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Resilience of Alaskan Boreal Systems: the mechanistic role of soil temperature in fractal geometry of fire scars

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The influence of near-surface discontinuous permafrost on ground-fuel storage, combustion losses, and post-fire soil climates was evident from a detailed study near Delta Junction, Ak in a 1999 wildfire. At this site, we sampled soils across a factorial design of burning (burned and unburned) and permafrost (permafrost and non-permafrost). Summer surface temperatures at 40 ∼meter square plots were significantly and negatively correlated with organic mat thickness, despite the wide range of shading, burning, and moisture content. Before and after burning, sites underlain by permafrost retained thicker mats of organic matter, with combustion losses not significantly different on permafrost vs non-permafrost landscapes. Therefore landscape patterns dictated by near-surface permafrost were maintained post-burn because of the fundamental role that ground fuels play on shallow soil temperature and resulting vegetation succession. Meanwhile, the slope between log fire number and log fire size for large fires (i.e., the fractal relationship) is similar between 1999 and the average for the fire record for the past ∼20 years of fire history, suggesting that our study year was typical of the recent past. We hypothesize that such patterns of ground fuel, fire severity, and soil temperature form the physical and mechanistic basis for spatial patterns in ecosystems that are maintained over fire cycles. By contrast, most recent fire year of 2004 was dramatically different from the historic and 1999 and historic fractal solutions. We hypothesize that a threshold by which the system responds differently was detected by the fractal relationship of fires in 2004. As a test to this hypothesis, we will analyze patterns of burn severity in permafrost and non-permafrost landscapes from 2004 fires.