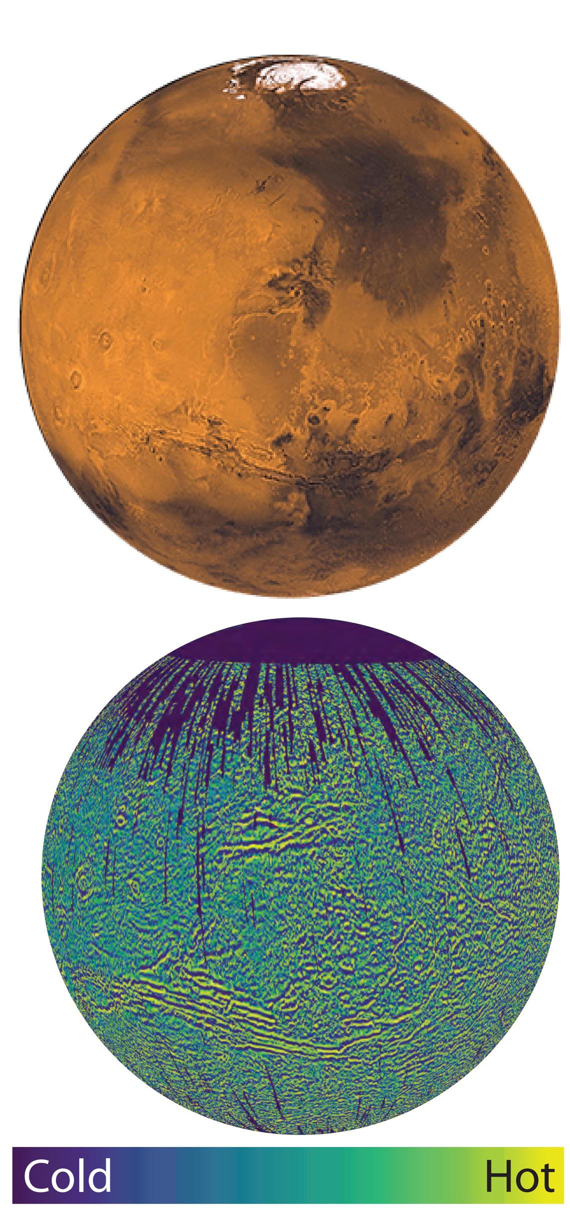
# LINKING THERMAL PROPERTIES OF TERRESTRIAL SEDIMENTARY ENVIRONMENTS TO MARS


A. Koeppel[1] (akoeppel@nau.edu), C. S. Edwards[1], K.A. Bennett[2], L.A. Edgar[2], H. Eifert[1], A. Gullikson[2], S. Nowicki[3], S. Piqueux[4], A.D. Rogers[5]

[1]Northern Arizona University, [2]U.S. Geological Survey, [3]University of New Mexico, [4]Jet Propulson Laboratory, [5]Stony Brook University


