AVALANCHE CROWN DEPTH DISTRIBUTIONS

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EXTENDED ABSTRACT:

Other researchers have suggested that crown depths follow either a scaling distribution (Birkeland and Landry, 2002; Faillettaz et al., 2004; Rosenthal and Elder, 2003) or a lognormal distribution (McClung, 2003; 2005). A variety of generating mechanisms have been proposed including: Self-Organized Criticality (Birkeland and Landry, 2002; Faillettaz et al., 2004; Louchet et al., 2002), chaotic processes (Rosenthal and Elder, 2003), and components of fracture toughness, including fracture size, creep, bonding and crack propagation (Heierli et al., 2008; McClung, 2005). We test seven distributions on two large avalanche crown depth datasets, from Mammoth Mountain, CA and from the entire Westwide Avalanche Network, to determine which fits best.

The generalized extreme value distribution provides a robust fit on path and area scales for crown depths above 30.5 cm at Mammoth Mountain. The most parsimonious explanation is neither self-organized criticality nor other complex cascades, but maximum domain of attraction; that is the maximum crown depth, not the average, is most commonly recorded. This recording bias generates scaling or power law distributions. More field observations on avalanche crown faces are needed to investigate whether individual avalanche crown face depths are scaling. Given the highly variable nature of snow depth, this result would not be surprising.

We also show that avalanches do not have a universal tail index. Rather, they range from 2 to 4 over different avalanche paths, consistent with other geophysical phenomena such as wildfires, which show similar variability (Malamud et al., 2005). We urge practitioners to record crown depth at multiple locations on crown faces. Last, we suggest using extra caution on stubborn paths, which can be identified by their low tail indices.

KEYWORDS: power laws, statistical distributions, extreme value theory, scaling

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