



## Modeling self organization of non-sorted circles

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Non-sorted circles are an abundant form of patterned-ground with limited vegetation located in the arctic tundra. These features can be found on fine-grained, frost-susceptible, moist to wet soils, mostly underlain with permafrost. The age of these patterns is estimated to be thousands of years, while during this time period the shape and size of these patterns is maintained. Biological versus physical interactions in the non-sorted circle system are balanced. Succession drives vegetation toward the center of the circle, where frost heave prevents vegetation development. Insulation due to vegetation and snow, drive a temperature difference in the soil profile during freezing. This temperature difference causes ice to accumulate in lenses, which prevents plant roots from developing. Over the lifetime of such a system, vegetation is successful in areas with minimum heave, resulting in an accumulation of organic matter, which stabilizes the system beyond the balance between heave and growth. This paper focuses on the initial-self organization of non-sorted circle systems. Landscapes, in which we observe non-sorted circles, underwent a transformation from barren homogeneous soils without circles to vegetated with circles. We discuss two theories for the initial development of the system. The first is instability of the freezing process, which results in a regular vegetation pattern, and the second being initial establishment of random vegetation with redistribution of liquid water, that results in a semi-regular vegetation pattern. The 'Differential Frost Heave model DFH' was applied to simulate

the initiation of non-sorted circles from bare soil. The 'WIT3D-ArcVeg model' is a heat and moisture transfer model coupled with an arctic vegetation succession model, was applied to simulate pattern formation and identify the stability between heave and growth of the regular pattern initiated by the DFH model. The models were compared and contrasted for field data obtained from Franklin Bluffs in Northern Alaska, using the number density of non-sorted circles, the vegetated cover area, and the amount of heave.