



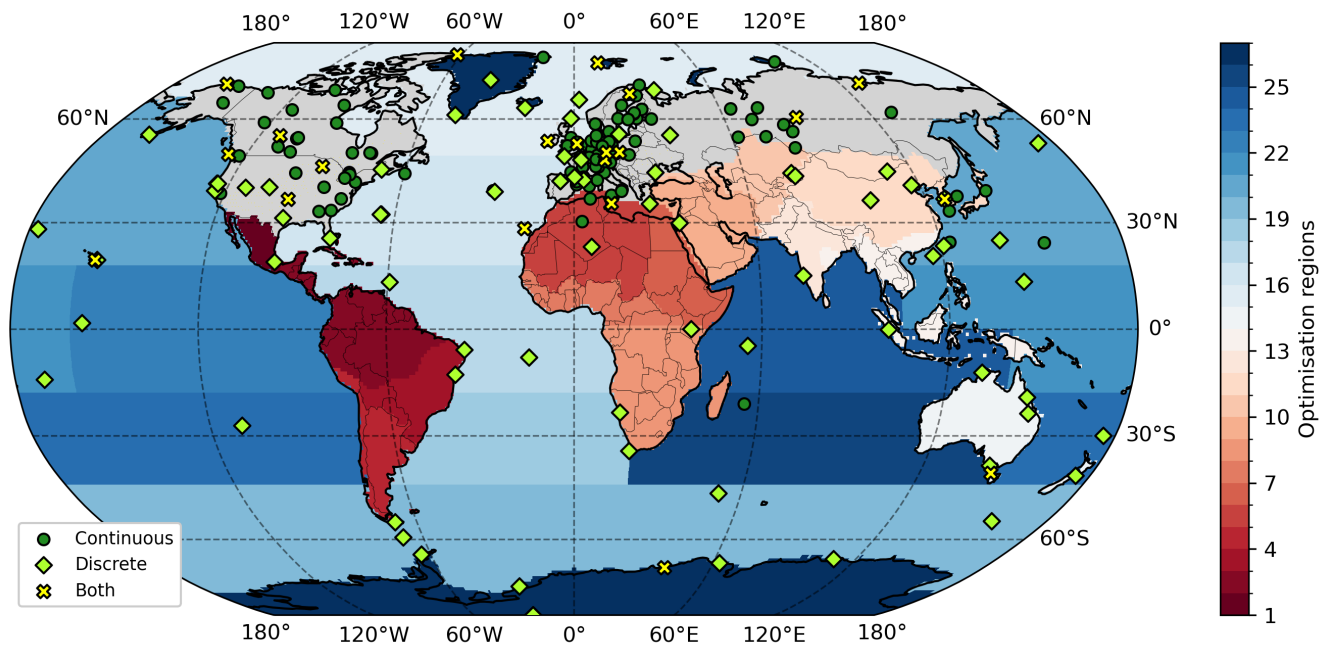
*Supplement of*

## **Partitioning anthropogenic and natural methane emissions in Finland during 2000–2021 by combining bottom-up and top-down estimates**

**Maria K. Tenkanen et al.**

*Correspondence to:* Maria K. Tenkanen (maria.tenkanen@fmi.fi)

The copyright of individual parts of the supplement might differ from the article licence.



**Figure S1.** The locations of the atmospheric CH<sub>4</sub> measurement sites and the type of measurement used (continuous, discrete or both) in the inversions. The areas optimised regionally are shown with blues and reds, and the grey colour shows the area optimised at 1° latitude × 1° longitude resolution.

**Table S1.** List of surface observation sites used in inversions. Observation Uncertainty (Obs. Unc.) is used to define diagonal values in the observation covariance matrix. The data type is categorised into two measurements (discrete (D) and continuous (C)).

Sitecode	Site Name	Country	Contributor	Longitude [°E]	Latitude [°N]	Height* [m a.s.l.]	Obs. Unc. [ppb]	Data type D/C	Date min.** [year/month]	Date max. [year/month]
ABP	Arembepe, Bahia	Brazil	NOAA ESRL	-38.17	-12.76	6.00	4.5	D	2006/10	2010/01
ABT	Abbotsford, British Columbia	Canada	ECCC	-122.34	49.01	93.00	30.0	C	2014/03	2020/12
ALT	Alert, Nunavut	Canada	NOAA ESRL	-62.51	82.45	190.00	15.0	D	2000/01	2021/10
ALT	Alert, Nunavut	Canada	ECCC	-62.51	82.45	195.00	15.0	C	2000/01	2020/12
AMT	Argyle, Maine	United States	NOAA ESRL	-68.66	45.01	157.00	30.0	D	2003/09	2006/11
AMY	Anmyeon-do	Republic of Korea	NOAA ESRL	126.33	36.54	87.00	30.0	D	2013/12	2021/11
ARA	Arcturus	Australia	CSIRO	148.47	-23.86	185.00	15.0	D	2010/05	2013/10
ASC	Ascension Island	United Kingdom	NOAA ESRL	-14.40	-7.97	90.00	15.0	D	2000/01	2021/11
ASK	Assekrem	Algeria	NOAA ESRL	5.63	23.26	2715.00	25.0	D	2000/01	2019/11
AZR	Terceira Island, Azores	Portugal	NOAA ESRL	-27.36	38.76	24.00	15.0	D	2000/01	2021/09
AZV	Azovo	Russian Federation	NIES	73.03	54.71	190.00	30.0	C	2009/10	2018/12
BAL	Baltic Sea	Poland	NOAA ESRL	16.67	55.35	28.00	75.0	D	2000/01	2005/01
BAR	Baranova	Russian Federation	FMI	101.62	79.28	30.00	4.5	C	2015/11	2021/02
BCK	Behchoko, Northwest Territories	Canada	ECCC	-115.92	62.80	220.00	15.0	C	2010/10	2020/12
BHD	Baring Head Station	New Zealand	NOAA ESRL	174.87	-41.41	90.00	4.5	D	2002/03	2021/10
BIK	Bialystok	Poland	MPIBGC	23.01	53.23	483.00	25.0	C	2005/07	2014/06
BIR	Birkenes	Norway	NILU	8.25	58.39	225.00	25.0	C	2014/01	2014/01
BKT	Bukit Kototabang	Indonesia	NOAA ESRL	100.31	-0.20	875.00	75.0	D	2004/01	2021/11
BLK	Baker Lake, Nunavut	Canada	ECCC	-96.01	64.33	61.00	15.0	C	2017/07	2019/11
BME	St. Davids Head, Bermuda	United Kingdom	NOAA ESRL	-64.65	32.37	17.00	15.0	D	2000/01	2010/01
BMW	Tudor Hill, Bermuda	United Kingdom	NOAA ESRL	-64.88	32.26	33.00	15.0	D	2000/01	2021/12
BRA	Bratt's Lake Saskatchewan	Canada	ECCC	-104.71	50.20	630.00	75.0	C	2009/10	2020/12
BRW	Barrow Atmospheric Baseline Observatory	United States	NOAA ESRL	-156.61	71.32	27.46	15.0	C	2000/01	2021/12
BRW	Barrow Atmospheric Baseline Observatory	United States	NOAA ESRL	-156.58	71.32	16.00	15.0	D	2000/01	2021/11
BRZ	Berezorechka	Russian Federation	NIES	84.33	56.15	248.00	75.0	C	2008/05	2018/12
BSC	Black Sea, Constanta	Romania	NOAA ESRL	28.66	44.18	5.00	75.0	D	2000/01	2005/01
BSD	Bilsdale	United Kingdom	UNIVBRIS	-1.15	54.36	628.00	30.0	C	2014/01	2019/12
CBA	Cold Bay, Alaska	United States	NOAA ESRL	-162.71	55.21	25.00	15.0	D	2000/01	2021/11
CBY	Cambridge Bay, Nunavut Territory	Canada	ECCC	-105.06	69.13	47.00	15.0	C	2012/12	2020/12
CDL	Candle Lake, Saskatchewan	Canada	ECCC	-105.12	53.99	630.00	30.0	C	2002/06	2007/12
CFA	Cape Ferguson	Australia	CSIRO	147.06	-19.28	5.00	25.0	D	2000/01	2021/04
CGO	Cape Grim, Tasmania	Australia	NOAA ESRL	144.68	-40.68	164.00	4.5	D	2000/01	2021/10
CGO	Cape Grim	Australia	CSIRO	144.68	-40.68	94.00	15.0	C	2012/07	2021/07
CGR	Charles Point, Darwin	Australia	CSIRO	12.65	37.67	9.00	25.0	C	2015/04	2018/12
CHL	Churchill, Manitoba	Canada	ECCC	-93.82	58.74	89.00	15.0	C	2011/10	2020/12
CHM	Chibougamau, Quebec	Canada	ECCC	-74.34	49.69	423.00	30.0	C	2007/08	2011/04
CHR	Christmas Island	Republic of Kiribati	NOAA ESRL	-157.15	1.70	5.00	15.0	D	2000/01	2020/01
CIB	Centro de Investigacion de la Baja Atmosfera (...)	Spain	NOAA ESRL	-4.93	41.81	850.00	25.0	D	2009/05	2009/05
CMN	Mt. Cimone Station	Italy	ICOS-ATC,CNR-ISAC	10.70	44.19	2173.00	15.0	C	2008/07	2021/12
CPS	Chapais, Quebec	Canada	ECCC	-74.98	49.82	431.00	15.0	C	2011/12	2020/12
CPT	Cape Point	South Africa	NOAA ESRL	18.49	-34.35	260.00	25.0	D	2010/02	2021/10
CRI	Cape Rama	India	CSIRO	73.83	15.08	66.00	75.0	D	2000/01	2013/01
CRV	Carbon in Arctic Reservoirs Vulnerability Expe...	United States	NOAA ESRL	-147.60	64.99	643.13	15.0	C	2011/10	2021/12
CRZ	Crozet Island	France	NOAA ESRL	51.85	-46.43	202.00	4.5	D	2000/01	2021/01
CUR	Monte Curcio	Italy	IIA	16.42	39.32	1801.00	15.0	C	2014/12	2017/12
CYA	Casey Station, Antarctica	Australia	CSIRO	110.52	-66.28	55.00	4.5	D	2000/01	2021/01