## BACKGROUND

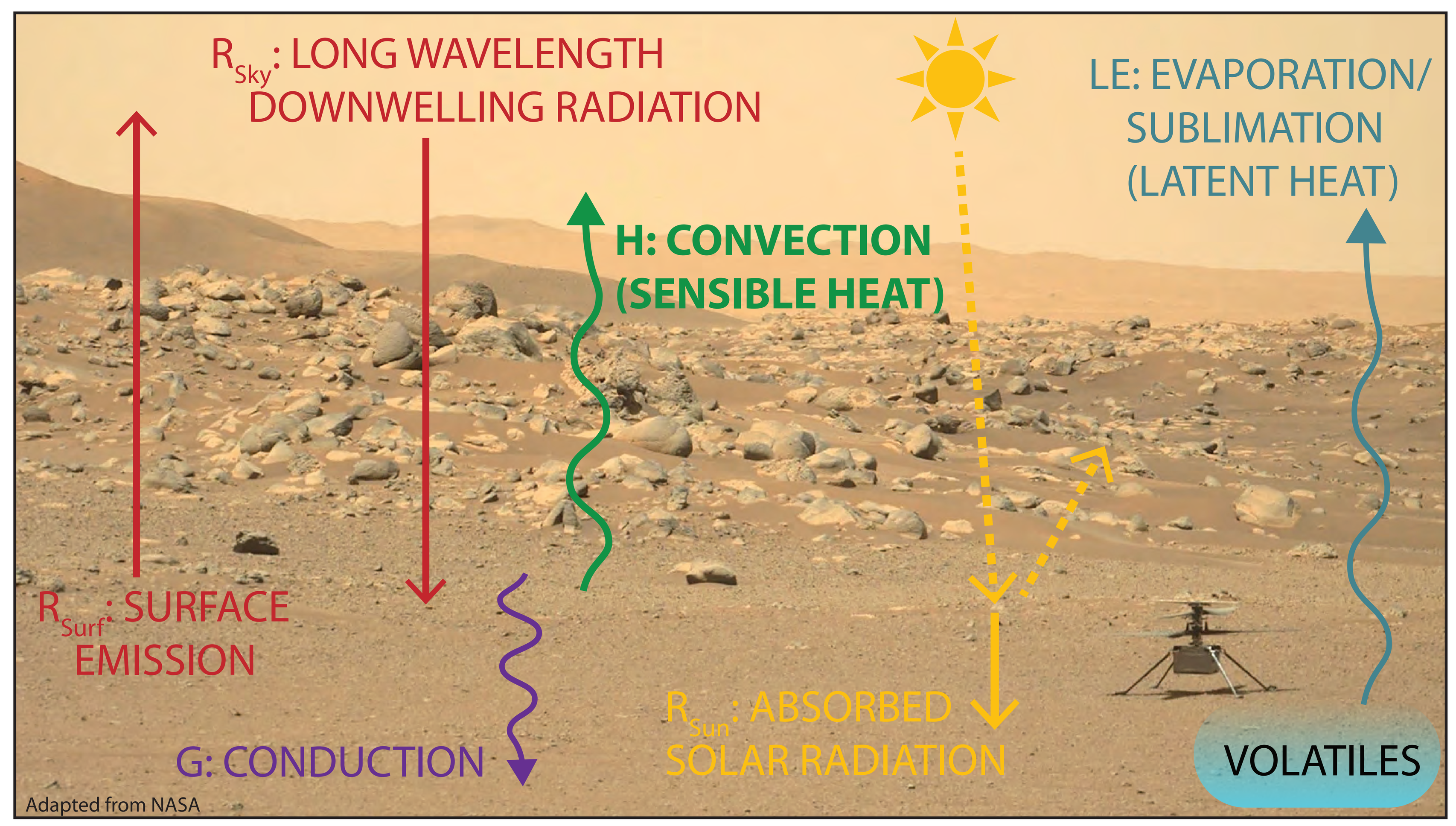
Infrared imagers orbiting Mars have collected an astoundingly complete record of surface temperatures spanning over five decades. Because the physical nature of different rocks and sediment affect how quickly they can heat up or cool down, temperature measurements provide us with a valuable tool for studying geology in areas where ground measurements are limited or absent. We can use inferred sedimentary features to help interpret past environmental processes.

