A NEW GLOBAL TOPOGRAPHIC MAP OF IO USING GALILEO STEREO AND LIMB DATA. O.L. White[1] and P.M. Schenk[1]. [1]Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston, Texas, 77058 (white@lpi.usra.edu).

Introduction: No instrumentation specifically designed to measure the topography of a planetary surface has ever been deployed to the Galilean moon Io. Available methods that exist to perform such a task include stereogrammetry [1], photoclinometry (PC) [2], and shadow length measurement [3, 4]. In addition, Galileo limb profiles provide the only available global topographic 'ground data' [5].

Stereo-derived digital terrain models (DTMs) are reliable at long-wavelength, regional scales, but are unable to resolve fine-scale topographic features; PC-derived DTMs are primarily used for mapping local-scale topography, displaying significant topographic undulations over longer distances. Io presents a challenging subject for stereo imaging given that much of its surface is comprised of smooth, low-contrast plains, at least at the resolution of most global images. In addition, changing surface patterns and radiation noise-can confuse attempts to correlate stereo images. PC can be complicated by surface albedo variations and phase variability.

Over the last two years we have combined stereo- and PC-derived DTMs to create a global topographic map of Io in order to constrain the shapes of local- and regional-scale features on this volcanic moon. A key advance is that our DTMs are being controlled using Galileo limb profiles. Applications include relation of regional-scale topographic variations to global heat flow patterns resulting from convection in Io's silicate mantle [6], in addition to precise characterization of the shapes of local topographic features such as paterae and mountains. We will examine the consistency between the topography in the limb profiles and the global stereo DTM, and identify any correlations between the topography in these datasets and geological units as mapped by [7].

Stereo DTM creation: Customized ISIS software at LPI has been used to create and process stereo- and PC-derived DTMs of Io's surface using Voyager and Galileo imagery. The stereo routine determines parallax and associated topographic relief by identifying corresponding pixels within the two stereo images through matching albedo patterns in finite-sized patches; where the surface is smooth and featureless, the inability of the program to identifying corresponding pixels can contribute to noise in the data. Fig. 1 presents the DTM coverage to date, which so far incorporates the hemisphere observed by Voyager; processing of the DTMs for the Galileo hemisphere is in progress.

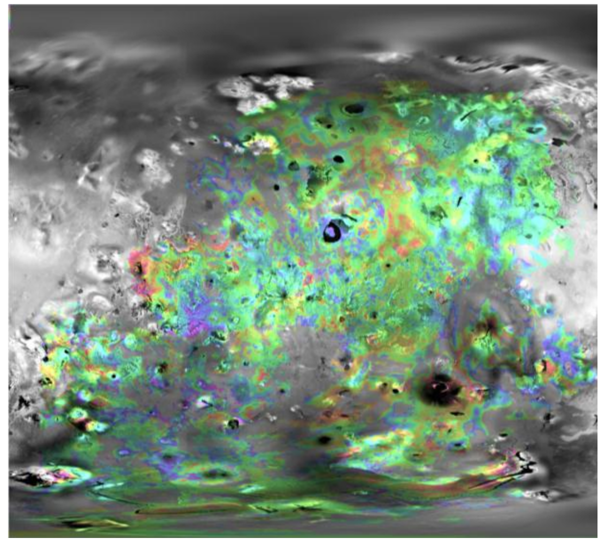

Fig. 1. Mosaic of 34 controlled stereo DTMs overlain on top of a mosaic of visible Galileo and Voyager images. Simple cylindrical projection centered at 0°N, 318.5°W, and extending from 219°W to 58°W. Elevation scale extends from -3.5 km (violet) to +4 km (red).

