THE MUSHY LAYER: ICE WATER INTERFACES AS ECOLOGICAL NICHES. J. J. Buffo[1], B. E. Schmidt[1]. [1]School of Earth and Atmospheric Sciences, Georgia Institute of Technology (311 Ferst Drive Atlanta, GA 30332; jacob.buffo@eas.gatech.edu).

Introduction: There has been a general consensus established that the presence of liquid water drastically improves the likelihood that an environment, terrestrial or otherwise, is habitable. [1] While this is undeniable, based on our current knowledge of biological life, there is another crucial intricacy that renders an environment habitable – how do the resident organisms acquire metabolic energy? This question is particularly relevant to the understanding of how ecosystems persist beneath ice-covered oceans and lakes that are absent of light and likely oligotrophic. Understanding possible mechanisms for nutrient transport and accretion in these locales is crucial to unraveling the yet unknown biogeochemical cycles that enable these biomes to exist. Additionally, these terrestrial environments are thought to be suitable analogs for subsurface oceans present on icy moons in our own solar system. [2] Successful comprehension of the physics that dictate the dynamics of these Earthly environments should thus be directly transferable to models attempting to simulate the dynamics, and potential habitability, of icy moons.

A key characteristic that facilitates cellular metabolism is the presence of chemical and energy gradients. Phase changes present an ideal opportunity for these types of gradients to exist, yet most current models of the basal ice processes for floating ice treat the ice-water interface as an impermeable boundary, and thus simulate a two phase system wherein ice can accrete or melt, but there exists separate solid and liquid layers that behave accordingly[3,4]. This treatment is both dynamically limitive and unrepresentative of the actual behavior of this interface. It has been shown that the basal surface of floating ice behaves like a porous medium. [5] Its dynamics are therefore dictated by equations for fluid transport in a porous media, enabling fluid and nutrient transport, convective and conductive heating, as well as chemical and temperature gradients to exist, in addition to accretion and melt. [6] In sea ice, this porous stratum is already known to harbor algal and macrofaunal life, and there are indications of similar behavior under ice shelves. A porous media is ideal for the coalescence of the nutrients that sustain this unique biome. The effects of treating the basal surface of terrestrial ice shelves as a porous media are not well known, and have not been thoroughly modeled. Furthermore, no one has utilized this representation of basal ice in any model attempting to simulate the ice shells of icy moons.

Approach: Here I describe the procedure for how we are producing an initial one-dimensional model of ice shelf/shell dynamics, treating the bottom layer as a porous media. There are a number of crucial parameters that need to be taken into account when designing such a model. Additionally there is a need for methodologies by which to truth test its validity. The architecture of the model will consist of a set partial differential equations that represent conservation equations necessitated by the laws of thermodynamics and the theory of fluid transport in porous media. Boundary conditions for the model will be implemented using a combination of theoretical and experimental results found in the literature. The most basic model of this type will be capable of producing temporally- and (one dimensional) spatially-dependent solutions of temperature, salinity, brine velocity, and accretion/melt rates for the ice-water interface in question. For the case of terrestrial ice shelves, this model can then be tested against *in situ* data obtained by the Antarctic submersibles Icefin and ARTEMIS, part of the SIMPLE project, over the 2014 and 2015 field seasons. This initial model will provide a benchmark study that expresses how cycling between the ice and ocean can affect the habitability of such systems on Earth and icy worlds. Such models are necessary to go beyond equations of state and describe the systems-level behavior of these environments.

I will discuss preliminary results of an implemented numerical model, and outline future research goals that include moving towards two and three dimensional models capable of simulating the basal dynamics of entire ice shelves, incorporating more complex dynamics such as currents and frazil formation, and scaling the model to accommodate the physics of a global ice shell typical of icy moons like Europa. Finally similarities and differences between the terrestrial and Europan environments will be discussed.

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