EGU22-12301
https://doi.org/10.5194/egusphere-egu22-12301
EGU General Assembly 2022

Spatiotemporal post-fire change analysis using optical and SAR imagery

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Wildfires on permafrost covered with the boreal forest can influence vegetation composition, surface soil moisture, and the active layer. Since wildfires on permafrost occur extensively in unpredictable areas, remote sensing is a useful tool for monitoring burn severity and ecosystem changes. Optical spectral indices such as the differenced normalized burn ratio (dNBR) and normalized difference vegetation index (NDVI) were traditionally used to detect burn severity and vegetation regrowth. However, since optical imagery is significantly affected by cloud cover and weather conditions, there is a limitation in acquiring temporally dense images. Synthetic Aperture Radar (SAR) can obtain images regardless of day/night or weather conditions, so it is possible to densely observe the area of interest spatiotemporally. In addition, SAR images, unlike optical images, can acquire information on the active layer of the permafrost in the winter season. This study aimed to analyze winter season time-series SAR backscattering coefficient change with burn severity in south Northwest Territories, Canada using optical and SAR data. The study area, south Northwest Territories, belongs to the discontinuous permafrost zone and consisted of the taiga. Burn severity and vegetation regrowth were estimated by dNBR and NDVI using optical imagery. To increase the temporal resolution, Landsat-8 OLI and Sentinel-2 MSI were acquired through the cloud-based Google Earth Engine (GEE) in the summer season. C-band dual-polarization Sentinel-1 and X-band single-polarization TerraSAR-X were obtained to understand the multi-frequency backscattering coefficient to fire-induced changes. The changes pattern of the SAR backscattering coefficient varies according to the burn severity, especially in the winter season, not affected by vegetation and soil moisture. It can be seen that the wildfires affected the changes in the scattering mechanism in permafrost on the boreal forests. These results represent that C-band and X-band SAR images have the potential to monitor the changes of the active layer with burn severity.