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Global and zonal methane growth rates between 2018–2023 derived from Sentinel-5P/TROPOMI data

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Summary

Global methane growth continues to decrease in 2023. This seems to be caused by reductions in the southern hemisphere growth rates.

Input data

- Sentinel-5P: global daily coverage with a nadir resolution of 5.5x7km²
- Two algorithms available:
  - Operational algorithm (OP) developed at SRON
  - WFMD algorithm developed at IUP Bremen

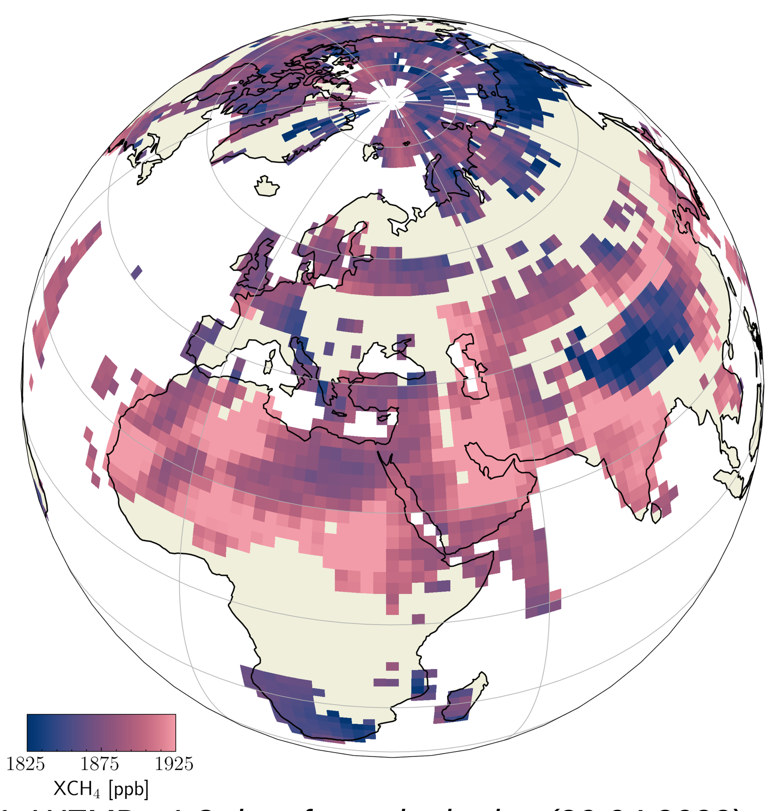

Fig 1. WFMD v1.8 data for a single day (20.04.2022) on a 2° x 2° grid.

Goal

- Calculate and compare methane growth rates from both data products
- Use growth rates within zonal bands to provide spatial information to global methane increases

Method

- The data is processed and fitted following the method laid out in our publication [1]
- Our method is based on a dynamic linear model approach, which allows for smoothly varying growth rates
- We tested the method against other methods used to derive growth rates using the same input data, and got an agreement within 1σ [1]

[1] Zonal Variability of Methane Trends derived from Satellite Data

Sampling bias

- To test for sampling related errors, we applied our method to model data with and without applying the satellite sampling mask
- We observe no systematic biases and an average random error of
  - 0.24 ppb for global methane increases
  - 2.1 ppb/yr for zonal methane growth rates

Acknowledgments

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Results

Global annual methane increase

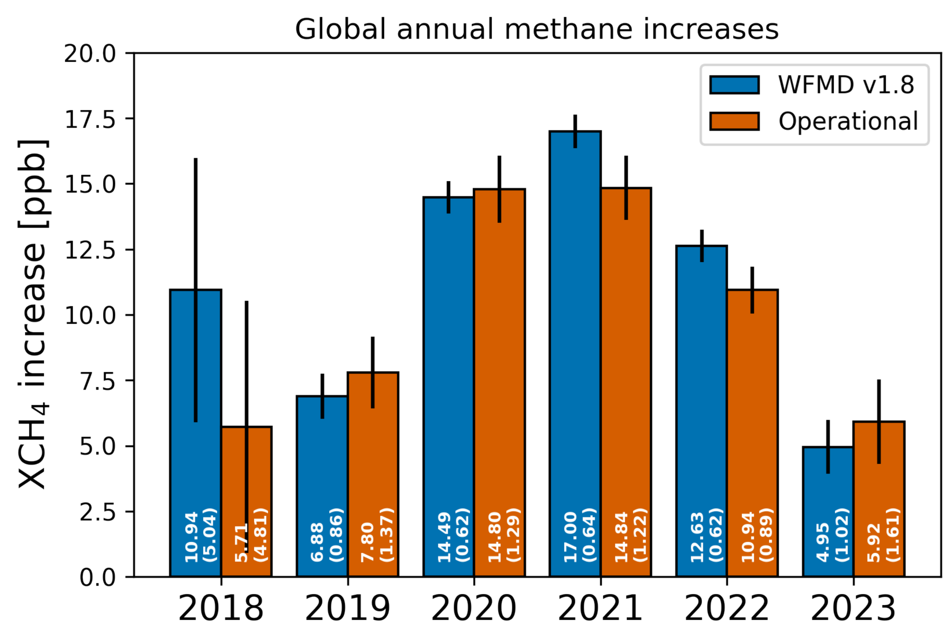

Fig 2. Global annual methane increases for both S5P products. Based on data between 01.05.2018 – 01.04.2024.

