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Quantifying the contribution of regional methane emissions to the global methane budget between 2009 and 2018 using the TOMCAT chemical transport model

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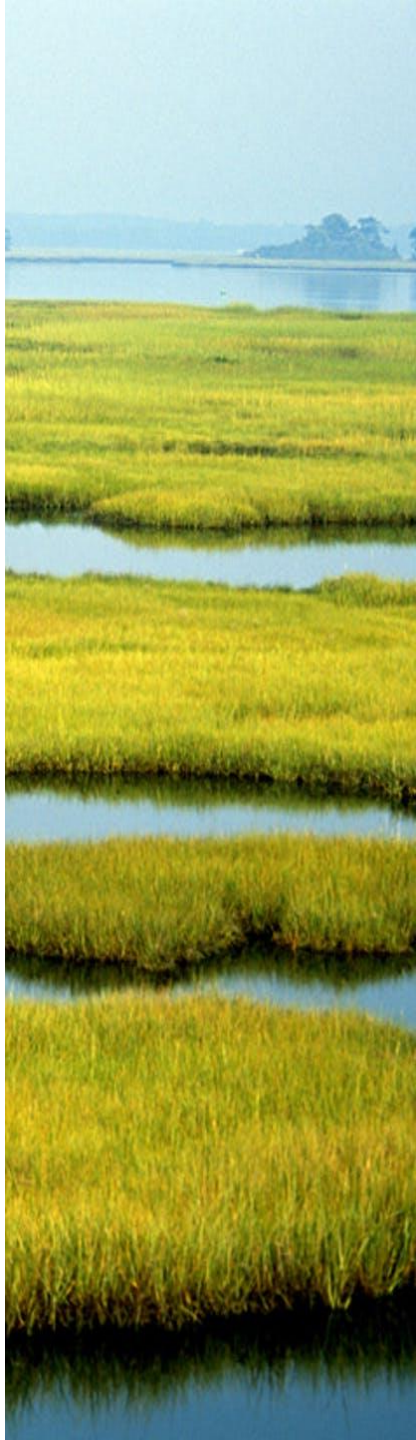

Why is methane important?