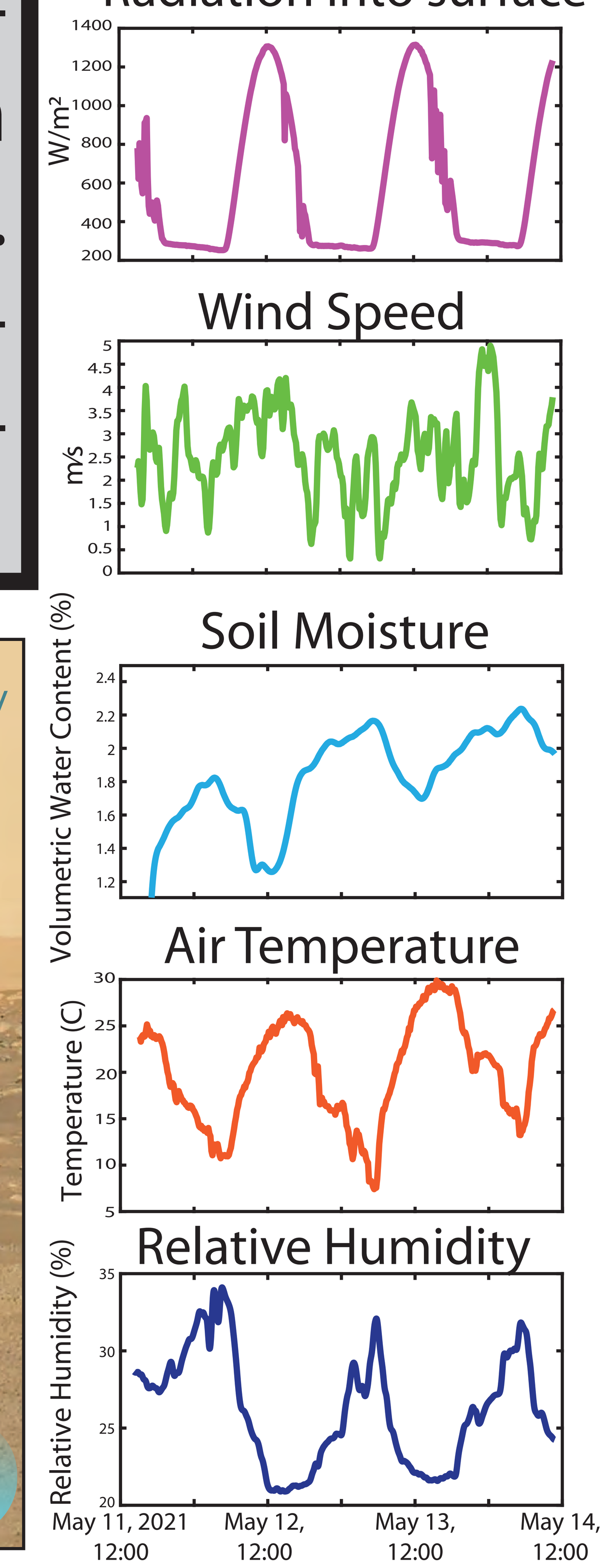



Mars visible and THEMIS Nighttime Surface Temperature data

However, directly quantifying how a given temperature response aligns with a sediment type is difficult without at least initial validation from direct observations on the ground. To aid our understanding of materials on Mars' surface, we are studying thermal responses at sedimentary field analog sites, each representing a different depositional environment. Shown here are results from a 72-hr observation of a basaltic eolian dune site near Sunset Crater, AZ. We collected weather data from a tower and used UAVs to map surface temperatures, replicating satellite viewing angles. We use a surface energy balance model to derive thermal inertia, allowing us to ultimately relate thermophysical controls between the two worlds.

