# MARSTHERM: *Thermophysical Analysis Tools for Mars Research*

http://marstherm.boulder.swri.edu

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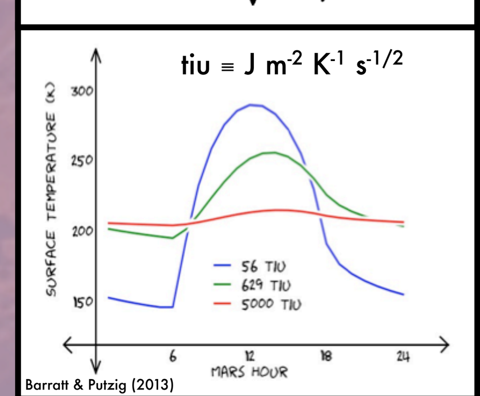
## MOTIVATION

Characterizing near-surface properties is essential for assessing landing sites and for understanding geologic processes on Mars. Critical to that effort is the analysis of thermal inertia, a material property derived from temperature data that provides a means to constrain grain size, induration, rock abundance, lateral mixtures of materials, and layering. To enable wider use, we developed a website that provides access to our thermal model, TES products and analysis tools, and software for deriving THEMIS thermal inertia.

## BACKGROUND

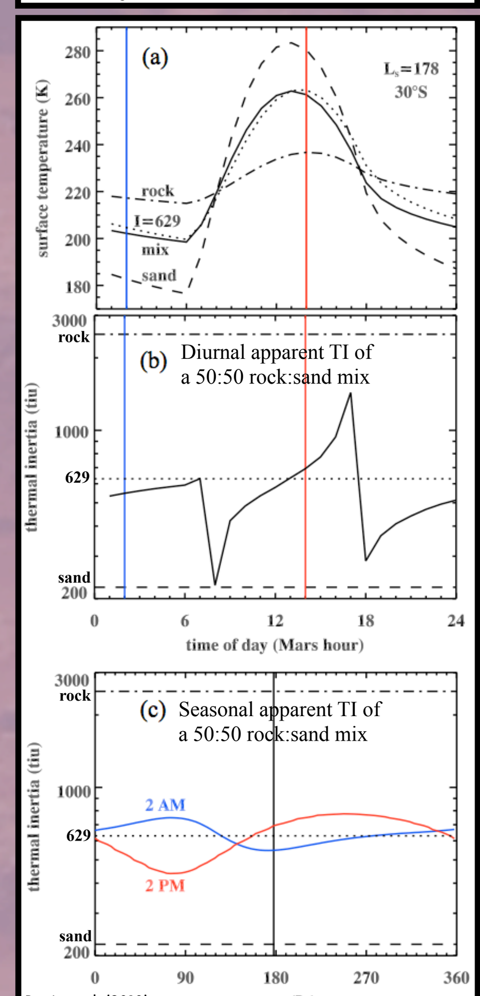
### Thermal Inertia

$$I \equiv \sqrt{k\rho c}$$




Conductivity, density, and heat capacity make up thermal inertia, which in a planetary context controls how a material stores heat during the day and reradiates it at night.

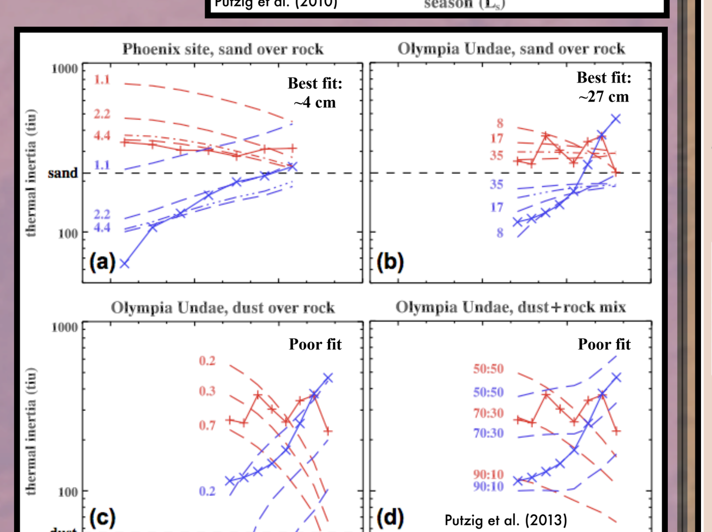
Modeled temperatures for a broad range of thermal inertia, albedo, and other conditions can be used to derive thermal inertia from temperature observations.




