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Sensitivity of Turbulent Fluxes to Wind Speed over Snow Surfaces in Different Climatic Settings

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Local wind speed variations influence the energy and mass fluxes over snow either through snow accumulation, sublimation of drifting and blowing snow, or variations in turbulent fluxes over static snow and ice surfaces. We use idealized model experiments to analyze the sensitivity of turbulent fluxes over static snow surfaces to variations in wind speed under different climatic conditions. We find that the sensitivity increases with increasing air temperature and relative humidity. The sensitivity of turbulent fluxes is highest when the stability parameter $\zeta = 1$, which occurs at wind speeds typical for glacierized catchments (3–5 m s^{-1}), and exponentially decreases either side of that range. That peak in sensitivity is caused by atmospheric stability effects, and occurs independently of the flux-profile relationships we tested. We quantify the significant effect of local wind speed variations on turbulent fluxes over snow and ice, which can be interpreted as the potential modeling error if the local wind speed is not known or has an error. Our results therefore help to better understand the often discussed sensitivity of energy balance models to (high quality) input data.