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Imaging unsaturated water flux in an ice-contact delta structure by GPR tomography inversion

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Three cross-well Ground Penetrating Radar (GPR) datasets, from two adjacent wells, were collected near Oslo's Gardermoen airport (Norway) before, during and after snowmelt in 2005. Velocity images from the GPR data, obtained using ray tracing and travel time tomography, provide a time dependent 2D picture of the vadose zone. The velocity images show two distinct units, the latter one with dipping structures. The results from the images are independently confirmed by surface GPR data and core data, as well as knowledge of local sedimentary geology. Hydrological parameters (porosity and water content) were estimated using the velocity tomograms. Porosity was estimated by combining an empirical model (Topp et al, 1980) and a physical model (Roth et al. 1990). The uncertainty varies from 0% to 7%. Water content was also compared to independent neutron probe measurements. Observed variations in the water content are consistent, and are interpreted to be a function of the amount of infiltration (which was non uniform due to local shrubbery), soil heterogeneity and the capillary zone. Finally, water balance in the vadose zone between cross-wells is calculated using local snow accumulation and regional precipitation data. Water balance calculation shows that there is also flux in non-vertical directions.