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AIRBORNE METHANE EMISSIONS MEASUREMENT SURVEY

FINAL SUMMARY REPORT

AGREEMENT NO. 18RD032

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ACKNOWLEDGEMENT

This Report was submitted in fulfillment of agreement no. 18RD032 entitled “Statewide Airborne Methane Emissions Measurement Survey by Scientific Aviation” under the sponsorship of the California Air Resources Board. Work was completed as of February 26, 2021.

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Executive Summary

Scientific Aviation was contracted by the California Air Resources Board to conduct airborne methane emissions quantifications at a variety of target sites representing known methane source sectors. 199 individual measurements were performed at 114 different target sites between November 18, 2019 – February 26, 2021. Target sites included industrial, agricultural, and waste sources. Several sites from each source type were sampled on more than one occasion to assess temporal variability.

The methodology used by Scientific Aviation is a modified mass balance approach based on Gauss's Law that has been extensively demonstrated to be accurate and robust and has been published in the peer-reviewed literature. This method involves flying multiple closed-loop patterns around a site of interest at increasing altitudes to fully sample upwind and downwind of a source and the full vertical extent of a plume. An emission rate is determined by using on-board wind measurements and in situ chemical measurements of methane to calculate the mass flow of methane emanating from the target site.

Of the 199 measurements conducted, methane emissions from 11 facilities were found to be below the detection limit of the method (i.e., < 5 kg h^{-1} CH_4). The landfill sites were found to be the largest methane emitters on a per site basis, with an average methane emission over all landfill measurements of 1026 ± 713 kg h^{-1} CH_4. The average emission from the dairy/ranch facilities was 271 ± 238 kg h^{-1} CH_4.

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I. Introduction

Methane is an important greenhouse gas, which is 84 times more potent than CO_2 over a 20-year time horizon[1]. After a prolonged period of nearly constant methane emissions and near-zero growth in the global atmospheric methane burden in the 1990's through early 2000's, the observation of a renewed methane increase beginning in 2007 has prompted the need to investigate and better quantify methane emissions sources. Several studies have identified weaknesses in the current national methane emissions inventory, particularly with respect to the oil and gas sector, where top-down measurements (via aircraft and satellite)[2] have found larger, and increasing, methane emissions relative to the traditional bottom-up inventory. Moreover, other methane sources (e.g., landfills, agriculture, wetlands) are known to be large contributors to total methane emissions, however there is significant uncertainty in the magnitude and the variability of those emissions.

The California Air Resources Board (CARB) estimates California annual methane emission as 40 MMT CO_2e for year 2014, arising primarily from agriculture (59%), landfills (21%) and industrial sources (19%)[3]. Methane is responsible for 9% of California's total greenhouse gas emissions. Researchers have suggested the CARB inventory underestimates total methane emission by 30%[4]. An extensive understanding of methane sources, including locations, emission potential, distribution and contribution is complementary for CARB to improve the emission inventory and develop policy programs. Randomly sampling various sources from each of the primary emission sectors can help inform the emission inventory by comparing those measurements with the inventory estimations.

In 2015, the Governor approved Assembly Bill 1496 (AB 1496), which requires the CARB to monitor and measure high methane emission hotspots within the state using the best available scientific and technical methods. The CARB, in conjunction with California Energy Commission (CEC) and NASA Jet Propulsion Laboratory (JPL) has initiated a large-statewide aerial survey to identify large methane point emissions whereby aircraft from JPL equipped with imaging spectrometers will map out 30,000 square kilometers to detect methane plumes and locate hot spots.

The current project complements the JPL survey and other CARB efforts, to identify large area sources and provide a defensible source emissions estimate that can be used to improve the CARB inventory. Aerial measurements using in situ chemical analyzers has the unique advantage of quantifying emissions from both large area sources and point sources without the need to access the facilities. This approach utilizes an instrumented aircraft and a modified mass balance methodology to quantify emissions from a variety of methane sources. The particular strength of this analytical approach was demonstrated, perhaps most notably, by Scientific Aviation during the 2015 Aliso Canyon Leak Incident[5] (Conley et al., 2016).

1 https://www.ipcc.ch/report/ar5/syr/

2 Conley et al. (2017). Application of Gauss's theorem to quantify localized surface emissions from airborne measurements of wind and trace gases. Atmos. Meas. Tech. *10*, 3345-3358.

3 https://www.CARB.ca.gov/cc/inventory/background/ch4.htm

4 https://www.CARB.ca.gov/research/single-project.php?row_id=65091

5 Conley et al. (2016). Methane emissions from the 2015 Aliso Canyon blowout in Los Angeles, CA. Science.

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In the present study, Scientific Aviation was contracted by CARB to perform airborne emissions quantification measurements from a variety of methane sources associated with industry, agriculture, and municipal waste, with several sites sampled repeatedly. This report presents the results of these survey measurements conducted from November 18, 2019 – February 26, 2021.

II. Project Goals

The primary objectives of this project were to better understand methane emissions from California's major emission sectors, including:

- Measurement of important sources in the various primary methane sectors and sub-sectors with the ability to study whole facility emissions
- Obtain data for CARB Methane Research Program for systematic analysis of facility-level emissions in each sector by measuring different types of sources (geographic locations, size, operational characteristics, etc.) in different seasons
- Use a state-of-the-art measurement tool to complement the multi-tiered measurement and analysis research program.

III. Methodology

This project utilized an instrumented Mooney aircraft owned and operated by Scientific Aviation to conduct emissions measurements from target sources. The aircraft is outfitted with a proprietary data system that measures and records aircraft speed, position, altitude, and horizontal winds (accurate to better than 0.5 m s^{-1}), as well as ambient temperature, pressure, and relative humidity. A Picarro G2210-m cavity ring down spectrometer interfaced with the on-board data system provides fast time response in situ measurements of methane, ethane, and CO_2. This analyzer measures methane with 1-s precision of 1 ppbv, and ethane with 1-s precision of ~5 ppbv. All data collected by the aircraft is uploaded and stored in real time to a secure cloud-based server.

The measurement approach used a modified version of mass balance based on Gauss's Law as described in Conley et al. (2017). For each target site, the aircraft flew a closed loop pattern around the facility, beginning at the minimum safe altitude (typically 200 to 500 feet) and climbing progressively higher, until on-board measurements indicated that the aircraft was above the plume. Additional loops were flown above the plume to confirm the extent of the vertical mixing, as shown in Figure 1.

Mass-based emissions were calculated for the closed path at each transect altitude by integrating plume mixing ratio enhancements measured during transects, and then integrating through the vertical extent of the plume, as shown in Equation (1):

$$Q_c = \langle\frac{\partial m}{\partial t}\rangle + \int_0^{z_{max}} \oint c' u_h \cdot \hat{n} dl\, dz \qquad (1)$$

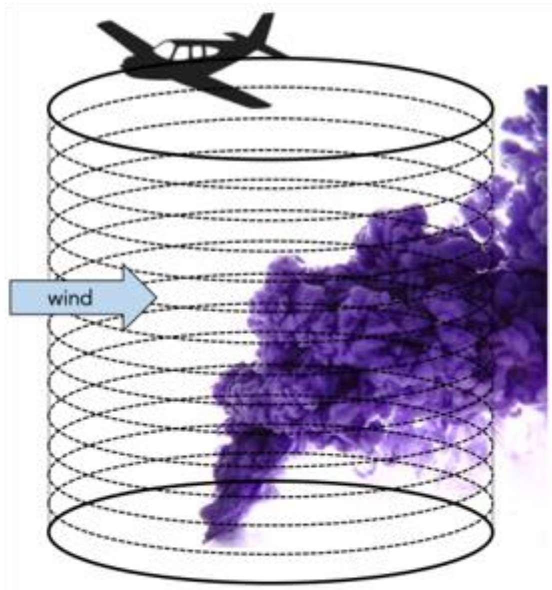

Figure 1. Theoretical flight path around a plume emitted from the surface. The cylindrical flight path and wind direction are shown.

In Eq. 1, Qc is the estimated surface mass emission rate, $\langle \delta m/\delta t \rangle$ is the observed rate of change of mass within the flight path, c' is the deviation from the mean of the density, u_h is the horizontal wind vector, and *n* is the unit normal to the flight path. A time-averaged atmospheric vertical profile was then reconstructed by averaging the horizontal mass flux divergence measured at each circle into equally-spaced bins spanning the vertical extent of the plume transects and extrapolating the value calculated for the lowest-altitude bin to the surface (Figure 2). Integrating the reconstructed vertical profile of the horizontal flux divergences gives the average emission for each site. Uncertainties on bin-averaged horizontal flux divergences were summed in quadrature to provide an estimated uncertainty on the average emission for each site.

The successful application of this method for quantifying emissions relies upon favorable wind conditions and sufficient vertical mixing. Ideal wind conditions are moderate and steady in both speed and direction. Completely calm conditions, very high speeds, or rapidly varying wind directions are not suitable for this method. Moreover, the highest degree of confidence in the results is contingent upon sampling the majority of the plume at and above the lowest flight altitude and below the top of the boundary layer to ensure complete sampling of the entire plume. Under ideal conditions, emissions uncertainties ≤10% can be achieved. The detection limit for methane and ethane is ~ 5 kg h^{-1} (Conley et al, 2017). A detection limit for CO_2 has not been robustly determined, so in this report values < 0 kg h^{-1} are designated as below the detection limit. Any conditions that are considered less than ideal will impose an increased level of uncertainty on the result and/or higher detection limits.

Aside from meteorological conditions, there is also a relationship between measurement uncertainty and the number of transects (laps) around a site. In general, increasing the number of laps will reduce the uncertainty on the final emissions result (and vice versa). For the majority of sites, we have found that 15–25 laps is an appropriate range. Fewer laps may be performed if no methane enhancements above the instrument detection limit are observed, or if the studied region is larger than a few kilometers in radius; a greater number of laps may be done if wind/mixing conditions are less than ideal in an effort to increase the measurement confidence.

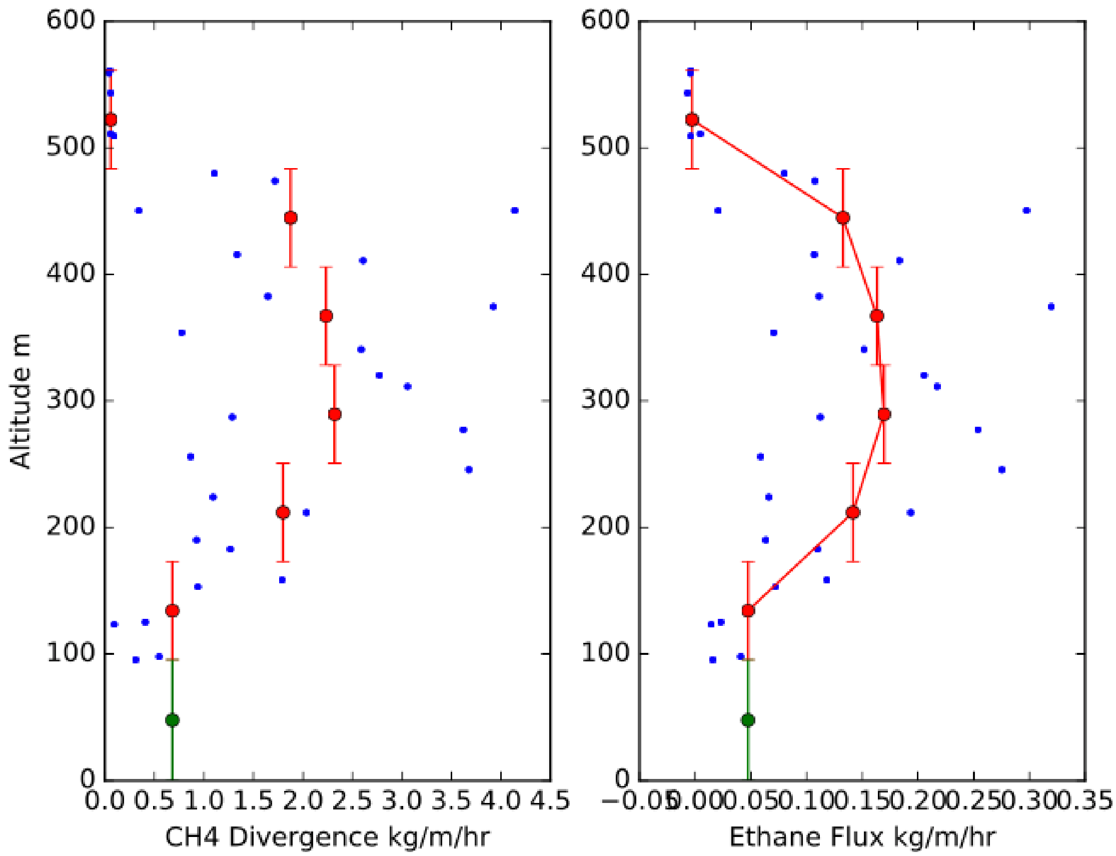

Figure 2. Flux divergence profile of methane and ethane from McDonald Island.

A further source of uncertainty for methane emissions estimated by this method, and any mass balance-based method, is the influence of emissions sources upwind of the target site. In theory, the method can account for emissions that enter and exit the volume defined by the flight path; however, in practice, if the upwind source is similar in magnitude or larger than the target source, the uncertainty associated with the upwind emissions transiting through the target volume can obscure emissions originating from the target source. Often an estimate of target emissions can still be made- but with larger associated uncertainty than in the absence of upwind sources.

Measurements to determine the height of the boundary layer are collected periodically during the day. Often during sampling of the larger perimeter sources, instances when mass balance boxes are employed, measurements are completed to near the top of the boundary layer. From the boundary layer height estimates it is determined whether the entire plume was completely sampled or whether emission rates need to be extrapolated to the boundary layer. These extrapolations result in a greater uncertainty. The vertical flux divergence gradient is less pronounced in larger mass balance boxes as compared to point sources, as sampling occurs at a greater distance from the source.

IV. Summary of Measurement Results

Methane emissions quantifications were performed at 114 unique sites between November 18, 2019 and February 26, 2021. Many sites were measured multiple times, giving 199 total site visits. 53 landfills (130 total measurements), 25 dairies (27 total measurements) and 36 (42 total measurements) oil- and gas-related sites were visited during the campaign.

Table 1. Summary of individual results sorted by source type. *indicates that the measurement was attempted but was not completed and should not be used for quantitative purposes. **indicates measurement of at least one species below detection limit. Negative emissions numbers indicate measurement below detection limit or upwind sources of a chemical species were present and not fully captured during the measurement. Latitude and longitude are omitted for anonymized dairies.

Site	Date	Lat.	Lon.	CH_4 Em. ($kg\ h^{-1}$)	C_2H_6 Em. ($kg\ h^{-1}$)	CO_2 Em. ($t\ h^{-1}$)	Laps	Wind Dir.	Wind Spd.	Pg. No.
Landfills										
Altamont	11/22/19	37.75	-121.65	1505 ± 764	NA	27 ± 7	10	12	1.9	12
Altamont*	01/11/20	37.76	-121.65	-12 ± 41	NA	3 ± 5	12	300	4.6	12
Altamont	04/21/20	37.75	-121.65	271 ± 158	NA	5 ± 17	17	252	7.2	13
Altamont	07/29/20	37.75	-121.65	832 ± 296	NA	40 ± 5	13	256	6.3	14
Altamont**	10/31/20	37.76	-121.65	997 ± 485	-1 ± 3	-31 ± 22	13	67	3	14
Altamont**	02/26/21	37.76	-121.65	2666 ± 675	-2 ± 6	2 ± 22	11	258	3.4	15
American Ave	05/23/20	36.67	-120.14	475 ± 274	NA	17 ± 6	15	335	4.4	16
Arizona St**	05/19/20	32.73	-117.14	-7 ± 5	NA	-5 ± 3	8	301	6.7	17
BKK West Covina	11/19/19	34.04	-117.90	511 ± 95	NA	43 ± 22	13	156	4.7	17
BKK West Covina	05/21/20	34.04	-117.90	96 ± 43	NA	89 ± 19	10	264	2.5	18
BKK West Covina**	10/28/20	34.04	-117.90	-4 ± 31	9 ± 9	-46 ± 25	6	253	3.3	19
Bradley Ave**	05/22/20	34.24	-118.38	73 ± 35	NA	-6 ± 10	20	152	4.9	20
Central	11/22/19	38.30	-122.75	563 ± 174	0 ± 0	12 ± 7	17	136	3.3	21
Central*	04/15/20	38.30	-122.75	3 ± 120	NA	-30 ± 34	10	159	3.5	21
Central**	10/09/20	38.30	-122.75	761 ± 139	0 ± 4	14 ± 4	16	258	3.8	22
Chiquita Canyon	11/18/19	34.43	-118.65	2074 ± 873	NA	25 ± 14	13	113	1.7	23
Chiquita Canyon**	11/19/19	34.43	-118.65	657 ± 351	NA	-12 ± 18	15	219	5.9	24
Chiquita Canyon	01/13/20	34.43	-118.65	590 ± 303	NA	49 ± 20	19	233	3.4	24
Chiquita Canyon	05/21/20	34.43	-118.64	379 ± 147	NA	21 ± 8	14	222	6.2	25
Chiquita Canyon	07/15/20	34.43	-118.65	506 ± 370	NA	49 ± 13	14	217	5	26
Chiquita Canyon	10/28/20	34.43	-118.65	739 ± 253	0 ± 5	25 ± 16	7	138	1.6	26
City of Fresno**	11/18/19	36.70	-119.83	-3 ± 99	NA	0 ± 12	16	119	1.5	27
Compost Solutions Inc**	11/02/20	39.68	-122.16	53 ± 27	1 ± 1	3 ± 1	11	46	1.1	28
Corinda Los Trancos	01/12/20	37.50	-122.41	2472 ± 1682	NA	21 ± 9	14	302	5.3	28
Corona Disposal Site**	11/19/19	34.01	-117.29	-26 ± 27	NA	-5 ± 11	12	197	6.7	29
Coyote Canyon	07/16/20	33.62	-117.83	84 ± 14	NA	15 ± 3	6	223	2.4	30
El Sobrante	05/20/20	33.80	-117.47	1326 ± 691	NA	41 ± 6	11	307	3.9	30
Foothill**	11/21/19	38.04	-120.94	112 ± 34	0 ± 0	-1 ± 1	17	152	2.8	31
Foothill	04/20/20	38.03	-120.93	411 ± 175	NA	3 ± 5	23	320	1.7	32
Foothill	10/08/20	38.03	-120.93	421 ± 157	0 ± 5	9 ± 4	9	318	4.4	32
Forward	11/21/19	37.87	-121.19	1618 ± 343	0 ± 0	20 ± 9	19	139	2.5	33
Forward	04/20/20	37.88	-121.19	728 ± 287	NA	13 ± 6	18	283	5.3	34
Forward	10/08/20	37.88	-121.19	2438 ± 613	5 ± 7	17 ± 7	13	295	4.1	35
Forward**	02/26/21	37.88	-121.19	2520 ± 634	-5 ± 6	3 ± 8	15	318	4.8	36

Landfills cont.

Site	Date	Lat.	Lon.	CH_4 Em. (kg h^{-1})	C_2H_6 Em. (kg h^{-1})	CO_2 Em. (t h^{-1})	Laps	Wind Dir.	Wind Spd.	Pg. No.
Frank R. Bowerman	11/19/19	33.72	-117.70	2976 ± 624	NA	179 ± 34	19	171	6.2	37
Frank R. Bowerman	01/14/20	33.72	-117.70	2765 ± 790	NA	27 ± 33	17	295	2	37
Frank R. Bowerman	05/20/20	33.72	-117.70	1270 ± 512	NA	77 ± 13	12	281	4.4	38
Frank R. Bowerman	07/16/20	33.72	-117.70	1559 ± 518	NA	79 ± 26	7	256	1.9	40
Frank R. Bowerman*	10/16/20	33.72	-117.70	163 ± 713	3 ± 3	20 ± 55	10	53	2.3	40
Frank R. Bowerman**	02/18/21	33.72	-117.70	975 ± 265	10 ± 10	-7 ± 9	14	287	4.3	41
Guadalupe	11/23/19	37.21	-121.90	332 ± 158	NA	17 ± 18	13	299	2.1	42
Keller Canyon	11/22/19	38.00	-121.93	1888 ± 733	NA	19 ± 9	8	37	1.1	43
Keller Canyon	01/11/20	38.00	-121.94	532 ± 514	NA	7 ± 17	10	290	7.7	43
Keller Canyon*	04/21/20	38.00	-121.93	362 ± 308	NA	22 ± 12	17	261	6.5	44
Keller Canyon	07/29/20	38.00	-121.93	733 ± 415	NA	73 ± 18	9	238	6.9	46
Keller Canyon**	10/31/20	37.99	-121.94	928 ± 409	-1 ± 2	-45 ± 59	6	72	4.6	46
Keller Canyon**	02/26/21	38.00	-121.93	1564 ± 415	6 ± 28	-13 ± 22	13	272	5.9	47
Kiefer**	11/22/19	38.52	-121.19	1970 ± 739	NA	-2 ± 7	19	324	2.4	48
Kiefer	04/10/20	38.52	-121.19	1958 ± 427	NA	25 ± 7	30	292	3.1	48
Kiefer**	10/08/20	38.52	-121.19	2163 ± 592	0 ± 4	50 ± 11	11	206	3.6	49
Kiefer**	11/02/20	38.52	-121.19	1914 ± 807	-2 ± 4	-13 ± 24	10	321	1.7	50
Kiefer**	02/16/21	38.52	-121.19	1089 ± 340	-1 ± 6	-4 ± 4	12	320	5.9	50
Kirby Canyon**	11/23/19	37.19	-121.67	287 ± 265	NA	-28 ± 65	14	297	2.1	51
Las Pulgas**	05/20/20	33.36	-117.42	39 ± 52	NA	-6 ± 3	5	293	8	52
Lopez Canyon	05/22/20	34.30	-118.39	259 ± 78	NA	6 ± 19	22	157	4	53
Lopez Canyon	10/28/20	34.29	-118.39	386 ± 94	5 ± 3	21 ± 5	8	188	2.2	54
MidValley	07/15/20	34.14	-117.42	337 ± 217	NA	22 ± 9	9	255	6.7	55
Miramar	05/19/20	32.85	-117.16	1127 ± 371	NA	23 ± 6	10	291	5.5	56
Miramar	05/20/20	32.85	-117.16	1564 ± 354	NA	19 ± 9	16	320	6.5	56
Monterey Peninsula**	10/30/20	36.71	-121.76	872 ± 248	1 ± 4	22 ± 4	11	257	4.1	57
Monterey Peninsula**	02/17/21	36.71	-121.76	1294 ± 544	0 ± 2	29 ± 6	11	290	3.4	58
Napa Mtrl Diversion Fclty**	10/31/20	38.21	-122.26	16 ± 20	0 ± 1	2 ± 2	8	198	1.3	58
Newby Island	04/22/20	37.46	-121.94	1932 ± 741	NA	29 ± 28	17	328	1.6	59
Newby Island	10/31/20	37.46	-121.94	2088 ± 525	6 ± 3	36 ± 12	12	323	3	60
Newby Island**	02/17/21	37.46	-121.94	2412 ± 608	0 ± 5	-6 ± 9	11	285	4.5	60
North County**	11/21/19	38.10	-121.10	259 ± 110	0 ± 0	3 ± 2	17	151	2.8	61
North County**	04/10/20	38.10	-121.10	530 ± 216	NA	-1 ± 4	23	272	3.1	62
North County**	10/08/20	38.10	-121.10	381 ± 134	-4 ± 4	-1 ± 4	13	295	3.7	63
Northern Recycling Compost**	11/02/20	38.78	-121.88	33 ± 12	1 ± 2	3 ± 2	12	339	3.5	63
Novato Redwood*	11/22/19	38.17	-122.57	*attempted- not successful*		-1 1	2	207	5	64
Olinda Alpha**	11/19/19	33.94	-117.83	679 ± 542	NA	-150 ± 43	10	182	6.4	65
Olinda Alpha**	01/14/20	33.94	-117.84	522 ± 400	NA	-8 ± 32	17	250	1.5	65
Olinda Alpha	05/20/20	33.94	-117.83	1325 ± 393	NA	35 ± 12	9	250	4.9	67
Olinda Alpha	07/16/20	33.94	-117.83	986 ± 200	NA	58 ± 13	7	236	3.1	68
Ostrom Rd	05/07/20	39.07	-121.40	531 ± 266	NA	12 ± 9	26	337	2.1	68
Ostrom Rd**	11/02/20	39.07	-121.39	1148 ± 483	0 ± 1	6 ± 2	12	307	1.8	69
Otay**	05/20/20	32.60	-117.01	-80 ± 130	NA	6 ± 13	16	328	4.9	70
Ox Mountain**	11/23/19	37.50	-122.41	965 ± 965	NA	-5 ± 30	13	27	4.4	71
Ox Mountain	04/22/20	37.50	-122.41	1689 ± 1141	NA	35 ± 19	20	331	8.1	72
Ox Mountain*	07/27/20	37.50	-122.41	43 ± 25	NA	3 ± 7	6	244	3.3	73
Ox Mountain**	10/31/20	37.50	-122.41	1808 ± 812	0 ± 4	3 ± 9	9	23	2.3	74
Ox Mountain*	02/26/21	37.50	-122.41	10 ± 1226	-1 ± 4	9 ± 15	4	36	1.6	75

Landfills cont.

