Royal Netherlands
Meteorological Institute
*Ministry of Infrastructure
and Water Management*

Satellite Derived CH_4 and NO_x Emissions from the Oil and Gas Industry in the Permian Basin in the U.S.A.

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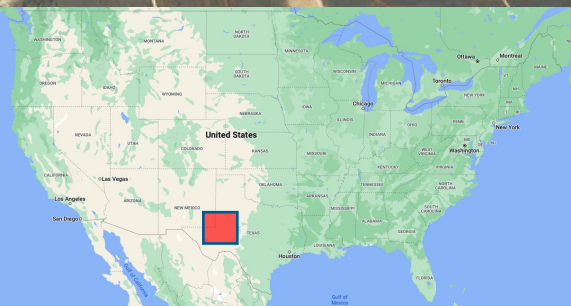
Source www.resilience.org

Summary

› The divergence method was applied to derive NO_x and CH_4 emissions.

› The divergence method was verified using model data.

› Spatial patterns of the emissions are in agreement with the oil and gas industry activities.

› Time series indicate that continuous emissions are significant for the Permian Basin.

› Total emissions estimated with the divergence for the Permian Basin are in agreement with other methods.
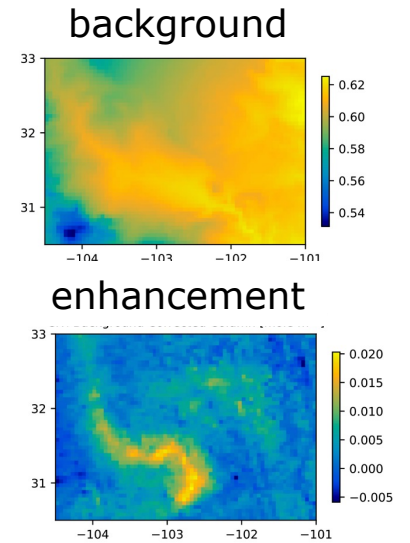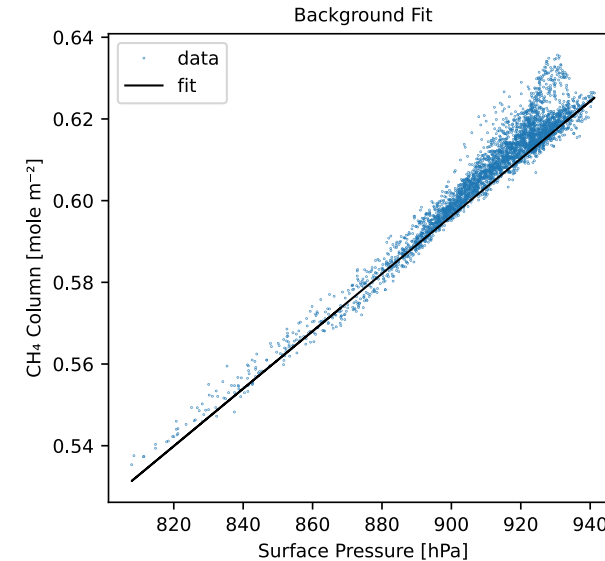
› Emissions in 2020 are lower compared to 2019.
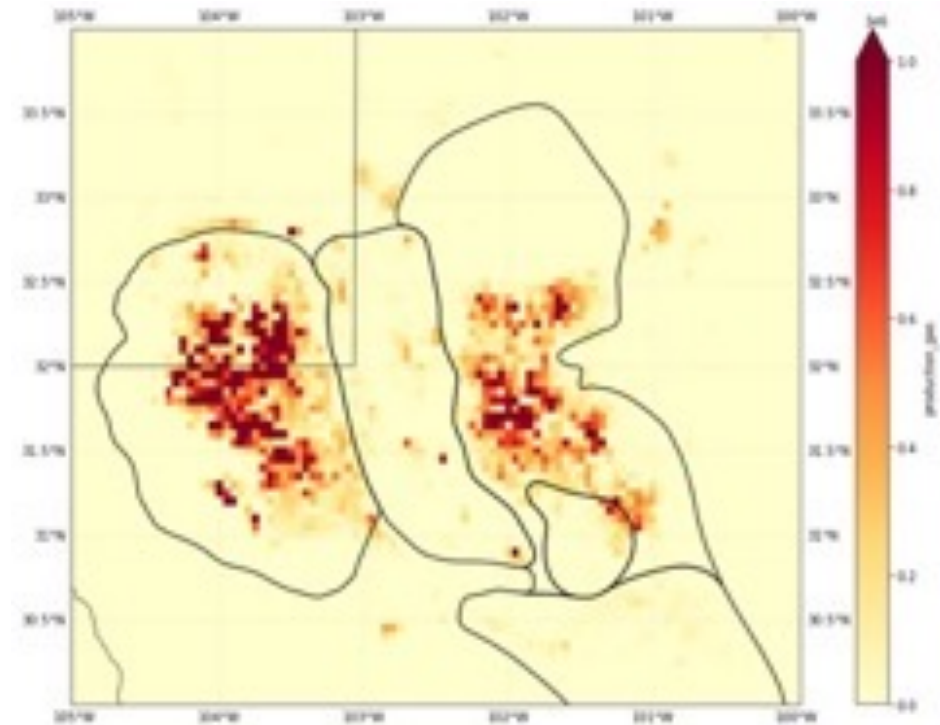
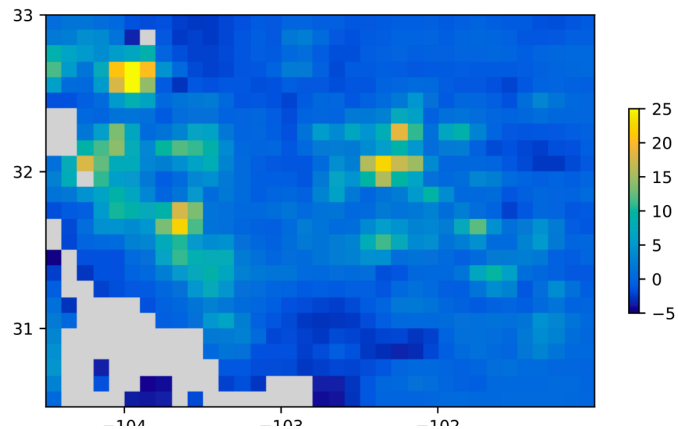*Monthly mean gas production in 2020.*

