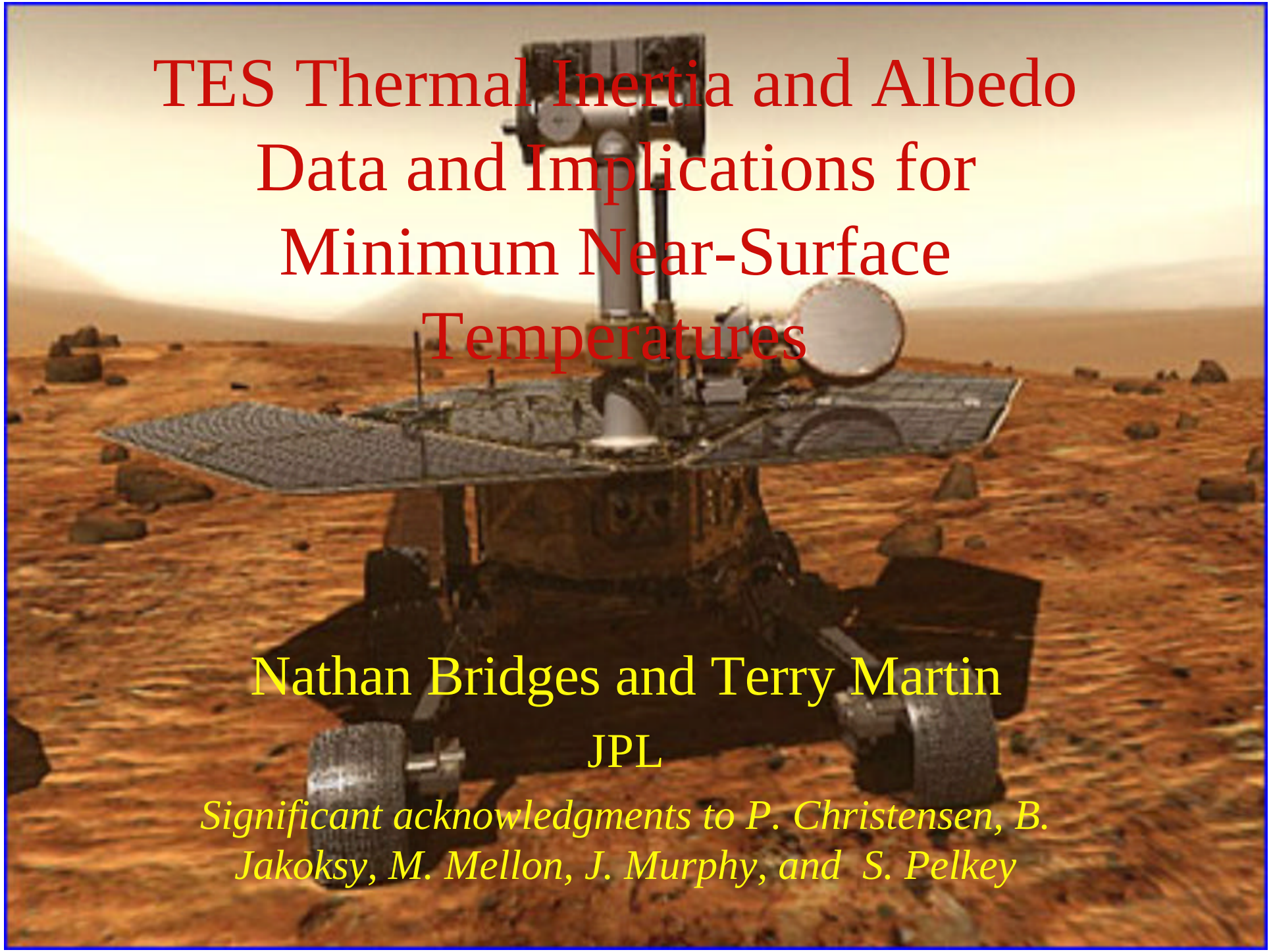


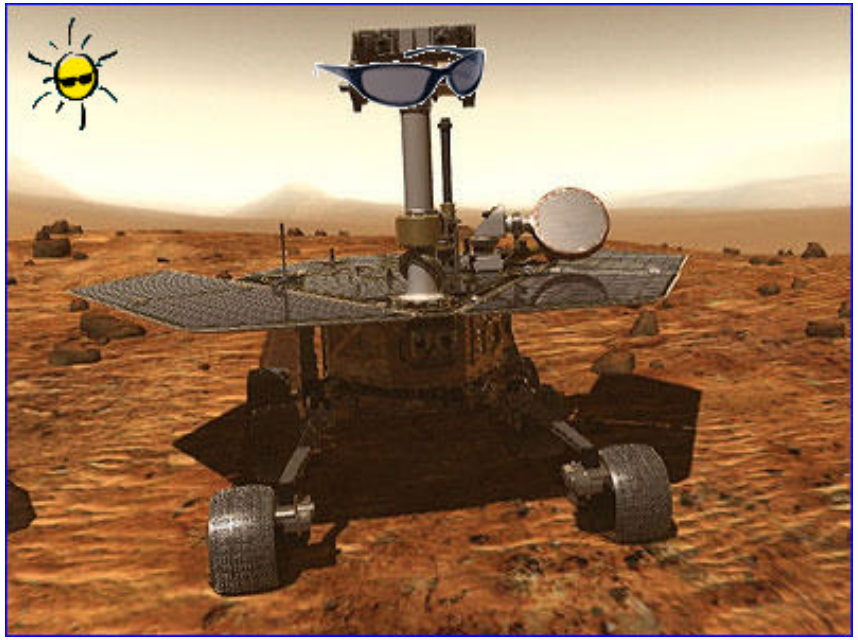
TES Thermal Inertia and Albedo Data and Implications for Minimum Near-Surface Temperatures

Nathan Bridges and Terry Martin

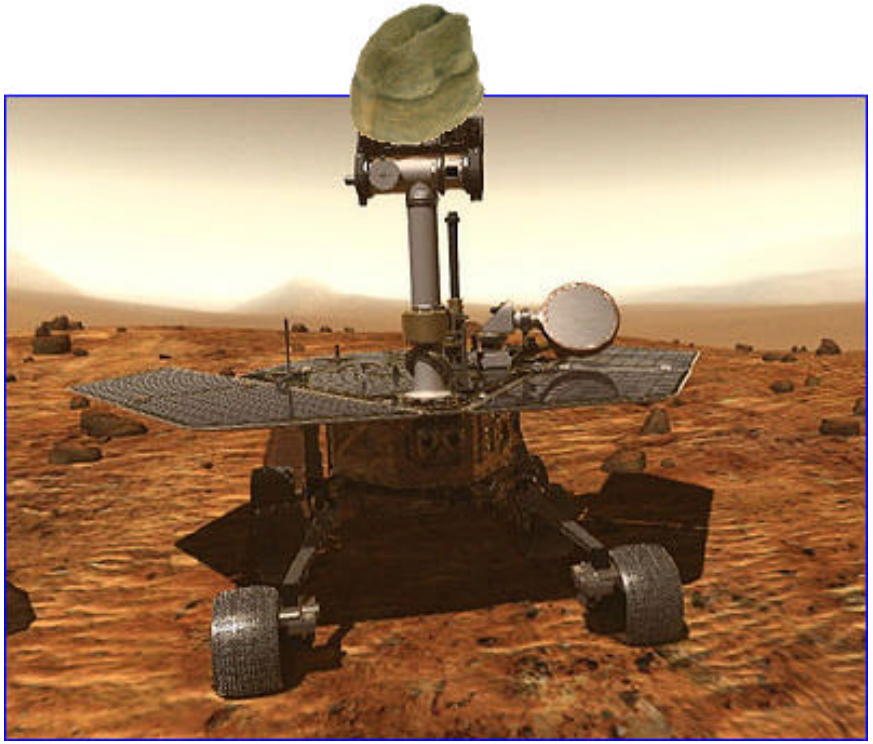
JPL

Significant acknowledgments to P. Christensen, B. Jakoksy, M. Mellon, J. Murphy, and S. Pelkey