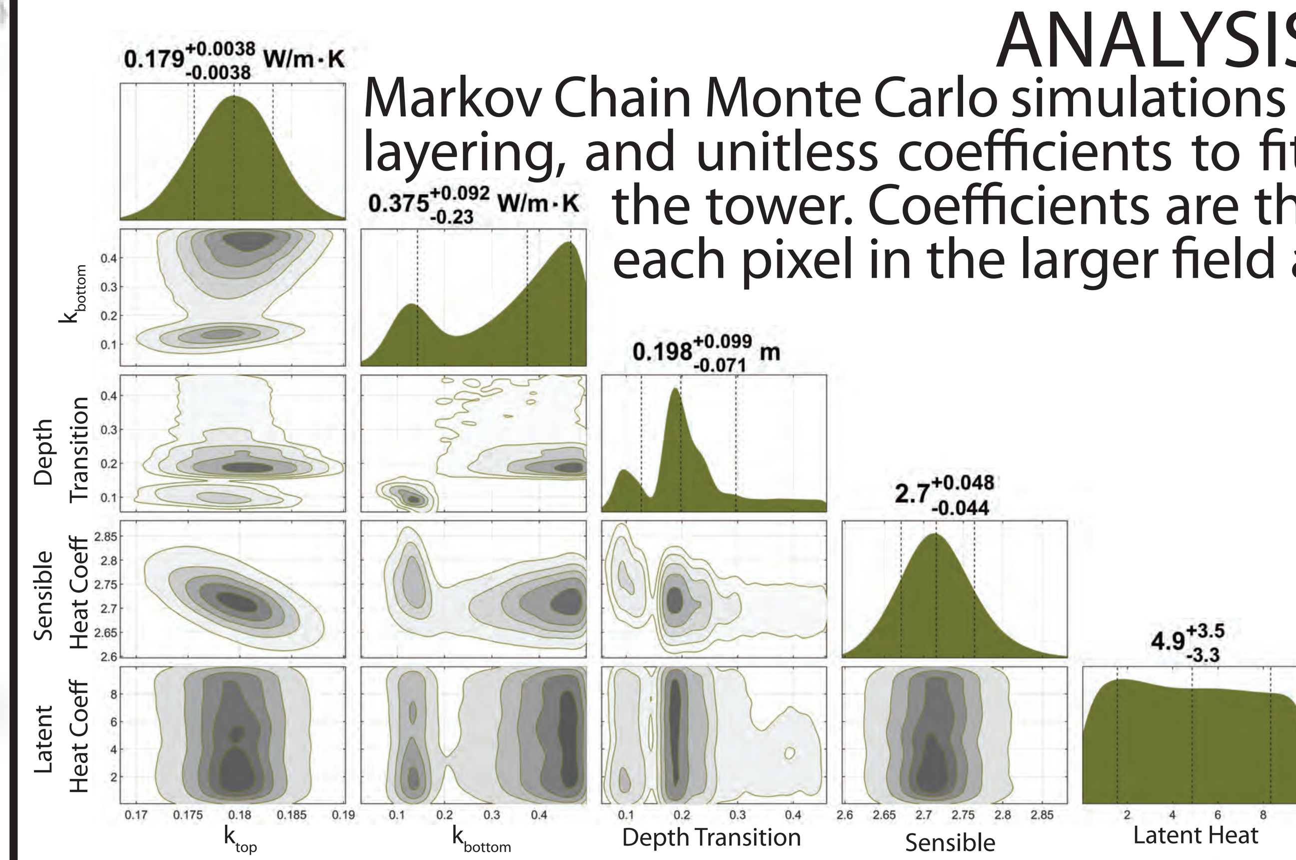

**We developed an approach to deriving thermal inertia in undisturbed sediments on Earth using UAS and weather station data. The method allows for relating thermophysical controls observed on Earth to environments captured in satellite data from Mars.**

