Update on the LEAG-MAPSIT Lunar Critical Data Products SAT

Preliminary findings presented at the LEAG Annual Meeting Sept 2, 2021

What is the LCDP SAT?

Chartered by NASA HEOMD STU and SMD PSD to engage the LEAG and MAPSIT communities as we begin the process of responding to the Artemis III SDT recommendations

Recommendation 8.2-1: Any needed updates to the standard lunar geodetic coordinate reference frame (e.g., currently used by the Lunar Reconnaissance Orbiter (LRO)) should be identified in 2021, and foundational products should be mapped onto it and/or developed to use it directly. Establishing a standardized coordinate reference frame can significantly improve data reliability and reduce the risk of errors.

Recommendation 8.3-1b: To support the level of accuracy and precision needed for landing and surface operations, new cartographic products, including mosaics and topographic models, for the south pole should be developed using the highest quality data available (e.g., LRO NAC and WAC frames; SELENE TC, MI, and Chandrayaan M3) and using the standard (possibly updated) lunar geodetic coordinate reference frame.

Recommendation 8.3-1c: New derivation of higher-order data products from existing missions should also be supported where needed for Artemis III. For example, it is vital that more detailed geologic mapping of candidate landing sites be accomplished at a scale similar to what was done in preparation for Apollo.

Recommendation 6.5-1b: as LEAG and CAPTEM, serve an important community role synthesizing community input across diverse stakeholders in the engineering, science, and commercial communities, and should be leveraged as the program continues to promote external community engagement to the fullest practical extent.

Membership

- Julie Stopar (LPI/USRA), Co-Chair
- Angela Stickle (JHUAPL), Co-Chair

- Brent Archinal (USGS Astrogeology)
- Maria Banks (NASA GSFC)
- Ross Beyer (SETI & NASA Ames)
- Lisa Gaddis (LPI/USRA)
- Trent Hare (USGS Astrogeology)
- Jose Hurtado (University of Texas El Paso)
- Sam Lawrence (NASA JSC)
- Myriam Lemelin (Université de Sherbrooke)
- Pete Mouginis-Mark (University of Hawaii)
- Noah Petro (NASA GSFC)
- Emerson Speyerer (Arizona State University)
- Jean-Pierre Williams (UCLA)
- Kelsey Young (NASA GSFC)

- **Ex-Officio Members**
- Sarah Noble (NASA)
- Jacob Bleacher (NASA)
- Rebecca McCauley-Rench (NASA)
- Amy Fagan (LEAG chair)
- Brad Thomson (MAPSIT chair)

ToR on MAPSIT website (www.lpi.usra.edu/mapsit/)
REPORT DUE SEP 30, DRAFT Sep 3, TODAY = PRELIM. FINDINGS - COULD CHANGE!

1 - Lunar Coordinate Reference

1a. Summarize the current lunar coordinate reference schema and practices known to be employed by active NASA lunar flight missions.

1b. Are any updates to the standard lunar geodetic coordinate reference frame required or highly desirable to enable near-future landings, surface operations, and maximize science.

Preliminary Findings:

- A lunar mean Earth/polar axis (ME) coordinate reference frame based on the **2021 DE 440** ephemeris represents the best available option for upcoming mission planning and data analysis activities.
    - The current LRO and IAU standards use a frame with the lunar mean Earth/polar axis system, a 1737.4 km lunar radius, and the 2008 JPL DE 421 ephemeris.
    - The new 2021 JPL DE 440 ephemeris shows differences in ME < 1m. There is no need to recompute existing data, but it is beneficial for upcoming missions and going forward to use the latest frame consistently.

2 - Mission-Derived Data for South Pole

2. Assess and prioritize any new mission-derived cartographic products, including mosaics and topographic models, that could be developed for the south pole region using the best currently available data.

Preliminary Findings:

- Precise and tightly controlled topographic data serve as a foundation for other data needed to plan landing sites and surface activities.
- Particularly useful foundational data at the south pole:
    1. **Local and Regional Products:** New high-res topographic products (Improved 5-m LOLA [Barker*], 1-m SfS, 2-5m LRO NAC) would be beneficial for additional landing site evaluations.