What we want: Warm minimum temperatures, nominal mission lifetime of 90 sols



What we don’t want: Cold minimum temperatures, shortened mission lifetime



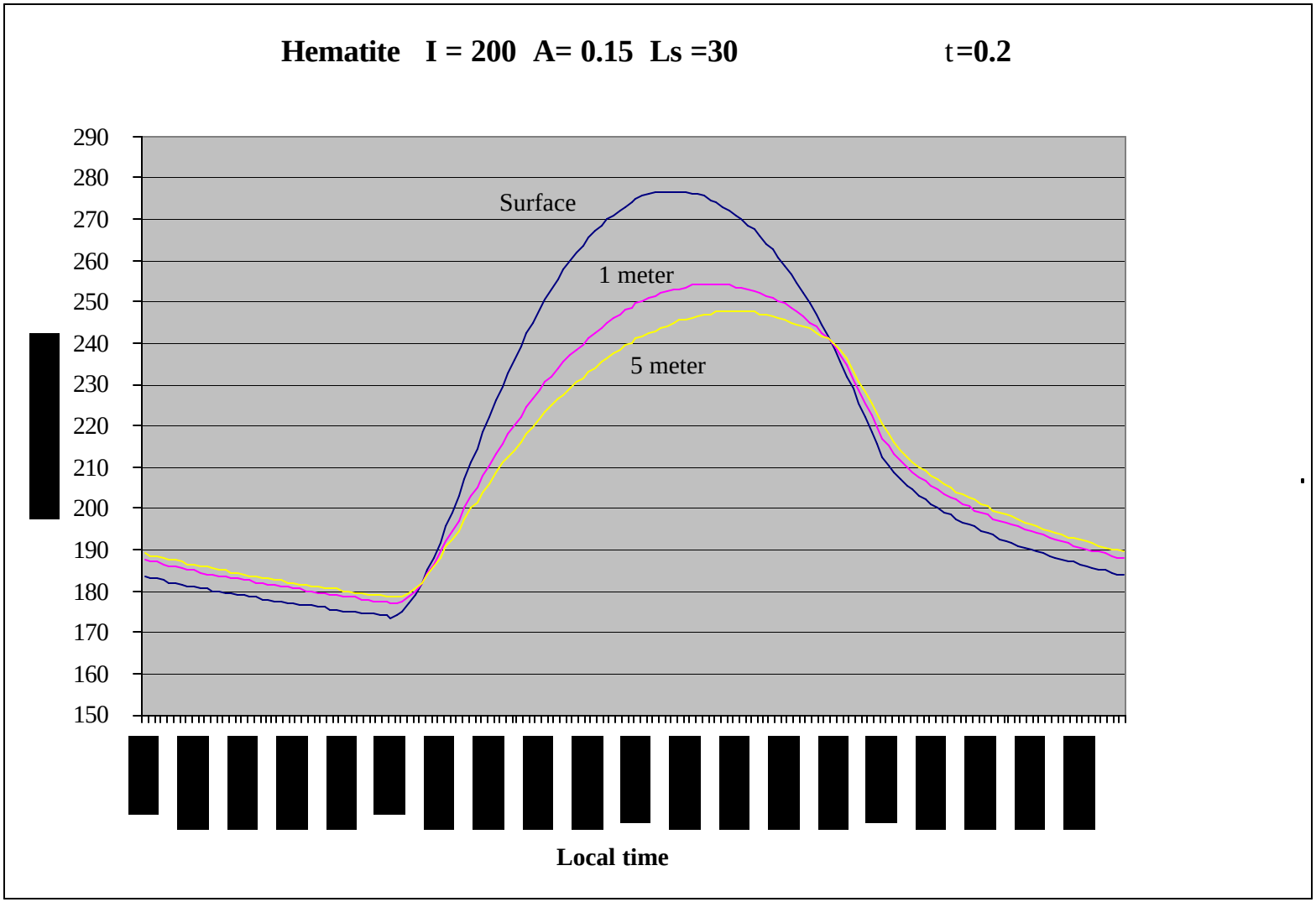
Process

- Albedo and inertia supplied by TES team
- Run 1-D model developed by J. Murphy (NMSU) to treat Viking and Pathfinder near-surface air measurements
- Other inputs are dust optical depth, latitude, L_s, surface pressure
- Model outputs surface and air temperatures as function of time of day

