Concept for Mars Polar Rover and Ice Sampling Excursion

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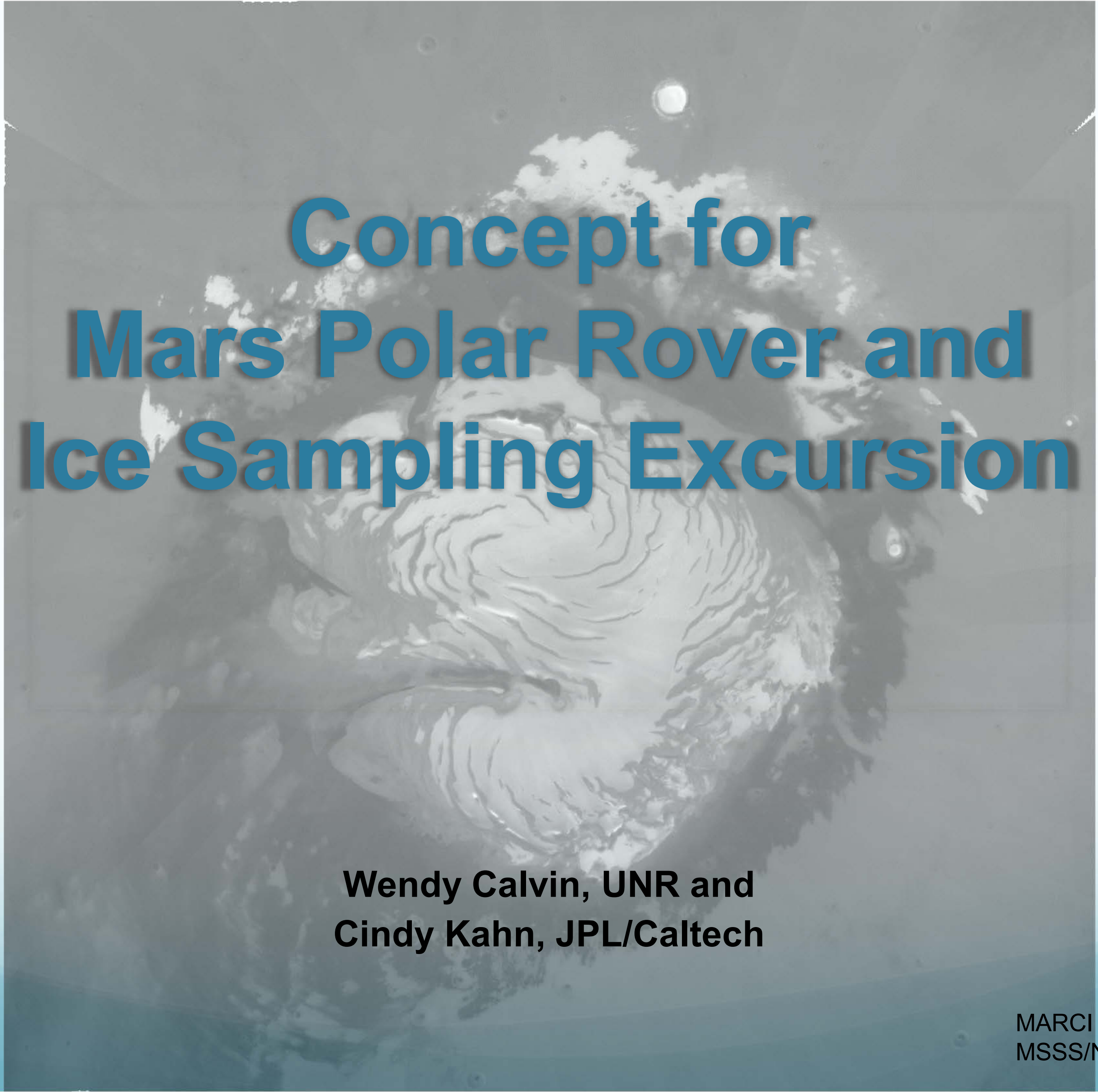
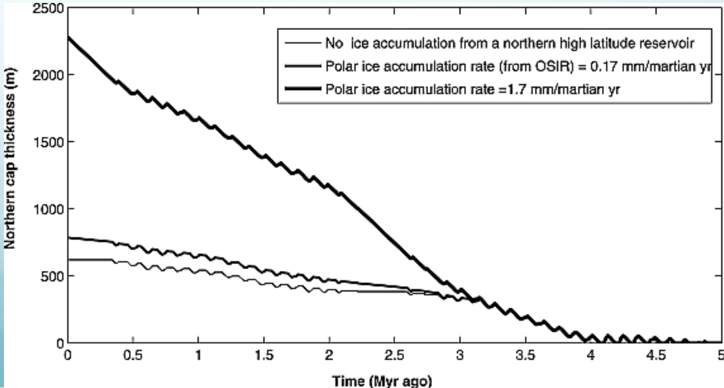


