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Solving Methane Fluxes at Northern Latitudes using Atmospheric and Soil EO data – MethEO

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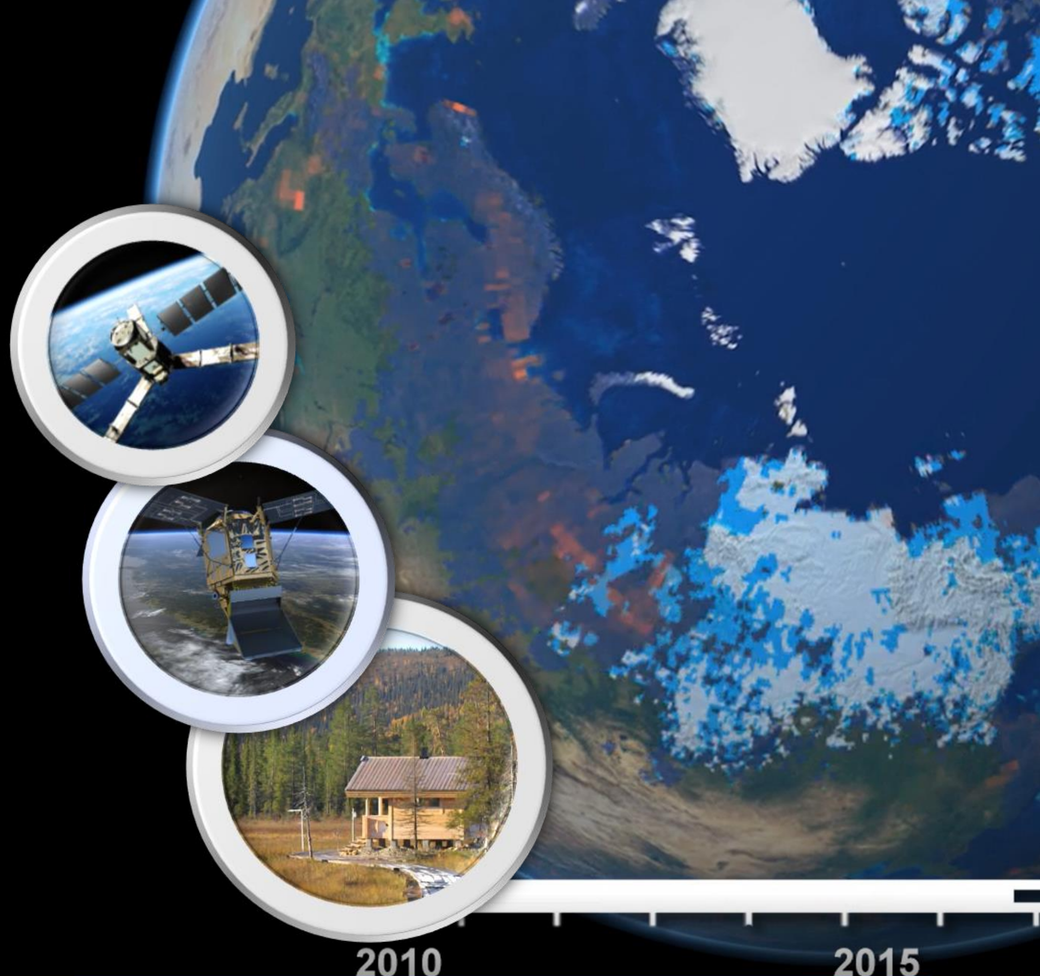