Site	Date	Lat.	Lon.	CH_4 Em. ($kg\ h^{-1}$)	C_2H_6 Em. ($kg\ h^{-1}$)	CO_2 Em. ($t\ h^{-1}$)	Laps	Wind Dir.	Wind Spd.	Pg. No.
Potrero Hills	04/15/20	38.21	-121.98	2116 ± 601	NA	12 ± 8	23	17	1.5	76
Potrero Hills	10/09/20	38.21	-121.98	946 ± 332	6 ± 6	15 ± 6	11	247	5.5	76
Potrero Hills**	02/26/21	38.21	-121.98	997 ± 275	4 ± 7	-1 ± 4	10	225	5.6	77
Puente Hills	05/21/20	34.02	-118.02	121 ± 56	NA	10 ± 19	10	254	2.9	78
Puente Hills*	07/17/20	34.02	-118.01	1 ± 37	NA	34 ± 13	4	233	2.2	78
Puente Hills**	10/28/20	34.02	-118.01	188 ± 61	-9 ± 7	25 ± 19	8	241	3.1	79
Redwood	04/15/20	38.17	-122.56	348 ± 108	NA	8 ± 9	9	122	3.3	80
Redwood*	10/09/20	38.17	-122.56	113 ± 86	0 ± 1	2 ± 3	5	58	0.8	80
Redwood**	11/02/20	38.17	-122.56	440 ± 140	0 ± 2	8 ± 6	9	144	2	81
San Marcos**	05/20/20	33.09	-117.20	32 ± 13	NA	-1 ± 2	4	290	5.3	82
Scholl Canyon	05/21/20	34.16	-118.19	245 ± 86	NA	21 ± 16	21	186	2.2	82
Scholl Canyon**	10/28/20	34.16	-118.19	338 ± 136	5 ± 5	2 ± 7	9	210	2.2	82
Shafter Wasco**	10/29/20	35.51	-119.41	285 ± 144	0 ± 1	-2 ± 2	10	1	2.6	84
Simi Valley	11/18/19	34.29	-118.80	1284 ± 617	NA	11 ± 4	13	230	2	84
Simi Valley	05/21/20	34.30	-118.79	1096 ± 427	NA	15 ± 6	12	259	4.5	85
Simi Valley**	10/28/20	34.30	-118.79	921 ± 330	-1 ± 3	13 ± 8	9	262	1.9	86
South Chollas	05/19/20	32.73	-117.07	15 ± 3	NA	9 ± 2	7	300	5.9	86
South Kern Compost**	10/30/20	35.13	-119.24	240 ± 74	5 ± 2	2 ± 2	14	15	1.5	87
Spadra	11/19/19	34.04	-117.83	179 ± 70	NA	57 ± 24	17	231	4	88
Spadra*	05/21/20	34.05	-117.83	-8 ± 15	NA	-19 ± 6	8	258	2.3	88
Spadra**	10/28/20	34.05	-117.83	47 ± 19	-1 ± 3	5 ± 8	8	242	3.6	89
Sunshine Canyon**	11/18/19	34.33	-118.51	768 ± 385	NA	-33 ± 53	8	344	2.2	90
Sunshine Canyon	01/13/20	34.33	-118.52	1918 ± 751	NA	127 ± 47	10	220	0.9	90
Sunshine Canyon	05/22/20	34.33	-118.51	604 ± 180	NA	54 ± 23	13	179	6	91
Sunshine Canyon*	07/17/20	34.33	-118.51	424 ± 211	NA	-44 ± 12	2	182	5.1	93
Sunshine Canyon**	10/29/20	34.33	-118.52	782 ± 235	-19 ± 36	173 ± 24	15	33	4.7	93
Sycamore	05/19/20	32.86	-117.03	996 ± 360	NA	6 ± 8	14	282	5.8	94
Toland Rd	11/18/19	34.40	-119.00	780 ± 494	NA	4 ± 5	8	250	0.7	95
Toland Rd*	05/21/20	34.40	-118.99	-18 ± 89	NA	41 ± 10	13	262	3.8	96
Toland Rd**	05/22/20	34.41	-118.99	240 ± 324	NA	-18 ± 20	6	279	6.7	96
Toland Rd**	10/28/20	34.40	-118.99	1786 ± 432	2 ± 4	3 ± 5	11	238	1.9	97
Vasco*	11/22/19	37.75	-121.72	*attempted- not successful*		0 3	3	23	3.8	98
Vasco**	11/23/19	37.75	-121.72	440 ± 253	NA	-9 ± 6	7	348	2.6	98
Vasco**	04/21/20	37.75	-121.72	165 ± 121	NA	-13 ± 6	17	251	5.7	99
Vasco	10/31/20	37.76	-121.73	988 ± 182	10 ± 14	154 ± 28	10	73	4.2	100
Visalia**	07/27/20	36.39	-119.39	336 ± 214	NA	-1 ± 7	16	289	2.5	101
W Contra Costa**	11/22/19	37.97	-122.39	-15 ± 24	NA	-7 ± 13	5	87	1.1	101
West Valley Recovery Facility*	10/28/20	34.09	-117.51	-3 ± 45	6 ± 4	2 ± 8	3	266	5.7	102
Western Regional	11/23/19	38.84	-121.34	815 ± 470	NA	3 ± 3	15	336	2	103
Western Regional**	04/03/20	38.84	-121.34	1067 ± 380	NA	-8 ± 4	26	273	1.9	104
Western Regional	07/30/20	38.84	-121.34	1326 ± 401	NA	11 ± 11	16	240	2.8	104
Western Regional**	11/02/20	38.83	-121.34	1709 ± 509	-2 ± 3	12 ± 7	9	290	1.6	105
Western Regional**	02/16/21	38.83	-121.35	760 ± 228	10 ± 6	-3 ± 6	12	325	4.8	106
Yolo	11/22/19	38.60	-121.69	810 ± 151	0 ± 0	16 ± 7	14	357	4.4	107
Yolo	04/14/20	38.60	-121.69	574 ± 170	NA	1 ± 3	21	336	7.7	108
Yolo	07/30/20	38.60	-121.69	548 ± 183	NA	16 ± 5	6	178	2.1	108
Yolo**	10/09/20	38.60	-121.69	642 ± 152	3 ± 2	17 ± 3	17	170	2.2	109
Yolo*	02/26/21	38.60	-121.69	317 ± 109	3 ± 2	0 ± 4	14	313	1.3	110

Dairies

Site	Date	CH_4 Em. (kg h^{-1})	C_2H_6 Em. (kg h^{-1})	CO_2 Em. (t h^{-1})	Laps	Wind Dir.	Wind Spd.	Pg. No.
Dairy #1**	10/29/20	55 ± 17	0 ± 1	5 ± 1	12	325	3.3	112
Dairy #2**	10/29/20	64 ± 19	3 ± 2	5 ± 2	11	345	2.7	112
Dairy #3*	10/13/20	-103 ± 204	0 ± 3	-8 ± 7	6	337	2.3	113
Dairy #3*	10/30/20	-124 ± 98	1 ± 1	-3 ± 3	7	331	2.2	114
Dairy #4**	10/31/20	28 ± 10	1 ± 2	3 ± 2	6	312	1.5	114
Dairy #5**	10/13/20	550 ± 157	-2 ± 2	22 ± 6	12	340	1.8	115
Dairy #6**	10/13/20	194 ± 111	2 ± 2	2 ± 2	10	349	3.1	116
Dairy #7	05/23/20	365 ± 146	NA	22 ± 5	14	321	4	116
Dairy #8**	10/30/20	69 ± 24	1 ± 1	13 ± 3	8	345	3.9	117
Dairy #9**	10/13/20	149 ± 131	1 ± 2	2 ± 3	7	334	2.5	118
Dairy #10**	10/13/20	42 ± 71	0 ± 2	0 ± 2	6	311	2.5	119
Dairy #11**	10/13/20	455 ± 153	-1 ± 1	18 ± 6	9	330	2.2	119
Dairy #12**	05/23/20	116 ± 58	NA	-3 ± 3	7	268	2.2	120
Dairy #12**	10/30/20	663 ± 165	4 ± 2	14 ± 5	7	312	1.8	121
Dairy #13**	10/13/20	8 ± 95	-2 ± 3	3 ± 4	6	358	1.8	122
Dairy #14**	10/31/20	166 ± 53	0 ± 3	5 ± 4	12	331	2.2	123
Dairy #15**	10/13/20	534 ± 217	-2 ± 2	13 ± 8	10	330	1.6	124
Dairy #16**	10/30/20	230 ± 81	-2 ± 2	13 ± 3	10	337	3.6	124
Dairy #17**	10/30/20	29 ± 14	-1 ± 1	-1 ± 2	8	333	1.9	125
Dairy #18**	10/13/20	352 ± 134	2 ± 1	5 ± 5	13	325	1.5	126
Dairy #19**	10/13/20	80 ± 54	-1 ± 1	4 ± 2	9	347	1.9	126
Dairy #20**	10/13/20	338 ± 83	-1 ± 2	14 ± 4	10	347	1.7	127
Dairy #21	05/23/20	488 ± 155	NA	5 ± 4	14	312	4.2	128
Dairy #22**	10/30/20	107 ± 52	2 ± 2	-1 ± 3	9	326	2.1	128
Dairy #23	05/23/20	431 ± 102	NA	10 ± 6	12	321	4.6	129
Dairy #24	05/23/20	915 ± 356	NA	22 ± 5	11	343	2.4	130
Dairy #25**	10/30/20	87 ± 70	-1 ± 2	4 ± 4	8	314	1.8	131

Oil and Gas

Site	Date	Lat.	Lon.	CH_4 Em. (kg h^{-1})	C_2H_6 Em. (kg h^{-1})	CO_2 Em. (t h^{-1})	Laps	Wind Dir.	Wind Spd.	Page No.
Adelanto CS**	10/16/20	34.56	-117.45	12 ± 5	0 ± 3	4 ± 3	12	35	4.0	133
Aliso Canyon GS*	01/13/20	34.32	-118.56	611 ± 424	NA	126 ± 84	12	289	1.7	133
Aliso Canyon GS**	07/15/20	34.32	-118.56	15 ± 115	NA	-17 ± 7	2	183	4.6	135
Aliso Canyon GS	10/29/20	34.31	-118.55	34 ± 13	5 ± 15	6 ± 6	7	36	7.0	136
AllenCo	07/16/20	34.03	-118.28	13 ± 7	NA	3 ± 4	6	250	3.5	137
Belridge North*	10/14/20	35.54	-119.80	-196 ± 49	-5 ± 6	18 ± 11	10	342	3.6	138
Belridge North**	10/30/20	35.54	-119.80	151 ± 49	3 ± 3	15 ± 6	5	35	2.2	138
Belridge South**	10/14/20	35.46	-119.72	400 ± 128	6 ± 2	-22 ± 26	3	342	4.2	139
Blythe CS	10/15/20	33.61	-114.65	208 ± 53	15 ± 7	4 ± 2	13	4	2.0	140
Brea Olinda Oil Field**	02/18/21	33.94	-117.88	-9 ± 188	14 ± 9	-21 ± 59	6	254	2.6	140
CRC Elk Hills 1	05/23/20	35.23	-119.43	41 ± 39	NA	0 ± 1	10	119	1.3	141
CRC Elk Hills 2	05/23/20	35.24	-119.38	5 ± 12	NA	2 ± 1	7	51	1.6	142
CRC Elk Hills 3**	05/23/20	35.31	-119.58	56 ± 15	NA	-1 ± 0	14	34	1.6	142
CRC Elk Hills Power	05/22/20	35.28	-119.47	161 ± 53	NA	160 ± 37	12	358	3.8	143
CRC Grimes	07/30/20	39.08	-121.91	79 ± 35	NA	0 ± 5	10	126	1.9	145
CRC Rio Vista 1**	07/29/20	38.14	-121.67	-1 ± 12	NA	0 ± 4	6	274	8.1	146
CRC Rio Vista 2**	07/29/20	38.15	-121.71	-13 ± 16	NA	14 ± 5	11	269	7.2	146
CRC Willows Central 1**	07/28/20	39.54	-122.11	76 ± 48	NA	-4 ± 11	11	152	4.0	147
CRC Willows Central 2**	07/28/20	39.53	-122.07	135 ± 56	NA	-37 ± 13	9	151	3.9	148
El Poso Creek 1**	10/29/20	35.58	-119.04	343 ± 67	4 ± 3	13 ± 7	10	337	2.1	149
El Poso Creek 2	10/29/20	35.54	-119.08	970 ± 193	12 ± 6	71 ± 29	9	345	2.5	149
El Poso Creek 3**	10/29/20	35.52	-119.08	388 ± 107	2 ± 3	24 ± 6	9	343	2.7	150
Elk Hills 4a	07/15/20	35.27	-119.47	965 ± 1223	NA	356 ± 173	3	99	2.0	151
Elk Hills 4a	07/17/20	35.27	-119.47	2849 ± 1217	NA	1137 ± 158	4	9	2.9	151
Fourth Avenue	07/16/20	34.04	-118.32	22 ± 7	NA	13 ± 3	7	244	4.7	152
Honor Rancho Gas Storage	01/13/20	34.46	-118.59	12 ± 183	NA	37 ± 12	13	236	3.0	153
Inglewood	07/16/20	34.00	-118.37	99 ± 43	NA	27 ± 7	7	235	4.5	153
Jefferson	07/16/20	34.03	-118.30	8 ± 7	NA	2 ± 1	5	249	4.4	154
La Goleta GS 1**	10/29/20	34.42	-119.82	8 ± 12	0 ± 1	-1 ± 2	3	269	2.6	155
La Goleta GS 2**	10/29/20	34.42	-119.84	14 ± 11	0 ± 1	1 ± 2	8	261	3.4	156
McDonald Island	01/12/20	37.99	-121.48	69 ± 25	NA	29 ± 11	20	268	2.9	156
McDonald Island	04/17/20	37.99	-121.48	192 ± 129	NA	5 ± 8	17	269	3.3	157
McDonald Island**	07/29/20	37.99	-121.48	96 ± 35	NA	-23 ± 13	8	294	6.9	158
Mojave-Daggett CS**	10/15/20	34.86	-116.85	0 ± 1	1 ± 1	-1 ± 1	7	107	2.5	158
Murphy**	07/16/20	34.03	-118.31	4 ± 8	NA	5 ± 2	6	239	4.2	159
Newbery Springs CS**	10/15/20	34.78	-116.59	9 ± 3	-2 ± 2	4 ± 2	15	336	3.0	160
North Needles Compressor Station**	10/15/20	34.91	-114.64	6 ± 2	1 ± 5	4 ± 2	7	8	11.1	160
PGE Hinkley CS	10/15/20	34.90	-117.16	169 ± 540	8 ± 8	0 ± 9	7	89	1.2	161
PGE Topock CS	10/15/20	34.71	-114.49	14 ± 14	5 ± 11	0 ± 14	11	336	11.4	162
South Needles Compressor Station**	10/15/20	34.69	-114.61	19 ± 21	-11 ± 10	13 ± 5	8	358	10.2	162
Wild Goose GS 1**	07/28/20	39.35	-121.82	32 ± 19	NA	-6 ± 6	5	152	3.7	163
Wild Goose GS 2**	07/28/20	39.32	-121.88	166 ± 66	NA	-38 ± 14	10	165	2.3	164

V. Individual Measurement Details (Alphabetical Order)

V.I. Landfills

1. Altamont LF, 11-22-19

Laps were flown between 201 and 598 m agl. A methane emission of 1505 ± 764 kg h^{-1} was calculated.

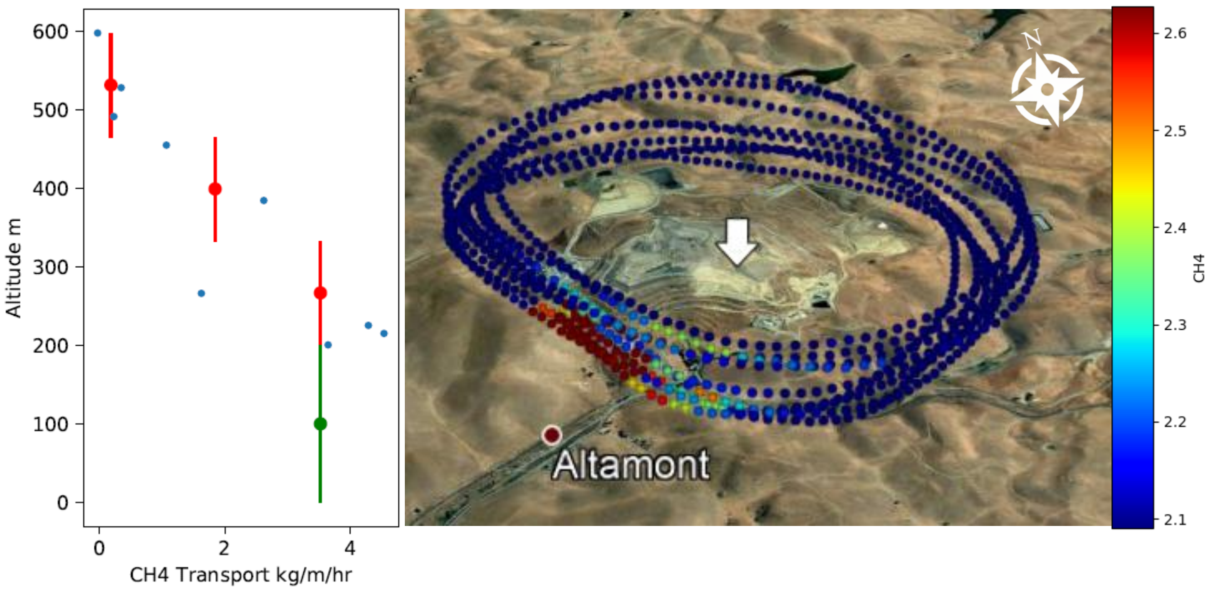

Figure 3. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

2. Altamont LF, 01-11-20

Terrain and turbulence prevented the aircraft from taking measurements below ~ 300 m, and it is likely that the majority of emissions were at altitudes < 300 m. The measured emission was -12 ± 41 kg h^{-1}, but this should not be interpreted as representative of emissions from this landfill.

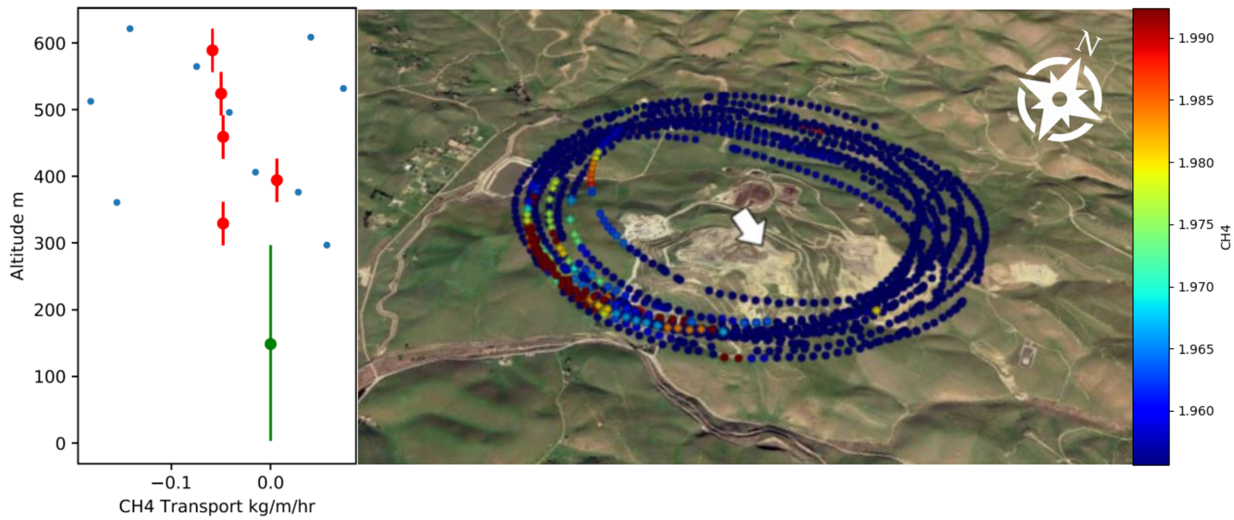

Figure 4. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

3. Altamont LF, 04-21-20

The aircraft flew laps between 250 and 717 m agl and a methane emission of 271 ± 158 kg h^{-1} was calculated.

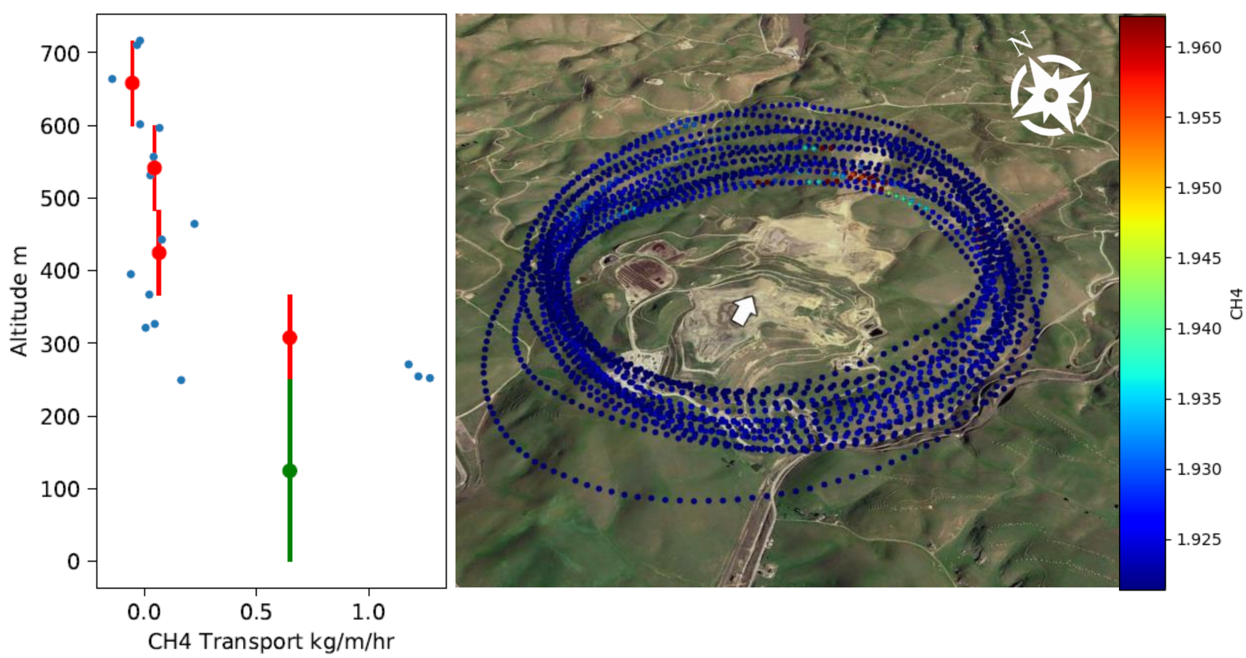

Figure 5. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

4. Altamont LF, 07-29-20

Laps were flown between 193 and 939 m agl a methane emission of 832 ± 296 kg h^{-1} was calculated.

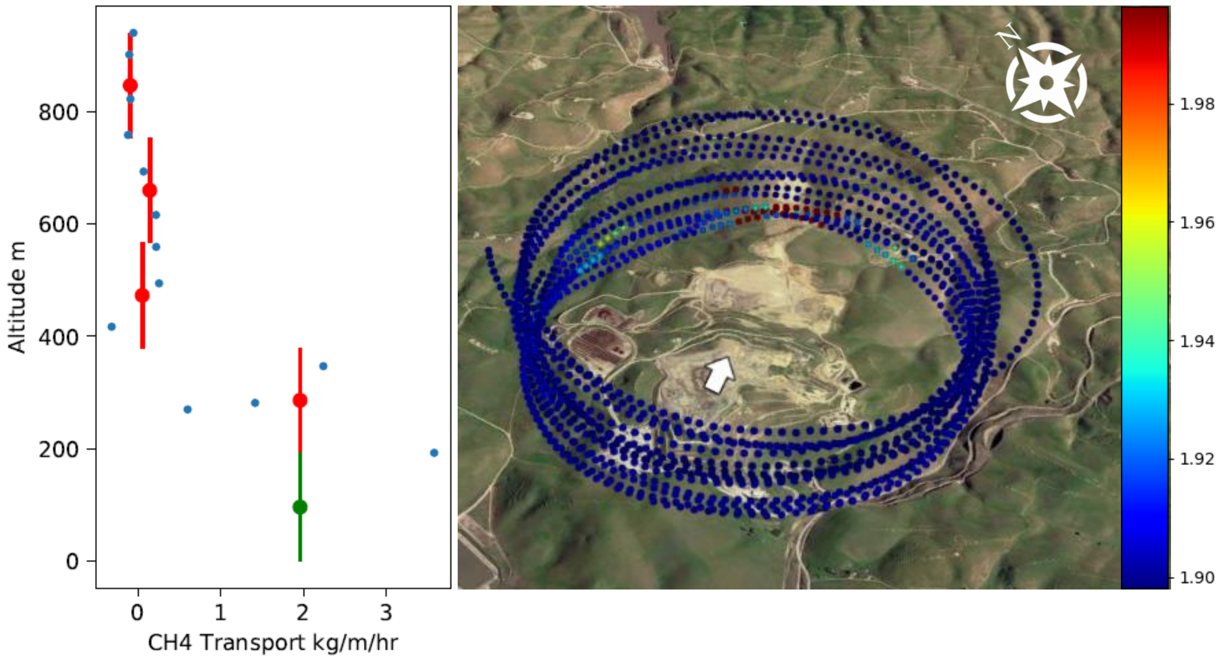

Figure 6. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

5. Altamont LF, 10-31-20

Laps were flown between 138 and 451 m agl. A methane emission of 997 ± 485 kg h^{-1} was calculated. No significant ethane was observed.

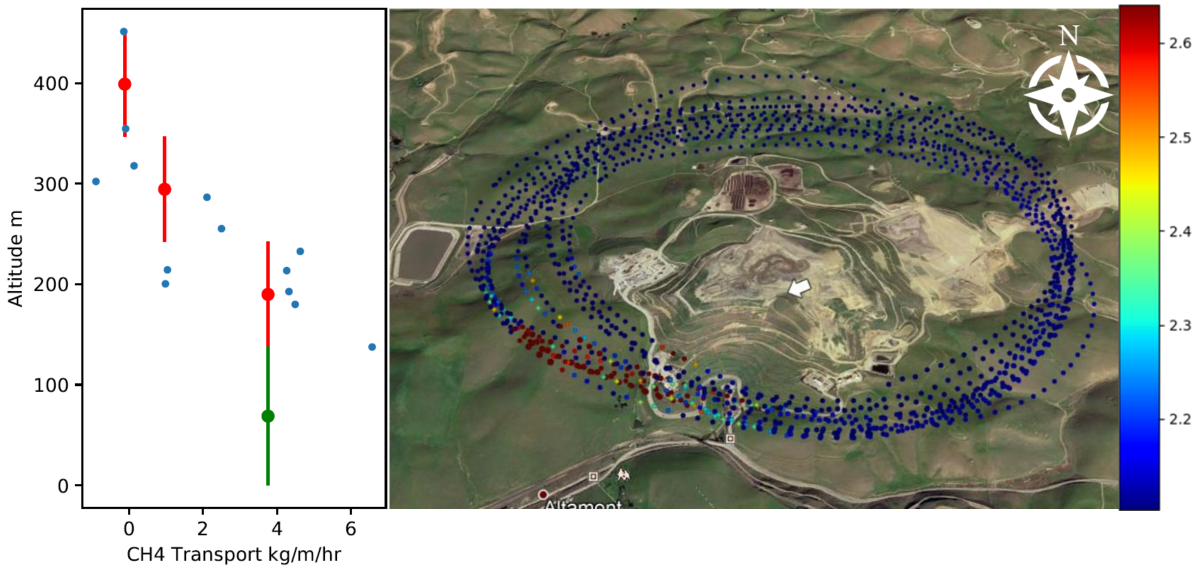

Figure 7. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

6. Altamont LF, 02-26-21

Laps were flown between 237 and 698 m agl. Methane emissions were 2666 ± 675 kg h^{-1}, and no significant ethane was observed.

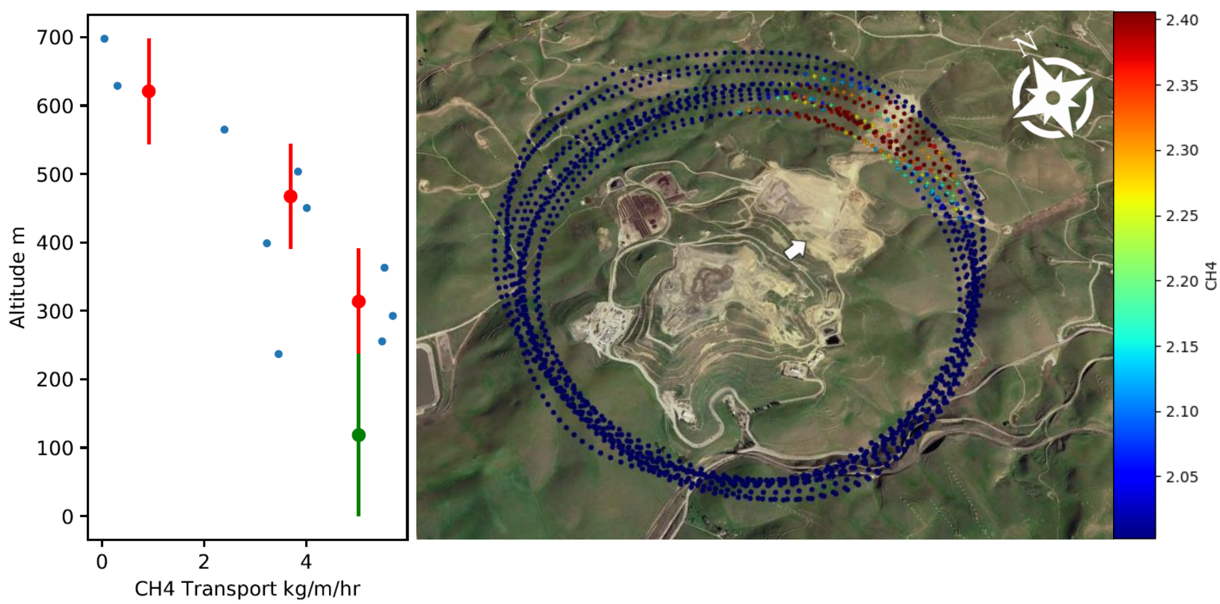

Figure 8. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

7. American Ave, 05-23-20

Laps were flown between 173 and 889 m agl. The estimated methane emission was 475 ± 274 kg h^{-1}.

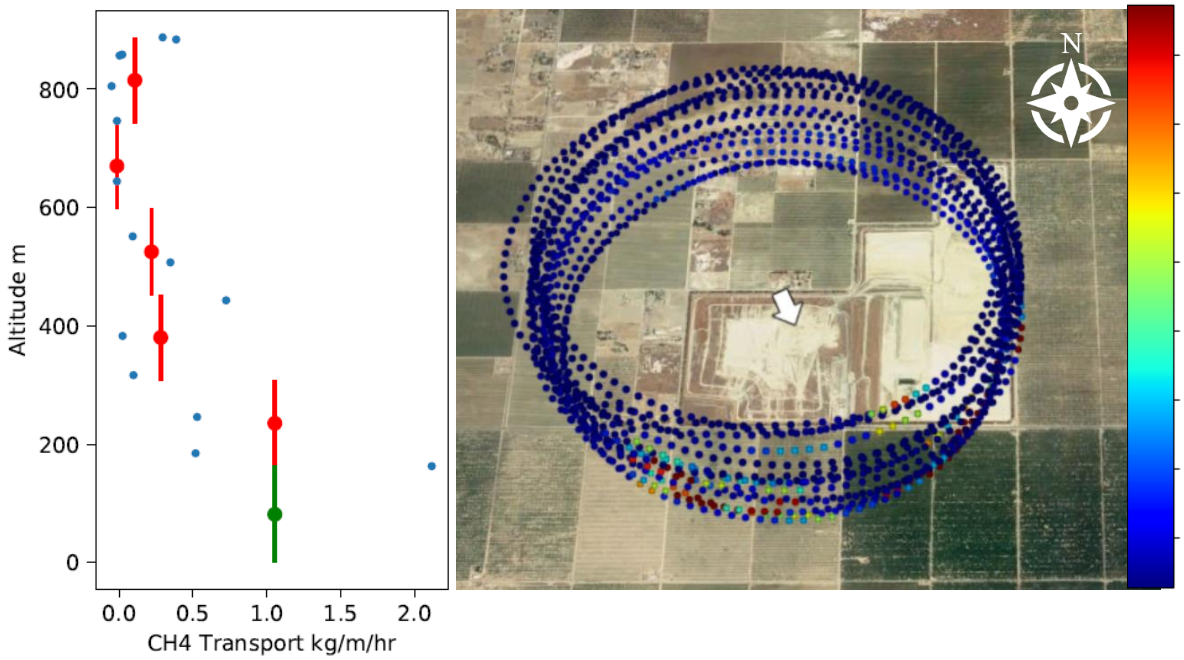

Figure 9. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

8. Arizona Street, 05-19-20

Laps were flown around the Arizona Street landfill between 375 and 818 m agl. The measured methane emission was -7 ± 5 kg h^{-1} (i.e., below the detection limit), however, an upwind source of methane and altitude restrictions both contribute to a low confidence in the emission rate.