\*Sampling heights from which atmospheric CH<sub>4</sub> is sampled in TM5. \*\*Observations used in this study between 2000 and 2021.

**Table S1.** Continuation to Table S1.

Sitecode	Site Name	Country	Contributor	Longitude [°E]	Latitude [°N]	Height* [m a.s.l.]	Obs. Unc. [ppb]	Data type D/C	Date min.** [year/month]	Date max. [year/month]
DEM	Demyanskoe	Russian Federation	NIES	70.87	59.79	155.00	30.0	C	2005/09	2018/12
DRP	Drake Passage	Drake Passage	NOAA ESRL	-61.68	-59.07	10.00	4.5	D	2006/03	2021/05
DSI	Dongsha Island	Taiwan	NOAA ESRL	116.73	20.70	8.00	15.0	D	2010/03	2021/10
DVV	Danville, Virginia	United States	PSU	-79.44	36.71	492.00	15.0	C	2016/07	2017/12
EGB	Egbert, Ontario	Canada	ECCC	-79.78	44.23	276.00	25.0	C	2005/03	2020/12
EIC	Easter Island	Chile	NOAA ESRL	-109.45	-27.13	72.00	4.5	D	2000/01	2019/11
ENA	Eastern North Atlantic, Graciosa, Azores	Portugal	LBNL-ARM	-28.03	39.09	40.48	25.0	C	2015/07	2019/12
ESP	Estevan Point, British Columbia	Canada	CSIRO	-126.53	49.38	47.00	25.0	D	2000/03	2002/01
ESP	Estevan Point, British Columbia	Canada	ECCC	-126.54	49.38	47.00	25.0	C	2009/03	2020/12
EST	Esther, Alberta	Canada	ECCC	-110.21	51.67	757.00	30.0	C	2010/01	2020/11
ETL	East Trout Lake, Saskatchewan	Canada	ECCC	-104.99	54.35	598.00	30.0	C	2005/08	2020/10
FNE	Fort Nelson, British Columbia	Canada	ECCC	-122.57	58.84	376.00	30.0	C	2014/07	2020/12
FSD	Fraserdale	Canada	ECCC	-81.57	49.88	250.00	30.0	C	2000/01	2020/05
GAT	Gartow	Germany	ICOS-ATC.HPB	11.44	53.07	411.00	25.0	C	2016/05	2021/12
GCI	Millerville, AL	United States	PSU	-85.89	33.18	428.00	25.0	C	2017/10	2018/05
GMI	Mariana Islands	Guam	NOAA ESRL	144.66	13.39	8.00	15.0	D	2000/01	2021/09
GPA	Gunn Point	Australia	CSIRO	131.04	-12.25	37.00	75.0	D	2010/08	2021/02
HBA	Halley Station, Antarctica	United Kingdom	NOAA ESRL	-26.21	-75.61	35.00	4.5	D	2000/01	2021/02
HEI	Heidelberg	Germany	IUP	8.68	49.42	143.00	30.0	C	2005/01	2014/09
HNP	Hanlan's Point, Ontario	Canada	ECCC	-79.39	43.61	97.00	25.0	C	2014/06	2020/12
HPB	Hohenpeissenberg	Germany	NOAA ESRL	11.02	47.80	941.00	25.0	D	2006/04	2006/04
HPB	Hohenpeissenberg	Germany	ICOS-ATC.HPB	11.02	47.80	1065.00	25.0	C	2015/09	2021/12
HSU	Humboldt State University	United States	NOAA ESRL	-124.44	41.57	7.60	30.0	D	2008/05	2017/05
HTM	Hyltemossa	Sweden	ICOS-ATC.LUND-CEC	13.42	56.10	265.00	25.0	C	2017/04	2021/12
HUN	Hegyhatsal	Hungary	NOAA ESRL	16.65	46.95	344.00	25.0	D	2000/01	2004/12
ICE	Storhofdi, Vestmannaeyjar	Iceland	NOAA ESRL	-20.29	63.40	121.70	15.0	D	2000/01	2021/11
IGR	Igrim	Russian Federation	NIES	64.41	63.19	89.00	30.0	C	2005/04	2013/07
INU	Inuvik,Northwest Territories	Canada	ECCC	-133.53	68.32	123.00	15.0	C	2012/02	2020/12
IPR	Ispira	Italy	ICOS-ATC.JRC	8.64	45.81	310.00	30.0	C	2007/10	2021/12
IZO	Izana, Tenerife, Canary Islands	Spain	NOAA ESRL	-16.48	28.30	2377.90	25.0	D	2000/01	2021/10
JFJ	Jungfrauoch	Switzerland	ICOS-ATC.HFSJG	7.99	46.55	3585.00	15.0	C	2005/02	2021/12
KEY	Key Biscayne, Florida	United States	NOAA ESRL	-80.20	25.67	6.00	25.0	D	2000/02	2021/12
KIT	Karlsruhe	Germany	ICOS-ATC.HPB	8.42	49.09	310.00	30.0	C	2016/12	2021/12
KJN	Kjolnes	Norway	Univ. Exeter	29.23	70.85	20.00	15.0	C	2013/10	2018/08
KMP	Kumpula	Finland	FMI	24.96	60.20	53.00	30.0	C	2010/01	2021/12
KRE	Kresin u Pacova	Czech Republic	ICOS	15.08	49.57	784.00	25.0	C	2017/04	2021/12
KRS	Karasevoe	Russian Federation	NIES	82.42	58.25	156.00	30.0	C	2004/09	2018/12
KUM	Cape Kumukahi, Hawaii	United States	NOAA ESRL	-155.01	19.51	3.00	15.0	D	2000/01	2021/12
KZD	Sary Taukum	Kazakhstan	NOAA ESRL	75.57	44.45	600.00	75.0	D	2000/01	2009/08
KZM	Plateau Assy	Kazakhstan	NOAA ESRL	77.87	43.25	2524.00	25.0	D	2000/01	2009/08
LEF	Park Falls, Wisconsin	United States	NOAA ESRL	-90.27	45.95	868.00	30.0	C	2010/09	2021/12
LEF	Park Falls, Wisconsin	United States	NOAA ESRL	-90.26	45.95	868.00	30.0	D	2000/01	2021/12
LIN	Lindenberg	Germany	ICOS-ATC.HPB	14.12	52.17	171.00	30.0	C	2015/10	2021/12
LLB	Lac La Biche, Alberta	Canada	NOAA ESRL	-112.45	54.95	546.10	30.0	D	2008/01	2013/02
LLB	Lac La Biche, Alberta	Canada	ECCC	-112.47	54.95	590.00	30.0	C	2007/04	2020/12
LLN	Lulin	Taiwan	NOAA ESRL	120.86	23.47	2867.00	25.0	D	2006/08	2021/11
LMP	Lampedusa	Italy	NOAA ESRL	12.63	35.52	50.00	25.0	D	2006/10	2006/10
LMP	Lampedusa	Italy	ICOS-ATC.ENEAA	12.63	35.52	53.00	25.0	C	2020/01	2021/12
LMT	Lamezia Terme	Italy	ISAC	16.23	38.88	14.00	30.0	C	2015/01	2016/12
LPO	Ile Grande	France	LSCE	-3.58	48.80	20.00	15.0	D	2005/01	2013/08
LUT	Lutjewad	Netherlands	ICOS-ATC.RUG	6.35	53.40	61.00	25.0	C	2006/05	2021/12

