

Soil Freeze-Thaw Detection using Sentinel-1 SAR Data in Agricultural Fields

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ABSTRACT

Seasonal soil freeze-thaw (FT) is a process of the flow of material and energy which occurs in the topsoil and proceeds into the deeper soil layers. In southern Canada, where the farmlands are dominantly located, the process plays an important role in hydrological regime, biogeochemical processes, and crop production in farmlands. To detect the FT state, the Saint-Maurice areas in southern Quebec has been selected as the test case for fieldwork purposes. This site has been instrumented and monitored to properly represent the heterogeneous characteristics of soil temperature in an agricultural field. We have used temperature loggers to measure soil temperature in eight patches using 40 points on two vertical levels (e.g., near-surface and 10 cm) including five patches in different agricultural fields and three in the forest areas. C-band synthetic aperture radar (SAR) of Sentinel-1 Ground Range Detected (GRD) scenes have been processed using Google Earth Engine (GEE) to generate the calibrated and incidence angle-corrected product. In this research, logistical regression of the freezing status against the freeze-thaw index has been applied. The FT index has been chosen during a post-harvest, frost, and frost-free period to get reference frozen and thawed values. Fitting a generalized linear model (GLM) as a flexible generalization of linear regression model shows that the probability of freezing in relation to the freeze-thaw index varies within and between farmland patches and forest patches. Based on the results, soil types and crop types significantly affect the probability of soil freezing in relation to Sentinel-1 backscattering in agricultural fields.

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