A MARS' YEAR OF TOPOGRPAHIC MAPPING WITH THE MARS ORBITER LASER ALTIMETER

David E. Smith[1], *Maria T. Zuber*[2], *and the MOLA Science Team.* [1]Laboratory for Terrestrial Physics, GSFC, Greenbelt, MD 20771, [2] Dept. Earth, Atmospheric and Planetary Sciences, MIT, Cambridge, MA.

Introduction – Since the end of February 1999 the Mars Obiter Laser Altimeter (MOLA) has been mapping the planet continuously except for a 2 month period around solar conjunction in June 2000. At the end of January 2001 the Mars Global Surveyor Spacecraft (MGS) had completed its prime Mission, one Mars year of observing the planet, and begun the Extended Mission of slightly more than 14 months. MOLA will had acquired over 530 million altimetric measurements by early 2001, and continued to work perfectly. During the Extended Mission the main objective for MOLA will be observations of the seasonal variations in the locations and altitudes of clouds, the changes in the elevations of the polar icecaps due to the deposition and sublimation of CO_2, as well as supporting NASA's search for suitable future landing sites.

The MOLA Instrument and Data Products

MOLA is a 10Hz laser altimeter with a wavelength of 1.064 mm that had an initial output energy of 48mJ and is currently operating at 18 mJ. Allowing for transient temperature effects the laser is now operating at approximately 50% of it's original power and has exceeded all lifetime expectations (Fig 1). In addition, we have reasonable expectation that MOLA will continue to operate thru' the Extended Mission.

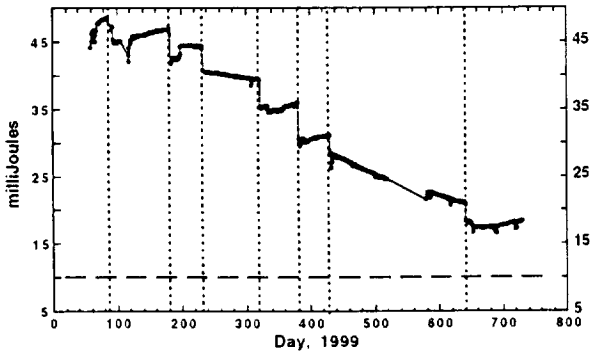

Fig. 1. Decline in MOLA output energy during the Prime Mission. MOLA can operate fully down to below 10 mJ.

The data collected by MOLA has has enabled a DEM to be created for Mars with a resolution of 1/64 deg x 1/32 deg, equivalent to a 1x2 km^2 grid at the equator (Fig. 2). We believe the accuracy of the topographic information is, on average better than 1 meter, although there are locations and times when the quality of the derived profiles and DEM are not of this quality. The use of the cross-over approach (locations where the orbital track cross each other) enables us to verify the measurement of the planetary radius at that location. All the data obtained thru' Nov 2000 have been delivered to the PDS along with a 1/32x1/32 degree DEM.

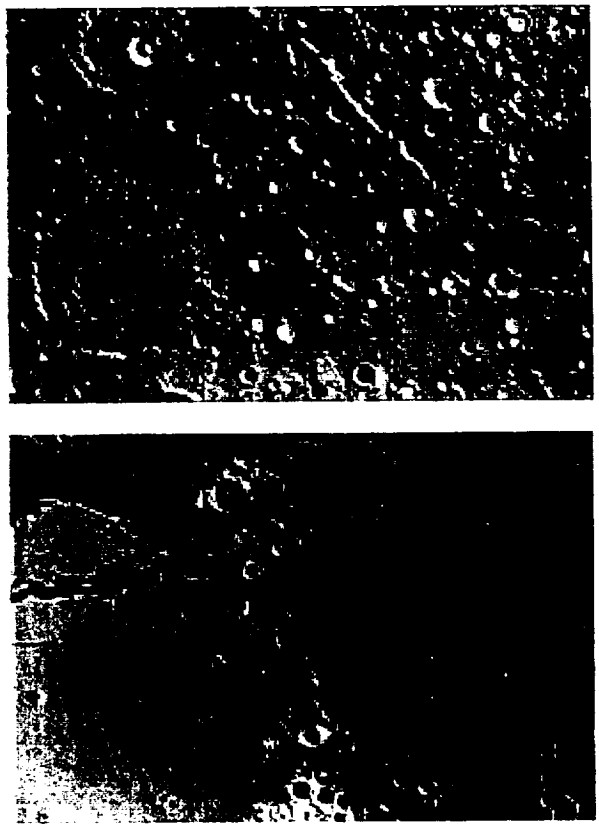

Fig. 2. Sections of the DEM in the southern highlands (5S,65E) and the Kasei Valles Region (20N, 305E).

A small percentage of the laser returns are from clouds which are regularly observed over the winter pole and occur at altitudes between zero and about 20 km, the maximum altitude that MOLA can effectively detect a return signal due to the gating of the receiver. Occasionally, clouds are observed by MOLA at lower latitudes, and over craters and high peaks. But there is no obvious correlation with clouds seen by MOC, the camera on MGS. Cloud "hits" are identified as such in the data files submitted to the PDS

In addition to altimetric measurements MOLA also measures the outgoing and returning energy of the laser pulse thus enabling an estimate of the 1.064mm reflectivity of the Martian surface to be derived. Also the width of the returning pulse provides information on the roughness of the surface within the 160 meter surface

spot. Models of the surface reflectivity and roughness on 100 meter scale will be deposited with the PDS later this summer.

Summary of Results

During the first year of mapping MOLA was able to develop a global geodetic control grid for Mars that we believe is accurate to the 100 meter level horizontally, and about 1 meter vertically. MOLA revealed the northern hemisphere of Mars to be flatter and smoother than had been expected and delineated the "down-hill" slope from south to north that has influenced the flow of volatiles since it earliest times on Mars. A large number of buried impact basins were discovered beneath the northern plains and cratering morphology showed that water was pervasive in the subsurface. Estimates of the volumes of the polar icecaps have provided information on the present-day surface water budget and were found to be inadequate to satisfy the requirements of a global ocean in the northern hemisphere. CO2 clouds have been detected that reveal the presence of gravity waves on the polar icecaps and strongly suggesting that we may be observing a CO2 snowfall.

References:

[1] Zuber, M.T., et al., *J. Geophys. Res.*, 97, 7781-7797, 1992
[2] Smith, D.E., et al., *Science*, 279, 1686-1692, 1998
[3] Zuber, M.T., et al., *Science*, 282, 2053-2060, 1998
[4] Smith, D.E., et al., *Science*, 284, 1495-1503, 1999
[5] Head, J.W., et al., *Science*, 286,2134-2137,1999
[6] Garvin, J.G., et al., *Geophys. Res. Lett.*, 26,181-184, 1999
[7] Frey, H., et al., *Geophys. Res. Lett.*, 26, 1657-1660, 1999
[8] Zuber, M.T., et al., *Science*, 287, 1788-1793, 2000
[9] Ivanov, A.B., D.O. Muhleman, *Icarus*, 144,436-338, 2000