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The effect of the Antarctic katabatic winds on near-surface temperatures

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A two-dimensional mesoscale model was applied to simulate winter-time katabatic winds in the Antarctic coastal region. Simulations were made for a constant slope angle with the slope height varying and for fixed slope heights with the slope angle varying. In all cases simulated, the 2-m potential temperature decreased along the slope fall line towards sea ice. With the slope aspect ratio of 5 m/km and a slope height below 1000 m, 2-m temperature (T2m) decreased down the slope. Three mechanisms contributed to the decrease: (a) the katabatic wind resulted in accumulation of cold near-surface air over the sea ice and the lower parts of the slope, (b) over the flat sea ice zone, the stratification was stronger, and (c) the shallow slope was within the strong surface inversion from over the sea ice. On the contrary, for slope heights of 1500 m and more T2m increased down the fall line. Adiabatic warming and, due to stronger wind, enhanced turbulent mixing of the warmer inversion air from aloft contributed to the warming, dominating over the cooling mechanisms (a-c). With a small slope height of 500 m, for all slope angles ranging from 1 to 20 m/km, T2m decreased along the fall line but not monotonically. With a slope height of 2000 m, yielding stronger winds and larger adiabatic warming, for all slope angles between 1 and 20 m/km, T2m increased monotonically down the fall line. The model results were supported by observations from several Antarctic sites with different topographic conditions.