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# Impacts of small-scale variability on the determination of bulk thermal diffusivity in snowpacks

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Thermal diffusivity of snow is an important physical property associated with key hydrological phenomena such as snowmelt and heat and water vapor exchange with the atmosphere. These phenomena have broad implications in studies of climate and heat and water budgets on many scales. Furthermore, sub grid scale phenomena may enhance these heat and mass exchanges in the snow pack due to its porous nature. We hypothesize that the heat transfer effects of these small-scale variabilities may be seen as an increased bulk thermal diffusivity of the snow. Direct measurements of snow thermal diffusivity require coupled measurements of thermal conductivity and density, which are nonstationary due to snow metamorphism. Furthermore, thermal conductivity measurements are typically obtained with specialized heating probes or plates and snow density measurements require digging snow pits. Therefore, direct measurements are difficult to obtain with high enough temporal resolution such that direct comparisons with atmospheric conditions can be made. This study uses highly resolved temperature measurements from the Plaine Morte glacier in Switzerland as initial and boundary conditions to numerically solve the 1D heat equation and iteratively optimize for thermal diffusivity. The method uses flux boundary conditions to constrain thermal diffusivity such that spuriously high values in thermal diffusivity are eliminated. Additionally, a t-test ensuring statistical significance between solutions of varied thermal diffusivity results in further constraints on thermal diffusivity that eliminate spuriously low values. The results show that time resolved thermal diffusivity can be determined from easily implemented and inexpensive temperature measurements of seasonal snow with good agreement to widely used parameterizations based on snow density. This high time resolution further affords the ability to explore possible turbulence-induced enhancements to heat and mass transfer in the snow.