### Heterogeneity

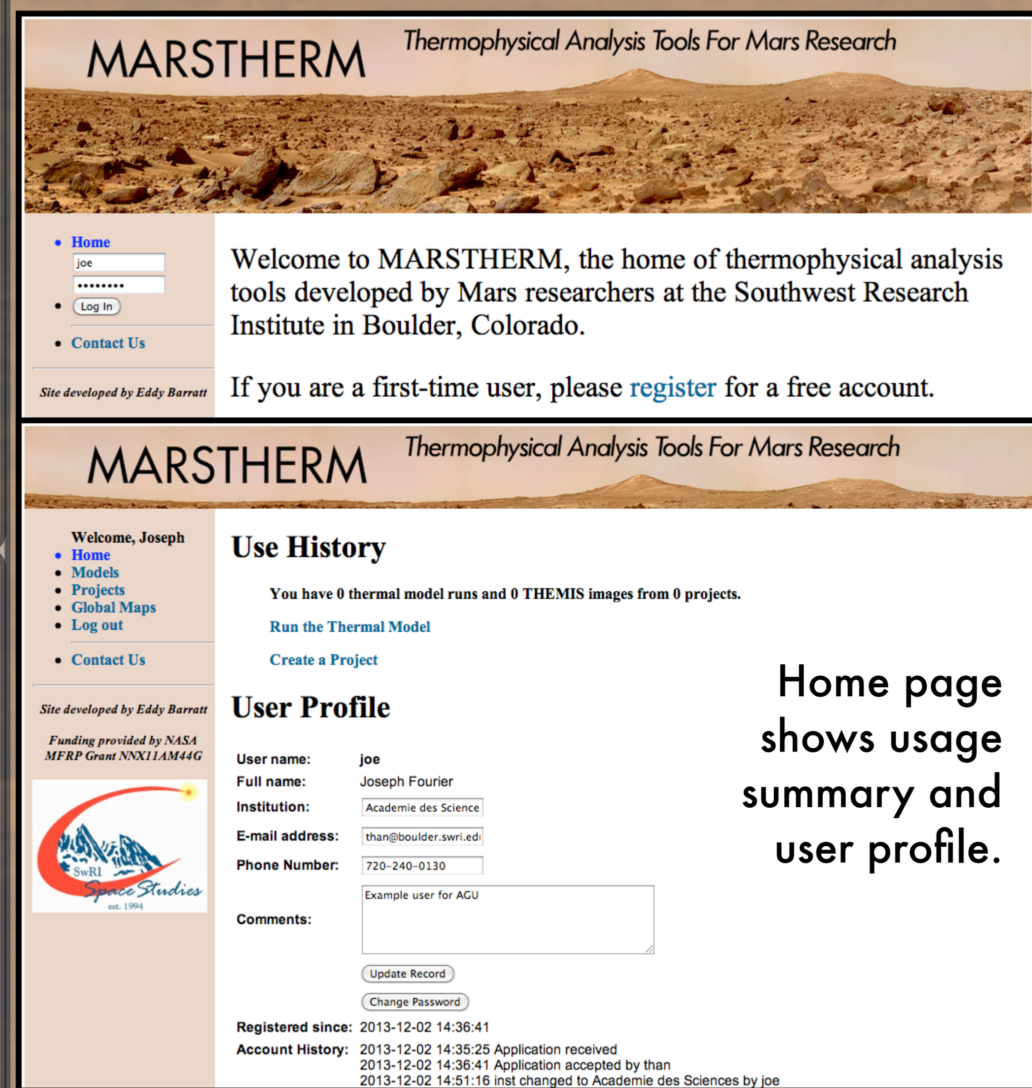
Because temperature varies nonlinearly with thermal inertia, mixtures or layers of materials in an instrument's view will yield different values of *apparent* thermal inertia.

These effects can be used to constrain physical properties of surfaces, such as the amounts of sand overlying ground ice (with rock-like thermal inertia) at the Phoenix site and in the north polar erg of Mars.



