Jet Propulsion Laboratory
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# *The Mars Reconnaissance Orbiter Mission:*

# Continuing a Record of Exploration from Mars Orbit (IAC-17-A3.3A.7)

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# Continuing a Record of Exploration from Mars Orbit

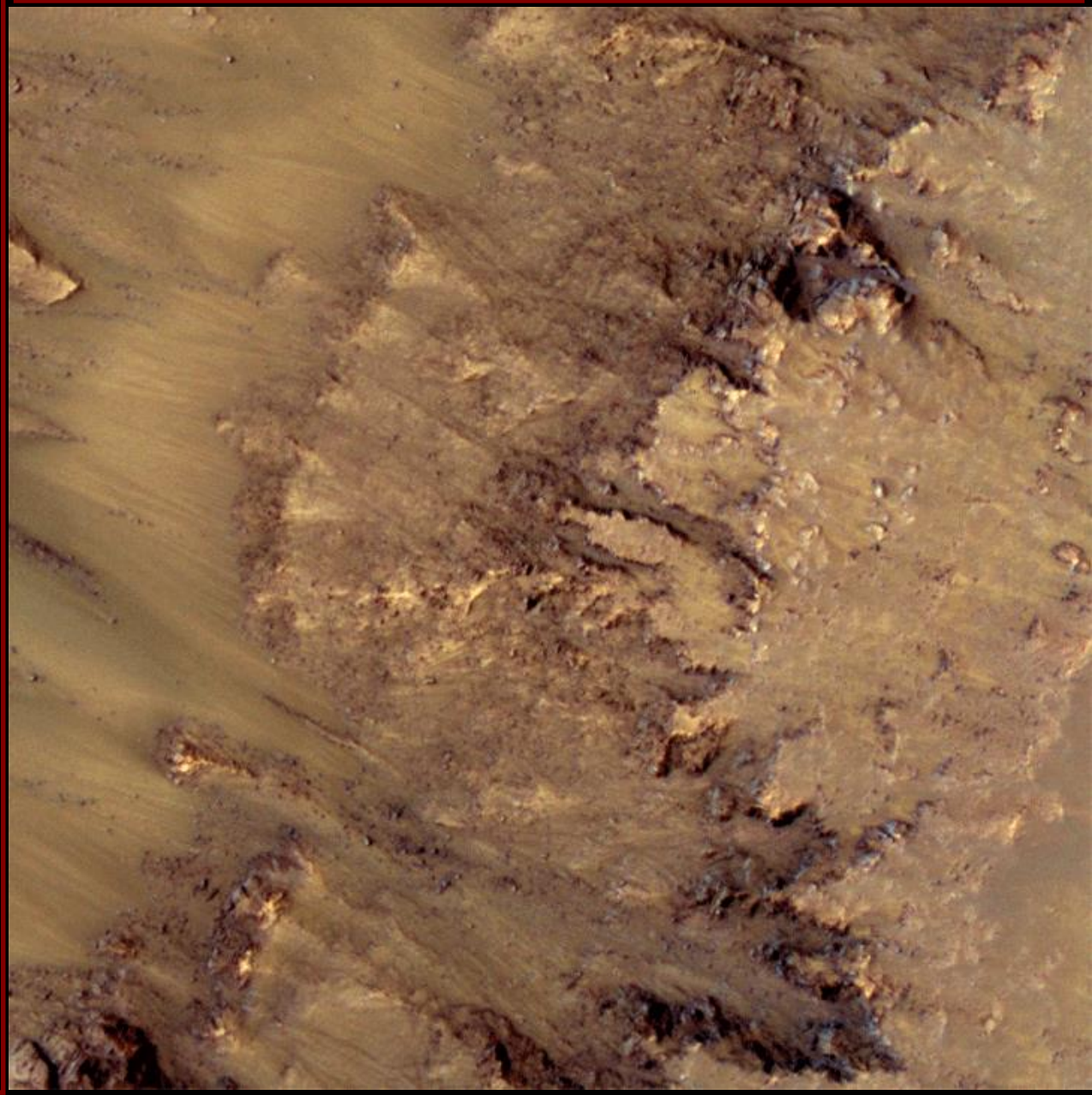
- Mission and Spacecraft Overview
- Recent Science Highlights
- Programmatic Functions
- Flight Status and Challenges
- Summary

