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Investigating the Thermophysical Properties of the Ice-Snow Interface Under a Controlled Temperature Gradient

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Of critical importance for avalanche forecasting, is the ability to draw meaningful conclusions from a handful of field observations. To this end, it is common for avalanche forecasters to not only have to rely on these sparse data, but also to use their own intuitive understanding of how these observations are correlated with the complex physical processes that produce mechanical instabilities within a snowpack. One such example of this is the long-held notion that kinetic snow metamorphism does not occur at bulk temperature gradients of less than -10°C/m. Although this may be true for the homogeneous case, it has become a point of contention as to whether or not this guideline should be applied to the more representative case of a heavily stratified and anisotropic snowpack. As an idealized case for our initial laboratory investigations, we have studied how an artificially created ice layer or "lens" would affect the thermophysical state of the snow layers adjacent to the ice lens and the ice lens itself, while being held under a controlled temperature gradient. Our findings have shown, via in-situ micro-thermocouple measurements, that a super-temperature gradient many times greater than the imposed bulk temperature gradient can exist within a millimeter above and below the surface of the ice lens. Furthermore, microstructural analysis via time-lapse X-ray Micro-Computed Tomography and environmental SEM imaging has been performed. Results from this analysis show new ice crystal growth and kinetic snow metamorphism occurring simultaneously on or near the ice lens itself with the connectivity density at the ice-snow interface increasing markedly more below the ice lens than above.