INITIAL RESULTS OF STRATIGRAPHIC AND SIGNAL ANALYSIS OF THE MARS SOUTH POLAR LAYERED DEPOSITS. S. M. Milkovich and J. J. Plaut, Jet Propulsion Laboratory, California Institute of Technology, M/S 183-501, 4800 Oak Grove Drive, Pasadena, CA 91109; Sarah.M.Milkovich@jpl.nasa.gov

Introduction: Distinctive layers are observed exposed on the walls of troughs and scarps at the north and south polar deposits on Mars. Formation theories regard the layers as products of climate change due to orbital cycles [1, 2, 3], similar to climate changes caused by Milankovitch cycles on Earth [4], although the details of the formation processes remain unknown. Recent analyses of the north polar layered deposits (NPLD) have taken the first steps in unraveling the polar stratigraphic record and the relationship between the layers and climate [5, 6, 7]. The south polar layered deposits (SPLD), while differing morphologically from those of the north, are also thought to record the signals of a changing climate. Here we adapt the techniques of [6, 7] to an analysis of the SPLD using Mars Global Surveyor MOC images, MOLA topographic data, and Mars Odyssey THEMIS images.

Methods: Many studies of terrestrial climate change are in the field of paleoceanography. We use two techniques commonly employed in paleoceanography for the study of deep-sea sediment cores on Earth to establish the characteristics of layers in individual cores (Fourier analysis) and to determine the correlation between cores (curve-shape matching algorithms). By applying these methods to study the stratigraphy of the SPLD we will be able to assess patterns and correlations between locations within the deposits.

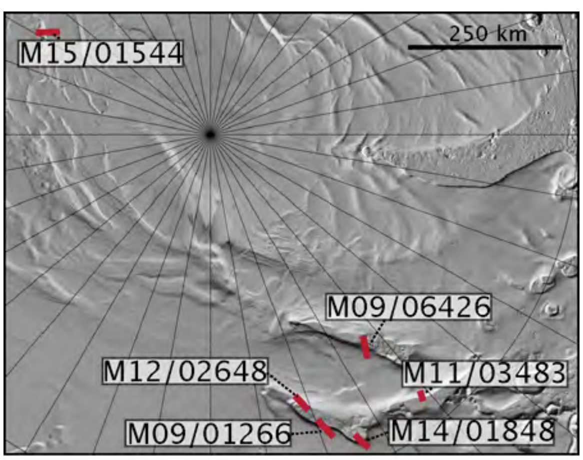

Figure 1: Location of MOC images used in FFT analysis.

Profiles of grayscale intensity, or digital number (DN), taken from MOC and THEMIS images are compared using Match 1.0, a program developed by Lisiecki and Lisiecki [8] to compare sets of paleoceanographic data. This program uses dynamic programming to minimize the square of the differences between the data sets in order to adjust one data set to fit as close as possible to the other set. The Fourier analysis is accomplished using a Fast Fourier Transform (FFT) program in Matlab on image profiles. Prior to comparing profiles from two images, the images must be calibrated and corrected for the slope of the trough wall using the associated MOLA data. The data from an overhead image is adjusted to be more like the data from a core sample perpendicular to the cap surface. This method of analysis has proved useful for understanding layer formation and its relationship to climate change in the NPLD [6, 7].

FFT Analysis: Profiles from six MOC images were analyzed; the locations of these images are indicated in Fig. 1. A dominant wavelength of 13-21 m was observed in the upper ~ 300-350 m of each profile (e.g., Fig. 2). Three of the six profiles also displayed strong signals at 30-35 m. In the region immediately below, a dominant wavelength of 25-37 m is observed in all images (e.g., Fig. 3). The dominant wavelengths are interpreted to be produced by fluctuating depositional environments due to climate cycles.

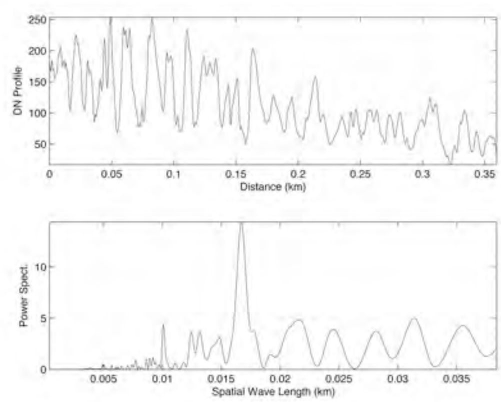

Figure 2: FFT Results for M14/01848, 0–350 m depth below the top of the scarp wall.

These two groups of dominant wavelengths may represent a shift in the climate signals recorded in the SPLD. Such shifts are observed in terrestrial datasets at such as at the mid-Pleistocene transition, where 41 kyr glaciation cycles switched to 100 kyr glaciation cycles [9]. The change in wavelength in the SPLD may indicate a shift in environmental conditions (and thus, accumulation rates) in the south polar region; alternatively, it may imply that the dominant orbital parameter forcing the entire climate system changed.

