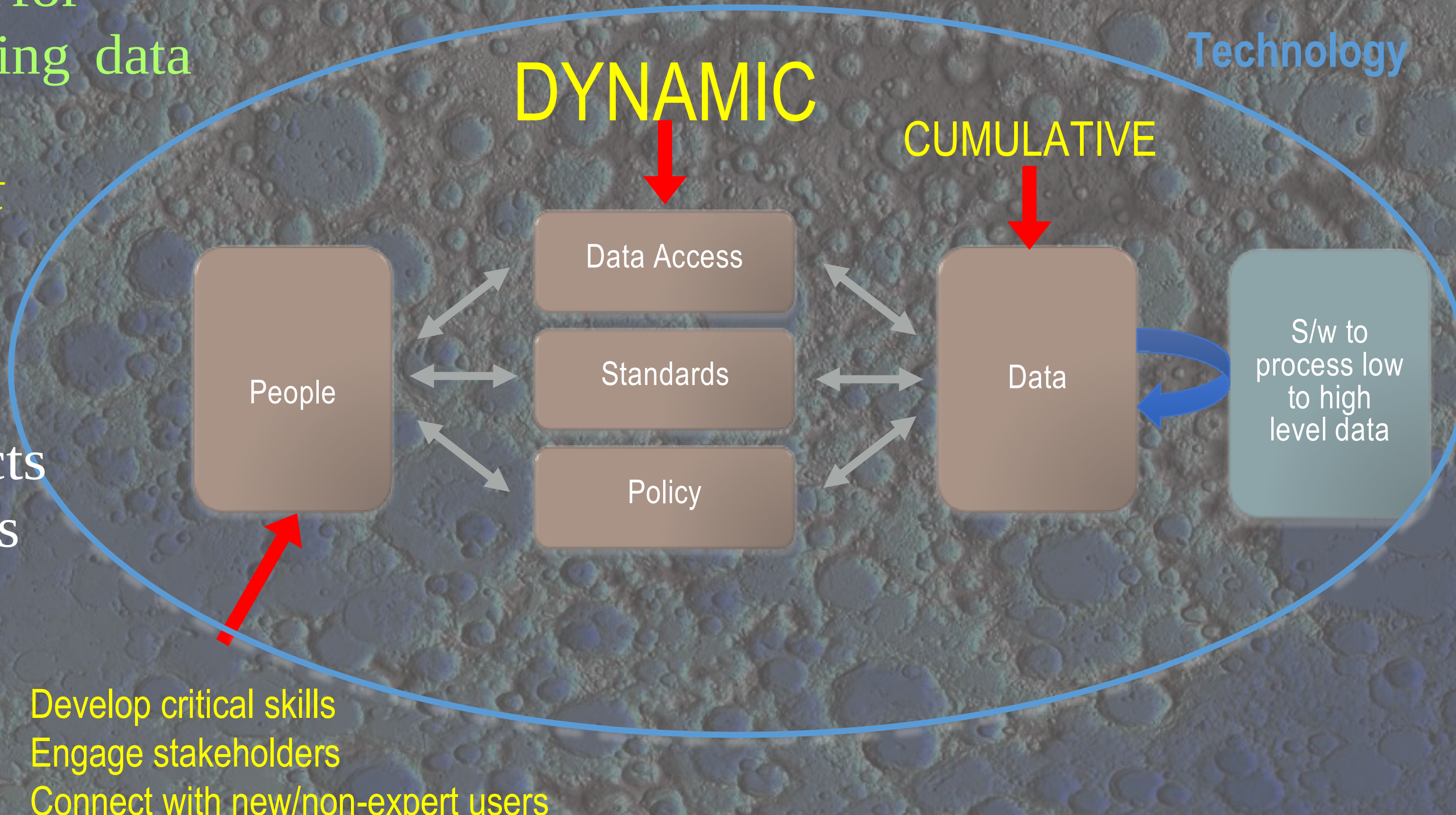
- Importance of Planetary Spatial Data
- The Mapping and Planetary Spatial Infrastructure Team
- What is a Spatial Data Infrastructure? Example from Earth
- Benefits of Spatial Data to Planetary Exploration
- Roadmap
- Planetary Spatial Data Infrastructures can help NASA get the most out of investment in spaceflight
- Determine where is most interesting and feasible to land, image or fly past planetary bodies

What is a Spatial Data Infrastructure?

