Initial Results of Super-Resolving THEMIS Data. C. G. Hughes and M. S. Ramsey, Department of Geology and Planetary Science, University of Pittsburgh, Pittsburgh, Pa 15260 USA, cgh1@pitt.edu, mramsey@pitt.edu

Introduction: Super-resolution is the process of improving a spatial resolution from that of the original data sources's (or native) resolution. A first-order approach is the fusion of original data with an additional source, which has the desired resolution. There are a variety of techniques that can be used to fuse data sources; however, a tradeoff has been noted between techniques that are the most visually appealing and those that are most radiometrically accurate [1]. The technique for super-resolution presented here is a modification of an algorithm [2] that was tested successfully using multi-resolution data from the Earth orbiting Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instrument (Fig. 1, Fig. 2) [3]. The spatial and spectral resolution of this instrument is broadly similar to the Mars orbiting Thermal Emission Imaging System (THEMIS) instrument [4]. The current study investigates the applicability of this technique to enhance the THEMIS thermal infrared (TIR) data using the instrument's visible (VIS) instrument,thus providing radiometrically-accurate data that has been improved from 100 to 36 m/pixel. This image enhancement provides a new technique independent of traditional sub-pixel deconvolution approached that can be used in the search for small-scale temperature and/or compositional anomalies.

Data and Methods: Data from the THEMIS instrument can be organized into two wavelength regions (VIS and TIR), with the VIS having fewer bands but better spatial resolution. First, VIS pixels in a given image are clustered using the previously described methodology [6]. Upon completion, a tree is created with the co-located TIR pixels on a per-cluster basis, the branches of which represent spectrally-similar pixels.

After completion of clustering, it is possible to super-resolve the image. Pixel values are assigned and then a radiometric correction is applied to the entire image as previously described for ASTER data [6], such that the super-resolved image, when degraded back to the lower resolution, will match the original image.

Preliminary Results: The modified super-resolution algorithm has been run on a number of THEMIS data (Fig. 1-2). These images, near the MER-A landing site, contain some problems, which are either minor or correctable. Despite a largely homogeneous environment, which can limit the success of the algorithm, the super-resolved image (Fig. 2) is sharper than the original (Fig. 1). Fig. 2 shows more muted coloring with a clear reduction in band-band image artifacts that appear as color variations in the decorrelation stretch image (DCS) image. It also reveals details within some of the smaller craters that are not present in the original decorrelation image. However, the super-resolved image also contains some noise (speckling), which is most likely attributable to the radiometric correction step over-correcting super-resolved pixels with significantly larger MD than their neighbors. These over-corrections are balanced out by corrections of similar magnitude in adjacent super-resolved pixels, which leads to this effect. Although this problem may have no perfect solution, minimizing this noise is part of the ongoing research.

Future Work: In addition to finding a radiometrically accurate correction for the speckle-noise, there are other future tasks, which are necessary. It will be necessary to estimate the best possible Point Spread Function (PSF) for the THEMIS instrument. This was not measured prior to launch. In addition, in order to test the validity of this PSF, it will be necessary to test the effects of an incorrect PSF on the super-resolution process. As the starting conditions can influence the final product, it is also necessary to explore how to choose the best starting conditions for any particular image pair. Once these tests are completed, the algorithm will be applied to contemporaneous multi-band THEMIS TIR and VIS data. High priority targets, where there is likelihood for small-scale compositional difference will be chosen for this process first. These areas could include the phyllosilicate or olivine rich areas near Nili Fossae [7,8], the quartzofeldspathic site [9], and/or regions of ejecta from small, fresh-appearing craters [10].

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[10] S. Wright and M. Ramsey (2006), *JGR, 111,* doi:10.1029/2005JE002472

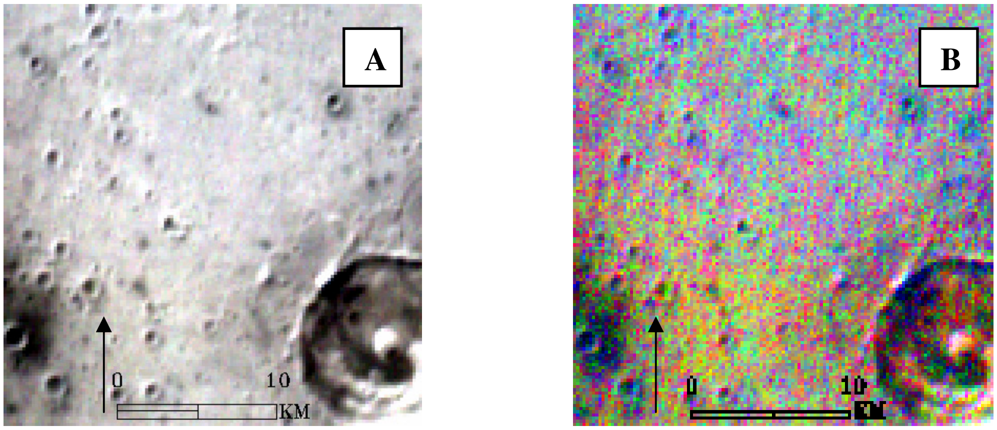

Figure 1. THEMIS daytime TIR data (IMG #I13263002), near the landing site of MER-A. (**A)** Temperature image representing the region for which the radiance data were used as input to the super-resolution algorithm. Brighter regions are lower thermal inertia (e.g. less-dusty) surfaces **(B)** A DCS stretch of bands 8,6,4 as R,G,B of the region in (B). A linear 2% stretch has been applied to all images.

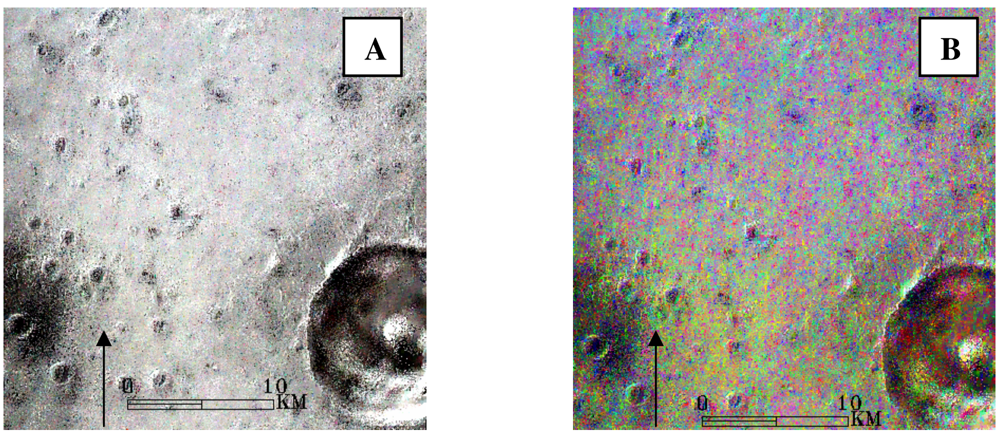

Figure 2. The super-resolved equivalents of the data shown in Figure 1 Note that much of the noise in the DCS image (Fig. 1C) shown as line to line color variations has been minimized and the spatial scale has been improved.