

December 19, 2011

Dear Editor,

We are pleased to submit our manuscript entitled, "Critical behavior of electrical transport in sea ice," for publication in *Nature Geoscience*. The electrical properties of sea ice have been studied for almost five decades, due to their importance in remote sensing of Earth's ice packs, and in monitoring thickness, porous microstructure, and transport and exchange processes. In two different experiments in the Arctic and Antarctic, we have found that the vertical electrical resistivity of sea ice undergoes a dramatic transition around a brine volume fraction of 5%. Through mathematical analysis relating electrical and fluid transport in sea ice, we show that this critical behavior is the electrical signature of a key phenomenon known as the *rule of fives* (Golden *et al.*, *Science*, 1998.). For brine volume fractions below about 5%, columnar sea ice is effectively impermeable to fluid flow, while it is increasingly permeable for volume fractions above this threshold value.

Fluid flow through sea ice mediates a broad range of processes that are important to its role in Earth's climate system as well as to the rich polar ecosystems, and it is the rule of fives which substantially controls such processes. By explicitly linking electromagnetic and fluid transport properties, our results thus lay the foundation for new techniques of tracking important sea ice properties and processes at a time of major transformations in the polar regions. In fact, we are able to electrically classify various layers in sea ice in terms of their fluid flow properties, thus connecting specific electrical signatures to important transport processes such as melt pond drainage, CO<sub>2</sub> pumping, and nutrient fluxes. Due to the broad implications of our work to studying polar climate and biology, as well as its highly interdisciplinary nature involving field experiments, mathematical analysis, phase transitions in statistical physics, and connections to other geophysical media such as porous rocks, we believe that a significant portion of your readers would be interested in this manuscript.

Thank you very much for your consideration.

Sincerely yours,



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