DOWNSIDE UP: EUROPA'S ICE-OCEAN INTERFACE AS AN INVERTED BENTHOS. J. J. Buffo[1], B. E. Schmidt[1] and C. Huber[2], [1]Georgia Institute of Technology (jacob.buffo@eas.gatech.edu), [2]Brown University.

Introduction: Constraining the amount of chemical transport between Europa's surface and underlying ocean has repeatedly been highlighted as a critical component in assessing the moon's habitability [1-3]. Emphasis has been placed on the movement of oxidants and reductants to and from the subsurface ocean, respectively, due to their key role in fueling metabolic processes on Earth. While there exist numerical simulations that investigate the convective timescales likely present in Europa's ice shell [1,3], and even some that include compositional impurities within the ice to bolster accuracy [4,5], all of the impurity entrainment rates are set *a priori* and do not include any local physics to quantify the ice composition. Because of the potential for physicochemical exchange at the ice-ocean interface of Europa, it is likely akin to those found beneath terrestrial sea ice and ice shelves. These interfaces are dynamic, multiphase environments governed by reactive transport processes. The impurity content of ice forming from an ocean is dictated by characteristics of the local environment, such as ocean composition, thermal gradients, and liquid fraction [6,7]. With a global ice-ocean interface on Europa likely experiencing a variety of oceanic conditions, there exists the potential for spatially and temporally dependent thermal and compositional heterogeneities in the basal ice layers.

Model: Here we present a one-dimensional reactive transport model capable of simulating the formation of oceanic ice under a variety of conditions. The model was constructed from a first-principles approach using mushy layer theory and allows for high resolution tracking of temperature, liquid fraction, fluid motion, and impurity content. The model additionally incorporates the phenomenon of frazil/platelet ice accretion due to supercooling of the underlying water column (a process that occurs in terrestrial waters in contact with floating ice shelves) that has been theorized as relevant for the Europan ice-ocean interface [8]. Cumulatively this enables the model to accurately simulate impurity entrainment, phase evolution, and solute/nutrient transport in forming ice (Figure 1). Together these attributes can help characterize the habitability of not only the local ice-ocean interface, but in conjunction with larger scale models, Europa as a whole. The model has been validated against empirical observations of sea ice affected by supercooling [9] and is primed for application to other icy worlds.

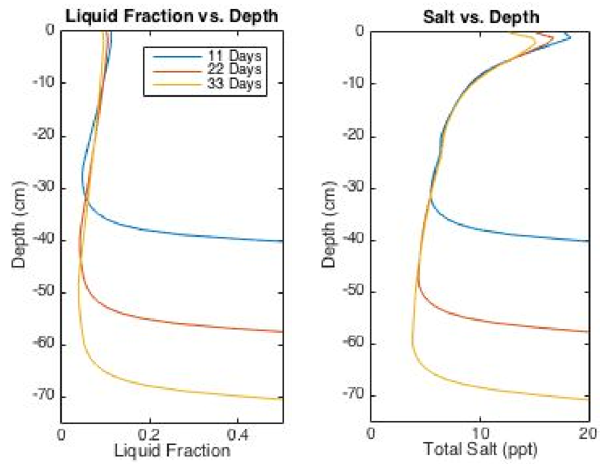

Figure 1 - Liquid fraction (left) and total salt (right) profiles of sea ice produced using the numerical model. The temporal evolution of the ice can be seen at three times (~11d, ~22d, and ~33d as blue, red, and yellow respectively). The model can accommodate a variety of boundary conditions and ocean chemistries.

Results and Implications: We will discuss the potential similarities and differences between the terrestrial and Europan ice-ocean interface and how the model accommodates these variables. Additionally we will present preliminary results of simulated ice-ocean interfaces subject to Europa-like conditions (both past and present) and discuss the impacts this may have on ice shell structure and composition, chemical transport, and habitability.

References: [1] Peddinti D. A. and McNamara A. K. (2015) *GRL, 42.11.* [2] Zolotov M. et al. (2004) *Europa's Icy Shell,* Abstract #7028. [3] Barr A. C. (2004) *PhD Thesis.* [4] Travis B. J. et al. (2012) *Icarus, 218.2,* 1006-1019. [5] Han L. and Showman A. P. (2005) *GRL, 32.20.* [6] Feltham D. L. et al. (2006) *GRL, 33.14.* [7] Hunke E. C. et al. (2011) *The Cryosphere, 5.4,* 989-1009. [8] Soderlund K. M. et al. (2013) *Nat. Geo., 7.1,* 16-19. [9] Buffo J.J. et al. (2016) *AGU,* Abstract #P34A-04.