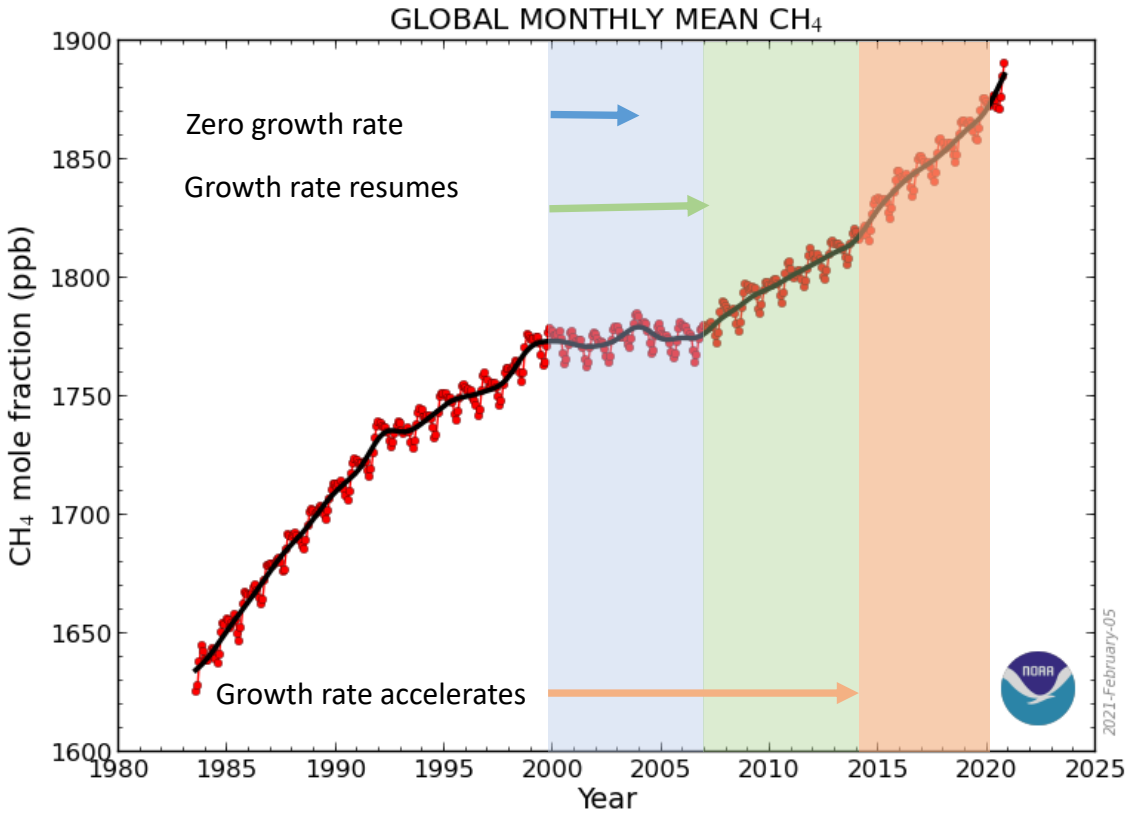

Figure: global monthly mean of atmospheric CH_4 taken from marine surface sites, esrl.noaa.gov (2021)

- Abundant greenhouse gas
- Anthropogenic emissions have contributed 23% to the additional radiative forcing in the lower troposphere since 1750 (Saunois et al, 2019)
- Methane has been increasing in the last decade

TOMCAT - Tagged Regional Tracer Study

- Tagged regional tracer study to investigate interannual variation and rising trends of methane between 2009-2018, following methods by Lin et al, 2019
- Surface fluxes were derived from a previous TOMCAT-based atmospheric inversion study (Wilson et al, 2021)
- The fluxes match the observed global growth rate due to assimilation of surface flask observations and GOSAT into the inversion
- 18 regions selected
- Each regional flux was split into fossil fuel and non-fossil-fuel, resulting in 36 tracers

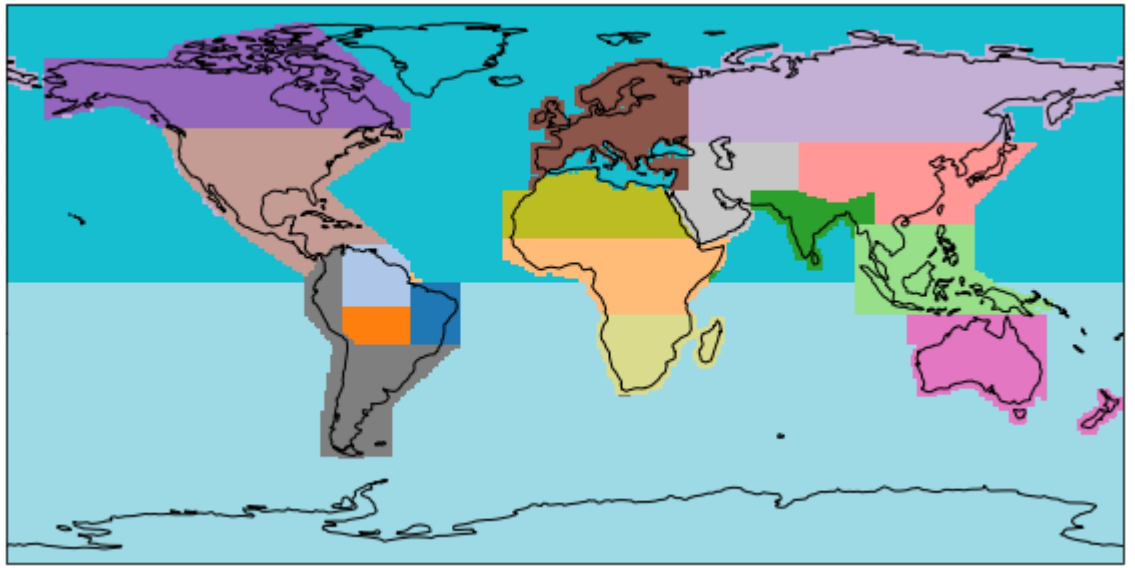

Figure: Selected regions for regional tracer study

Seasonal Cycle Amplitude

- Investigating Seasonal Cycle Amplitude

$$SCA = SC_{Dmax} - SC_{Dmin}$$

Where D_{max} and D_{min} are the days where observed or simulated annual CH_4 cycle maximum or minimum