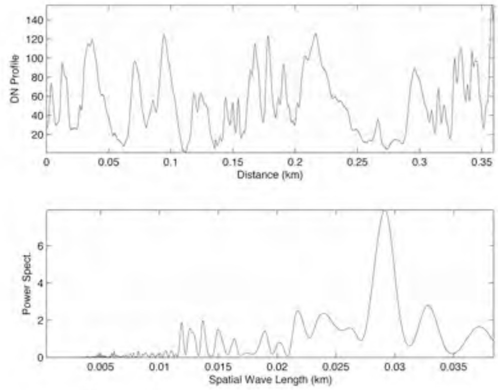

Figure 3: FFT Results for M14/01848, ~350–700 m depth below the top of the scarp wall.

Recent stratigraphic analysis of the SPLD in the same region as five of the MOC images used here identify multiple SPLD units [10]; further investigation is required to determine if the separate units are related to the changing climate signals observed in our FFT analysis. Similar signals are observed on opposite sides of the pole, which may imply widespread deposition of layers or formation of separate layer deposits under similar climate conditions.

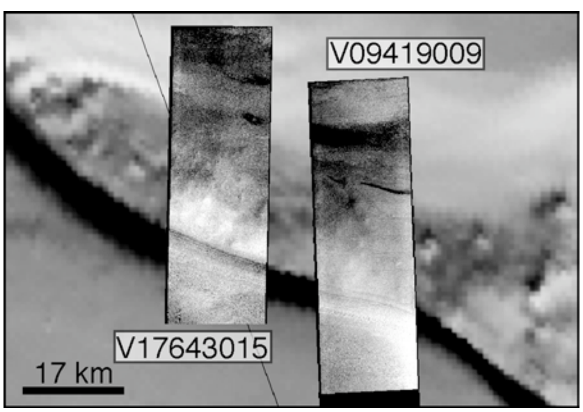

Figure 4: Location of sample THEMIS VIS images shown in matching analysis in Figure 5.

Matching Analysis: Matching analysis was begun on the SPLD exposed in the walls of Ultimum Chasma, located ~ 81˚S, 158˚E. We can easily compare layers visually as a check on the performance of the Match-1.0 analysis. An attempt to match MOC images yielded poor results; the thin layers of the SPLD are less individually distinctive than those of the NPLD, which makes them more difficult to match. THEMIS visible images, however, are at a resolution where there are many distinctive layers distinguishable. We therefore performed a matching analysis on datasets constructed DN from THEMIS 36 m/pxl and 17 m/pxl images; the results from one match can be found in Figures 4 and 5. The resulting matches had r^2 ranging from 0.32 to 0.39. These r^2 values are lower than the ones found in the NPLD matching analysis using MOC images [6, 7]; this is most likely due to the resolution difference between the datasets and the slightly higher slope of the scarp wall (~ 11˚) than the northern trough walls (~ 7˚) affecting the effective resolution of the layer exposures. The r^2 values are all higher than those found in an analysis of randomly produced data ($0.25 \leq r^2 \leq 0.30$, with a median and mean of 0.27).

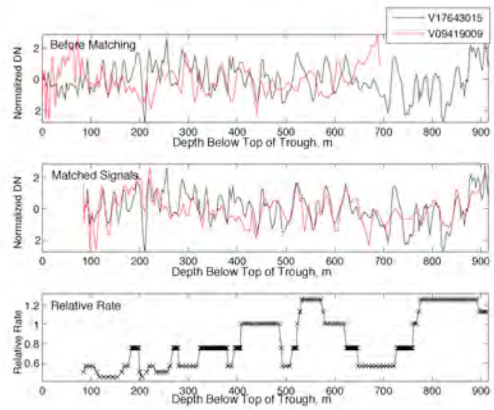

Figure 5: Curve-shape matching results for THEMIS images V17643015 and V09419009. Resulting match has r^2=0.39.

Discussion: Quantitative matching of THEMIS images is a promising tool for study of SPLD stratigraphy; our future efforts will focus on improved alignment of the THEMIS and MOLA datasets for profile construction and further characterization of SPLD in a local region before extending both the FFT and the matching analysis elsewhere around the cap. Stratigraphic analysis with the Match-1.0 program and more traditional techniques of stratigraphic analysis will help place the results of our ongoing FFT analysis in context within SPLD history in addition to providing insight into the SPLD formation process.

References: [1] Blasius, K.,et al. (1982) *Icarus*, *50*, 140-160. [2] Howard, A.,et al. (1982) *Icarus 50*, 161-215. [3] Squyres, S. (1979) *Icarus 40*, 244-261. [4] Imbrie, J. (1982) *Icarus 50*, 408-422. [5] Laskar, J. et. al. (2002) *Nature 419*, 375-377. [6] Milkovich, S., Head J. (2005) *JGR* 110, doi: 10.029/2004/JE002349. [7] Milkovich, S. et al (2005) submitted to *Planet. Space Sci*. [8] Lisiecki, L., Lisiecki, P. (2002) *Paleoceanography*, *17*, art no. 1049. [9] Elkibbi, M., Rial, J. (2001) *Earth Sci. Re.*, *56*, 161-177. [10] Kolb, E., Tanaka, K. (2005) submitted to *Mars.*