

Ising model for melt ponds on Arctic sea ice

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ABSTRACT: Perhaps the most iconic feature of melting Arctic sea ice is the formation of distinctive, complex ponds on its surface during late spring. The evolution of melt ponds and their geometrical characteristics determines the albedo of sea ice, a key parameter in climate modeling. However, a theoretical understanding of this evolution, and predictions of geometrical features, have remained elusive. To address this fundamental problem in polar climate science, here we introduce a two dimensional random field Ising model for melt ponds. The ponds are identified as metastable states of the system, where the binary spin variable corresponds to the presence of melt water or ice on the sea ice surface. With only a minimal set of physical parameters, the model predictions agree very closely with observed power law scaling of the pond size distribution and critical length scale where melt ponds undergo a transition in fractal geometry.