MARCI Image Mosaic
MSSS/NASA

Science Motivation

- Follow up to Phoenix by landing on north polar layered ice deposits.
- Study the age and evolution of polar ice and how that reflects recent climate change on Mars.
  - Recent models suggest the current configuration could have formed in the last few million years.
- Observe surface-atmosphere exchange of dust and volatiles.
- Explore habitability of the known and observable water ice deposits.



Levrard et al. 2007

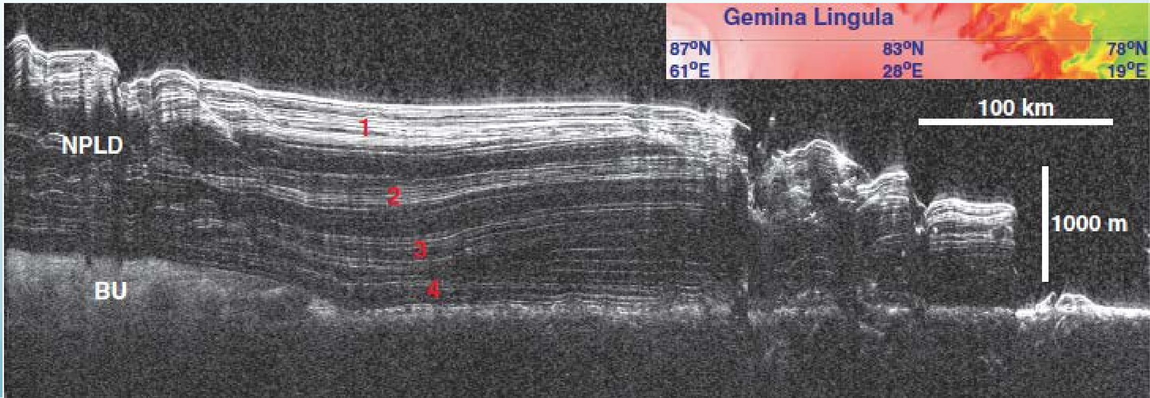
Specific Measurements

- Grain size, dust content, composition, and extent of layers in residual H_2O ice.
- Accumulation/ablation rates, linking present accumulation/ablation to observed stratigraphy.
- Elemental and isotopic ratios relevant to age (D/H) and astrobiology (CHNOPS).
- Measurement of gas entrained in ice (clathrates).
- In-situ measurement of pressure, temperature, winds, at multiple locations with monitoring of seasonal changes in these values.
- Constrain porosity, compaction, and thermal inertia of the residual ice.
- Mass, density, and volume of late seasonal CO_2 ice in time and space.

Traverse Sampling vs Stationary Drilling

- Majority of ice sampling missions consider drilling deeply (meters) at a fixed location.
- Phoenix has shown that ice cemented ground is not laterally uniform, even over small regions.
- Drilling on the ice dome assumes a steady accumulation rate, similar to Earth.
- Sharad radar does show laterally contiguous reflections, but at extreme depths (100's m to km) in the NPLD. Near surface (upper tens of meters) is not well imaged.
- Multi-Mars year imaging by Viking, MOC, MARCI show deposition and erosion of high albedo deposits is highly spatially variable.
- A traverse that samples the upper few cm over many km provides a better view of deposition and erosion of this uppermost surface.

