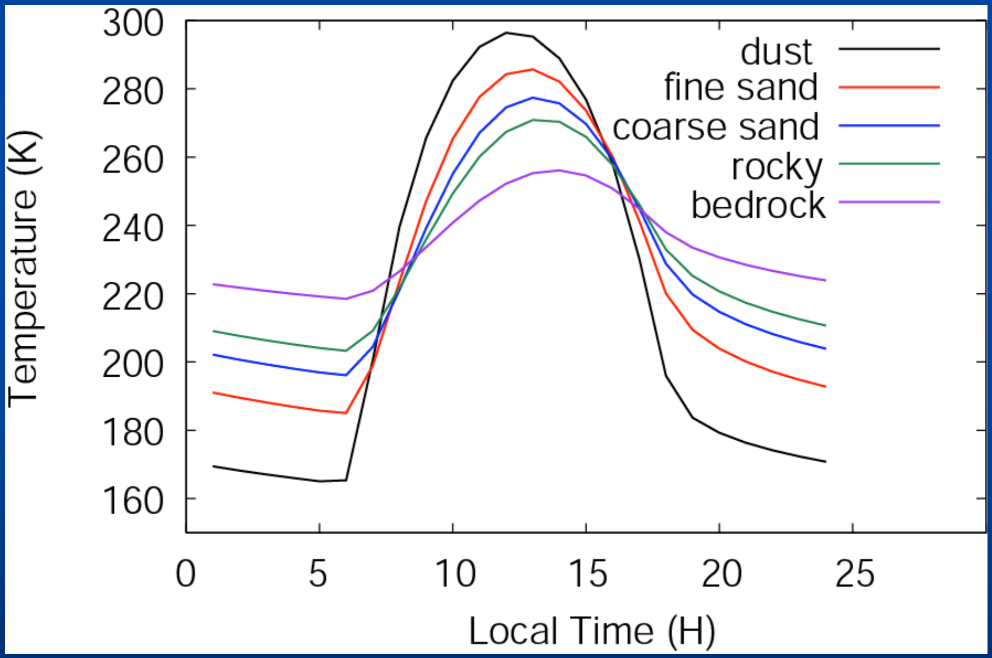
Thermophysics with THEMIS

- Background
- THEMIS daytime infrared images
  - Comparison with visible images
- THEMIS nighttime infrared images
  - Proxy for qualitative thermal inertia
- THEMIS thermal inertias
  - Comparison with TES and Mini-TES data

Background



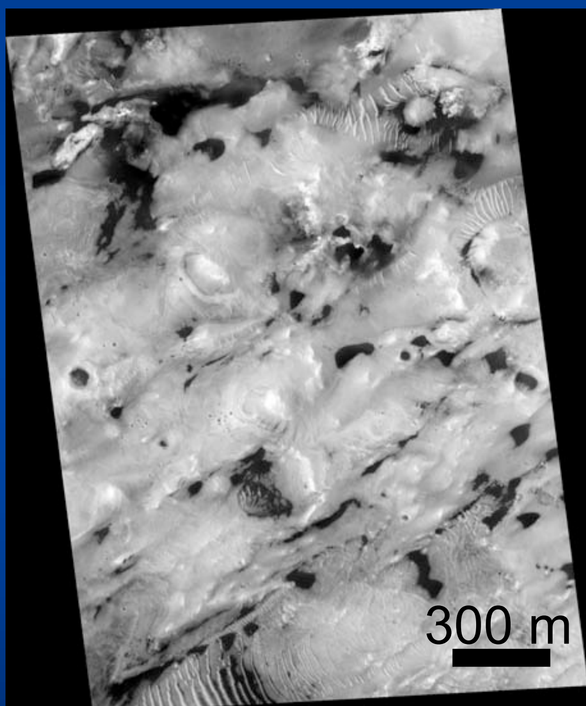
- Surface temperature affected by:
  - Solar radiation onto the surface
  - Albedo – thermal energy absorbed or reflected
  - Conductivity of the surface material
  - Presence of CO_2 ice

THEMIS Daytime IR

- During the day surface temperature is primarily a function of:
  - Surface albedo
  - Topography
  - Thermal inertia
- Poor time to derive thermal inertia
- Good proxy for morphology and context for THEMIS and MOC visible images
- Absolute accuracy: ~1° K

Pasteur Crater

MOC Visible



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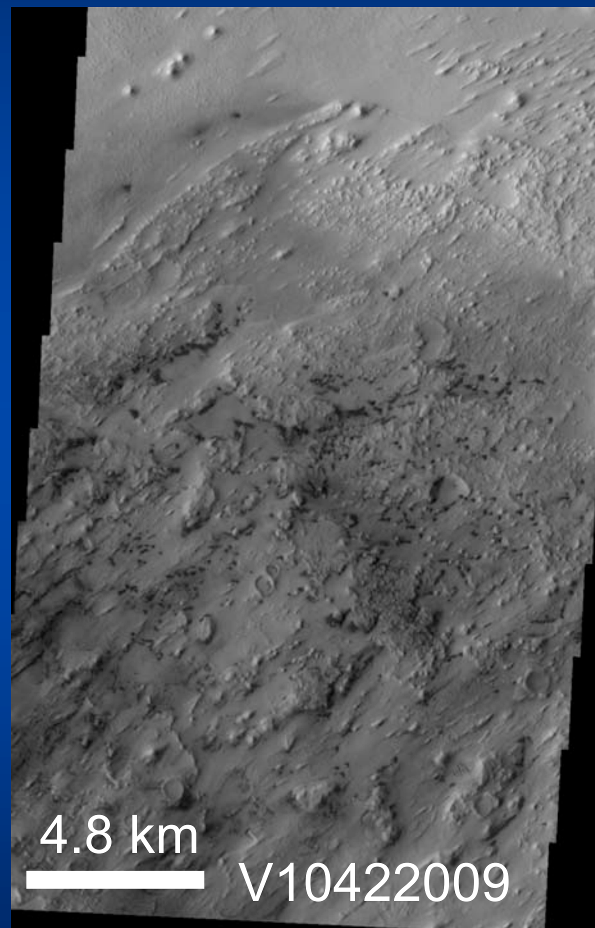
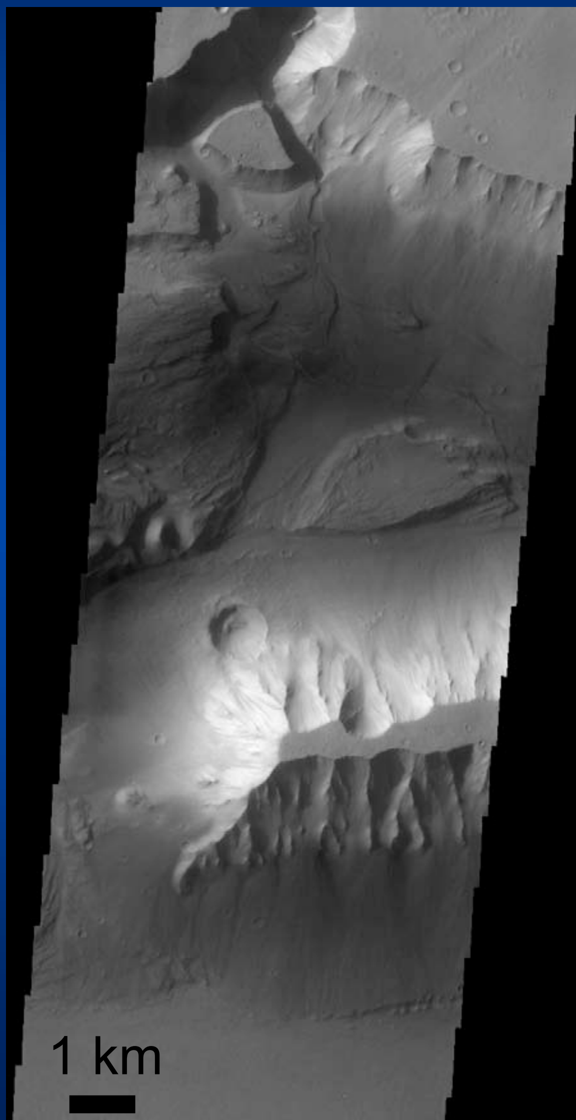
THEMIS Visible



