

The nearshore ice complex is a seasonal structure, where shifting ice forms large, highly variable structures along the shorelines of large temperate lakes. Many geomorphological forces such as temperature, wind, and shoreline shape contribute to, and affect the annual formation and destruction of the nearshore ice complex. This research is important because the nearshore ice complex is a significant driver of shoreline change and erosion on the Great Lakes, which is relevant to shoreline development regulations. This research also informs the general public about the relative dangers of these nearshore ice structures, which will be important for public safety amid rising winter tourism within the Great Lakes region. Further research on this topic is needed because past research is in the context of civil engineering, and present geological field methods are not sufficient to analyze this dynamic structure on a large scale. This research applies and develops modern field methods utilizing digital photography, photogrammetry, and computer aided analysis. These methods are capable of analyzing the temporal and spatial scale of the nearshore ice complex in greater detail than has been previously possible.

Photogrammetry is the method of creating a three-dimensional model of an object by processing a collection of overlapping two dimensional images. Due to recent advances in computer processing and image quality, this method is becoming increasingly accessible. For this project, we utilize Agisoft PhotoScan, a photogrammetry processing and analysis software. In this work, image capture is done using a Samsung S4 cell phone with a 13 megapixel camera. The field methods of close range and aerial photogrammetry have been adapted from a paper by Neffra Matthews of the Bureau of Land Management.

The Lake Michigan nearshore ice complex was observed in the field at three locations, Atwater Beach, Milwaukee County, Lion's Den Gorge, Ozaukee County, and Robert LaSalle County Park, Door County. These sites were selected based on their natural, undisturbed shorelines, and varied beach types. Three three-dimensional models of ice features from Robert LaSalle County Park have been produced. Numerous ice features and residual features such as ice lagoons, ice caves, ice volcanos, ice groins, and ice channels have been identified, described, and documented at Atwater Beach and Lion's Den Gorge. Additionally, a three-dimensional scale bar used for calibrating photogrammetry models and a gravity indicator used for leveling photogrammetry models have been developed. Several open questions regarding the challenges of outdoor close range photogrammetry have been answered, such as the effect of moving water on model processing. Future field methods utilizing drone videography and streamlined model processing methods have been described and are being prepared for future field seasons.

The Lake Michigan nearshore ice complex is a natural laboratory for the development of next generation geoscience field methods. The challenges presented by the dynamic environment of the nearshore ice complex necessitates the development of new tools and methods in order to advise shoreline development regulation and to inform public safety. This work will guide the future development and application of photogrammetric research in the field of geosciences.