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ICESat-Derived Surface Changes Across the Permafrost Zones of Eurasia and North America

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An outcome of the intensification of permafrost research during the International Polar Year is the recognition that Pan-Arctic landscapes are changing from thermokarst processes and wildfire occurrence (instability and feedback), and permafrost thawing which will impact human communities and livelihood. Lunched in January 2003 through middle October 2009 the Ice, Cloud and land Elevation Satellite (ICESat) Geoscience Laser Altimeter System (GLAS) provided high-accuracy global land-surface elevation measurements. GLAS exact-repeat elevation data offer snap-shots of land-surface elevation changes. Our processing removes backscatter and cloud errors and transforms to the terrestrial reference-frame World Geodetic System 1984 – Earth Geopotential Model 1996. In our investigation we use the exact-repeat elevation changes across the arctic landscapes of Eurasia and North America to derive signatures of changing permafrost regions. In Alaska, the Wainwright tundra wildfire of 1993, south of Barrow, Alaska offers a reference-frame of elevation changes long-after wildfire occurrence. Across this fire-scar difference profiles show a progression of elevation changes in the form of terrain roughening from June 16 2004 to November 23 2006. Gullies deepened up to 1.7 m with some lateral migration. Intra-gully areas show elevation decreases on north-facing slopes and elevation increases on south-facing slopes. Published reports confirm thermokarst degradation of ice-wedges and permafrost beneath gullies. We suspect cryoturbation with sub-surface water movement into intra-gully areas promoting water mass redistribution. On field-monitored tundra fire-scars in Canada both active layer thinning with subsidence and ice aggradation at the top of permafrost with surface uplift have been observed. Our presentation will give comparison of ICESat-derived surface changes in the high-latitude permafrost zones of Eurasia and North America.