**Table S1.** Continuation to Table S1.

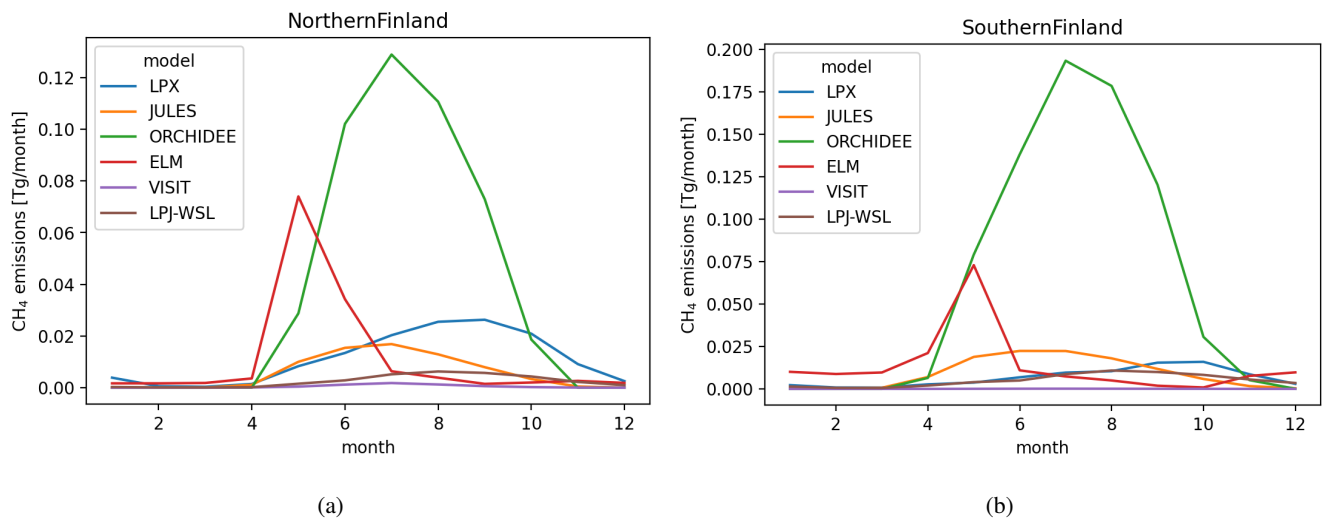
Sitecode	Site Name	Country	Contributor	Longitude [°E]	Latitude [°N]	Height* [m a.s.l.]	Obs. Unc. [ppb]	Data type D/C	Date min.** [year/month]	Date max. [year/month]
MAA	Mawson, Antarctica	Australia	CSIRO	62.87	-67.62	32.00	4.5	D	2000/02	2021/02
MEX	High Altitude Global Climate Observation Center	Mexico	NOAA ESRL	-97.31	18.98	4469.00	15.0	D	2009/01	2021/09
MHD	Mace Head, County Galway	Ireland	NOAA ESRL	-9.90	53.32	26.00	25.0	D	2000/01	2005/01
MID	Sand Island, Midway	United States	NOAA ESRL	-177.38	28.21	8.00	15.0	D	2000/01	2021/11
MKN	Mt. Kenya	Kenya	NOAA ESRL	37.30	-0.06	3649.00	25.0	D	2003/12	2011/06
MLO	Mauna Loa, Hawaii	United States	NOAA ESRL	-155.58	19.54	3437.00	15.0	C	2000/01	2021/12
MLO	Mauna Loa, Hawaii	United States	NOAA ESRL	-155.58	19.54	3402.00	15.0	D	2000/01	2021/12
MNM	Minamitorishima	Japan	JMA	153.98	24.29	27.10	15.0	C	2000/01	2020/12
MQA	Macquarie Island	Australia	CSIRO	158.97	-54.48	13.00	4.5	D	2000/01	2021/02
MRC	Marcellus Pennsylvania	United States	PSU	-76.42	41.47	652.00	75.0	C	2015/05	2018/12
NAT	Farol De Mae Luiza Lighthouse	Brazil	NOAA ESRL	-35.19	-5.51	20.00	15.0	D	2010/09	2020/03
NGL	Neuglobsow	Germany	UBA	13.03	53.14	62.00	75.0	C	2005/01	2013/12
NMB	Gobabeb	Namibia	NOAA ESRL	15.01	-23.58	461.00	25.0	D	2000/01	2021/09
NOR	Norunda	Sweden	ICOS-ATC.LUND-CEC	17.48	60.09	146.00	15.0	C	2017/04	2021/12
NOY	Noyabrsk	Russian Federation	NIES	75.78	63.43	188.00	30.0	C	2005/10	2018/12
NWR	Niwot Ridge, Colorado	United States	NOAA ESRL	-105.57	40.05	3526.00	15.0	D	2000/01	2021/11
OPE	Observatoire perenne de l'environnement	France	ICOS-ATC.LSCE	5.50	48.56	510.00	30.0	C	2011/07	2021/12
OTA	Otway Basin	Australia	CSIRO	142.82	-38.52	50.00	30.0	D	2005/09	2014/08
OXX	Ochsenkopf	Germany	NOAA ESRL	11.81	50.03	1185.00	30.0	D	2003/03	2006/07
OXX	Ochsenkopf	Germany	ICOS-ATC.HPB	11.81	50.03	1185.00	30.0	C	2006/06	2021/12
PAL	Pallas-Sammaltunturi, GAW Station	Finland	NOAA ESRL	24.12	67.97	570.00	15.0	D	2001/12	2005/01
PAL	Pallas-Sammaltunturi, GAW Station	Finland	FMI	24.12	67.97	570.00	15.0	C	2004/02	2005/01
PAL	Pallas-Sammaltunturi, GAW Station	Finland	ICOS-ATC.FMI	24.12	67.97	577.00	15.0	C	2005/01	2021/12
PDM	Pic du Midi	France	LSCE	0.14	42.94	2887.00	15.0	D	2005/02	2018/02
POC	Pacific Ocean	Pacific Ocean	NOAA ESRL	-130.75	0.12	20.00	15.0	D	2000/01	2017/07
PSA	Palmer Station, Antarctica	United States	NOAA ESRL	-64.05	-64.77	15.00	4.5	D	2000/01	2021/05
PTA	Point Arena, California	United States	NOAA ESRL	-123.74	38.95	22.00	25.0	D	2000/01	2011/05
PUI	Puijo	Finland	ICOS-ATC.UEF	27.66	62.91	84.00	30.0	C	2011/11	2020/12
PUY	Puy de Dome	France	ICOS-ATC.LSCE	2.97	45.77	1475.00	15.0	C	2010/07	2021/12
RPB	Ragged Point	Barbados	NOAA ESRL	-59.43	13.16	20.00	15.0	D	2000/01	2021/11
RUN	La Réunion	France	ICOS-ATC.LSCE	55.38	-21.08	2160.00	15.0	C	2018/05	2021/12
RYO	Ryori	Japan	JMA	141.82	39.03	280.00	15.0	C	2000/01	2020/12
SAC	Saclay	France	ICOS-ATC.CEA	2.14	48.72	260.00	75.0	C	2017/05	2021/12
SCT	Beech Island, South Carolina	United States	NOAA ESRL	-81.83	33.41	420.20	75.0	C	2015/08	2021/12
SDZ	Shangdianzi	China	NOAA ESRL	117.12	40.65	298.00	15.0	D	2009/09	2015/09
SEY	Mahe Island	Seychelles	NOAA ESRL	55.53	-4.68	7.00	15.0	D	2000/01	2021/08
SGP	Southern Great Plains, Oklahoma	United States	NOAA ESRL	-97.50	36.62	339.00	75.0	D	2002/04	2021/12
SGP	Southern Great Plains, Oklahoma	United States	LBNL-ARM	-97.49	36.61	374.00	75.0	C	2011/01	2020/12
SHM	Shemya Island, Alaska	United States	NOAA ESRL	174.08	52.72	28.00	25.0	D	2000/01	2021/07
SIS	Shetland Islands	United Kingdom	CSIRO	-1.25	60.09	33.00	15.0	D	2000/01	2003/12
SMO	Tutuila	American Samoa	NOAA ESRL	-170.56	-14.23	60.30	15.0	D	2000/01	2021/11
SMR	Hyytiälä	Finland	ICOS-ATC.UHELS	24.29	61.85	306.00	25.0	C	2016/12	2021/12
SNB	Sonnblick	Austria	EAA	47.05	12.96	3111.00	15.0	C	2012/04	2018/12
SOD	Sodankylä	Finland	FMI	26.64	67.36	227.00	25.0	C	2012/01	2021/12
SPO	South Pole, Antarctica	United States	NOAA ESRL	-24.80	-89.96	2821.30	4.5	D	2000/01	2021/10
STE	Steinkimmen	Germany	ICOS-ATC.HPB	8.46	53.04	281.00	75.0	C	2019/07	2021/12
STM	Ocean Station M	Norway	NOAA ESRL	2.00	66.00	5.00	25.0	D	2000/01	2009/11
SUM	Summit	Greenland	NOAA ESRL	-38.42	72.60	3214.54	15.0	D	2000/08	2021/07
SVB	Svartberget	Sweden	ICOS-ATC.SLU	19.77	64.26	419.00	25.0	C	2017/06	2021/12
SYO	Syowa Station, Antarctica	Japan	NOAA ESRL	39.59	-69.00	16.00	4.5	D	2000/01	2020/12