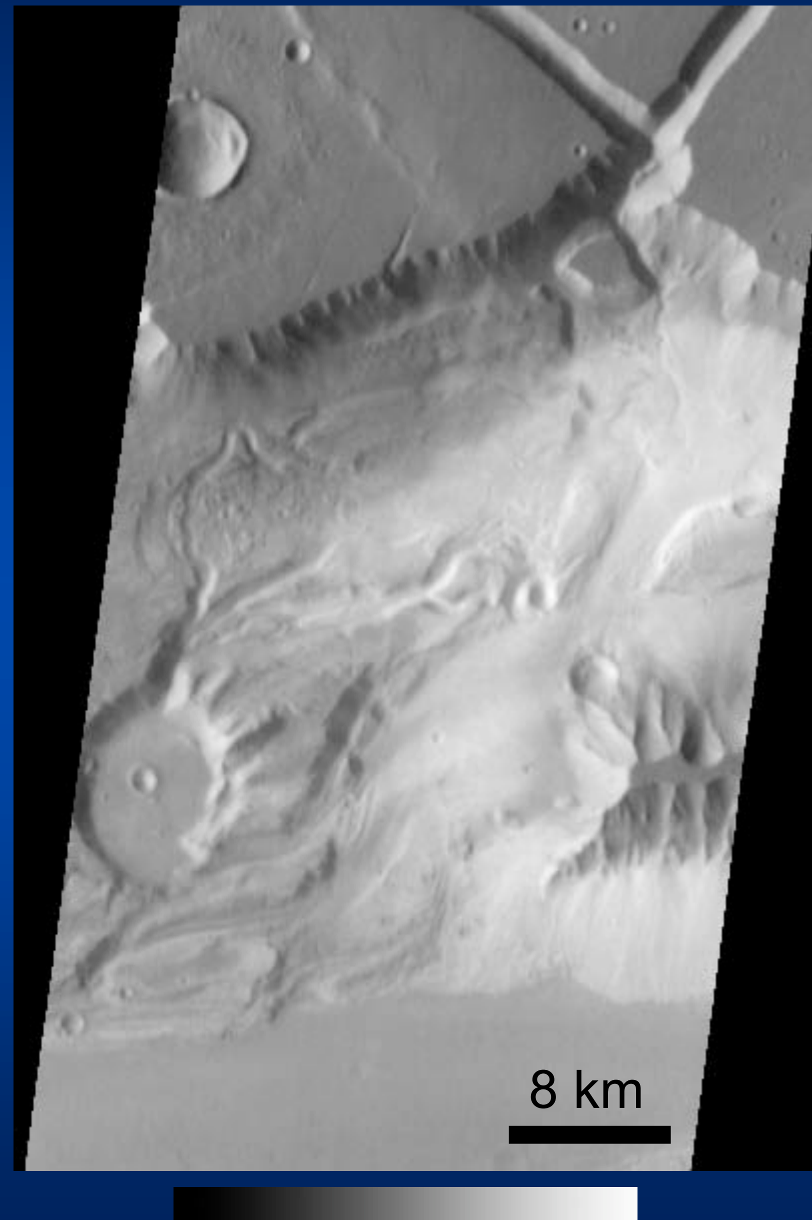
Kasai Valles

THEMIS Visible



V12060006

Day IR

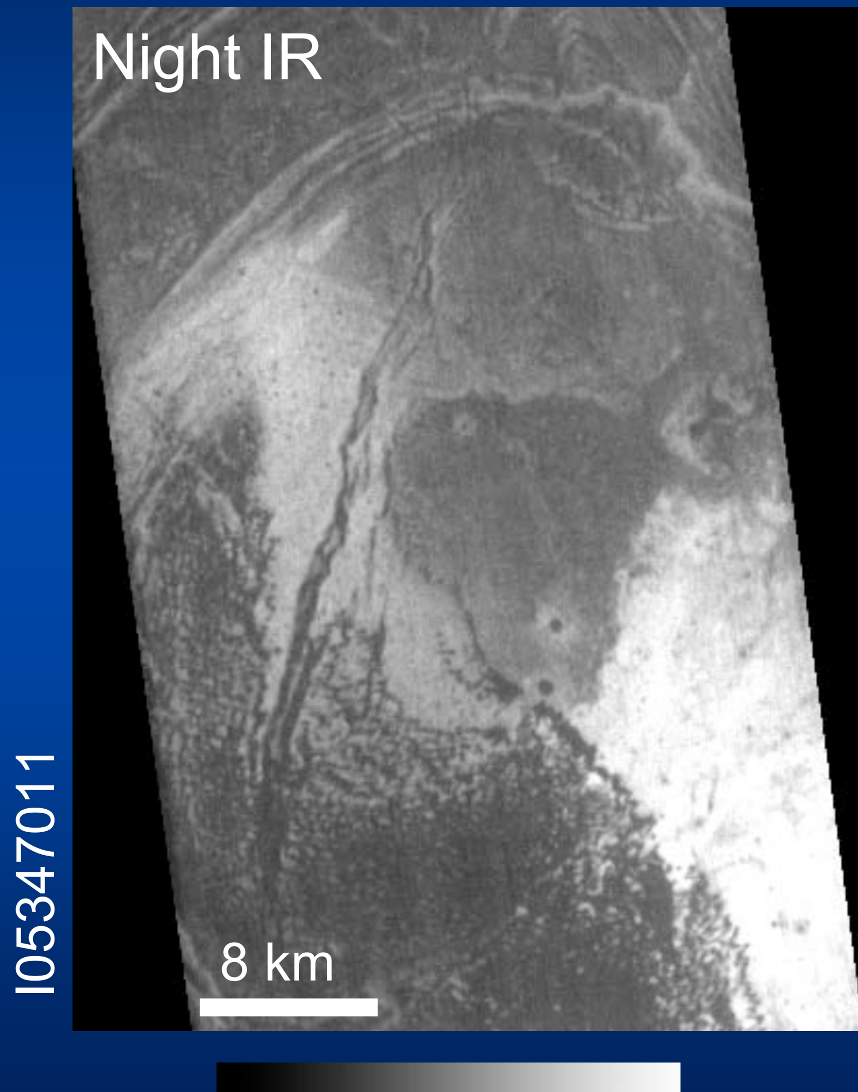


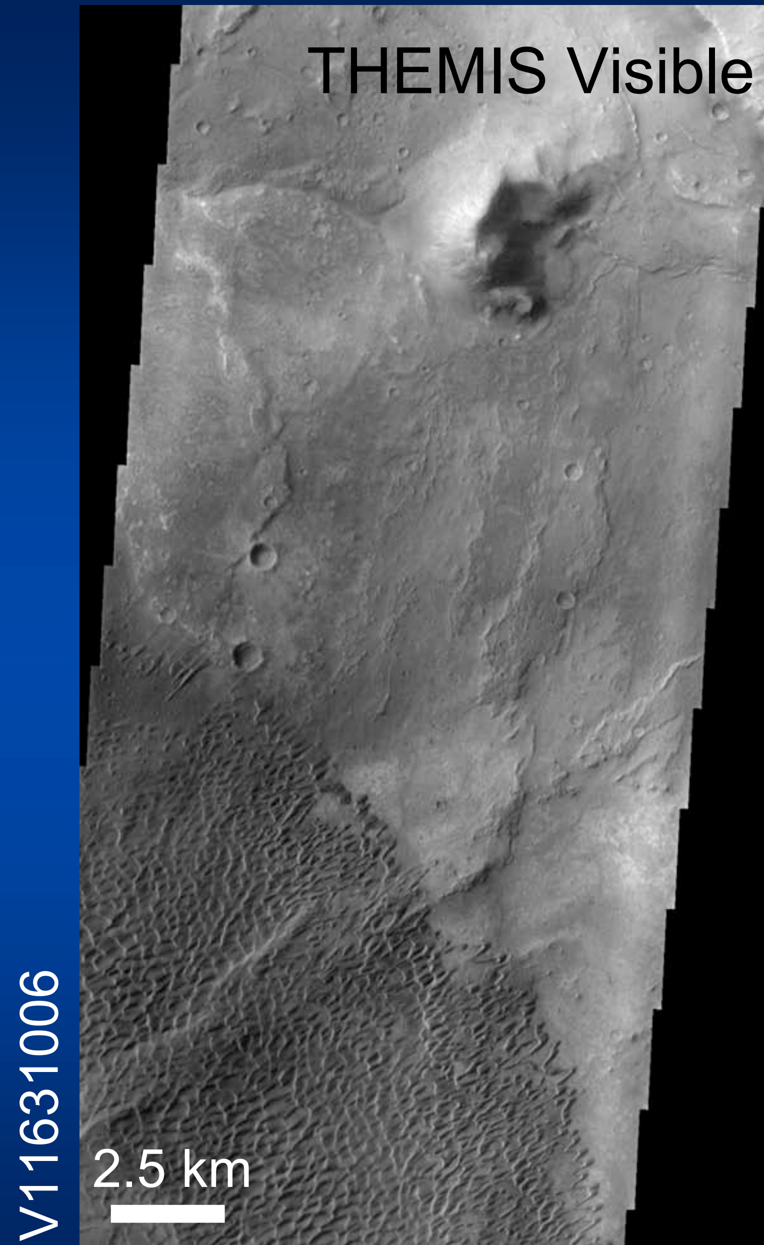
I10837006

THEMIS Nighttime IR

- Surface temperature at night dominated by:
  - Thermal inertia - Physical nature of the surface, such as particle size
  - Effects of albedo and topography have largely dissipated
- Qualitative thermal inertia – band 9
  - High signal to noise
  - Fairly transparent to the atmosphere
- Most images are acquired between 4.5-5 H
  - CO_2 frost may be present
- Absolute accuracy – ~4º K

