White Paper Topic 1-slide Lightning Talks

Mars Atmospheric and Surface Processes // Climate Record

Mars Atmospheric and Surface Processes // Climate Record				
10:25 AM		MOSAIC PMCS: A comprehensive view of the Mars climate system	Rob Lillis	01:25 PM
10:35 AM PDT	#13	Observing Mars from Areostationary Orbit: Benefits and Applications	Luca Montabone	01:35 PM EDT
10:37 AM	14	Measuring Mars Atmospheric Winds from Orbit	Scott Guzewich	01:37 PM
10:39 AM	15	Terrestrial Planets Comparative Climatology Mission Concept	Leslie Tamppari	01:39 PM
10:41 AM	16	Current Activity on the Martian Surface: A Critical Scientific Objective for Future Exploration	Colin Dundas	01:41 PM
10:43 AM	17	Toward Predicting Martian Dust Storms and Climate	Claire Newman	01:43 PM
10:45 AM	18	Mars as a "Natural Laboratory" for Studying Surface Activity on a Range of Planetary Bodies	Serina Diniega	01:45 PM
10:47 AM	19	A Critical Gap: In Situ Meteorological and Aeolian Measurements Beyond Earth	Serina Diniega	01:47 PM
10:49 AM	20	Planetary Aeolian Processes – Mars as an Analog for the Rest of the Solar System	Timothy Titus	01:49 PM
10:51 AM	21	Facilities for Planetary Aeolian Experimental Research	Devon Burr	01:51 PM
10:53 AM	22	A Case for Mars Polar Science in the Solar System	Isaac Smith	01:53 PM
10:55 AM	23	A Comparative Overview of Glacial and Periglacial Landforms on Earth and Mars	Anna Grau Galofre	01:55 PM
10:57 AM	24	Mid-Latitude Ice on Mars: A Science Target for Planetary Climates and a Resource for Exploration	Ali Bramson	01:57 PM
10:59 AM		PMCS: MORIE	Wendy Calvin	01:59 PM
11:09 AM		Discussion - e.g., thoughts on these topics? what's missing?		02:09 PM

These slides and 1-pagers for each of these concepts can be found at: https://mepag.jpl.nasa.gov/meetings.cfm?expand=m38

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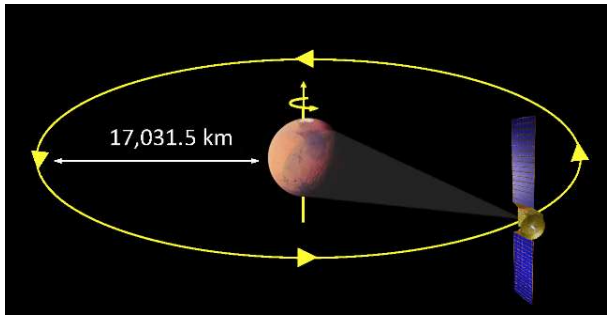
Observing Mars from Areostationary Orbit: Benefits and Applications

Objectives:



- Discuss the overall benefits of the areostationary orbit
  - Continuous and simultaneous coverage
- Look at future scientific and operational applications
  - Atmospheric and space weather monitoring/forecasting
  - Study of physical surface properties (thermal inertia/albedo)
  - Telecom and computational resources for exploration
- Consider single satellites as well as a network/constellation.

Status and Invitation:

- 20 contributors/endorsers so far; Welcoming many more!
- Contributions include: collaborative section writing, suggestions, reviewing
- We are especially interested in seeking contributions on space weather and surface studies (including possible Aeolian studies) from areostationary.
- Team and task definition by end of April, first draft planned by end of May

Point of contact: Luca Montabone → lmontabone@spacescience.org

More information: White paper #13 at https://mepag.jpl.nasa.gov/meetings.cfm?expand=m38

Measuring Mars Atmospheric Winds From Orbit

Scott Guzewich, scott.d.guzewich@nasa.gov

- This White Paper will:
  - Advocate for global atmospheric wind observations from orbit; particularly vector-resolved horizontal winds from the surface to >60 km altitude with a horizontal resolution of ≤300 km
  - Demonstrate the science case for measuring Mars atmospheric winds MEPAG high priority science: Goal II A1.1, Goal IV A1.3, Goal IV A3.3
  - Discuss the relevance of wind measurements to future human and robotic exploration
  - Describe the existing and in-development instruments that could make such measurements
- Additional co-authors/co-signers/contributors are welcome!
- Writing will begin in the next 1-2 weeks with the goal of a complete draft by June 7, 2020

