

Critical Behavior of Electrical Transport in Sea Ice

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Fluid flow through porous sea ice mediates the evolution of melt ponds, the formation of snow-ice, the exchange of heat and CO₂ between the atmosphere and ocean, and nutrient replenishment for microbial communities. However, fluid can flow vertically through columnar sea ice only if the brine volume fraction is above about 5%. In two very different experiments conducted in the Arctic and Antarctic, we have found the electrical signature of this transition in fluid transport. Above this threshold, the vertical conductivity is accurately described by percolation theory with a universal critical exponent. The data also indicate marked changes in the conductivity profile with the onset of melt ponds, the principal determinant of Arctic sea ice albedo. Our findings lay the foundation for the use of electromagnetic monitoring in studying transport phenomena which are important in gauging the impact of climate change on the polar ice packs and their ecosystems.