- The tagged tracer SCA_i was calculated using a pseudo maximum and minimum point of its annual cycle corresponding to D_{max} and D_{min}

$$SCA_i = SC_{i,Dmax} - SC_{i,Dmin}$$

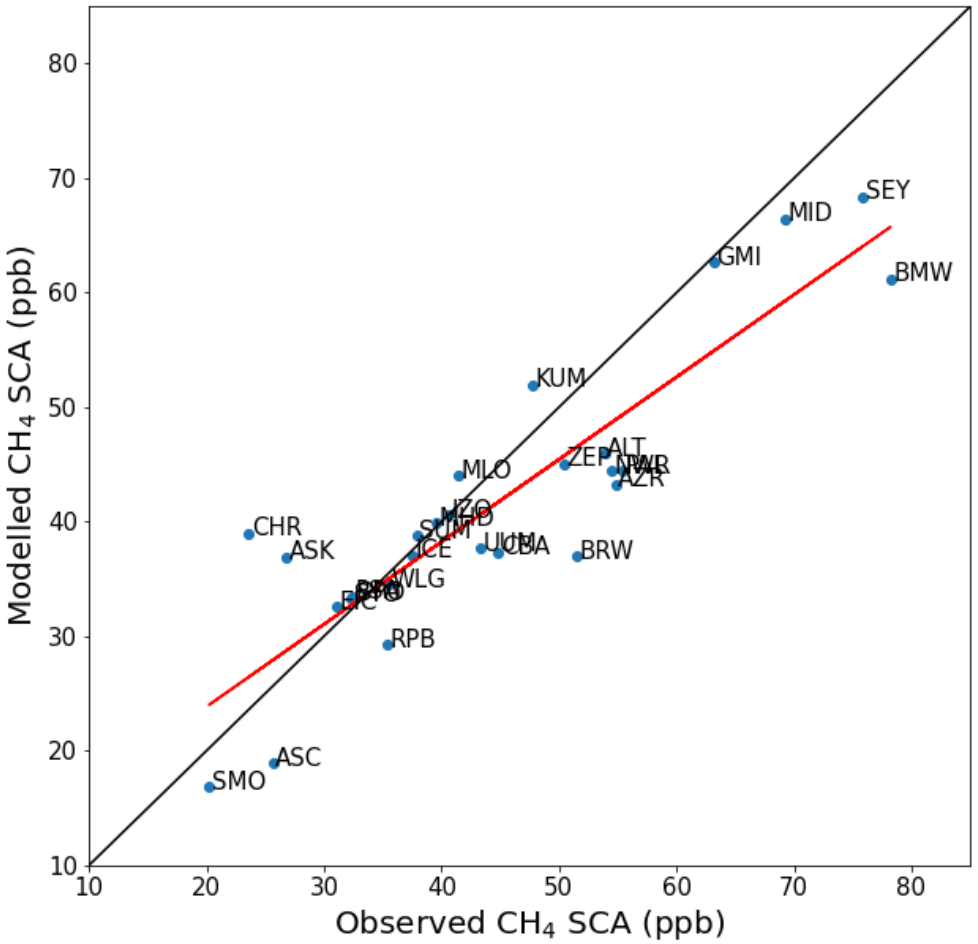

Figure: Modelled SCA against observed SCA at 28 surface observation sites.

