DETERMINATION OF POTENTIAL LOCALIZED MARTIAN DUST SOURCES AND SINKS IN ELYSIUM PLANITIA. J. Kozdon[1], C. S. Edwards[1], Sylvain[2], [1]Department of Physics and Astronomy, Northern Arizona University, PO BOX 6010, Flagstaff, AZ, 86011, jtk64@nau.edu, [2]Jet Propulsion Laboratory-California Institute of Technology, Pasadena, CA.

Introduction: Aeolian features like wind and slope streaks [1-3], dust devils [4] and sand dunes are apparent across the Mars landscape. Records of Mars dust storms, global [5-7] and local [8], have been recorded since Mariner 9 [9] and further detailed through missions like Mars Express, Mars Reconnaissance Orbiter, the Mars Exploration Rovers, and 2001 Mars Odyssey. The construction of such records has been done in ways including, observations in variable albedo change of surficial features [9-11], implying deposition or erosion, and atmospheric studies using atmospheric dust opacities obtained through retrievals from orbital and landed datasets [12]. Mechanisms to raise dust into the atmosphere [13-14] and estimated settling rates are determined from observational data and laboratory studies from dust deposition on the rover instruments [15-16].

Surface changes have been documented in literature from thermal infrared data and observed in imagery [17]. Such changes range from small-scale wind streak changes due to variable dust layer thicknesses, revealing lower albedo materials mantled prior [11], to large-scale regional albedo changes of 10% or more [9,18,19] from dust storms. Large changes like these may be fairly common and may not require vast amounts of mobilized dust for what is observed, where 9×10^{-5}g/cm^2 and 9×10^{-4}g/cm^2 of deposition can cause a ~35% and ~70% brightening respectively [10]. Factors like atmospheric opacity, temperature profiles and water vapor content observations that continue to be made with instruments such as the Mars Climate Sounder (MCS) and Thermal Emission Imaging System (THEMIS) will give a better insight of the martian dust cycle [20]. Observations made during the MGS mission underscore the necessity of incorporating various datasets and observations to reach a comprehensive understanding of the global martian dust cycle (Figure 1). However, the exact context of mobilization (deposition or erosion) of dust on Mars remains largely understudied. Observations like these are important to atmospheric monitoring tools for current and future missions as they place constraints on climate modeling endeavors.

This study uses THEMIS thermal infrared data to identify the context of observed regional scale changes (Figure 1). Based on TES and MCS data, several regions of interest are identified to help constrain locations where dust may be deposited or removed.

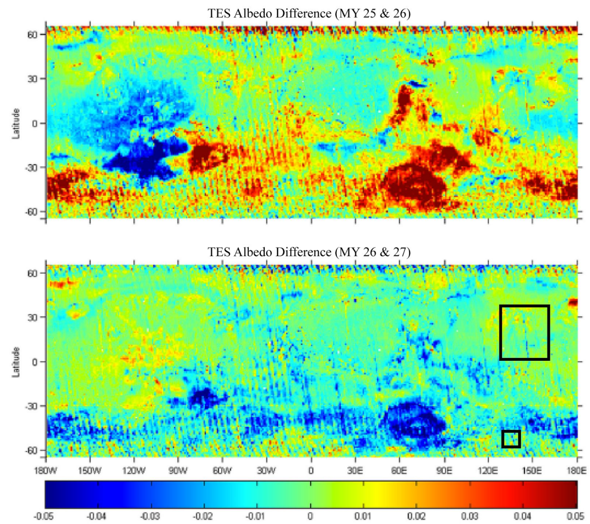

Fig 1. Global maps of Mars albedo changes from TES data between MY 25/26 and 26/27. Boxed areas are the regions of interest (Szwast et al. 2006).

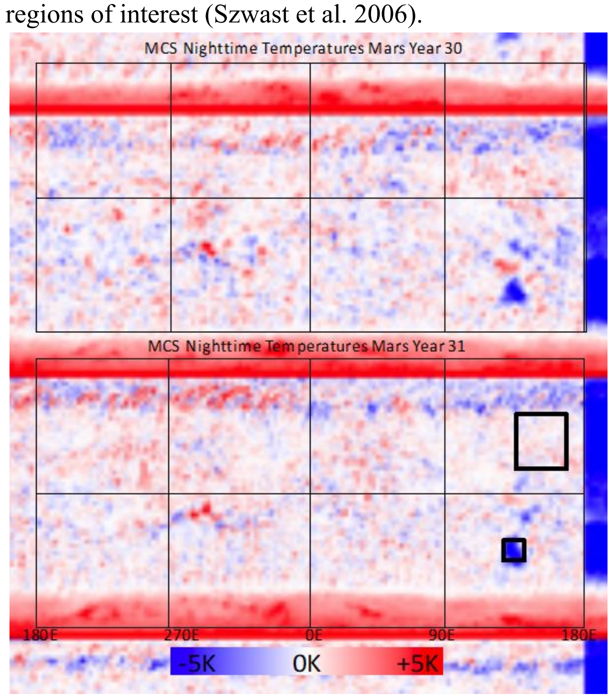

Fig 2. Global maps of Mars nighttime temperature from MCS data between MY 30 and 31. Temperature differences from the median 3AM temperatures are shown (Szwast et al. 2006).

