THE EFFECT OF SURFACE THERMOPHYSICS ON TEMPERATURES AT EUROPA. L. Glogau¹, A. R. Khuller¹, School of Earth and Space Exploration, Arizona State University, Tempe, AZ, USA (lglogau@asu.edu)

Introduction: Europa, the Jovian moon, is completely covered by water ice of spatially varying thickness (~1 - 5 km) [1]. However, it is believed that beneath its ice lies the largest liquid water ocean in the solar system, covering the entire surface of the moon. Additionally, plumes of water from this subsurface ocean have been observed to erupt at a range of latitudes, potentially providing further evidence that subsurface temperatures are conducive to liquid water [2]. We chose to investigate the variation of surface temperatures on Europa in preparation of the arrival of the E-THEMIS thermal imaging instrument aboard Europa Clipper [4], scheduled to launch by 2025.

Methods: To observe the optimal parameters for the warmest feasible surface temperatures on Europa, we used Davinci (http://davinci.asu.edu) to call KRC, a one-dimensional planetary thermal model [5] to model temperatures at the surface of Europa. Since the thermophysical properties are not certain at small scales at this time, we varied the thermal inertia and albedo for different latitudes, local solar time and time of year to characterize surface temperatures. All model results use an emissivity of one, although variations in surface emissivity are to be expected, but are currently poorly characterized.

Results: As expected, the darker streaks seen near the equator on Europa [3] can be significantly warmer (up to ~35 K at peak insolation) than locations at higher latitudes although the observation of plumes of water (perhaps indicating ‘hot spots’) have been observed above 45° latitude. Peak temperatures occur at a local solar time of 15 at all non-polar latitudes.

Figure 1. Modeled surface temperatures at 0° latitude and 1000 J m⁻² K⁻¹ s⁻⁰.₅, at a local solar time of 15 at Ls = 100 and albedo of 0.6.

Temperature is inversely proportional to thermal inertia on Europa; note that the thermal inertia values used here encompass the range of solid water ice (~2000 J m⁻² K⁻¹ s⁻⁰.₅) although thermal inertia values determined from relatively coarse resolution (80 – 200 km) Galileo data indicate significantly lower values, suggesting a particulate surface [6] that is perhaps formed by the recrystallization of ejected plume water.

Figure 2. Modeled surface temperatures at 0° latitude, for a local solar time of 15, an albedo of 0.6 for varying thermal inertia values.

Temperatures do not vary tremendously throughout the year due to Europa’s orbital parameters. As expected, the lowest albedo corresponds to the highest surface temperatures, with surfaces of intermediate albedo (~0.6; similar to those observed from Galileo observations [6]) show little variation.
Implications for Potential Life: Lake Vostok, a subsurface lake beneath Antarctica (the largest lake on Earth in terms of size and volume) contains traces of life, which consist mostly of bacteria and fungi [10]. The lake has been sealed by ice for ~15 million years, not receiving any sunlight or circulation of oxygen. Despite these harsh conditions, extremophiles on the order of $10^4$ cells/mL have managed to survive there [10]. If that is the case, we might ask, can life similar to that seen in Vostok form on Europa? The variation of tidal forces, coupled with a possible radiation-driven energy system [11] could perhaps lead to conditions conducive to microbial life in the subsurface ocean, similar to those found in Lake Vostok on Earth. The upcoming Europa Clipper will hopefully shed light on this enigmatic Jovian moon and further our understanding of its surface and subsurface.

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