Trend In Seasonal Cycle Amplitude

- Investigating trend in Seasonal Cycle Amplitude
- ΔSCA is the linear trend of SCA multiplied by data length in years
- Modelled ΔSCA compares well with observed ΔSCA
- Northern hemisphere high latitude sites have strong positive ΔSCA amongst others

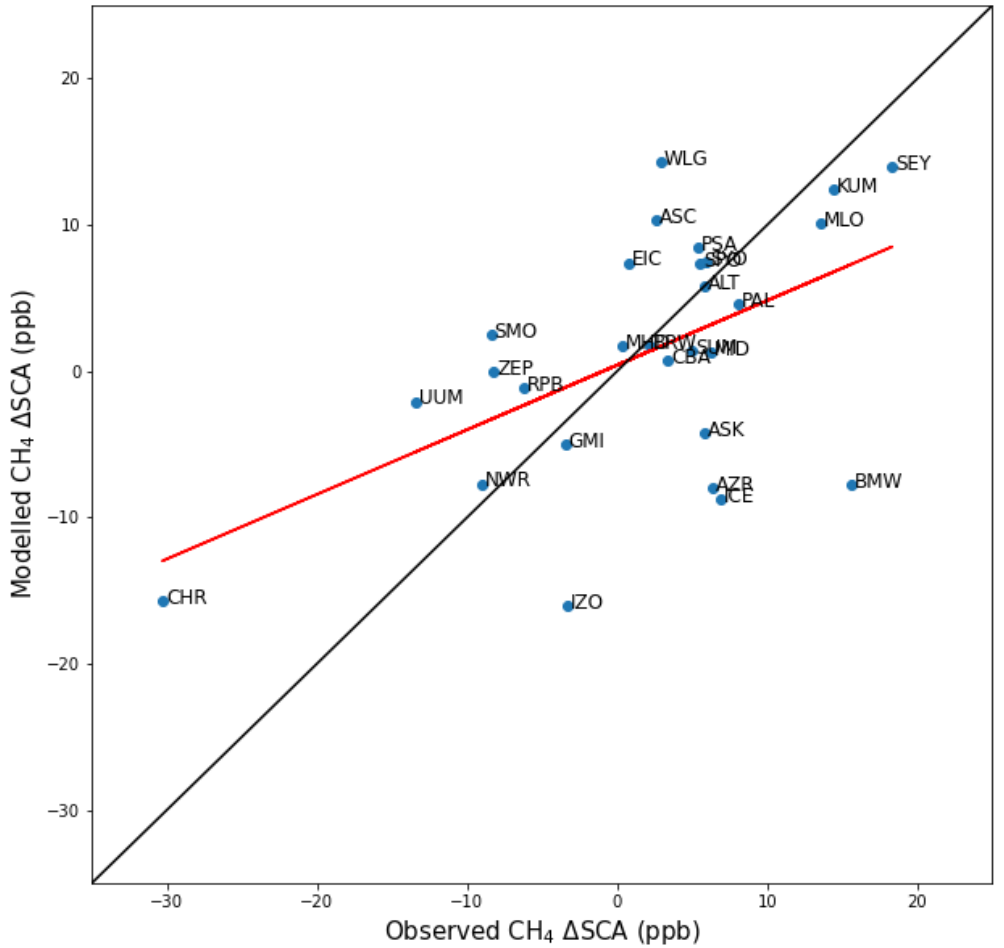

Figure: Modelled ΔSCA against observed ΔSCA at 28 surface observation sites.