Data and Methods

› CH₄ Data

– TR_____ S v1.5

– Ba_____ based on surface pressure

– En_____ divergence method

› NO₂ _____ I v1

› Meteo Data: ECMWF ERA-5

› Model XCH4 data: CAMS IFS cycle 47R1

– Used to produce simulated observations

› Oil a_____ tion data
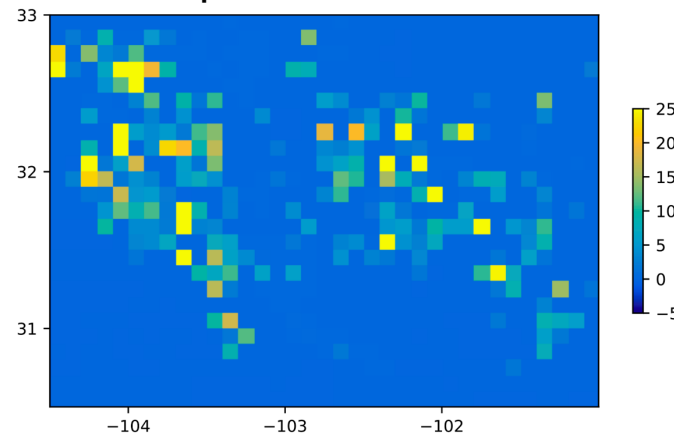Drill_____ Analyt_____
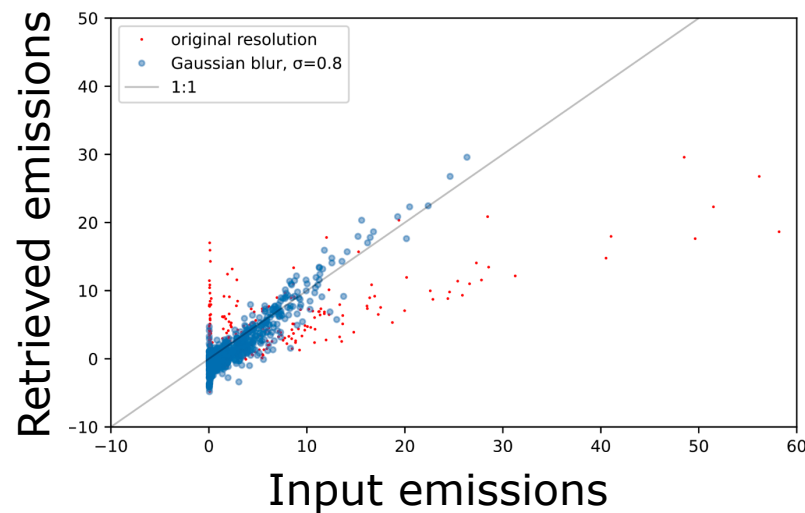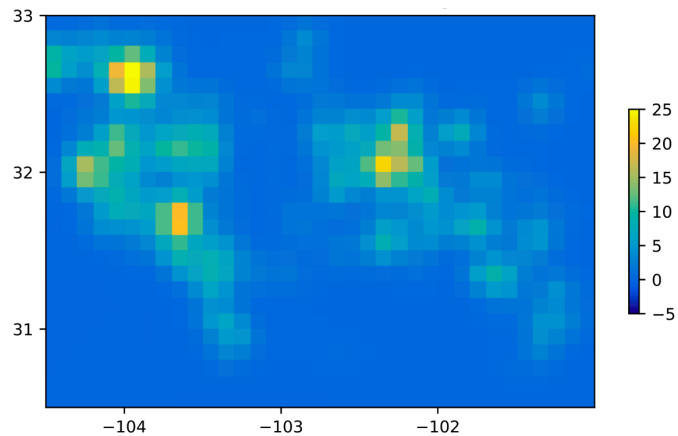
– Gr_____ oduction_____ y

CH$_4$ CAMS Verification

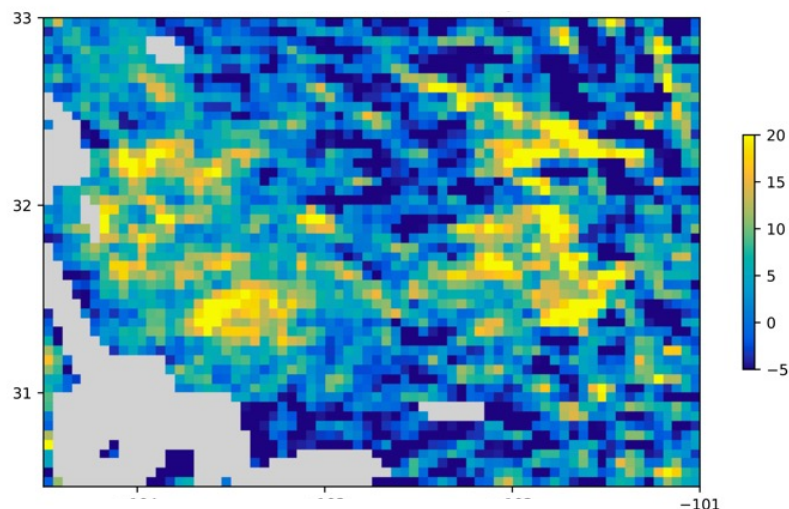Retrieved emissions

Input emissions

Smoothed input emissions

With the divergence method we can retrieve the spatial variations in the emissions on ~10x10 km^2 scales

