InSAR detection of thermokarst after a tundra wildfire, using ALOS-PALSAR

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Through the subsidence of ice-rich permafrost upon thaw (thermokarst), the consequences of
permafrost degradation for surface ecology, landscape evolution, and hydrological processes have
been of great scientific interest and social concern. Part of a tundra patch affected by wildfire
in northern Alaska (27.5 km2) was investigated here, using remote sensing and in-situ survey to
understand permafrost thaw dynamics after surface disturbances. L-band InSAR with spatial
resolution of less than ten meters detected ground subsidence triggered by the tundra fire. We
introduced a calibration procedure comparing burned and unburned areas for InSAR subsidence signals
to remove the noise from seasonal surface movement. In the first year after the fire, an average
surface subsidence rate of 6.2 cm/year (vertical) was measured. Subsidence in the burned area
continued over the following two years with decreased rates. These results suggest that this
InSAR-measured ground subsidence is caused by the thaw of ice-rich permafrost (thermokarst), a
feature supported by surface change observations from high-resolution optical images and in-situ
ground level surveys. InSAR analysis clearly showed spatial variation in thermokarst subsidence at
fine scale, enabling us to investigate dynamics of thermokarst processes and quantify permafrost
degradation, and leading to accurate estimates of ground ice loss upon permafrost thaw.