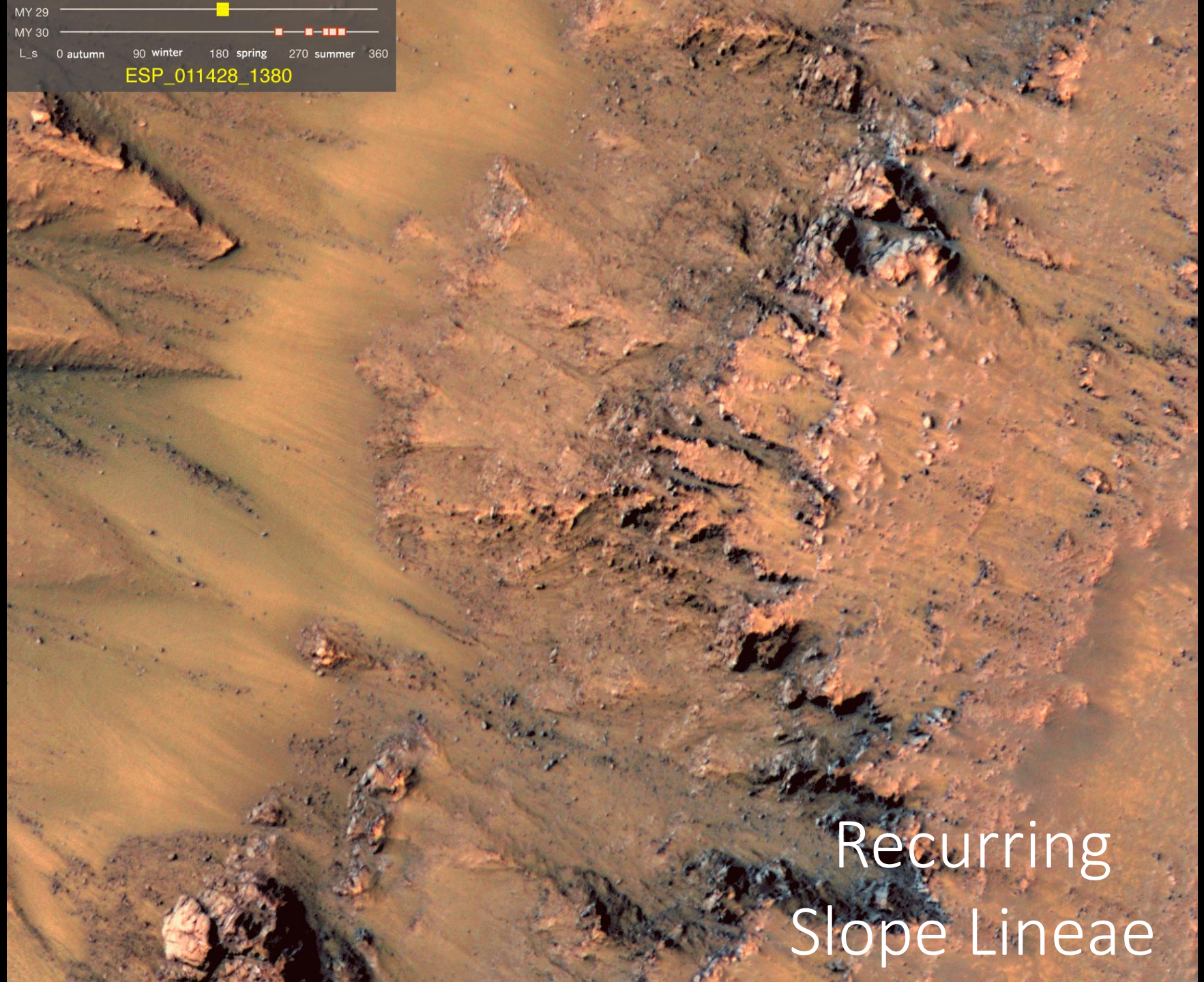
# *MRO Spacecraft*

# *Seasonal Flows on Warm Martian Slopes*

**(A. McEwen et al., Science, 14 July 2011)**

- Recurring Slope Lineae (RSL) are narrow (0.5-5 m), dark markings on steep slopes (>25°)
- Form and incrementally grow in warm seasons (late spring to summer), then fade or disappear in cold seasons.
- Reform at nearly same locations in multiple Mars years.
- Extend downslope from bedrock outcrops or rocky areas; often associated with small channels.
- Concentrated in southern hemisphere (32°S to 48°S), favoring equator-facing slopes.
- Form and grow at temperatures at which brines (salty water) would be liquid.
- Exact mechanism not understood, but activity of brines is current best model.