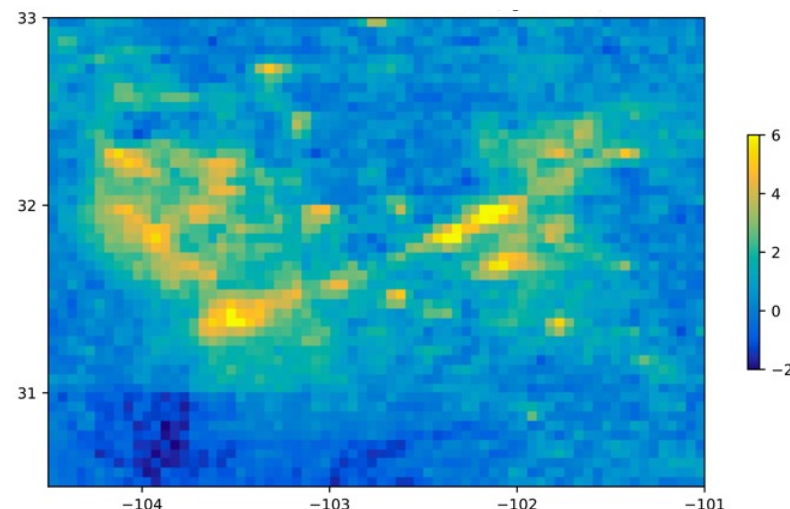# TROPOMI Results for 2019-2020

Retrieved CH$_4$ emissions
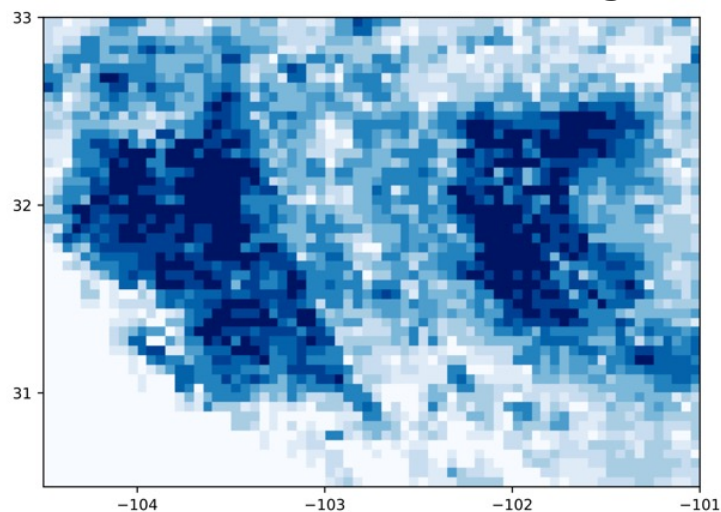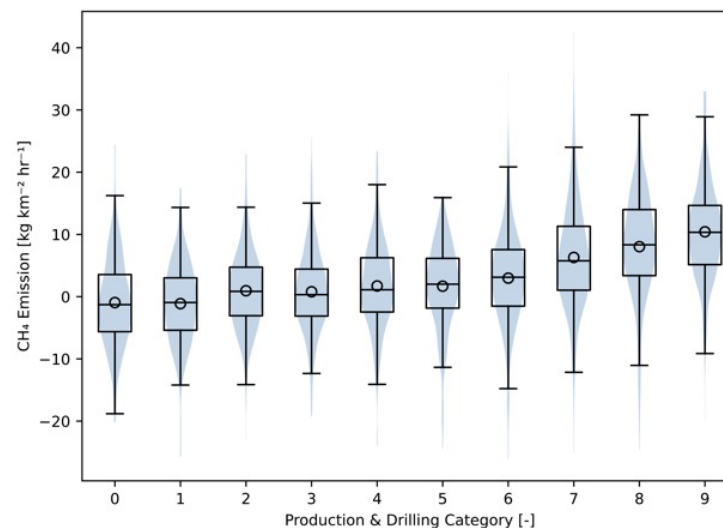

Retrieved NO$_x$ emissions

Production and Drilling

CH$_4$ Emission vs. Production and Drilling

CH$_4$, NO$_x$ and activity data show similar spatial patterns.