Regions of Interest: Elysium Planitia was chosen because it is a relatively large plains region whose contribution to the dust cycle appears to be primarily as a source with localized sinks. The observations that indicate this are that the region sees a small decrease in albedo while exhibiting some localized increases (indicating deposition). Regions of interest in Elysium Planitia were chosen based on the prominent geologic feature within them. The regions of interest focus features like hills, canyons, craters, plains and volcanoes. Each feature is morphologically distinct to help understand the dust cycle as it relates to such structures. Another region around -50N 145E was also identified for inspection because a large nighttime temperature change was recorded with MCS data (Figure 2). The area became much colder in MY31 near Ls300 (not observed in PM data) and may indicate a change in surface dust content (likely deposition).

Methods: This study consists of 3 parts: 1) target regions of suspected change 2) use THEMIS data to provide geologic context (e.g. morphology etc.) and 3) construct difference images to try to determine dust cycle patterns for the region.

THEMIS data must be processed for image pair analysis and this consists of reduction, co-registration and normalization. The reduction steps are undrift and dewobble (time-dependent focal plane temperature –induced error), remove tilt (calibration flag temperature variation), spiceinit (spacecraft altitude information), map projection, deplaid (column- and row-correlated band-independent noise), automatic radiance correction (atmospheric emission correction) and destreak (instrument artifact) [21]. The radiance data are then converted to brightness temperatures.

Co-registration is completed during mosaic assembly by overlying images together and computing a two-dimensional brightness difference minimization where every image is moved so that features are coincident down to the pixel level, and also represent the same x/y coordinate in the data array [21]. It is at this point where image pairs are examined and chosen. The pairs are normalized before analysis to remove seasonal differences, as the overall temperatures vary with season; however, images close to the same season but from different MYs are pre-selected to minimize this effect. This is done by adjusting the averages and standard deviations of one image to match that of the other. Discrepancies in the images at this point should just be signal differences of surface dust (or other surface differences). THEMIS images from different MYs but same seasons will be constructed and registered so that they can be quantitatively differenced from one another, illustrating the fine-scale locations of change. Information captured in these difference images include a variety of statistical measures including averages, standard deviations, medians, min/max, etc. Once regions of significant change are identified, thermal differences will be modeled using the KRC thermal model to convert the temperature difference data to corresponding dust thicknesses.

Path Forward: Image pairs are chosen based on their MY, season, and time of day. Once a sufficient number of pairs for a location have been analyzed, a detailed analysis of these locations to identify the context of any changes will be done. For example, if the area under investigation saw a general increase/decrease of the amount of dust, or if the changes relate to geologic features. Subsequent sites identified in TES and MCS data will also be characterized and compared to THEMIS local-scale data. A more systematic survey of THEMIS data is currently underway where every image pair with a different year and a similar season is being compared from a statistical perspective, searching for small-scale changes not captured by the regional scale data of TES and MCS.

Acknowledgements: This work is funded by the Mars Data Analysis Program under PI Piqueux and Co-I Edwards (NNH14ZDA001N-MDAP), the Northern Arizona University Hooper Undergraduate Research Award, and the NASA Space Grant Program.

References: [1] Sagan, C., et al., (1972). *Icarus* **17**, 346-372. [2] Veverka, J., Gierasch, P., Thomas, P., (1981). *Icarus*. **45**, 154-166. [3] Aharonson, O., Schorghofer, N., Gerstell, M. F., (2003). *J. Geophys. Res* **108**, 5138. [4] Haberle, R. M., Kahre, M. A., Murphy, J. R., Christensen, P. R., Greeley, R., (2006). *Geophys. Res* Lett. 33. [5] Zurek, R. W., (1982). *Icarus*. **50**, 288-310. [6] Martin, L. J., Zurek, R. W.,(1993). *Journal of Geophysical Research*. **98**, 3221-3246. [7] Strausberg, M. J., Wang, H. Q., Richardson, M. I., Ewald, S. P., Toigo, A. D., (2005). *J. Geophys*. Res. 110. [8] Cantor, B. A., James, P. B., Caplinger, M., Wolff, M. J., (1999) *Journal of Geophysical Research*. **106**, 23653-23688. [9] Geissler, P. E., (2005). *J. Geophys*. Res. 110. [10] Wells, E. N., Veverka, J., Thomas, P., (1984). *Icarus*. **58**, 331-338. [11] Greeley, R., et al., (2005). *J. Geophys.* Res. 110. [12] Fenton, L. K., Pearl, J. C., Martin, T. Z., (1997). *Icarus*. **130**, 115-124. [13] Greeley, R., White, B. R., Pollack, J. B., Iversen, J. D., Leach, R. N., (1977). NASA TM 78423. [14] Greeley, R., (2002). *Planetary and Space Science*. **50**, 151-155. [15] Landis, G. A., Jenkins, P. P., (2000). *Journal of Geophysical Research*. **105**, 1855-1858. [16] Kinch, K. M., Shohl-Dickstein, J., Bell III, J. F., Johnson, J. R., Goetz, W., Landis, G. A., (2007). *J. Geophys.* Res. 112. [17] Smith, M. D., (2004). *Icarus*, **167**, 148-165. [18] Smith, M. D., (2004). *Icarus*. **167**, 148-165. [19] Fenton, L. K., Geissler, P. E., Haberle, R. M., (2007). *Nature*. **446**, 646-649. [20] Szwast, M. A., Richardson, M. I., Vasavada, A. R., (2006). *Journal of Geophysical Research*. **111**. [21] C.S. Edwards, P.R. Christensen, J. Hill, (2011). *J. Geophys.* Res. 116.