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Understanding the underwater noise of melting glacier ice

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Ocean-forced melting of tidewater glaciers and ice shelves has the potential to drive grounding line retreat and ice shelf thinning that can, in turn, increase the mass flux from marine-terminating ice sheets into the global oceans, causing sea level to rise. Efforts to improve understanding of ice sheet–ocean interactions are key to reducing uncertainty in long-term estimates of global sea level rise. The question of how quickly ice melts under given far-field ocean conditions remains difficult to answer, though, in part because measurements of submarine melting rates are difficult to make. Some recent work suggests that conventional approaches may be significantly underestimating ambient rates of submarine melting. In recent years, progress has been made towards using passive acoustics to observe submarine melting. This method makes use of the sound produced by the release of air bubbles from the ice into the water. The bubbles are compressed by the overburden pressure in the ice, and are released rapidly into the water if their internal pressure is greater than the hydrostatic pressure in the water. So far, conclusions drawn from the use of passive acoustics to study submarine melt have been largely qualitative and comparative. Quantitative estimates of melting rates would require sufficient knowledge of the properties of the ice and the air bubbles trapped in it, and sufficient understanding of the physical processes involved in the sound production during release of the bubbles, to predict the total sound energy radiated per unit volume of ice that melts. We will present the results of experimental work carried out with glacier ice collected in Hornsund Fjord, Svalbard. Pieces of floating ice, calved from several glaciers in Hornsund Fjord, were collected and analyzed to determine bubble sizes and average gas pressure in the bubbles. Some blocks were melted in tanks and the sound produced during the melting was recorded. We have demonstrated a correlation between estimates of the potential energy stored by compressed air bubbles in the ice and the measurements of the acoustic energy released during melting. This represents a first step towards making quantitative estimates of submarine melting from passive acoustic measurements. Additionally, we will discuss implications of this relationship for potential applications of passive acoustic measurements of submarine melting of glacier ice.