

## Sensible Heat Balance Determines Subsurface Evaporation or Freezing and Thawing Rates

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Recent advancements in fine-scale measurements of soil thermal properties provide new opportunities to observe heat transfer associated with soil-water evaporation in the upper centimeters of the vadose zone and with soil freezing and thawing in the soil profile. Heat-pulse sensors provide all of the necessary measurements required for sensible heat balance determinations. The residual from a sensible heat balance (i.e., the net sensible heat flux minus the change in heat storage) is attributed to latent heat from water evaporation/condensation in unfrozen soil or to latent heat from freezing/thawing in partially frozen soil. Evaporation estimates from the sensible heat balance provide depth and time patterns consistent with observed soil-water depletion patterns. Sensible heat balance is particularly useful for quantifying the initial soil freezing rates. Implementation of fine-scale measurement techniques for the soil sensible heat balance provides a new opportunity to improve the understanding of soil-water evaporation and soil freezing.

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