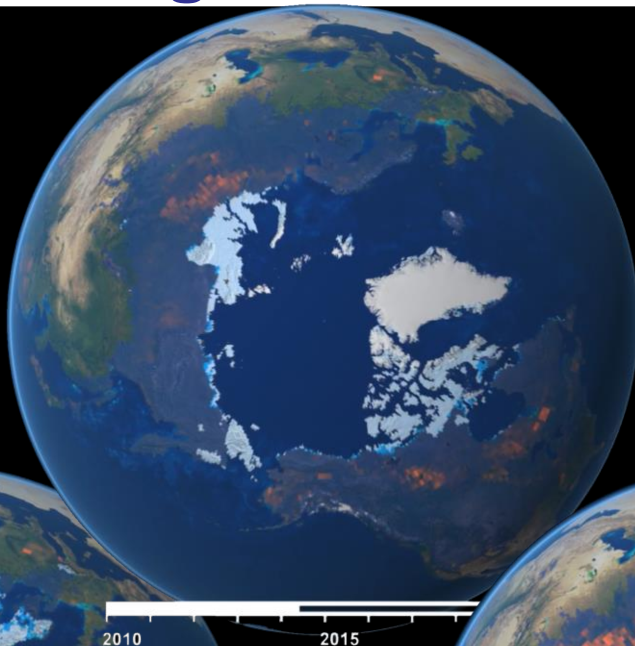
- Methane emissions from the Arctic and boreal wetlands constrained with inverse modelling and using satellite observations of methane (GOSAT, TROPOMI) and soil frost (SMOS).
- **MethEO-I:** Focus on freezing period methane emissions and trends
    - Freezing period is shortening but emissions showed no systematic trends (still preliminary!)
- **MethEO-II ongoing**: Focus on permafrost regions, winter, and spring. Anthropogenic emissions, trends and hotspots at high latitudes also considered.
- Collaboration with the Nasa-ESA AMPAC initiative

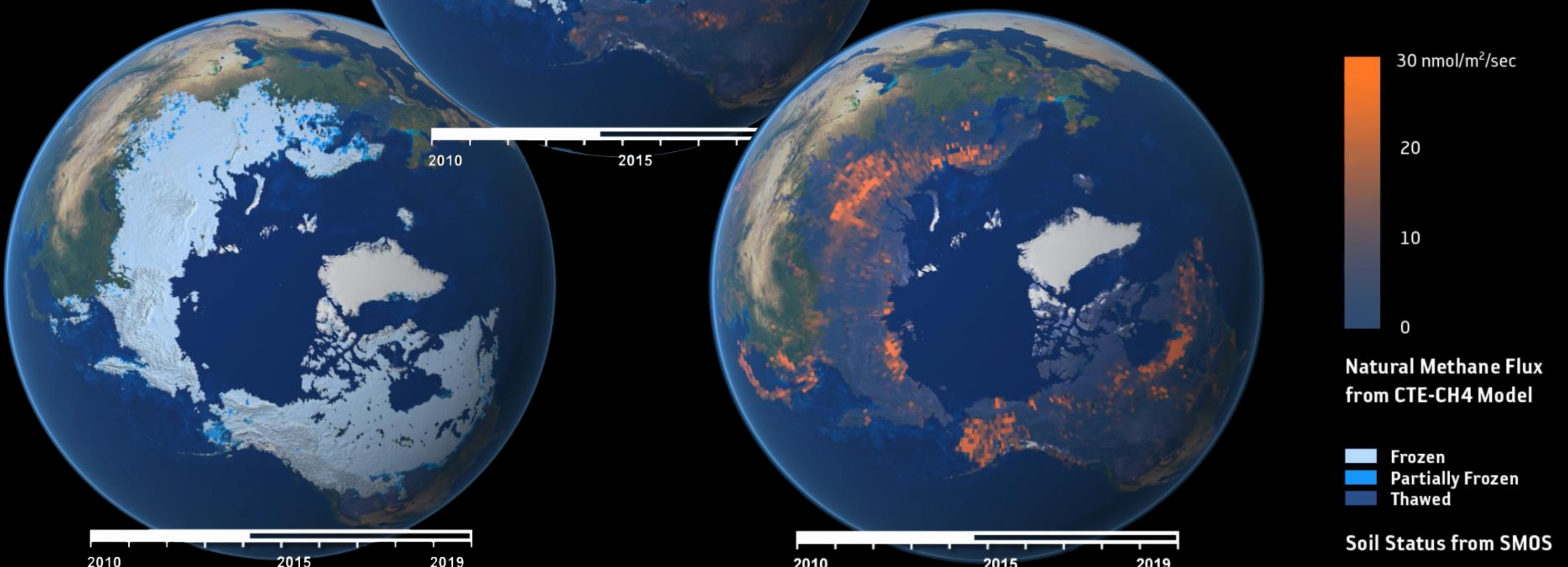
Soil frost controls natural methane emissions from wetlands in large scales