**Table S1.** Continuation to Table S1.

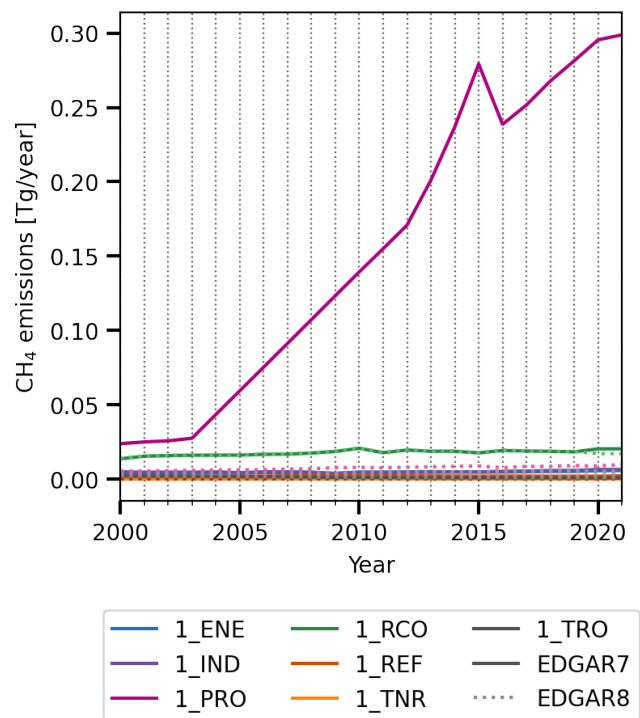
Sitecode	Site Name	Country	Contributor	Longitude [°E]	Latitude [°N]	Height* [m a.s.l.]	Obs. Unc. [ppb]	Data type D/C	Date min.** [year/month]	Date max. [year/month]
TAC	Tacolneston	United Kingdom	NOAA ESRL	1.14	52.52	236.00	25.0	D	2014/06	2016/01
TAP	Tae-ahn Peninsula	Republic of Korea	NOAA ESRL	126.13	36.73	21.00	75.0	D	2000/01	2021/10
THD	Trinidad Head, California	United States	NOAA ESRL	-124.15	41.05	112.00	25.0	D	2002/04	2017/06
TIK	Hydrometeorological Observatory of Tiksi	Russia	NOAA ESRL	128.89	71.60	29.00	15.0	D	2011/08	2018/09
TIK	Tiksi	Russian Federation	FMI	128.89	71.60	29.00	15.0	C	2010/09	2020/12
TOH	Torfhaus	Germany	ICOS-ATC,HPB	10.53	51.81	948.00	25.0	C	2017/12	2021/12
TPD	Turkey Point, Ontario	Canada	ECCC	-80.56	42.64	266.00	25.0	C	2012/11	2020/12
TRN	Trainou	France	ICOS-ATC,LSCE	2.11	47.96	311.00	25.0	C	2006/08	2021/12
USH	Ushuaia	Argentina	NOAA ESRL	-68.31	-54.85	32.00	4.5	D	2000/01	2021/06
UTA	Wendover, Utah	United States	NOAA ESRL	-113.72	39.90	1332.00	25.0	D	2000/01	2021/12
UTO	Uto	Finland	FMI	21.37	59.78	65.00	25.0	C	2012/03	2018/03
UTO	Uto	Finland	ICOS-ATC,FMI	21.37	59.78	65.00	25.0	C	2018/03	2021/12
UUM	Ulaan Uul	Mongolia	NOAA ESRL	111.10	44.45	1012.00	25.0	D	2000/01	2020/10
VGN	Vaganovo	Russian Federation	NIES	62.32	54.50	277.00	30.0	C	2008/06	2018/12
VKV	Voikovo	Russian Federation	MGO	30.70	59.95	76.00	25.0	C	2008/05	2014/12
WIS	Weizmann Institute of Science at the Arava Ins...	Israel	NOAA ESRL	35.06	29.96	482.00	25.0	D	2000/01	2021/11
WKT	Moody, Texas	United States	NOAA ESRL	-97.32	31.31	256.00	75.0	D	2001/03	2006/11
WLG	Mt. Waliguan	Peoples Republic of China	NOAA ESRL	100.90	36.27	3890.00	15.0	D	2000/01	2021/09
WPC	Western Pacific Cruise	Western Pacifi	NOAA ESRL	143.70	0.13	10.00	15.0	D	2004/12	2013/06
WSA	Sable Island, Nova Scotia	Canada	ECCC	-60.01	43.93	8.00	25.0	C	2003/06	2020/03
YAK	Yakutsk	Russian Federation	NIES	129.36	62.09	344.00	30.0	C	2007/09	2013/12
YON	Yonagunijima	Japan	JMA	123.01	24.47	50.00	30.0	C	2000/01	2020/12
ZEP	Ny-Alesund, Svalbard	Norway and Sweden	NOAA ESRL	11.89	78.91	479.00	15.0	D	2000/01	2005/01
ZEP	Ny-Alesund, Svalbard	Norway and Sweden	ICOS-ATC,NILU	11.89	78.91	489.00	15.0	C	2012/04	2021/12
ZOT	Zotino	Russian Federation	MPIBGC	89.21	60.48	415.00	25.0	C	2009/05	2016/12
ZOT	Zotino	Russian Federation	MPIBGC	89.21	60.48	415.00	15.0	D	2006/10	2013/06

**Table S2.** Continuation to Table 1 "List of inversion setups". The prior emissions of termites, ocean and geological priors used the atmospheric sink used are specified.