- Overall qualitative agreement
- Largest difference Δ in 2021 and 2022 with 2σ>Δ>1σ
- Possible reasons: different coverage between both products
- Both products report an increase of 5-6 ppb in 2023, which is significantly lower than 10.64±0.58 ppb reported by the NOAA GML [2]
- However: comparison between NOAA and satellite imperfect, due to different atmospheric sampling (troposphere vs. complete atmosphere) → investigation ongoing

Zonal contributions to global methane growth rate

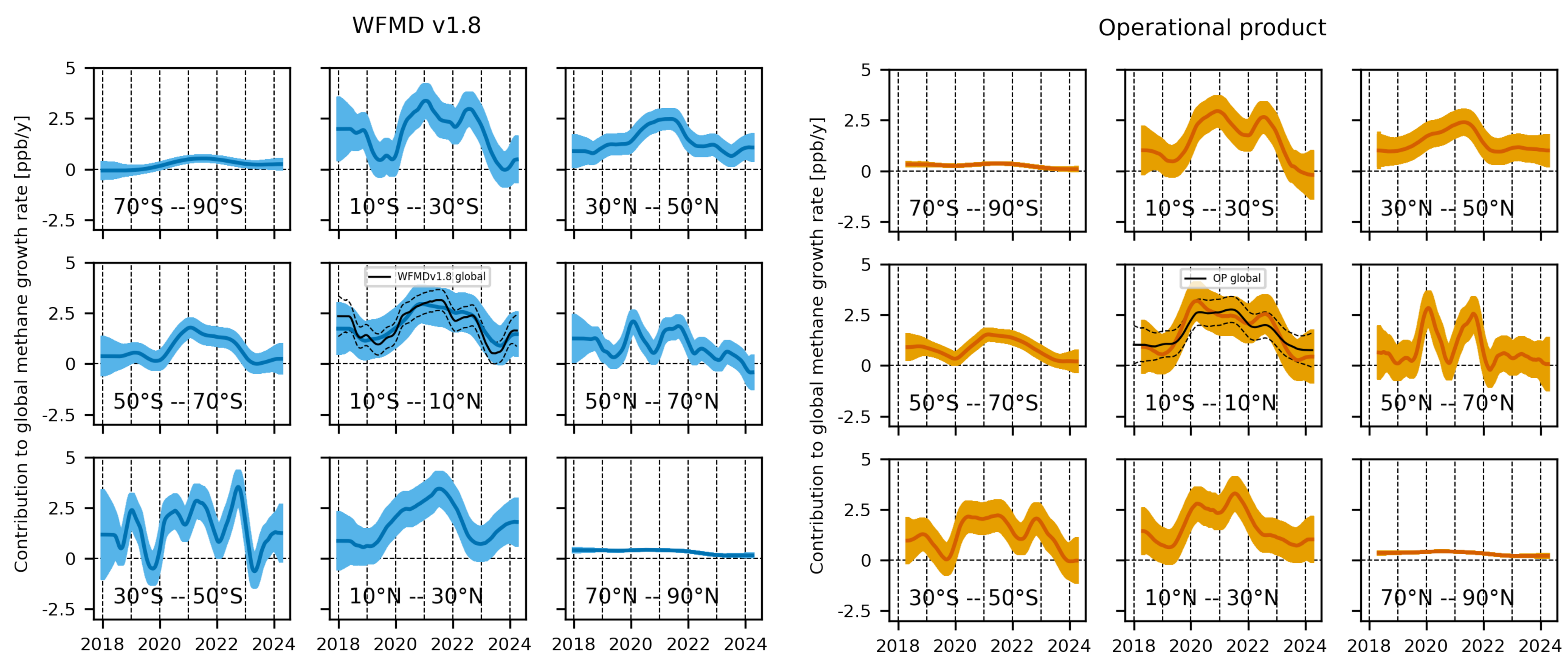

Fig 3. Contribution of zonal growth rates to the global growth rate. Zonal growth rates are weighted by the area in their band. Based on data between 01.05.2018 – 01.04.2024. The sum of the weighed zonal growth rates matches the global growth rate within 1σ.

- Reduction in global methane growth in 2022 can be mainly attributed to the northern hemisphere (NH) (see [1])
- During 2023 the NH growth rates remain relatively stable, with a minor increase visible in the NH (sub)tropics for WFMD
- The SH growth rates decline strongly between 10° - 50° S from the end of 2022
- ***Continued decrease in the global methane growth for 2023 can be attributed to reduced growth rates in the southern hemisphere***

Outlook

- Comparison to growth rates derived from TCCON data
- Continued analysis of latest S5P data
- Investigation of S5P-NOAA growth rate difference

Bibliography

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[2] Lan, X., Thoning, K. W., and Dlugokencky, E. J.: Trends in globally-averaged CH4, N2O, and SF6 determined from NOAA Global Monitoring Laboratory measurements. Version 2024-05, https://doi.org/10.15138/P8XG-AA10, 2024. URL: https://gml.noaa.gov/ccgg/trends_ch4/