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A network model for ponding on sea ice

Michael Coughlan
University of Oxford, Mathematical Institute, Mathematics, Oxford, United Kingdom of Great Britain – England, Scotland, Wales (coughlan@maths.ox.ac.uk)

I present a physically-based network model for systems of ponds which accounts for both the individual and collective behaviour of ponds, and allows us to investigate the behaviour of both. Each pond initially occupies a distinct catchment basin and evolves according to a mass-conserving differential equation representing the melting dynamics for bare and water-covered ice. Ponds can later connect together to form a network with fluxes of water between catchment areas, constrained by the ice topography and pond water levels.

I use the model to explore how the evolution of pond area and hence melting depends on the governing parameters, and to explore how the connections between ponds develop over the melt season. Comparisons with observations are made to demonstrate the ways in which the model qualitatively replicates properties of pond systems, including fractal dimension of pond areas and two distinct regimes of pond complexity that are observed during their development cycle. The network structure, and tools from percolation theory also allows us to probe how the connectivity of pond systems affect the system at each stage of development.