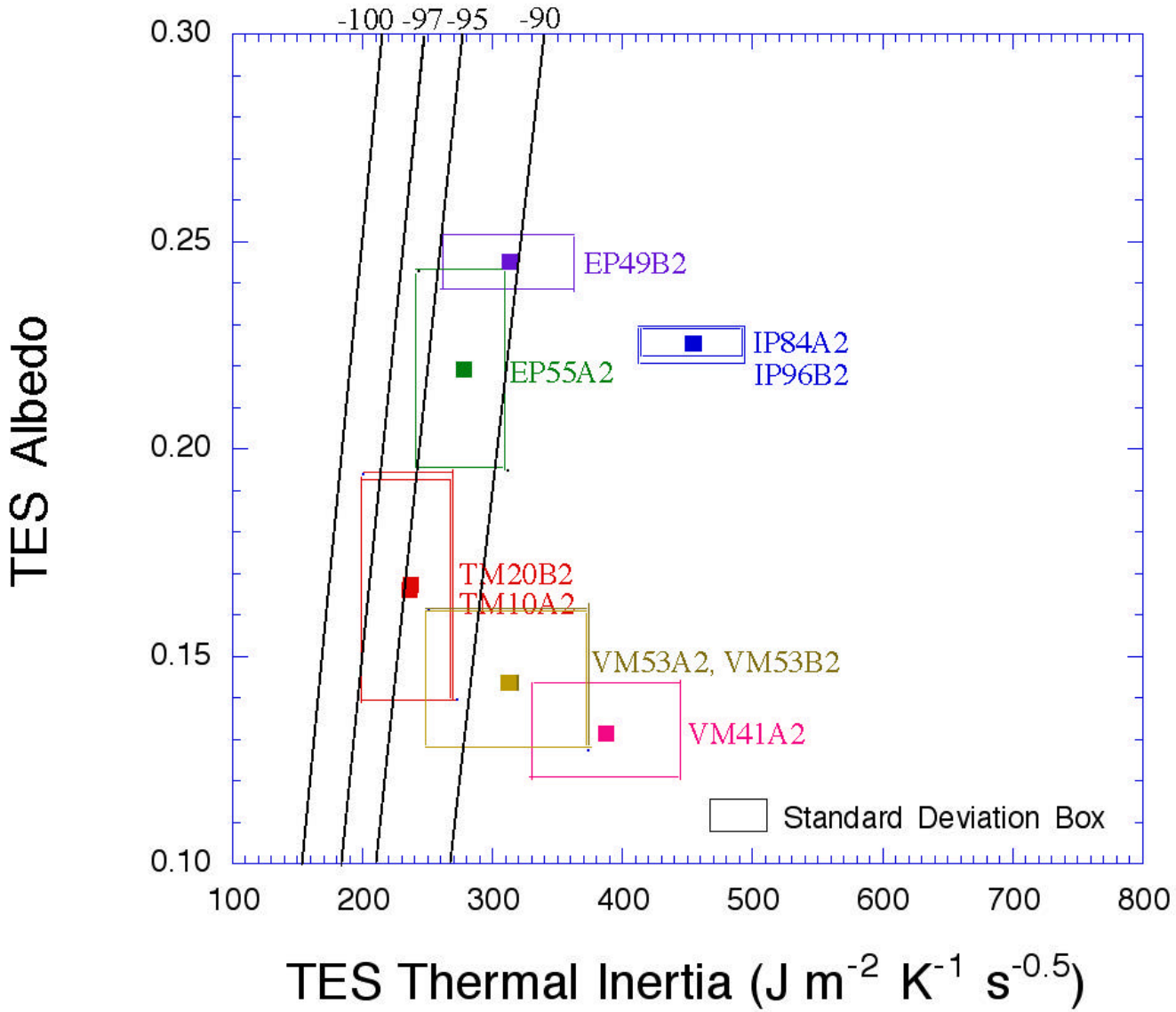
1-m Air Temperatures

- Surface and sky temperature are the biggest thermal drivers
- Rover equilibrates to local air temperature at night
- Thermal inertia is the strongest influence
- Worst case cold values occur predawn
- Other parameters:
  - Dust optical depth
  - Latitude
  - L_s
  - Albedo
  - Elevation (surface pressure)

