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Estimating active layer thickness from remotely sensed surface deformation

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We estimate active layer thickness (ALT) from remotely sensed surface subsidence during thawing seasons derived from interferometric synthetic aperture radar (InSAR) measurements. Ground ice takes up more volume than ground water, so as the soil thaws in summer and the active layer deepens, the ground subsides. The volume of melted ground water during the summer thaw determines seasonal subsidence. ALT is defined as the maximum thaw depth at the end of a thawing season. By using InSAR to measure surface subsidence between the start and end of summer season, one can estimate the depth of thaw over a large area (typically 100 km by 100 km). We developed an ALT retrieval algorithm integrating InSAR-derived surface subsidence, observed soil texture, organic matter content, and moisture content. We validated this algorithm in the continuous permafrost area on the North Slope of Alaska. Based on InSAR measurements using ERS-1/2 SAR data, our estimated values match in situ measurements of ALT within 1-10 cm at Circumpolar Active Layer Monitoring (CALM) sites within the study area. The active layer plays a key role in land surface processes in cold regions. Current measurements of ALT using mechanical probing, frost/thaw tubes, or inferred from temperature measurements are of high quality, but limited in spatial coverage. Using InSAR to estimate ALT greatly expands the spatial coverage of ALT observations.