ESA SMOS satellite, primarily focused on monitoring of soil moisture and ocean salinity can also detect whether the soil is frozen or thawed

Information on soil status can improve estimates of natural CH_4 emissions, particularly during freeze/thaw transitions

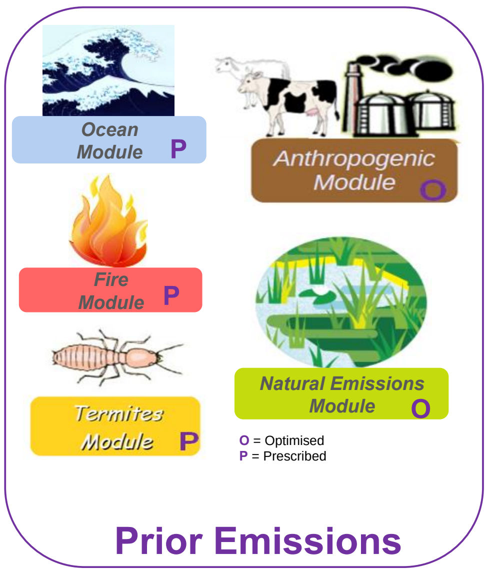
Methane emission may rise as areas of permafrost are lost in the warming climate

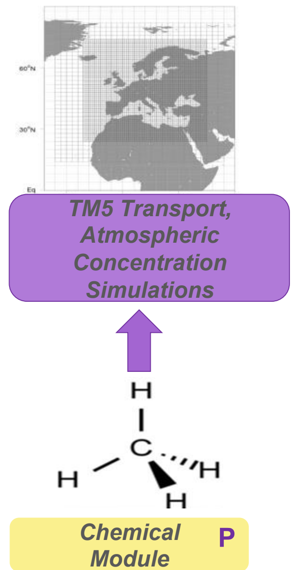


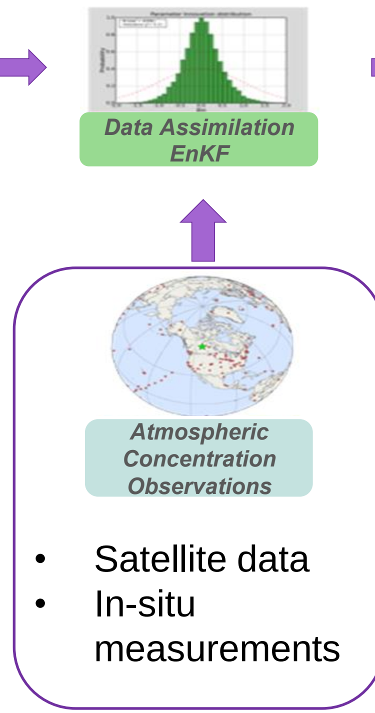


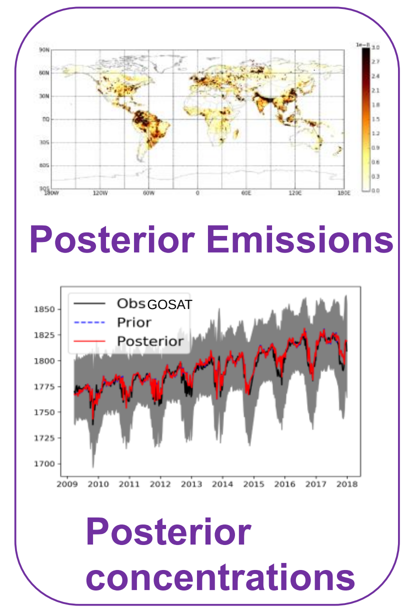
Methane fluxes: CarbonTracker Europe – CH_4 (CTE–CH_4)

- Inversion model system which uses global atmospheric observations (in-situ and/or satellite-based) to optimise the prior estimates of anthropogenic and natural emissions.
- TM5 atmospheric transport model and Ensemble Kalman Filter data assimilation methodology.