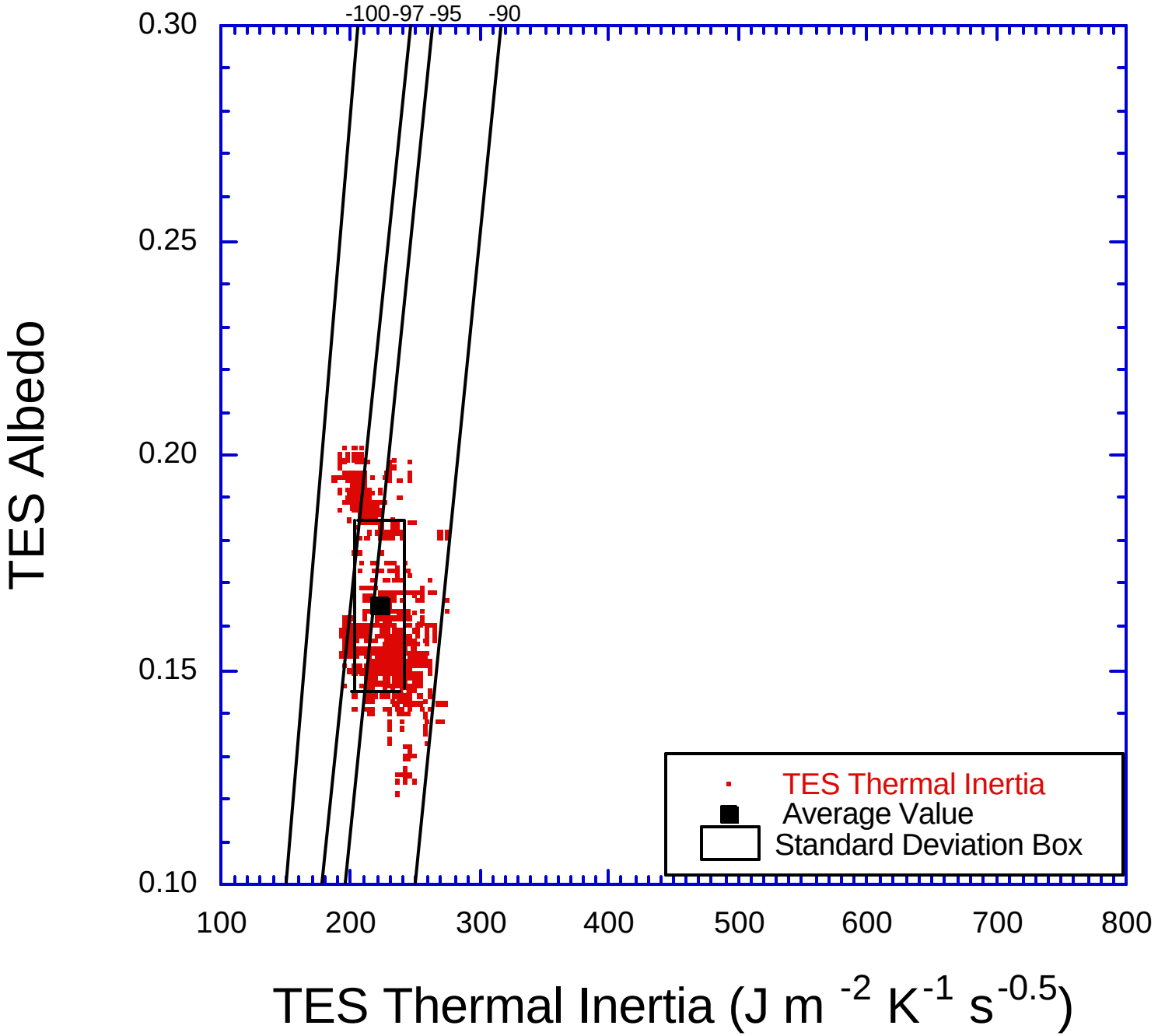
Typical 1-D Model Results

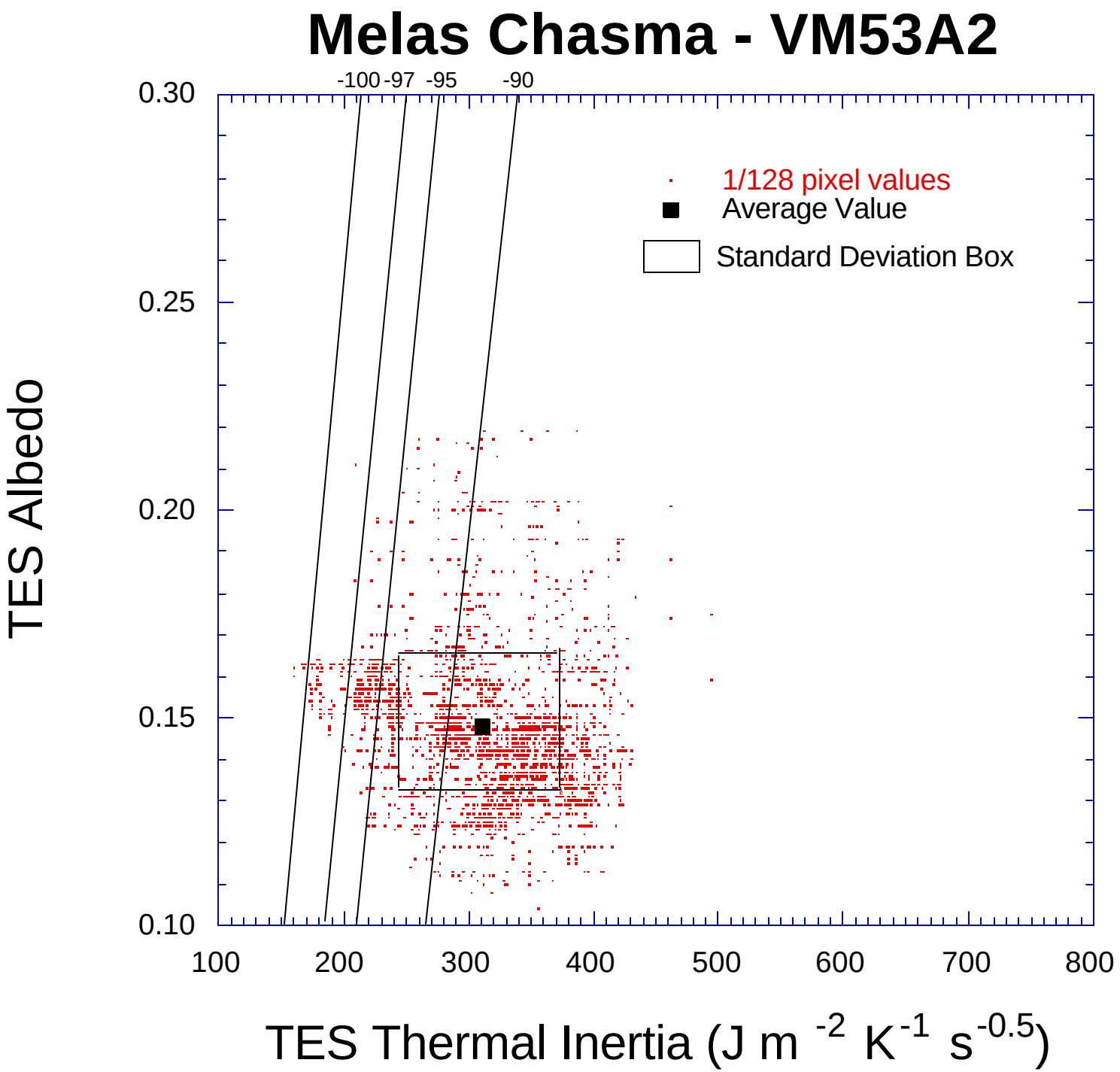


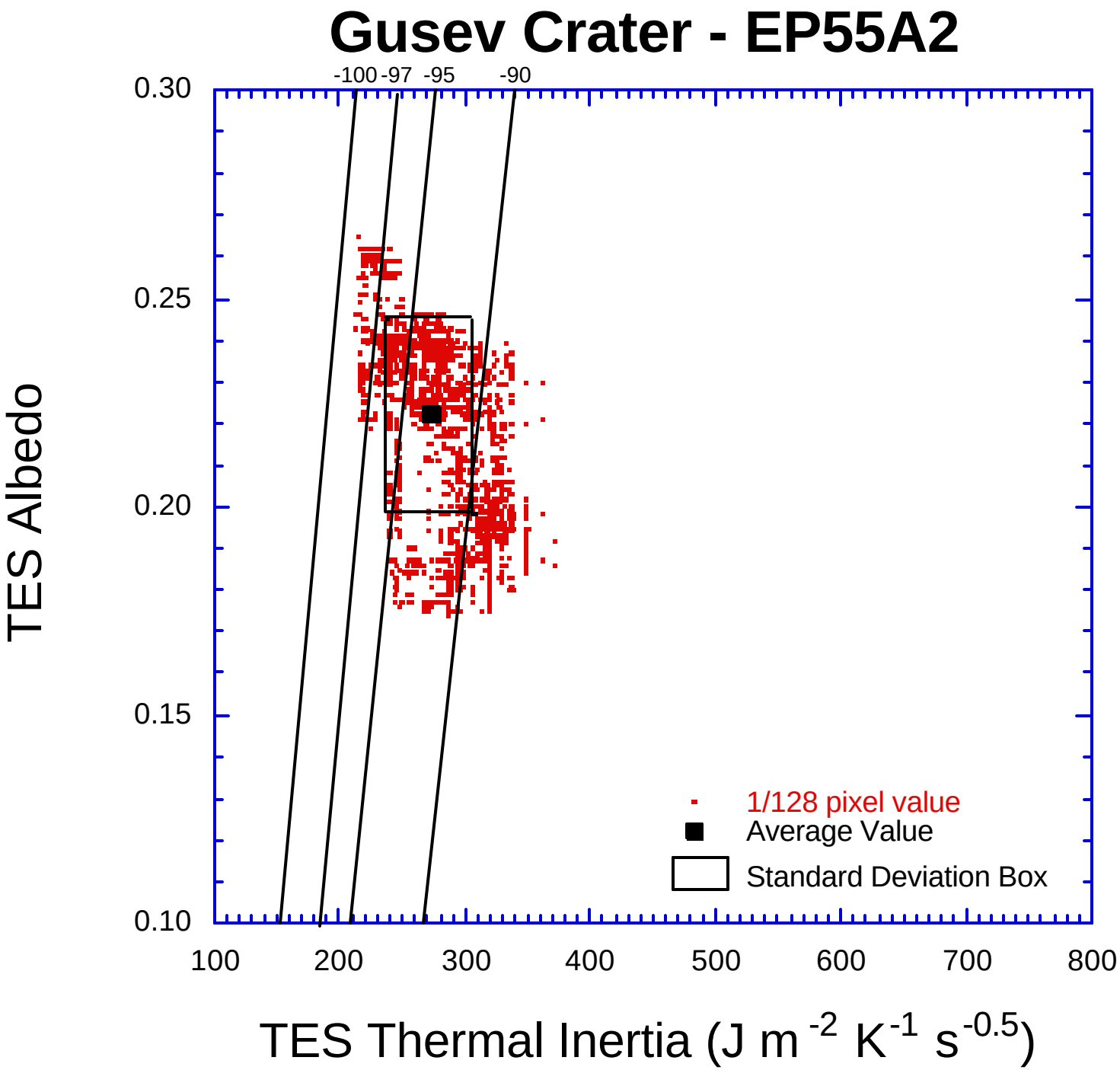
Prime and Backup MER Sites as of 1/02



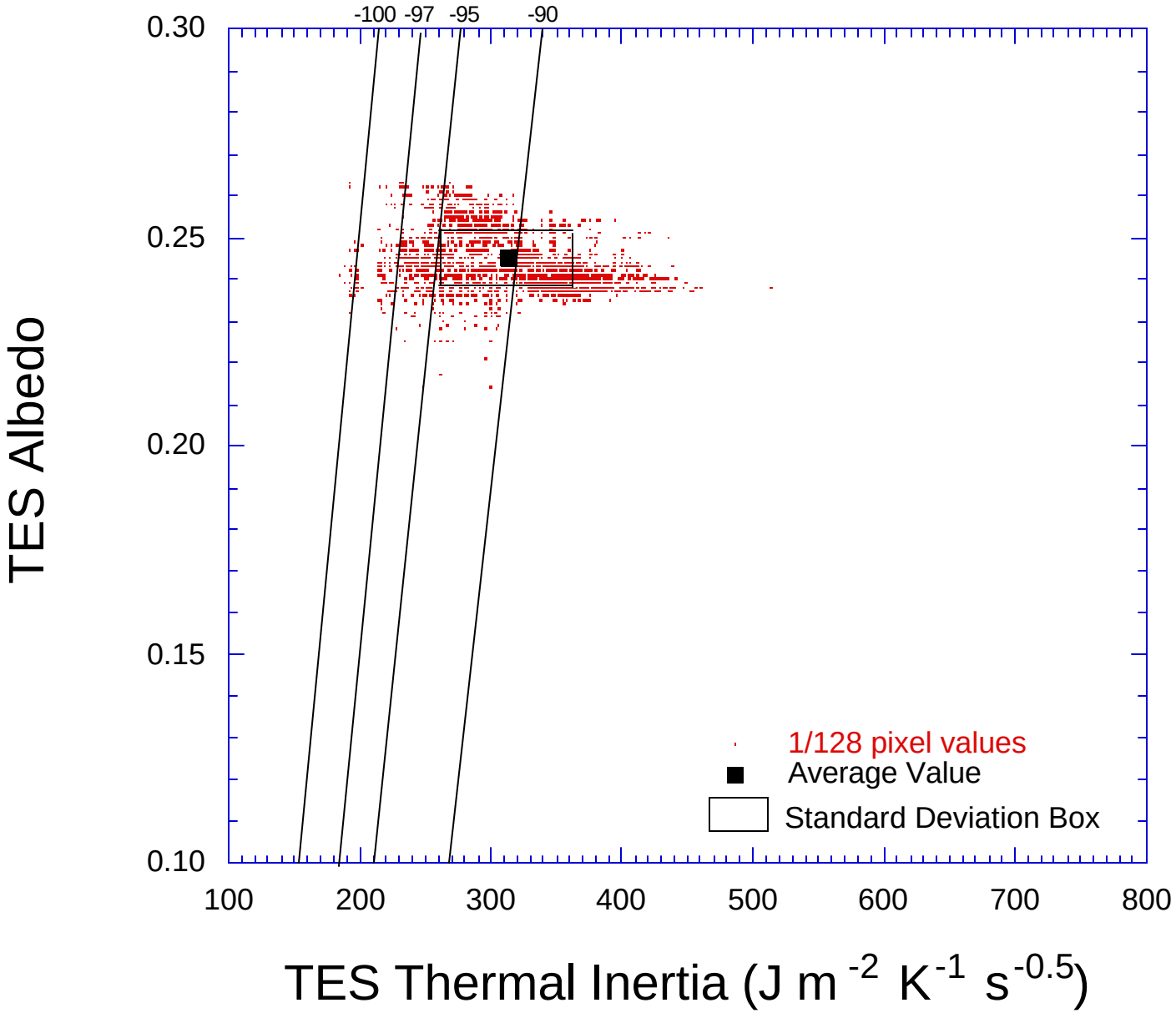
Hematite in Terra Meridiani - TM10A2