Recurring
Slope Lineae

# Widespread Ice in Arcadia Planitia on Mars

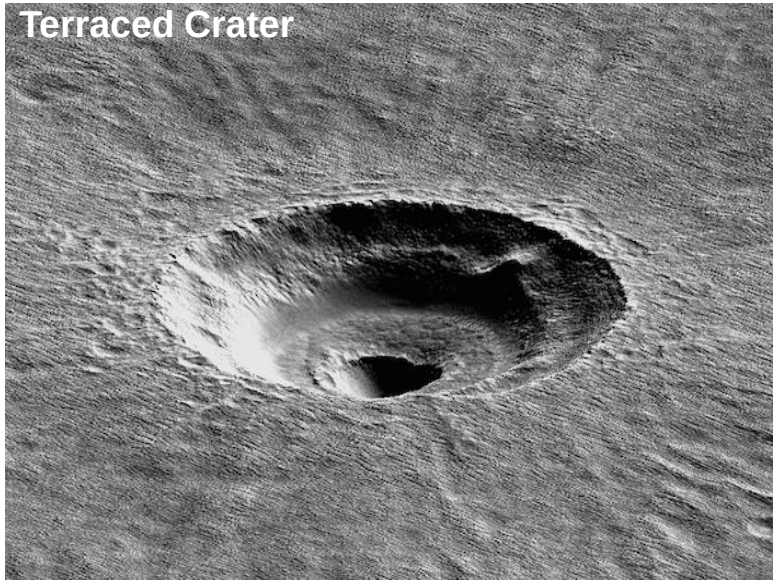
- **Impacts into layered targets can form craters with terraces in their walls at the layer boundaries of materials with different strengths.**

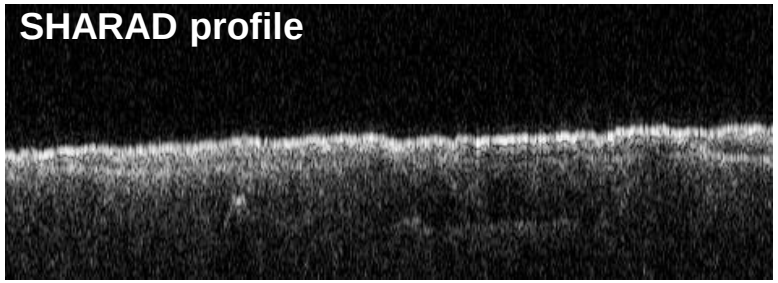
- **MRO cameras have imaged dozens of these craters across the northern mid-latitude region of Arcadia Planitia, indicating a widespread layer. The Shallow Radar (SHARAD) sounder on MRO has also detected a subsurface layer in this region**

- **Using HiRISE stereo images of the terraced craters, 3D digital terrain models allow the depth to the terraces to be measured, and thus the thickness of the layer (~40 meters)**

- **Comparing the layer thickness with measurements of the time it takes for the radar signal to pass through the layer, it has been determined that the layer is composed mostly of water ice.**

- **This ice sheet covers an area of ~$10^6$ km$^2$, the size of California and Texas combined! It extends to 38°N latitude, where conditions are more favorable for human explorers than at the polar ice caps.**

