Jet Propulsion Laboratory
California Institute of Technology

Mars 2020 Project

Surface Site Assessment Overview and Summary

Landing Site Workshop #2

Surface Phase Team

8/4/15

Surface Landing Site Assessment Contents

- Surface Mission Challenge
- Key Landing Site Drivers on Surface Mission Performance
- Schedule for Site Assessments Moving Forward
- Surface Landing Site Workshop #2 Assessment

- Surface presentations include:
  - Introduction – Trosper
  - A Rover Driver's View of Site Traversability – Heverly
  - Preliminary Traverse Distance Estimates for Sites - Ono
  - Surface Performance Site Summary – Trosper

Introductory Comments

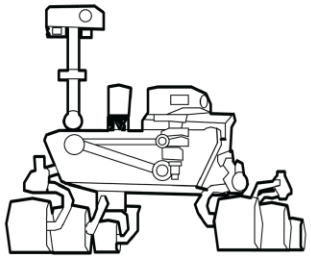
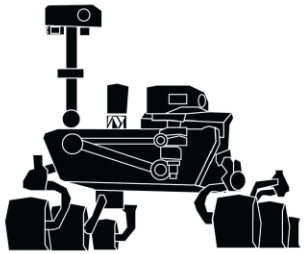
- The analysis in this presentation is **preliminary** and **will change** as the EDL design, surface design and proposed sites mature.
  - We intend this to be the start of an iterative process over the next few years, not an "answer" to the surface mission performance question for each site.
  - Traverse distance estimates for the sites is dependent on assumptions regarding ROIs delivered by the site proposers. We do expect updates to these assumptions and ROIs after this workshop once we have the opportunity today to discuss with the science community how we use them.

- Mars 2020 is working hard to **improve surface productivity** to assist with meeting the level 1 requirements with a largely heritage hardware design based on MSL
  - This is a **challenging** mission and our historical experience indicates that not all of the planned improvements will be fully realized when implementation is complete, but overall surface vehicle performance should be significantly better than MSL.

The Surface Mission Challenge

1.5 MARS YEARS

context

MSL	M2020
	
MARS YEARS: **1.5**	MARS YEARS: **1.5**
DISTANCE COVERED: **10.6 km**	DISTANCE TO COVER: **15 km**
SAMPLES COLLECTED: **2 scooped 6 drilled samples**	SAMPLES TO COLLECT: **20 drilled samples**

Highlights of Productivity Improvements In Work for Mars 2020

- Robust Wheels
  - Significantly more robust wheels vs MSL against damaging terrains, with comparable performance

- Faster Traverse
  - Additional processing on rover for running auto-navigation algorithms to increase speed from ~12 m/hr on MSL up to 60 - 80 m/hr on M2020

- 5 Hour Tactical Timeline
  - Emphasis on Strategic and Campaign planning while automating, abstracting and minimizing work on tactical timeline to essential items (e.g. targeting)
  - Changes mission efficiency from ~55% from MSL to up to 80% - 95% for M2020

- Additional on-board autonomy/operability to achieve science requirements
  - On-board energy and pre-heat management to improve resource usage efficiency
  - Closed-loop image based positioning and targeting for arm and remote sensing

- Additional mission duration capability
  - 1.5 Mars year hardware qualification change request approved and in cost estimates
  - 1.25 Mars Year baseline Reference Scenario

Landing Site Characteristics that Drive Surface Mission Performance (1 of 3)

1) **Latitude (see next page)**
   - Southern latitudes experience wider temperature fluctuation across seasons
     - **colder winters** result in higher Thermal-related energy consumption
     - **hotter summers** encroach on hot-side operation constraints and sample tube temperature requirements
   - Northern and equatorial latitudes are more temperate