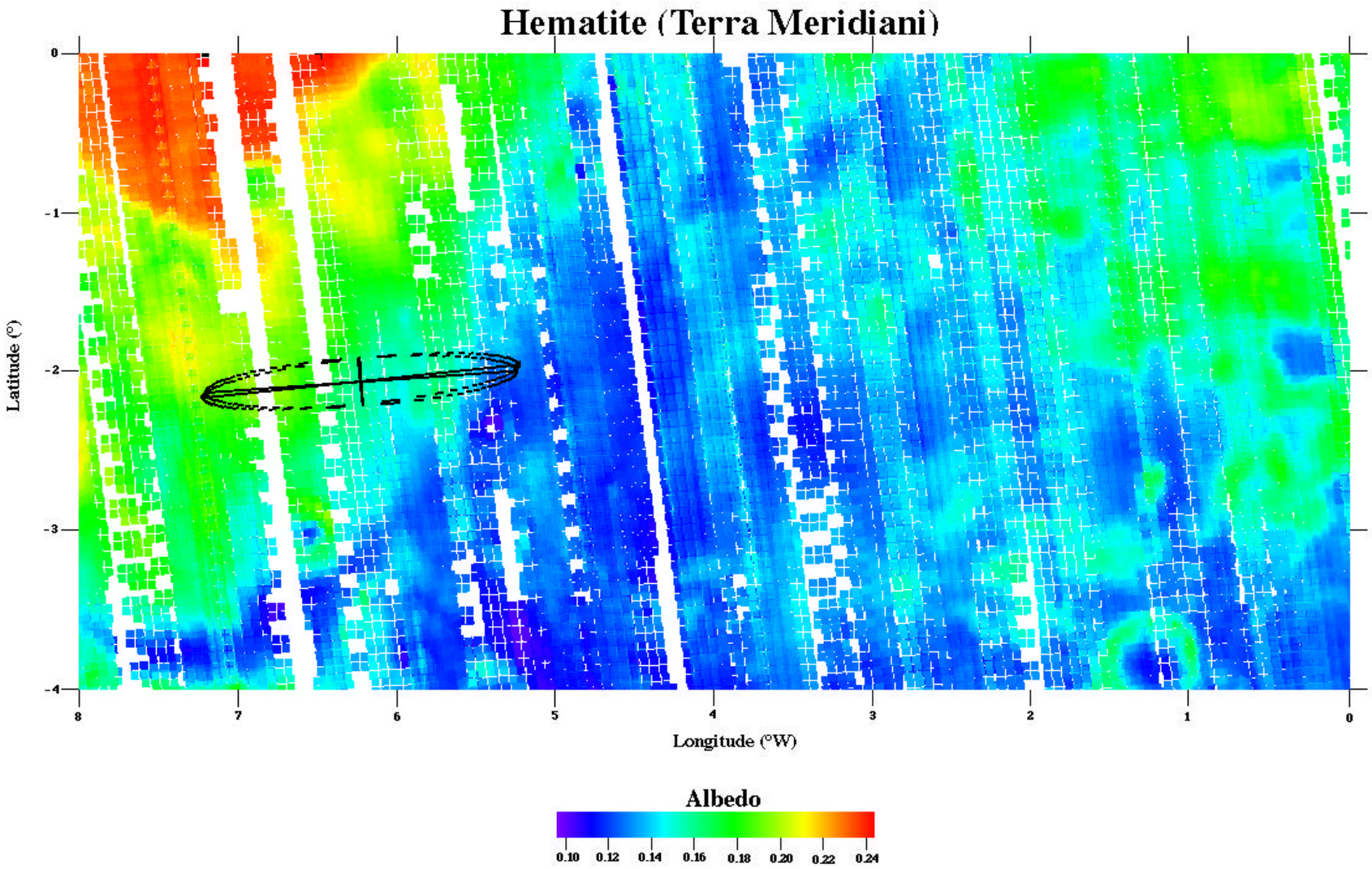


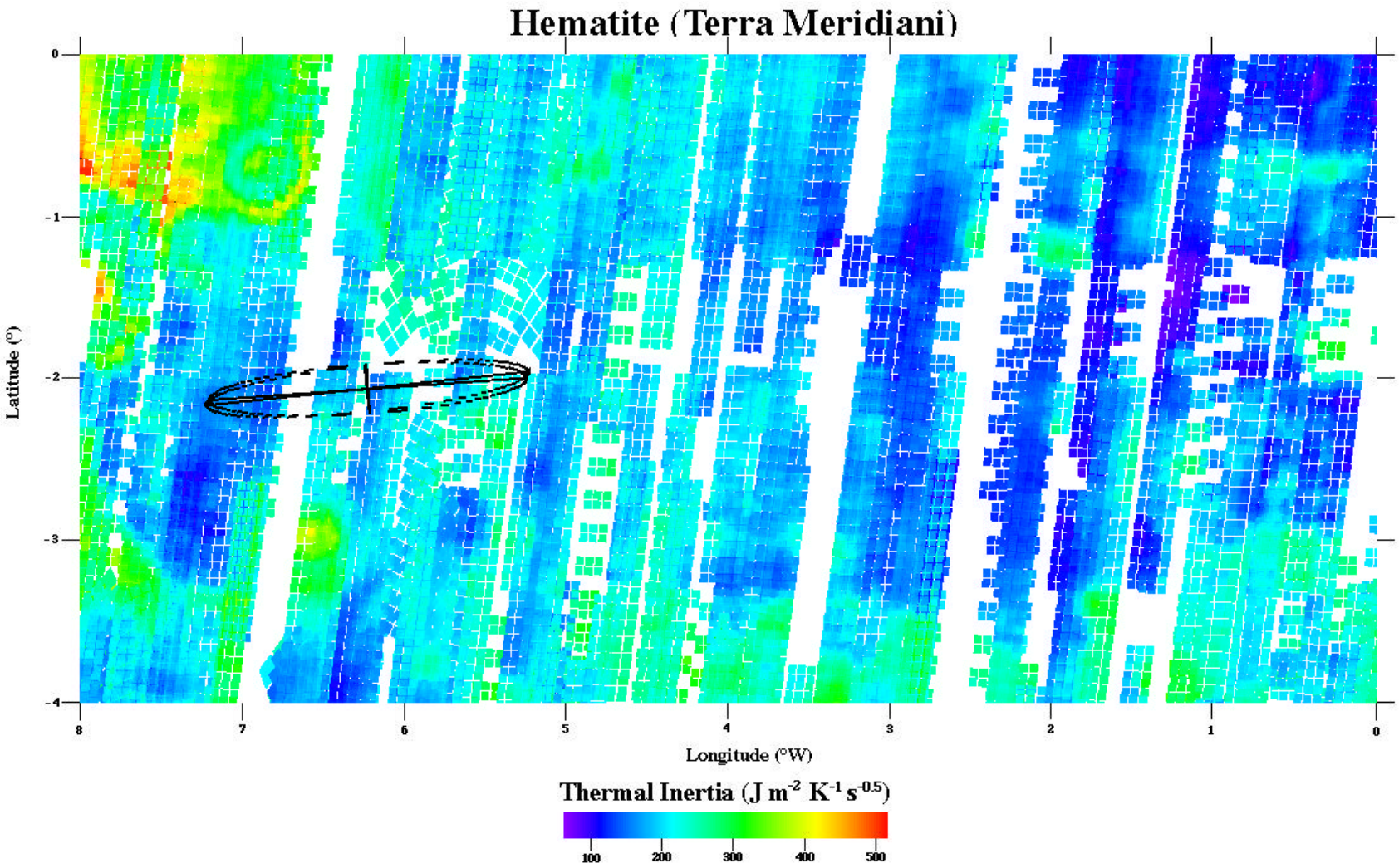

Melas Chasma - VM53A2
-100
-97
-95
-90
0.30
0.25
0.20
0.15
0.10
100
200
300
400
500
600
700
800
1/128 pixel values
Average Value
Standard Deviation Box
TES Albedo