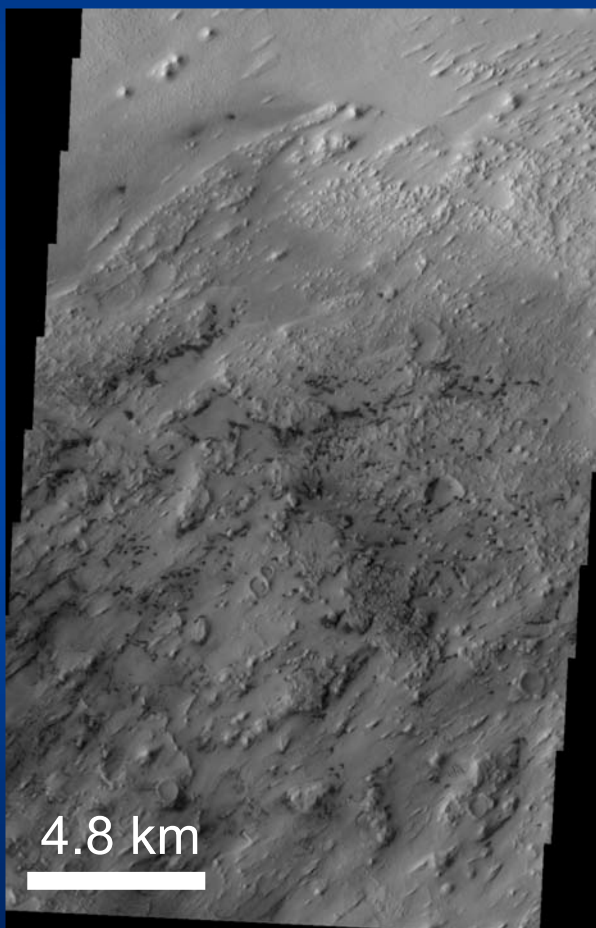
Nili Patera


Night IR
8 km
I05347011
170
210


THEMIS Visible
2.5 km
V11631006

Pasteur Crater

THEMIS Visible



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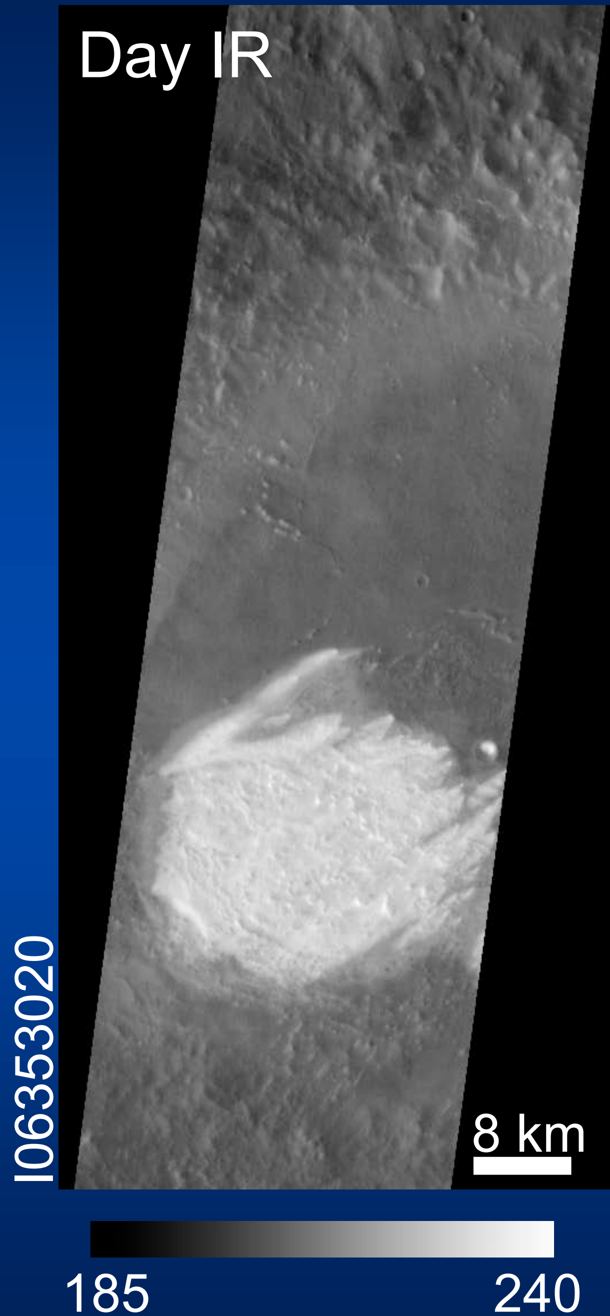
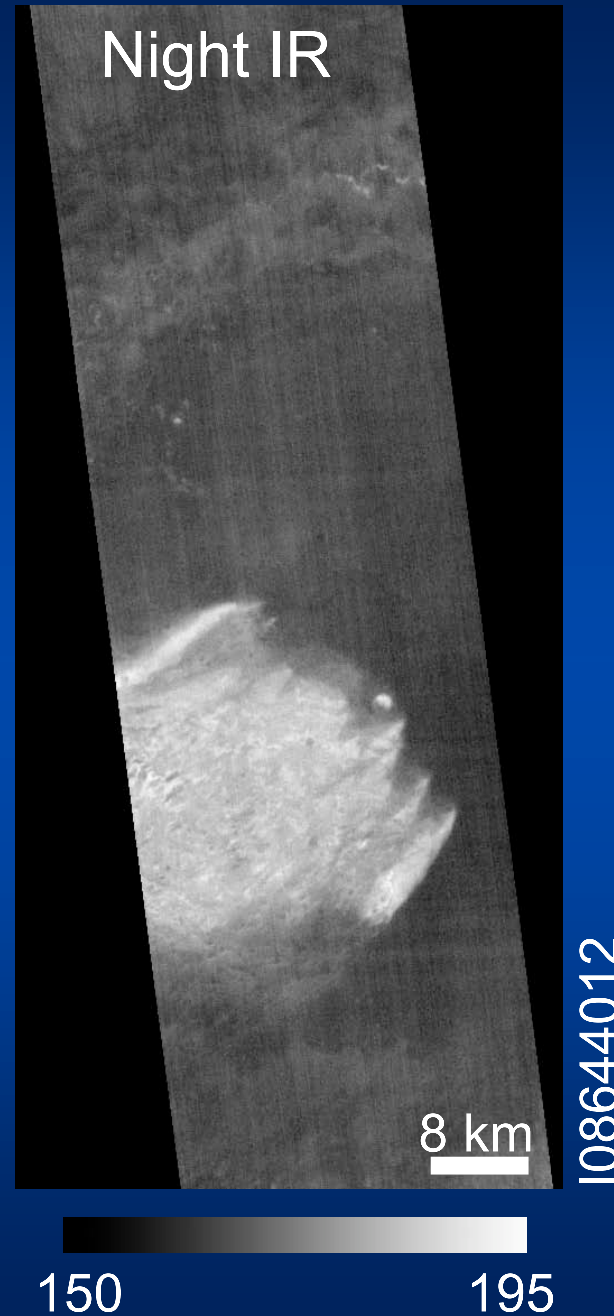
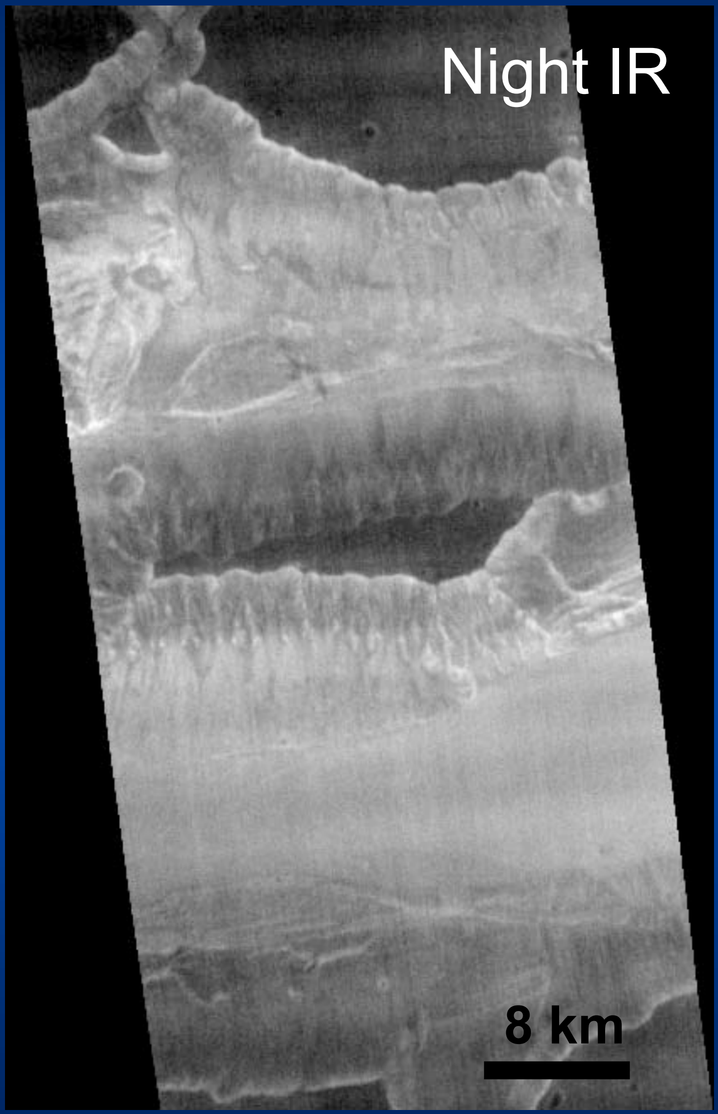


