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Modelling advection of heat over patchy snow

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For large-scale atmospheric and hydrological models, efficient parametrizations are required to calculate average surface heat fluxes on the catchment or grid scales on which these models are applied. Melting snow is generally patchy on these scales, and there can be large spatial variations in surface fluxes. Snow-free ground has a much lower albedo than snow, and its temperature is not limited to the melting point, so it can become substantially warmer than the surrounding snow, and upward fluxes of sensible heat from the surface warm the air. As this warmed air flows over a snow patch, downward heat fluxes cool the air and warm the snow; heat is thus advected from snow-free ground to snow and provides an additional source of energy for melt. An internal boundary layer in which air temperatures and heat fluxes differ from those at the upwind edge of the snow patch develops and grows in depth with downwind distance. Standard flux parametrizations based on the assumption of a constant flux layer are inappropriate in this situation. A simple model for advection of heat over heterogeneous snowcover will be presented and results from this model will be compared with measured temperature profiles and internal boundary layer growth rates over snow patches. Parametrizations for heat fluxes over isolated snow patches, regular patterns of snowcover and more realistic complex snowcover distributions will be discussed and evaluated in comparison with results from the advection model.