Terrestrial Planets Comparative Climatology (TPCC) Mission Concept

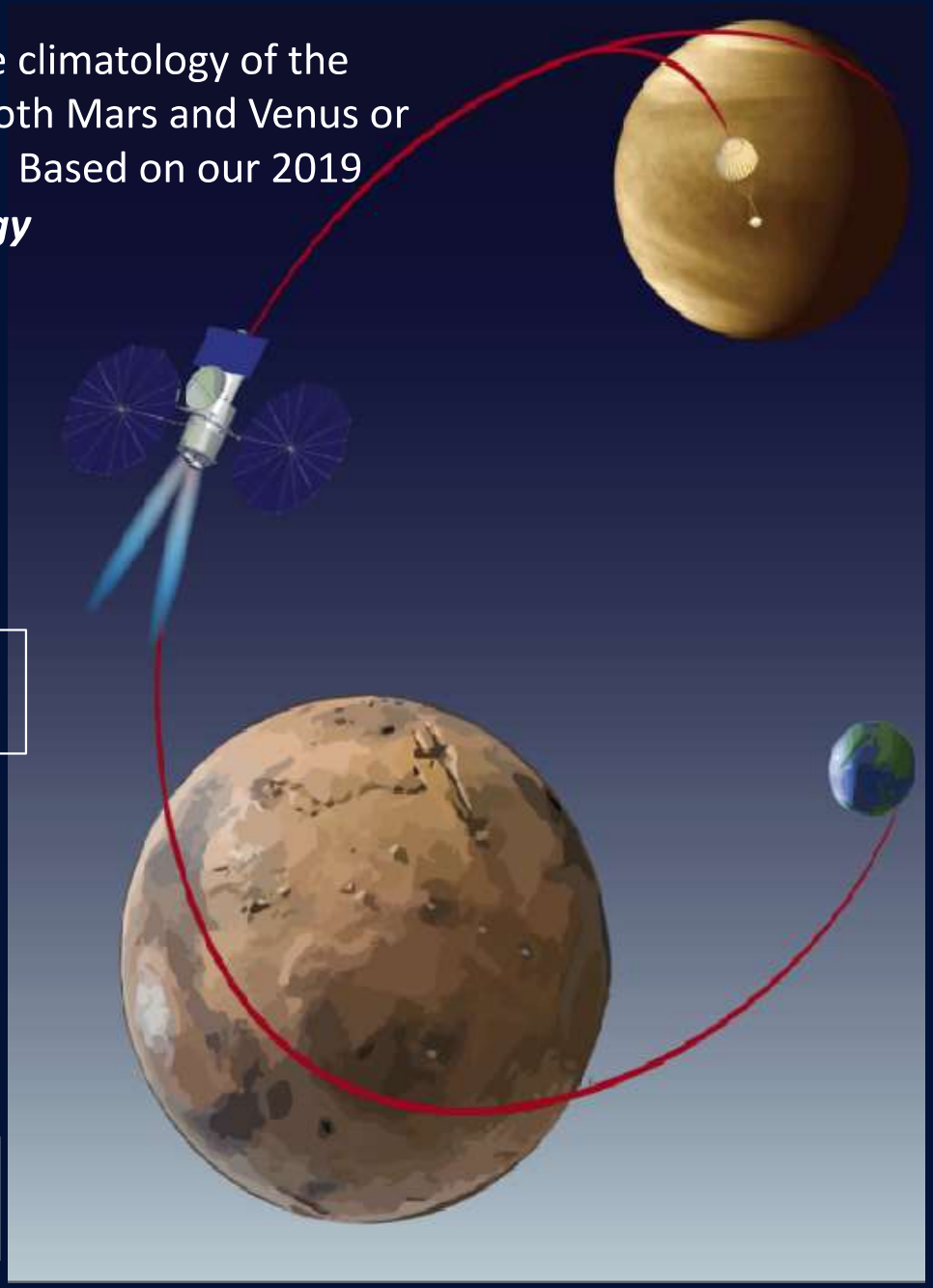
Purpose: Describe a mission concept to compare the climatology of the terrestrial planets by sending a single spacecraft to both Mars and Venus or possibly sending twin spacecraft, one to each planet. Based on our 2019 Mission Concept proposal. ***Theme: Follow the Energy***

Artist's concept (Taylor, 2011)

Science: Determine (1) loss of Venus atm/time, (2) net energy input to both planets, (3) the dynamical behavior of Venus' (60-100 km) and Mars' (0-100 km) atm.