Phillips et al. 2008



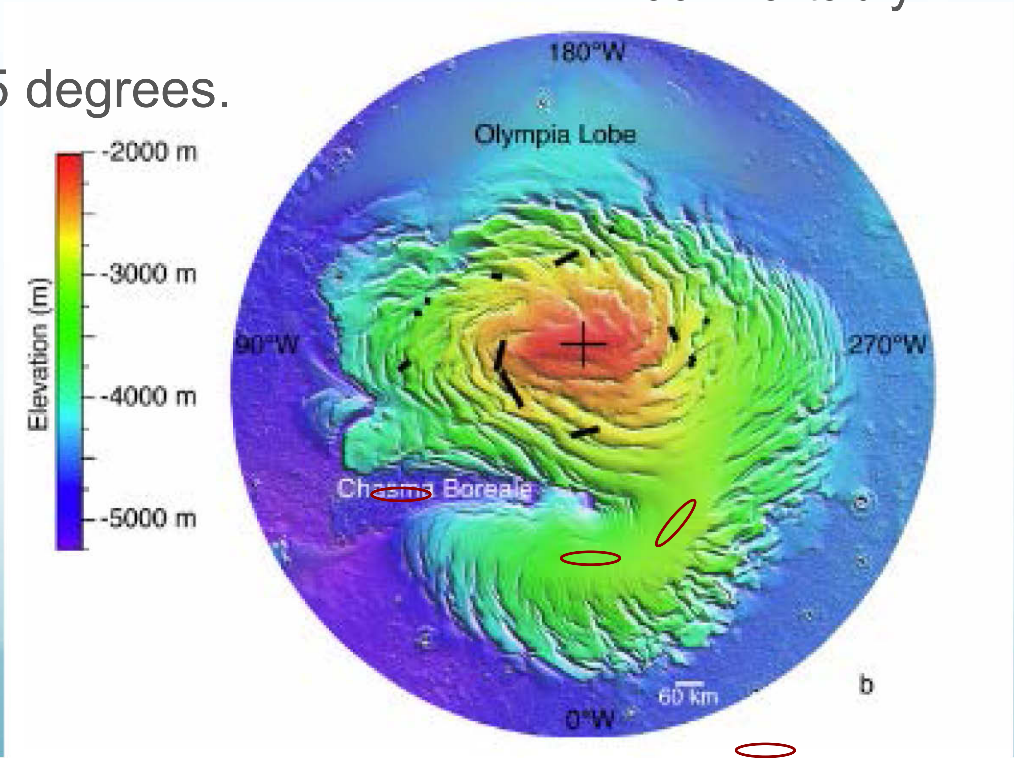
Environmental Conditions

Elevation: Below -3000m

- Proposed landing on Gemini Lingula or in Boreale Chasma.
- Slopes < 5 degrees.