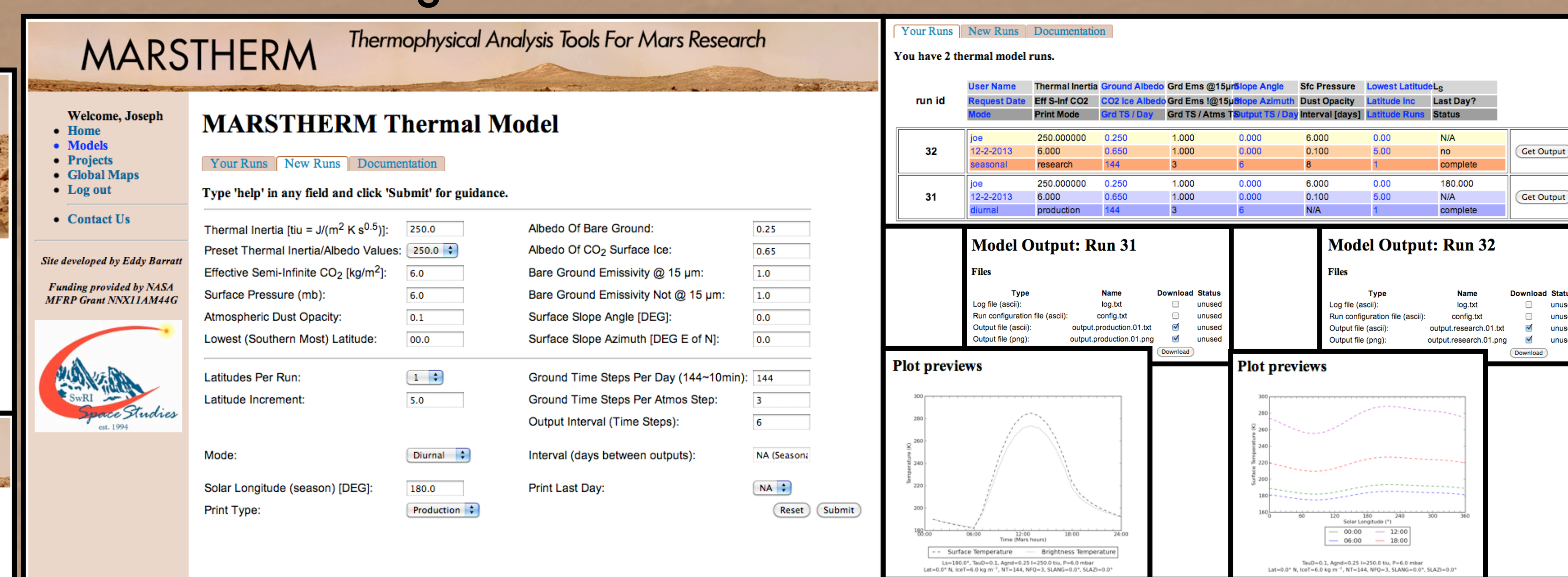

## WEBSITE FEATURES

### User Accounts