POC: Leslie K. Tamppari, leslie.tamppari@jpl.nasa.gov

Authors: Amanda Brecht, Larry Esposito, Scott Guzewich, Kandis Lea Jessup, Armin Kleinböhl, Kevin Baines, Brian Drouin, Nick Schneider

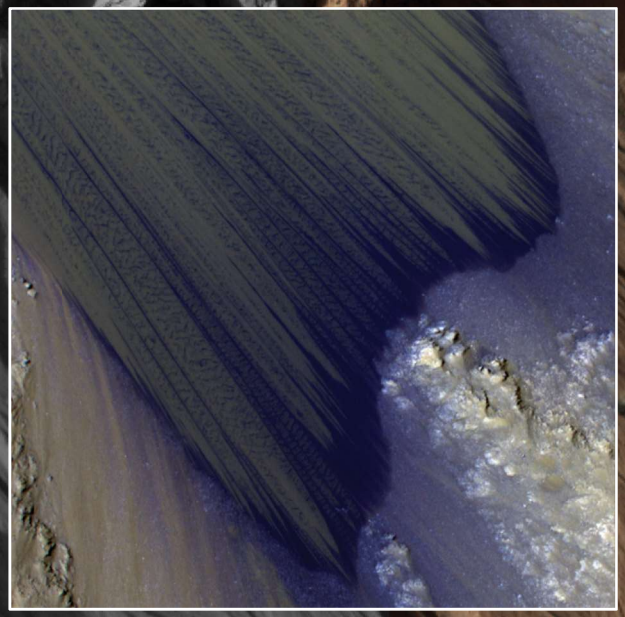


For more information, please see my 1-pager at:
https://mepag.jpl.nasa.gov/meetings.cfm?expand=m38

Current Activity on the Martian Surface: A Critical Scientific Objective for Future Exploration

Contact: Colin Dundas (cdundas@usgs.gov)

- Many types of surface change have been observed on the Martian surface, and others may be occurring.
- Studying active processes is important for understanding the current surface, assessing recent climate changes, and correctly interpreting the ancient rock record.



https://mepag.jpl.nasa.gov/meeting/2020-04/whitetopics/WhitePaper_16_Dundas.ActiveMars.pdf

ESP_059476_1670; ESP_017868_2440; ESP_036387_2640; ESP_020661_1440 (background)

Toward predicting Martian dust storms and climate

Point of contact: Claire Newman, claire@aeolisresearch.com

- Martian dust storms are the biggest source of Mars climate variability
- But no Mars atmospheric model can spontaneously generate dust storms at realistic times and locations, let alone predict dust storms in advance
- This also casts doubt on predictions of *past* dust cycles and climate, which are crucial to interpretations of geologic features e.g. polar layered terrain
- Better understanding of and predictive capabilities for major dust storms is also important to the success of future robotic and human missions
- Understanding dust lifting and storm growth mechanisms is crucial. Key measurements needed to improve our understanding are:
  - Joint environmental and aeolian measurements during dust lifting at the surface;
  - Global and seasonal mapping of mobile surface dust/sand availability; and
  - Comprehensive observations of the atmospheric dust distribution and climate response during major dust storms, from orbit and from the surface

Over 30 co-authors so far but more are welcome, especially those with additional perspectives!

See our 1-pager #17 at: https://mepag.jpl.nasa.gov/meetings.cfm?expand=m38

Mars as a "natural laboratory" for studying surface activity on a range of planetary bodies

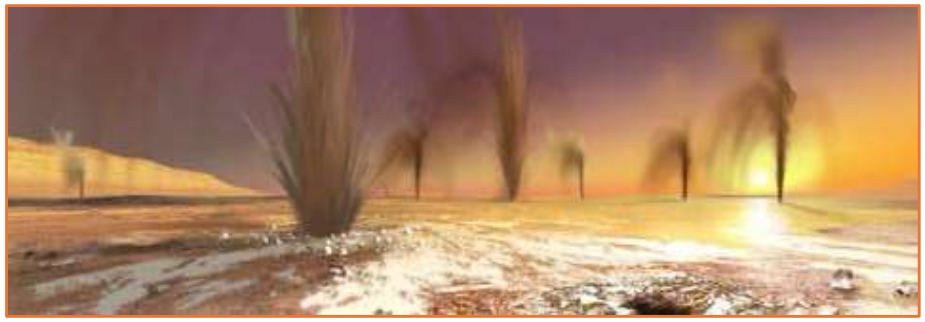
Serina Diniega (serina.diniega@jpl.nasa.gov)