TES Thermal Inertia (J m -2 K-1 s-0.5)

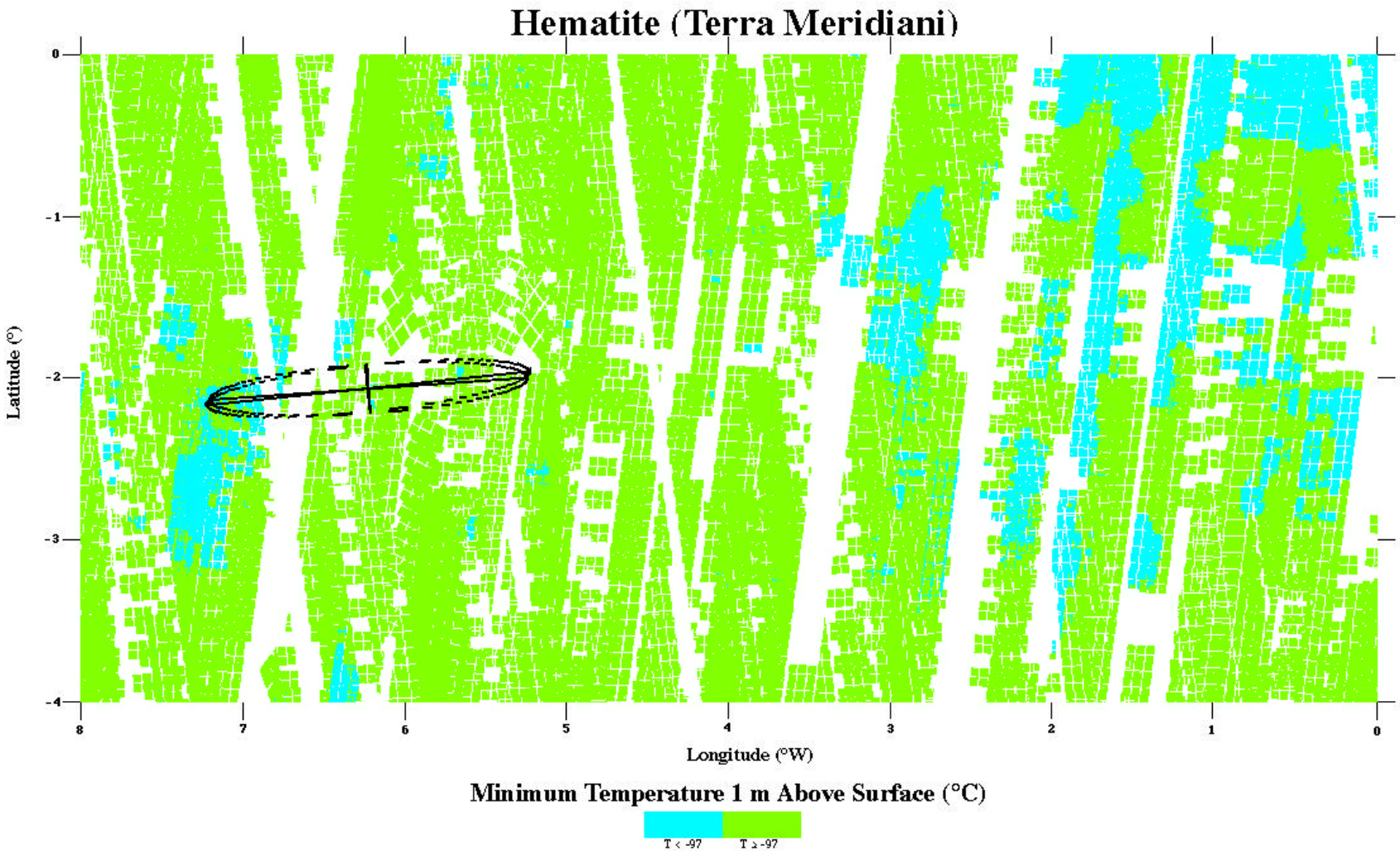

Gusev Crater - EP55A2
-100
-97
-95
-90
0.30
0.25
0.20
0.15
0.10
100
200
300
400
500
600
700
800
TES Albedo
TES Thermal Inertia (J m -2 K -1 s -0.5)
1/128 pixel value
Average Value
Standard Deviation Box