IWGGMS-17: see also Tsuruta et al. "European CH4 flux distributions estimated from CTE-CH4 atmospheric inversion assimilating TROPOMI XCH4 data"

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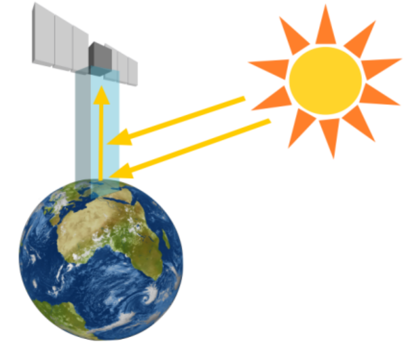
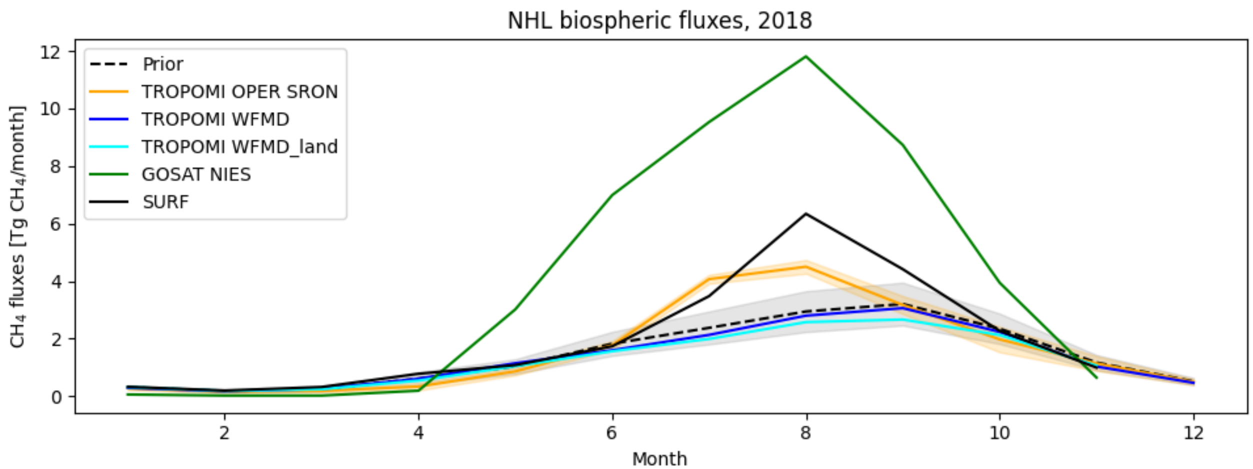
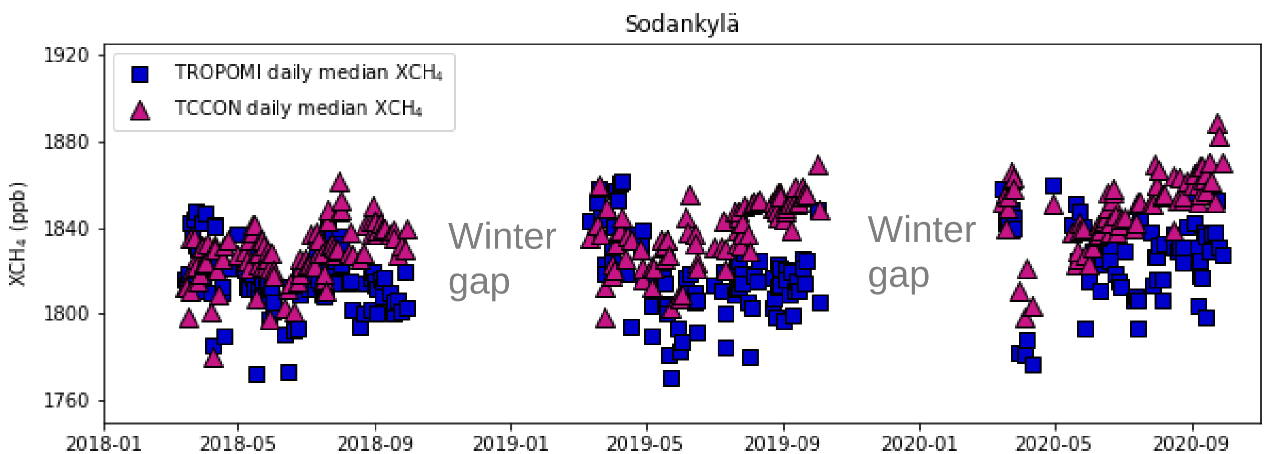
Tsuruta et al.: Global methane emission estimates for 2000–2012 from CarbonTracker Europe-CH4 v1.0, *Geosci. Model Dev.* 10, 2785-2800, 2017.

