ANALYSIS OF PROPERTIES OF THE NORTH AND SOUTH POLAR LAYERED DEPOSITS. A. B. Ivanov[1], S. Byrne[2], M. I. Richardson[2], A. R. Vasavada[3], T. N. Titus[4], J. F. Bell[5], T. H. McConnochie[5], P. R. Christensen[6], THEMIS Science Team, [1]*Jet Propulsion Laboratory, MS168-416, Pasadena, CA, 91106; e-mail : anton.ivanov@jpl.nasa.gov*, [2]*California Institute of Technology, Division of Geological and Planetary Sciences, Pasadena, CA*, [3]*University of California, Los Angeles, CA*, [4]*U.S. Geological Survey, 2255 North Gemini Drive, Flagstaff, AZ*, [5]*Cornell University, Department of Astronomy, Ithaca, NY*, [6]*Arizona State University, Tempe, AZ.*

1 Introduction

One of the many questions of Martian exploration is to uncover the history of Mars, through analysis of the polar layered deposits (PLD). Martian polar ice caps hold most of the exposed water ice on the surface of Mars and yet their history and physical processes involved in their formation are unclear. We will attempt to contribute to our knowledge of the composition and stratigraphy of the PLD.

In this work we present the latest imaging data acquired by the Mars Odyssey THermal EMission Imaging System (THEMIS) [1] and place it into context of the Mars Global Surveyor (MGS) data. We have discussed the North Polar data in [5]. This work concentrates on data acquired over the South pole of Mars and compares properties of North and South PLD.

We are primarily interested in properties of the layers in both ice caps : their continuity, morphology and stratigraphy. These questions can be addressed by THEMIS VIS color images, along with MOC high resolution data and MOLA Digital Elevation Models (DEM). We will investigate thermophysical properties of the layered deposits employing THEMIS IR images. Based on the data obtained by the orbiting spacecraft and described here, we will attempt to expose major directions for modeling and further understanding of the physical processes involved in the formation of the polar layered terrain

2 Available data

2.1 THEMIS VIS

The THEMIS Visible Imaging Subsystem (VIS) is a 5-color, 1024x1024 interline transfer CCD camera that acquires high spatial resolution 18 to 72 m/pixel multispectral images (425 to 860 nm) from Mars orbit ([1, 6]). In order to gain coverage some images are downsampled to a resolution of 36m/pixel. This averaging mode was primarily employed to obtain full coverage of the South Polar Layered Deposits (SPLD) during early spring, when this area is still covered by seasonal frost. A fragment of THEMIS VIS mosaic is shown in Figure 1. This fragment shows a part of residual south polar ice cap between 270E and 320E. Layers are clearly seen in this figure. Since this area is all covered by seasonal frost at this time, brightness variations in this image are primarily due to changes in topography. The staircase structure of the layered deposits is clearly seen. Layers in the North PLD are much smoother and don't exhibit staircase structure. Figure 2 shows a THEMIS 36m/pix image and a MOC high-resolution image of a scarp in the SPLD. Layers are clearly visible in both THEMIS VIS and MOC images. Continuity of the layers can be easily analyzed from the one band THEMIS VIS mosaic, while color images can be taken in selected areas. MOC high-resolution images taken along the trough provide excellent high-resolution morphology.

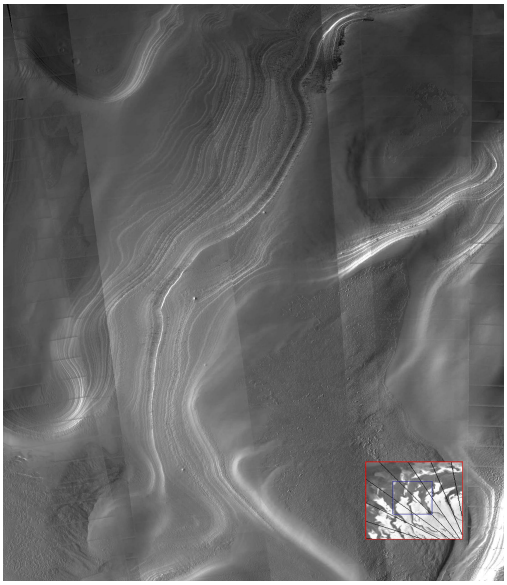

Figure 1: A fragment of THEMIS VIS mosaic of SPLD. The original image resolution is 36 m/pixel. Location of this fragment is shown in the lower right corner on top of the MOC image mosaic. Images were taken in early spring, while ground is still covered by CO_2 frost. Existence of frost on the ground is confirmed by the THEMIS IR data. Context image is shown in the lower-right corner (inside the blue box).