The vertical profile of methane emissions and the flight path colored by methane concentration both show that an upwind source of methane was transiting through the study area at the altitudes flown. The aircraft was also limited in (low) altitude by congested residential areas along the flight path, so it is possible some emissions from the landfill were located below the aircraft lowest flight altitude, and therefore missed in the measurement.

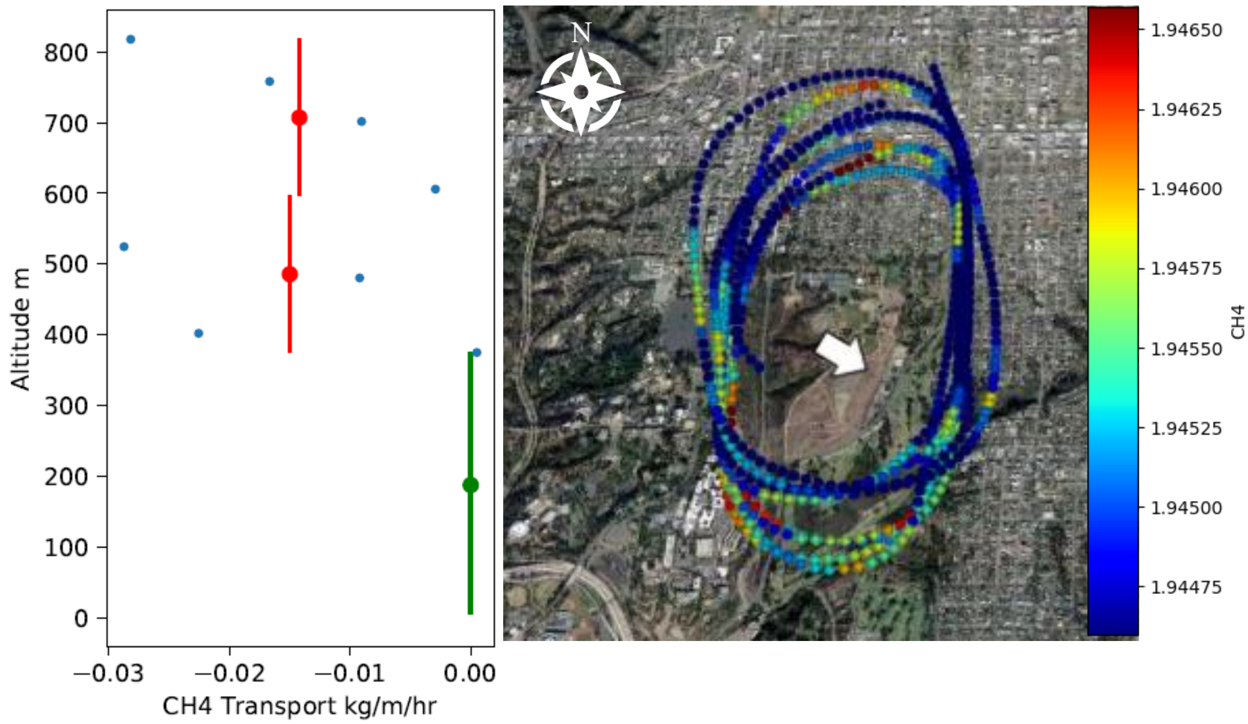

Figure 10. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

9. BKK West Covina, 11-19-19

Laps were flown between 147 and 475 m agl. A methane emission of 511 ± 95 kg h^{-1} was calculated.

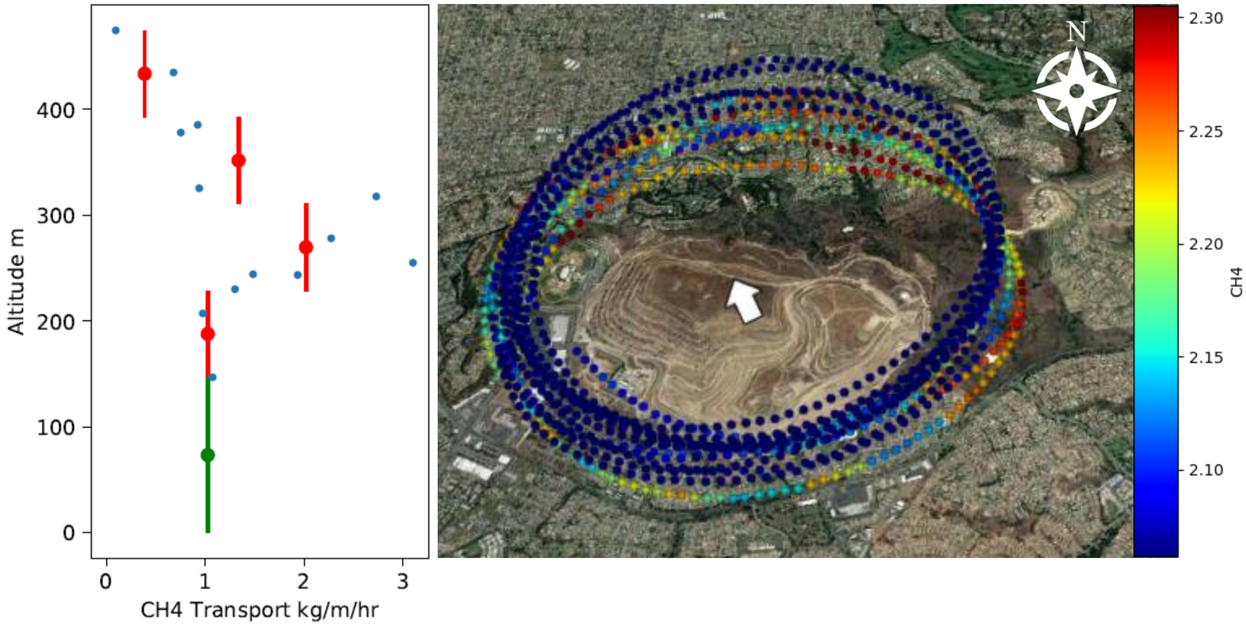

Figure 11. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

10. BKK West Covina, 05-21-20

Laps at BKK West Covina were flown between 214 and 630 m agl and the calculated methane emission was 96 ± 43 kg h^{-1}.

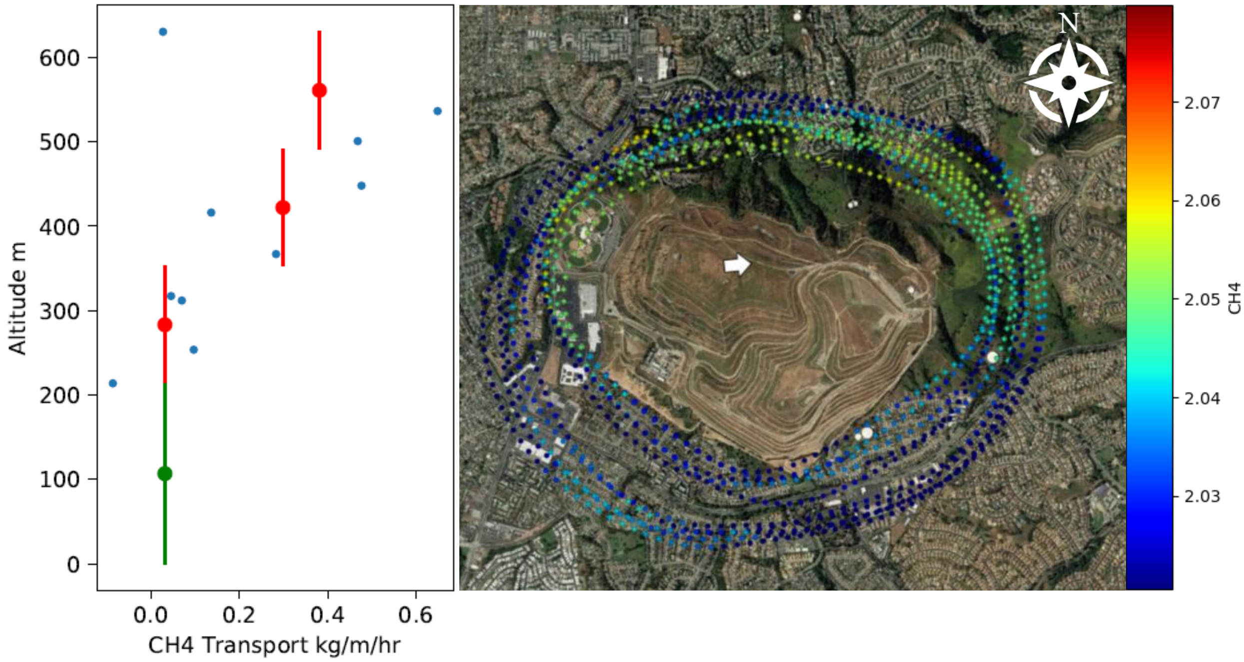

Figure 12. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

11. BKK West Covina, 10-28-20

Laps were flown between 155 and 657 m agl. No significant methane or ethane emissions were observed. An upwind source of methane, seen in the southwest edge of the flight path is clearly transiting through the target area.

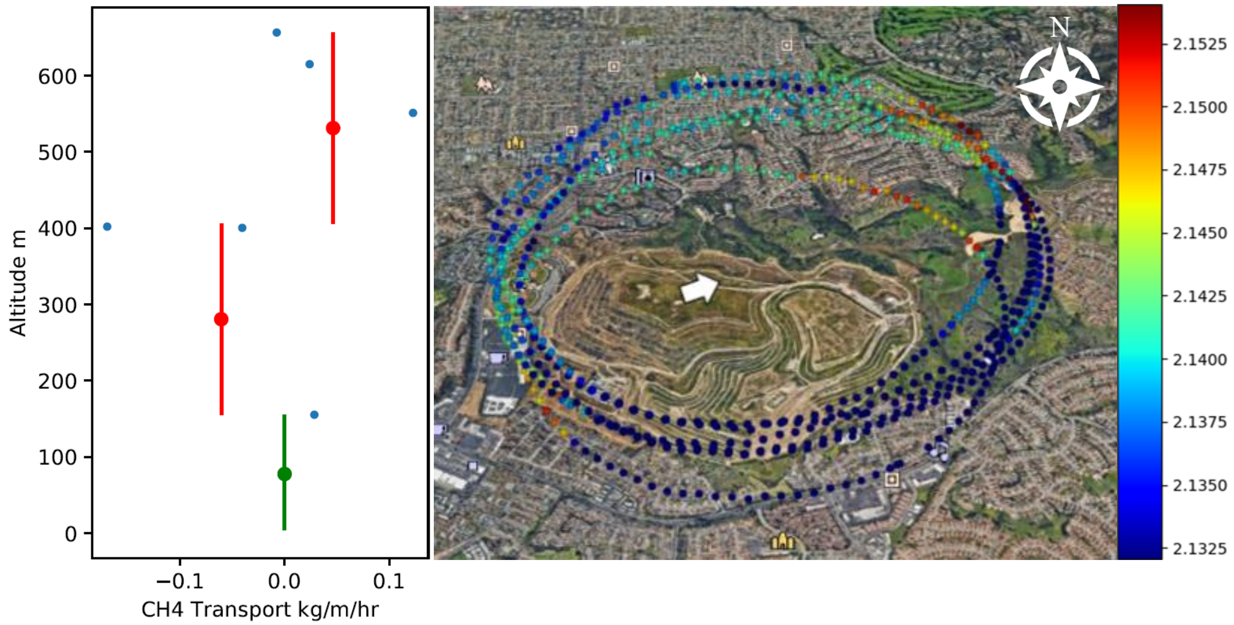

Figure 13. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

12. Bradley Ave LF, 05-22-20

Laps were flown between 178 and 940 m agl, and methane emissions were estimated as 73 ± 35 kg h^{-1}.

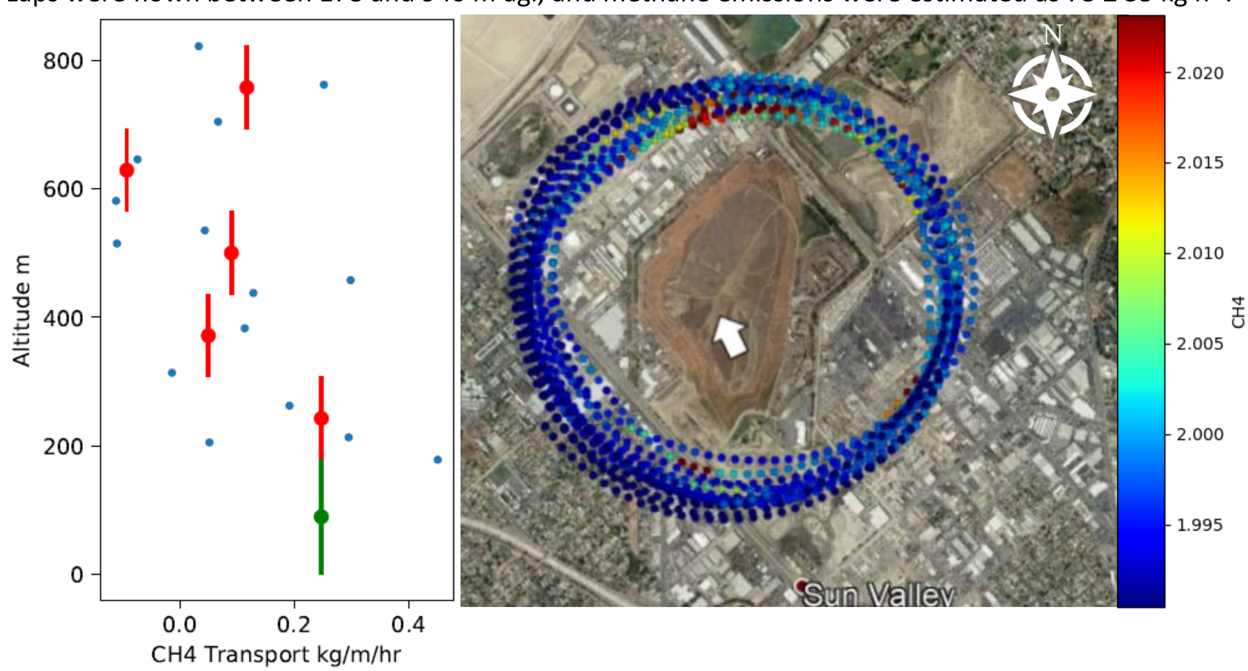

Figure 14. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

13. Central LF, 11-22-19

Laps were flown between 156 and 569 m agl. A methane emission of 563 ± 174 kg h^{-1} was calculated.

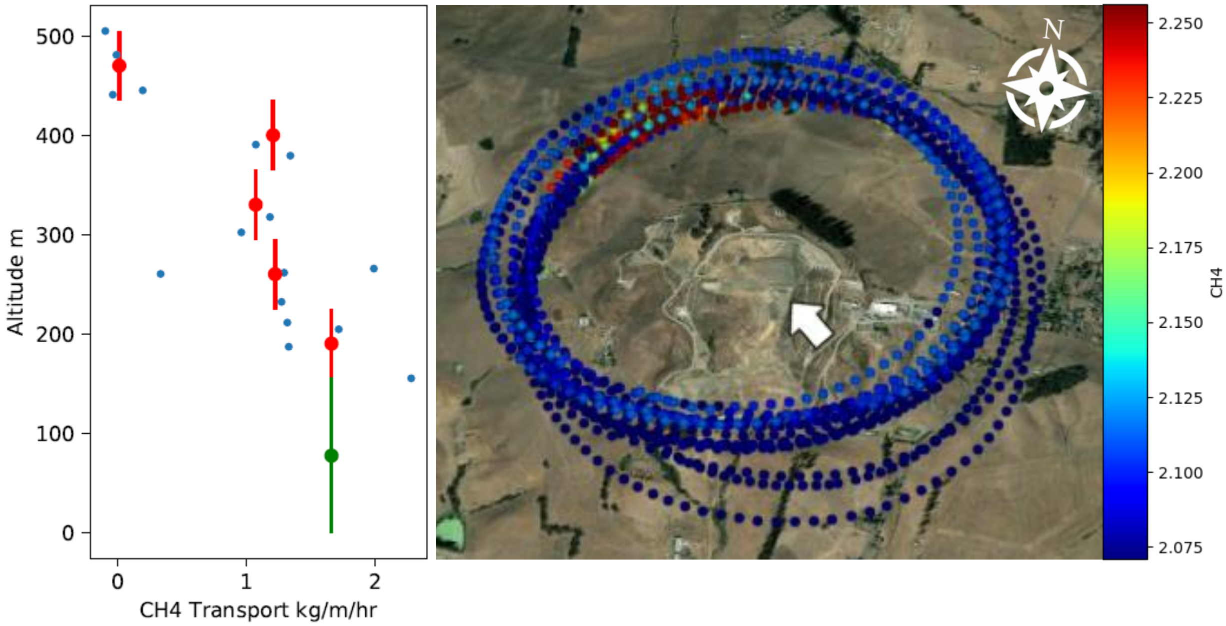

Figure 15. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

14. Central LF, 04-15-20

The aircraft flew laps between 201 and 472 m agl and a methane emission of 3 ± 120 kg h^{-1} was calculated. The high uncertainty originates from the influence of an upwind methane source, which is observed as a negative horizontal transport flux at low altitude and can also be seen as upwind methane enhancements in the flight path plot. Additionally, some emissions may have been located below the lowest flight altitude of 201 m agl, and this estimate may therefore be an underestimate of the total land fill emissions.

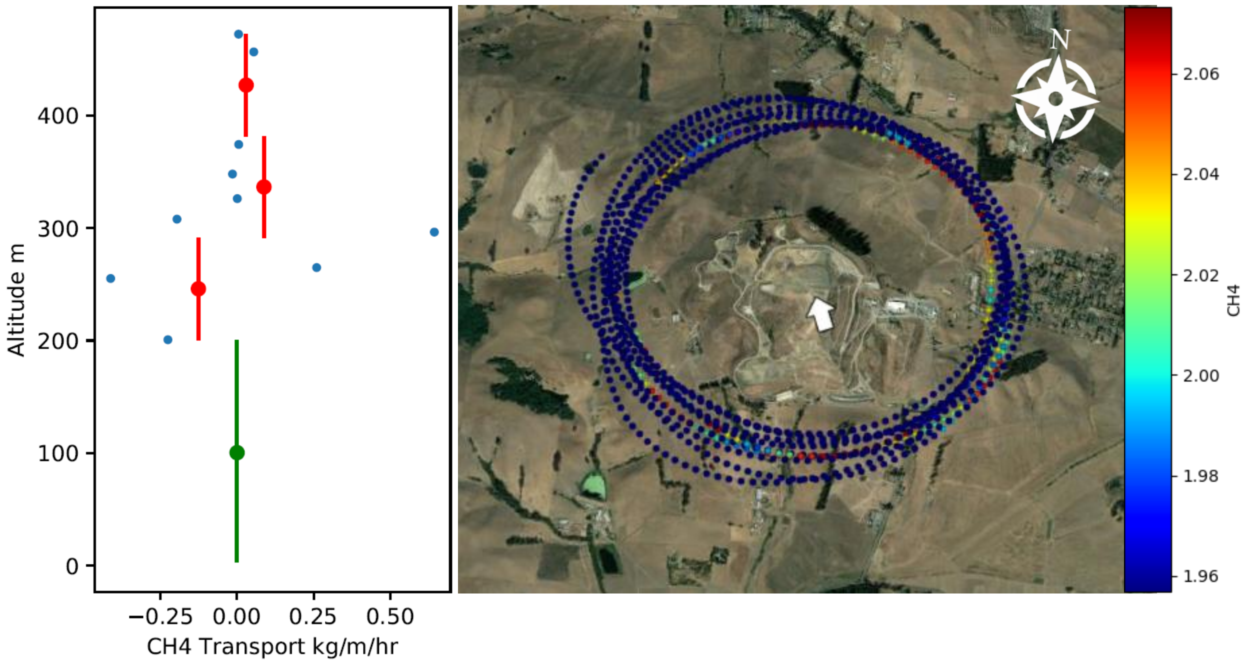

Figure 16. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

15. Central LF, 10-09-20

Laps were flown between 110 and 682 m agl. A methane emission of 761 ± 139 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

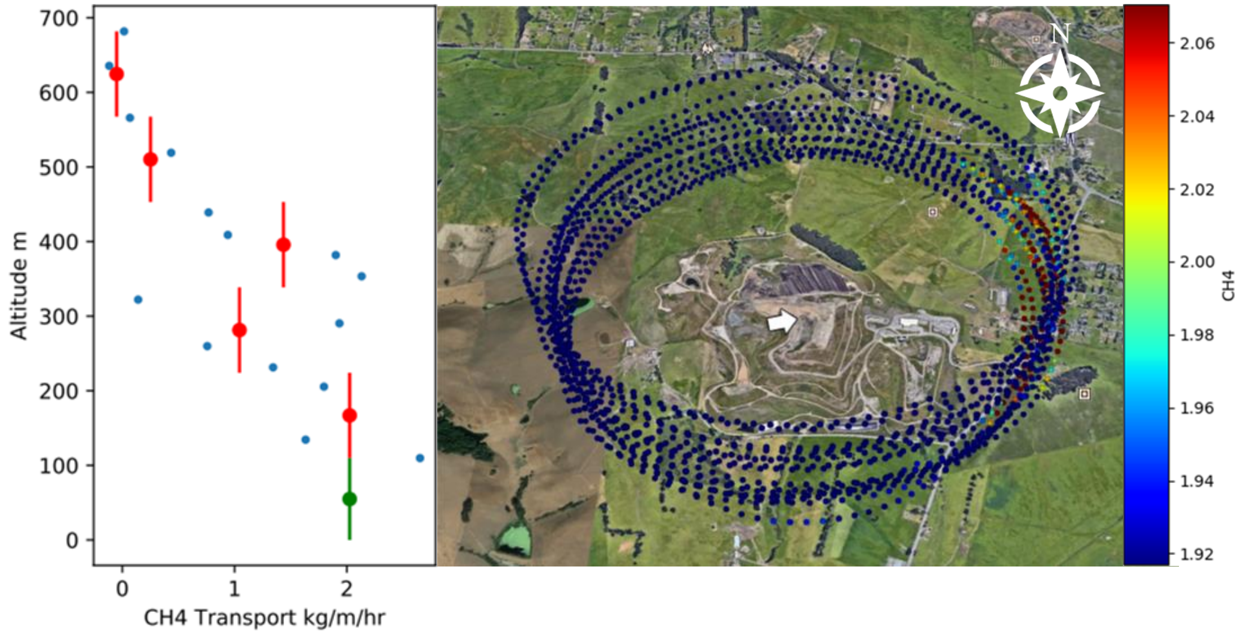

Figure 17. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

16. Chiquita Canyon LF, 11-18-19

Laps were flown between 252 and 884 m agl. A methane emission of 2074 ± 873 kg h^{-1} was calculated.

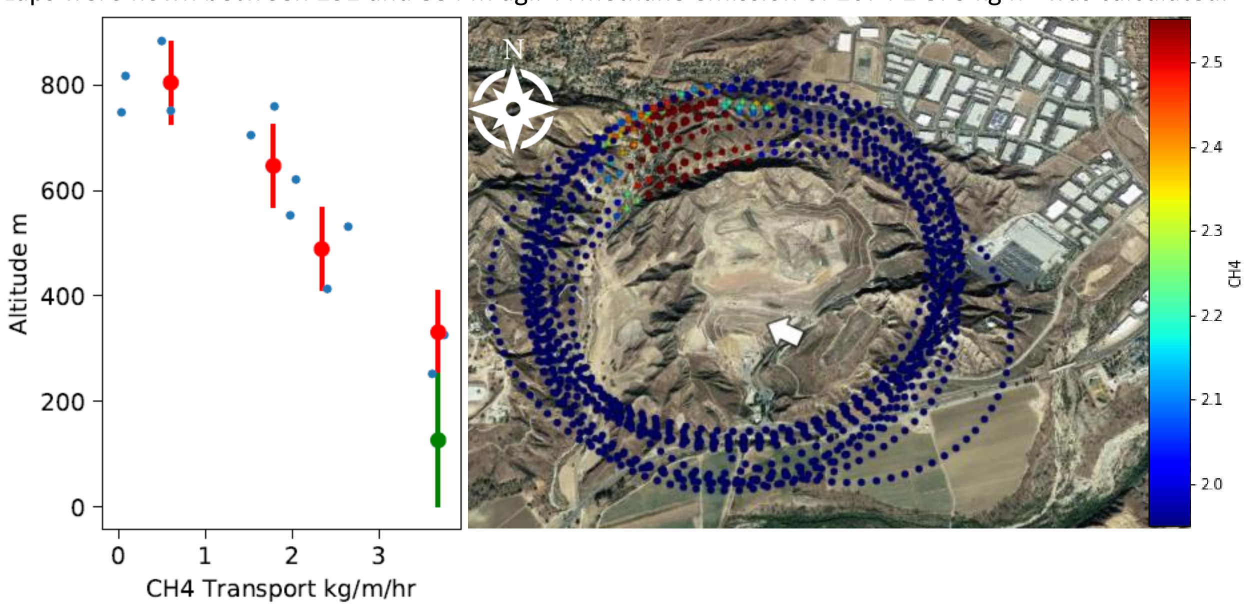

Figure 18. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

17. Chiquita Canyon LF, 11-19-19

Laps were flown between 183 and 369 m agl. A methane emission of 657 ± 351 kg h^{-1} was calculated.

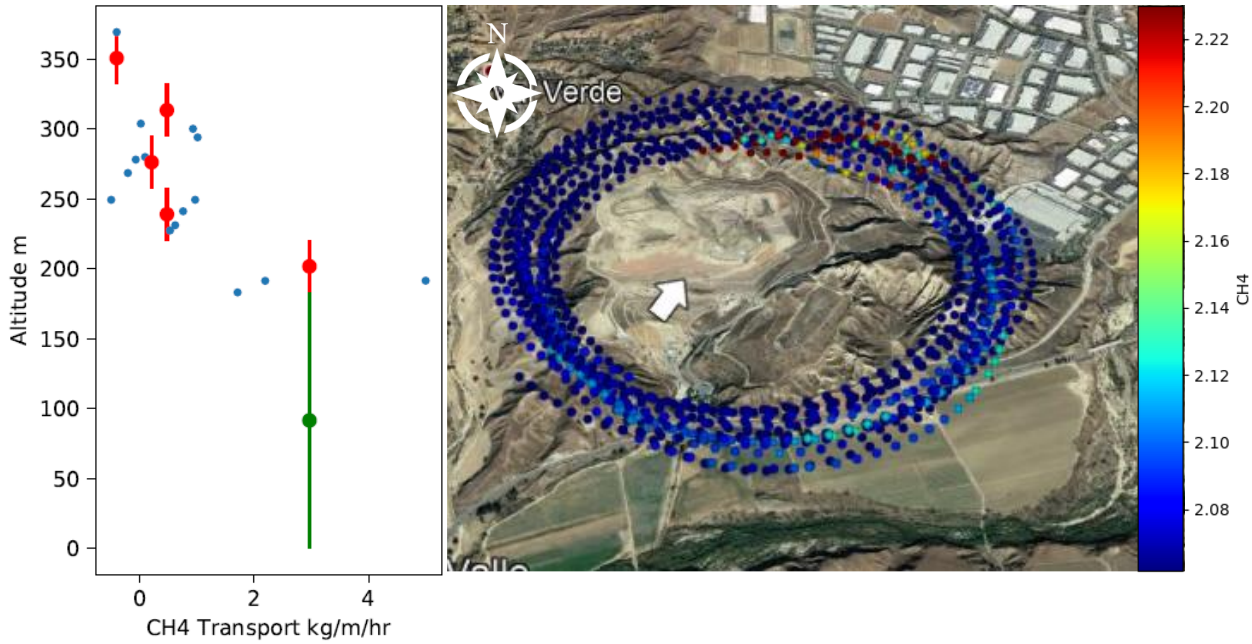

Figure 19. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

18. Chiquita Canyon LF, 01-13-20

The aircraft flew a total of 19 circles around the Chiquita Landfill. Altitudes ranged from 309 m agl to 936 m agl. Winds were out of the southwest, averaging 3.4 m s^{-1}. Total methane emission is estimated at 589.9 ± 303.2 kg h^{-1}.

