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Determining thermal diffusivity of snow from highly resolved temperature measurements

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The thermal diffusivity of snow is an important quantity associated with key snow hydrology phenomena such as heat and mass exchanges with the atmosphere. However, direct measurements of snow thermal diffusivity require coupled point measurements of thermal conductivity and density, which are nonstationary due to snow metamorphism. Furthermore, these point measurements generally require digging snow pits and hence, are difficult to monitor with significant temporal resolution. Therefore, the ability to obtain a bulk thermal diffusivity with inexpensive and easily implemented measurement techniques becomes important for better understanding of exchanges between snow surface and atmosphere over the course of a season. This study uses highly resolved (7.5 to 10 cm for depth and 1 min for time) temperature measurements from the Plaine Morte glacier in Switzerland to determine thermal diffusivity by numerically solving the 1D Fourier equation. These solutions are compared to the measurements and subsequently, thermal diffusivity is determined by the solution that minimizes the error. Results compare well with values of thermal conductivity reported in the literature for various densities. Additionally, the determined thermal diffusivity values are used to explore turbulence-induced heat and mass transport at the interface of snow and atmosphere.