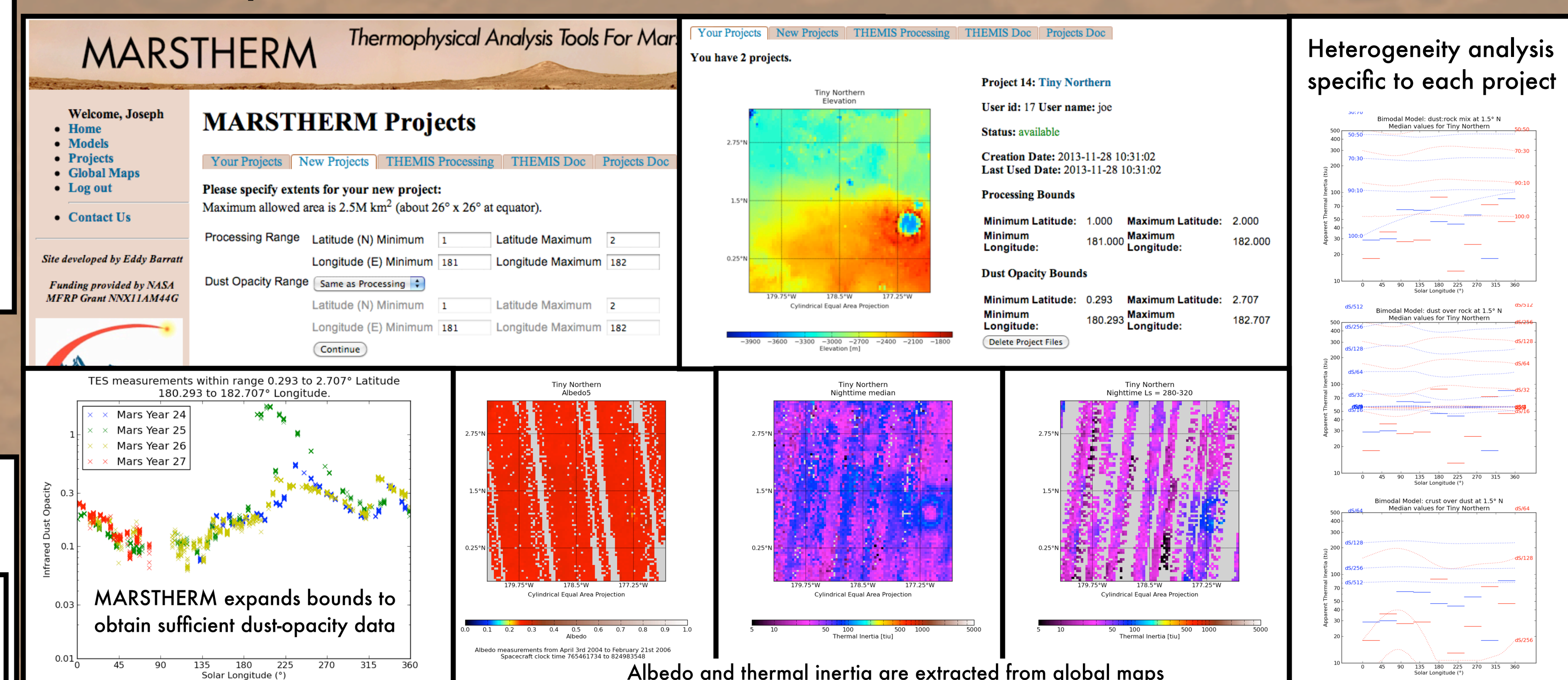


Home page shows usage summary and user profile.

