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Mass movements in lowland permafrost terrain, northern Canada: implications for climate change

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Long-term observations of geomorphic processes are recognized as essential to capture the true frequency of episodic landsliding processes. However, measurements at lowland study sites on the Fosheim Peninsula, Ellesmere Island (80˚N) show that while strain is generally greatest in the basal part of the active layer leading to convex-downslope velocity profiles (e.g. on one slope, 70% of the surface movement from 1991-2005 occurred in the bottom 8 cm), considerable temporal variability exists in solifluction rates. Average velocities from 1991-1996 were lower than those for 1996-2005 and displacements occurred higher in the active layer.

Active-layer detachment constitutes the major type of rapid mass movement in the study areas. Major landsliding events triggered by one to two weeks of high surface heating occurred in 1987, 1988 and 1998, and in 2005 the mechanism of detachment failure was observed for the first time in the field. Some active-layer detachments developed almost instantaneously as had been inferred previously, but others enlarged over several days. In the latter case, displaced material moving at velocities ranging from $<$1 to 9 cm/minute overloaded the otherwise stable terrain downslope. Such progressive development helps explain how some slides can extend onto very low-angled slope segments (less than 3˚).

The increase in solifluction rates in the 1996-2005 period when two major episodes of detachment sliding also occurred suggests that short periods of particularly strong surface heating are important to both processes. The implications are that warmer summers may enhance both slow and rapid mass movement activity in areas of cold permafrost providing they include short periods of high energy inputs.