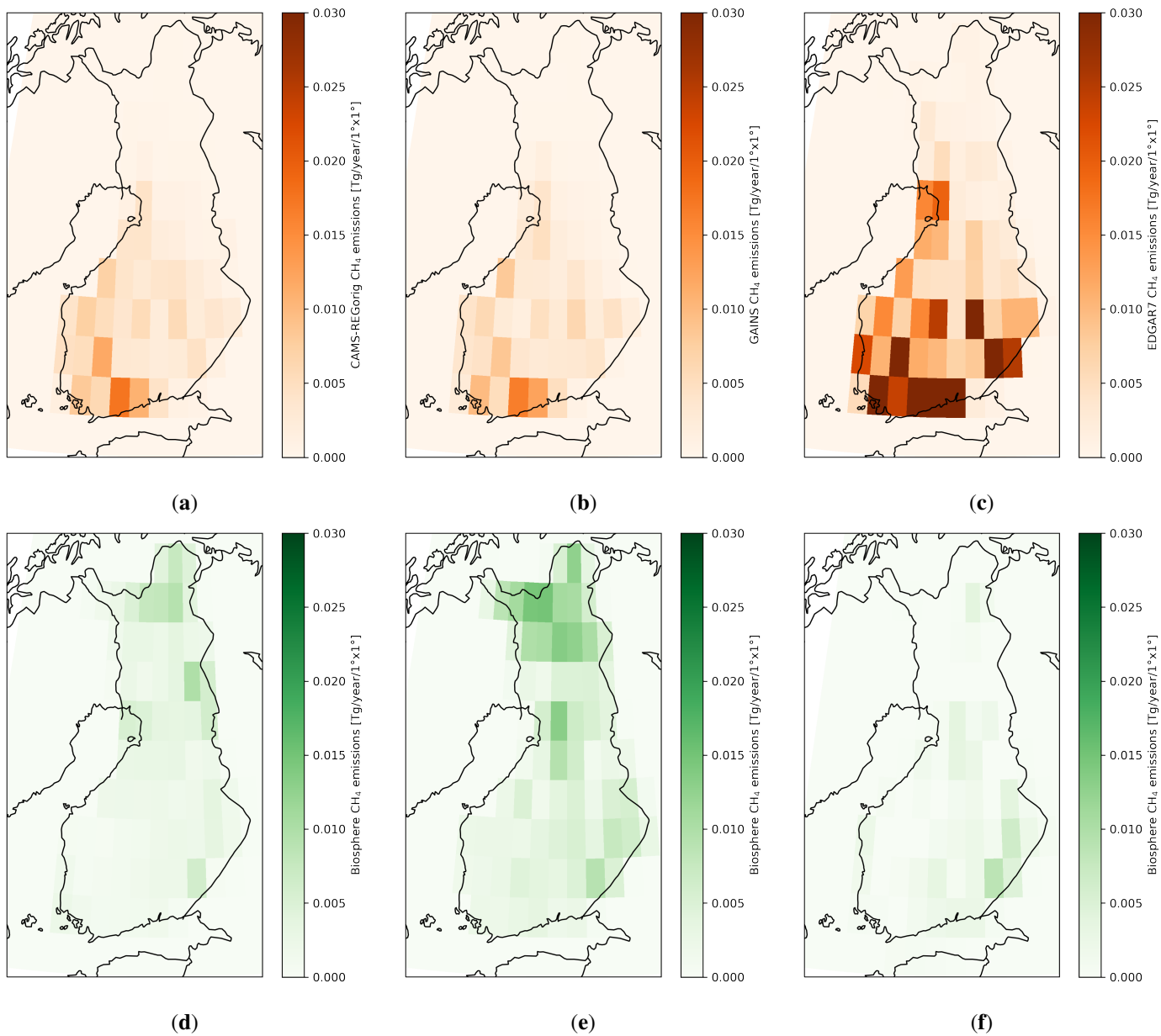
Inversion	Termite prior	Ocean prior	Geological prior	Atmospheric sink
InvJSBACH_CAMSREG	VISIT	Tsuruta et al. (2017)		ECHAM5/MESSy1
InvLPX_CAMSREG	VISIT	Tsuruta et al. (2017)		ECHAM5/MESSy1
InvLPX_EDGAR	VISIT	Weber et al. (2019)		ECHAM5/MESSy1
InvLPX_EDGAR_UNC	VISIT	Weber et al. (2019)		ECHAM5/MESSy1
InvGCP_EDGAR	Saunois et al. (2020)	Weber et al. (2019)	Etiopie et al. (2019)	Brühl and Crutzen (1993)



**Figure S2.** Average monthly CH<sub>4</sub> emissions of process-based models from Saunois et al. (2020) in a) northern and b) southern Finland.

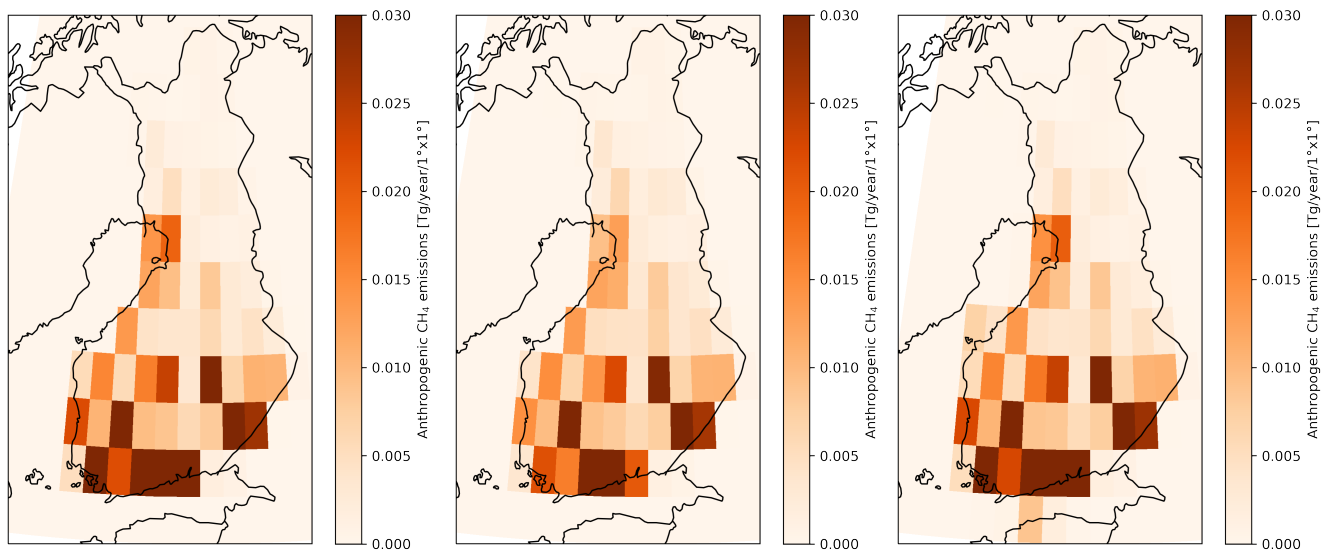


**Figure S3.** Annual energy sector CH<sub>4</sub> emissions by its components from EDGAR v7 (solid line) and v8 (dotted line).



**Figure S4.** Average annual  $\text{CH}_4$  emissions from 2010–2020 of (a) CAMS-REG (orig), (b) GAINS, (c) EDGAR v7, (d) LPX-Bern DYPTOP, (e) JSBACH-HIMMELI and (f) GCP biospheric prior.