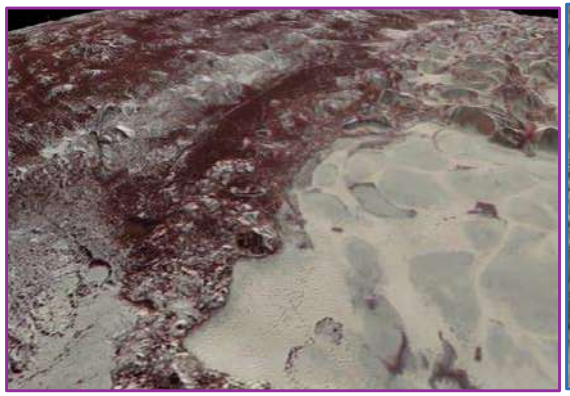
This white paper aims to:

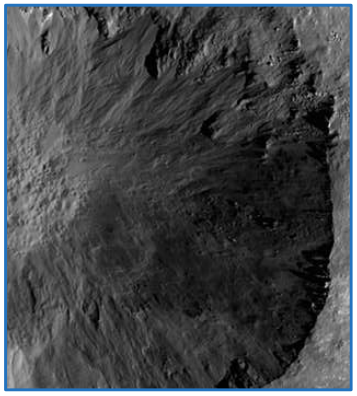
- Establish that Mars is currently a planet with an active surface.
- Identify and describe areas in which studies of Mars' environmental conditions & processes enable testing of models of analogous processes on other planetary bodies.
  - Current focus is on wind and frost-driven surface activity, in the present or recent past (Amazonian).
  - Mars provides a comparative planetology basis for e.g., lower gravity/air-density, sublimation-driven processes.
  - **Example:** the study of Mars wind-formed bedforms challenged (and challenges) models of moving sand [e.g., 1,2] and the bedforms created [e.g., 3].
- Outline how the large amount of contextual information available for Mars coupled with models derived from Earth/laboratory/first principles, etc. can be used to develop or test fundamental physics models.
  - **Example:** on Mars [4] we have global maps of bedform locations, coupled in situ and orbital observations of those bedforms (over many wavelengths), overlapping high-res images enabling change detection, models of wind over known topography, wind direction maps based on landforms, (limited) observations of wind and sand motion, known grain sizes, etc.
- Prioritize the science questions and/or measurements that would best advance planetary surface process studies.

References: [1] Claudin & Andreotti, 2006, doi:10.1016/j.epsl.2006.09.004. [2] Kok, 2010, doi:10.1103/PhysRevLett.104.074502. [3] Lapotre et al., 2016, doi:10.1126/science.aaf3206. [4] Diniega et al., 2017, doi: 10.1016/j.aeolia.2016.10.001.

For more info, see https://mepag.jpl.nasa.gov/meeting/2020-04/whitetopics/WhitePaper_18_Diniega.NaturalLab.pdf







Images (from top): Mars aeolian bedforms upon bedforms, Artistic representation of Mars seasonal frost jets, Pluto surface features, Vestan crater wall gullies

A critical gap: in-situ meteorological and aeolian measurements beyond Earth

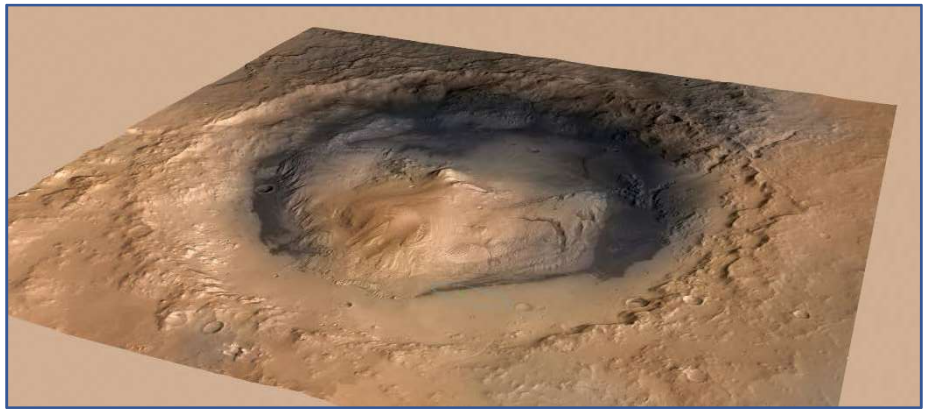
Serina Diniega (serina.diniega@jpl.nasa.gov)