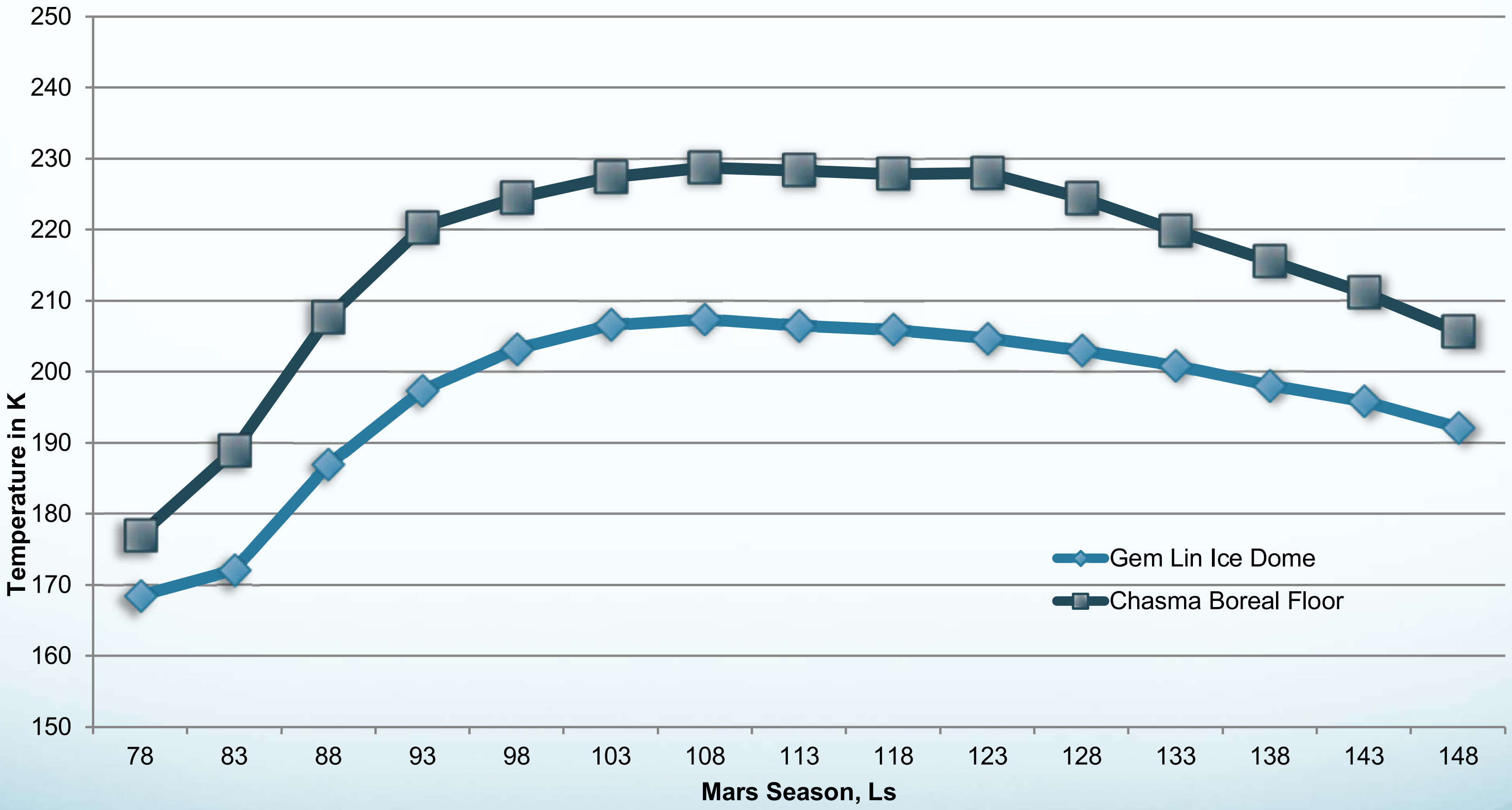
No Precision Landing

- Phoenix/MER landing ellipse of 100km x 30km fits comfortably.