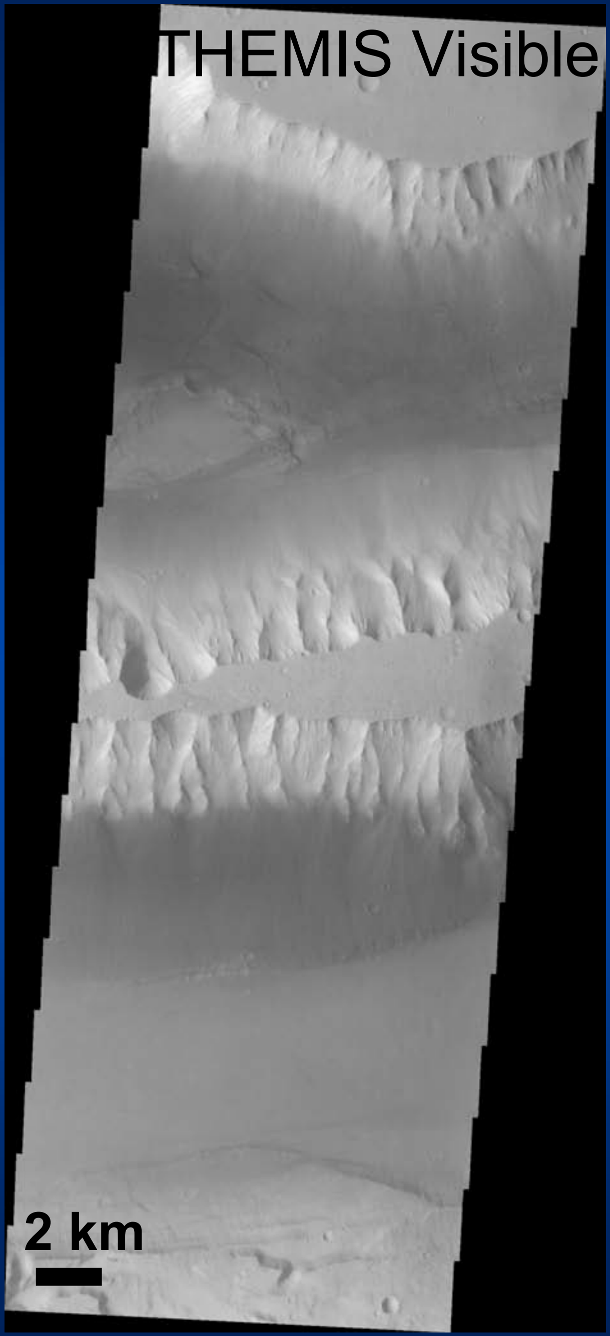


Kasai Valles



I15149007

155 200

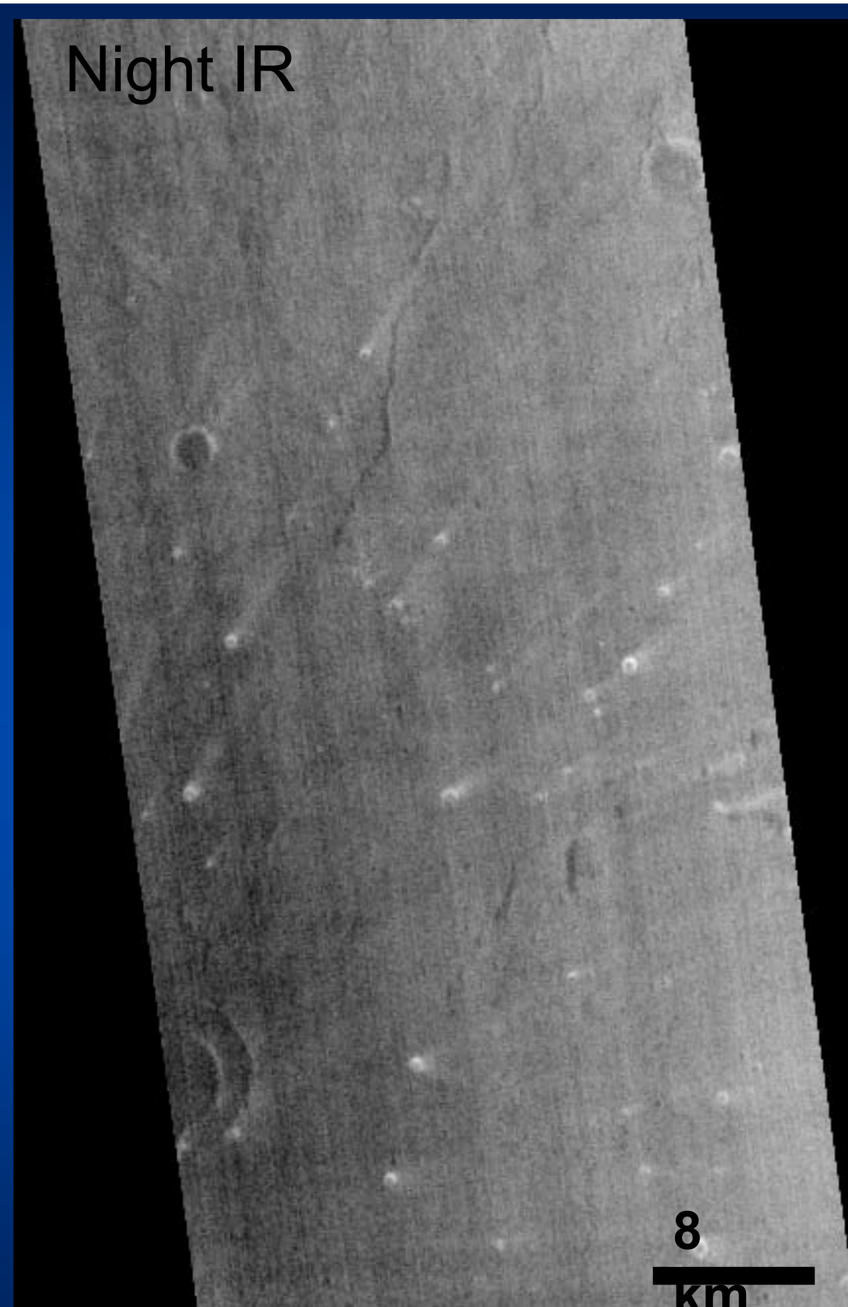


V09901021

Hecates Tholus

200 265

I02017005

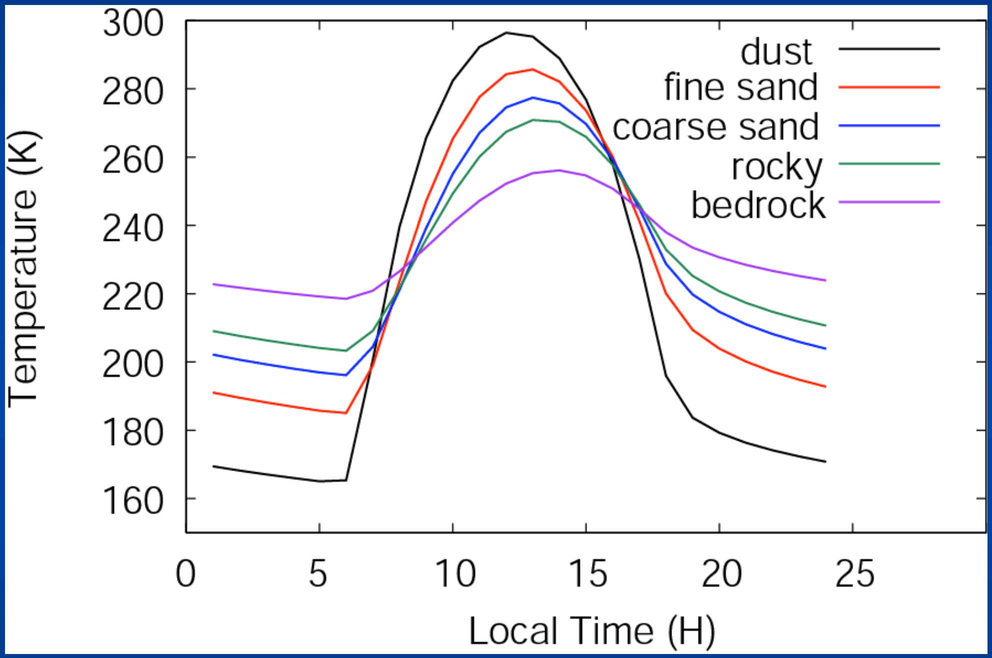


150 190

I01262005

Thermal Inertia

- $I = (\rho k c)^{1/2}$
  - ρ – bulk density
    - ($kg\ m^{-3}$)
  - k – conductivity
    - ($J\ kg^{-1}\ °K^{-1}$)
  - c – specific heat
    - ($J\ s^{-1}\ °K^{-1}\ m^{-1}$)



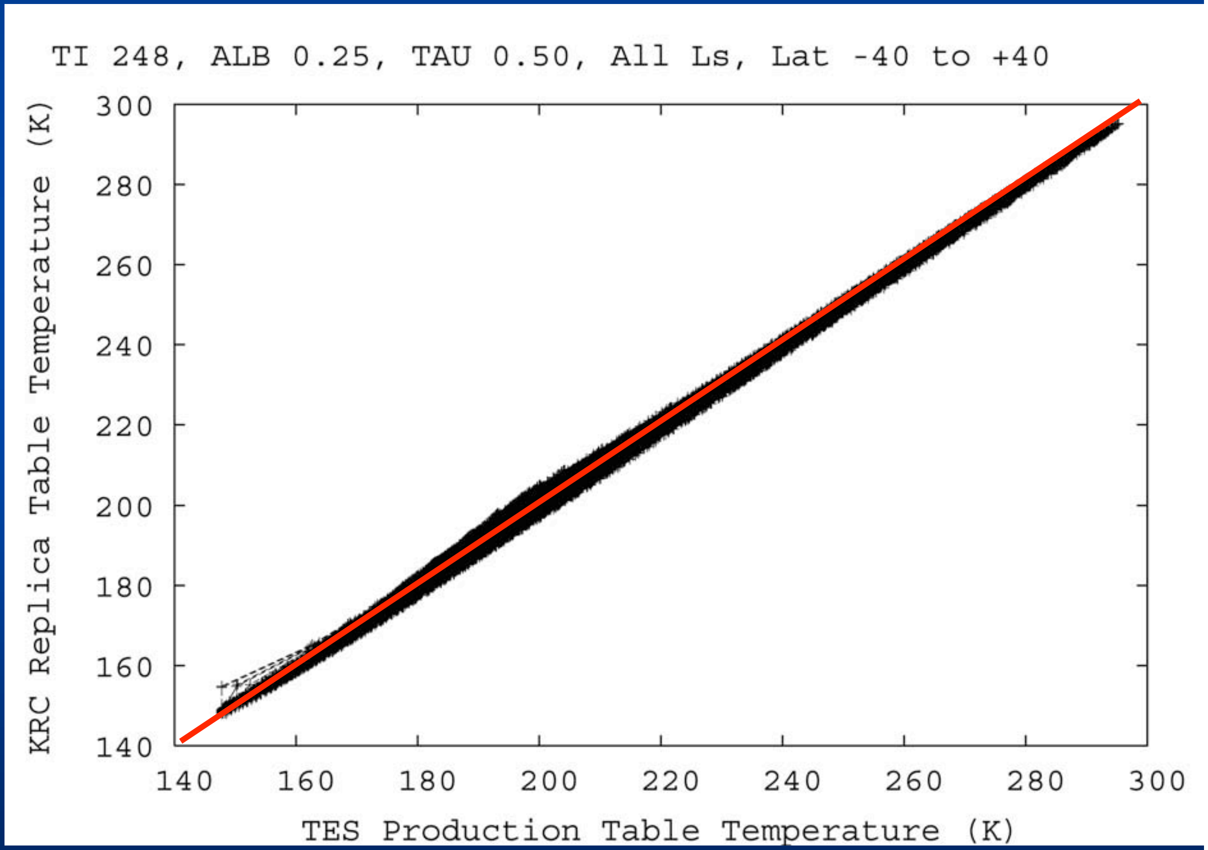
- Units of $J\ m^{-1}\ °K^{-1}\ s^{-1/2}$
- Measure of the resistance of a material to a change in temperature

Thermal Inertia Method

- Use thermal model developed by H. H. Kieffer
  - Ls, latitude, local time from spacecraft ephemeris
  - TES-derived albedo (8ppd)
  - MOLA-derived elevations (128 elem. per degree)
  - TES-derived dust opacity (2 ppd) every 30° Ls
- Radiance at 12.57 µm (Band 9) is converted to brightness temperature, correcting for drift and wobble of the spacecraft.
- Interpolate upon a 7-D look-up table