       High-res controlled South Pole image mosaics (e.g., NAC and WAC frames, SELENE TC, MI, and Chandrayaan-2 TMC-2 controlled to LOLA).

    2. **Global Products:** Current foundational products are LRO LOLA and WAC mosaics. For the longer term, globally controlled products and standardization would have several benefits, including reducing processing time for landing sites and surface operations, and datasets can be more easily compared and analyzed.

- Upcoming missions should agree on best practices (e.g., controlling to LOLA 5m DEMs) and standardize to facilitate data interoperability.

* https://doi.org/10.1016/j.pss.2020.105119

3. Higher-Order Data Products for South Pole

3. Assess and prioritize which higher-order data products need to be created to support early human landed missions and surface operations, robotic precursor missions, and commercial activity on the lunar surface near the south pole.

Preliminary Findings:

- Geologic and resource maps will be a likely outcome of landing site assessments for upcoming missions. There are multiple scales at which geologic and other maps would be needed (e.g., 1:10,000 scale for surface operations to 1:250,000 scale for regional context).
    - We can make plans with the data we now have in hand; recognizing that maps will improve with time, ground-truth, and the “field” perspective (i.e., it will be an iterative process).
    - Map production requires a significant time investment and early identification of top priority areas and necessary scale(s) would help focus community efforts.
- Illumination models are high priority for mission planning (e.g., solar power as a resource, astronaut safety, survive periods of darkness, thermal models)

Give us feedback on the google doc: Are there other higher order data products should we discuss?

4. New Data or Products to Enable Missions

4. Identify any new mission-enabling data or products that are required from existing or future assets.

Preliminary Findings:

- LRO and other spacecraft have and are providing an abundance of critical data for planning a return to the surface (topography, images, resources, geologic information), but opportunities exist to fill in critical data gaps.

  For the mid- and longer-term there are several aspects to consider:

  - "Field-scale" (<1 m) topography and illumination products will be important for surface operations (e.g., power and navigation).
  - Apollo and future LRRs could be used to improve global geodetic control; farside stations would need orbital ranging.
  - Upcoming missions like Trailblazer and ShadowCam will provide new data for later missions

* https://doi.org/10.1029/2018EA000390

5. Data availability and accessibility

5. Assess the general availability and accessibility of lunar data and tools for the science community, the Artemis program, and the general public.

Preliminary Findings:

- Publicly available data analysis tools currently exist within the planetary and mission communities (e.g., ASU JMars, NASA Treks, ACT QuickMap), but mission planning tends to require specialized tools.
  - More communication of how these tools can be used for mission planning and their limitations is necessary
  - Option 1: Any new mission-specific tools are be built on or within currently existing tools.
  - Option 2: Develop a basic mission-planning tool set that can be used by the community to build on.

- Community-standardized data processing tools (for example ISIS, ASP, and SOCET SET/GXP) exist. Future investments could be considered to improve existing data processing tools to make them more efficient, user-friendly, or capable. Other tools might be available and leveraged from the data science and technology communities, including NASA, universities, commercial or non-traditional providers.

6. Planetary Spatial Data Infrastructure for the Moon

6. Define preliminary steps to enable a “Planetary Spatial Data Infrastructure” (PSDI) for the Moon, and assess long-term implications.

Preliminary Findings:

- Continued and improved documentation of data provenance and uncertainty (error) is needed.
- It is beneficial for the community to define a set of “best practices” in using different tools for a particular purpose such as landing site assessments, as data consumers need to be aware of the accuracy, precision, level of control, etc.
- We recommend that terminology of “controlled”, “semi-controlled”, and “uncontrolled” data is promoted and used consistently.
- Ongoing discussions and working groups will be beneficial in the iterative assessments of quality and control of data products, upcoming data needs, and set community standards to facilitate data useability and interoperability.

* https://doi.org/10.5194/isprs-archives-XLIII-B3-2021-659-2021; ◈ https://doi.org/10.3847/PSJ/abcb94

Comments?

Input is welcome on our preliminary responses to the requested deliverables!

Google Form https://forms.gle/eJXSXGRQhmwQMuUj6

Contact: Angela Stickle (angela.stickle@jhuapl.edu) or Julie Stopar (stopar@lpi.usra.edu)