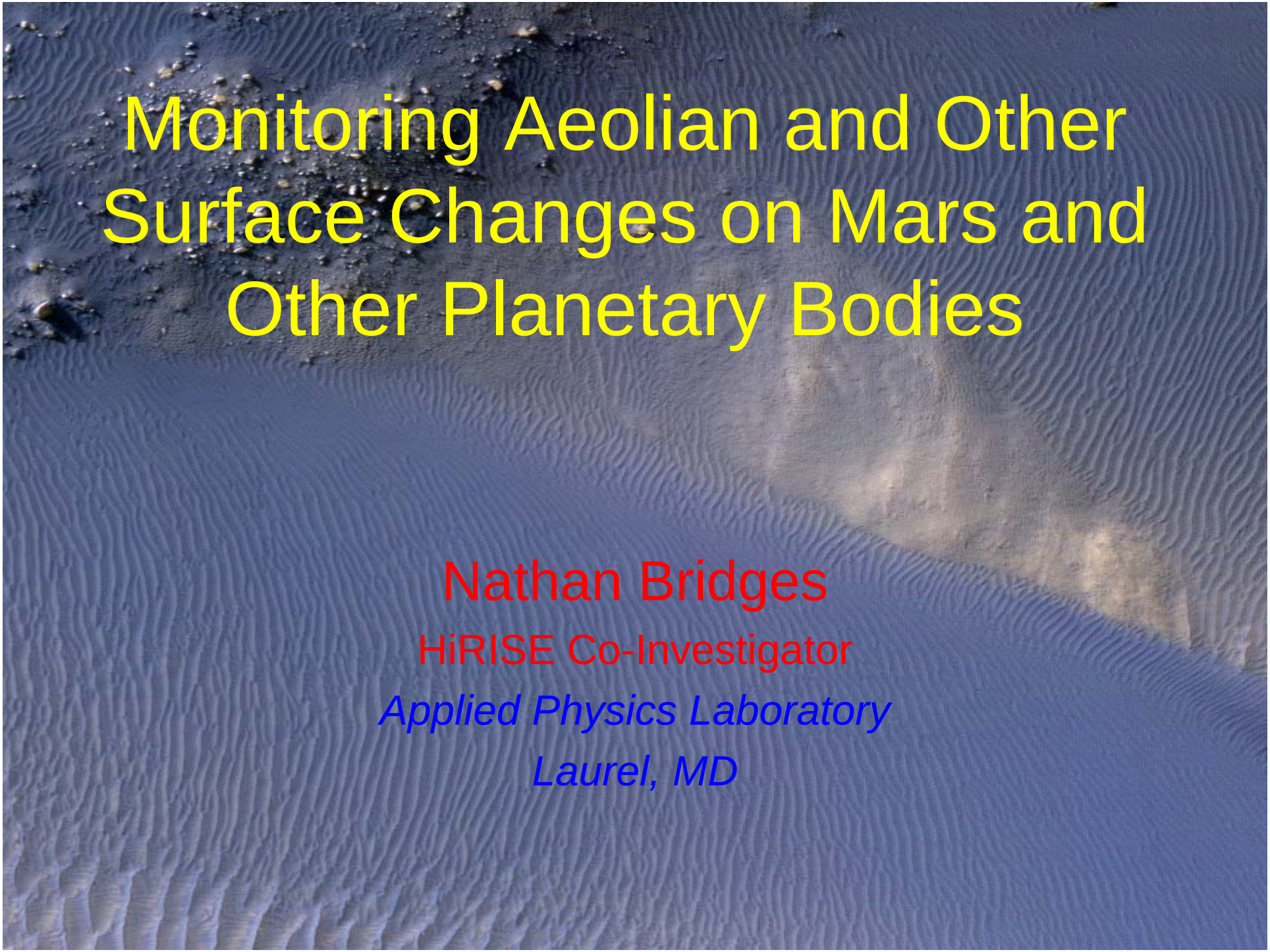

Monitoring Aeolian and Other Surface Changes on Mars and Other Planetary Bodies

