NEW DATA ON LUNAR TOPOGRAPHY DERIVED FROM GALILEO AND CLEMENTINE STEREO IMAGES; J. Oberst, M. Wählisch, W. Zhang, T. Roatsch, A.C. Cook, and R. Jaumann, DLR, Institute of Planetary Exploration, Rudower Chaussee 5, D-12489 Berlin, Germany.

Abstract and Introduction. We analyzed images, obtained by the Galileo and Clementine spacecraft in 1992 and 1994 using state-of-the-art photogrammetric techniques to derive Digital Terrain Models (DTMs) for selected lunar regions. These regions include: the near-side northern hemisphere, parts of Mare Orientale, and the Alpine Valley. The new topographic data allow us to study the morphology of the Moon, in particular large craters and the multi-ring impact basins in unprecedented detail.

Data. The Galileo spacecraft passed the Moon in December 1992 at a distance of 110,000 km. Multi-look-angle images of the near-side northern hemisphere were obtained at approximately 1.2 km/pixel [1]. The Clementine spacecraft orbited the Moon between February and May, 1994, at altitudes ranging from 400 to 2900 km. Images were obtained by the UVVIS camera at approximately 100 to 300 m/pixel [2]. Though most of them are nadir images, a number of imaging sequences were obtained during which the spacecraft was tilted in order to obtain stereo data [3]. In this study we analyzed a sequence of approximately 100 stereo images obtained from two orbits overlaying the Eastern Mare Orientale (see also [4]), as well as stereo images obtained near the Alpine Valley (see also [5]).

Method. The photogrammetric processing of Galileo and Clementine images is essentially the same. First, the spacecraft trajectory and camera pointing data for all images were photogrammetrically adjusted using the nominal navigation parameters and control point information [6]. During the adjustment, variances of position and attitude measurements, of image coordinates, and of ground coordinates of control points were determined. Gross errors in the measurements were automatically removed. Next, parallel digital image matching was carried out using an automated area-based matching algorithm that searched for conjugate points in multiple images [7]. Finally, object coordinates were obtained from these disparity data and converted to line/sample values in a map of appropriate projection, and then interpolated to form a contiguous DTM grid.

Results and Future Prospects. The Digital Terrain Model produced from Galileo images covers much of the near-side northern hemisphere, at a grid spacing of 2 km and a height resolution of 500 m (see Fig.1). Prominent features in this area are the Humboldtianum Basin, Mare Crisium, and parts of Serenitatis. Several 100 km-sized craters are also visible in the DTM. The Orientale basin terrain model produced from Clementine images has a grid spacing of 200 m and a height resolution of 50 m. It covers the Cordillera mountains and then crosses the outer and inner Rook ring where elevations drop from +4000 to -3000 m (see [4]). Both the Galileo and the Clementine stereo terrain models greatly exceed the Clementine Laser Altimeter dataset in terms of spatial resolution and noise level. The geological analyses that are now beginning (see e.g. [8], [5]) will give us new insights into the origin and evolution of the lunar crust, and into the formation of the large multi-ring impact basins.

NEW LUNAR TOPOGRAPHY; OBERST et al.

Acknowledgements. We wish to thank our colleagues of the Technical University of Berlin who supplied important software contributions for this study. We are also grateful to A. Hoffmeister and A. Rexin for help in the processing of the Clementine data.

References. [1] Belton M.J.S. et al. (1994) Science, 264, 1112 [2] Nozette S. et al. (1994) Science, 266, 1835 [3] Cook A.C. et al. (1996) Planet. Space Science, submitted [4] Wählisch M. et al. (1996) Lunar and Planetary Science, this issue [5] Cook A.C. and Hiesinger H. (1996) Lunar and Planetary Science, this issue [6] Zhang et al., ISPRS, Vienna 1996, submitted [7] Oberst J. et al. (1996) Planet. Space Science, submitted [8] Hiesinger H. et al. (1996) Lunar and Planetary Science, this issue.

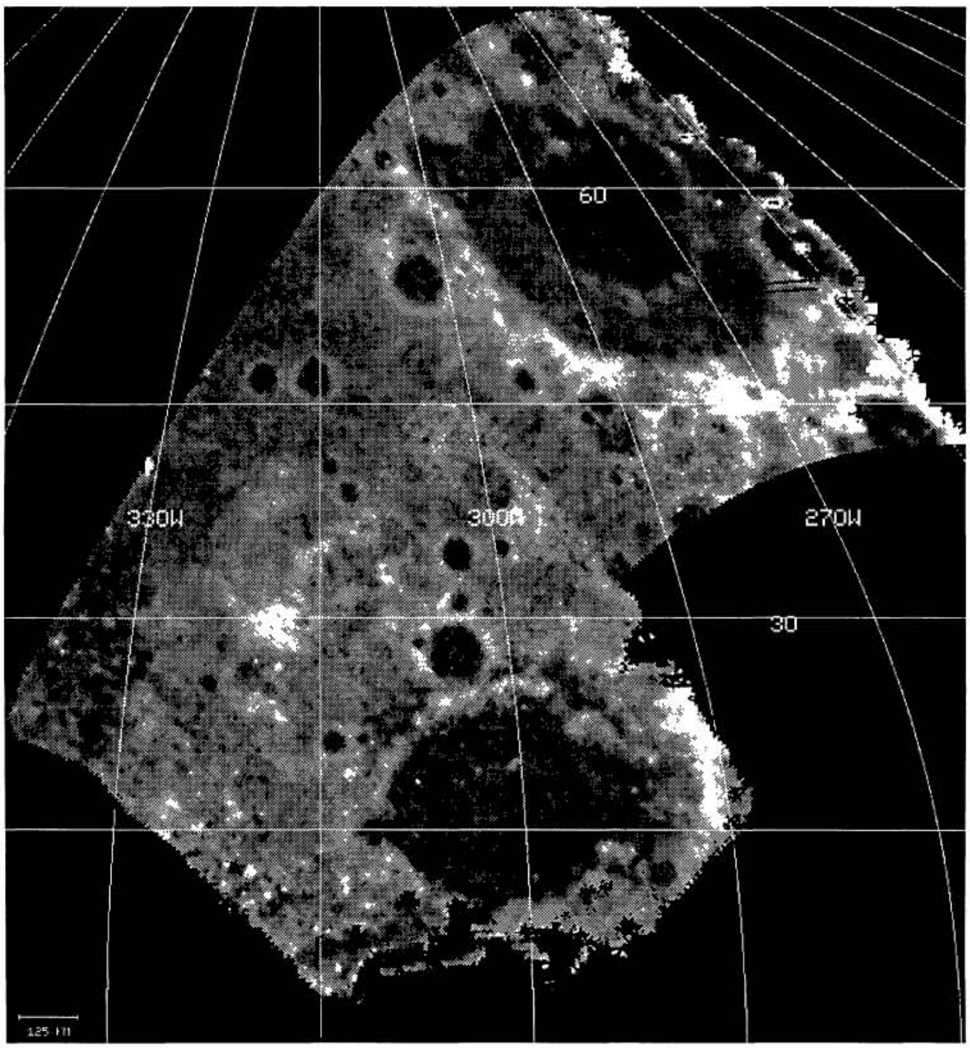

Fig. 1: Digital Terrain Model of the near-side northern lunar hemisphere derived from Galileo stereo images with dark and bright areas marking low (-4000m) and high (+2000m) elevations with respect to the lunar reference sphere of 1737.4 km radius. The depression near 15° North, 300° West is Mare Crisium, the double-ring structure at high latitudes is the Humboldtianum basin. The DTM is displayed in a sinusoidal map projection with center longitude = 315° West.