Athabasca Vallis - EP49B2

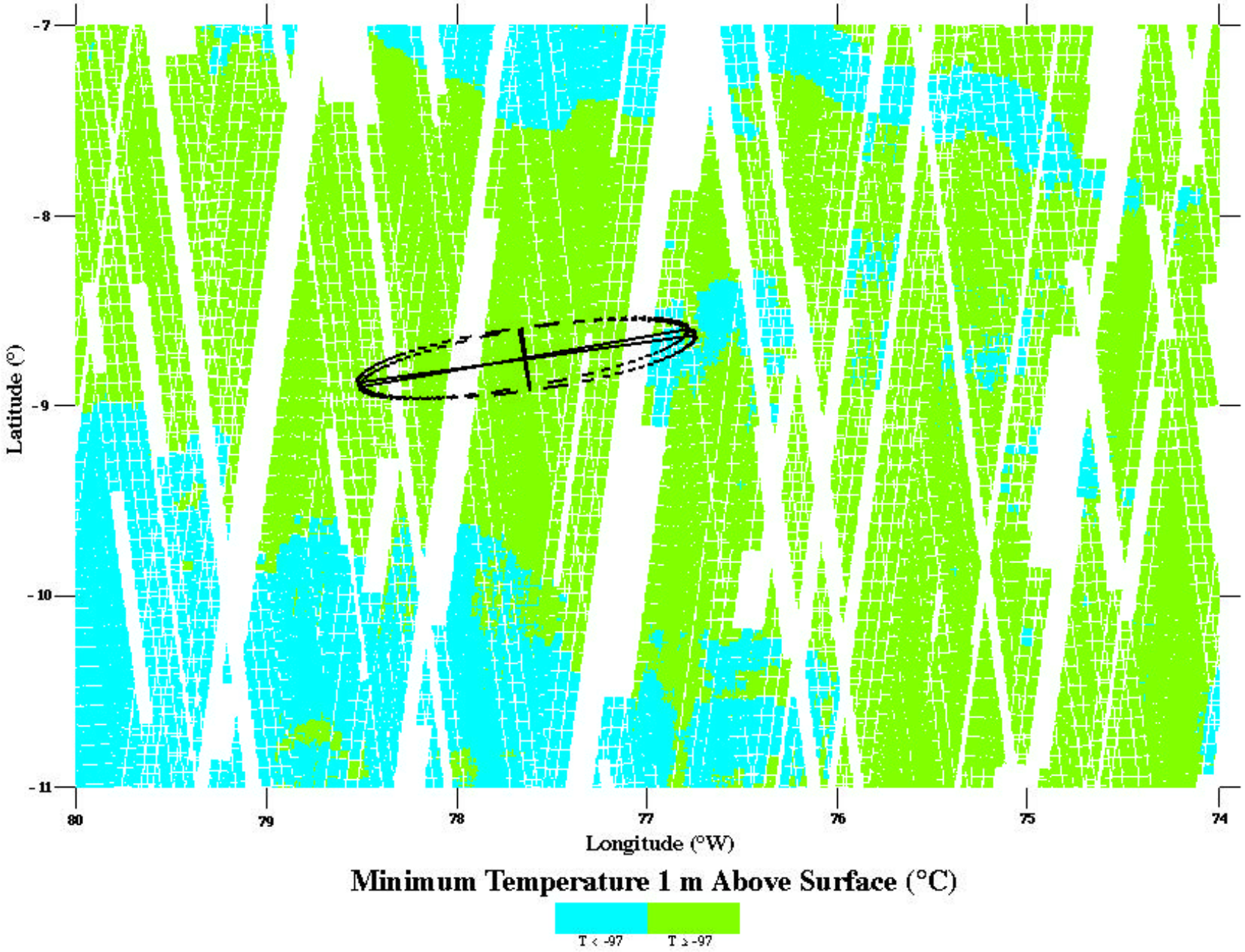



Hematite (Terra Meridiani)
Latitude (°)
0
-1
-2
-3
-4
8
7
6
5
4
3
2
1
0
Longitude (°W)
Albedo
0.10
0.12
0.14
0.16
0.18
0.20
0.22
0.24