- Conceptual tool for finding and using data

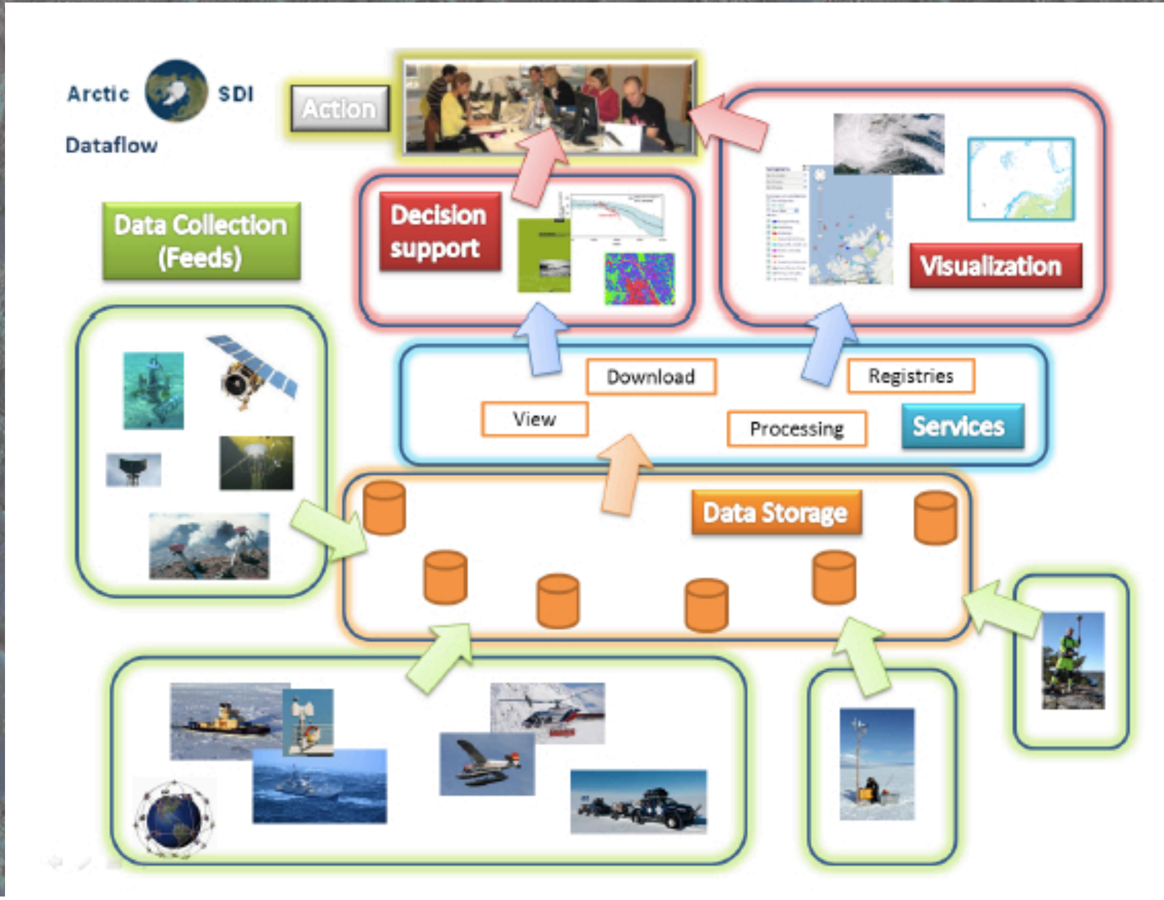
- *Data should just work!*

- Involved are:
  - Data products
  - Technologies
  - Standards
  - People



Example – Arctic Spatial Data Infrastructure

- Data from 12 different organizations – required heavy standardization
- Available in widely used geospatial formats
- Search enabled by tight data/information coupling
- Data available to all kinds of users



Roadmap Overarching Themes

JUST WORK

A. Ensure planetary data are discoverable and useable

B. Strategize for needed expertise, tools, and capability

C. Enable future NASA Science and Exploration Goals

Draft Roadmap Themes and Goals

A. Ensure planetary data are discoverable and useable

- Should be discoverable – develop a clearinghouse
- Should be useable – proper mission planning, geodetic control
- Establish Planetary Spatial Data Infrastructure for each body

Draft Roadmap Themes and Goals

B. Strategize for needed expertise, tools, and capability

- Advocate for availability and development of tools
- Ensure key expertise for PSDI is maintained
- Encourage robust standards

Draft Roadmap Themes and Goals

C. Enable future NASA Science and Exploration Goals

PSDIs can help NASA determine where it is most interesting and scientifically feasible to land, image or fly past planetary bodies

- Work with NASA to determine foundational data products
  - How and when to develop reference frames
  - Which orthoimages, DTMs most useful for planetary exploration
  - Encourage creation of geologic maps
- Recommend plans for data infrastructure for future missions
  - Coordinate systems, data format standards, nomenclature
  - Data interoperability between platforms and tools
- Determine relationship between PSDI and other areas of SS exploration
  - Make use of lessons learned in Earth SDIs
  - Consider how this helps HEO, sample return, planetary astronomy

Roadmap Timeline

- Draft by end of 2017
- Circulate early 2018, get feedback at LPSC town hall, possible community meeting April 2018 (PSIDA, Wash University)
- Delivery to NASA first half of 2018