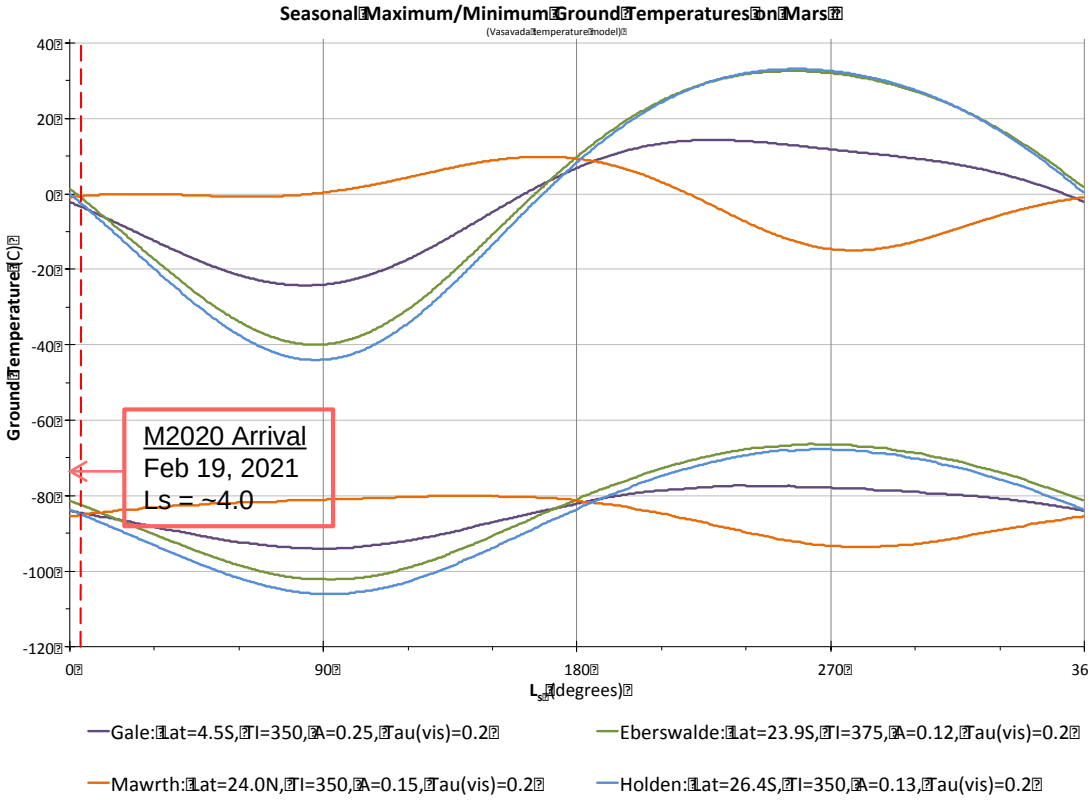
2) **Landing Site Traversability (Heverly)**
   - The complexity of the terrain traversed to reach ROIs is a significant contributor to the time it will take to accomplish the drive distance and therefore overall mission performance

3) **Traverse Distance (Ono)**
   - Although we are working extremely hard to increase traverse performance on M2020 compared to MSL, overall drive distance required to reach the ROIs is a driver for mission performance

Landing Site Characteristics that Drive Surface Mission Performance (2 of 2)

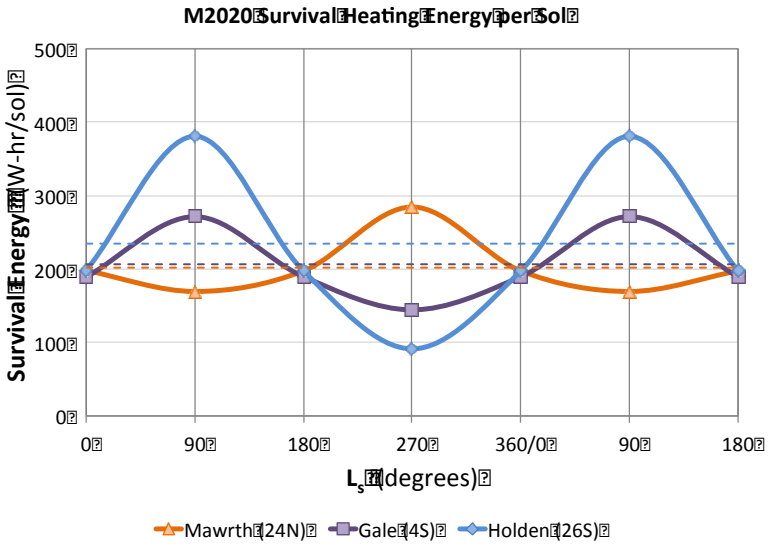
- As the design matures, there are other things that can also impact overall mission performance. However, at this point in the mission design, we do not believe any of these are currently drivers
  - Telecommunications constraints
    - Orbiter availability and geometry
    - Earth rise and set times at site
    - Local topography interferences with communications
  - Instrument operating constraints
    - Thermal constraints (hot or cold)
    - Altitude / pressure constraints for MOXIE (not currently an issue)
  - Dust, winds, etc.
    - M2020 design is robust to these variations in general