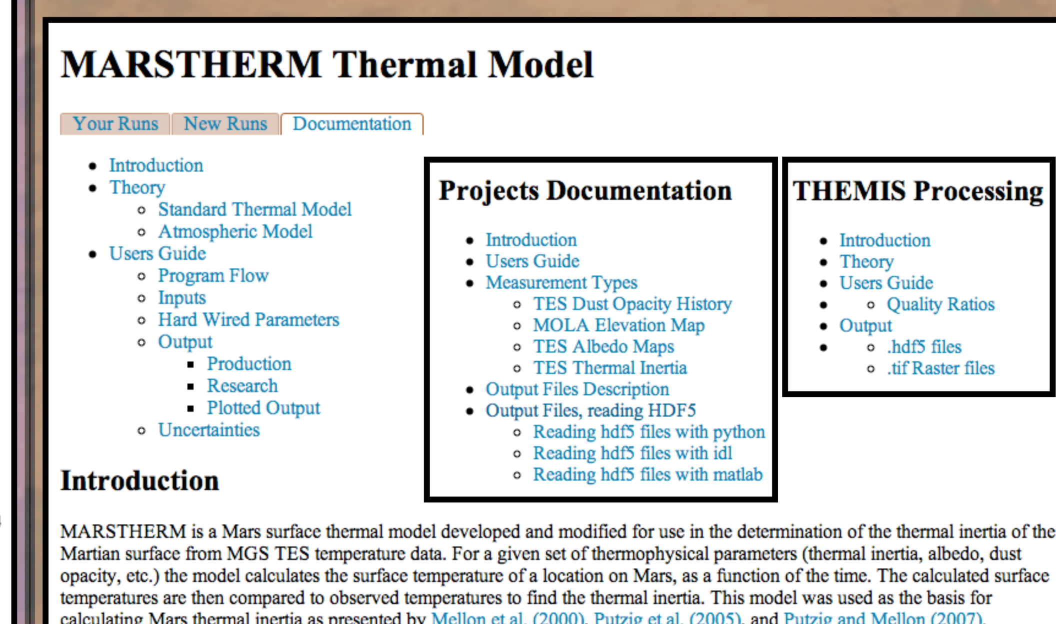
### Thermal Modeling



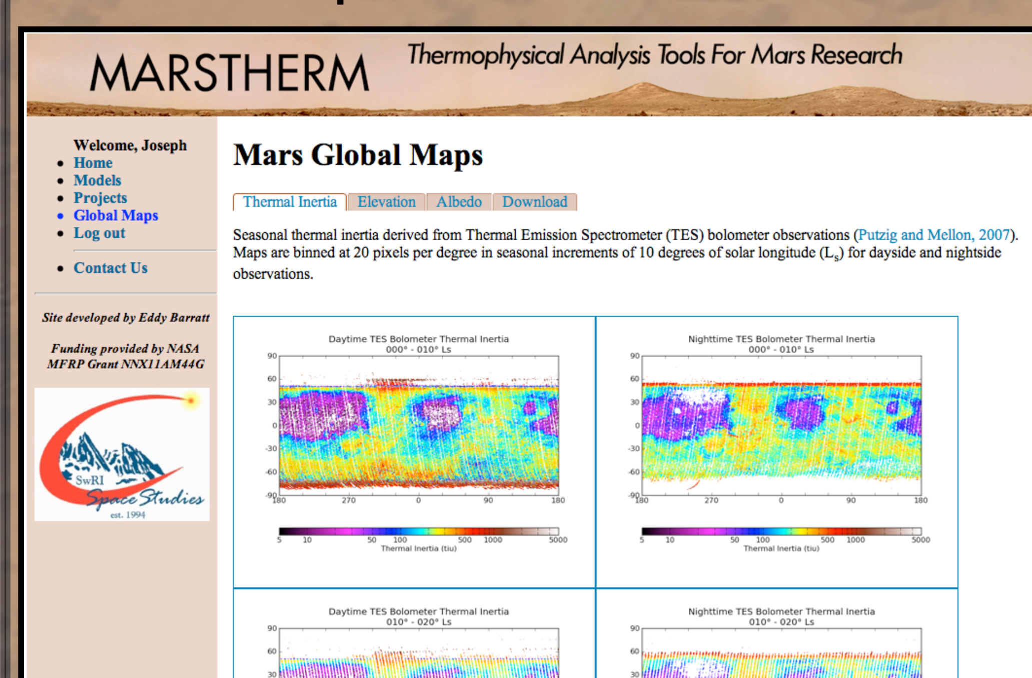
### User Projects



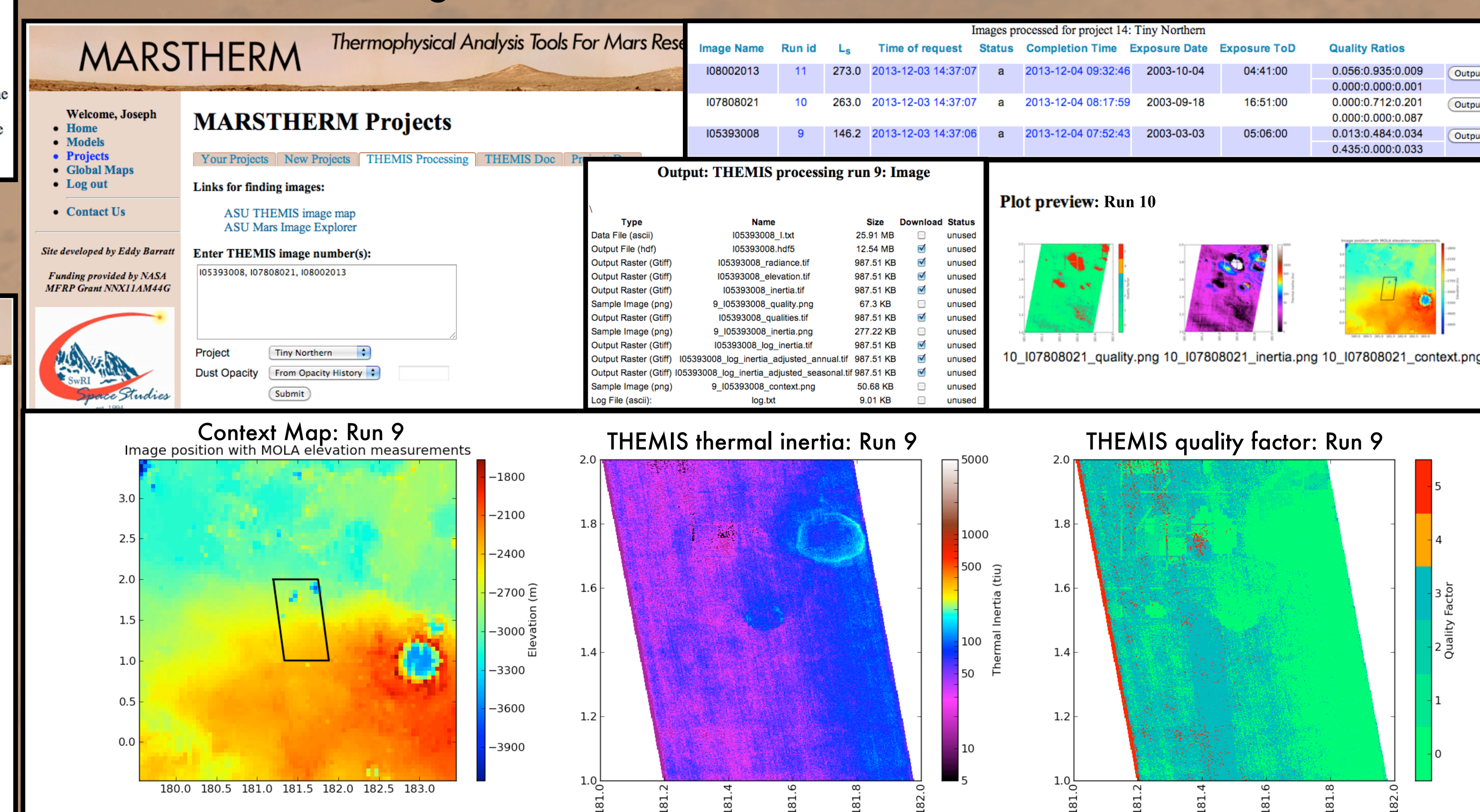

### Online Documentation



### Global Maps



### THEMIS Processing




## GALE CRATER CASE STUDY

Barratt (2013) used MARSTHERM to study thermophysical properties within Gale crater, site of the MSL Curiosity rover.

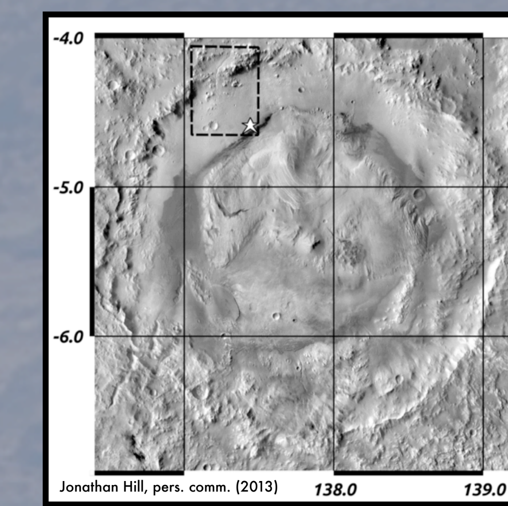


Fig. 1: Gale crater in a THEMIS-visible mosaic. Dashed box: Fig. 3. Star: MSL.