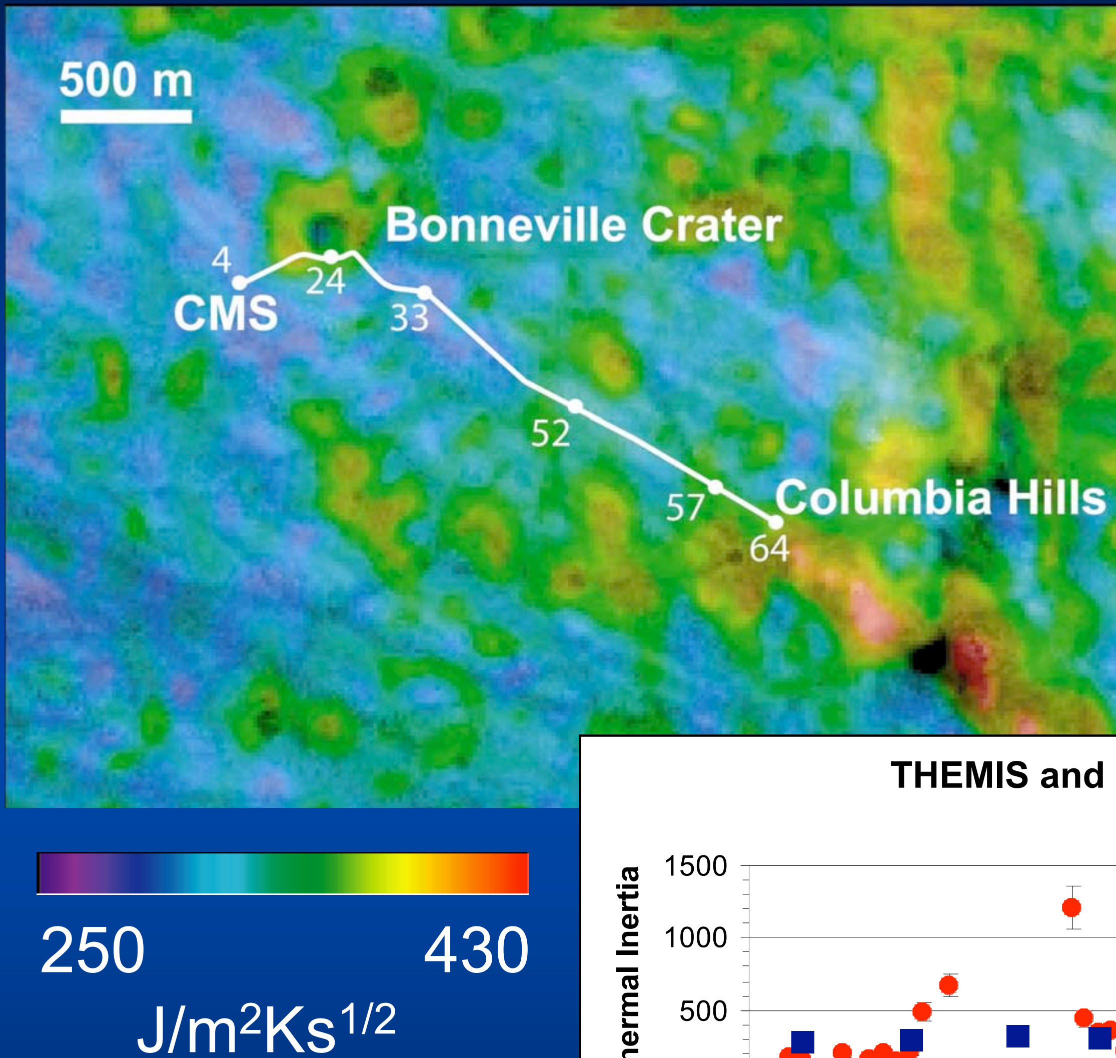
Comparison with Orbital Data - TES

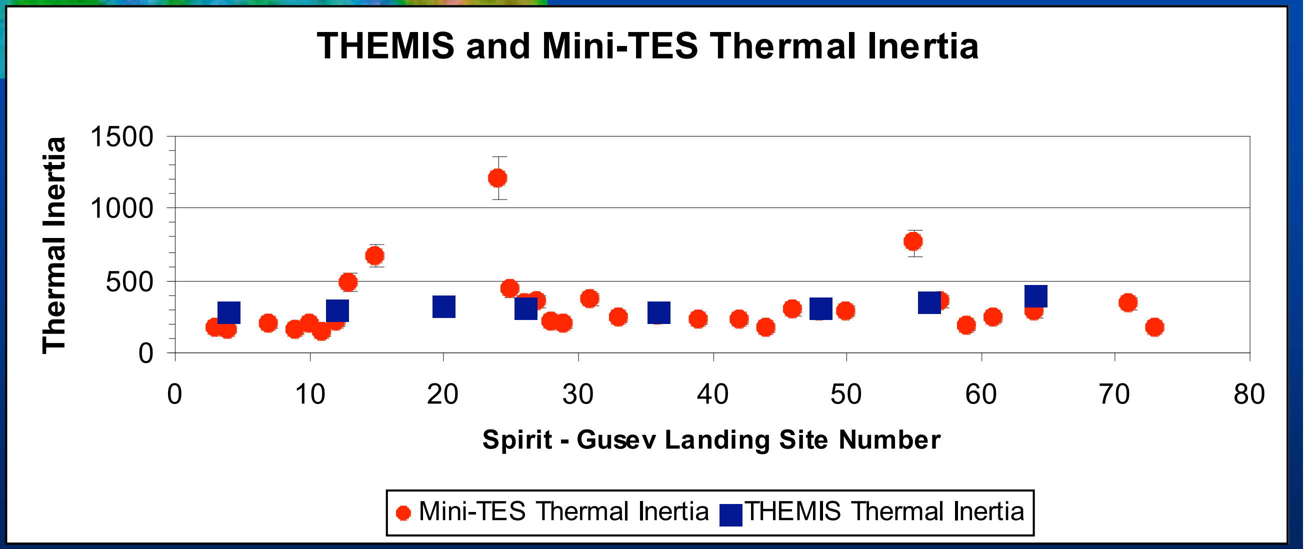
- Thermal models results used for TES and THEMIS agree within 3°K
- Differences in thermal inertias are primarily due to differences in surface temperature
  - Differences are roughly the same as THEMIS uncertainty
  - This difference does not change the scientific interpretation of the geology



Fergason et al., in prep.

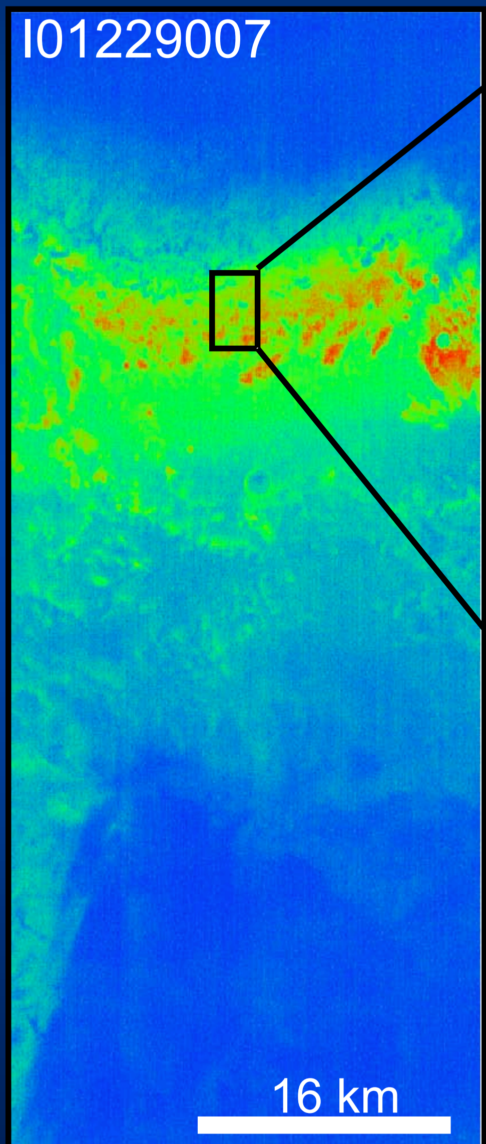
Comparison with Surface Measurements - MER

