TOPOGRAPHY OF THE NORTH AND SOUTH POLAR ICE CAPS ON MARS. Anton B. Ivanov, Duane O. Muhleman, *California Institute of Technology, Pasadena, CA, 91125, USA, anton@gps.caltech.edu*.

Recent observations by Mars Orbiter Laser Altimeter have provided high resolution view of the Northern Ice cap [7], compiled on the basis of data returned during Science Phasing Orbit. Starting in March 1999, Mars Global Surveyor was transferred into its mapping configuration and began systematic observations of Mars. Data returned during the mapping orbit allowed compilation of high resolution topography grid for the southern ice cap ([5]). This paper will concentrate on description of observations of the southern ice cap topography and comparison with the northern ice cap. We will compare topography across the ice caps and apply a sublimation model ([2]), which was developed to explain the shape of the Northern Ice Cap, to the Southern Ice Cap.

A review of our knowledge about the polar ice caps can be found in [6]. Observed differences between north and south residual ice caps manifest themselves in size and albedo of the caps. It is known that the north polar ice cap consist of water ice [3] and the southern residual ice cap, much smaller in size, probably composited of CO_2 ice. However, we are not certain whether the southern residual ice cap is permanent. Mariner 9 spacecraft reported enhanced levels of water vapor, which were not observed by Viking Orbiters. The southern residual ice cap is offset from the pole, by about 2 deg., while the northern polar ice cap is centered at the pole. A lack of basic geophysical information prevented detailed investigation of these questions. Mars Global Surveyor spacecraft is now returning a wealth of information, which can now be utilized to approach questions about Mars past, present and future.

High resolution topography grids now allow direct comparison of north and south ice caps and layered deposits. First analysis of the southern ice cap and estimates for volume can be found in [5]. Cross section through the centers of both ice caps along 0-180 deg. longitude are shown at fig. 1 . It is apparent, that central parts of the ice caps are quite similar in size, at least cuts through this particular longitude. Durham et al. [1] suggested, based on rheological properties of CO_2 ice, that it is not possible to construct ice CO_2 cap this big. An immediate implication of this comparison is similarity of composition of both ice caps. This conclusion awaits further examination in the lab.

We have recently suggested [2] that sublimation is an important process for the formation of the Northern Ice Cap along with wind and flow. We applied the same model to the southern ice cap. The results can be seen in fig. 2 . The model fits the slopes of the southern ice cap fairly well. The number of iterations (130) required to fit this South Polar Cap slope is the same as required for the same longitude cut at the North Polar Cap. The model was not able to reproduce the top of the ice cap and the edge of the cap. The latter is probably due to extensive edge erosion, enhanced by the katabatic winds. Clearly, sublimation model can not be expected to explain 3 deg. offset of the center of the south polar ice cap. We do not know whether this offset is due to a polar wander or details of the underlying topography under the ice cap or some other large scale process. We know from Viking observations that there is substantially less amounts of water vapor observed over the south pole than over the north pole. On the other hand the albedo of the southern ice cap is lower, so we can expect higher temperatures on the surface and hence more extensive evaporation. Possibly, an insulating layer of dust prevents water ice from escape. Relative age estimates, obtained from craters by [4] suggest older ages for the southern polar layered deposits, than for the northern polar layered deposits. We do not know well composition of the south polar layered deposits and it is hard to hypothesize on evaporation rates at this point. All of the south polar passes will be analyzed in terms of the sublimation time and shape model.

Results obtained from investigation of the high-resolution topography data obtained by MOLA, suggest similar composition of the ice caps, but very different evolution history. Clearly, we have only began to understand the impact of the new data on our knowledge about the climatic history of Mars. High resolution imagery from MOC and temperature - pressure information from TES and RS experiments will help us to better understand polar mysteries of Mars. We also hope that MGS spacecraft will be tilted towards the pole to perform topography mapping of the centers of the ice caps, like it was done for the Northern Ice Cap. *In situ* data from Mars Polar Lander will provide extremely important information about the polar layered deposits, such as polar meteorology and composition of the surface layer.

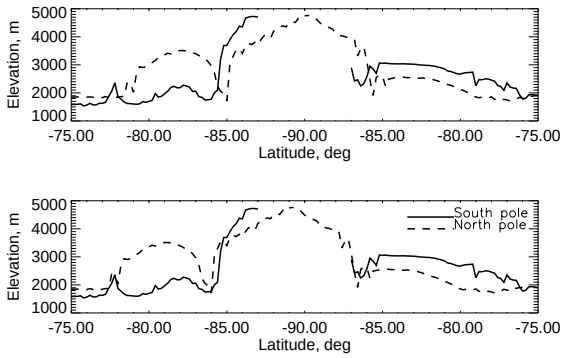

Figure 1: Comparison of north and south ice caps topography. South Pole profiles is solid black, North Pole profile is solid red line. Holes in the middle are obviously due to lack of coverage in north/south of 87N/S. The upper panel shows relative offset ($\approx$ 3 deg.) of the south polar cap topography maximum from the real pole. Topography across the North polar ice cap is shifted 1 deg. on the lower panel to emphasize similar sizes of the ice caps. Vertical exaggeration about 100:1

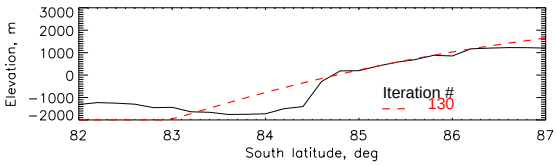

Figure 2: Application of the sublimation model [2] to the southern ice cap. Black solid line is the MOLA data across the cap and dashed red line is the sublimation model results. Note that MOLA topography data was shifted 3.5 km down. Slope of the southern ice cap fit the sublimation curve well, which suggest sublimation is important process for the formation of the southern ice cap. The number of iterations (130) required to fit this profile is the same as for the Northern Polar Ice Cap along the same longitude. Vertical exaggeration is about 15:1

References

[1] W. B. Durham. Factors affecting rheological properties of martian polar ice. In *1st International Mars Polar Science and Exploration Conference*, pages 8--9. LPI contribution no. 953, Lunar and Planetary Institute, Houston, 1998.

[2] A. B. Ivanov and D. O. Muhleman. The role of sublimation for the formation of the northern ice cap: Results from the Mars Orbiter Laser Altimeter. *submitted to Icarus*, 1999.

[3] H. H. Kieffer. H_2O grain size and the amount of dust in Mars' residual north polar ice cap. *J. Geophys. Res*, 95: 1481--1493, 1990.

[4] J. J. Plaut, et. al. Accumulation of sedimentary debris in the south polar region of Mars and implication for climate history. *Icarus*, 75:357--377, 1988.

[5] D.E. Smith, et. al. The global topography of Mars and implications for surface evolution. *Science*, in press, 1999.

[6] P. Thomas, et. al. Polar deposits of Mars. in *Mars*, H. H. Kieffer et. al., editors, chapter 23, pages 767--798. The University of Arizona Press, 1992.

[7] M.T. Zuber et. al. Observations of the north polar region of Mars from the Mars Orbiter Laser Altimeter. *Science*, 282(5396):2053--2060, 1998.