Trend In Seasonal Cycle Amplitude – Regional Contribution

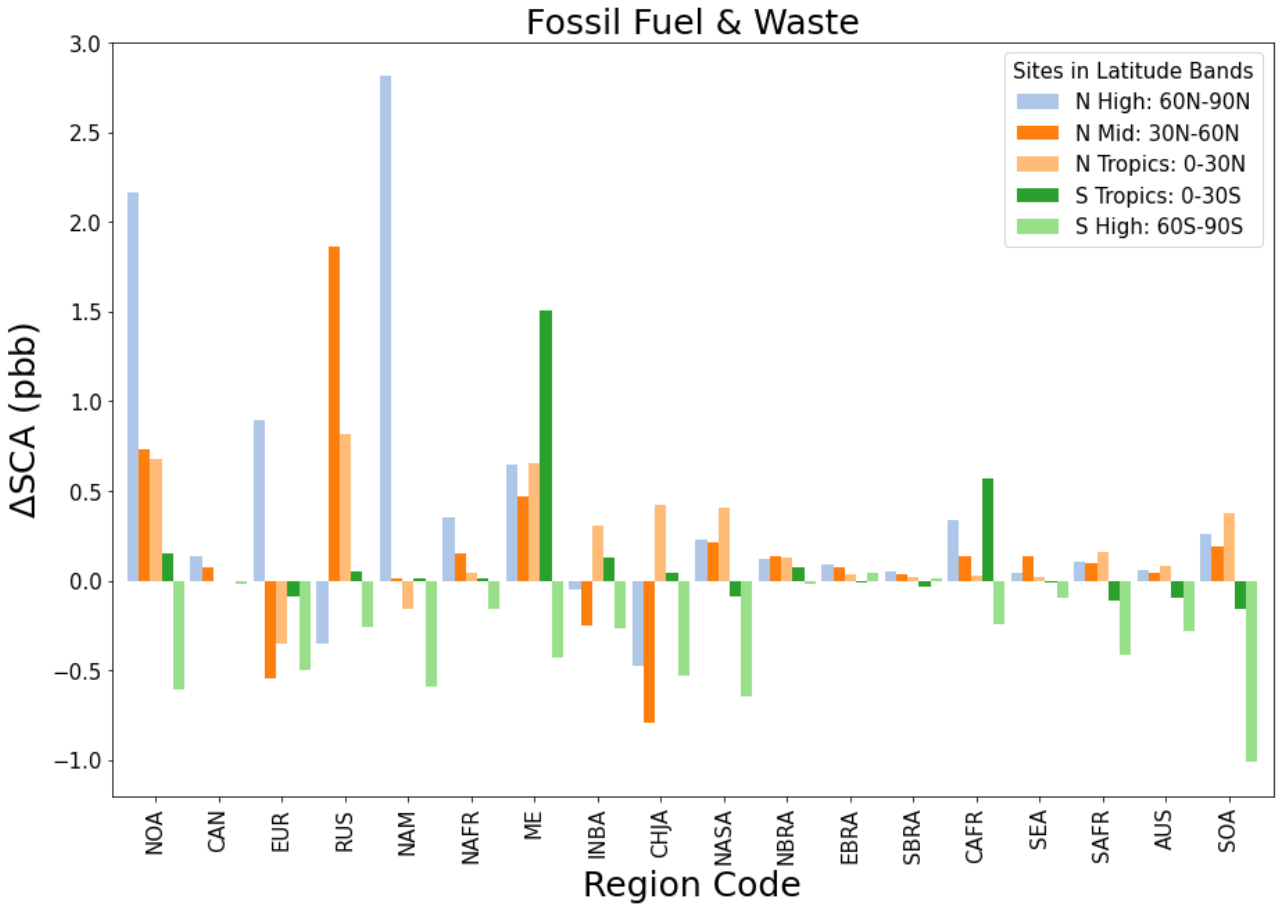

Figure: Fossil Fuel & Waste regional contribution to ΔSCA to observation sites, grouped by latitude bands

- North America Fossil Fuel emissions are contributing to the increasing trend of SCA in northern high latitudes
- Russia fossil fuel emissions are contributing to the mid latitudes
- Middle East fossil fuel emissions are contributing to the southern tropics

Key:

AUS - Australasia
CAFR - Central Africa
CAN - Canada
CHJA - China & Japan
EBRA - East Brazil
EUR - Europe
INBA - India & Bangladesh
ME - Middle East
NAFR - North Africa
NAM - North America
NASA - Non-Amazon South America
NBRA - North Brazil
NOA - North Oceans & Arctic
RUS - Russia
SAFR - South Africa
SBRA - South Brazil
SEA - South East Asia
SOA - South Oceans & Antarctica

