Modeling and Analyzing Melting Arctic Sea Ice with Percolation Theory

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Extreme losses in summer Arctic sea ice pack, a leading indicator of climate change, have led to the need for significant revisions of global climate models. Part of the efforts to improve these models is an increased emphasis on sea ice albedo (reflectance), which is closely related to the formation of melt ponds on the sea ice. This project investigates the novel use of percolation theory to model melt pond formation. Innovative methods were implemented to calculate the percolation probability as a function of p, the probability of an edge being open. The results were analyzed to determine the critical threshold value pc, which was compared with the known value of 0.50 for a two dimensional square lattice. This model was then adapted to determine the critical area threshold for melt ponds on sea ice as 0.4845, which had not been numerically determined previously. This threshold allows for simple detection of percolation, and thus also changes in the albedo and the melting rate of the sea ice. The calculation of this parameter is a first step to creating more dynamic models for the growth and disappearance of melt ponds over time. Keywords: Climate Change, Sea Ice Albedo, Graph Theory, Composite Materials Theory, Percolation Thresholds, Recursion, Weighted Sparse Matrices

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