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TROPOMI CH₄ Median Emission 2019-2020 [kg km⁻² hr⁻¹]

A. Lat 32.275°N, Lon 102.725°W, Mean 28.8, Median 21.6, Q1: -1.7, Q3: 56.0

B. Lat 31.925°N, Lon 103.075°W, Mean 25.7, Median 23.2, Q1: -2.1, Q3: 57.5

C. Lat 31.625°N, Lon 103.375°W, Mean 16.4, Median 21.1, Q1: -21.4, Q3: 51.5

D. Lat 31.425°N, Lon 103.575°W, Mean 28.9, Median 25.8, Q1: -0.6, Q3: 56.3

E. Lat 31.375°N, Lon 103.625°W, Mean 24.4, Median 22.5, Q1: 3.1, Q3: 41.0

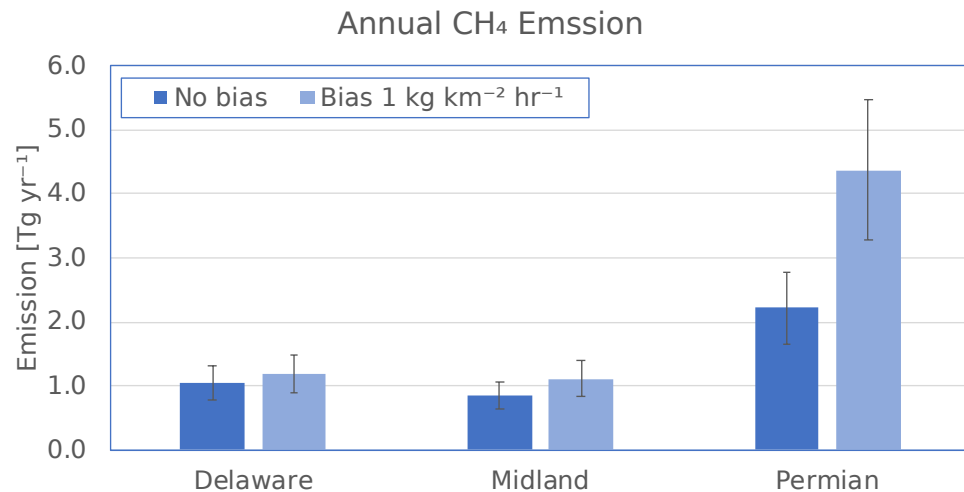The statistics are not dominated by super-emitting events.

Blue points: daily data
Black line: median 2019-2020
Grey area: inter-quartal range
Green line: 30-day running mean
Orange line: 30-day running median

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Total Emission Estimates

Annual Emission [Tg yr^{-1}]	Delaware		Midland		Permian	
	min	max	min	max	min	max
2019	1.07	1.20	0.91	1.18	2.22	4.38
2020	0.90	1.03	0.75	1.01	1.94	4.10
2019-2020	1.06	1.19	0.85	1.12	2.22	4.38
Difference 2019-2020	-16%	-14%	-18%	-14%	-13%	-6%

Estimated uncertainty of the emission is 25%

Annual CH$_4$ Emssion

Conclusions

›	The divergence was successfully used to derive spatial variability of CH_4 and NO_x emissions over the Permian Basin.

›	The statistics of the CH_4 emissions are not dominated by super-emitter events.

›	The total CH_4 emissions are in good agreement with other top-down estimates and are lower in 2020 compared to 2019.

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May 13, 2022