LUNAR TOPOGRAPHY AND BASINS MAPPED USING A CLEMENTINE STEREO DIGITAL ELEVATION MODEL. A. C. Cook[1], P. D. Spudis[2], M. S. Robinson[3] and T. R. Watters[1], [1](Center for Earth and Planetary Studies, National Air and Space Museum, Washington DC 20560-0315 (tcook@nasm.si.edu & twatters@nasm.si.edu), [2]Lunar and Planetary Institute, Houston, TX 77058 (spudis@lpi.usra.edu), [3]Northwestern University, 1847 Sheridan Road, Locy Hall 309, Evanston, IL 60208 (robinson@eros.earth.northwestern.edu).

Introduction: A locally detailed "planet-wide" [1] (1 km/pixel) and nearly complete "global" (5 km/pixel) Digital Elevation Model (DEM) of the Moon have been produced using Clementine [2] UVVIS camera along-track stereo coverage. The Clementine imaging sequencing [3] was designed for global color mapping, not stereo mapping, however enough parallax exists between adjacent along-track color-set frames such that useful stereo data can be derived [4]. Repeating gaps in stereo overlap in the 1 km/pixel DEM occur on each orbit between color sets resulting in a chess-board type of coverage pattern, except within 30° of the lunar poles [4,5], where the tracks of the Clementine polar orbit stereo converge, or where the camera was occasiponally tilted intentionally for special stereo imaging purposes [3]. The "global" 5 km/pixel DEM (Fig. 1) was produced using a larger pixel size (coarser spatial resolution) filling the majority of gaps in coverage. Using both datasets 6 new basins have been discovered [5,6], 2 suspected basins have been confirmed, and the dimensions of existing basins better defined.

Production of the Topographic Dataset: In April/May 2000 work was completed on stereo matching ~700,000 Clementine UVVIS stereo pairs using a patch-based correlation stereo matcher [7] with a patch radius of 7 pixels (UVVIS image resolution 100-150 m/pixel). The matched point sample and line coordinates were passed through a stereo intersection camera model using JPL Clementine SPICE data and the NAIF toolkit [8] and used to generate Digital Terrain Model (DTM) tiles. Each DTM tile consists of longitude, latitude, height, and a weight. The weight reflects the quality of the match of each point, and the topographic noise present in the DTM tile. The DTM tiles are then fitted iteratively to absolute height Clementine laser altimeter [9] points and/or previously fitted DTM tiles. Using the absolute height controlled DTM tiles a weighted mean DEM mosaic in sinusoidal-equal area projection is generated at a scale of 1 km/pixel. The 1x1 km pixel can contain tens-hundreds of matched points due to the fact that the UVVIS image resolution was 100-150 m/pixel, and there are overlaps between bandpass and across-track stereo pairs. Consequently this allows the averaging of height points contained within each 1 x 1 km pixel bin, hence improving the topographic signal to noise ratio over the theoretical height accuracy of a single stereo matched point [4]. The DEM pixel size of 1 km has another use in that it compensates for most gross navigation errors in camera pointing. We used JPL NAIF ephemeris camera position and orientations [8] because this was available for more stereo pairs than the counterpart USGS controlled mosaic navigation data [10]. Comparisons between the Clementine laser altimeter points and our UVVIS stereo DEM mosaic are finally made to identify rouge altimeter points, so their effects may be blocked during DTM tile fitting iterations. Clementine laser altimeter points are removed if they lie 3 standard deviations outside a pre-processed, smoothed Clementine laser altimeter ¼ deg DEM [9], or if they lie 3 standard deviations outside each iteration of the stereo DEM mosaic. Manual removal of any remaining suspect laser altimeter points can also be used, and the DTM tile fitting re-run.

Results: The total observed relief ranges from the lowest point on the Moon on the floor of Leibnitz crater in the SPA at –6.8 km to the highest point at +9.5 km on the NW rim of Korolev. Major provinces can be seen as in the smoothed laser altimeter dataset [9], but are better defined in the stereo DEM mosaic.

Basins. The DEM mosaic confirms earlier polar basins [5]. To determine if the ring of the proposed Sylvester-Nansen basin is an artifact of the DEM mosaicking process, laser altimeter points and systematic camera pointing errors are being investigated; however other remote sensing data supports the validity of a shallow basin here [5]. Several new basins have been found (see table 1) ranging from 300-500 km in diameter. These include a 400 km diameter basin to the SE of Moscoviense, and a 400 km diameter basin on the nearside just S of Grimaldi. A previously suspected shallow Dirichlet-Jackson basin [6,10] has been confirmed to the north of the slightly smaller Korolev basin (440 km diameter). Revisions in the topography of previously known basins include a very high elevation of the near side rim of the SPA (+4 to +5.5 km) and an enlargement of the eastern side of the Moscoviense basin to ~600 km in diameter. Earlier estimates gave the latter a smaller diameter of between 445 km [11] and 420 km [12].