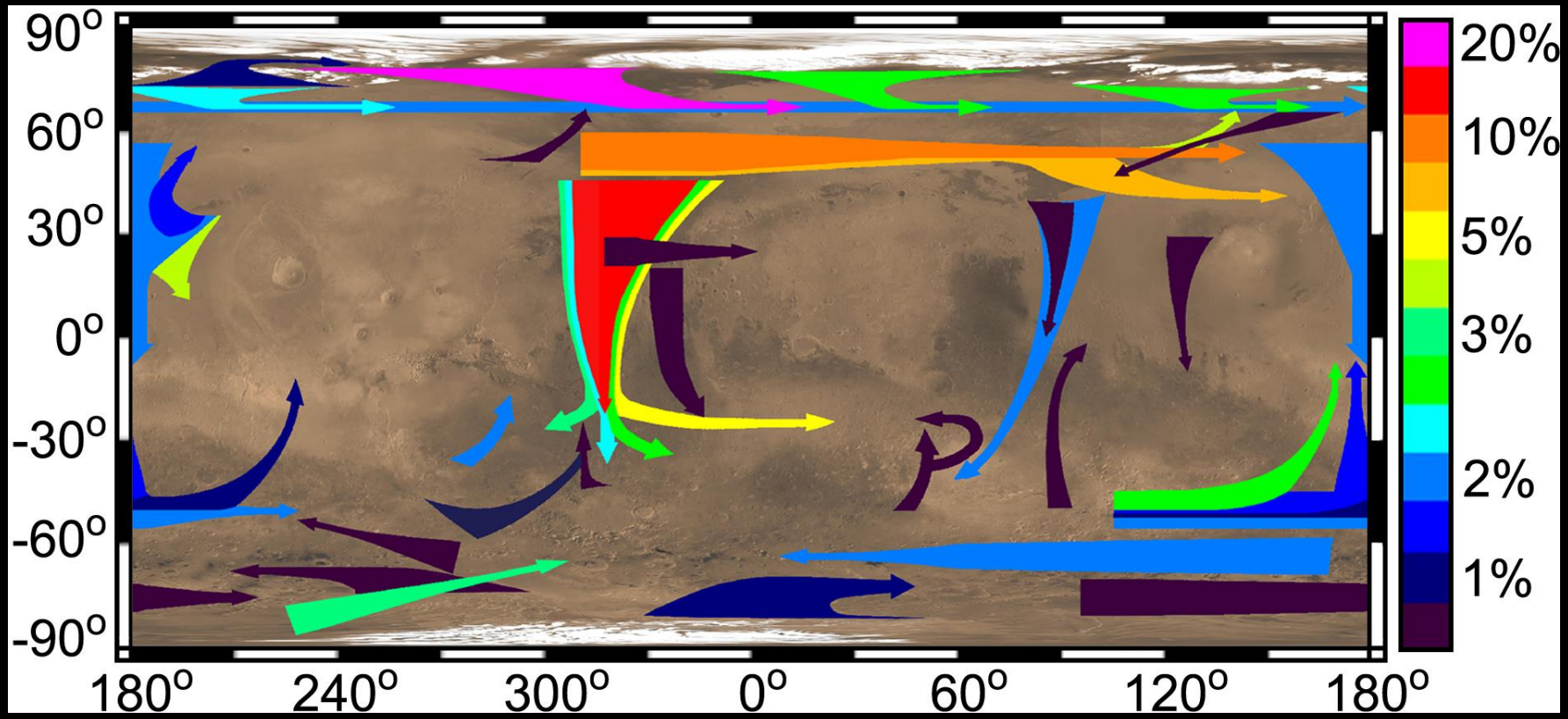



**Results published in Bramson, A. M., S. Byrne, N. E. Putzig, S. Sutton, J. J. Plaut, T. C. Brothers, and J. W. Holt (2015), Widespread excess ice in Arcadia Planitia, Mars, Geophys. Res. Lett., 42, doi:10.1002/2015GL064844.**