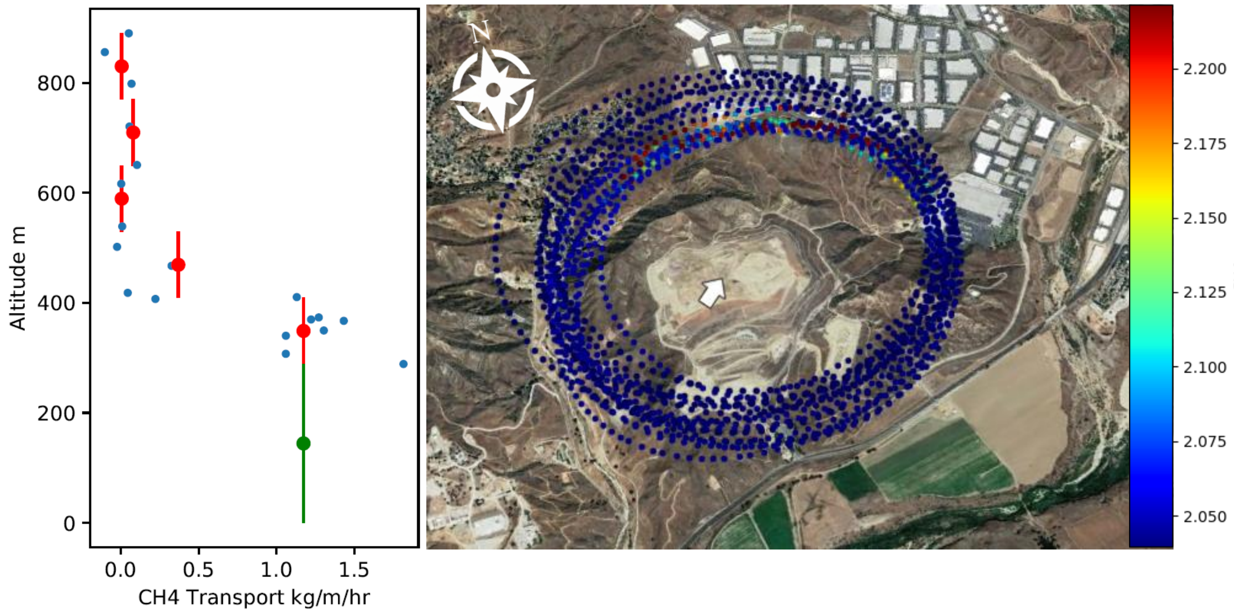

Figure 20. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

19. Chiquita Canyon LF, 05-21-20

Laps were flown between 246 and 1027 m agl, and a methane emission of 379 ± 147 kg h^{-1} was calculated.

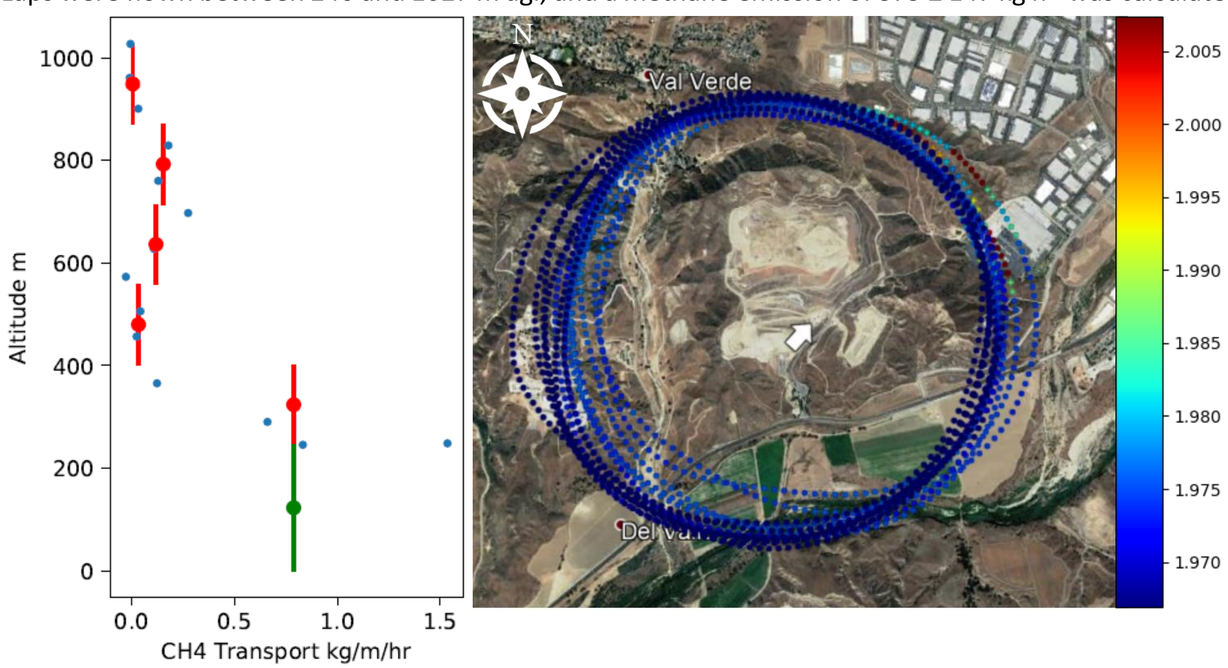

Figure 21. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

20. Chiquita Canyon LF, 07-15-20

Laps were flown between 206 and 883 m agl. A methane emission of 506 ± 370 kg h^{-1} was calculated.

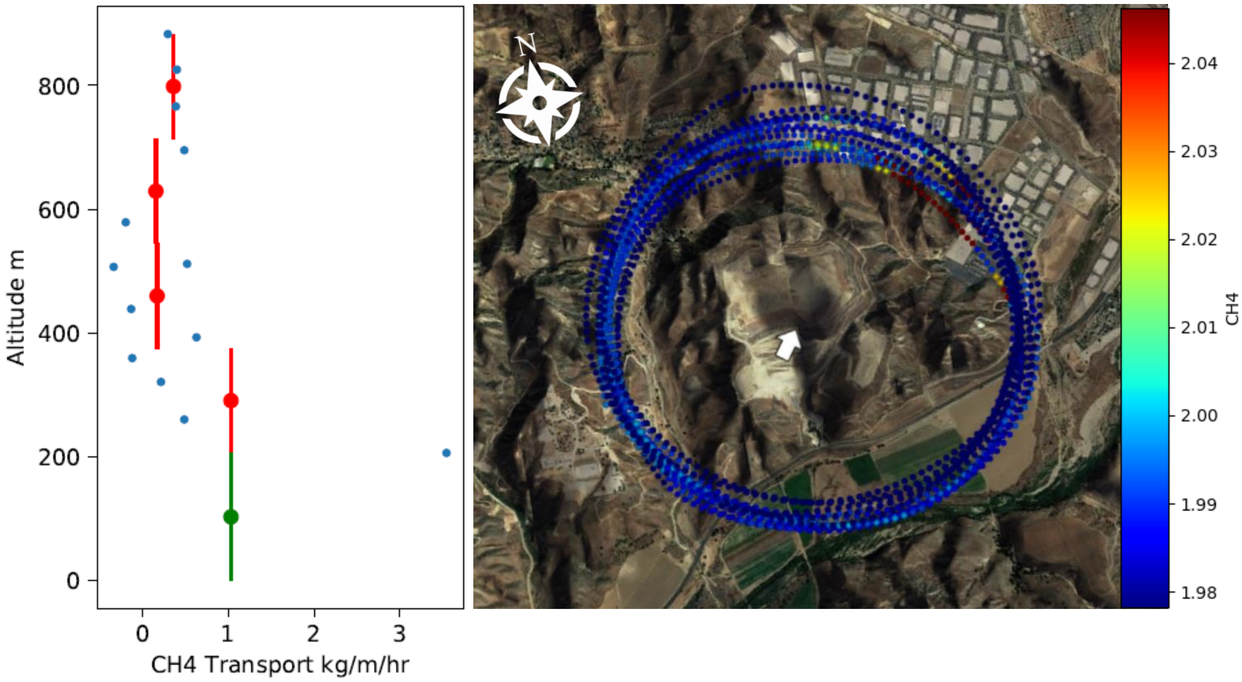

Figure 22. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

21. Chiquita Canyon LF, 10-28-20

Laps were flown between 206 and 590 m agl. A methane emission of 739 ± 253 kg h^{-1} was calculated. No significant ethane emission was observed.

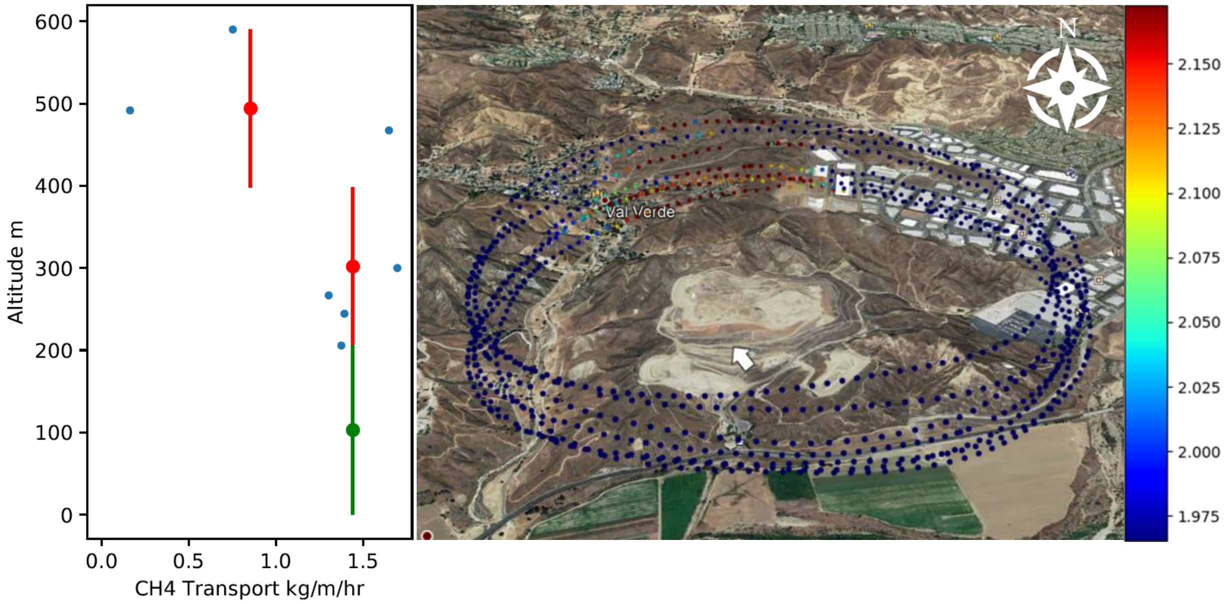

Figure 23. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

22. City of Fresno LF, 11-18-19

Laps were flown between 44 and 311 m agl. A methane emission of -3 ± 99 kg h^{-1} was calculated.

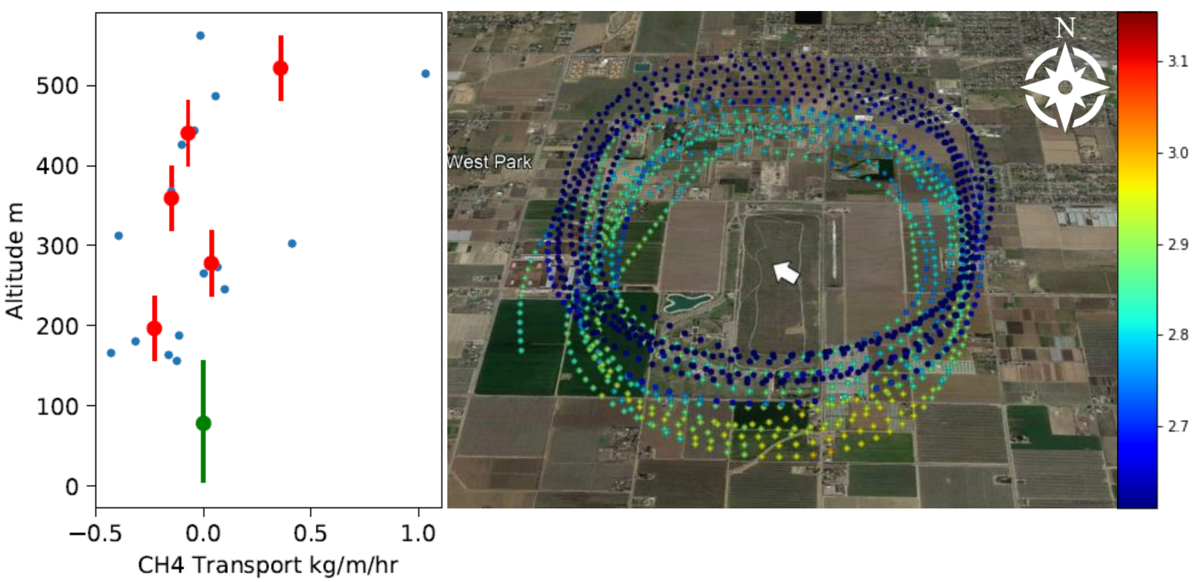

Figure 24. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

23. Compost Solutions Inc. LF, 11-02-20

Laps were flown between 49 and 340 m agl. A methane emission of 53 ± 27 kg h^{-1} was calculated. No significant ethane was observed.

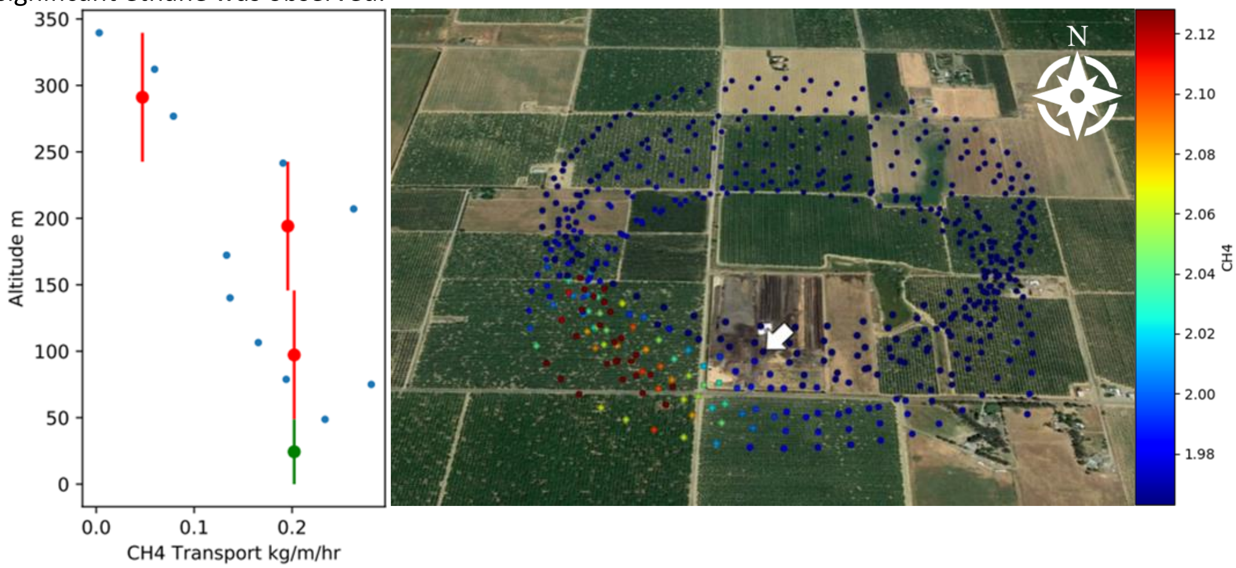

Figure 25. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

24. Corinda Los Trancos LF, 01-12-20

The aircraft flew a total of 14 circles around the Corinda Los Trancos Landfill. Altitudes ranged from 293 m agl to 460 m agl. Winds were out of the northwest, averaging 5.3 m s^{-1}. Total methane emission is estimated at 2472± 1682 kg h^{-1}.

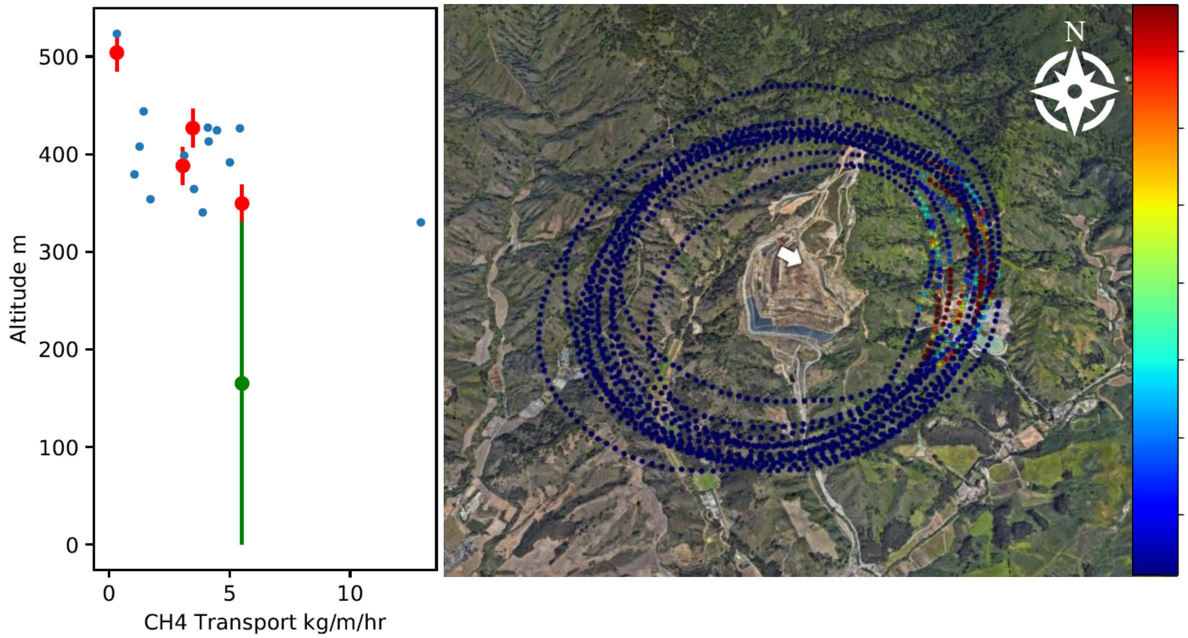

Figure 26. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

25. Corona Disposal Site, 11-19-19

Laps were flown between 349 and 754 m agl. A methane emission of -26 ± 27 kg h^{-1} was calculated.

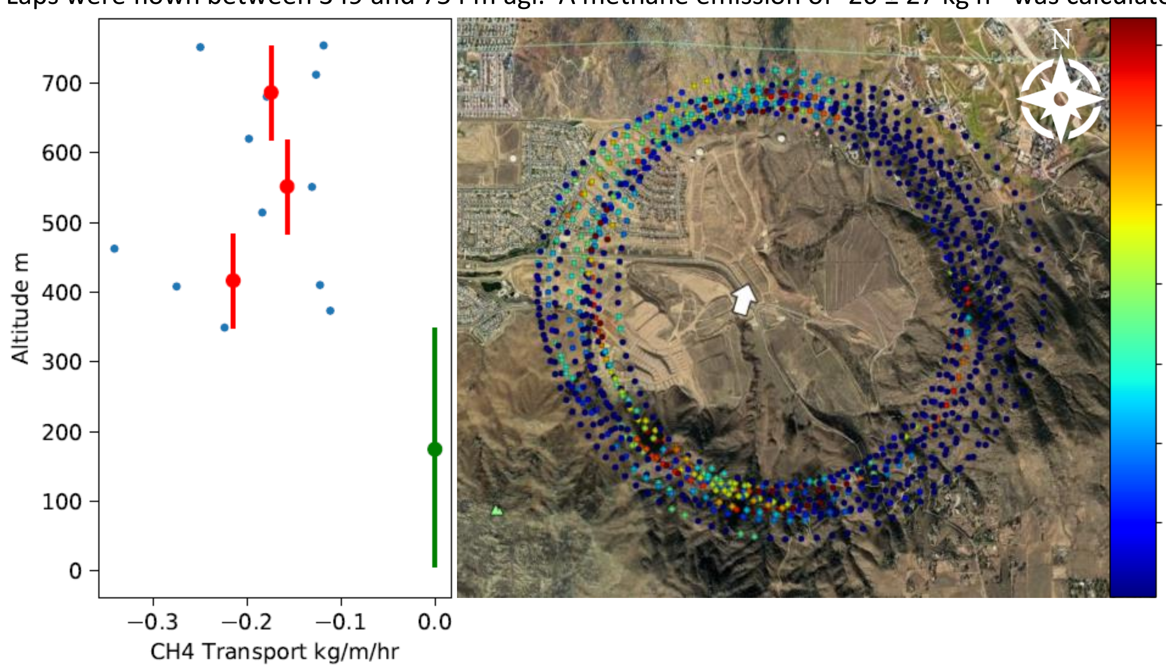

Figure 27. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

26. Coyote Canyon LF, 07-16-20

Laps were flown between 141 and 410 m agl. A methane emission of 84 ± 14 kg h^{-1} was calculated.

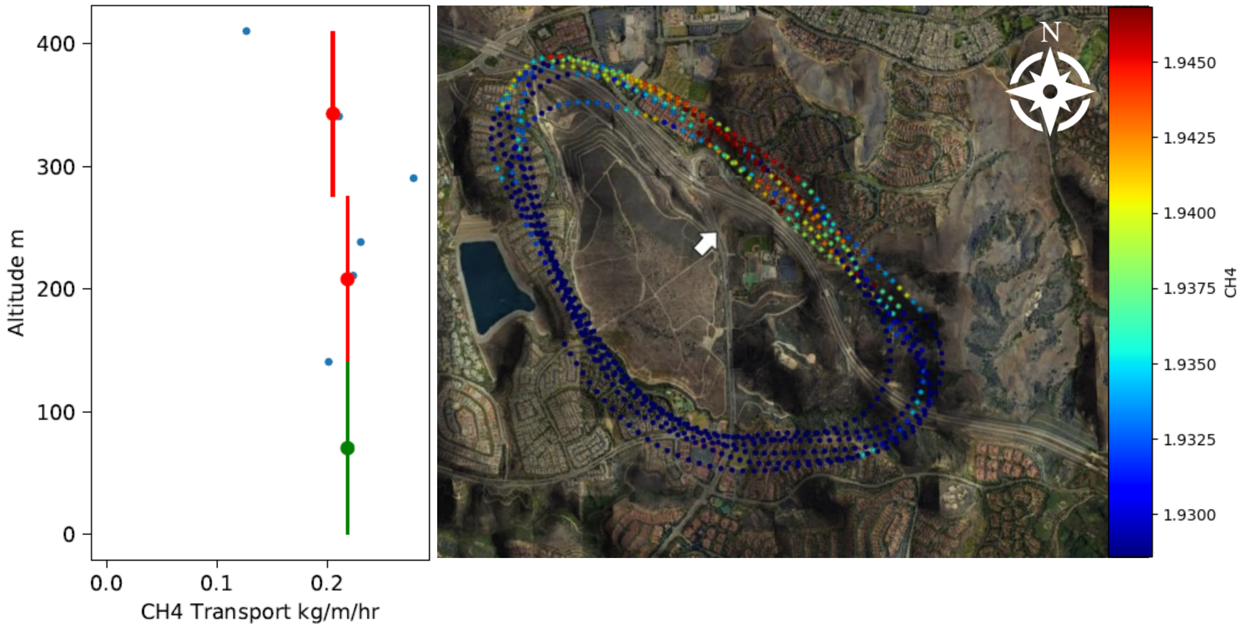

Figure 28. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

27. El Sobrante LF, 05-20-20

Laps were flown around El Sobrante between 206 and 867 m agl. Calculated methane emission was 1326 ± 691 kg h^{-1}.

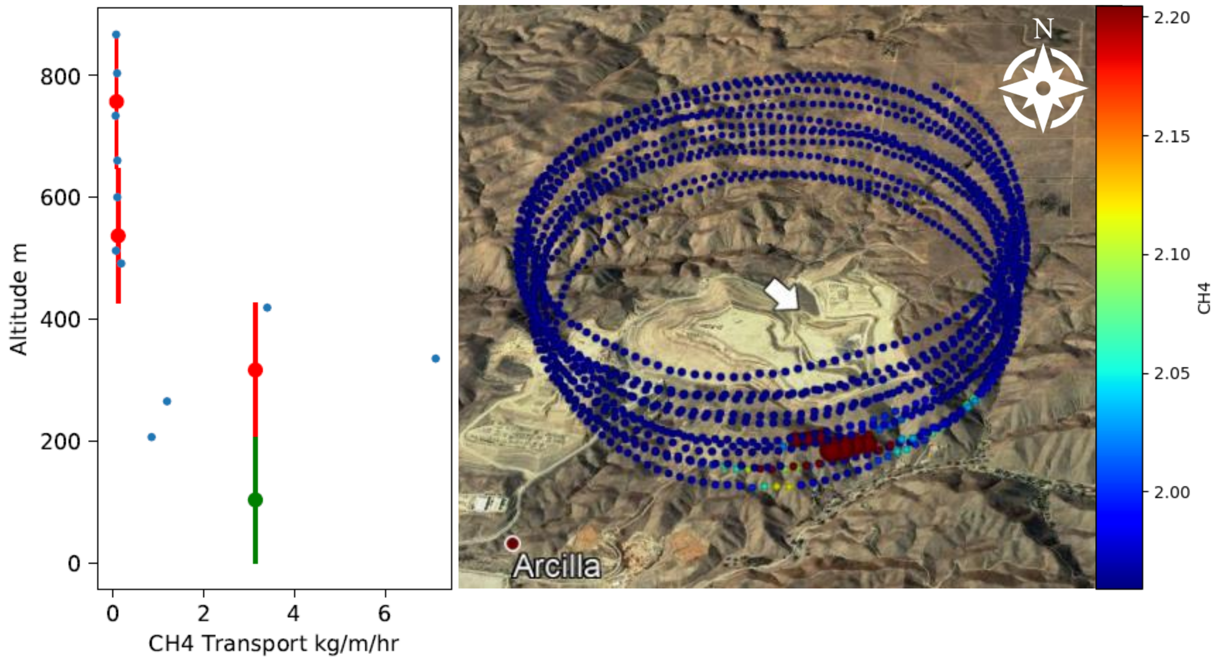

Figure 29. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

28. Foothill LF, 11-21-19

Laps were flown between 68 and 408 m agl. A methane emission of 112 ± 34 kg h^{-1} was calculated.

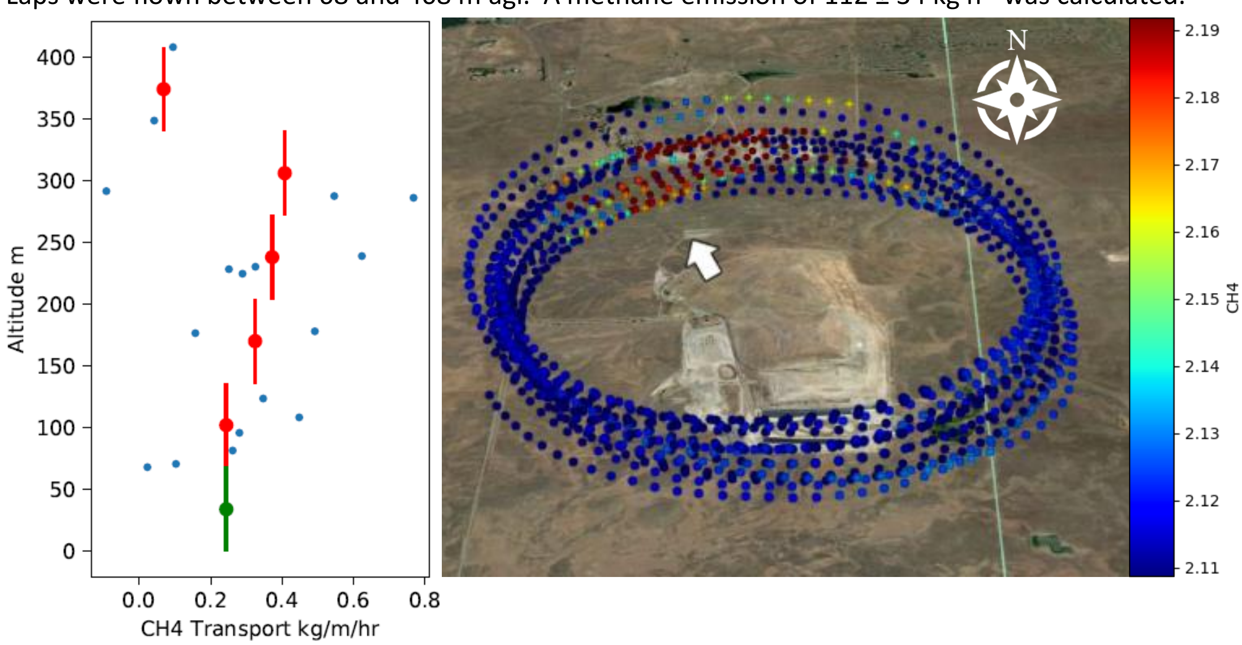

Figure 30. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

29. Foothill LF, 04-20-20

The aircraft flew laps between 163 and 841 m agl and a methane emission of 411 ± 175 kg h^{-1} was calculated.