The high quality of the THEMIS VIS data and the high data rate available to download the images will allow us to complete mosaic of the SPLD. We plan to re-image this area during southern summer, when all the seasonal frost will be gone.

2.2 THEMIS IR

The THEMIS IR camera has 10 bands from 6 to 15 μm [1]. Due to to signal-to-noise restrictions the most useful band for polar observations is band 9 (12.57μm). Band 10 (14.88μm) data can be used for atmospheric calibration. High resolution THEMIS IR data allows us to distinguish bulk properties of of layered terrain and ice [5]. We were not able to distinguish between individual layers, however bulk thermophysical properties are under investigation.

2.3 Mars Global Surveyor data

Very interesting details of the polar layered deposits become evident in high resolution MOC Narrow Angle images [4].

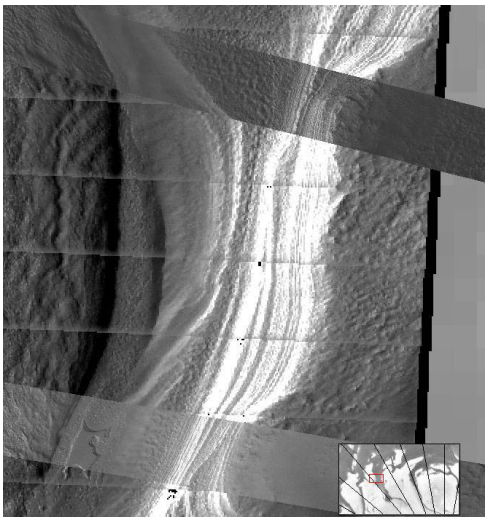

Figure 2: Mosaic of THEMIS VIS and two MOC NA images of a scarp in the SPLD. Images were taken during early southern spring with sun geometry is approximately the same for both MOC and THEMIS images. MOC NA images provide great morphological detail of the layers, while THEMIS VIS images allow to extrapolate this information over much larger areas of SPLD. Context area is shown in the lower-right corner of the figure. Pronounced stripes in the THEMIS image are due to scattered light from adjacent filter in the THEMIS camera.

These images are invaluable for interpreting details of the layered deposits observed with THEMIS. Narrow Angle MOC and THEMIS VIS images are ideal complements for each other An example of a MOC images mosaicked with THEMIS VIS is shown in Figure 2.

3 Discussion

Large spatial and relatively high-resolution coverage provided by the THEMIS visible camera can resolve individual layers in the NPLD over long distances [5]. Higher resolution MOC narrow angle data can be used to characterize these individual layers. Comparing the trace of these layers to topographic data generated by the Mars Orbiter Laser Altimeter (MOLA) yields information in three dimensions about the position of the layer exposure. Strikes and dips of individual layers can be extracted allowing us to predict if this same layer will be exposed in troughs elsewhere in the layered deposits. Testing large-scale continuity of layers in this fashion may help us distinguish between a flowing or non-flowing ice cap. In addition the possibility of extracting a low-resolution version of the topography underlying the icecap from the three dimensional shape of many layers also exists.

The surface appearance of the layered deposits is distinctly different between the two poles [4]. However MOLA data [2] suggests that the general form of the ice caps is roughly the same and they are both composed of water ice mixed with dust [1]. A possible explanation for this difference lies in the timescale of the processes responsible for the formation of the layered deposits. Short-time scale processes are currently eroding the surface of the SPLD, while long-term (compared to obliquity cycle) formation processes are still the same for both caps. We will attempt to probe the internal structure of the cap by collecting vertical positions of selected layers in North and South PLDs.

We have successfully demonstrated the use of THEMIS VIS and MOC data in [5]. We were able to trace a marker bed through a trough and locate the same layer in other troughs.

4 Summary

In this work we present a description of the properties of the South Polar Layered Deposits and compare them with their North counterparts. We employ all available datasets, concentrating on data from Mars Odyssey's THEMIS investigation. Our ultimate goal is to characterize major properties of the polar layered terrains and suggest mechanisms and timescales for their formation. Our approach is to use THEMIS VIS images to investigate continuity of the layers in the layered deposits and their stratigraphic relationships using high-resolution MOLA topography. MOC images will provide important morphological detail. We will also attempt to detect heating or cooling trends in THEMIS Thermal IR imagery for selected troughs in the PLD and interpret these data in terms of thermophysical properties (e.g. thermal inertia) of the layers. The MGS TES atmospheric dataset will provide context and will be important for calibration of THEMIS data.

References

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