MOLA Topo/NASA

Surface Temperatures

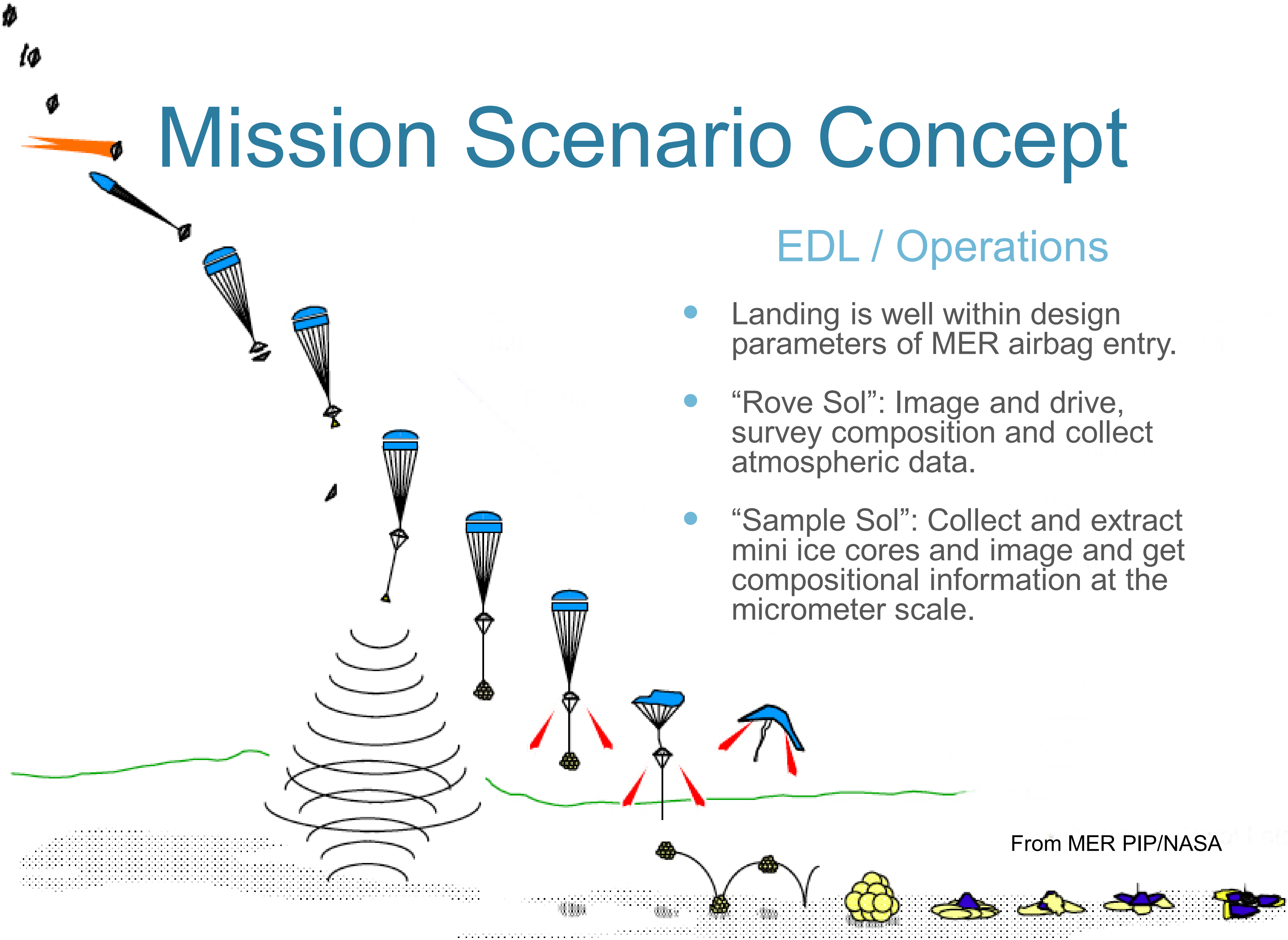


Average temperature from TES bolometer, Calvin & Titus, 2008
It is chilly, but warmer than surface temperatures of Europa or Titan.

Mission Scenario Concept

EDL / Operations

- Landing is well within design parameters of MER airbag entry.
- “Rove Sol”: Image and drive, survey composition and collect atmospheric data.
- “Sample Sol”: Collect and extract mini ice cores and image and get compositional information at the micrometer scale.