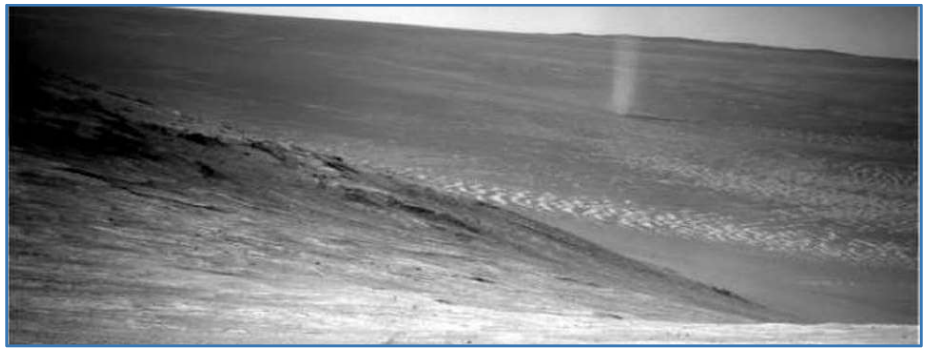
This white paper aims to describe

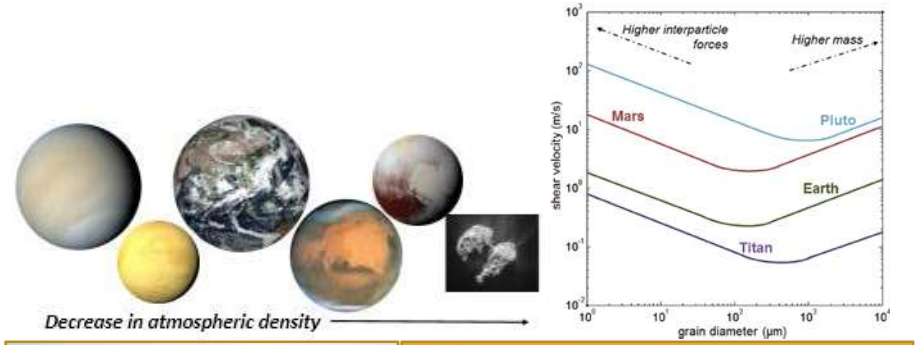
- How direct observations of surface-atmosphere processes and exchange rates would fill a critical gap within high-priority Planetary and Mars science,
- What type of measurements are needed to fill this critical gap,
- That acquisition of these types of measurements from the surface of Mars is technically, scientifically, and fiscally feasible in the next decade, and
- Identified key areas of technology investment to enable or enhance the ability to acquire needed measurements.

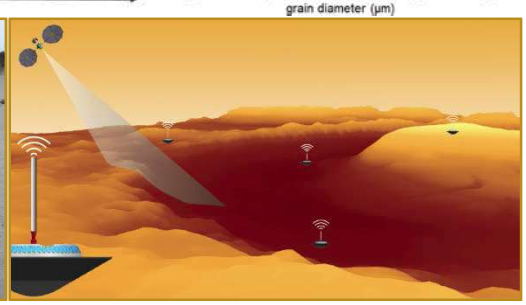
While the science focus of this white paper includes fundamental physics and planetary science, the type and frequency of the opportunities to visit Mars and the large amount of contextual data that have been acquired at Mars makes that body the natural planetary target for relevant in-situ studies in the next decade.

For more info, see https://mepag.jpl.nasa.gov/meeting/2020-04/whitetopics/WhitePaper_19_Diniega.CriticalGap.pdf.









Images (from left, then top): Gale crater, An Opportunistic observation of a martian dust devil, Two comparisons between Mars and other bodies, Example terrestrial in situ instrumentation that could maybe work on Mars, Artistic schematic of an example meteorological/aeolian network.