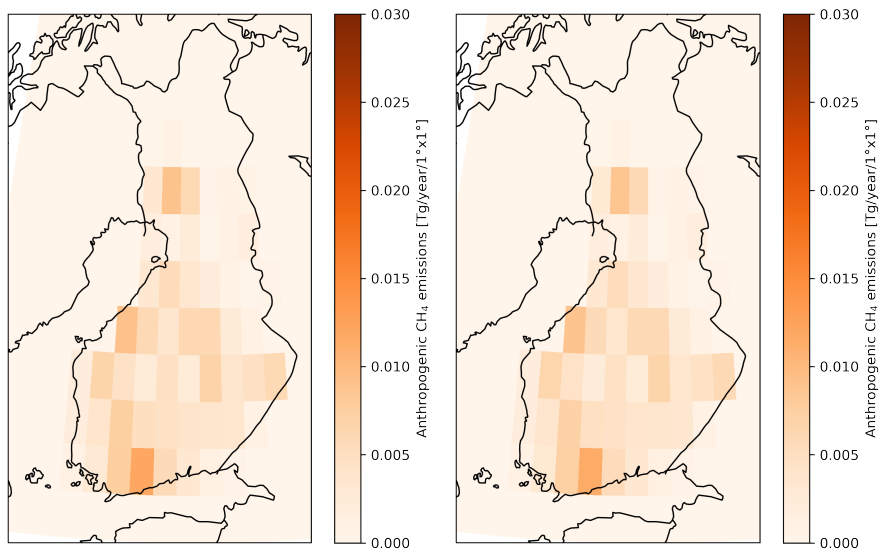




(a) InVLPX\_EDGAR

(b) InVLPX\_EDGAR\_UNC

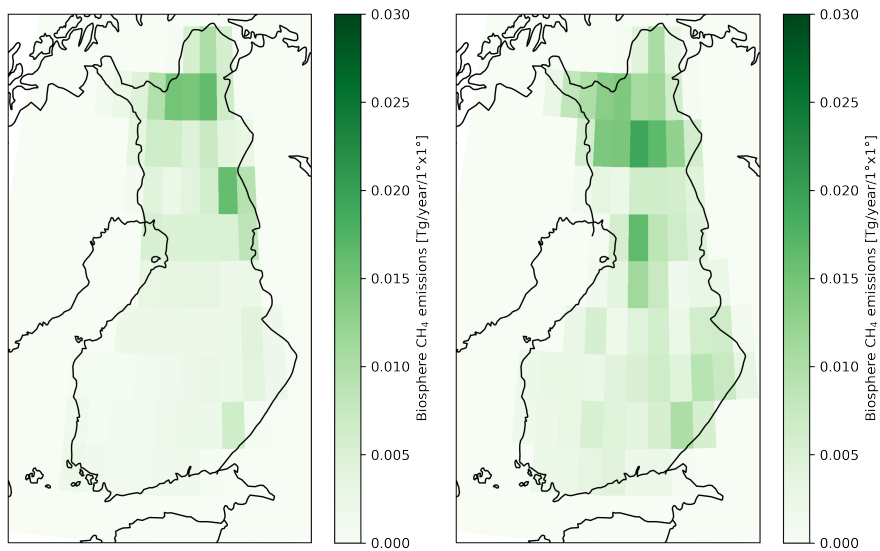
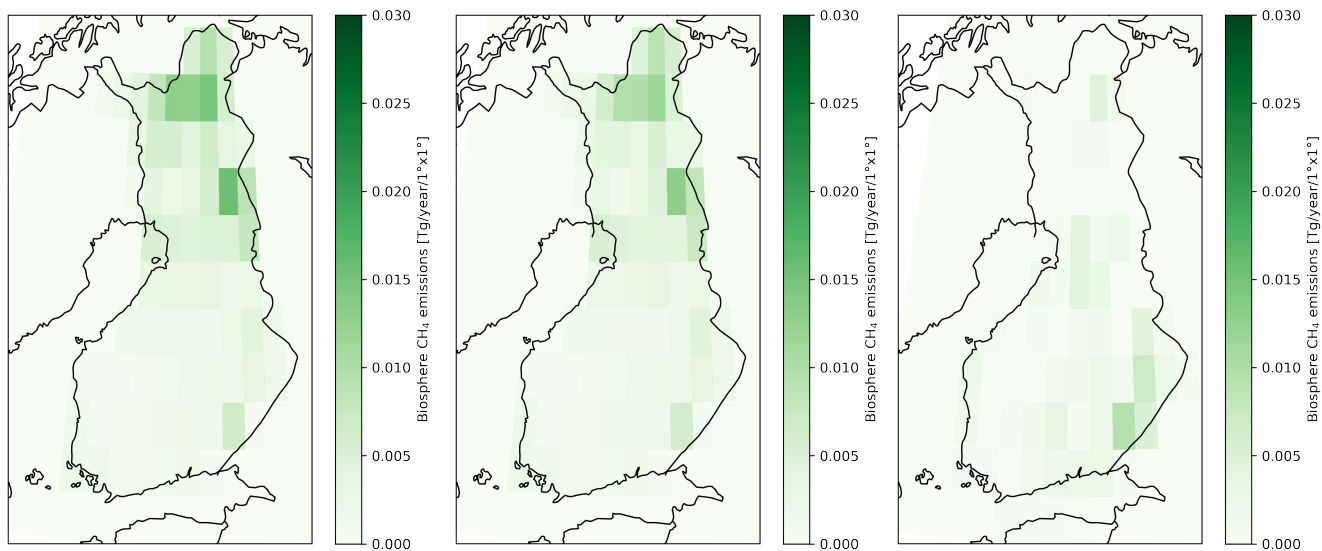
(c) InVGCP\_EDGAR



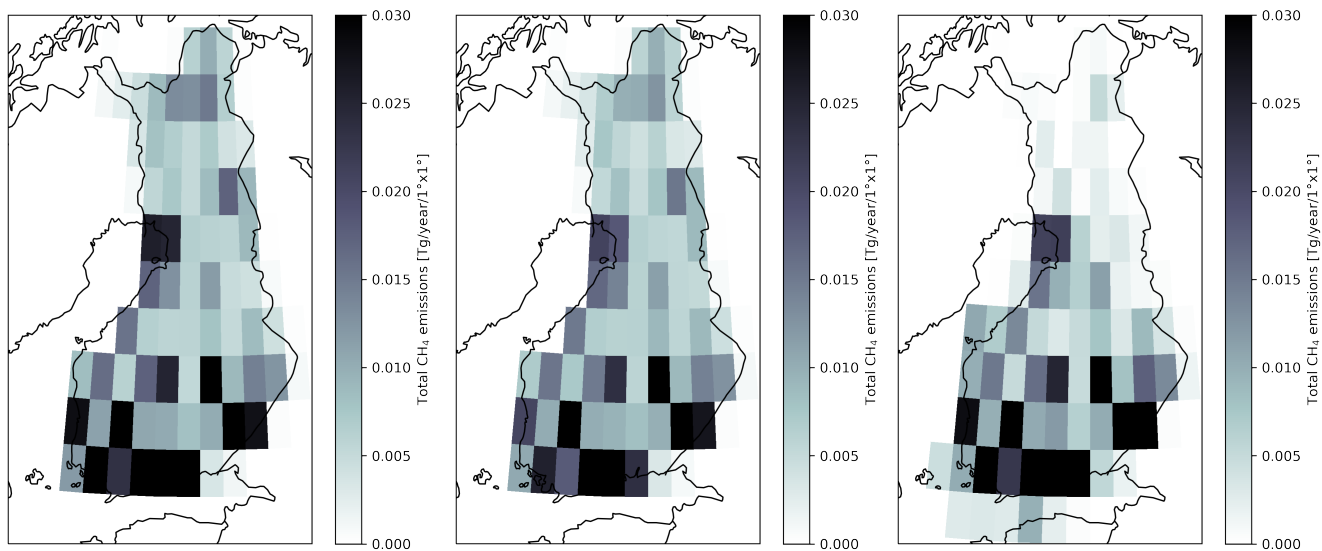
(d) InVLPX\_CAMSREG

(e) InVJSBACH\_CAMSREG

**Figure S5.** Average optimised annual anthropogenic CH<sub>4</sub> emissions from 2010–2020 from (a) InVLPX\_EDGAR, (b) InVLPX\_EDGAR\_UNC, (c) InVGCP\_EDGAR, (d) InVLPX\_CAMSREG and (e) InVJSBACH\_CAMSREG