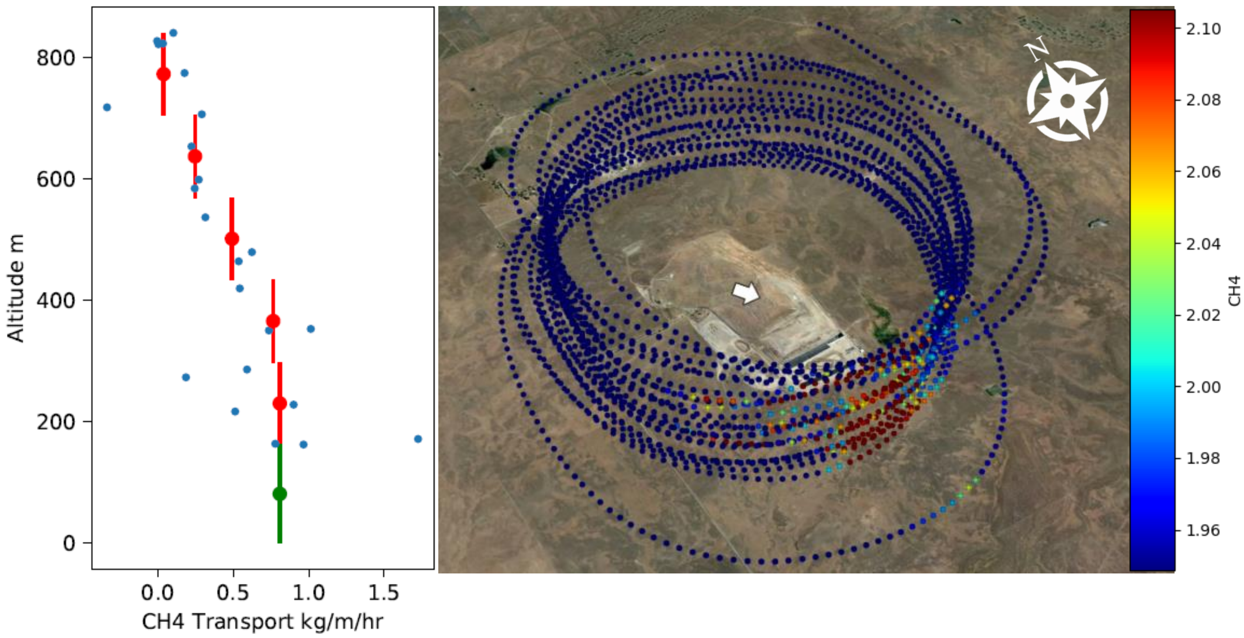

Figure 31. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

30. Foothill LF, 10-08-20

Laps were flown between 96 and 283 m agl. A methane emission of 421 ± 157 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

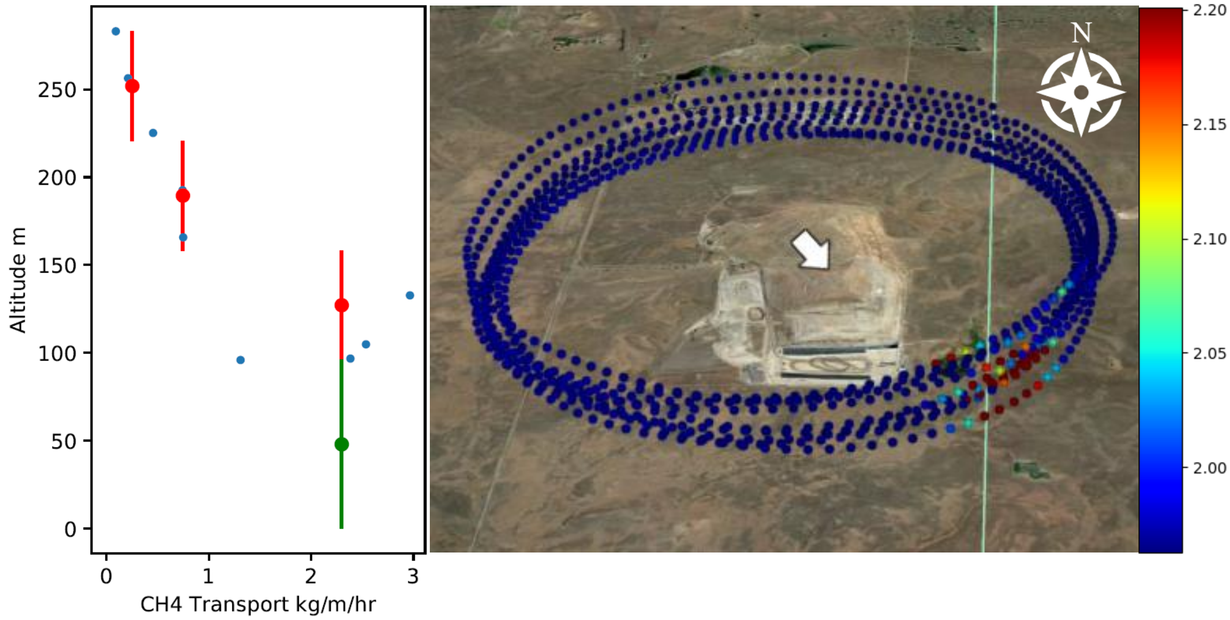

Figure 32. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

31. Forward LF, 11-21-19

Laps were flown between 119 and 1006 m agl. A methane emission of 1618 ± 343 kg h^{-1} was calculated. No significant ethane emission was observed.

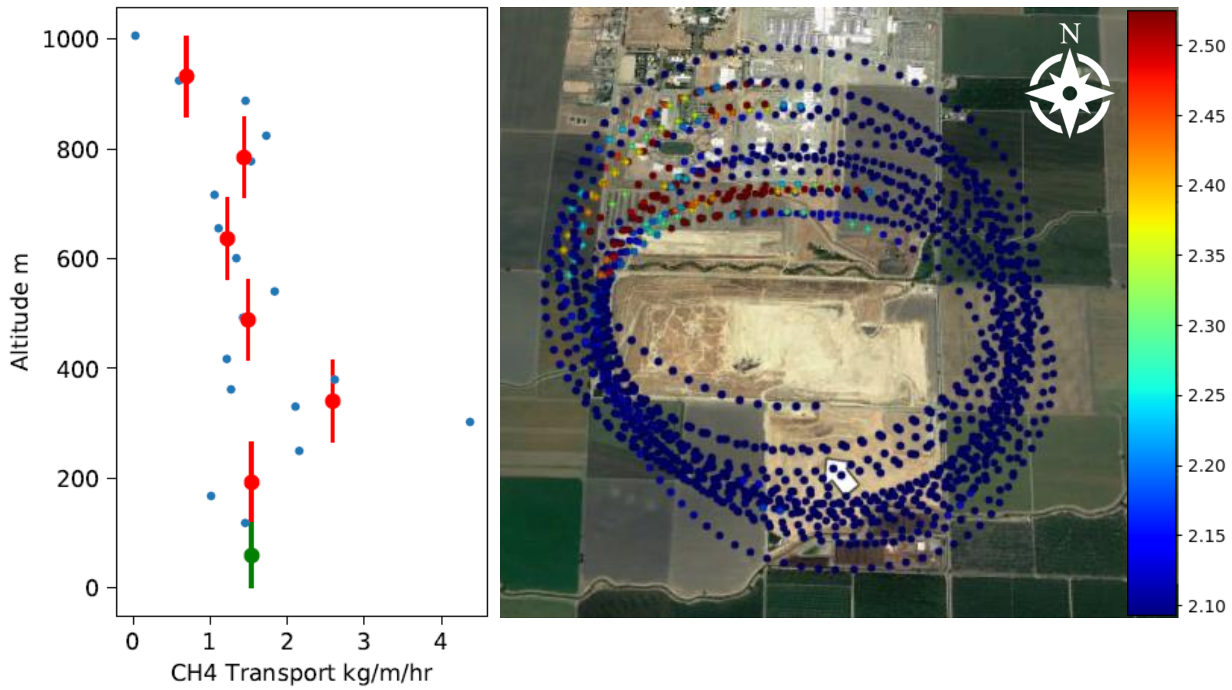

Figure 33. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

32. Forward LF, 04-20-20

The aircraft flew laps between 153 and 761 m agl and a methane emission of 728 ± 287 kg h^{-1} was calculated.

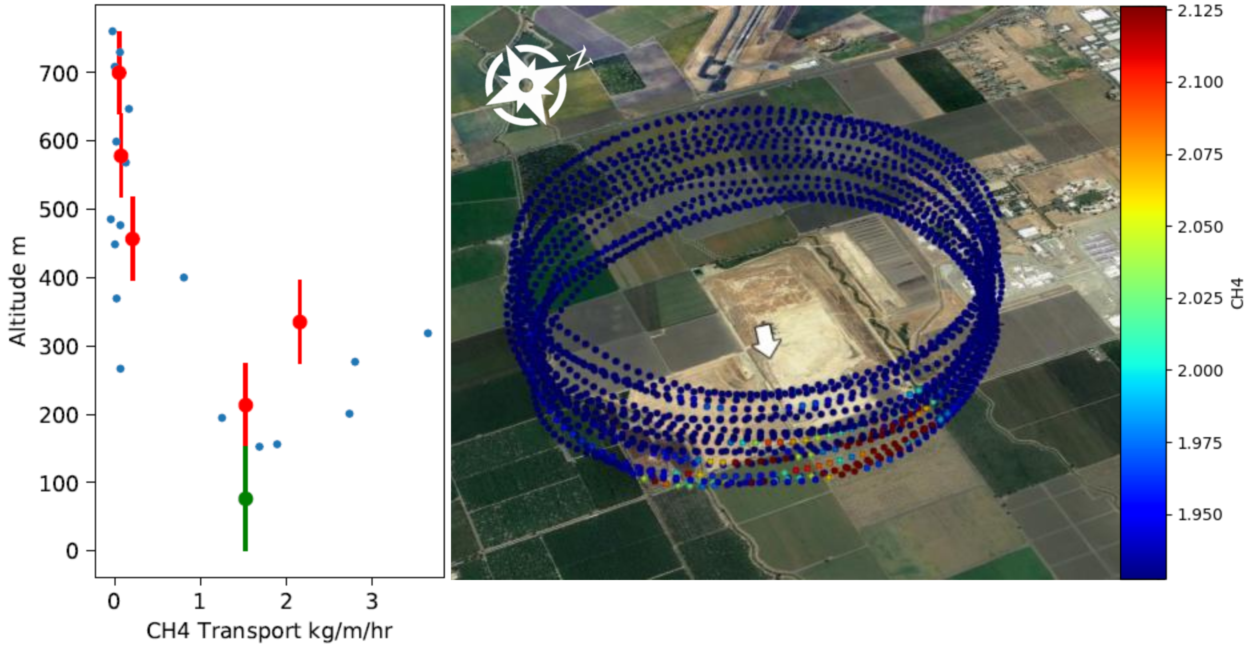

Figure 34. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

33. Forward LF, 10-08-20

Laps were flown between 80 and 628 m agl. A methane emission of 2438 ± 613 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured.

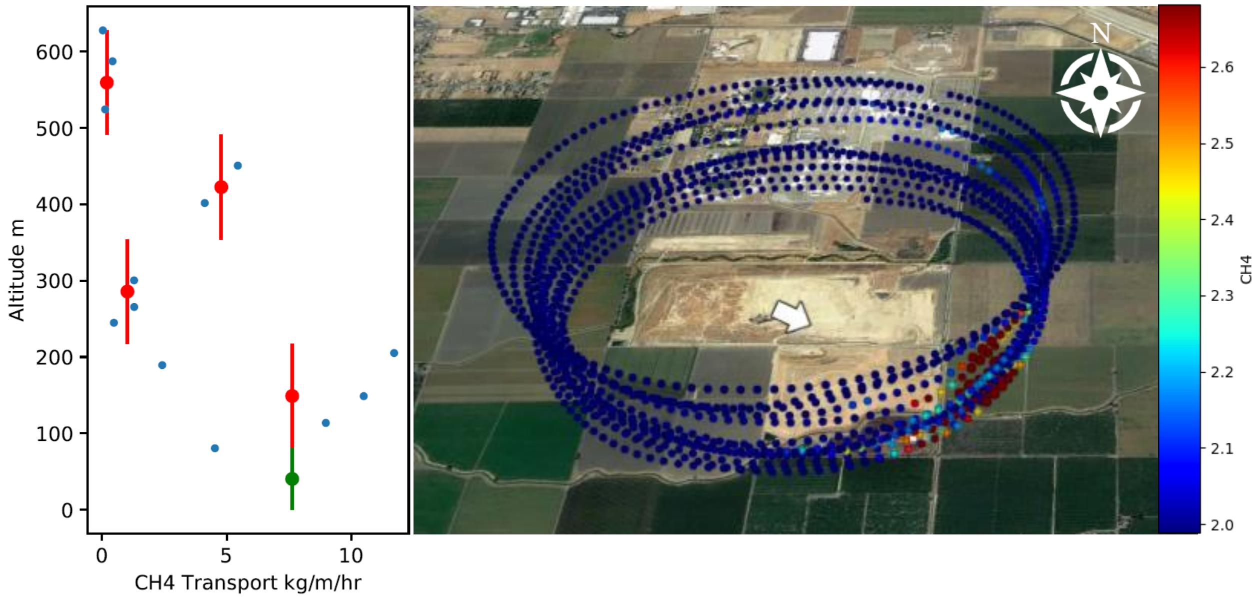

Figure 35. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

34. Forward LF, 02-26-21

Laps were flown between 116 and 677 m agl. Methane emissions were 2520 ± 634 kg h^{-1}. No significant ethane emissions were observed.

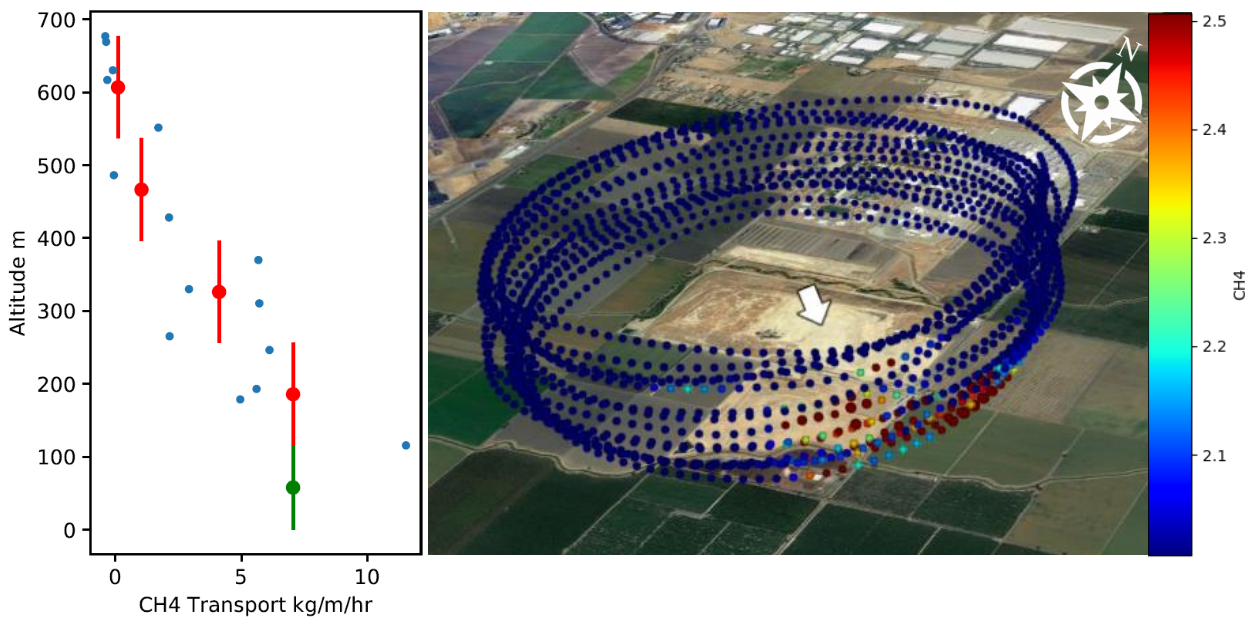

Figure 36. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

35. Frank R. Bowerman LF, 11-19-19

Laps were flown between 206 and 721 m agl. A methane emission of 2976 ± 624 kg h^{-1} was calculated.

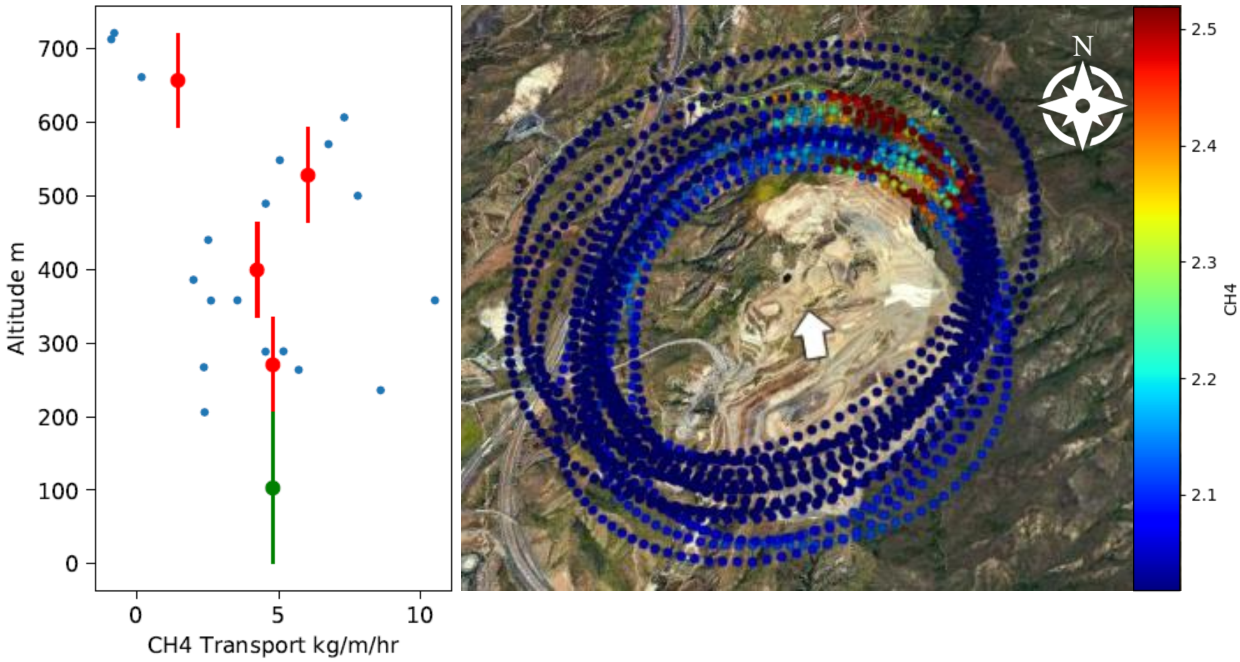

Figure 37. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

36. Frank R. Bowerman LF, 01-14-20

The aircraft flew a total of 17 circles around the Frank R. Bowerman Landfill. Altitudes ranged from 265 m agl to 520 m agl. Winds were out of the northwest, averaging 2.0 m s^{-1}. Total methane emission is estimated at 2765.0 ± 790.3 kg h^{-1}.

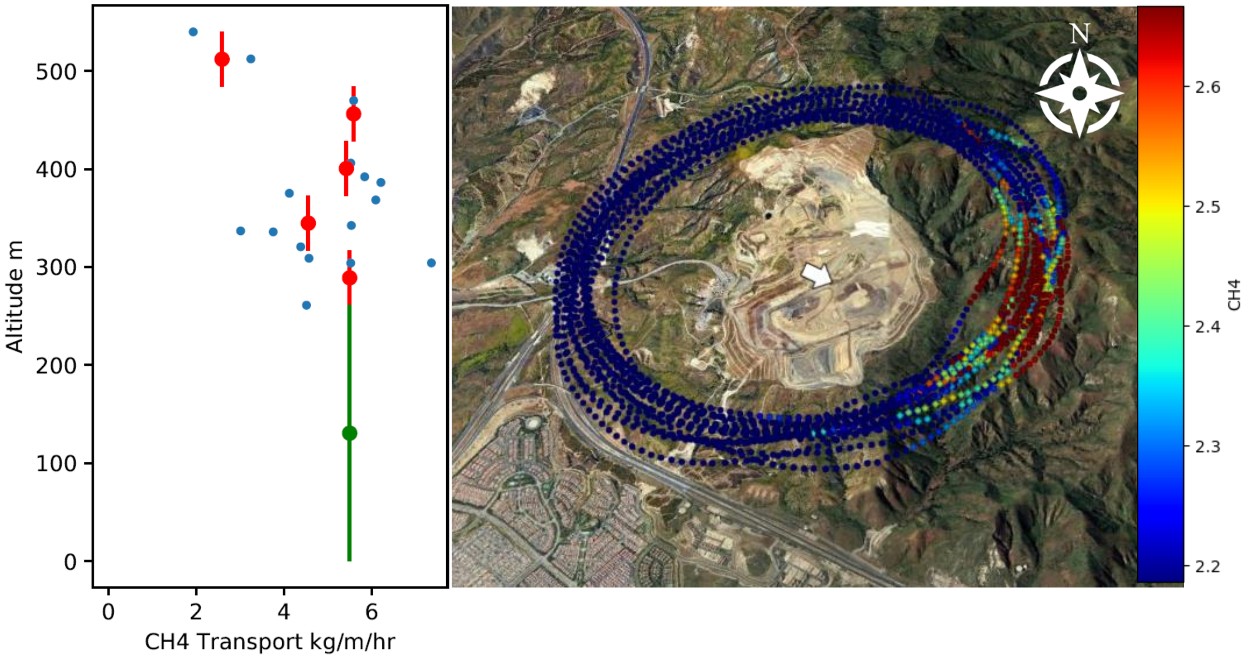

Figure 38. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

37. Frank R. Bowerman LF, 05-20-20

The aircraft flew laps between 230 and 773 m agl, and the resulting calculated methane emission was 1270 ± 512 kg h^{-1}.

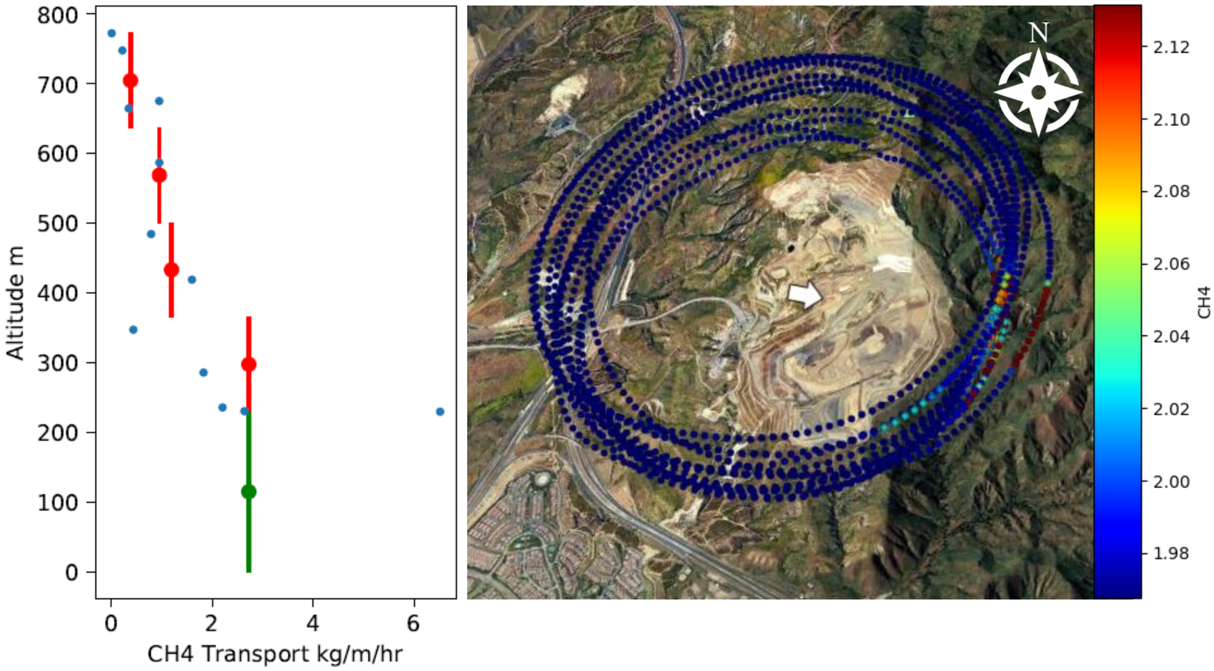

Figure 39. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

38. Frank R. Bowerman LF, 07-16-20

Laps were flown between 246 and 491 m agl. A methane emission of 1559 ± 518 kg h^{-1} was calculated.

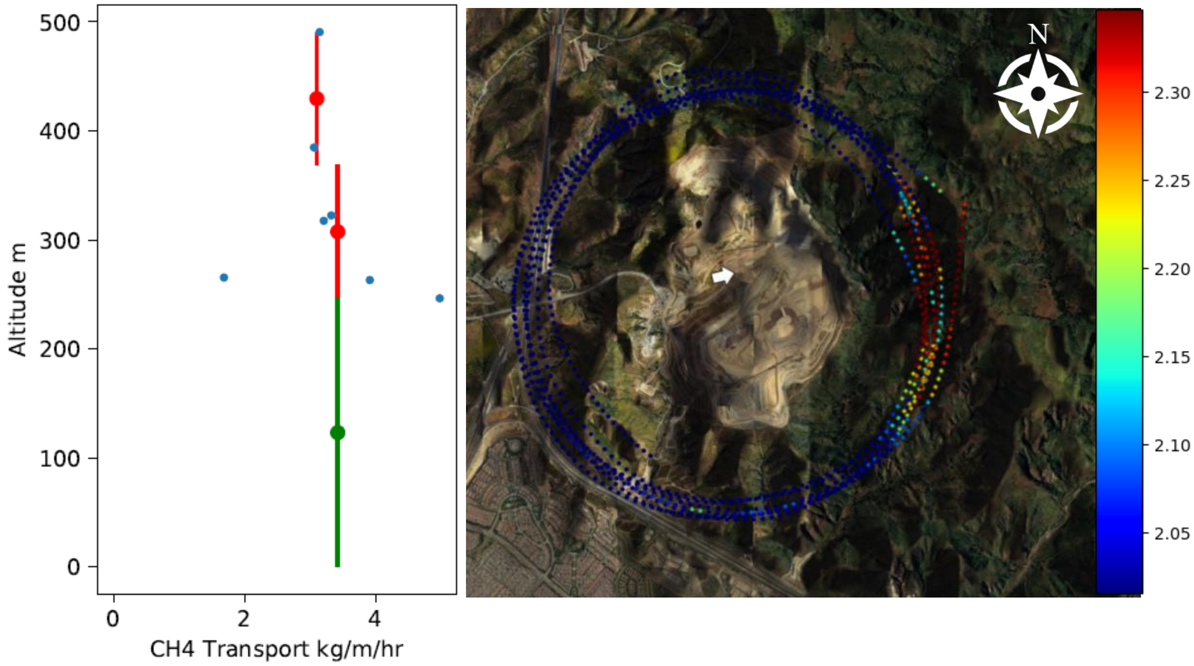

Figure 40. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

39. Frank R. Bowerman LF, 10-16-20

Laps were flown between 207 and 698 m agl. A methane emission of 163 ± 713 kg h^{-1} was calculated. No significant ethane emission was observed. The winds were low and not uniformly transiting across the target area, so confidence in this measurement is very low.

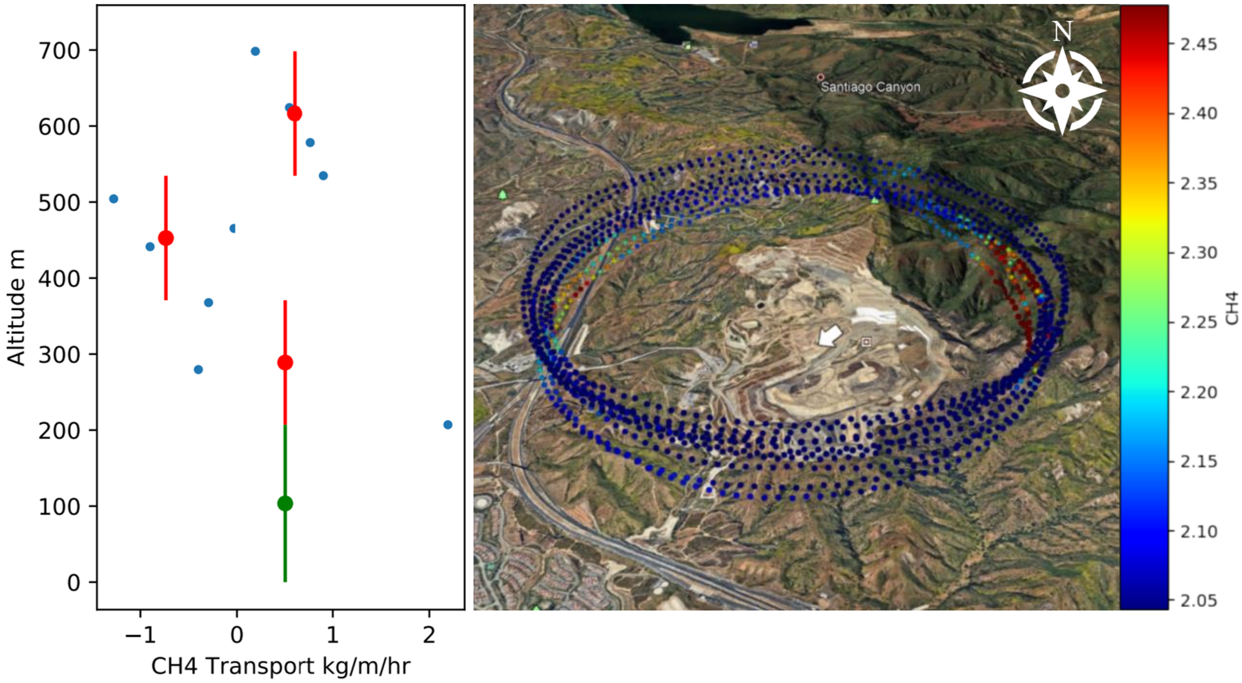

Figure 41. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

40. Frank R. Bowerman LF, 02-18-21

Laps were flown between 169 and 826 m agl. Measured methane emissions were 975 ± 265 kg h^{-1}, and no significant ethane was detected.

