Estimating Oxygen Flux Into Subglacial Lake Vostok, Antarctica, Using Englacial Radar Attenuation. P. Kintner[1], D. P. Winebrenner[2], K. Matsuoka[3], J. A. MacGregor[4]. [1]University of Washington Earth and Space Science Department (kintner@uw.edu), [2]University of Washington Applied Physics Laboratory, [3]Norwegian Polar Institute, [4]Institute for Geophysics, The University of Texas at Austin.

Introduction: Ice-covered seas, observed throughout the solar system, are compelling environments for life not only because of the presence of liquid water but also due to the possibility of chemical energy sources. On Earth, over 300 subglacial lakes [1] lie beneath the Antarctic ice sheet, of which Lake Vostok is the largest. These lakes are of direct importance to astrobiology because of their similarities to ice-covered seas in the outer solar system, such as Europa [2]. Chemoautotrophic microorganisms likely reside in Lake Vostok [3], and while not all microbes are dependent on oxygen, the presence of oxygen greatly increases the amount of chemical energy.

Quantifying the available chemical energy for metabolism is difficult for Europa, but Antarctic subglacial lakes offer numerous analogous and accessible environments. Energy availability in Lake Vostok depends on many specific environmental inputs. Chemical inputs into the lake come from sediments in the lakebed and the melting of ice-enclathrated air. While the former cannot be easily determined, the latter has been postulated.

Considerable amounts of radar-sounding data have already been collected over Lake Vostok, which could be used to further constrain the oxygen flux at the ice–lake interface there. Since radio-wave energy is absorbed by ice at a rate that depends predominately on temperature [4], the englacial attenuation of radio waves can be used as a proxy for englacial temperature. Hence, the distribution of melting and freezing at the ice–lake interface (the "lake lid") can be constrained and related to oxygen flux into Lake Vostok.

Methods: Freeze-on and melt rates at the bed of the ice sheet generate vertical advection and a heat source or sink at the lake lid. As such, shallower basal temperature gradients are associated with freezing conditions and steeper gradients under melting conditions. Freezing ice is warmer and will attenuate radio waves at a greater rate.

A 1-D steady-state temperature model is constructed in the style of Robin [5] that also accounts for the melting and freezing of ice at the lake lid. This model was fitted to the Lake Vostok borehole-temperature profile using the reported freeze-on rates reported by Bell *et al.* [6] and adjusting the millennial-scale surface accumulation rate accordingly.

We use 60-MHz airborne radar data grid over Lake Vostok collected by the The University of Texas at Austin's Institute for Geophysics to constrain the englacial radar-attenuation rate. To calculate this attenuation, we correct for spherical spreading, transmission loss at the surface, the lake-lid reflectivity, and refractive gain in firn. We assume that the attenuation due to englacial chemistry is horizontally uniform.

Results: Here this method is applied to modeled attenuation rates along the Vostok flow line calculated by MacGregor *et al.* [7]. The result is shown in Figure 1, by calculating freeze rates based upon a modeled depth-averaged radar-attenuation rate.

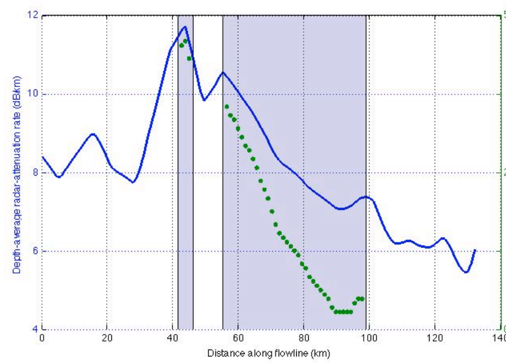

Figure 1. Depth-averaged radar-attenuation rate and inferred freeze-on rate at the lake lid along a flowline that passes through the Vostok ice core. The grayed areas are over Lake Vostok.

Discussion: Issues remain in the determining attenuation from the collected radar data. The surface reflection is clipped by the receiver, so we must estimate the transmitted power to then calculate the lake-lid reflectivity.

The temperature model is currently a steady state model, but the time scale for ice to traverse Lake Vostok is relevant to the vertical advection of ice. Therefore, a 2-D flowband model will be developed to understand the effect of a switch between melting and freezing as ice advects horizontally, as well as the effect of past climate forcing.

Methods developed here for inferring englacial temperature from existing radar data could provide further constraints for ice-sheet models.

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