Experimental Constraints on Ocean Wave Erosion of Icebergs and Glaciers
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Introduction
Global climate changes are leading to a rise in sea level through the melting of glaciers and ice sheets with warm ocean water. What processes and parameters control the rate at which waves transfer heat to ice, resulting in melting?

Theory
In 1980, at the University of Rhode Island, Dr. Frank M. White, and his colleagues, produced a technical paper that developed a theoretical estimate for iceberg deterioration. The estimates account for iceberg erosion for smooth and rough ice wall types, and includes variation for wave characteristics, such as amplitude and period. The theoretical estimate most closely matches the data collected by White and his team. This was the experiment that fell most in line with White's theoretical estimate. (Figure 1).

White’s theoretical melt rate was about 0.069 cm/min, which is about 3 times slower than the experimental rate found (Table 2).

White’s theoretical estimate most closely, suggests that the theory is valid for certain waves, but not all

White’s theoretical melt rate is on the lower end of the overall range – from 0.057 cm/min to 0.158 cm/min (Figure 8).

Research Objectives
• Expand on White’s work through:
  • Further experimental parameterization
  • Implement different wave characteristics – amplitude and period
  • Vary temperature – controlled air and water temperatures
  • Create larger database to test White’s theory

Methods
In order to conduct this study, a 1.29 meter long wave tank was used (Figure 2). This study tested various wave parameters, and followed White’s experimental setup as closely as possible. Certain tank size limitations and tank design (linear vs circular) differences were taken into account when comparing results to White’s theory (about 0.069 cm/min).

Preliminary Results
The range of average melt rate was higher than anticipated for all experiments, except Experiment 3, which matched White’s theoretical estimate most closely, and thus will be used for the remainder of the project (Figure 4).

Temperature-Controlled Experiments
The wave tank was moved inside of a freezer to control the rate at which waves transfer heat to the block, in which was placed at the end of the tank. Video was taken to track changes in erosion (Figure 3).

Temperature-Controlled experiments fell within a factor of 3 from the theoretical estimates, which suggests that the theory is valid for certain waves, but not all

Future Work
• White’s theoretical estimates fall within a factor of 3 of our replication experiments
• Temperature, water height, and wave parameters play a significant role in melt rates
• Further experimentation may lead to a greater confidence in White’s theory, by providing insight into the cause of the differences
• Difference in experimental and theoretical erosion rates may be caused by systematic differences

Conclusion
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