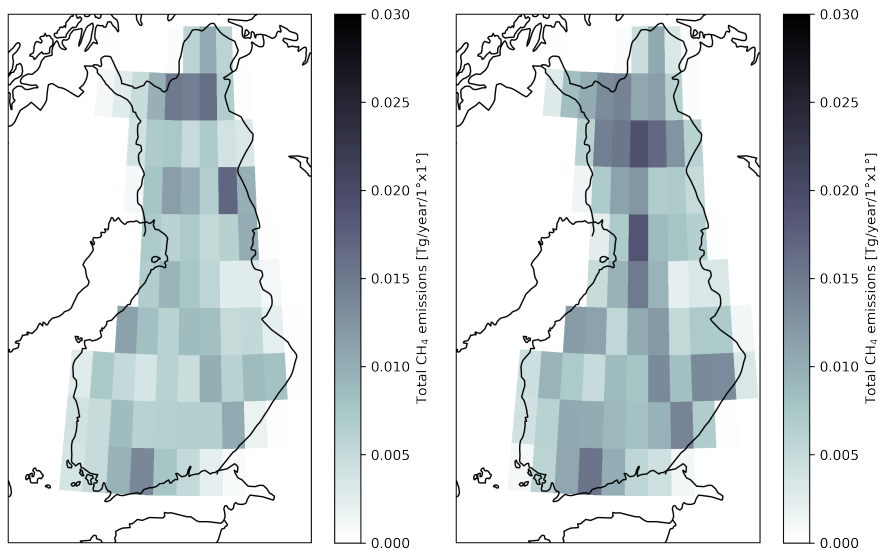
**Figure S6.** Average optimised annual natural CH<sub>4</sub> emissions from 2010–2020 from (a) InVLPX\_EDGAR, (b) InVLPX\_EDGAR\_UNC, (c) InVGCP\_EDGAR, (d) InVLPX\_CAMSREG and (e) InVJSBACH\_CAMSREG.



(a) InvLPX\_EDGAR

(b) InvLPX\_EDGAR\_UNC

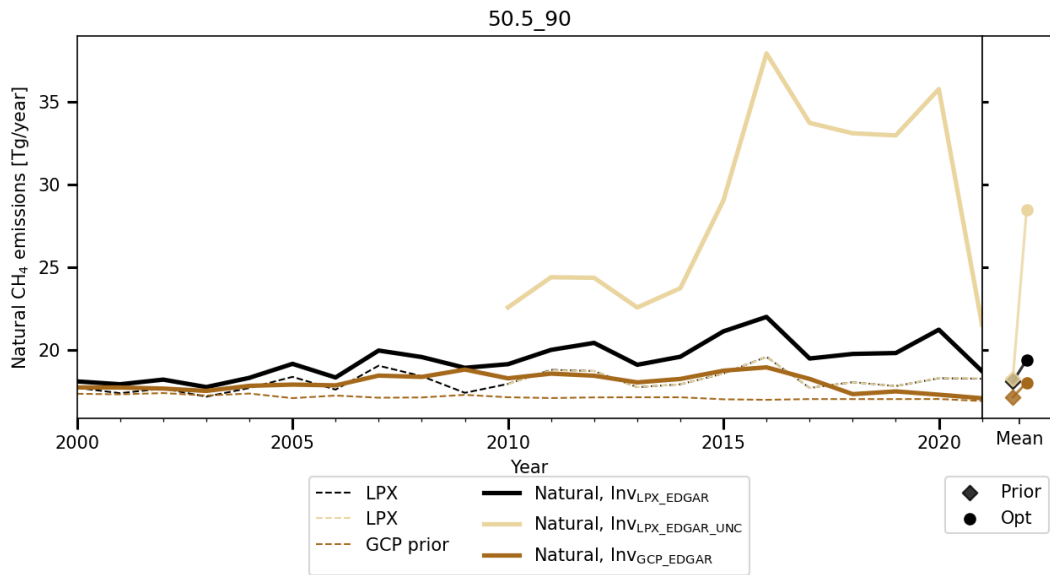
(c) InvGCP\_EDGAR



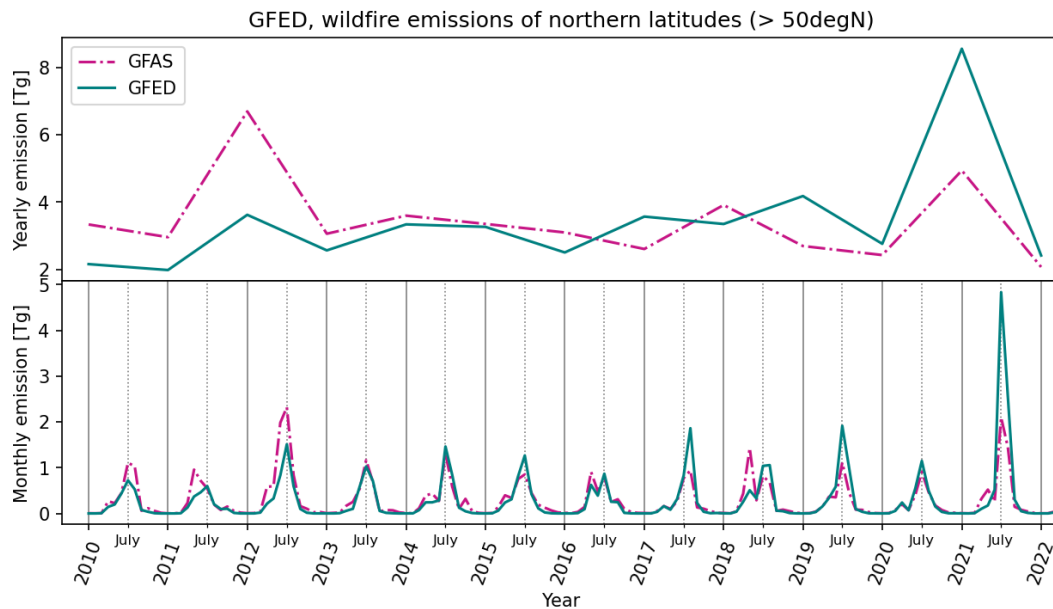
(d) InvLPX\_CAMSREG

(e) InvJSBACH\_CAMSREG

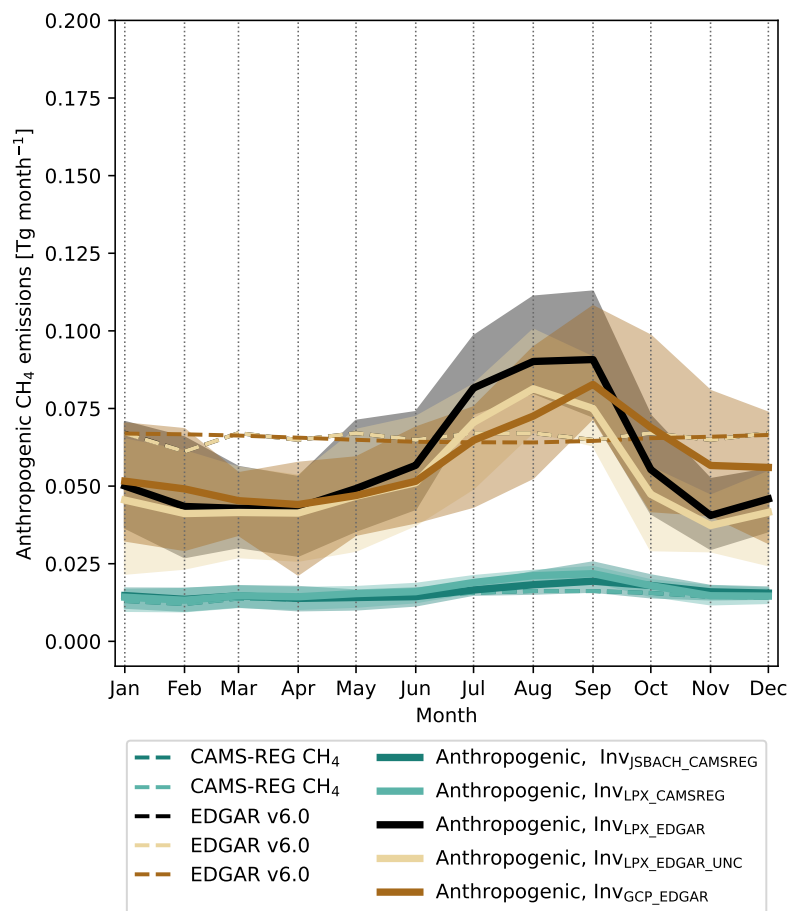
**Figure S7.** Average optimised annual total CH<sub>4</sub> emissions from 2010–2020 from (a) InvLPX\_EDGAR, (b) InvLPX\_EDGAR\_UNC, (c) InvGCP\_EDGAR, (d) InvLPX\_CAMSREG and (e) InvJSBACH\_CAMSREG