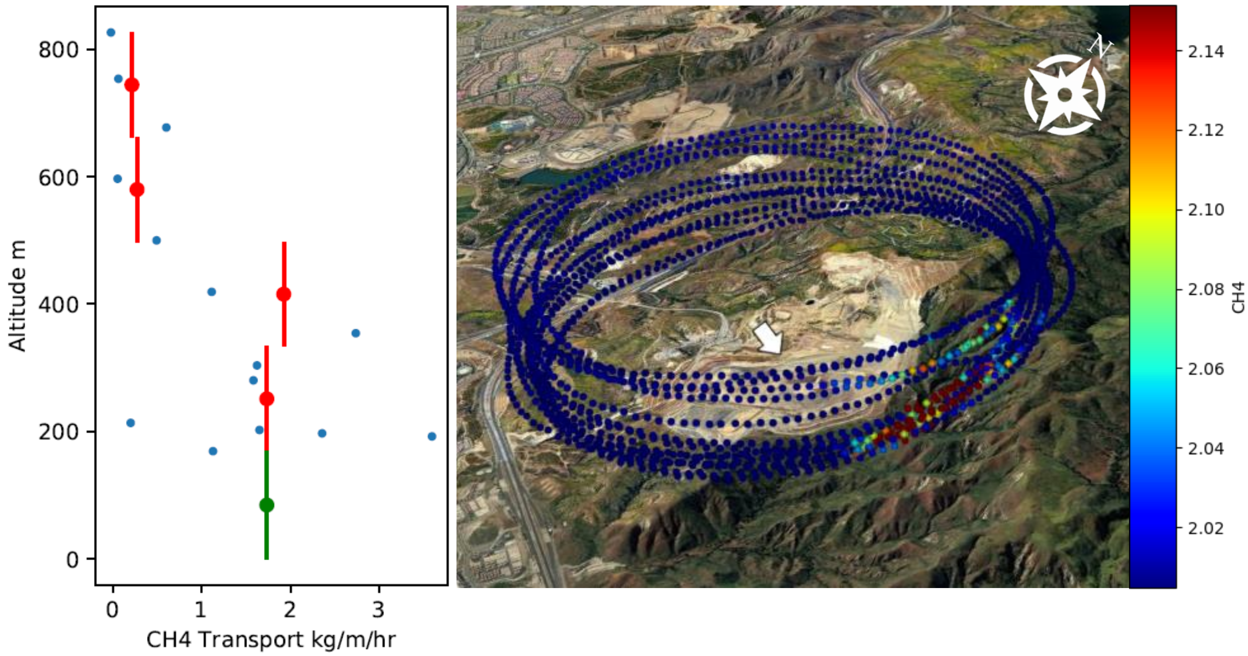

Figure 42. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

41. Guadalupe LF, 11-23-19

Laps were flown between 246 and 471 m agl. A methane emission of 332 ± 158 kg h^{-1} was calculated.

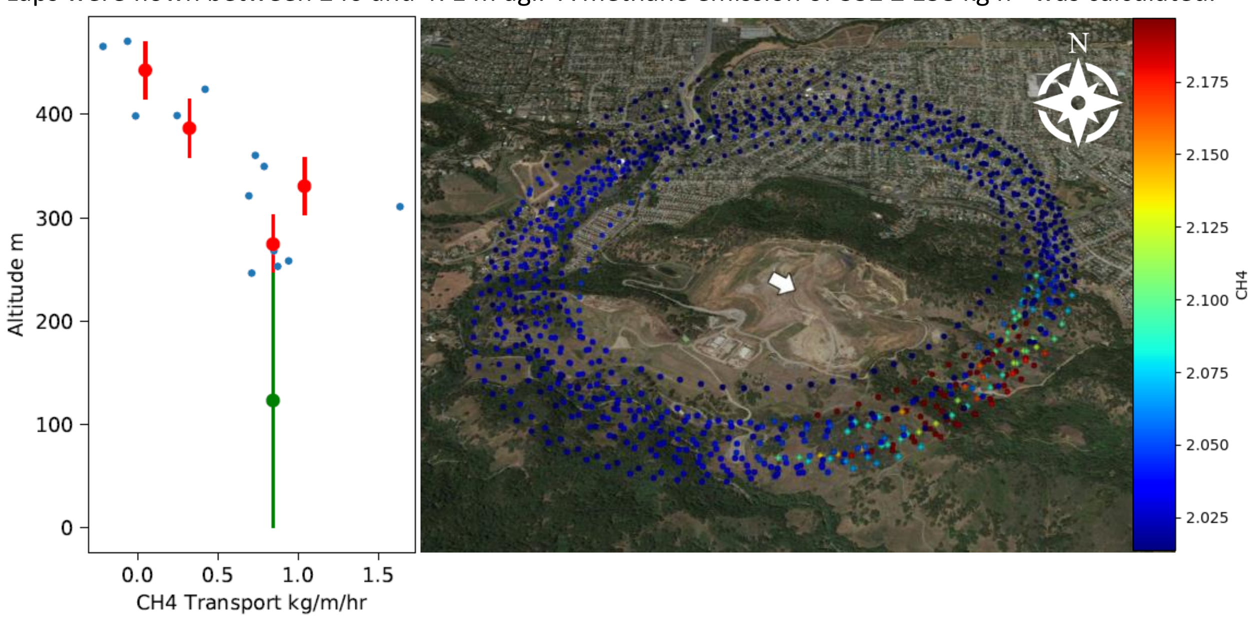

Figure 43. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

42. Keller Canyon LF, 11-22-19

Laps were flown between 204 and 535 m agl. A methane emission of 1888 ± 733 kg h^{-1} was calculated.

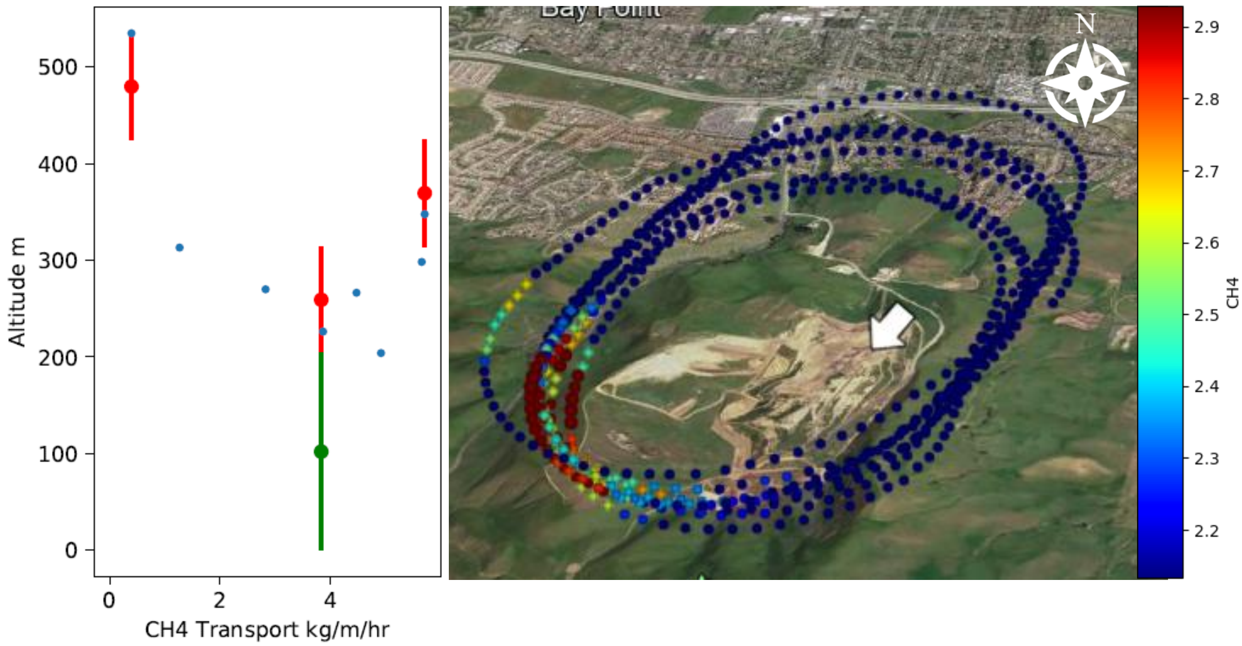

Figure 44. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

43. Keller Canyon LF, 01-11-20

The aircraft flew 12 circles around the Keller Canyon Landfill. Altitudes ranged from 227 m agl to 363 m agl. Winds were out of the west, averaging 7.8 m s^{-1}. Total methane emission is estimated at 531.6 ± 514.1 kg hr^{-1}. The emissions estimate for this site is likely and underestimate due to the low boundary layer. The lower winter temperatures and increased cloud cover contribute to a lower boundary layer. The effect is that the plane is not able to get low enough to fully sample the plume. The terrain surrounding the landfill makes it more difficult to get as low as we are able to do on sites in flat areas.

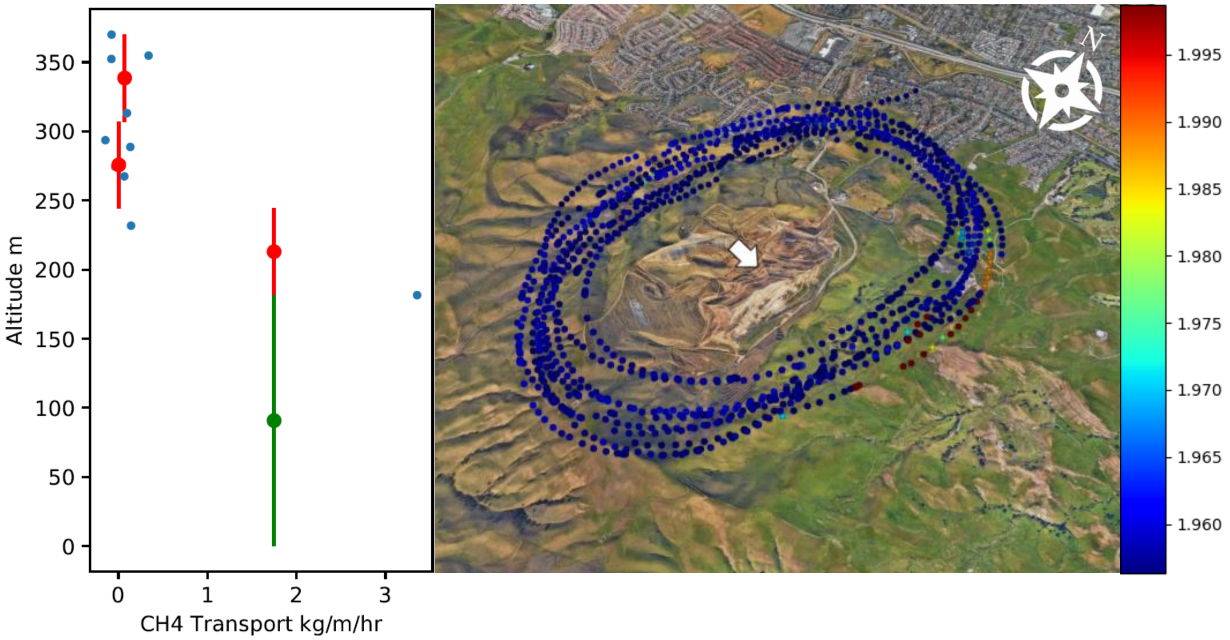

Figure 45. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

44. Keller Canyon LF, 04-21-20

The aircraft flew laps between 320 and 749 m agl and a methane emission of 362 ± 308 kg h^{-1} was calculated. This is likely an underestimate because the aircraft was not able to fly below 362 m due to terrain and turbulence, and therefore may have missed some of the methane signal.

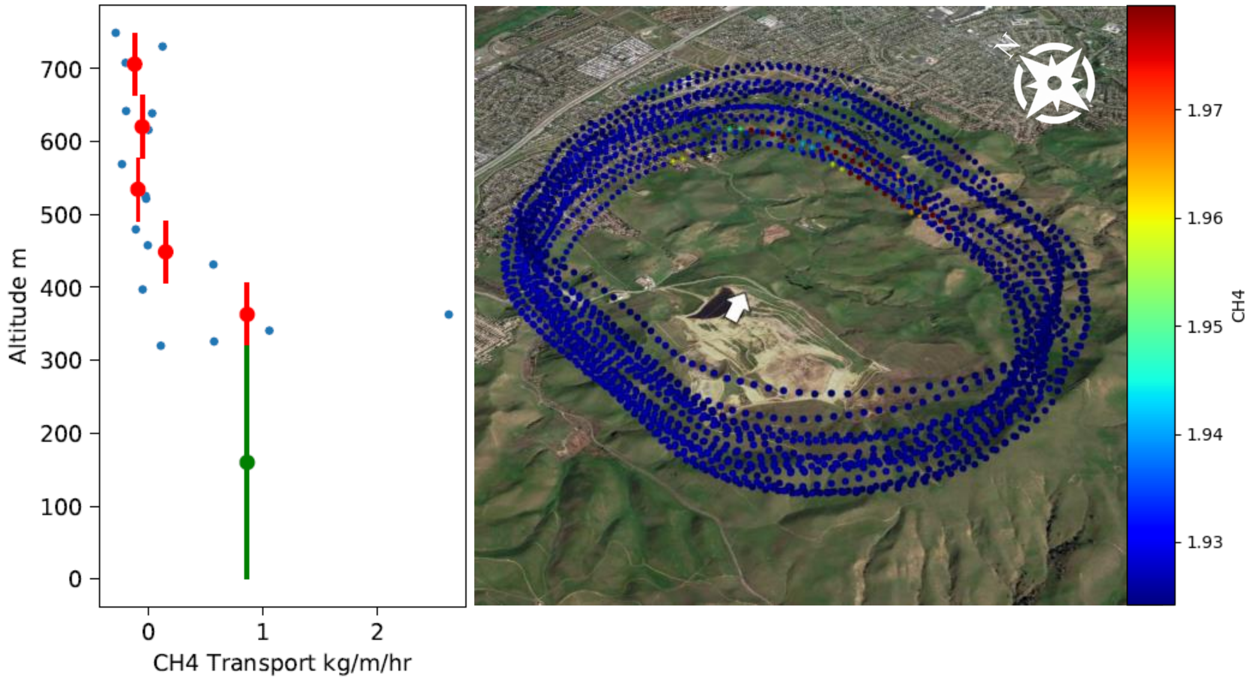

Figure 46. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

45. Keller Canyon LF, 07-29-20

Laps were flown between 205 and 723 m agl and a methane emission of 733 ± 415 kg h^{-1} was calculated.

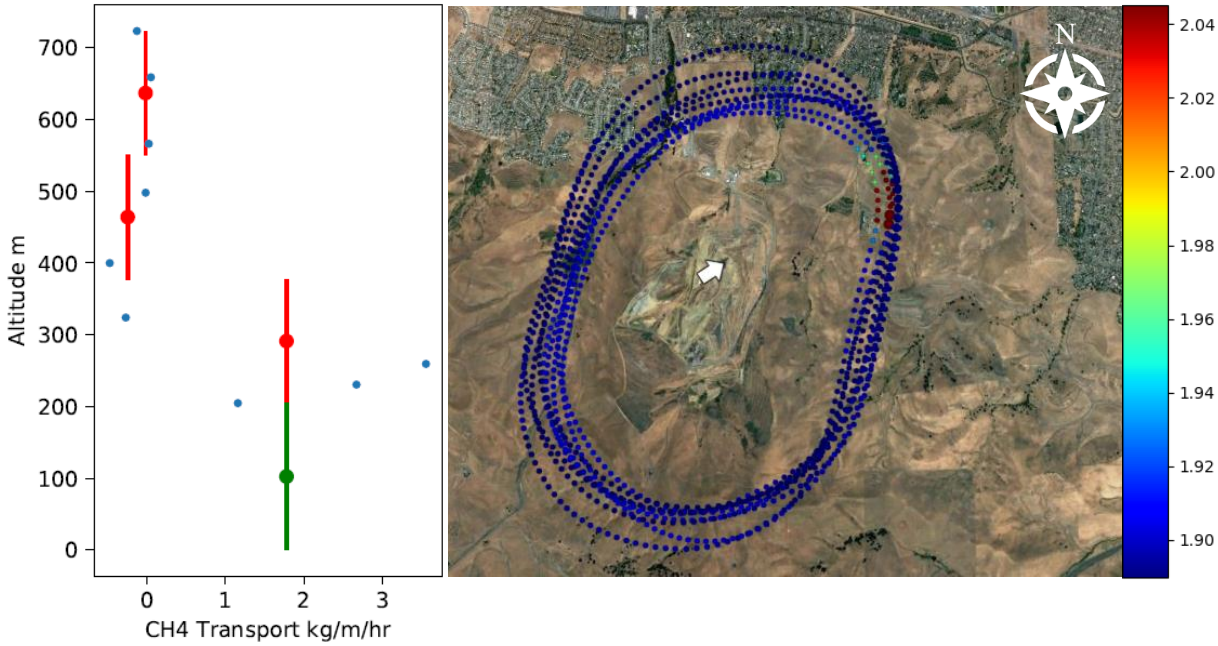

Figure 47. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

46. Keller Canyon LF, 10-31-20

Laps were flown between 110 and 150 m agl. A methane emission of 928 ± 409 kg h^{-1} was calculated. No significant ethane was observed.

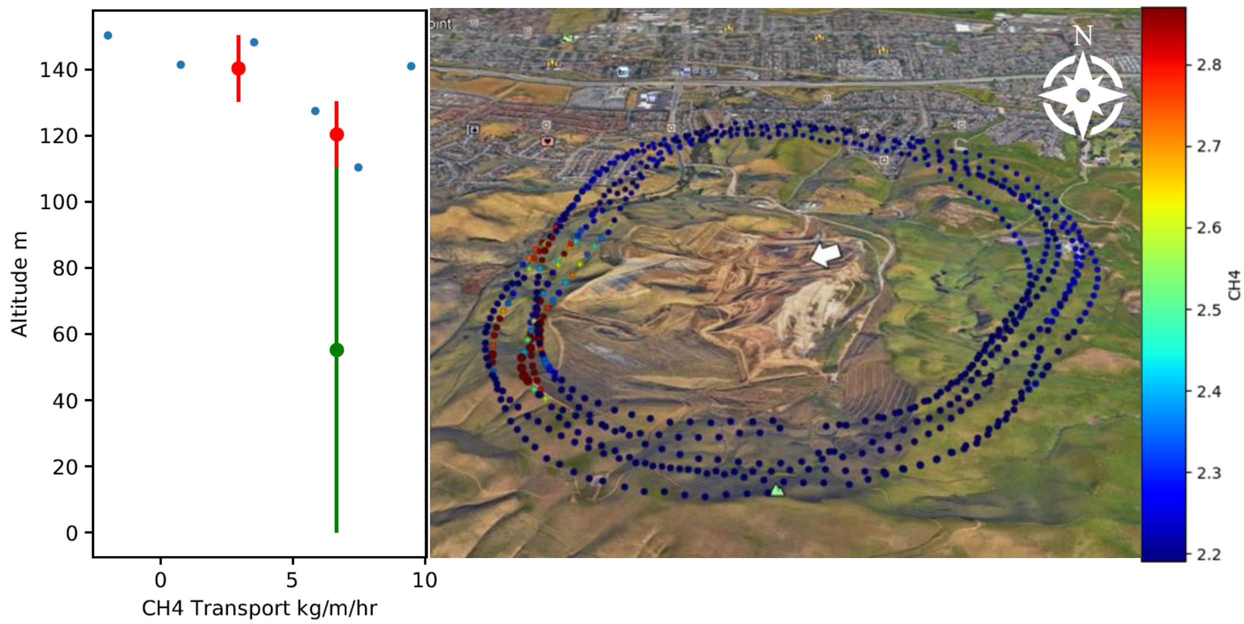

Figure 48. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

47. Keller Canyon LF, 02-26-21

Laps were flown between 169 and 761 m agl, and methane emissions were 1564 ± 415 kg h^{-1}. No significant ethane emissions were observed.

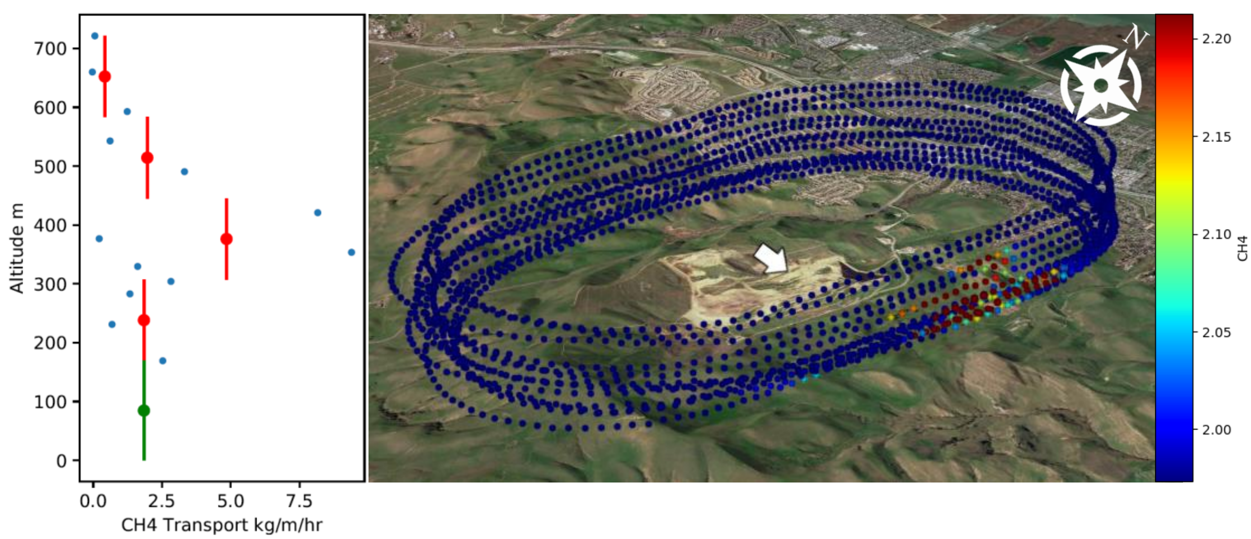

Figure 49. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

48. Kiefer LF, 11-22-19

Laps were flown between 140 and 588 m agl. A methane emission of 1970 ± 739 kg h^{-1} was calculated.

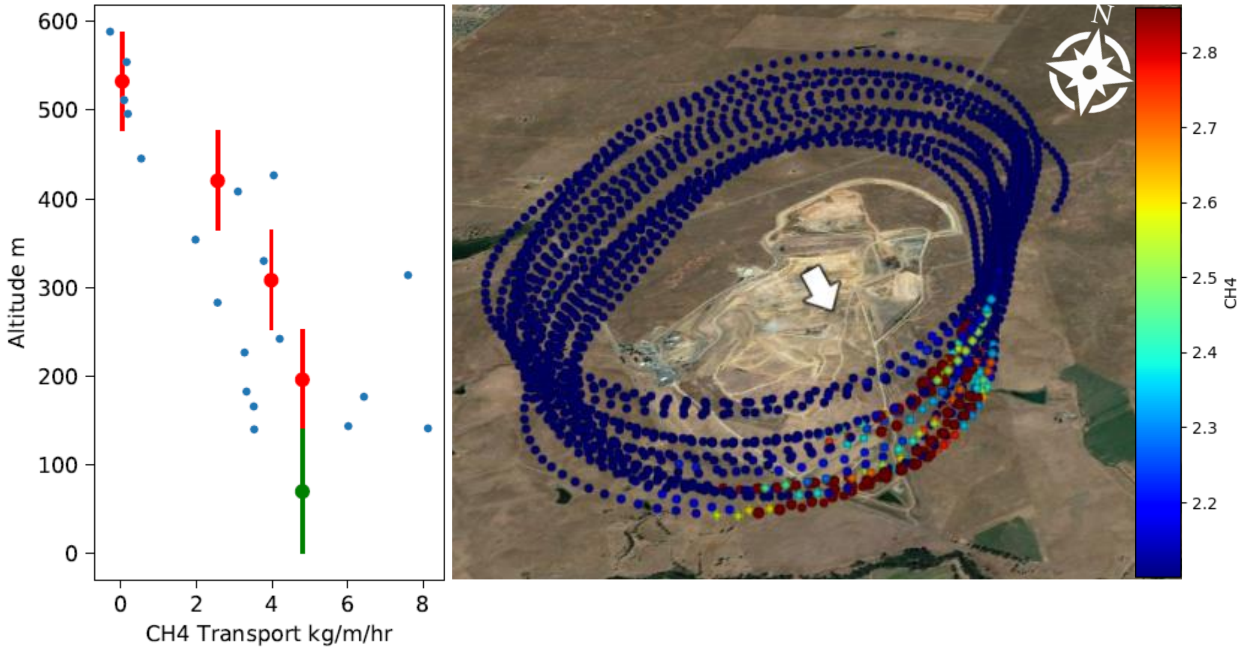

Figure 50. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

49. Kiefer LF, 04-10-20

Laps were flown between 174 and 950 m agl and a methane emissions of 1958 ± 427 kg h^{-1} was calculated.

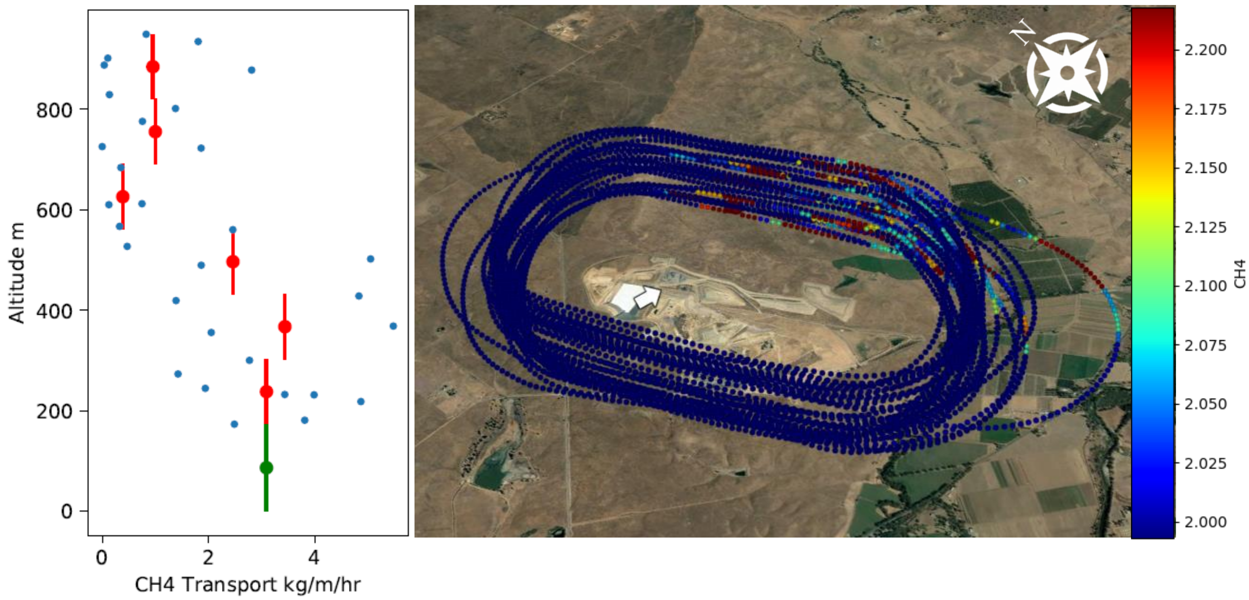

Figure 51. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

50. Kiefer LF, 10-08-20

Laps were flown between 113 and 509 m agl. A methane emission of 2163 ± 592 kg h^{-1} was calculated. No ethane was observed at this site.

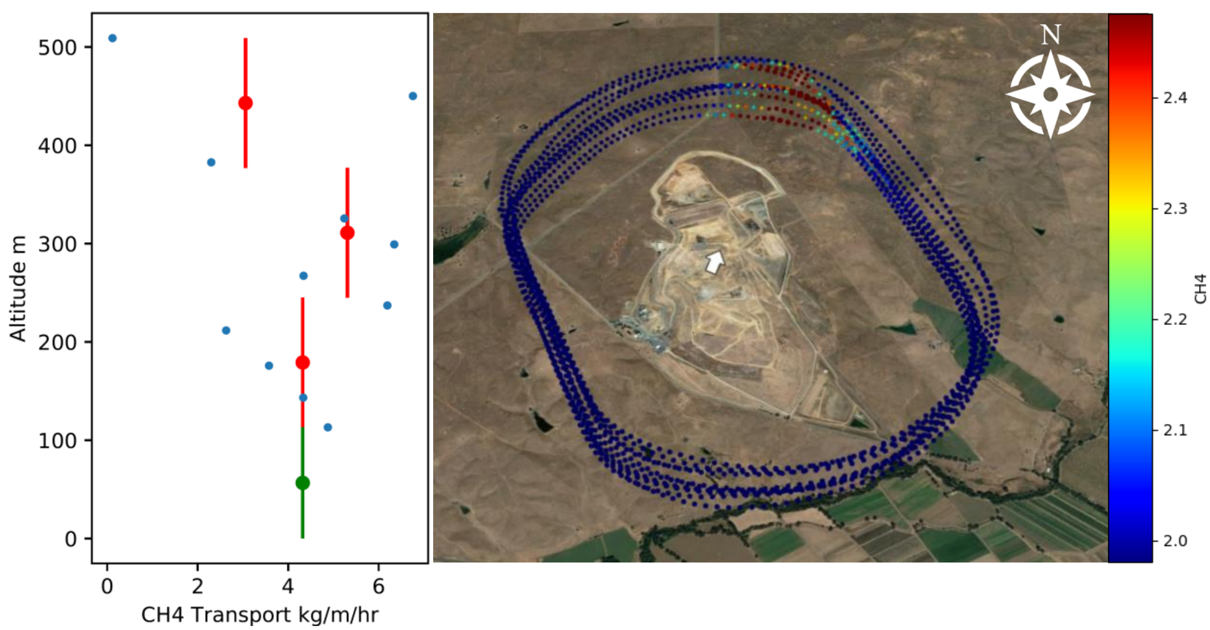

Figure 52. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

51. Kiefer LF, 11-02-20

Laps were flown between 86 and 572 m agl. A methane emission of 1914 ± 807 kg h^{-1} was calculated. No significant ethane was observed.