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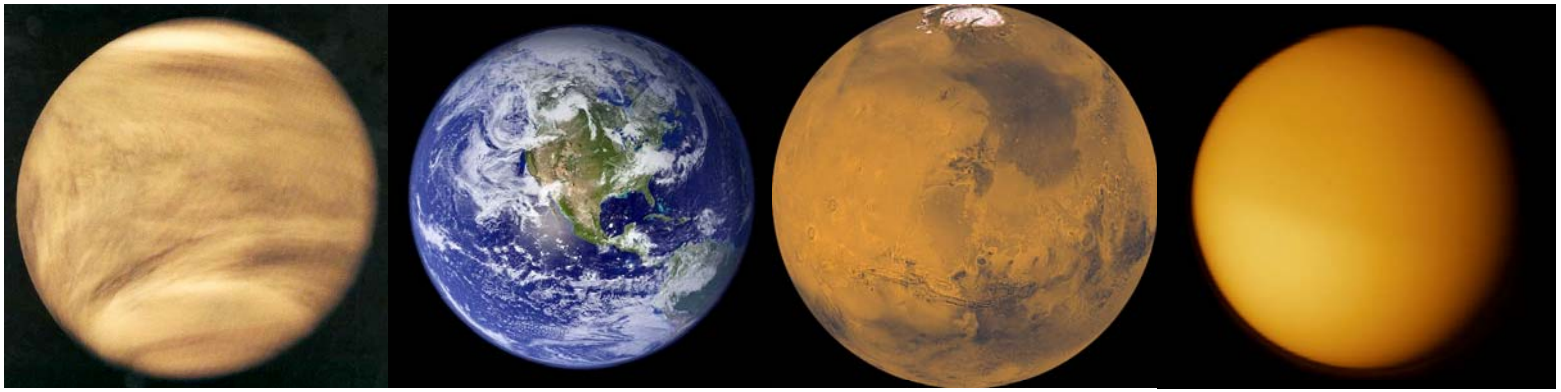
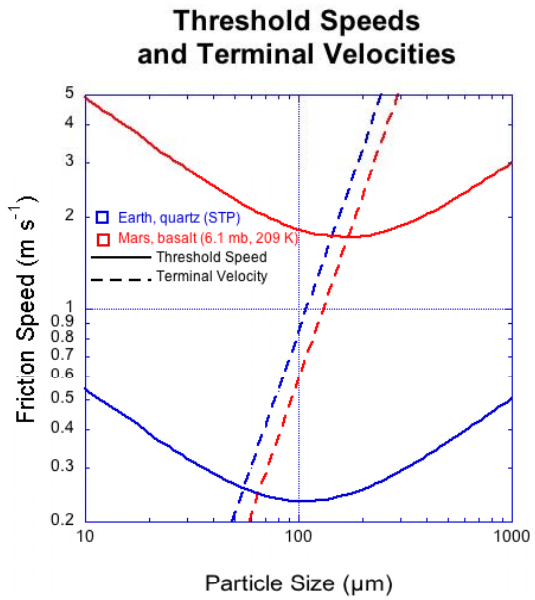
Applied Physics Laboratory