**Figure S8.** Annual natural CH<sub>4</sub> emission estimates from three CTE-CH<sub>4</sub> inverse model runs in latitudes northern than 50° N. Prior estimates are shown with dashed and optimised estimates with solid lines. The right panel shows the mean prior and optimised estimates from the whole study period.



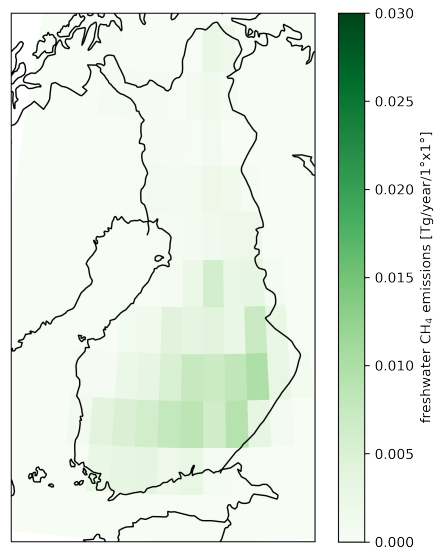
**Figure S9.** Annual (top) and monthly (bottom) CH<sub>4</sub> emissions from GFAS (dashed line) and GFED (solid line) in latitudes northern than 50° N.



**Figure S10.** Average monthly anthropogenic CH<sub>4</sub> emission estimates from the five CTE-CH<sub>4</sub> inverse model runs in Finland in 2010–2020. Prior estimates are shown with dashed and optimised estimates with solid lines. The shaded areas show the smallest and the largest monthly posterior emission estimates.

Inversion run	Site						
	UTO	KMP	PUI	SMR	PAL	SOD	Mean
Prior Inv <sub>JSBACH_CAMSREG</sub>	2.67	1.33	2.33	2.67	2.33	2.33	2.28
Prior Inv <sub>LPX_CAMSREG</sub>	2.33	2.33	2.67	3.00	2.67	2.67	2.61
Prior Inv <sub>LPX_EDGAR</sub>	4.00	4.00	4.00	3.33	4.00	3.67	3.83
Prior Inv <sub>GCP_EDGAR</sub>	1.00	2.33	1.00	1.00	1.00	1.33	1.28

**Figure S11.** The average rank calculated for each site for each forward run (with prior emissions) is shown. The bias, the detrended RMSE and the detrended R were calculated with each forward run in each site and values were then ranked between the model estimates (the smallest being the best with bias and RMSE and the highest being the best with R). Additionally, the right-most column is the average over all sites averages.



**Figure S12.** Average annual freshwater CH<sub>4</sub> emissions from 2010–2020 by Stavert et al. (2022).

## References

- Brühl, C. and Crutzen, P. J.: MPIC two-dimensional model, Tech. rep., NASA, Washington, DC, 1993.
- Etiopie, G., Ciotoli, G., Schwietzke, S., and Schoell, M.: Gridded maps of geological methane emissions and their isotopic signature, *Earth System Science Data*, 11, 1–22, <https://doi.org/10.5194/essd-11-1-2019>, 2019.
- 5 Saunois, M., Stavert, A. R., Poulter, B., Bousquet, P., Canadell, J. G., Jackson, R. B., Raymond, P. A., Dlugokencky, E. J., Houweling, S., Patra, P. K., Ciais, P., Arora, V. K., Bastviken, D., Bergamaschi, P., Blake, D. R., Brailsford, G., Bruhwiler, L., Carlson, K. M., Carrol, M., Castaldi, S., Chandra, N., Crevoisier, C., Crill, P. M., Covey, K., Curry, C. L., Etiopie, G., Frankenberg, C., Gedney, N., Hegglin, M. I., Höglund-Isaksson, L., Hugelius, G., Ishizawa, M., Ito, A., Janssens-Maenhout, G., Jensen, K. M., Joos, F., Kleinen, T., Krummel, P. B., Langenfelds, R. L., Laruelle, G. G., Liu, L., Machida, T., Maksyutov, S., McDonald, K. C., McNorton, J., Miller, P. A., Melton, J. R., Morino, I., Müller, J., Murguía-Flores, F., Naik, V., Niwa, Y., Noce, S., O’Doherty, S., Parker, R. J., Peng, C., Peng, S., Peters, G. P., Prigent, C., Prinn, R., Ramonet, M., Regnier, P., Riley, W. J., Rosentretter, J. A., Segers, A., Simpson, I. J., Shi, H., Smith, S. J., Steele, L. P., Thornton, B. F., Tian, H., Tohjima, Y., Tubiello, F. N., Tsuruta, A., Viovy, N., Voulgarakis, A., Weber, T. S., van Weele, M., van der Werf, G. R., Weiss, R. F., Worthy, D., Wunch, D., Yin, Y., Yoshida, Y., Zhang, W., Zhang, Z., Zhao, Y., Zheng, B., Zhu, Q., Zhu, Q., and Zhuang, Q.: The Global Methane Budget 2000–2017, *Earth System Science Data*, 12, 1561–1623, <https://doi.org/10.5194/essd-12-1561-2020>,  
15 2020.
- Stavert, A. R., Saunois, M., Canadell, J. G., Poulter, B., Jackson, R. B., Regnier, P., Lauerwald, R., Raymond, P. A., Allen, G. H., Patra, P. K., Bergamaschi, P., Bousquet, P., Chandra, N., Ciais, P., Gustafson, A., Ishizawa, M., Ito, A., Kleinen, T., Maksyutov, S., McNorton, J., Melton, J. R., Müller, J., Niwa, Y., Peng, S., Riley, W. J., Segers, A., Tian, H., Tsuruta, A., Yin, Y., Zhang, Z., Zheng, B., and Zhuang, Q.: Regional trends and drivers of the global methane budget, *Global Change Biology*, 28, 182–200, <https://doi.org/10.1111/gcb.15901>,  
20 2022.
- Tsuruta, A., Aalto, T., Backman, L., Hakkarainen, J., van der Laan-Luijkx, I. T., Krol, M. C., Spahni, R., Houweling, S., Laine, M., Dlugokencky, E., Gomez-Pelaez, A. J., van der Schoot, M., Langenfelds, R., Ellul, R., Arduini, J., Apadula, F., Gerbig, C., Feist, D. G., Kivi, R., Yoshida, Y., and Peters, W.: Global methane emission estimates for 2000–2012 from CarbonTracker Europe-CH4 v1.0, *Geoscientific Model Development*, 10, 1261–1289, <https://doi.org/10.5194/gmd-10-1261-2017>, 2017.
- 25 Weber, T., Wiseman, N. A., and Kock, A.: Global ocean methane emissions dominated by shallow coastal waters, *Nature Communications*, 10, 4584, <https://doi.org/10.1038/s41467-019-12541-7>, 2019.