ILLUMINATION AND THERMAL CONDITIONS AT SMALL BODIES. Erwan Mazarico[1] , Samuel F. Potter[2], and Michael K. Barker[1]. [1] NASA Goddard Space Flight Center, Greenbelt, MD (erwan.m.mazarico@nasa.gov); [2] University of Maryland, College Park, MD.

Introduction: The illumination and thermal states of planetary bodies are directly tied to their shape, orbit, and orientation. Complex and diverse conditions can exist, particularly at small bodies due to their more irregular shapes. Small obliquity angles also create unique conditions in the polar regions of large bodies, such as cold traps and permanently shadowed regions. These have been well-studied at the Moon, Mercury, and Ceres but remain an active area of research.

In our recent work [1,2], we developed software to simulate illumination conditions for arbitrary geometry, with either the horizon method [3] or direct raytracing [1,2]. We can consider either the singly-scattered [1] or multiply-scattered [2] radiation, which contributed to the integration of subsurface 1D temperature profiles [4]. We account for the presence of a primary (e.g., Mars in the case of Phobos), both for eclipses and for additional energy input in the form of reflected sunlight and planetary thermal radiation (Figure 1).

Outline: We will present the results of numerical simulations at a number of small bodies. We will use the shape data and orientation information obtained from recent spacecraft missions to contrast their illumination conditions. We will also assess their thermal states, using simplified assumptions for thermal properties. We will use shape models on the NASA Planetary Data System (PDS). These include:

- Near-Earth asteroids: Eros, Itokawa [6]
- Mars' moons: Phobos [7]
- Saturn's moons: Atlas, Calypso, Daphnis, Epimetheus, Helene, Janus, Pan, Telesto [8]
- Comets: 67P/Churyumov-Gerasimenko [9]

We will also model illumination conditions at large main belt bodies Vesta and Ceres [2].

Preliminary results: We used detailed global shape models of both Vesta and Ceres obtained from camera images [10,11]. A study of illumination conditions at Vesta was performed [12], but prior to Dawn and at coarse spatial resolution. The north polar region of Ceres was previously surveyed for permanent shadow regions and cold traps [13,14], but no global assessment of illumination was done. Figure 2 shows some preliminary results of average incident flux for Vesta and Ceres, at two different obliquities within the range of periodic (~25 kyr) variations expected given Vesta's and Ceres' moments of inertia [14,15].

Further results will be presented at the meeting.

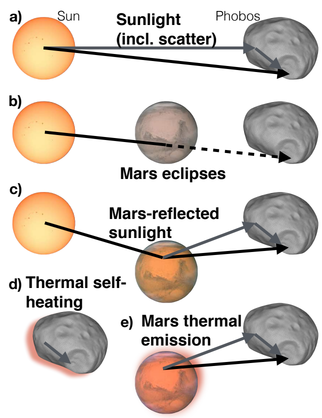

***Figure 1.** In the case of Phobos, many sources can be considered, from direct sunlight to Mars albedo and thermal radiation sources. Mars can also put Phobos in eclipse which affects the near-side overall energy budget and average temperature [5].*

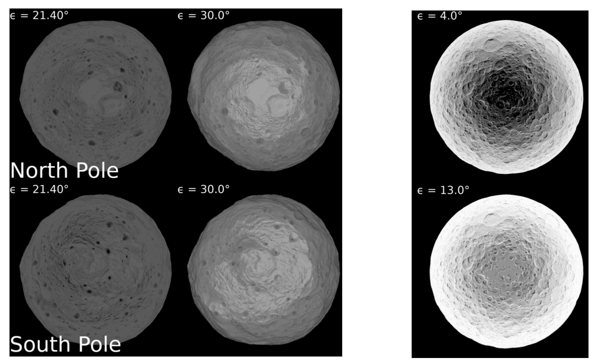

***Figure 2.** Average incident flux at Vesta (left) and Ceres' northern hemisphere (right) for two different obliquity values (ϵ).*

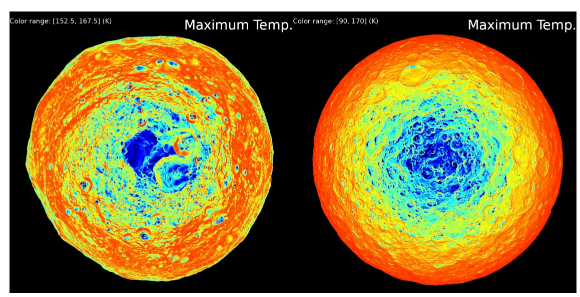

***Figure 3.** Maximum temperatures for the northern hemispheres of Vesta (left) and Ceres (right) from preliminary thermal simulations at current obliquity.*

References: [1] Mazarico E. et al. (2018), ASR; [2] Potter S., et al. (2018), AGU Fall Meeting; [3] Mazarico E. et al. (2011), Icarus; [4] Schorghofer N. (2018), GitHub; [5] Stubbs T.J. et al. (2016), NESF; [6] Gaskell R.W. et al. (2008), PDS SBN; [7] Gaskell R.W. et al. (2011), PDS SBN; [8] Thomas P. et al. (2018), PDS SBN; [9] Gaskell et al. (2017), PDS SBN; [10] Preusker F. et al. (2016), PDS SBN ; [11] Park R.S. et al. (2018), PDS SBN; [12] Stubbs T.J. et al. (2011), Icarus; [13] Schorghofer N. et al. (2016), GRL; [14] Ermakov A. et al. (2017), GRL; [15] Vaillant T. et al. (2018), A&A.