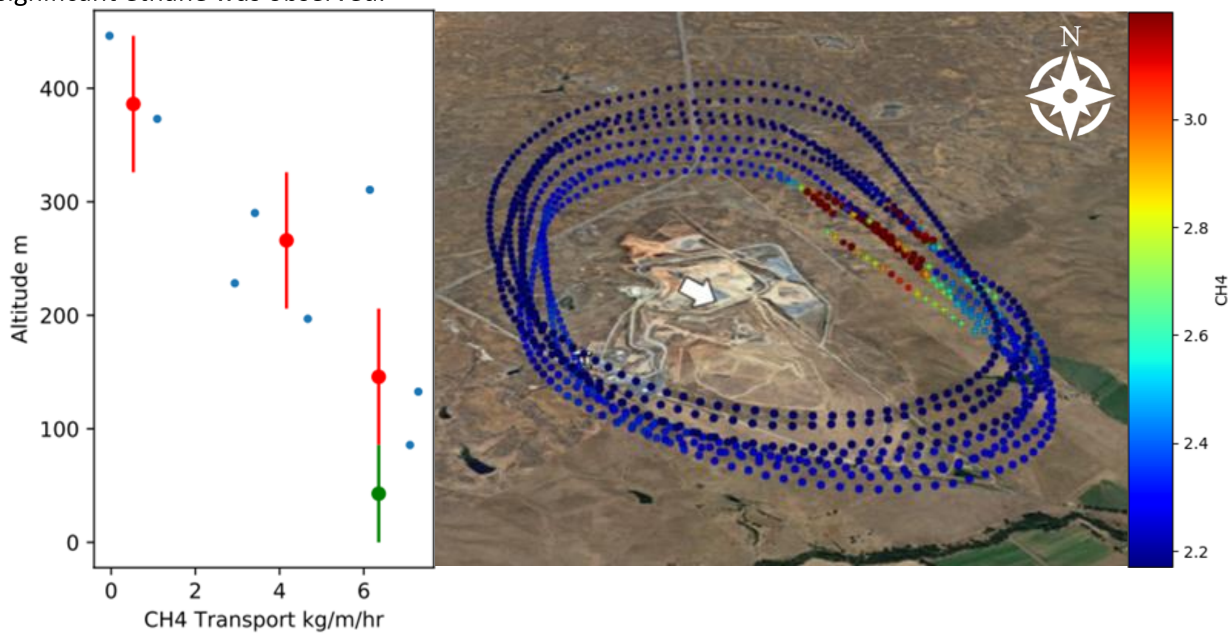

Figure 53. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

52. Kiefer LF, 02-16-21

Laps were flown between 101 and 481 m agl. Clear downwind methane enhancements were observed. No clear downwind ethane was observed.

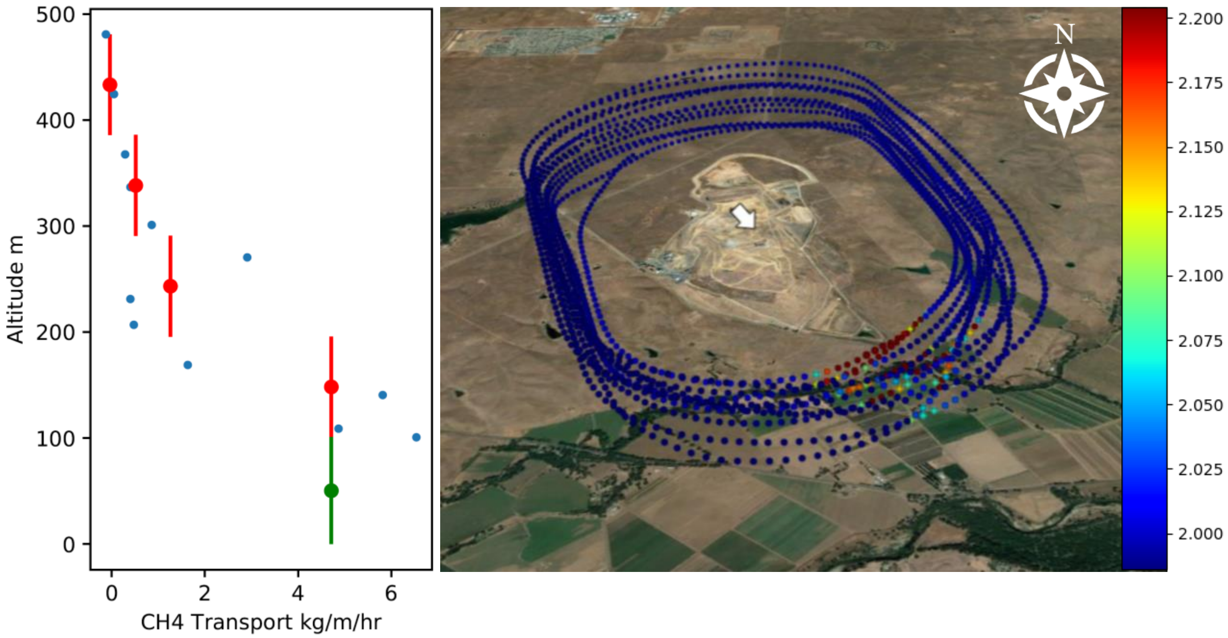

Figure 54. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

53. Kirby Canyon, 11-23-19

Laps were flown between 237 and 512 m agl. A methane emission of 287 ± 265 kg h^{-1} was calculated.

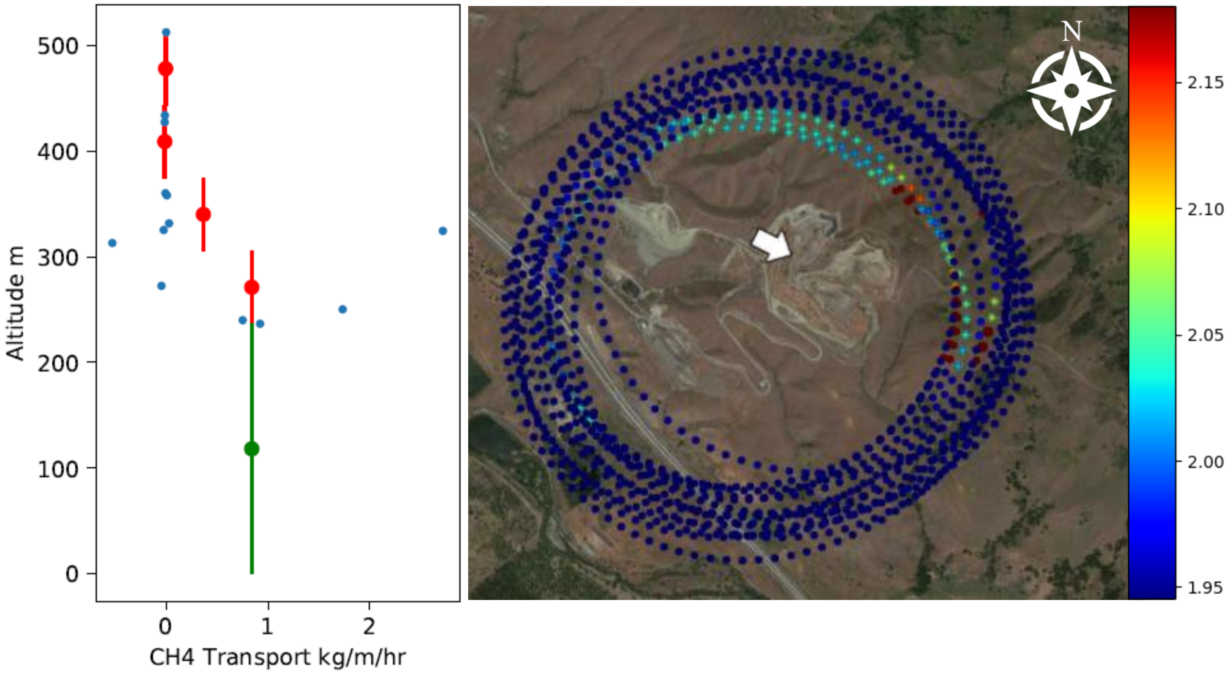

Figure 55. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

54. Las Pulgas, 05-20-20

Laps were flown around Las Pulgas between 247 and 374 m agl. The methane emission calculated was 39 ± 52 kg h^{-1}, but this is likely an underestimate because emissions below the lowest flight altitude are possible. The number of laps and altitude range are small because Las Pulgas is in a restricted flight area: The aircraft was granted access but was required to leave the airspace after ~15 minutes of measurement time.

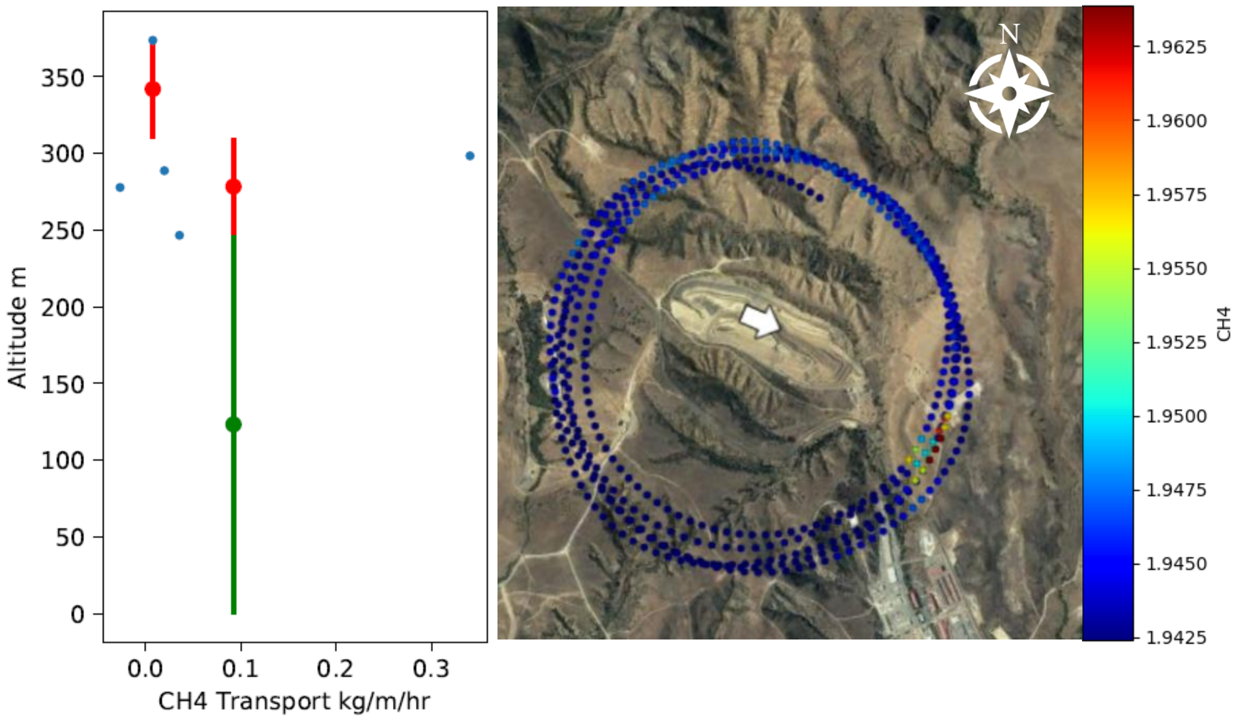

Figure 56. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

55. Lopez Canyon LF, 05-22-20

The aircraft flew laps between 211 and 997 m agl, and the calculated methane emission was 259 ± 78 kg h^{-1}.

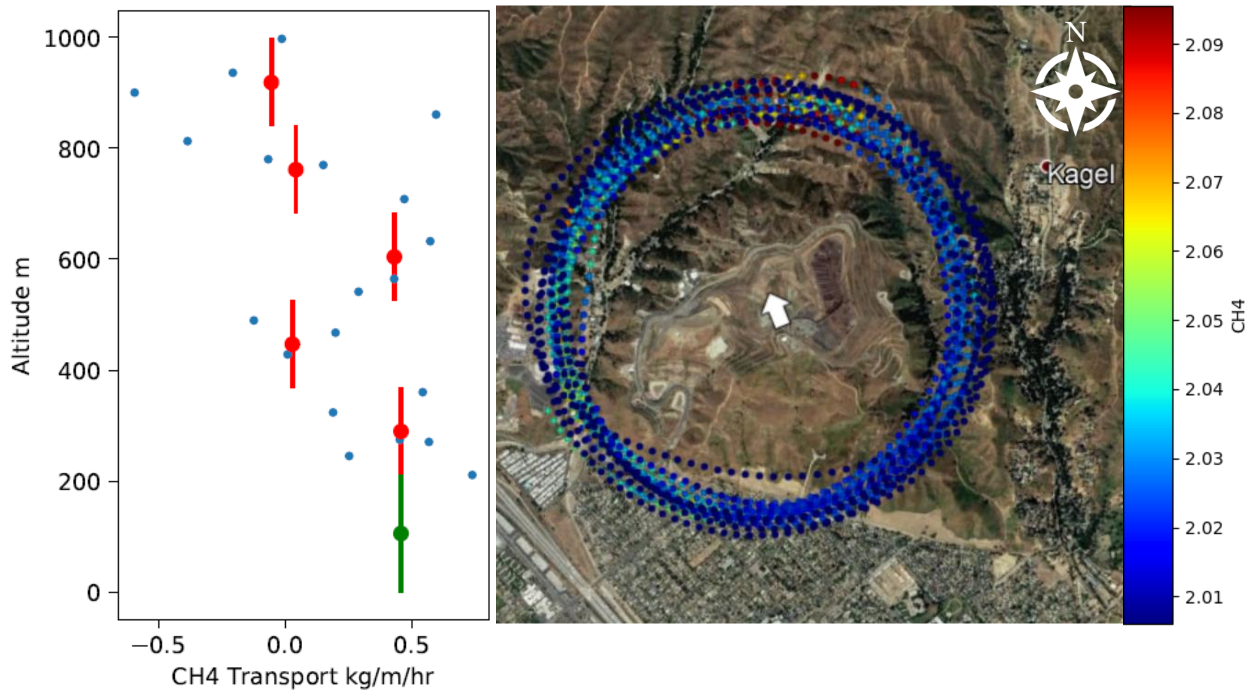

Figure 57. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

56. Lopez Canyon LF, 10-28-20

Laps were flown between 136 and 349 m agl. A methane emission of 386 ± 94 kg h^{-1} was calculated. A small amount of ethane was observed (4.5 ± 3.0 kg h^{-1}) but estimates of < 10 kg h^{-1} should be treated with caution.

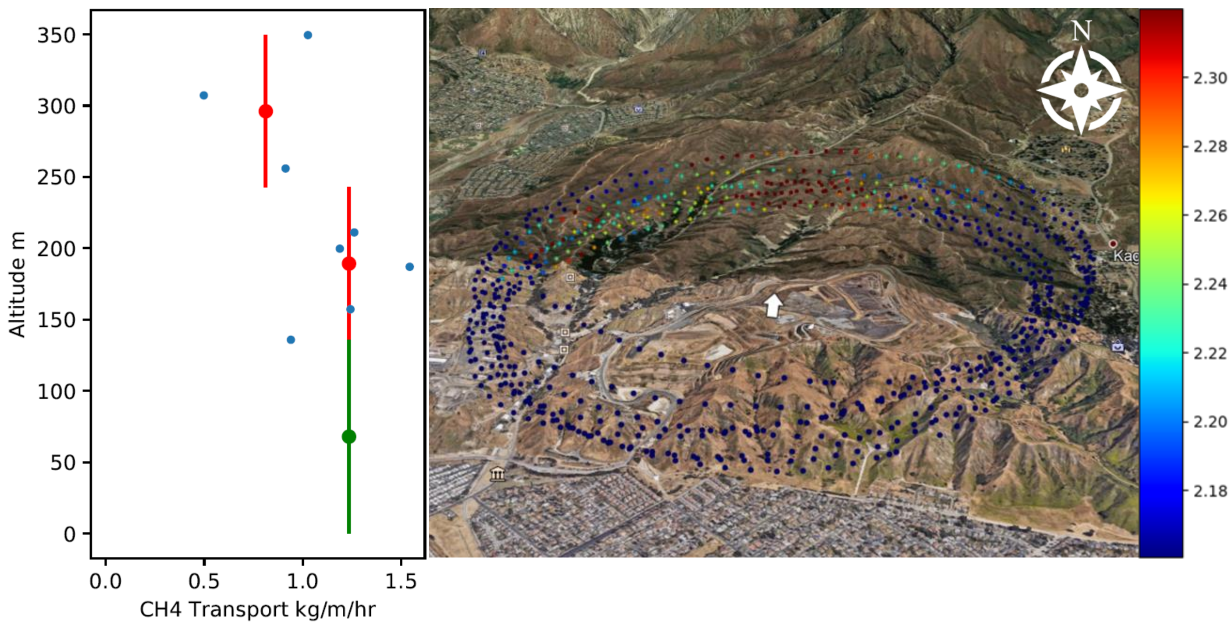

Figure 58. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

57. MidValley LF, 07-15-20

Laps were flown between 173 and 638 m agl. A methane emission of 337 ± 217 kg h^{-1} was calculated.

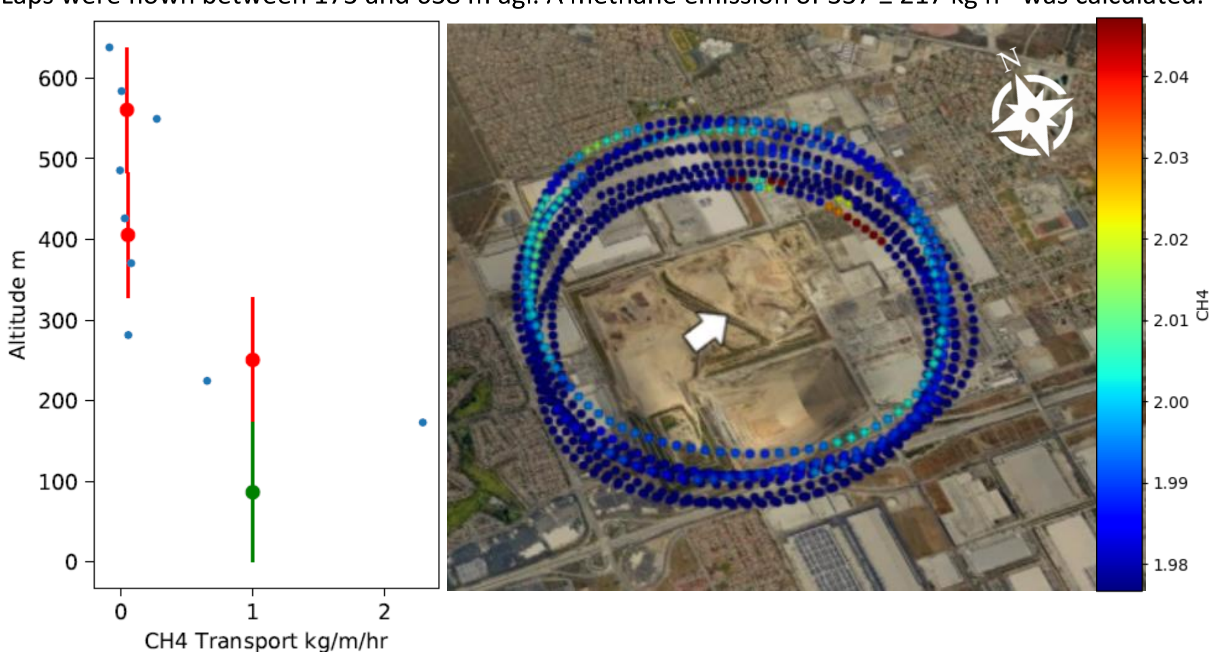

Figure 59. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

58. Miramar LF, 05-19-20

Laps were flown around the Miramar landfill between 214 and 756 m above ground level (agl) and a methane emission of 1127 ± 371 kg h^{-1} was calculated. This is likely a slight underestimate because the plot of CH_4 transport shows that the aircraft may not have fully captured the top of the emissions plume.

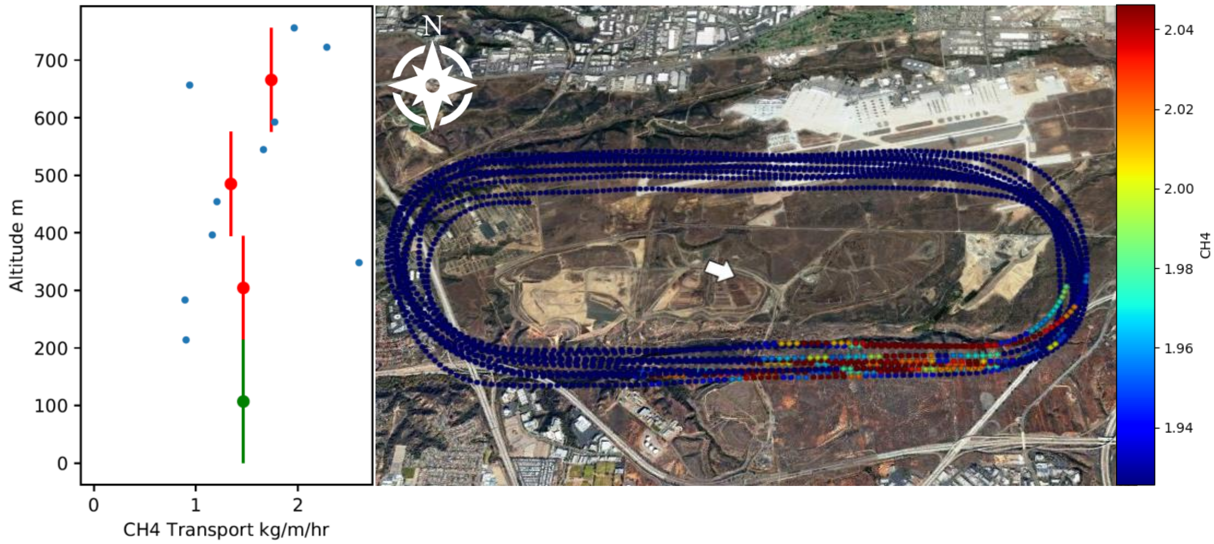

Figure 60. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

59. Miramar LF, 05-20-20

Miramar land fill was flown a second time to capture the entire plume, and the calculated methane emissions were 1564 ± 354 kg h^{-1}.

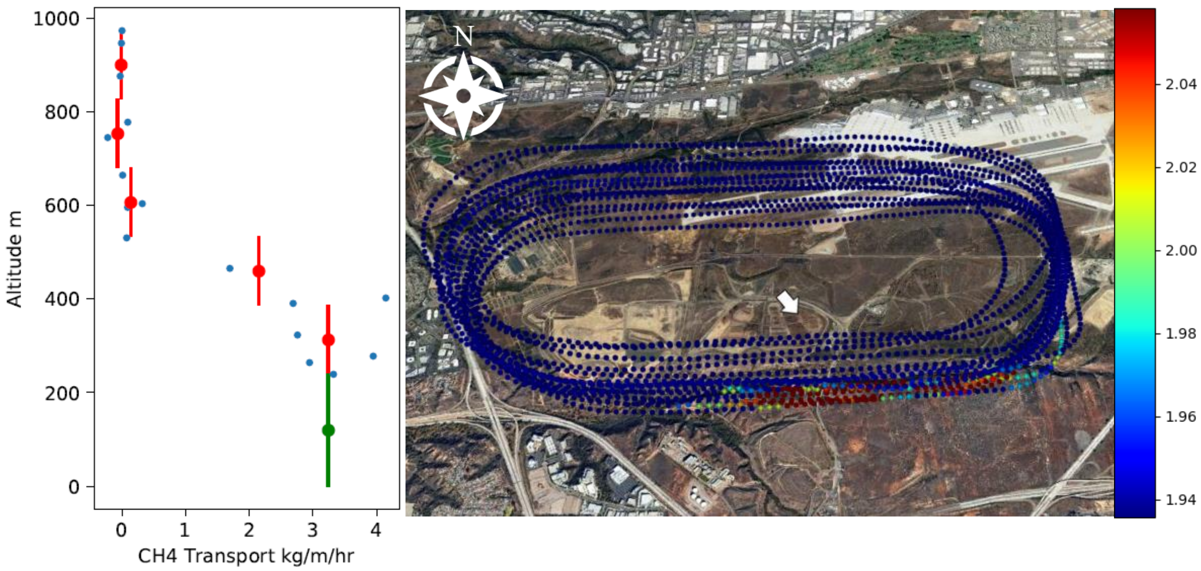

Figure 61. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

60. Monterey Peninsula LF, 10-30-20

Laps were flown between 77 and 271 m agl. A methane emission of 872 ± 248 kg h^{-1} was calculated. No significant ethane was observed.

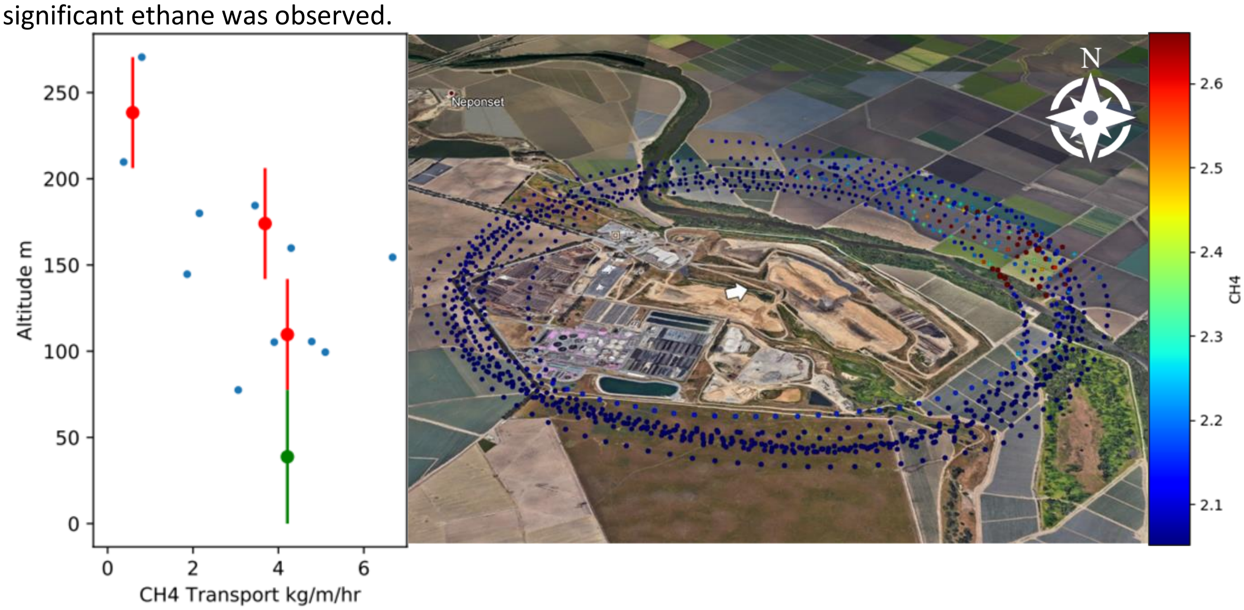

Figure 62. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

61. Monterey Peninsula LF, 02-17-21

Laps were flown between 73 and 327 m agl. A methane emission of 1294 ± 544 kg h^{-1} was calculated. No significant ethane was observed.

Figure 63. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

62. Napa Material Diversion Facility/LF, 10-31-20

Laps were flown between 60 and 137 m agl. A methane emission of 16 ± 20 kg h^{-1} was calculated. No significant ethane was observed.