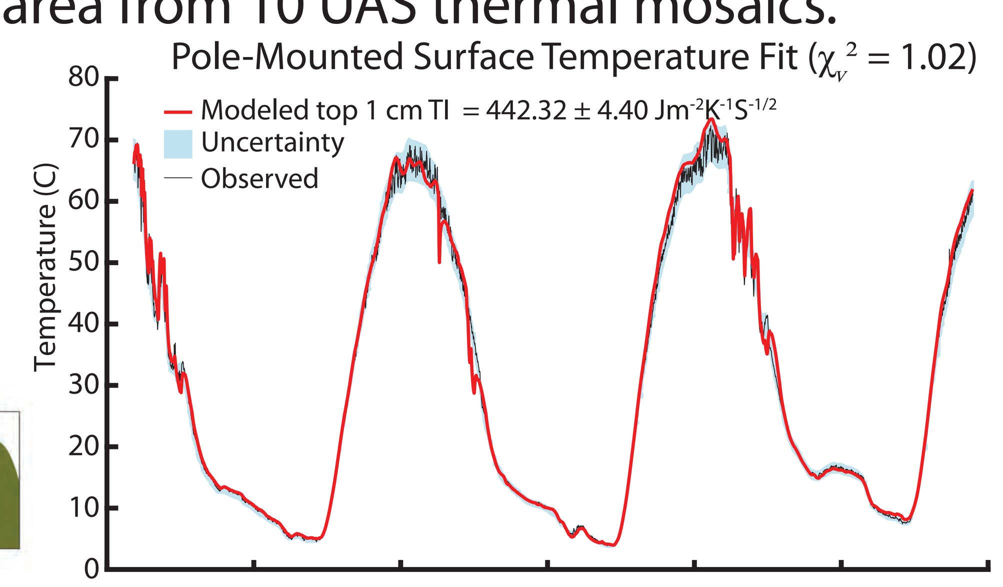


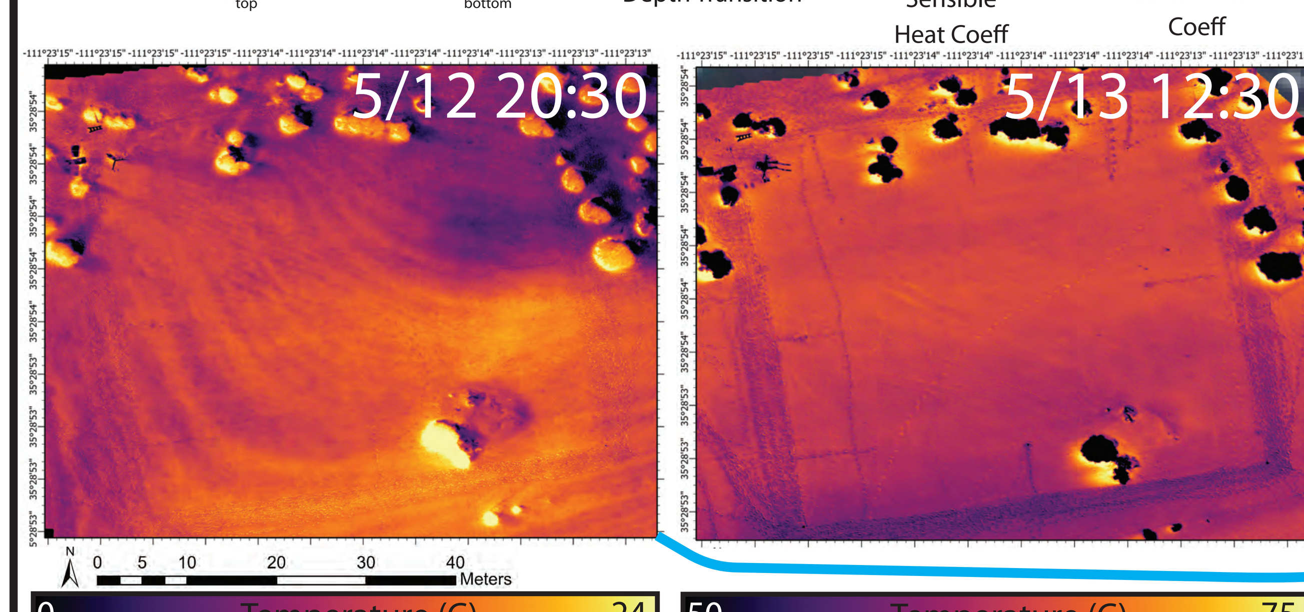



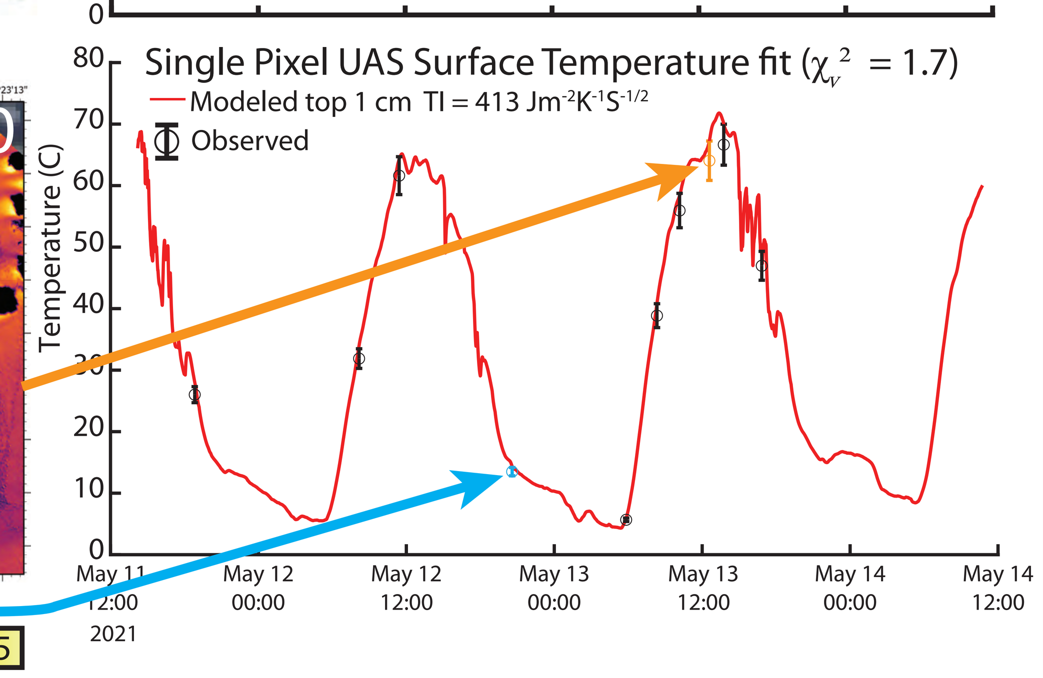

## ANALYSIS

Markov Chain Monte Carlo simulations optimize thermal conductivity, subsurface layering, and unitless coefficients to fit observed surface temperatures beneath the tower. Coefficients are then recycled to fit thermal conductivity for each pixel in the larger field area from 10 UAS thermal mosaics.