Latitude Characteristics



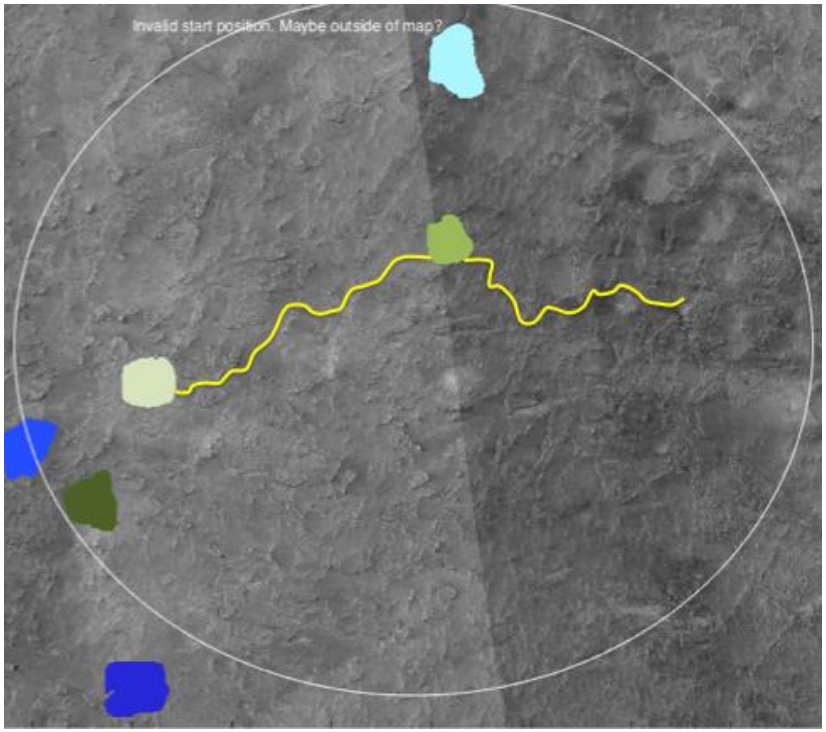
- In general latitude based energy variances average out across a Mars year

- For M2020, we will land in Southern fall making southern sites more energy challenged averaged across 1.5 Mars years (e.g. 2 winters)



Baseline Reference Scenario

- The project system shall have the capability to perform the following Baseline Reference Scenario (BRS) surface mission within 1.25 Mars years (836 sols) with appropriate margin, which includes the following:
  - Conduct the investigations required to meet science objectives A and B and meet technology objective D
  - Explore 2 Regions Of Interest (ROI)
    - Each requiring [6 km] of long traverse length to achieve
    - Each requiring [1.5 km] of local traverse length to explore
    - Each acquiring a total of 10 samples consisting of 8 Mars rock / regolith samples and 2 reference blank samples
  - Cache the collected 20 samples on the surface of Mars
  - Note hardware design life is 1.5 MYears



Surface Performance Landing Site Assessment Status and Plans

- **Landing Site Workshop #2 assessments will show:**
  - Traversability assessment for top 9 sites by a rover driver
  - Traverse distance for top 9 sites based on site ROI information
  - Surface energy rating based on latitude
  - Qualitative rating for each of top 9 sites from an integrated surface performance perspective

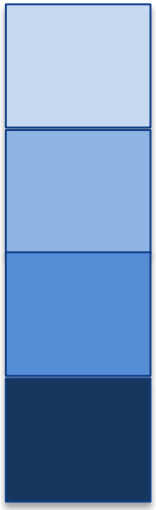
- **Landing Site #2 assessments with not show:**
  - Not showing the evaluation of instrument constraints and impact across latitudes
  - Not showing the ability to achieve mission performance requirements at each site (e.g. can we get 20 samples?)

- **Landing Site Workshop #3**
  - Mission Performance will be evaluated at each of the 8 top sites
    - Instrument thermal constraints (as necessary) will be factored into this overall performance
    - Additional data will be factored into traverse assessments
    - Mobility model to output time for traverse

Preliminary Surface Site Ratings

- All ratings are preliminary and relative. We expect to iterate on this information over the next two landing site workshops

- Rating scale is different from EDL rating scale. It is a qualitative assessment of relative likelihoods of given sites meeting the overall mission performance (e.g. 20 samples) requirements.



= best chance of meeting mission performance requirements

= some challenges to meeting mission performance requirements

= significant challenges to meeting mission performance requirements

Preliminary Relative Surface Landing Site Assessment

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#	Site	Energy	Dist. (50 – 90%tile) conservative	Traverse (complexity, Gale = 5)	Sum	Comments
1	NE Syrtis	17N	10-15			Mature data used for assessment. Longish traverse distance but easy terrain
2	Nili Fossae Trough	21N	13-18			Longish traverse distance but very easy terrain. Non-TRN site.
4	Jezero Crater Delta	18N	12-17		↑	Very concerned about traversability. Possibility of shrinking the ellipse to remove eastern hazards will improve this site
5A	Holden Crater (MSL)	26S	~TBD			Assume you do not need to get to critical ROIs south of ellipse. Energy concerns.
5B	Holden Crater (Land On)	26S	12-17			Combined thermal and traverse make overall mission performance concerning
6	McLaughlin Crater	21N	9-14			Immature data, particularly slopes. Concern over inescapable hazards overall.
7	Southwest Melas Basin	10S	9-14		↑	Traversability concerns. Possibility of shrinking ellipse to remove northern hazards will help this site.
8	Mawrth Vallis	24N	4-9			Traversability concerns but land on site makes this less concerning.
9	East Margaritifer	5S	3-6			Land on site.

↑ = trending better