# Weather On Mars (MARCI)

## Identification of Storm-Tracks

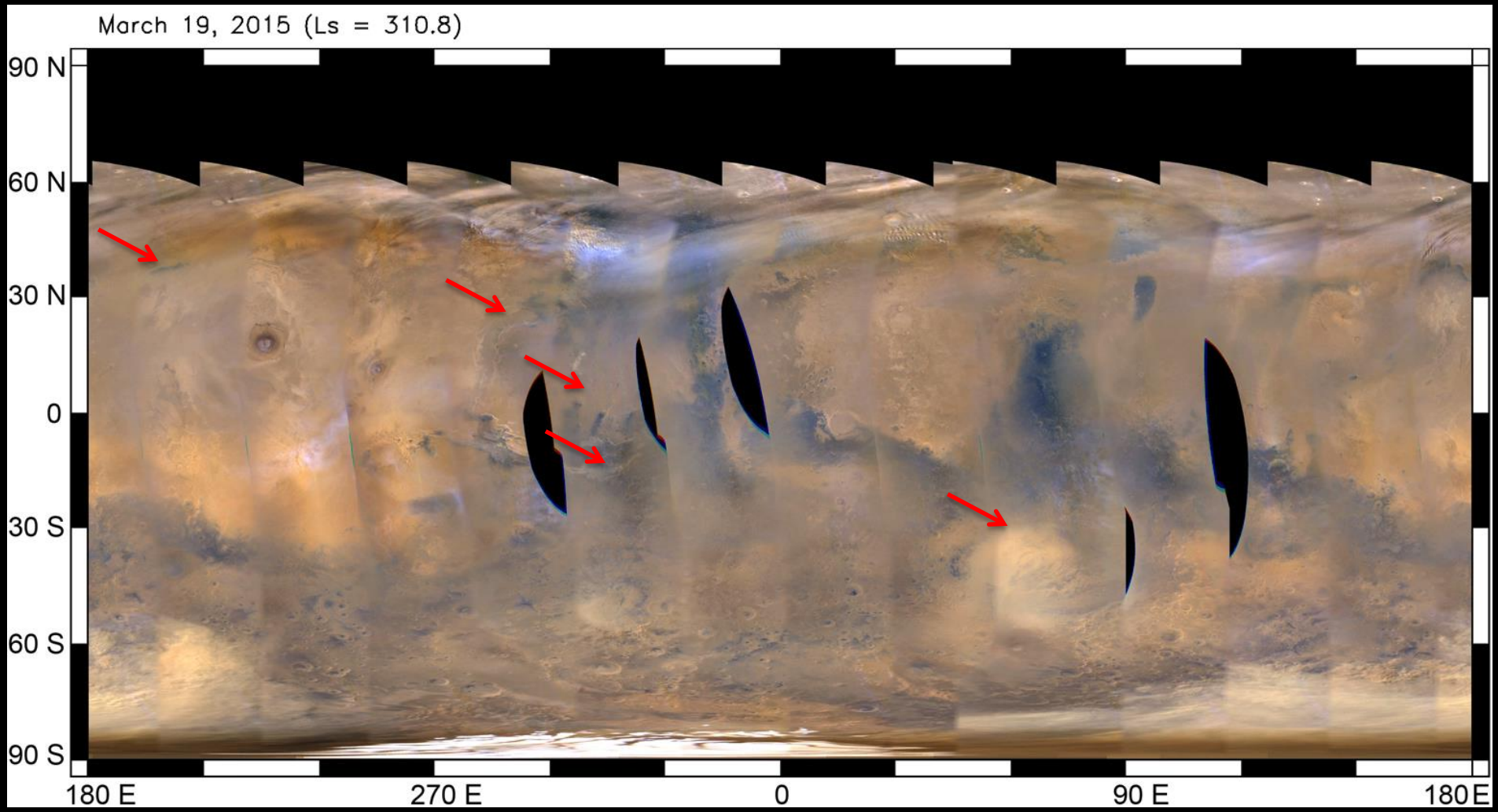



- *Cantor et. al., in preparation*

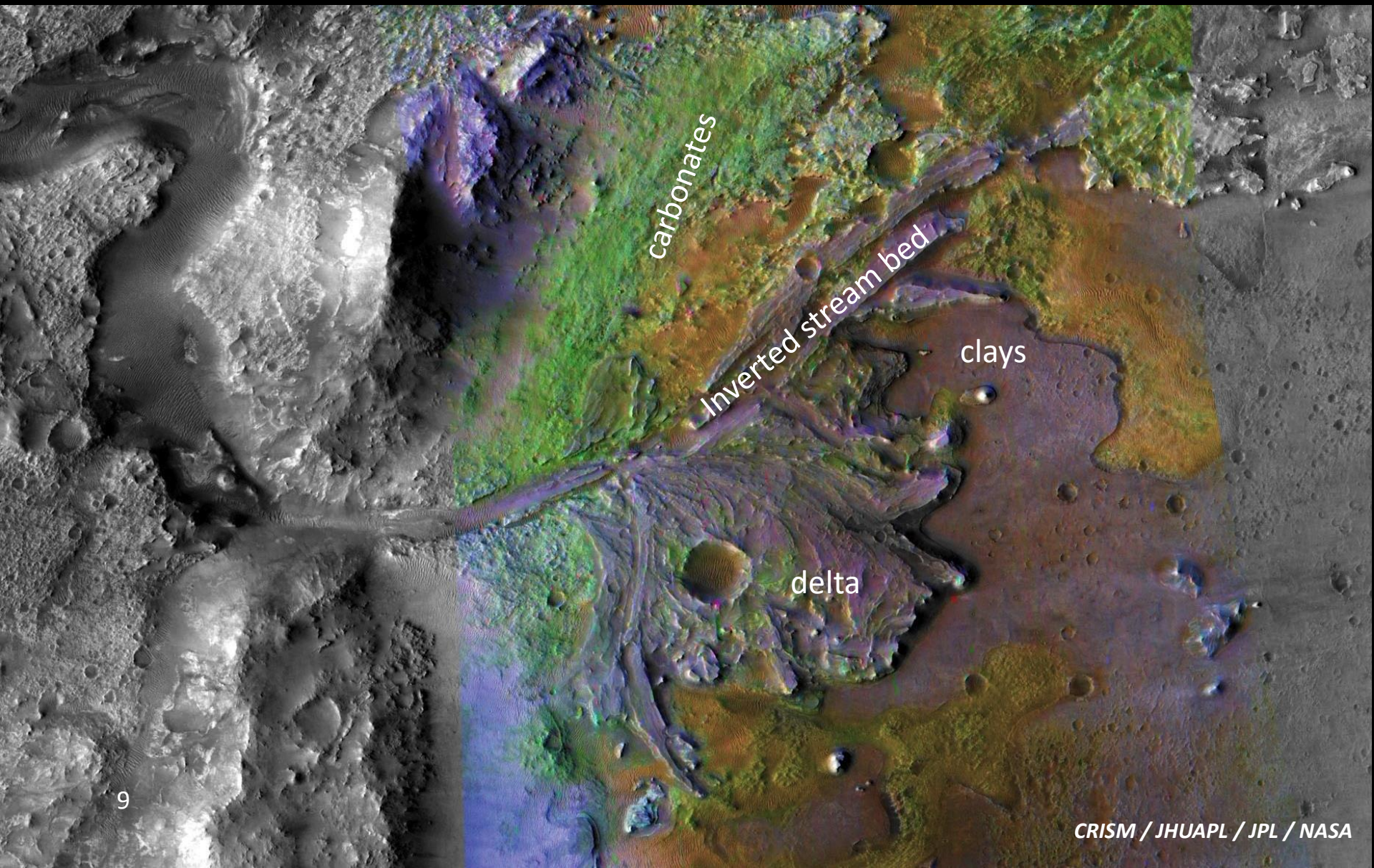
- A decade of nearly daily global imaging from MRO-MARCI and MGS-MOC has produced a climatological record of 252 regional-scale storms (duration > 3 sols).
- These storms are responsible for dusty periods that can persist for several months, possibly impacting EDL, aerobraking, data acquisition from orbit, and surface operations.