Planetary Aeolian Processes – Mars as an Analog for the Rest of the Solar System

- Aeolian processes occur on all planetary "rocky" bodies with an atmosphere.
- Mars aeolian features range from ripples to dunes to yardangs.
- Record of atmospheric-surface interactions:
  - Climate
  - Geology
- Due to orbital/robotic surface exploration: Mars – the new analog site.
- Mars as a Technology Test Bed:
  - E.g. Mars 2020 Helicopter
- Desired End State for the Input Into the Decadal Survey:
  - A Goals Document/Roadmap for the study of Planetary Aeolian Processes
- International Planetary Dunes Workshop (12-13 May 2020) provides another opportunity for white paper development

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Contact: Timothy Titus (ttitus@usgs.gov)

Image Credit: NASA/JPL-Caltech,
https://www.nasa.gov/image-feature/jpl/glimpse-of-bagnold-dunes-edging-mount-sharp

The importance of experimental facilities for Mars aeolian research

POC: Devon Burr (Devon.burr@nau.edu)

NASA's Planetary Aeolian Laboratory:

Guidebook for Proposers

RESULTS: "The Venus simulator showed that particles can be abraded even with the very low impact velocities expected under Venus conditions [13, 14]. Vortex data, combined with field observations and modeling, have quantified the processes of dust lifting on Earth and Mars [15]. Results from the low-pressure facility [MARSWIT] were used to quantify aspects of sediment transport processes, such as threshold wind speeds required to move sediments on Mars [16-18] and to model aeolian-type transport resulting from jetting on comets [19]. The high-pressure wind-tunnel provided data for modeling aeolian thresholds on Venus [20] and Titan [21]."

Review of SMD Facilities (Feb 2016)

For the Planetary Aeolian Laboratory:

Numerous strengths, e.g., greater accessibility under PI and efficient on-site operations by PAL engineer, unique scientific capability and relevance

Notable weaknesses, e.g., small user community, limited transparency at Ames

Findings: e.g., user workshops, subject matter experts, research scientist with active interest in PAL

***DRAFT* White Paper on this topic (Spring 2019):**

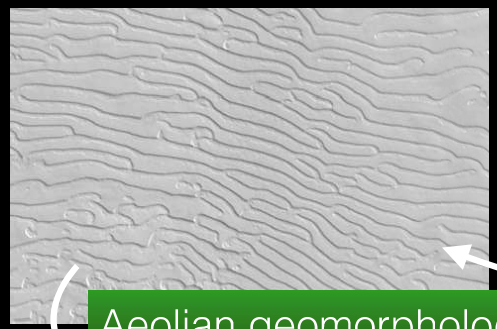
1. That NASA consider multi-year PAL funding;
2. that NASA consider additional funding to bring the instrumentation and capabilities of the PAL in line with those at other wind tunnel facilities;
3. that, given the possible limitations of the current facilities, NASA conduct a feasibility study into building one or more new wind tunnels;
4. that NASA evaluate the prospects for operating a NASA wind tunnel facility at an institution with more transparency, managerial engagement, and/or proximity to aeolian researchers.

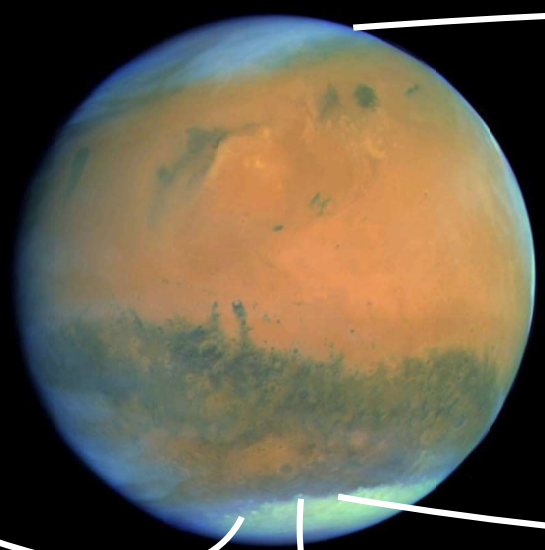
Continued [*engineering*] input requested

Low temperature simulation (down to -10° C) and full humidity control are several of the primary distinguishing features of this facility.