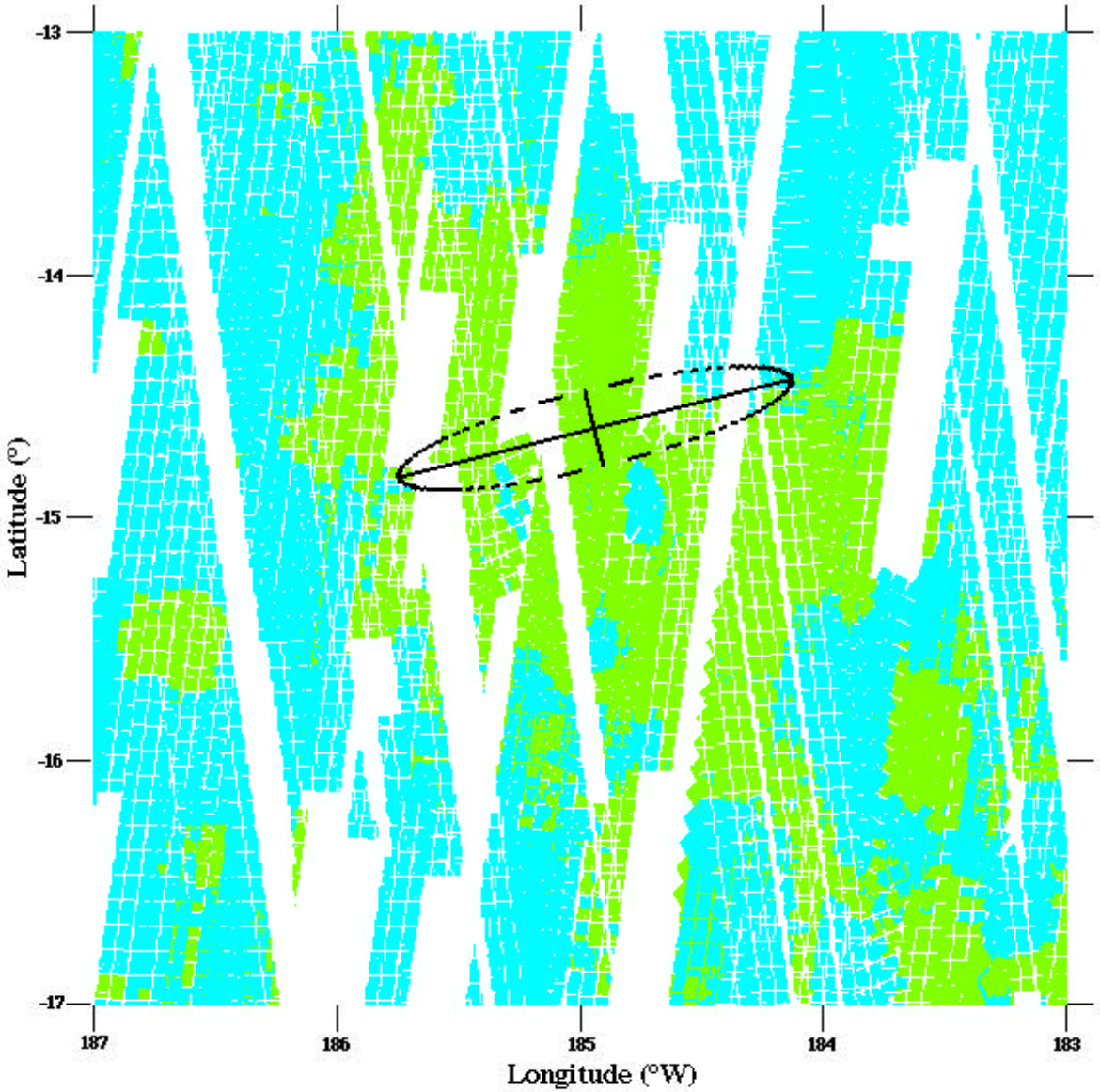

Hematite (Terra Meridiani)
Latitude (°)
0
-1
-2
-3
-4
8
7
6
5
4
3
2
1
0
Longitude (°W)
Thermal Inertia (J m-2 K-1 s-0.5)
100
200
300
400
500


Hematite (Terra Meridiani)
Latitude (°)
0
-1
-2
-3
-4
8
7
6
5
4
3
2
1
0
Longitude (°W)
Minimum Temperature 1 m Above Surface (°C)
T < -97
T ≥ -97

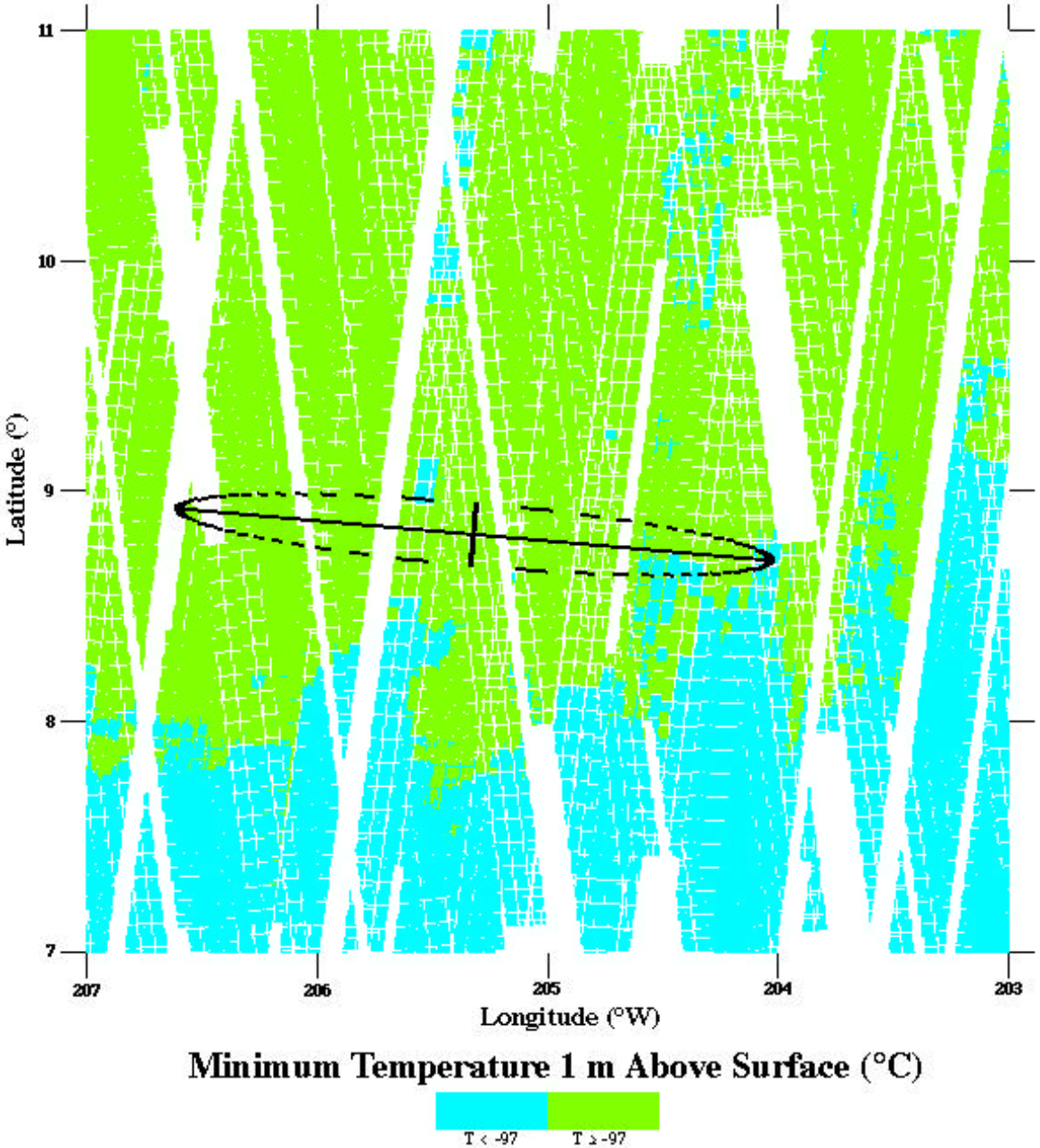
Melas Chasma



Gusev Crater



Athabasca


11
10
9
8
7
Latitude (°)
207
206
205
204
203
Longitude (°W)
Minimum Temperature 1 m Above Surface (°C)
T < -97
T ≥ -97

Thoughts

- Ponding of cold air in topographic lows under still conditions could create colder nighttime minima; rover may roll into such lows upon landing
- Wind-induced mixing of warmer air from higher altitudes at night would help; mesoscale models may shed light on the probability of such winds; but Hematite shows little drainage wind
- Winds would also act to mix air from varying A/I domains, making our low-resolution A/I data more relevant
- Dust opacity higher than 0.2 would also help; estimating probability of encountering this value would be useful

Conclusions

- Low nighttime temperatures are not going away as we examine albedos, inertias, and the 1-m model itself
- Hematite site is of greatest concern, but Melas, Gusev, and Athabasca have some low temperaure areas: Shortened mission life is possible
- THEMIS will measure nighttime temperatures at 100 m resolution. This will help, but it is unlikely that this will alter regional inertia behavior we see with TES
- More could be done: Probe thermal models; produce mesoscale runs tailored to relevant L_s and dust opacity parameters, to compare their 1-m temps; derive probabilities for each ellipse of encountering cold regions