# Weather On Mars (MARCI)

## Weather the Week of March 19, 2015

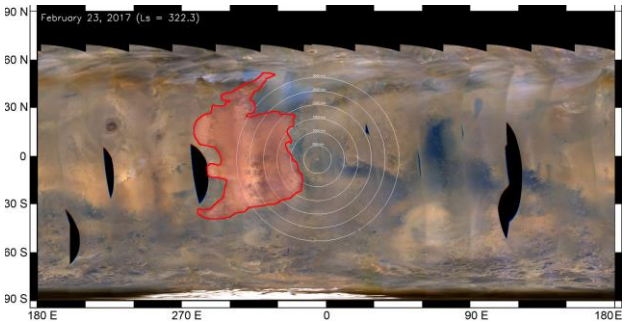


# Jezero Crater (A Mars 2020 Candidate Landing Site): Morphology and Mineralogy Indicate Ancient Wet Past (CRISM)

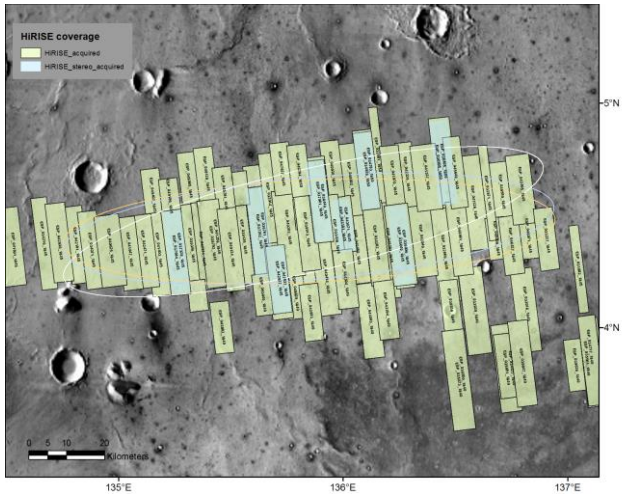



CRISM / JHUAPL / JPL / NASA

# Landing Site Reconnaissance - Surface Operations Support

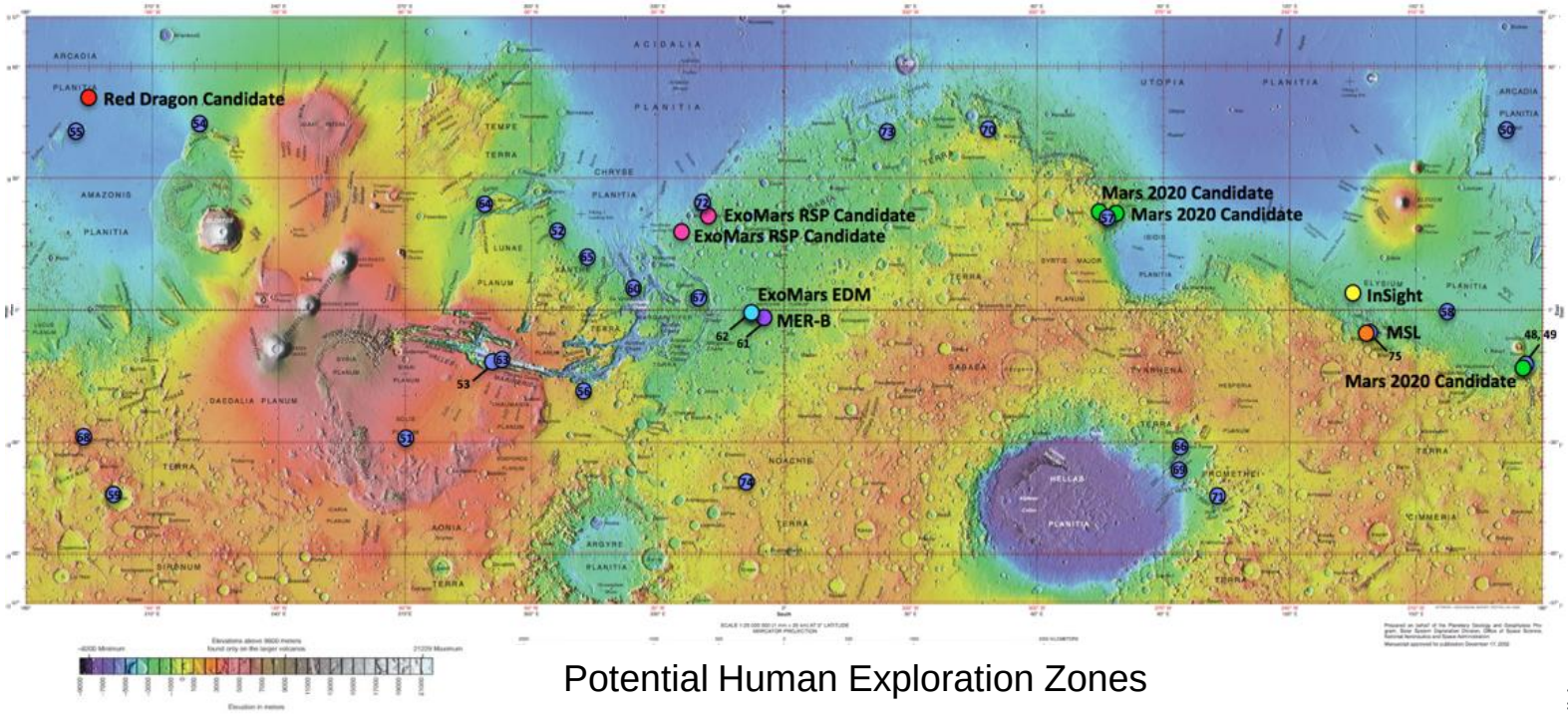



*Opportunity* – Dust Storm Warning



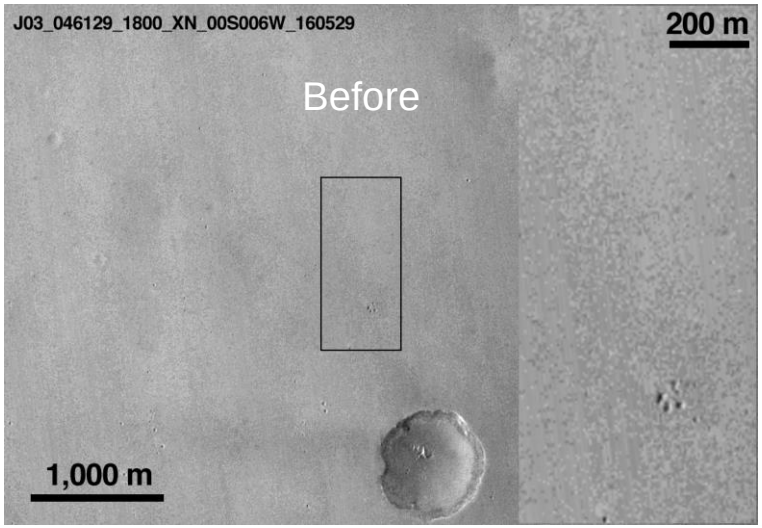

2018 InSight Landing Site Imaging

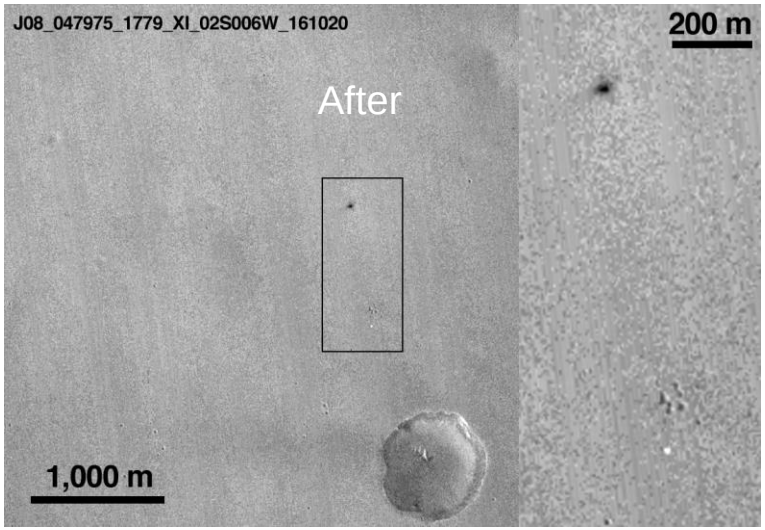
*Curiosity* On the Move

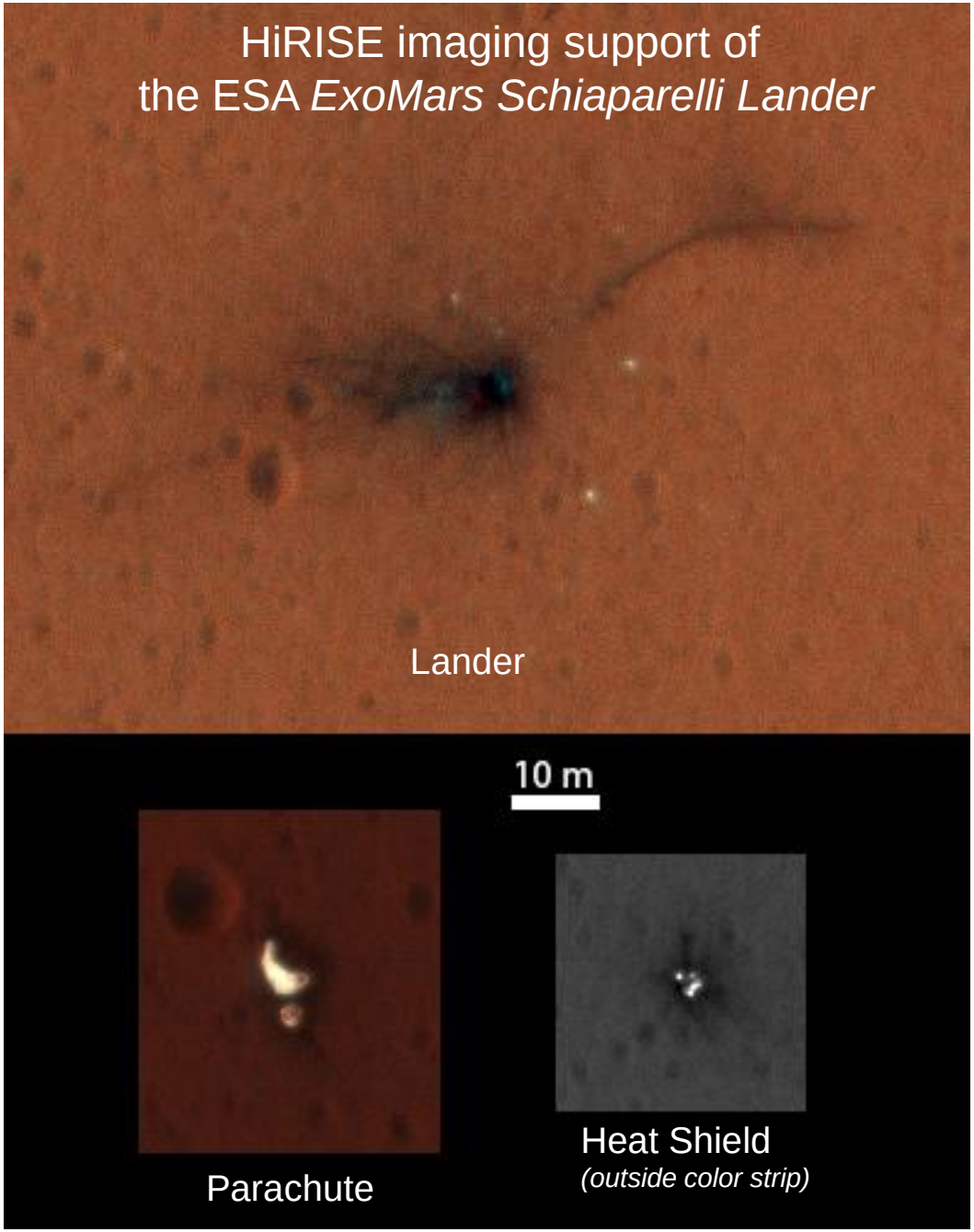



Potential Human Exploration Zones

*October 2016* - CTX found the lander and parachute within first image (below). Subsequent images were re-targeted so that all components were in HiRISE frame and the parachute and lander were within color strip (right).






*HiRISE / U. Arizona / JPL / NASA*

# Flight Status and Challenges

- Component Lifetime Limitations
  - Nearly all spacecraft redundancy is in place – Large fuel reserves
  - IMU-1 showing indications of limited life => Swapped to IMU-2
    - Developed All-Stellar Attitude Determination Capability
      - Flight Demonstrations to Characterize Performance in Progress
  - Battery Management
- Instrument-produced EMI impacts on the Electra UHF Link
  - Mitigation methods introduce operations complexity
- Expansion of UHF Relay Capability
  - From Nadir-oriented to Rolled relay passes
  - From fixed data rates to adjustable data rates (ADR)
  - From a single-vehicle per pass to split-pass (2 vehicles on the same overflight) relay capability

***Earth (and Moon) as seen by MRO (HiRISE) from Mars Orbit on Nov 20, 2016.***

*Acquired at a range of 205 million km (~200 km/pixel)*

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