ICE THICKNESS OF EUROPA: EFFECTS OF CONVECTION AND RIFTING. L. G. J. Montési[1], S. M. Howell[2], and R. T. Pappalardo[2], [1]University of Maryland, College Park, MD, USA, montesi@umd.edu, [2]Jet Propulsion Laboratory, Caltech, Pasadena, CA, USA

Summary: The thickness of the ice shell of Europa is related to heat generated in the satellite's interior, especially by tidal heating, and the mode of heat transport [1]. We present models of the steady-state ice shell thickness assuming stagnant lid convection. The shell is partitioned into a nearly isoviscous core heated from inside and from below, overlain by a conductive thermal boundary layer. We include the temperature dependence of thermal conductivity and viscosity. We report here how ice thickness may vary with latitude due to differences in heat generation and surface temperature [2], as well as the effect of rifting [3] on ice thickness.

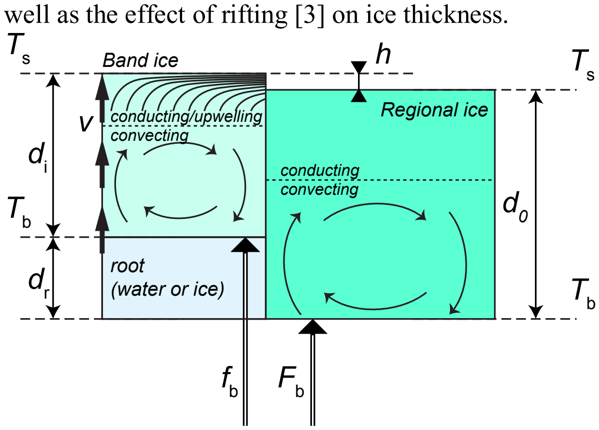

Figure 1: Schematic diagram of the thermal structure of the ice shell inside and outside an isostatically-supported band (left and right).

Results: The thickness of ice shell for different latitudes is compared in Figure 2. Heat generation is higher at the poles [2], which decreases the thickness of the convective core (the heat flow at the top of the cell cannot accommodate the basal heat flow and the tidal heat generated over a thick convective cell). However, the shell is thicker at the pole because of the lower surface temperature at the poles, requiring a thick conductive lid

The variation of ice thickness predicted here exceeds 25 km, which is too large to be accommodated in the observed 3 km ellipticity of Europa [4]. A high basal heat flux, which prevents convection, would reduce this issue. Alternatively, long-range ice transport at the base of the shell would reduce the thickness variations [4].

The increased heat generation at the pole can shut down convection (Figure 2). In that case, we would expect that geological evidence for convection, such as a pits and domes [5, 6] would be absent close to the poles. Where this change takes place depends on basal heat flow and the reference viscosity of ice.

Rifting increases the basal heat flow as ice crystallizes at the base of the ice shell. As a result, it can also shut down convection. In a conductive shell, rifting thins the ice, which, if supported by a liquid water root (active band), should stand several kilometers lower than the surrounding plains. These depressions should be more pronounced near the poles (Figure 3). Conversely, the freezing of this root should lift the band to higher elevation at the poles than near the equator. High-resolution global topography would help testing whether this elevation cycle does take place on Europa.

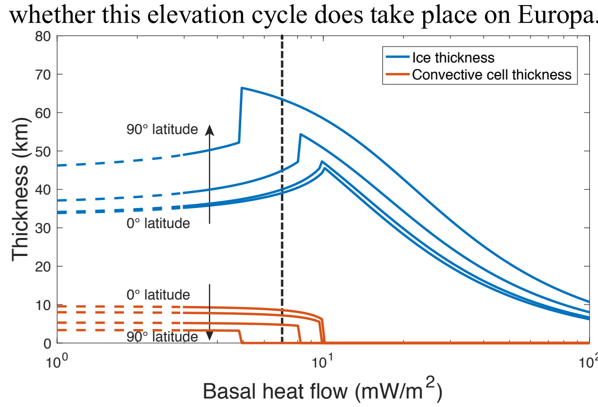

Figure 2: Ice thickness (blue) and thickness of the convective cell (orange) as a function of basal heat flow for conditions corresponding to various latitude. The dashed lines indicate that the convective cell should be melting. Heat generation is smaller but surface temperature is higher near the equator. The dashed black line indicates 7 mW/m^2.

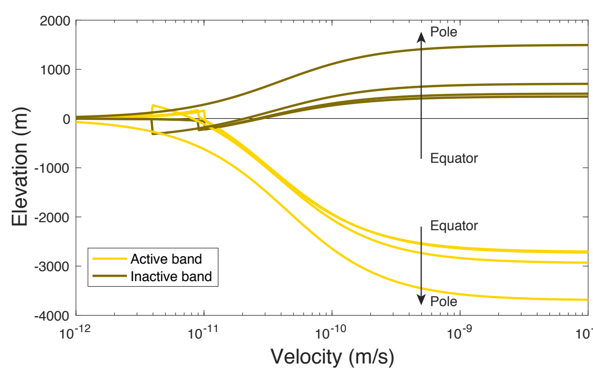

Figure 3: Band elevation(yellow) against upwelling velocity for conditions corresponding to various latitude. The root underneath the band (Figure 1) is taken to be liquid water for an active band and ice at 270K for the inactive band.

References: [1] Nimmo F. and Manga M. (2009) *Europa*, 381–404. [2] Ojakangas G. W. and Stevenson D. J. (1898) *Icarus*, 156, 152-161. [3] Prockter L. M. et al. (2002) *JGR,* 107, 5028. [4] Nimmo F. et al. (2007) *Icarus* 191, 183-192. [5] Pappalardo R. T. et al. (1998) *Nature*, 391. 365-368. [6] Figueredo P. H. et al. (2002) *JGR*, 107, 5026.