Laurel, MD

Geomorphic Processes Potentially Observable From Remote Platforms

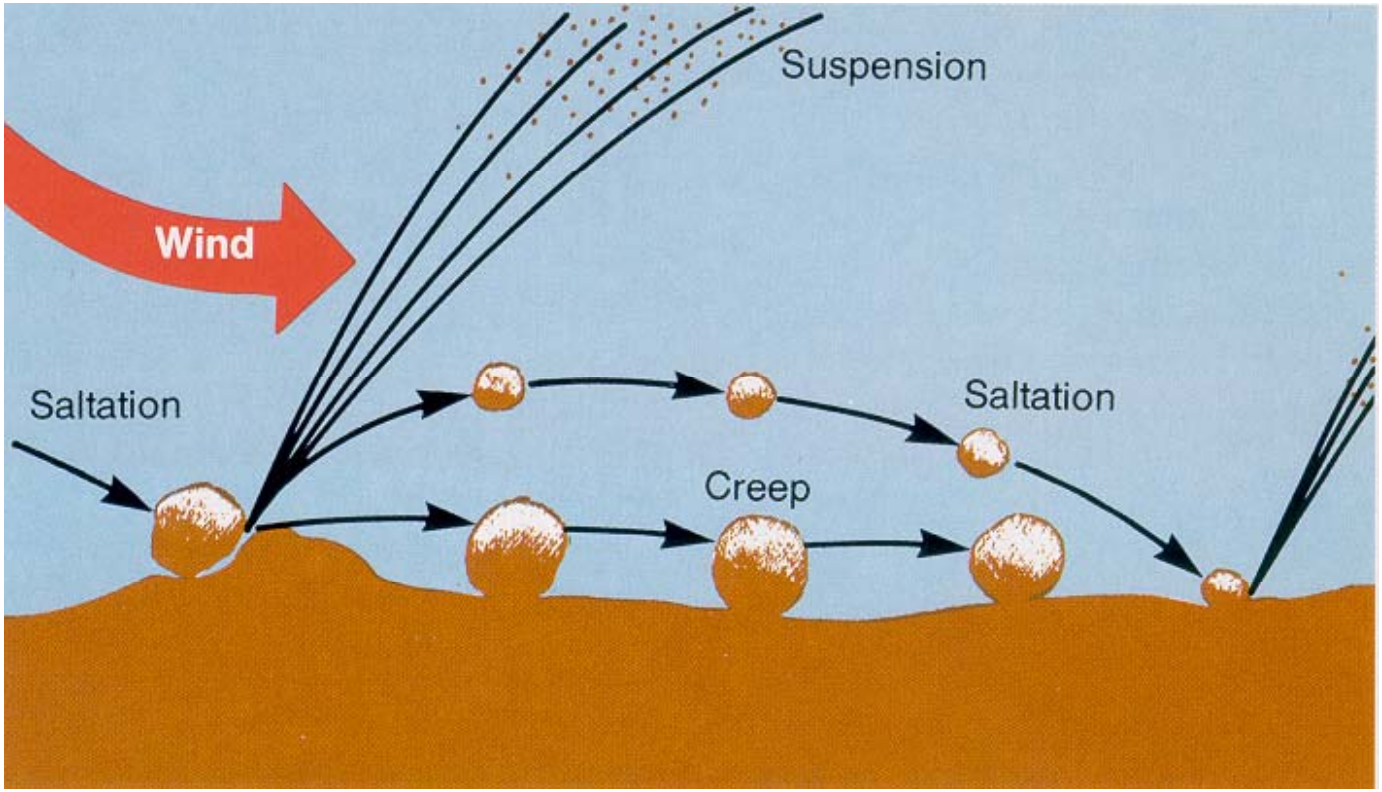


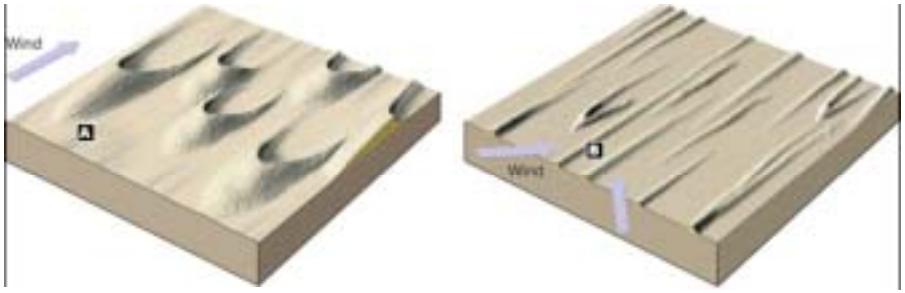
	Venus	Earth	Mars	Titan
Impact	no	minor	yes	minor?
Volcanism	yes	yes	unlikely	?
Fluvial	NA	yes	yes (gullies, debris flows)	yes
Glacial/ice	NA	yes	unlikely	likely?
Tectonic/Seismic	no	yes	no	no?
Aeolian	unlikely	yes	yes	yes