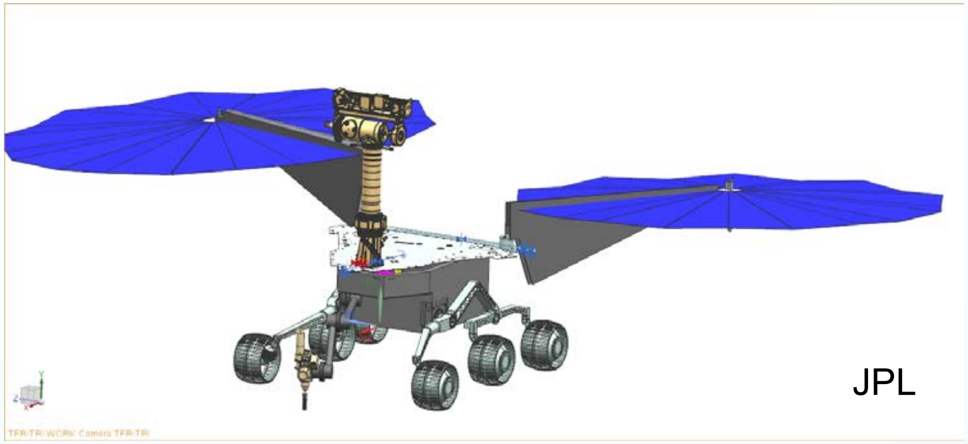
From MER PIP/NASA

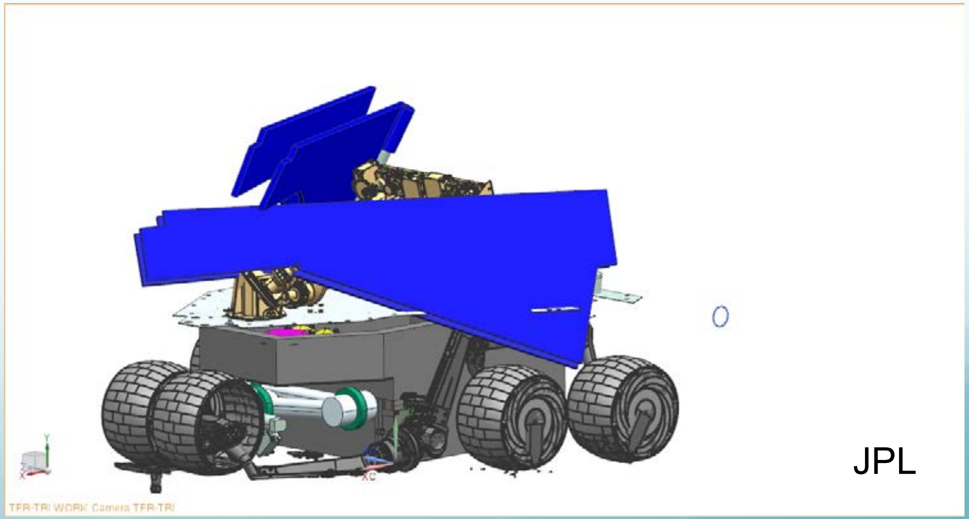
Straw Payload

	Instrument	Specs	Heritage	Mass (kg)	Power (W) (Peak)	Data (Science)
Mast/Deck	Camera	3 color (no filters)	Pancam, Mastcam	1.2	3	8Mbps
	Imaging Spectrometer	0.4 to 2.5 μm, 225 channels	Mini-M3, Kittyhawk	1.5	5	4 to 200 Mbps
	Atmosphere (P, T, V)	0.1 Pa, 0.5K, 1m/s @ 0.5Hz	Phoenix, Viking	0.2	0.1	1kbps
Arm	Mini-Corer	2mm x 2.5 cm mini core	(Athena - descoped, Max-C)	5	30	1kbps
	Micro-imager	15 μ/pix, color but no zoom	MI, MAHLI	0.3	0.4	5 to 20 Mbps
	μ–FTIR or Raman (TLS?)	400 to 2350 cm^{-1} @ $4cm^{-1}$	ASTEP, PIDDP	3	14	500 kbps

Operations Concept and Duration

- Landing between Ls 70 and 90.
- Mission lifetime of 90 sols (potentially 150).
- Power of ~2300 W-hrs / sol (for deployable solar array).
- Drive/Image or Sample Sols.
- Traverse up to few km during mission lifetime.





Links to Knowledge Gaps

- (1 & 2) Create and further technologies to investigate the shallow subsurface of Mars and develop light weight instruments for triage of samples for investigation.
- (4) Detect organic matter in ice samples, as ices can be expected to preserve these elements as seen in terrestrial ice cores.
- (6) Provide direct measurement of atmospheric winds in a unique latitude band, further constraining atmospheric models for future landing.
- (7) Guided entry is not required, but could be added to further EDL designs for higher accuracy landing.
- (11, 12, 16) Paired delivery of rovers to different locations from a single platform, novel methods of surface exploration, trafficability in new terrain.
- (P-SAG) Atmospheric modeling, water resources, dust characterization.

Along the Path to MSR

- Can't afford MSR as envisioned in the Decadal Survey.
- MER and Phoenix have shown the value of exploring diverse landing sites.
- OMEGA and CRISM have identified numerous terrains with distinct compositions and evolutionary histories.
- MSL will sample only one of these.
- Next best step is to continue exploring surface compositional diversity and adding to our knowledge base for the best site for MSR.
- Unique challenges and opportunities presented in the polar regions make them worthy targets and the best locations to achieve some science goals.