Space-based methane observations from GOSAT and Sentinel 5P TROPOMI







Satellite data manifolded the number of informative data used for flux estimations.

Residual biases in satellite retrievals complicated the interpretation of fluxes.

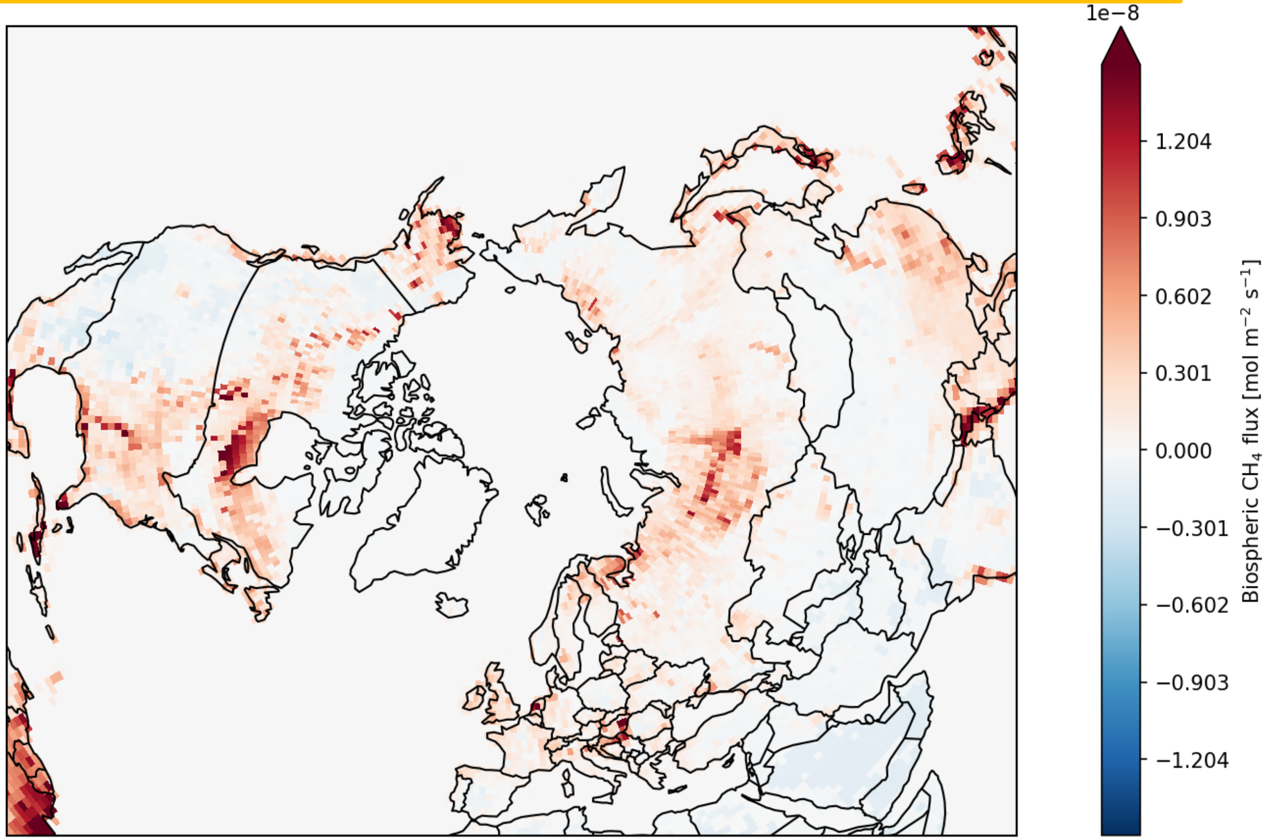
IWGGMS-17: see also Lindqvist et al. “Systematic evaluation of TROPOMI XCH_4 observations at high latitudes”

Global and Northern high latitude emissions

The global total wetland methane emissions ranged between 110–126 ± 35 Tg CH4 per year. The NHL share of the global wetland emissions is estimated to be 13%–18%.