Trend In Seasonal Cycle Amplitude – Regional Contribution

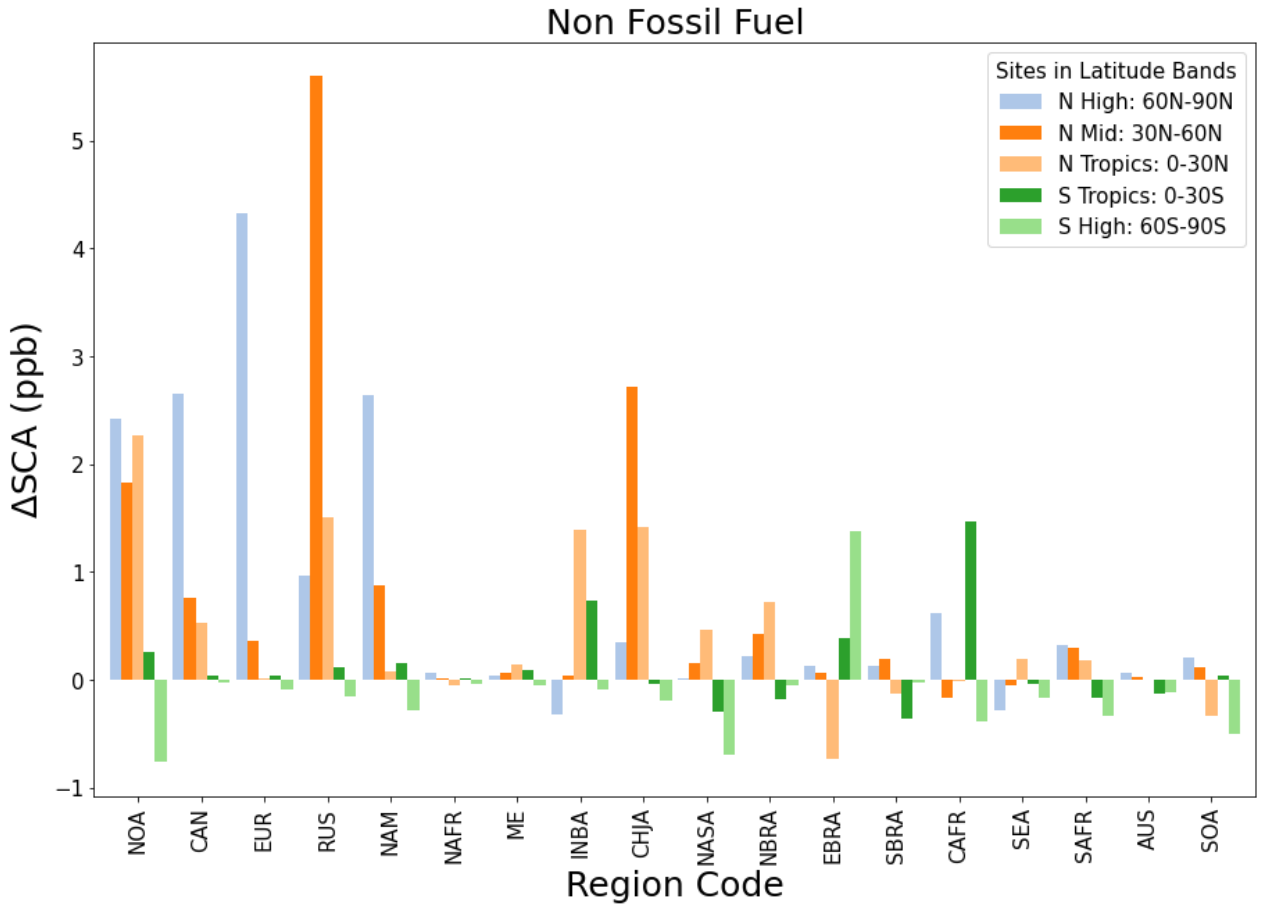

Figure: Fossil Fuel & Waste regional contribution to ΔSCA to observation sites, grouped by latitude bands

- European Non-Fossil-Fuel emissions are contributing to the increasing trend of SCA in northern high latitudes
- Canada and North American Non-Fossil-Fuel emissions are also significant contributors to northern high latitudes
- Russia and China & Japan are contributing to northern mid latitudes

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References

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