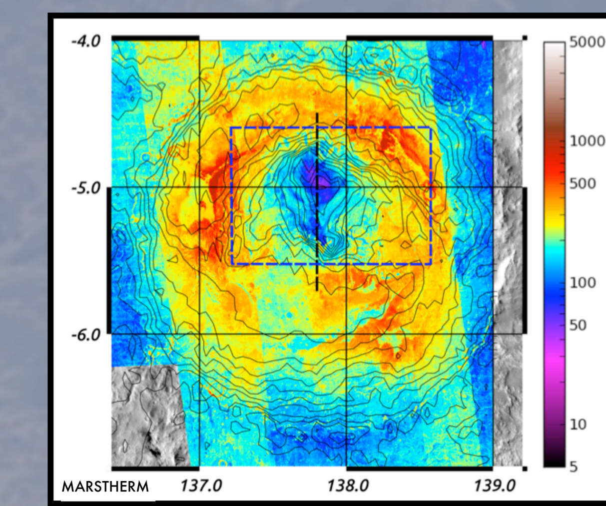


Fig. 2: Thermal inertia of Gale in a mosaic of results from THEMIS-IR nighttime images.

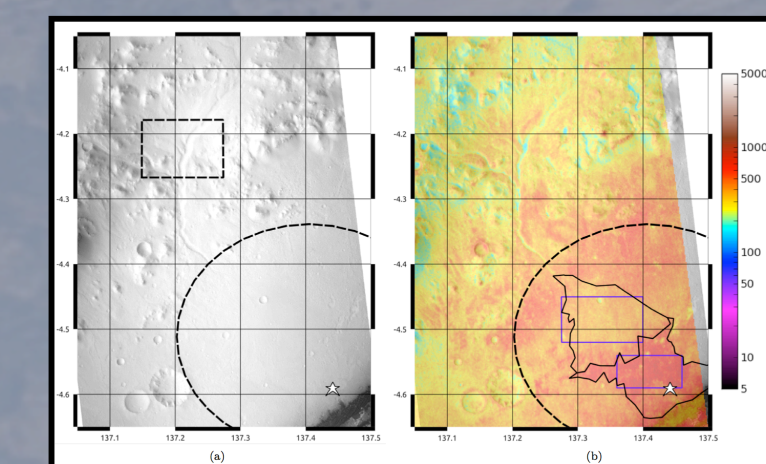


Fig. 3: Peace Vallis in (a) CTX imagery and (b) THEMIS thermal inertia (image I18262008). Dashed line and star show MSL landing ellipse and location. Thin solid outlines show Low and High Thermal Inertia Fan units.

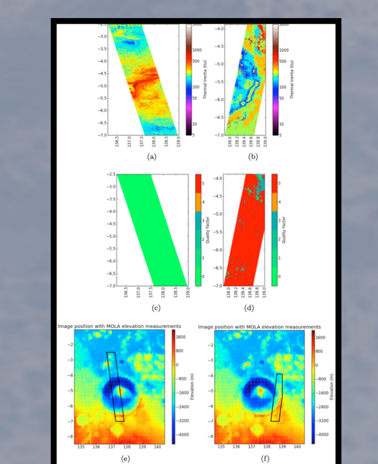


Fig. 4: Thermal inertia, quality, and context for two THEMIS images in Gale MARSTHERM project.