Maria. The low relief of near side maria is very uniform and varies by less than 2 km over vast regions. Crypto maria or areas of ancient mare basalts covered by basin ejecta are evident by vast regions of flat, low relief terrain e.g., Schiller-Schickard (44S, 62W), Mendel-Rydberg (50S, 96W), Balmer (18S, 71E), and Lomonosov-Fleming (22N, 112E).

Unusual Features. Several highland blocks: +3 km, E of Ptolemaeus (9S, 6E) and + 5-8 km, W of Orientale at (22-27S, 122-137W). These features apparently appear similar to basin blocks but presently it is not possible to determine how, or to which basins?

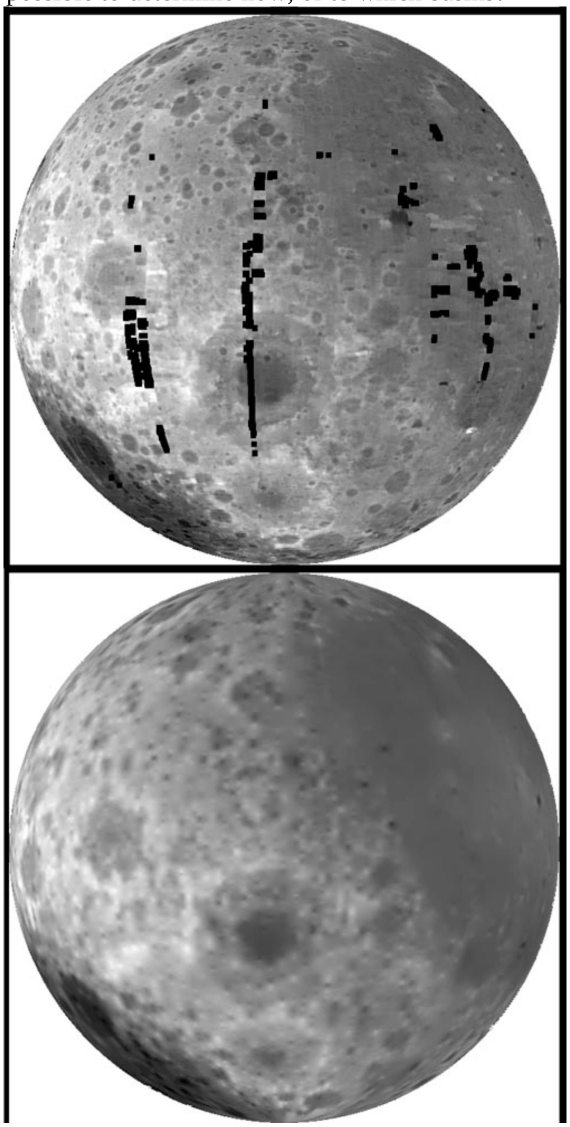

Figure 1. Grey-scale DEMs of the Moon (black=-8 km, white=+8 km) centered on 90W: top from Clementine stereo, bottom from Clementine laser altimeter [9].

Discussion: Our 5 km/pixel global DEM has the advantage that it is an order of magnitude improved in spatial resolution over the smoothed laser altimeter DEM [9] where the mean distance between altimeter points was ~50 km. Our 1 km/pixel "planet-wide" DEMs can supply local topographic details such as crater depth to diameter ratios in areas of the Moon that shadow height measurements have been unable to measure. A comparison of laser altimeter points with the DEM shows absolute height errors in our stereo DTM tiles of ~+/-300 m, but local relative height resolution within each DTM tile is ~100 m. Both DEMs have been used to discover 6 new basins (Table 1), to confirm suspected basins, and to refine the knowledge of existing basins. The total of known lunar impact basins has been increased from 39 to 45 with the possibility of 2 additional suspected basins.

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Acknowledgement: To University College / Laser-scan for the use of the Gotcha stereo matching software originally written by Tim Day. To NASA PG&G grant: NAG5-7852.

Basin	Location	Diameter
Wegner-Winlock	42N, 109W	300 km
Fowler-Charlier	37N, 139W	316 km
Riemann-Fabry	41N, 99E	320 km
Bailly-Newton [5]	73S, 57W	330 km
Amundsen-Ganswindt [11]	81S, 122E	360 km
Cruger-Sirsalis	15S, 66W	400 km
Fitzgerald-Jackson	23N, 170W	400 km
Kohlschutter-Leonov	13N, 156E	400 km
Dirichlet-Jackson [6,10]	13N, 158W	480 km
Sylvester-Nansen [5]	83N, 43E	500 km

Table 1. Lunar impact basins: confirmed (underlined), discovered using the stereo DEMs (**bold**), and probable (italics).

On-line Lunar DEMs are available at:
http://www.nasm.edu/ceps/research/cook/topo.html