Forecasting the degradation of deep permafrost using temperature-depth observations

Victor Bense (1), Annabelle Neefjes (1), Huijun Jin (2), and Yu Sheng (2)

(1) Wageningen University and Research, Department of Environmental Sciences, Wageningen, Netherlands
(victor.bense@wur.nl), (2) Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, Lanzhou, Gansu, PR China

Timing of permafrost disappearance in a warming climate is a crucial control on a suite of environmental processes including the reactivation of groundwater flow, landscape development and the associated release of carbon into the atmosphere. Forecasting of permafrost demise has mainly been approached as a near-surface phenomenon from the land-surface modeling perspective, with limited consideration of heat flow processes below a few meters depth. We show, using numerical models and temperature-depth profiles of warm and vulnerable permafrost that the thermal state of deep permafrost during thaw can be obtained using relatively simple measurements of the depth at which thermal gradient is zero, the temperature at this depth and the thickness of permafrost, without the need of repeated measurements. As an example, we demonstrate that across the Source Area of the Yellow River on the Qinghai-Tibet Plateau, China it will take approximately another 80 -140 years before permafrost will be fully degraded.