Soil freezing period methane emissions were correlated with the length of the soil freezing period. Constraining the winter methane emissions with SMOS soil F/T data improved the inversion model performance.

Two major Northern high latitude wetland emission regions were Western Siberian Lowlands in Russia, and Hudson Bay Lowlands in Canada.



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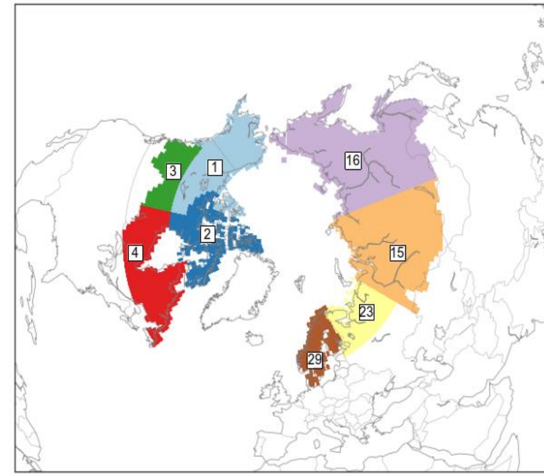
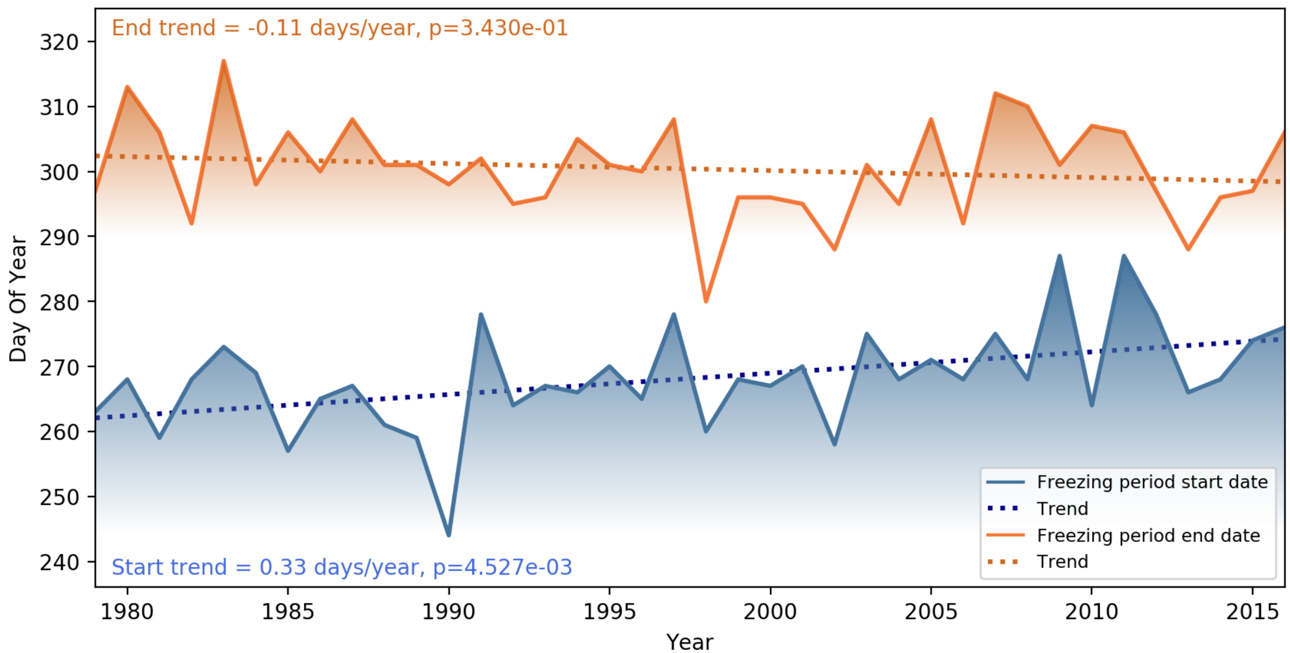
Did we identify high-latitude trends?

The soil freezing period in Northern Siberia is shortening.

Reliable determination of systematic trends in freezing period methane emissions still requires further investigations.





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The work continues in MethEO-II and wider, e.g. in the AMPAC collaboration.