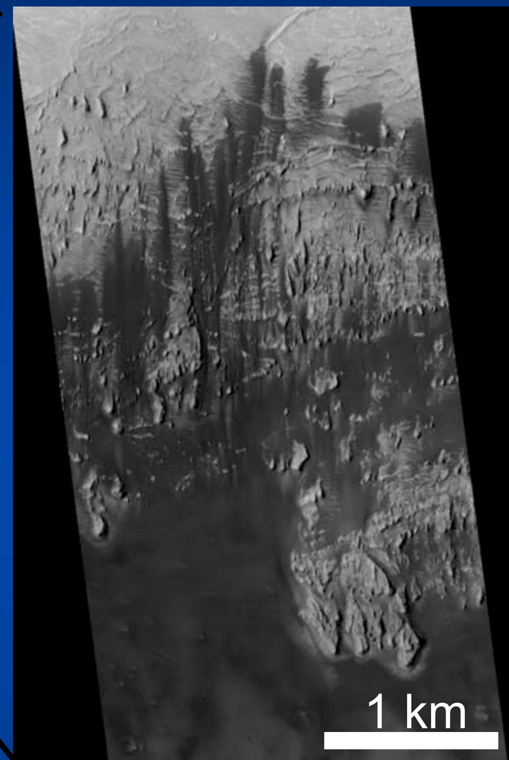




Fergason et al., in submission

Arabia Terra



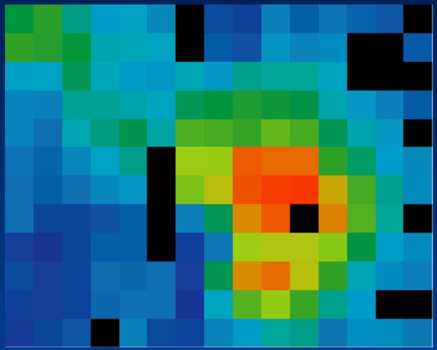


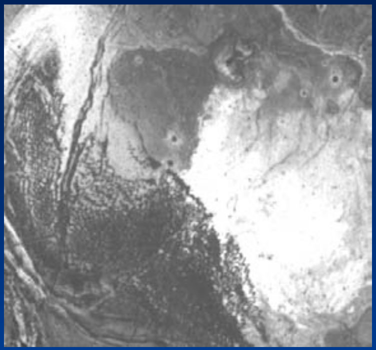
M0310925
NASA/JPL/MSSS

24 $J/m^2Ks^{1/2}$ 430

- Blue – dust
  - TI: 60-85
- Green – sand
  - TI: 210-250
- Red – resistive outcrops
  - TI: 400-435

Nili Patera



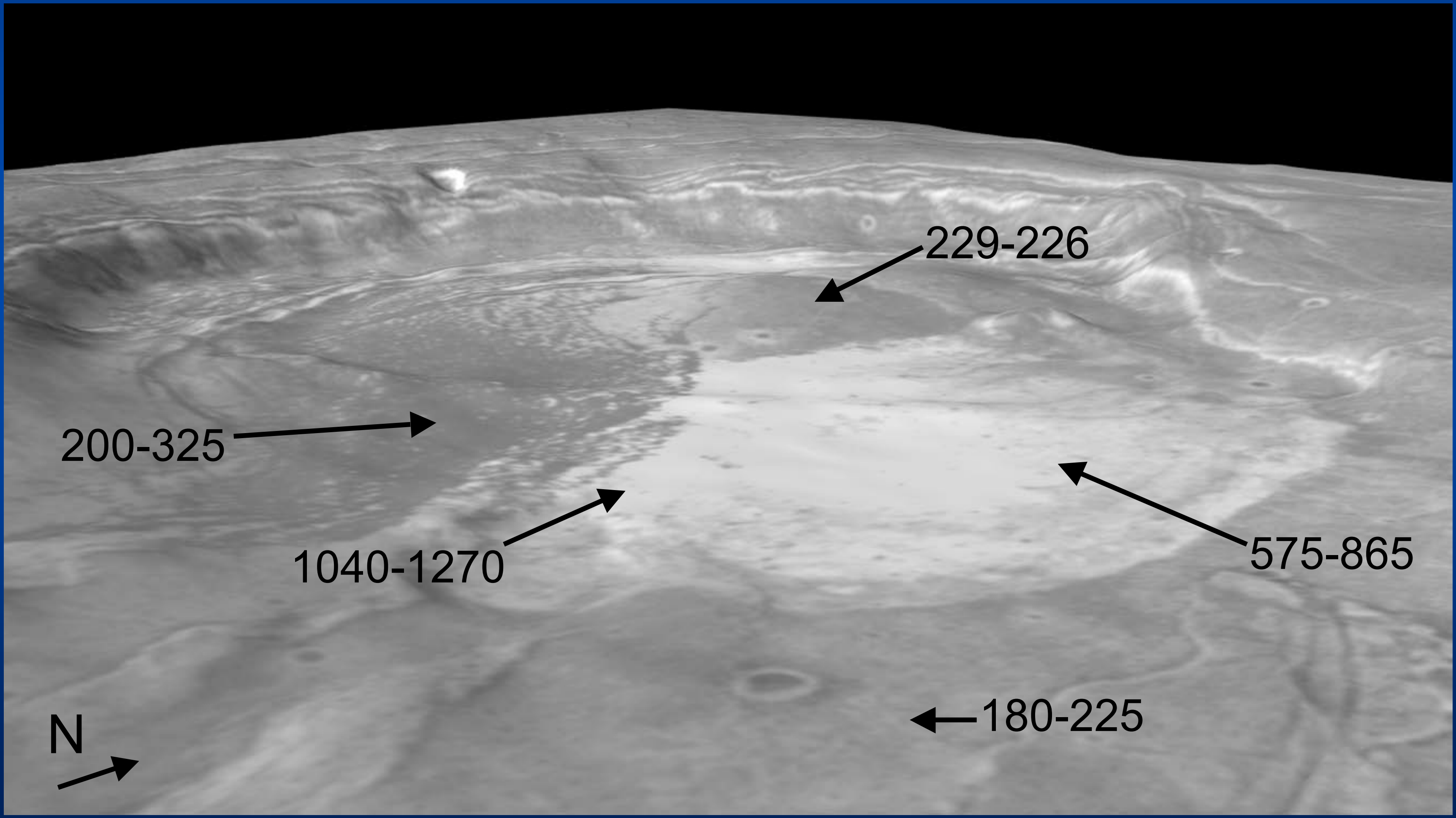


66.5 E

67.9 E

9.5 N

8.3 N



Conclusions

- Day IR
  - Good morphologic context
  - Temperatures strongly controlled by albedo and local topography
- Night IR
  - Qualitative thermal inertia – relative within an image
- Thermal Inertia
  - Improved spatial resolution
  - Consistent with TES and Mini-TES data