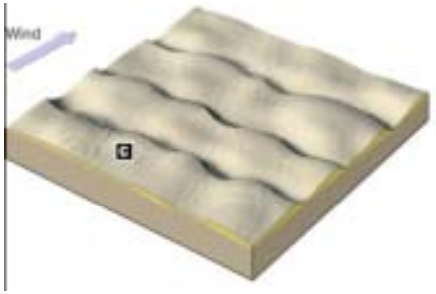


$$u^* = (\tau/\rho)^{0.5}$$

$$u(z) = (u^*/\kappa)\ln(z/z_0)$$







Earth

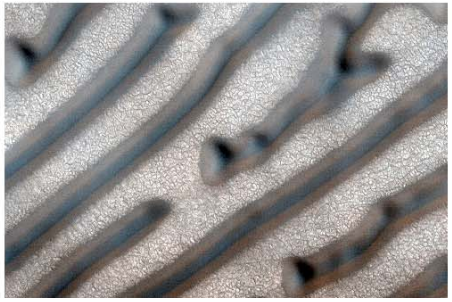
barchan

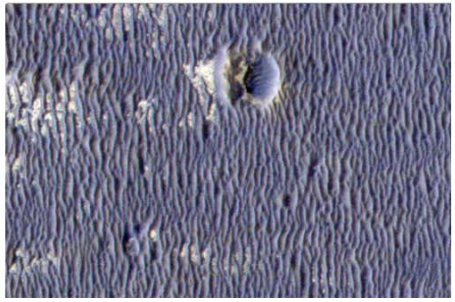
linear

transverse

rippled sand sheet

Mars





Bedform Movement on Earth and Mars

- Bedform Movement on Earth
  - Dunes: Inverse correlation with height
    - 1 m heights: ~10 m/year
    - 10 m heights: ~1 m/year
    - This assumes active aeolian regime and mobile sands
  - Sand ripples
    - Fast: Daily timescales
  - Granule ripples
    - Slow, only moving a few cm in high wind events
- Evidence For Bedform Movement on Mars
  - Bedforms exist (but can they move today?)
  - Downslope streaks on dune slipfaces: 1-2 cm/year [*Fenton*, 2006]
  - Shrinkage and disappearance of ice-cored dunes [*Bourke et al.*, 2008]. How much is abrasion and sublimation?
  - Some sand ripple movement at *Spirit* rover site: 2 cm in one wind event! But how does this scale to larger ripples?
  - Granule ripples should be very slow: ~1-10 mm/year [*Zimbelman et al.*, 2009]
- Implications for Mars
  - If bedforms moving today, then surface is very dynamic
  - If bedforms are not moving, then the climate in the past was probably different

Relevant Recent Investigations

- Dune migration on Earth measured using COSI-Corr
  - "World's fastest" barchans in Chad; ASTER [*Vermeesch and Drake*, 2008]
  - Dunes in Kobuck National Park, AK; ASTER and SPOT [*Necsouiu et al.*, 2009]
- Mars: HiRISE images (25 cm/pixel +) were successfully co-registered and correlated using the COSI-Corr correlator (JPL-funded internal investigation)

Upcoming Work

- MDAP: Sub-pixel Change Detection Using HiRISE Images
  - Submitted in 2008, but not accepted (☹)
  - Revised for 2009, with appropriate changes made. Should hear about status in spring of 2010 (☺?)
- Goal: Look for bedform migrations down to 3 cm over 1+ Mars year time span
- Challenges
  - Acquisition geometry
  - Topographic error
  - Illumination changes
  - Brightness changes

Recommendations for Future Instrumentation/Missions

- Cameras:
  - Higher SNR
  - Higher resolution
  - Offset detectors
- Mission design:
  - Instantaneous stereo to build DEM
  - Early AM or late PM orbit
- High stability platform
- First, of course, we should analyze HiRISE data, which will hopefully happen soon