Limb profiles: An earlier study used 18 raw Galileo limb profiles to define an ellipsoidal fit for the shape of Io [5], as well as to reveal the amplitude of the topography that is residual to the fit. The present study has used 25 limb profiles to control stereo DTMs with reference to the global shape model. They also provide an independent topographic dataset. The raw limb profiles display varying degrees of noise, and so have been smoothed in order to eliminate short-wavelength (tens of km), high-amplitude (several km) noise features. In addition, features in the profiles that are interpreted to originate from off-limb sources (i.e. high-relief features such as mountains, layered plains, and some shield volcanoes), are eliminated from the profile. Fig. 2 displays four profiles with identical groundtracks: a raw limb profile, the same limb profile that has been smoothed, a profile taken across the global stereo DTM (which displays its own noise), and the same stereo profile that has been smoothed. Various off-limb topographic features have been eliminated from the smoothed limb profile. Between 900 and 4500 km along the smoothed limb profile, the amplitude of long-wavelength topography is minimal (σ of $\pm$0.84 km), but the topography at the edges of the profile is more extreme (σ of $\pm$1.47 km); this is likely a consequence of increased noise at the edges of the limb profile, as the extreme topography is not replicated in the stereo data (at least for the south pole). The long-wavelength topography is elevated by 1.23 km between 900 and 2250 km relative to that between 2250 and 4500 km in the limb profile. This is replicated, albeit to a lesser degree (relative elevation of 0.64 km), in the stereo profile, indicating that control of the stereo DTMs using the limb profiles does yield consistent results between the two datasets.

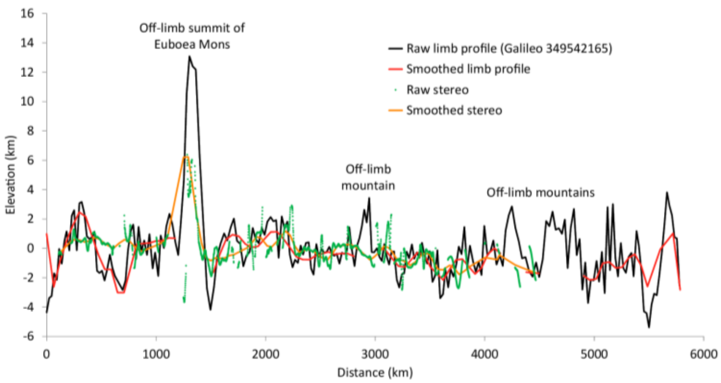

Fig. 2. Raw and smoothed versions of limb and stereo profiles with identical groundtracks (crossing the equator at 339°W). Profile runs from south (at left) to north (at right).

Correlation of topography with geology: Fig. 3 shows the smoothed limb profiles superimposed on the global geological map of Io created by [7], which, prior to the completion of the global stereo map, allows the first investigation of whether the long-wavelength topography of Io correlates to the mapped geology in any way. An earlier study [5] highlighted certain topographic features in the limb profiles such as the topographic high at 43°N, 320°W and the topographic lows at 38°S, 315°W and 47°S, 159°W. These features do not obviously correspond to any of the units mapped by [7], and are notable in that similar topography is not reflected in profiles at nearby longitudes. The most prominent large-scale geologic boundaries on Io are those dividing the yellow-white plains material at low latitudes from the red-brown plains material at high latitudes. These terrains display very similar mean elevations of -0.31 km (σ ±0.62 km) and -0.29 km (σ ±0.74 km) respectively, indicating that the different deposits that comprise these units do not display distinct topographic signatures.

Forthcoming work: Upon completion of the global DTM, we will perform a more complete assessment of the consistency between the limb and stereo datasets, and our investigation of topographic correlations with geology will be extended laterally from the limb profiles using the controlled stereo and PC DTMs.

References: [1] Pike, R.J. (1974) *Geophys. Res. Lett.*, *1*, 291-294. [2] Bonner, W.J., and R.A. Schmall (1973) *U.S. Geol. Surv. Prof. Pap.*, *812-A*. [3] Cintala, M.J., and P.J. Mouginis-Mark (1980) *Geophys. Res. Lett.*, *7*, 329-332. [4] Pike, R.J. (1980) *LPSC XI*, 2159-2189. [5] Thomas, P., et al. (1998) *Icarus*, *135*, 175-180. [6] Tackley, P.J., et al. (2001) *Icarus*, *149*, 79-93. [7] Williams, D.A., et al. (2011) Geologic map of Io: U.S. Geological Survey Scientific Investigations Map 3168, scale 1:15,000,000, 25 p.

Fig. 3. Global geological map of Io in simple cylindrical projection, with the smoothed Galileo limb profiles overlain (with off-limb topography removed). Elevation scale for the profiles ranges from -2 (violet) to +1.5 (red). Refer to [7] for definitions of the units.