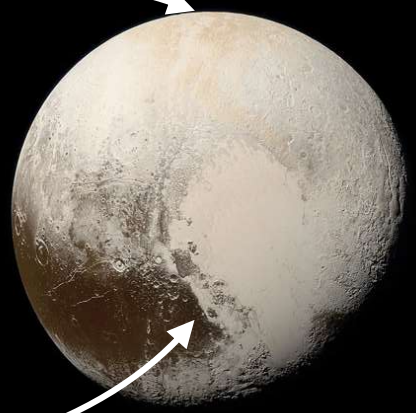
A Case for Mars Polar Science in the Solar System

Numerous atmospheric and geologic analogues



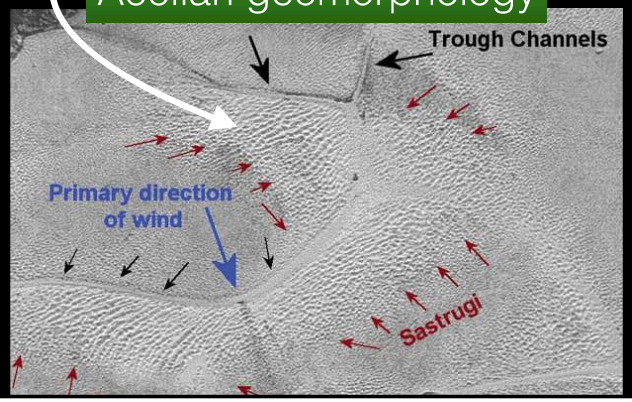


Seasonal and permanent layers deposits

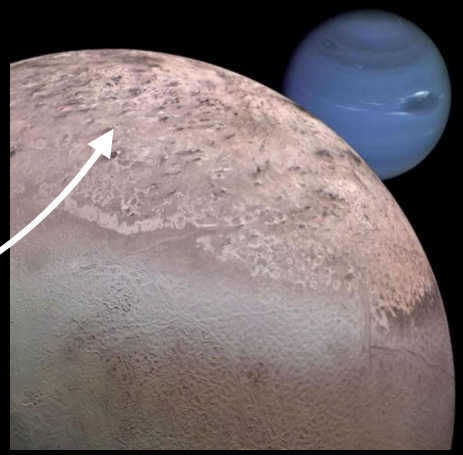


Long-term residual caps

Aeolian geomorphology



Seasonal processes



Outstanding questions include but aren't limited to:

- The extent and quantities of solid volatiles on each planetary body
- The processes that act on those solids state volatiles
- Interactions between the gaseous phase and the surface
  - geomorphology and atmospheric science
- Climate records in layered deposits

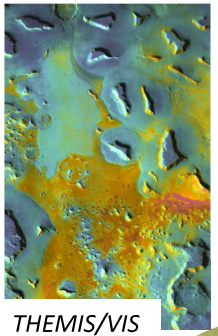
Similar tech development: Cold-tech, instrumentation

point of contact: ibsmith@yorku.ca

https://mepag.jpl.nasa.gov/meeting/2020-04/whitetopics/WhitePaper_22_Smith.PolarSci.pdf

A COMPARATIVE OVERVIEW OF GLACIAL AND PERIGLACIAL LANDFORMS ON EARTH AND MARS

Lead author: Anna Grau Galofre
(agraugal@asu.edu)



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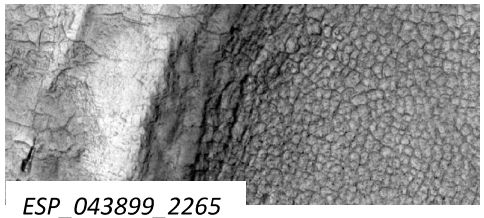

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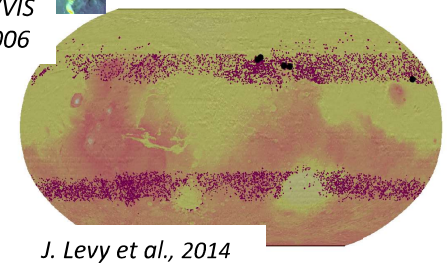

J. Levy et al., 2014

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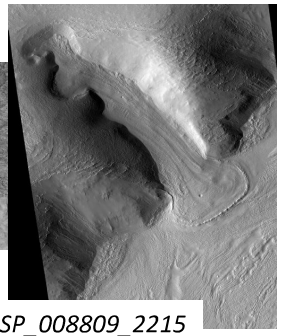

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Glacial and periglacial surface record

