Microbial activity in the intergranular habitat of a temperate glacier. Brent C. Christner[1], Heather Lavender[2], Erin Oliver[3], Christina Davis[4], Slawek Tulaczyk[5], and Peter Doran[6], [1]University of Florida, Department of Microbiology and Cell Science, Biodiversity Institute, 1355 Museum Drive, Gainesville, FL 32611, xner@ufl.edu, [2]Louisiana State University, Department of Biological Sciences, 202 Life Sciences Building, Baton Rouge, LA 70803, heatherl@lsu.edu, [3]Louisiana State University, Department of Biological Sciences, 202 Life Sciences Building, Baton Rouge, LA 70803, eoliver1120@gmail.com, [4]University of Florida, Department of Microbiology and Cell Science, 1355 Museum Drive, Gainesville, FL 32611, christinadavis@ufl.edu, [5]University of California Santa Cruz, Department of Earth and Planetary Sciences, Santa Cruz, CA 95064, tulaczyk@pmc.ucsc.edu, [6]Louisiana State University, Department of Geology and Geophysics, E235 Howe Russell Geoscience Complex, Baton Rouge, LA 70803, pdoran@lsu.edu

Introduction: Various studies have shown that both freshwater and saltwater ices provide conditions that support microbial metabolism and biogeochemical processes [1]. In glacial ice, cells are physically located in the aqueous interstitial veins that exist at ice grain boundaries [2], and microbial persistence has been documented in samples of ancient ice cores many thousands of years old [e.g., 3,4]. However, little is known about the nature of microorganisms and their metabolic processes in englacial systems. During the summers of 2013-15, we examined microorganisms and associated metabolic activity a near-subsurface glacial environment in the ablation zone of the Matanuska Glacier, a temperate glacier located in southcentral Alaska.

Results: A number of boreholes were melted into the ice surface, some to depths of 30 m below the surface with a cylindrical cryobot prototype that uses a high-energy laser as the primary power source (see image). In shallow boreholes of ~4 m depth, we observed that removal of the water generated during melting resulted in the gradual infiltration of water from the walls of the borehole, indicating the adjacent ice was porous and contained a significant liquid water fraction at the time of sampling. The interstitial water collected was aerobic (~10 mg O_2 L^{-1}; ~70% air-saturation), and based on measurement of O_2 consumption and respiration, contained viable and metabolically active microorganisms. Based on measurement of photosynthetically active radition in the boreholes, light fluxes that could sustain photosynthesis (~1 μmol photons m^{-2} s^{-1}) were observed to depths of at least 3.5 meters below the surface. Based on small subunit rRNA gene amplification and sequencing, the composition of microorganisms in the interstitial water was distinct from assemblages entrapped in the ice, and in particular, was enriched with sequences most closely related to photosynthetic species in the phylum *Streptophyta*.

Conclusions: These data provide evidence for a seasonal ecosystem in near-surface ice at the ablation zones of temperate glaciers. Energy to support ecosystem processes may be derived from material entrapped within the ice and/or in situ organic carbon production via photosynthesis. Although liquid oceans are viewed as attractive targets in the search for life beyond Earth [5], warm ice at depth in the ice shell may also provide suitable habitat.

References: [1] Doyle, S.D. et al., 2012. Polar Microbiology: Life in a Deep Freeze. American Society of Microbiology Press, Washington, D.C., pp. 103-125. [2] Price, P.B. 2000. PNAS USA, 97:1247-1251. [3] Christner, B.C. et al., 2003. Environ Microbiol, 5:433-436. [4] Bidle, K.D., et al., 2007. PNAS USA, 104:13455-13460. [5] Priscu, J.C., and K. P. Hand. 2012. Microbe, 7:167-172.