Past and possible future evolution of the Yukon Flats southern upland yedoma region, Alaska

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The course of permafrost degradation depends on climate, vegetation, disturbance, and excess ground-ice content and distribution, which vary over time. The first three of these drivers are undergoing considerable change with arctic warming. Using combined lake-sediment records, field observations, aerial observations and LiDAR imagery, we reconstructed the late-Quaternary history of the marginal upland of the Yukon Flats, interior Alaska, a loess-mantled region with massive ground ice and numerous thermokarst lakes that is identified as yedoma. A switch to warmer, moister conditions during deglaciation triggered substantial thermal erosion and transport of silt, which washed into existing basins and formed widespread linear corrugations cutting across the uplands. Lakes began to form via thermokarst as early as 13,000 cal yr BP. Lakes intersect the corrugations, indicating lake formation followed initial landscape instability. Charcoal in basal sediments indicates fire may have influenced lake initiation. Small-scale surface topography revealed by LiDAR images includes deep gullies, features resembling lake drainage channels, and lowered lake shorelines. After ca 10,000 yr BP the region became colonized by dense evergreen conifer forest, which likely served to stabilize and insulate the ground surface, preventing the continuation of the high rates of permafrost degradation recorded in the earliest Holocene. Initial lake lowering and generation of steep local topography favouring drying of uplands, plus a summer water deficit, have also likely combined to shift the system to a more quiescent state through much of the Holocene. However, these changes have not prevented lake drainage events entirely. In 2013, several lakes drained or partially drained, possibly in response to fires and a high spring melt-water volume. The observed pattern of drainage is echoed in the older features preserved on the land surface. Based on the Holocene evolution of the region, increasing regional moisture and/or fire disturbance in the future could lead to an increase in permafrost degradation and lake drainage events.