Introduction:
Investigation of eolian dunes, including dune morphology and thermophysical properties, provides insight into local climate and climate trends. Characterization of thermophysical properties provides insight into the near surface composition, including the identification of subsurface volatiles.

Research presented here investigated and classified 171 dune fields to identify the presence of subsurface volatiles through the analysis of derived thermal inertia values and comparisons to two-layer thermal models and slope models.

Southern Hemisphere Dunes:
- Six morphological classes of dunes were established by Fenton and Hayward (2010).
- Sharp-crested dunes, interpreted to be the most active, are located nearest the equator.
- Dunes trend from active to stabilized poleward of 60°S.
- Changing trends of morphological classes are hypothesized to be attributed to variations in the influence and presence of subsurface water ice, which has the potential to cement dunes in place and inhibit dune activity.
- Stabilization coincides with an increase in the presence of water-equivalent hydrogen as detected by the Mars Odyssey Neutron Spectrometer [2].

Thermal Inertia:
- Thermal inertia of a material measures its resistance to temperature change and may be used to infer grain size, induration, rock abundance and, percent of exposed bedrock.
- Thermal inertia SI units: tiu = 1 m² K⁻¹ s⁻¹/².
- On Mars, thermal inertia is most influenced by a material’s thermal conductivity and secondarily by its heat capacity and density.
- Apparent thermal inertia (ATI) is derived from brightness temperatures values obtained at discrete times of day by the Mars Global Surveyor Thermal Emission Spectrometer (TES) and the Mars Odyssey Thermal Imaging System (THEMIS).
- ATI exhibits systematic diurnal and seasonal variations attributed to heterogeneity within the field of view of the observations.

THEMIS analysis:
- ATI from THEMIS images (100m/pixel) are used to identify smaller-scale variations within a dune field.
- We limit analysis to nighttime observations since the majority of daytime observations are too close to dust to provide accurate ATI values.
- We consider three categories of dune fields based on the observed patterns of thermal inertia.
- Figures 2-4 are THEMIS ATI overlaying HiRISE images.
  - Type 1: Exposed substrate in the interdunes, lower ATI compared to the surrounding material (Figure 2).
  - Type 2: Higher ATI in the crests than in the troughs (Figure 3).
  - Type 3: Homogenous ATI with no interdunes (Figure 4).

TES analysis:
- ATI from TES (3 km/pixel) is used to identify larger-scale heterogeneities.
- We compare diurnal and seasonal variations in TES ATI to values calculated for two-component heterogeneity models.
- Derivation of ATI employs a lookup table of model temperatures for a broad range of season, time of day, latitude, albedo, surface pressure, dust opacity, and thermal inertia.
- Models are created for a variety of materials with either horizontal or vertical layering, representing the top few cm of the surface.
- Materials include dust (56 tiu), sand (233 tiu), duricrust (889 tiu) and rock or ice-cemented materials (2506 tiu).

Slope models:
- Slope models are employed to investigate the influence of topography on the apparent thermal inertia.
- Mixed-slope models are created using MARSTHERM and the parameters include, albedo, dust opacity, average thermal inertia, latitude, slope angle, and slope azimuth.
- Results of mixed-slope models are compared to two-layer and horizontal material-mixture models as well as TES-derived ATI results.

Discussion:
- Using TES in conjunction with THEMIS to assess ATI behavior provides a clearer picture of the thermophysical properties of near-surface materials.
- THEMIS is important for identifying smaller-scale heterogeneities and trends and is advantageous for investigating sparse features that may reveal underlying surface materials.
- Comparing TES ATI results to those of heterogeneity models is useful for identifying larger-scale variations. However, available models do not fully explain the observed behavior.
- Comparing TES ATI results to those of slope models provides insight into the effects of slope on the observed thermal behavior.

Conclusions:
- THEMIS analysis reveals trends in apparent thermal inertia.
- Type 1 dunes occur most frequently near the equator, Type 2 dunes occur in mid latitudes, and Type 3 dunes occur closest to the poles.
- Thermal dune types identified follow a similar pattern to morphological trends identified in previous research.
- TES analysis indicates most of the dunes in this study match layered heterogeneity models, specifically ‘crust over dust’, ‘dust over crust’, or ‘dust over sand’.
- Sharp crested dunes typically match ‘crust over dust’ models while degraded dunes and sand sheets typically match ‘dust over sand’ models.
- Some slope models match observed trends in TES results while others do not, indicating that slope effects contribute to observed ATI but do not explain all observed variations.

References: