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Interactions between thresholds and spatial discretizations of snow: insights from estimates of wolverine denning habitat in the Colorado Rocky Mountains

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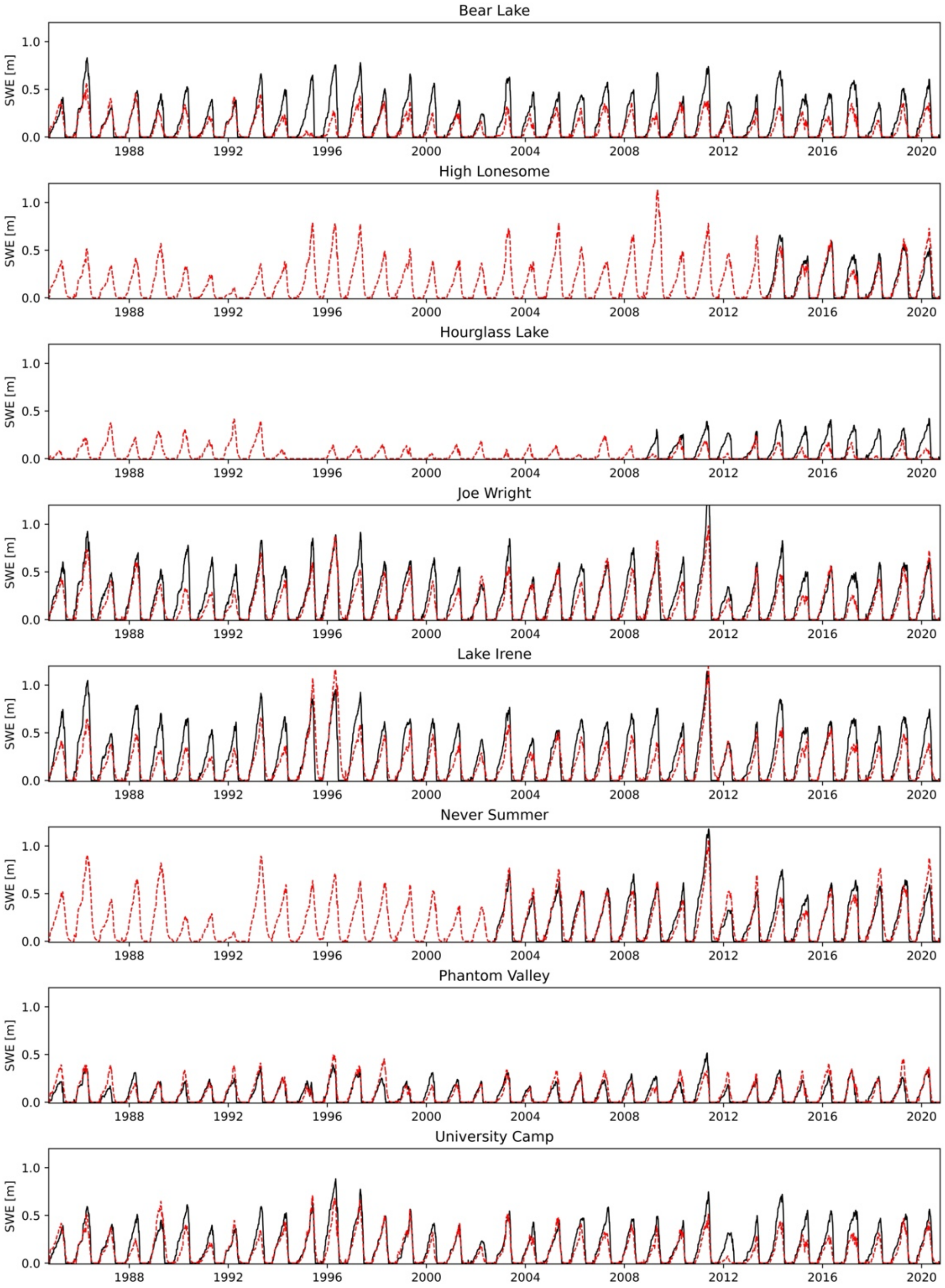
Bear Lake

High Lonesome

Hourglass Lake

Joe Wright

Lake Irene

Never Summer

Phantom Valley

University Camp

Figure S1. SWE compared between SNOTEL point observations (black) and the 90m overlapping grid cells from the snow reanalysis (red, dashed).

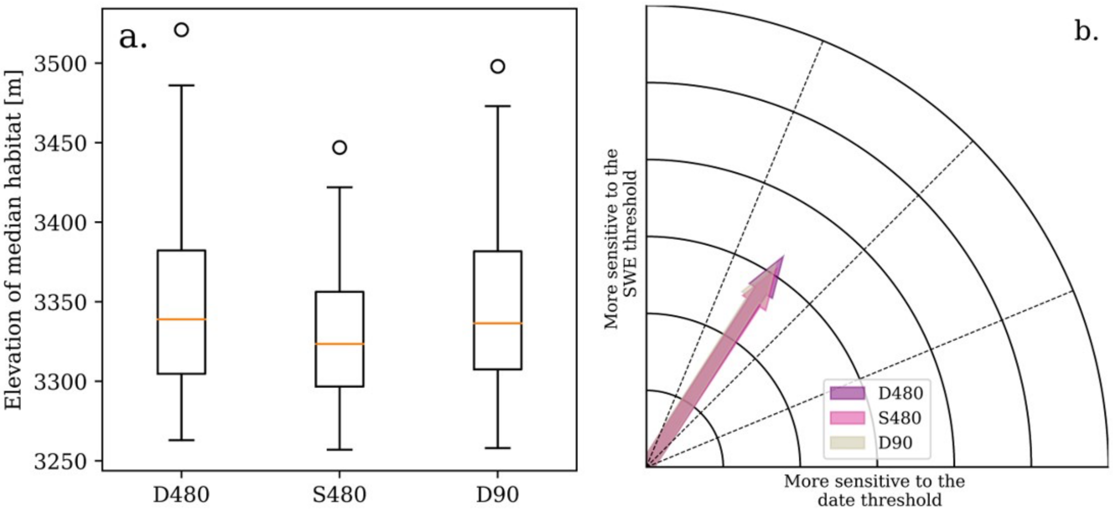

Figure S2. The spread of elevations of median habitat (a) and the average threshold sensitivities (b) for each discretization across the full 36-year reanalysis period.

Section S1: Subgrid CoV of snow accumulation

The evolution of subgrid SWE heterogeneity was parameterized using a method developed by Liston (2004). This method relied on an estimate of the coefficient of variation (CoV, Eq. 1 in the main text) of the subgrid accumulation of SWE, which was assumed to be constant throughout the accumulation season. More information on this method can be found in Section 3.1 of the main text. It is important to note that although both Liston (2004) and Sturm and Liston (2021) provide estimates of CoV for the contiguous United States, we estimated CoV using the 90 m reanalysis gridcells that covered each 480 m reanalysis gridcell (discussed more below). In doing so, we ensured similarity between the three discretizations.

To estimate the CoV of subgrid SWE accumulation, we extracted the daily SWE accumulation maps (snowfall maps) from all days with increases in total SWE volume from the 90 m reanalysis. We then filtered snow dusting events by keeping only SWE accumulation maps with total snowfall magnitudes greater than the 10th percentile. Then, we extracted the 90 m snowfall maps that fell within the bounds of each 480 m gridcell. For each subset group of 90 m snowfall maps, we performed a principal component analysis (PCA) (space component) across the 36 years of events (time component).

We found that the first principal component (PC1) described approximately 89% of the spatial variability of SWE accumulation patterns, on average. However, at lower elevations (< 2700 m), PC1 was slightly less-informative (~52% of the variance). This was not surprising given the smaller amounts of snow, fewer snowfall events, and spatially-variable snow accumulation (relative to mean snow accumulation) at these elevations. However, more than 90% of the 480 m gridcells exhibited subgrid snow accumulation patterns that were time-invariant. In other words, the 90 m spatial pattern of deeper and shallower snow deposition persisted for more than 90% of the snowfall events. In short, PC1 explained the dominant pattern of snow accumulation well, in both space and time. Therefore, 90 m SWE accumulation was recalculated for each snowfall event and gridcell using only the dominant pattern (PC1) for each 480 m gridcell. Then, the CoV of subgrid SWE accumulation was calculated from gridcells that fell within each 480 m gridcell for each individual snowfall event. Finally, the median CoV was then calculated across all snowfall events, and used to calculate the CoV map shown in Figure 2b. We acknowledge that the spatial pattern of individual snowfall events sometimes varied. However, by parameterizing the CoV of subgrid SWE accumulation using the most-dominant pattern of SWE accumulation (PC1), we captured the most-informative and most-prominent mode of snow accumulation. This is particularly true since snow accumulation in mountainous terrain may vary on an event-by-event basis, but is most-driven by season-cumulative snowfall, which often exhibits repeatable patterns (e.g., Pflug et al., 2021; Schirmer et al., 2011; Vögeli et al., 2016).

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