Detection of CH4 emissions from permafrost peatlands with TROPOMI XCH4

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Some fraction of the carbon in northern circumpolar permafrost will be released as CH4 or CO2 as permafrost thaws in the coming years. Recent column-averaged methane (XCH4) observations (2018-2023) from the Tropospheric Monitoring Instrument (TROPOMI) on the Sentinel-5 Precursor satellite are assessed for evidence of CH4 emissions from permafrost regions. Using the Weighting Function Modified Differential Optical Absorption Spectroscopy (WFMD) v1.8 TROPOMI XCH4 data product, XCH4 anomalies north of 50°N are calculated and averaged bi-monthly onto a high spatial resolution (0.09°x0.18° ≈ 10 km) grid. Soil temperature anomaly maps (down to 1.5 m depth) are also generated from reanalysis data. Considering the XCH4 and soil temperature anomalies along with information on soil carbon content and wind variability leads to a focus on Canada's Hudson Bay Lowlands (HBL). The HBL is an area of wetlands and peat underlain by continuous through to isolated permafrost, containing very high soil carbon content. With the HBL on the southern edge of the permafrost zone, it has been identified as vulnerable to thaw and high carbon emissions. Wind conditions in the HBL are also favorable for the detection of surface emissions from space. We find strong evidence in TROPOMI XCH4 of enhanced CH4 emissions correlated with elevated summer soil temperature for the HBL permafrost peatlands, although the attribution of CH4 emissions to a specific geophysical process is difficult.

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