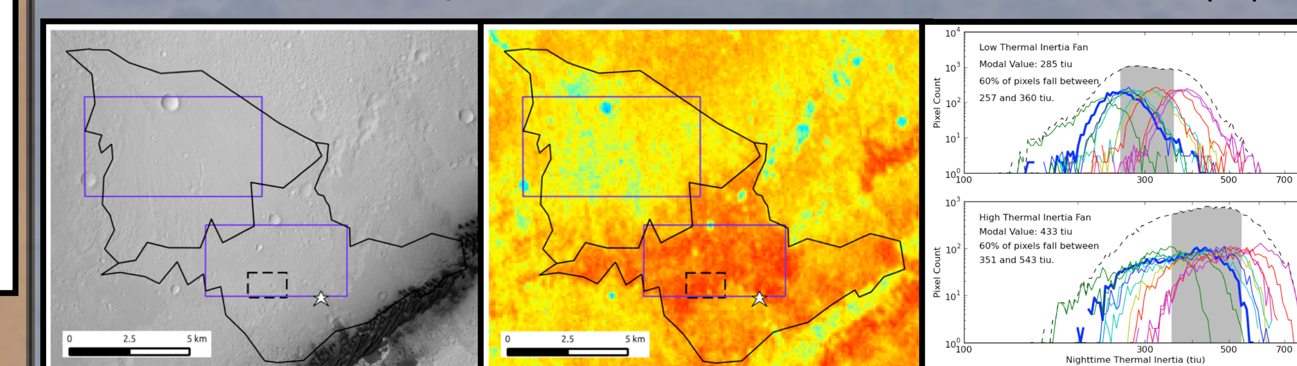



Fig. 5: Outlines show Low and High Thermal Inertia Fan units in (left) CTX imagery and (center) THEMIS thermal inertia (image I01350002). Purple boxes are areas used for histograms at right, which show values for 11 THEMIS images. Thick blue lines correspond to image at center, dashed line is histogram for all images. Gray bars delineate 60% of pixel values for all images.

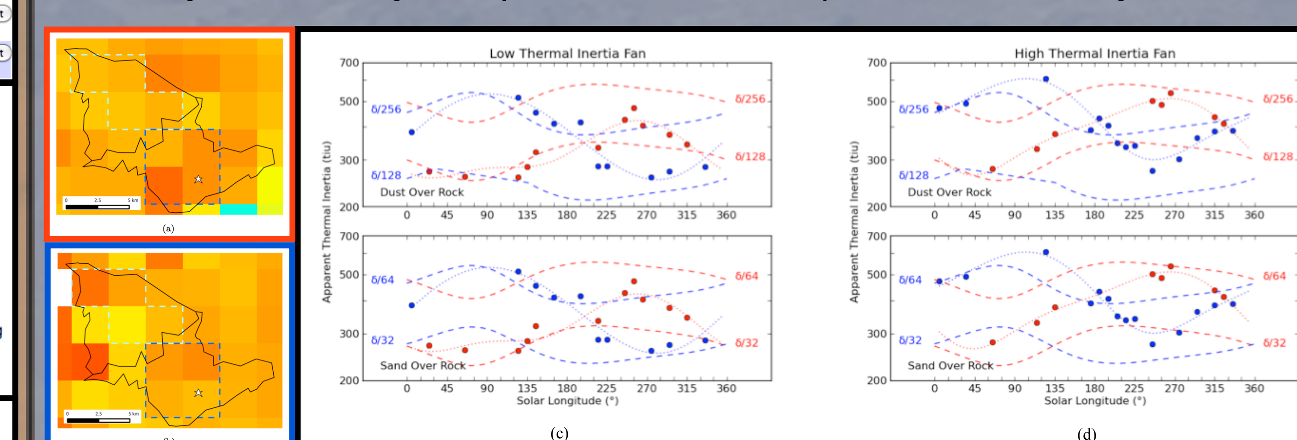



Fig. 6: TES thermal inertia in the Peace Vallis fan compared to two-component model results. Annual-median maps show (a) dayside and (b) nightside values, with dashed outlines of pixels used in seasonal analysis for the Low (c) and High (d) Thermal Inertia Fan units. TES seasonal dayside (red dots) and nightside (blue dots) values are fit with second-order harmonics (dotted lines) and compared to apparent thermal inertia derived from layered models (dashed lines) with differing thicknesses of dust or sand overlying rock (seasonal skin depth δ is 20 cm for dust, 70 cm for sand).

Conclusions: THEMIS results show distinct variations in apparent thermal inertia consistent with TES results, at higher resolution. TES seasonal variations in apparent thermal inertia indicate a layered structure with either dust or sand overlying bedrock.

REFERENCES: Barratt, E. M., 2013, Univ. CO MS thesis. Barratt, E. M., Putzig, N. E., 2013, EPSC Abs. 613. Mellon, M. T., Jakosky, B. M, Kieffer, H. H., Christensen, P. R., 2000, Icarus 148, 437–455. Putzig, N. E., Mellon, M. T., 2007, Icarus 191, 68–94. Putzig, N. E., Mellon, M. T., Kretke, K. A., Arvidson, R. E., 2005, Icarus 173, 325–341. Putzig, N. E., Mellon, M. T., Michaels, T. I., 2010, MFRP proposal. Putzig, N. E., Mellon, M. T., Herkenhoff, K. E., Phillips, R. J., Davis, B. J., Ewer, K. J., Bowers, L. M., 2013, Icarus (in press).