**THEMIS GEODETICALLY CONTROLLED MOSAICS OF MARS.** R. L. Fergason¹, E. M. Lee¹, L. Weller¹, Astrogeology Science Center, ¹U.S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ 86001, rfergason@usgs.gov.

**Introduction:** The objective of this work is to geodetically control and mosaic Thermal Emission Imaging System (THEMIS) [1] daytime infrared (IR) and nighttime IR images. We have also investigated how best to register THEMIS images to a known reference coordinate frame (such as that of the Mars Orbiter Laser Altimeter (MOLA) data set [2;3]). The results of this work are controlled, orthoprojected daytime IR and nighttime IR mosaics of Mars at 100 m/pixel scale for selected regions (Figure 1). These mosaics, and the associated networks, have improved registration of the THEMIS IR data set, enhance our knowledge (position, precision, and accuracy) of image placement and the location of small-scale surface features, and provide for improved targeting for current and future orbital acquisition of data and spacecraft landings and planning of spacecraft surface operations.

**Background:** The THEMIS instrument onboard the 2001 Mars Odyssey spacecraft [1] has attained near global coverage of Mars in the daytime and nighttime IR at a scale of ~100 m/pixel, providing the needed images to geodetically control (i.e., precisely and accurately register in a consistent solution with estimates of uncertainty) these data into a common reference coordinate frame at the sub-pixel level. Registration to single-pixel precision is essential for comparison of multiple data sets, and sub-pixel precision reduces the possibility for misinterpretation and increases the information extracted from individual images. Precise coregistration and the knowledge of the precision and accuracy of that registration is necessary for several types of analysis designed to extract valuable information from the subtle differences between multiple images, such as topography, composition (through multispectral analyses), surface texture, and surface albedo change detection. We have generated control networks for five regions of Mars (gray areas in Figure 1) and have achieved sub-pixel registration (precision) in all cases. THEMIS is the highest resolution near global data set currently available, and being able to accurately register other data sets to a controlled global THEMIS mosaic would enhance the science return from the THEMIS instrument and most other past and future instruments as well.

THEMIS global daytime and nighttime IR mosaics have been created by Arizona State University using the ISIS 3 camera model and dead-reckoning camera pointing (i.e., no individual image adjustment to match features or an attempt to correct for uncertainties in the camera model) [4]. These mosaics are not controlled; spacecraft ephemeris and attitude have not been adjusted geometrically for consistency with the collected image information and with known error estimates. Therefore, the current global mosaics do not reach their full potential precision (sub-pixel average error at ~100 m/pixel) and accuracy. Errors in image position on the 2-4 pixel level (but as large as 30 pixels) are apparent (Figure 2) and are likely to be primarily due to uncertainties in the image start time. This uncertainty is random, and there are no future plans to improve the THEMIS IR camera model further. Controlling the pointing will enable the correction of these errors and improve both the registration between images and registration to a known coordinate reference frame (e.g., MOLA) at known levels of precision and accuracy. In all tiles generated to date, the accuracy of image position is less than a single pixel, and the 3-sigma residual is also less than a single pixel.

**Products Generated:** We also investigated the feasibility and accuracy of tying THEMIS images to the gridded MOLA DTMs [2; 3], Viking MDIM 2.1.
The equator the data may have been interpolated between MOLA tracks for multiple kilometers. The improved MDIM 2.1 network therefore has comparable, and in many areas superior, horizontal accuracy compared to the MOLA gridded data. This improved MDIM network can now be utilized to tie THEMIS images (or any other martian image dataset) into a MOLA provided reference frame, using reliable and often automatic image to image ties. THEMIS tiles were tied to the improved MDIM network ground points.

THEMIS daytime IR and nighttime IR control networks and mosaics for the following regions (i.e., tiles) are complete: Aeolis, Coprates, Lunae Palus, Margaritifer Sinus, and Oxia Palus (gray areas in Figure 1). These mosaics will be distributed to the planetary science community through publicly available websites, such as the Planetary Cartographic Catalogue and Web Services (Astrophoto; http://astrogeology.usgs.gov/astrophot) in ISIS 3 cube, GeoTIFF, and PNG data formats. These formats are easily utilized by ArcGIS, ENV, and JMaps data analysis software tools.

Future Work: We are currently generating additional THEMIS daytime and nighttime IR control networks and mosaics for the following regions: Casius, Cebreria, Hellas, Iapygia, Mare Acidium, Mare Tyrrhenum, and Sinus Sabaeus (orange areas in Figure 1), and expect these tiles to be publicly available by September 2014. This project is phase two of a multi-year effort to geodetically control and generate mosaics for the ±65° latitude region of Mars. In addition to mosaics, updated image pointing kernels of all THEMIS images included in the control networks will be released to the community. We anticipate that the new kernels will be added to the standard ISIS “spiceinit” program, where the user has the option of selecting predicted, reconstructed, or updated SPICE kernels. We may also deliver this product to the Navigation and Ancillary Information Facility (NAIF) team so they can include it on the PDS NAIF FTP site.