GRAVITY ANOMALIES OF THE LUNAR ORIENTALE BASIN AND THE MERCURIAN CALORIS BASIN. D. M. Blair[1,*], B. C. Johnson[1], A. M. Freed[1], and H. J. Melosh[1]; [1]Department of Earth, Atmospheric, and Planetary Sciences, Purdue University, *dblair@purdue.edu.

Introduction: Gravitational anomalies of large impact basins [e.g. 1] expose structure deep inside of a planetary body, and provide a window to its past. Recent work [2] has shown that these anomalies form via a combination of syn- and post-impact processes, but this work focuses on just two basins, both on the Moon and both having an annulus of negative Bouguer gravity anomaly ~ 400 km in diameter (D_{masdef}). How might gravity anomaly formation differ for a larger impact, with a larger melt pool and non-negligible surface curvature, or an impact into a body other than the Moon?

Here we attempt to model the formation and evolution of the lunar Orientale ($D_{\mathrm{masdef}} \sim 600$ km) and mercurian Caloris ($D_{\mathrm{masdef}} > 1000$ km) basins to explore how gravity anomaly patterns form following very large bolide impacts. Our goal is to match the basins' observed free-air and Bouguer gravity anomalies, as well as their final topographies.

Methods: Our modeling effort occurs in two stages, allowing us to create a self-consistent representation of a basin's formation and evolution. First, we simulate bolide impact using the iSALE hydrocode, with the goal being to reproduce a basin where the annulus of thickened crust matches that suggested by gravity measurements. This model treats impactor kinetic energy, pre-impact crustal thickness, and subsurface thermal gradient as free parameters, and models the first few hours after impact. We then take the output state of the hydrocode model—its geometry, temperature, and density structure—and use that as the basis for a finite element model (FEM) using the Abaqus software suite [e.g. 2, 3], which simulates the basin's linked thermal and viscoelastic evolution over subsequent geologic time.

At the Moon, our models are constrained by gravity observations from NASA's dual GRAIL spacecraft [4] and topography from LRO/LOLA data [5]. At Mercury, the MESSENGER spacecraft provides both gravity [6] and topography [7, 8].

Results: Modeling is ongoing for both basins; in this abstract, we show preliminary results for Orientale (Fig. 1). Current models accurately predict the basin's present-day topography while slightly under-predicting both free-air and Bouguer gravity anomalies at the basin center. These models do not yet include mare basalt, however, which could alter our results; the presence of several major faults in Orientale could also explain some portion of the misfit.

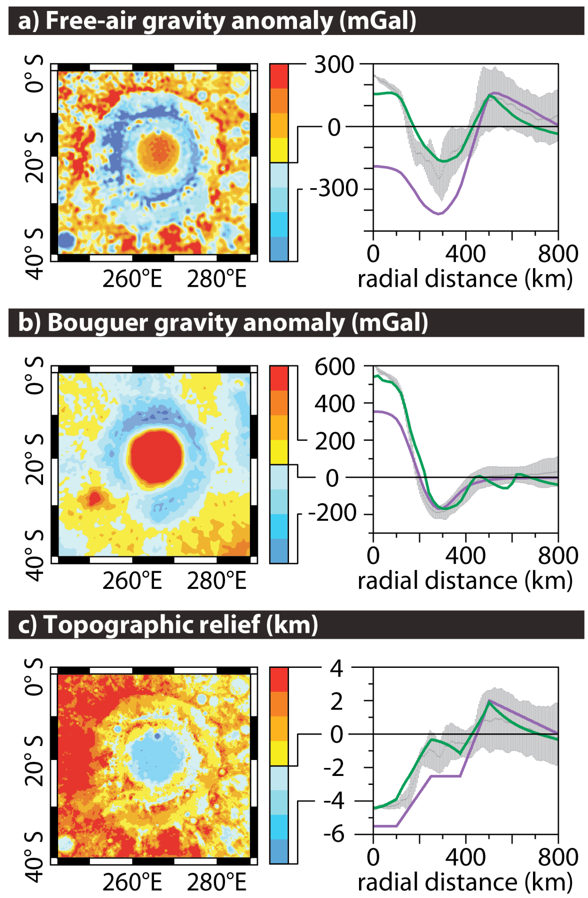

Figure 1: Observations and current model results for Orientale basin, showing a) free-air and, b) Bouguer gravity anomaly, and c) topographic relief. Purple lines represent the model results at the end of the hydrocode simulation, and green lines show results from after finite element simulations. Gray lines with error bars represent azimuthally-averaged data from [7] (a & b) and [8] (c), with topography observations uniformly shifted to match our model result of 0 km elevation at 800 km radius.

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