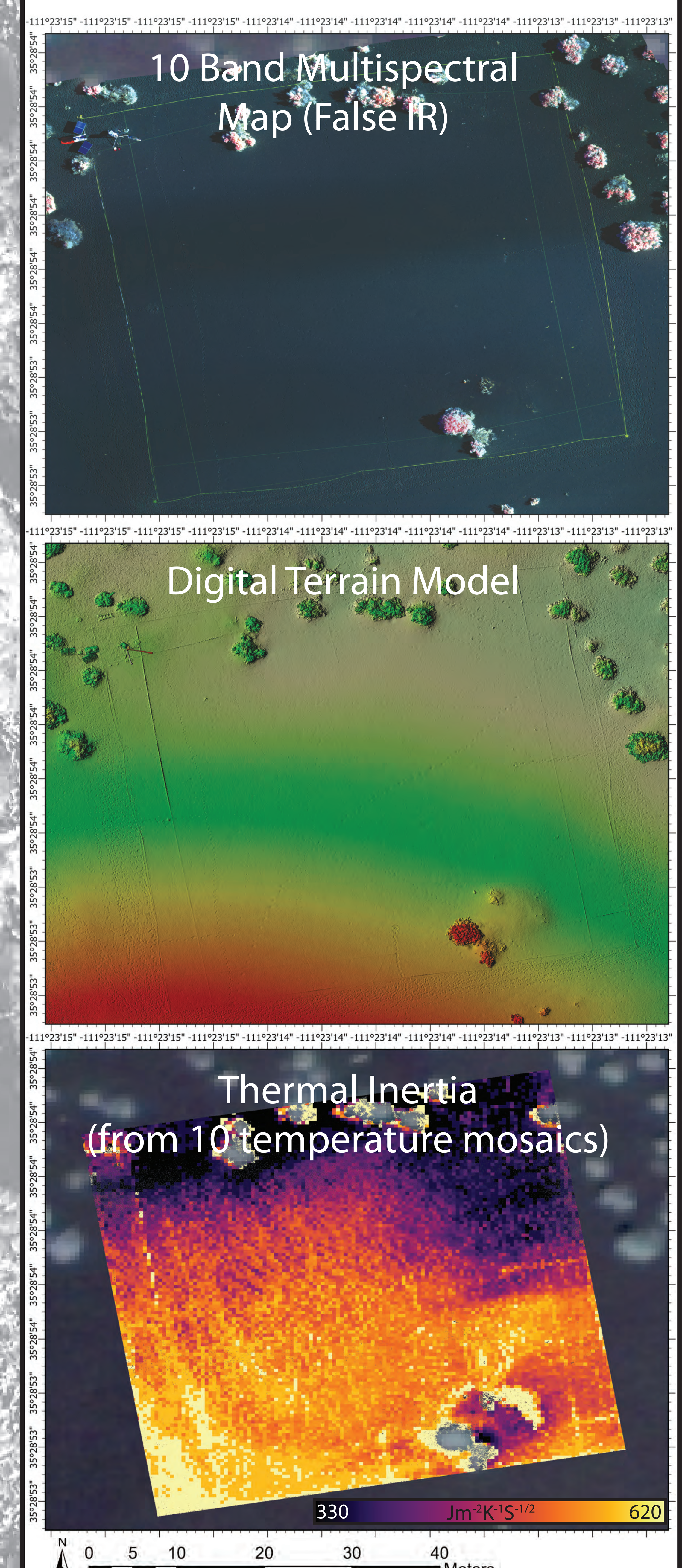



## RESULTS




Thermal inertia is derived from the modeled thermal conductivity for each pixel. The ultimate goal will be to quantify how thermal inertia is correlated with measured sediment properties that include: soil moisture, grain size and shape, subsurface stratigraphy, mineralogy, and cementation in the context of each field site (eolian, fluvial, alluvial, glacial, pyroclastic).


**Sources:** Rogers et al. (2018) *GRL*; Cadieux & Kah(2015) *Icarus*; Kieffer (2013) *JGR*; Christensen et al. (2004) *SSR*; Farrand & Singer (1992) *JGR*; Navarre-Sitchler & Brantley (2007) *EPSL*; Schiffman et al. (2000) *GGG*; Seelos et al. (2010) *JGR*; Piqueux & Christensen (2009a) *JGR*; Piqueux & Christensen (2009b) *JGR*; Presley & Christensen (1997) *JGR*; Vasavada et al. (2017) *Icarus*; Edwards et al. (2018) JGR; Morgan et al. (2018) *SSR*.



**Acknowedgements:** Thank you to A. St. Romain for field assistance. Data processing was completed using Matlab, Agisoft, and ArcGIS. This work is funded in part by the NASA PSTAR (17-PSTAR17_2-0044) and FINESST (19-PLANET20-0138) Programs.