- Identification, observation, description
- Interpretation of the record and understanding of the processes
- Implications for surface & climate evolution and astrobiology
- Implications for resource availability

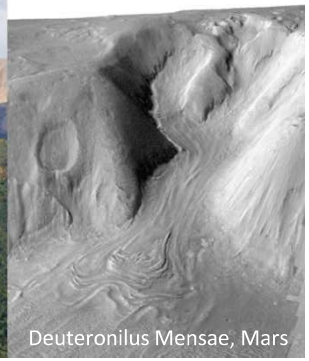
Recommendation: High resolution imagery, topography, and monitoring

↓

Comparative & quantitative geomorphology

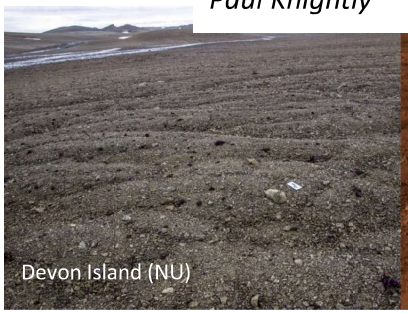
Eric Petersen

Sourdough Rock Glacier (AK)



Deuteronilus Mensae, Mars

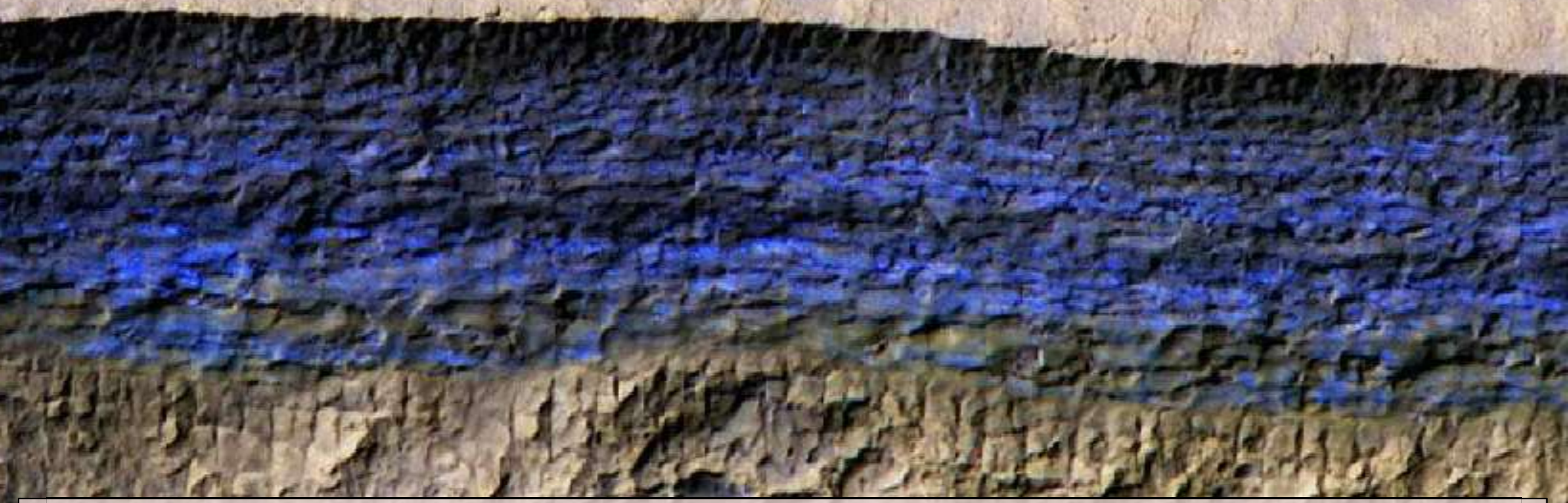
Paul Knightly



Devon Island (NU)

Phoenix landing site, Mars

Mid-Latitude Ice on Mars: A Science Target for Planetary Climate Histories and a Resource for Exploration



<u>Quantifying the volumes, distribution, and properties of the ice</u> are crucial for addressing the overarching questions to be answered in the next decade:

1. What climate record is preserved in these mid-latitude deposits?
2. How accessible is the ice as a resource for future exploration?

Point of Contact: Ali Bramson (<u>BramsonA@purdue.edu</u>)

For more information: https://mepag.jpl.nasa.gov/meeting/2020-04/whitetopics/WhitePaper_24_Bramson.MidlatIce.pdf