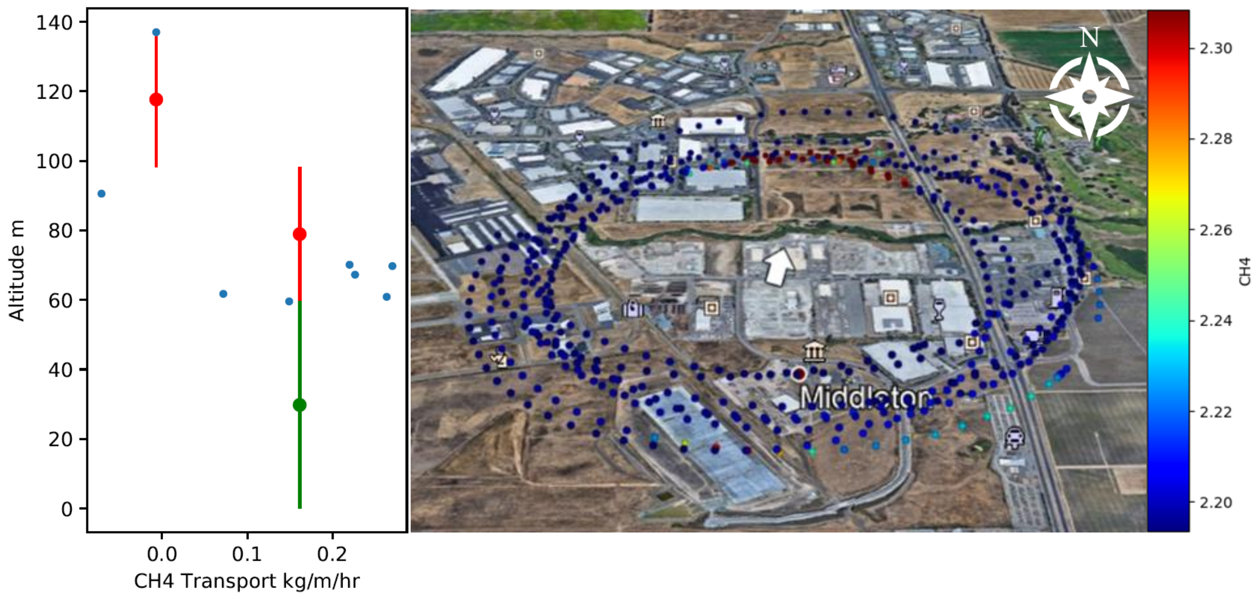

Figure 64. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

63. Newby Island LF, 04-22-20

The aircraft flew laps between 152 and 760 m agl and a methane emission of 1932 ± 741 kg h^{-1} was calculated.

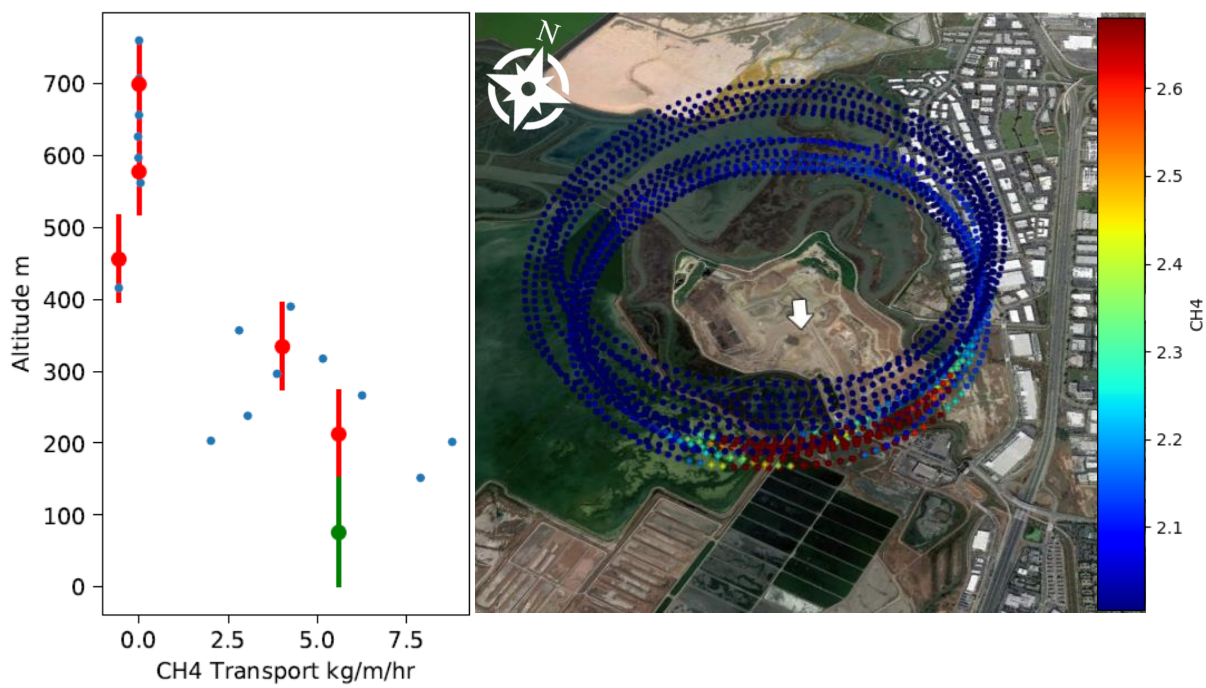

Figure 65. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

64. Newby Island LF, 10-31-20

Laps were flown between 72 and 430 m agl. A methane emission of 2088 ± 525 kg h^{-1} was calculated. A small ethane emission of 5.7 ± 3.0 kg h^{-1} was calculated.

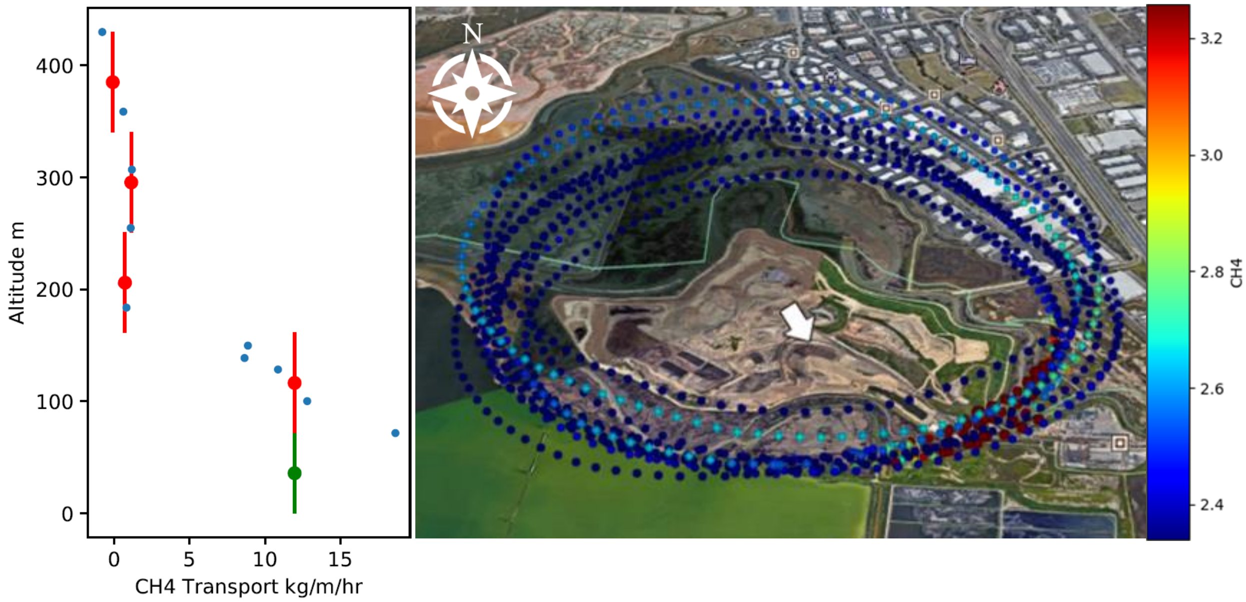

Figure 66. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

65. Newby Island LF, 02-17-21

Laps were flown between 89 and 576 m agl. A methane emission of 2412 ± 608 kg h^{-1} was calculated. No significant ethane was observed.

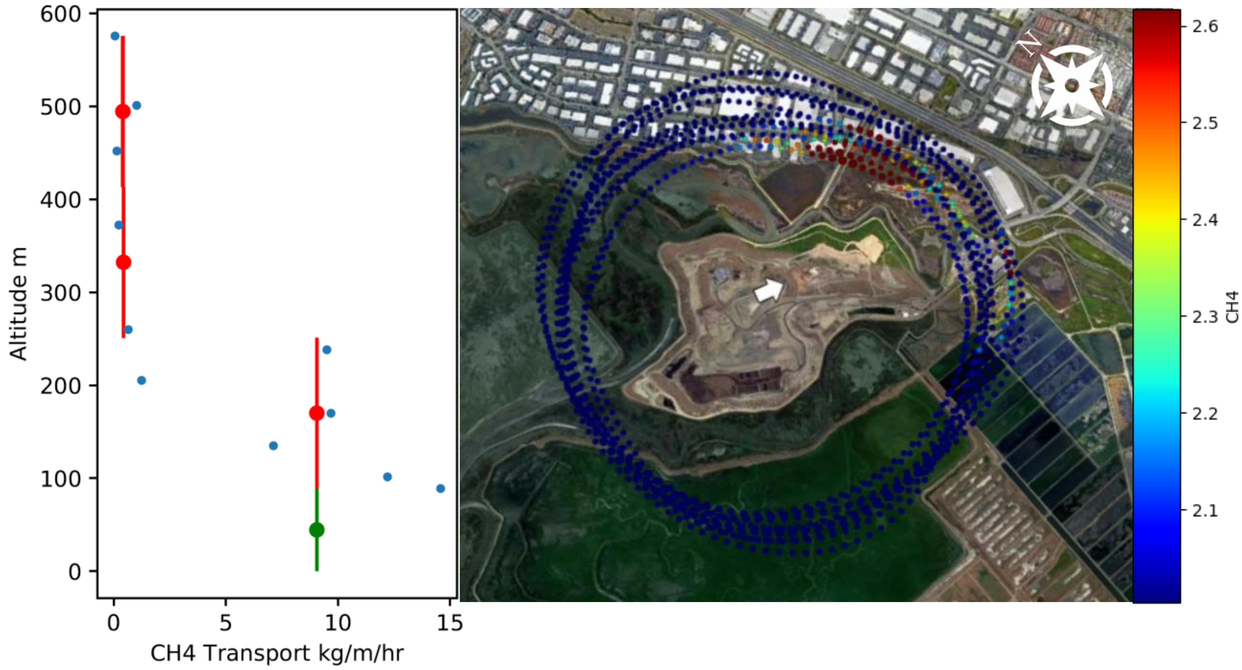

Figure 67. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

66. North County LF, 11-21-19

Laps were flown between 113 and 480 m agl. A methane emission of 259 ± 110 kg h^{-1} was calculated.

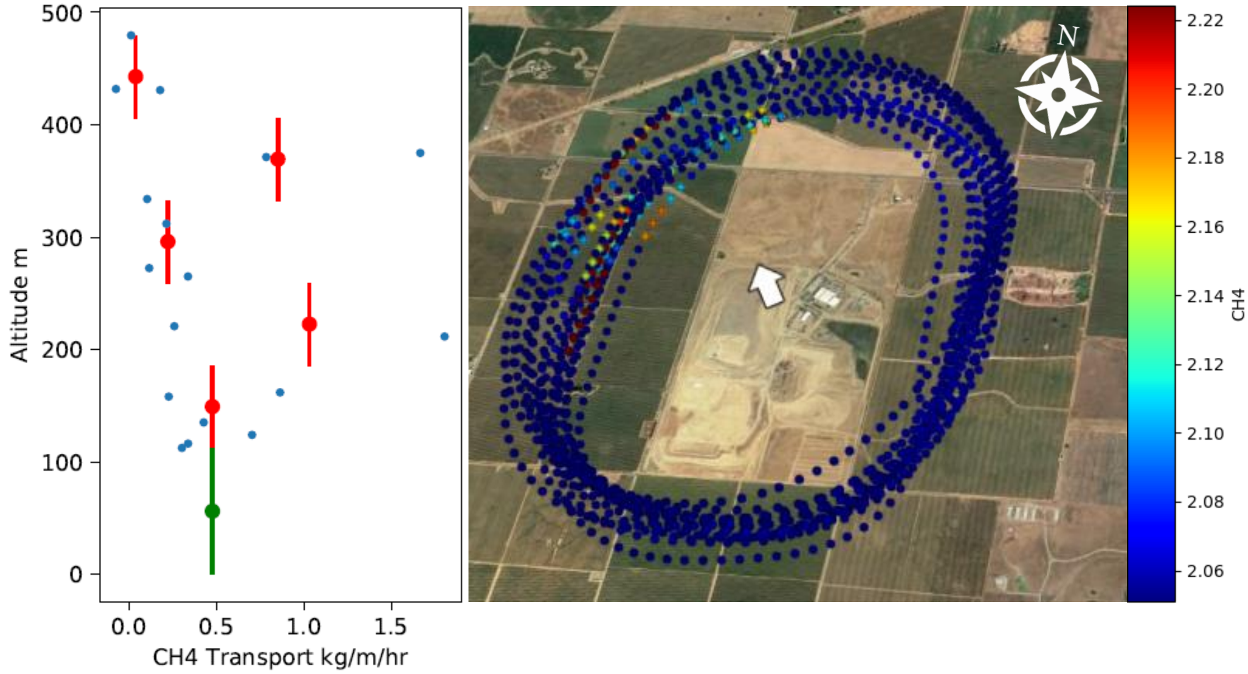

Figure 68. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

67. North County LF, 04-10-20

Laps were flown between 166 and 870 m agl and a methane emission of 530 ± 216 kg h^{-1} was calculated.

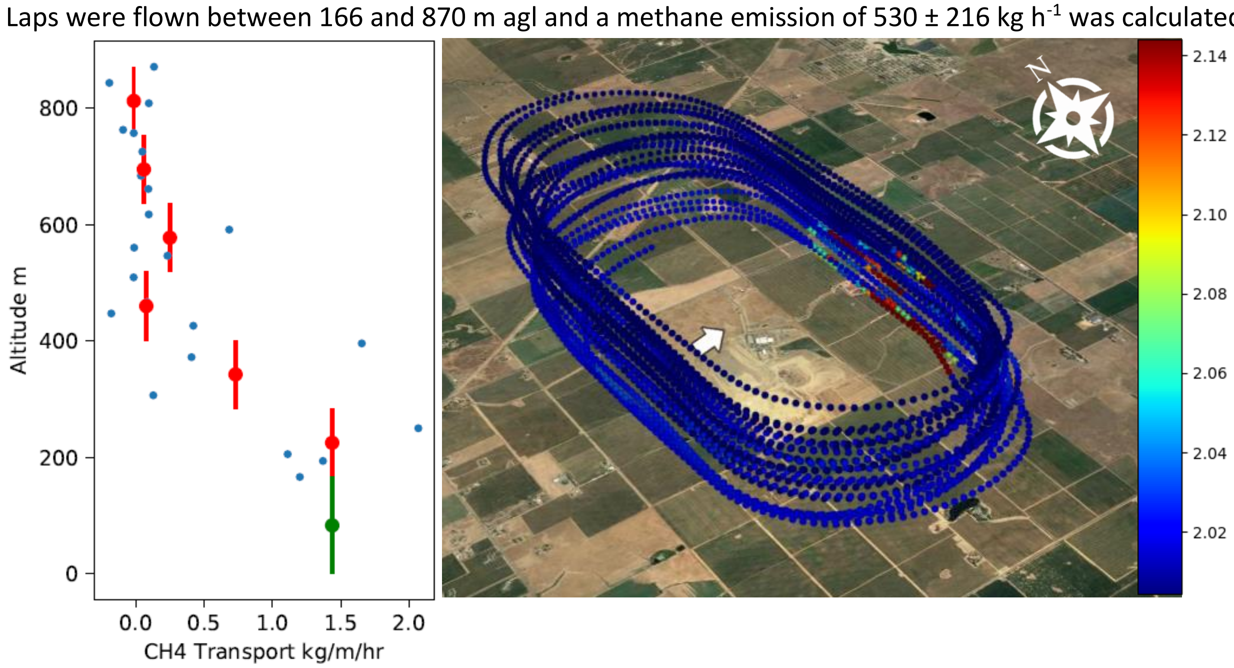

Figure 69. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

68. North County LF, 10-08-20

Laps were flown between 77 and 562 m agl. A methane emission of 381 ± 134 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

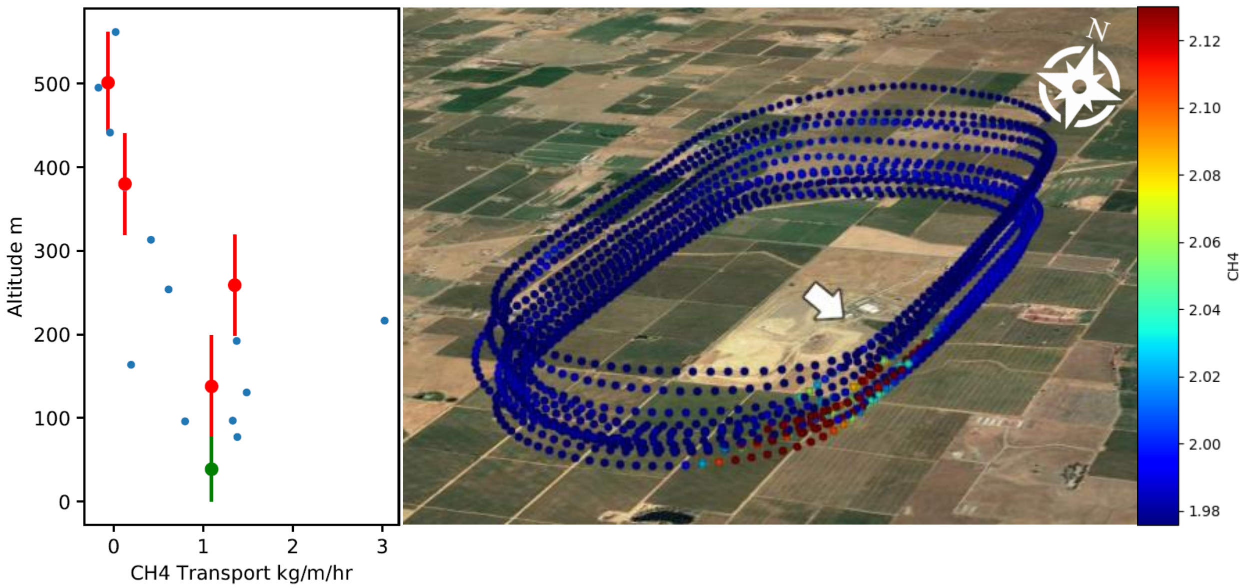

Figure 70. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

69. Northern Recycling Compost/LF, 11-02-20

Laps were flown between 64 and 405 m agl. A methane emission of 33 ± 12 kg h^{-1} was calculated. No significant ethane was observed.

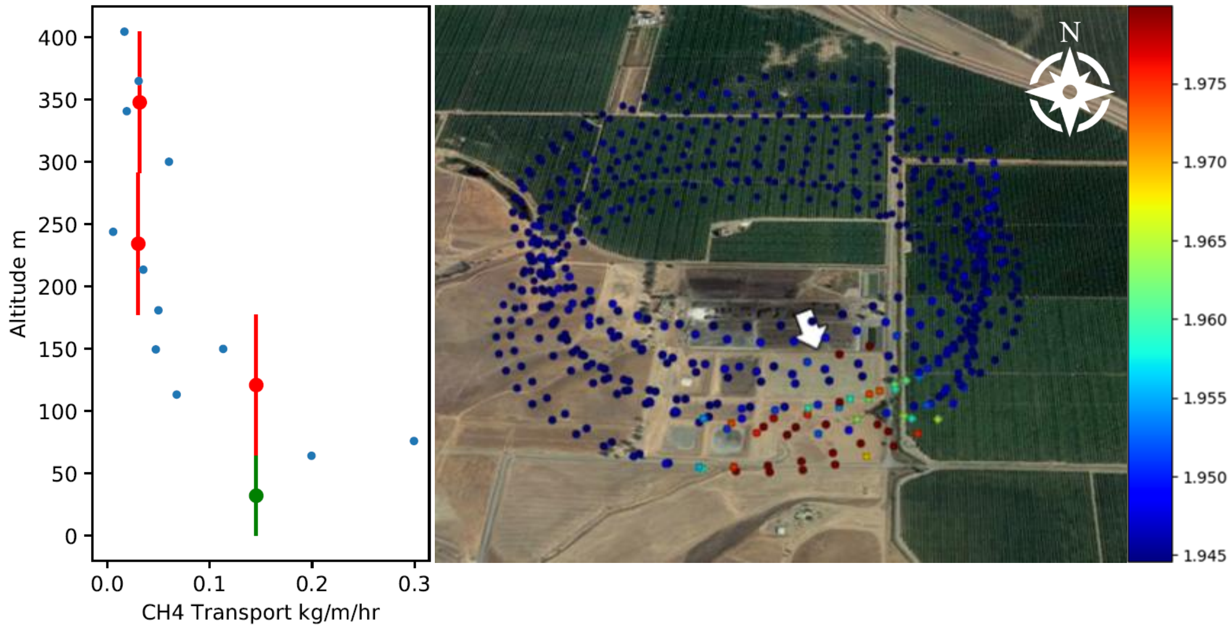

Figure 71. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

70. Novato Redwood LF, 11-22-19

During the measurement, there was significant wireless interference that caused the data acquisition system to drop data. Therefore, the measurement had to be aborted.

Figure 72. Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction. The data drop out due to interference is apparent on the southeast side of the flight path.

71. Olinda Alpha LF, 11-19-19

Laps were flown between 190 and 398 m agl. A methane emission of 679 ± 542 kg h^{-1} was calculated.

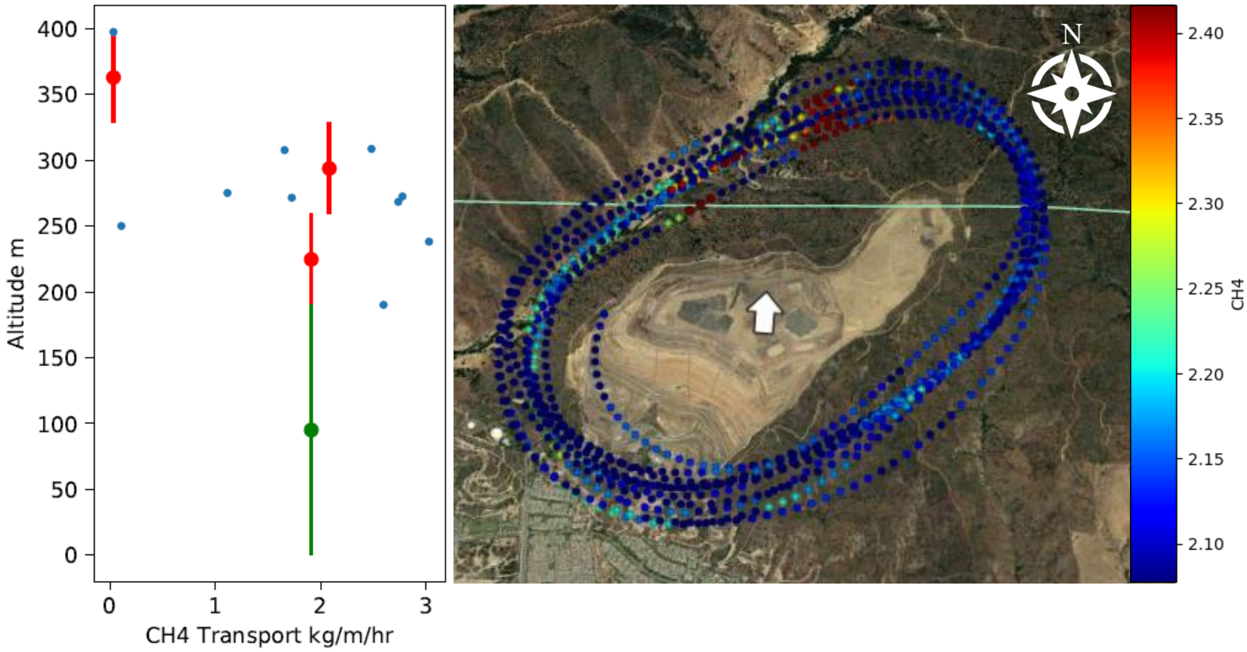

Figure 73. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

72. Olinda Alpha LF, 01-14-20

The aircraft flew 17 circles around the Olinda Alpha Landfill at altitudes between 298 m agl and 599 m agl. Winds were out of the west, averaging 1.5 m s^{-1}. Total methane emission is estimated at 521.6 ± 399.7 kg h^{-1}.

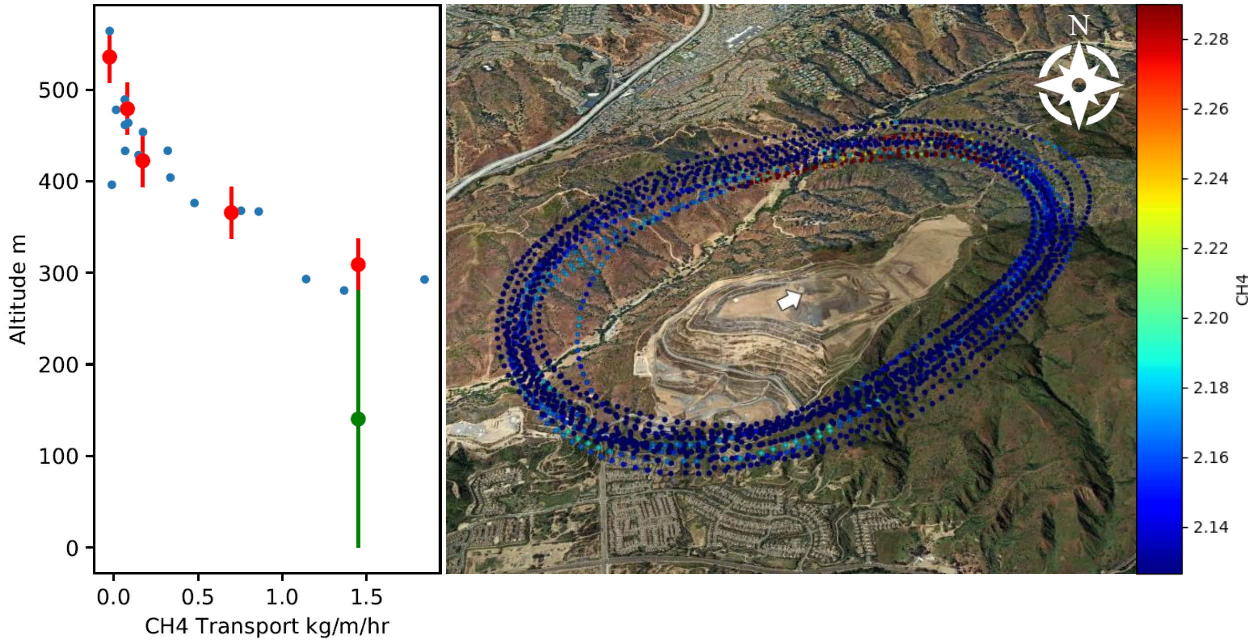

Figure 74. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

73. Olinda Alpha LF, 05-20-20

Laps were flow between 265 and 948 m agl, and the calculated methane emission was 1325 ± 393 kg h^{-1}.

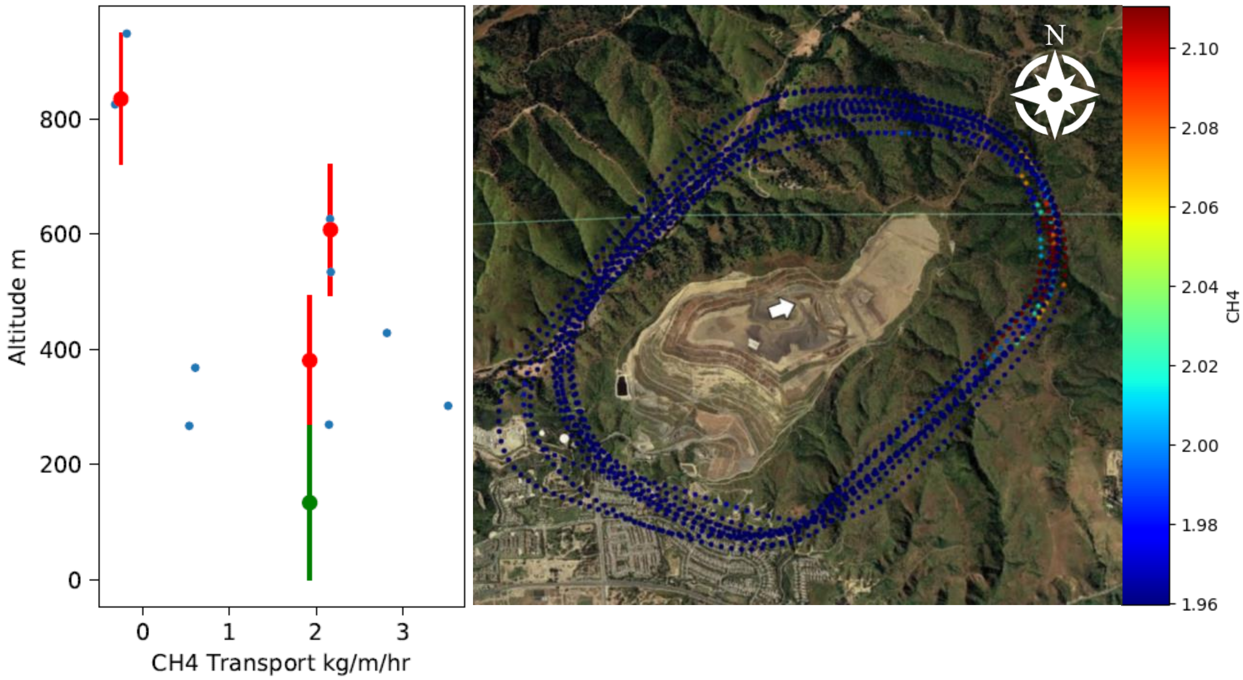

Figure 75. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

74. Olinda Alpha LF, 07-16-20

Laps were flown between 208 and 594 m agl. A methane emission of 986 ± 200 kg h^{-1} was calculated.

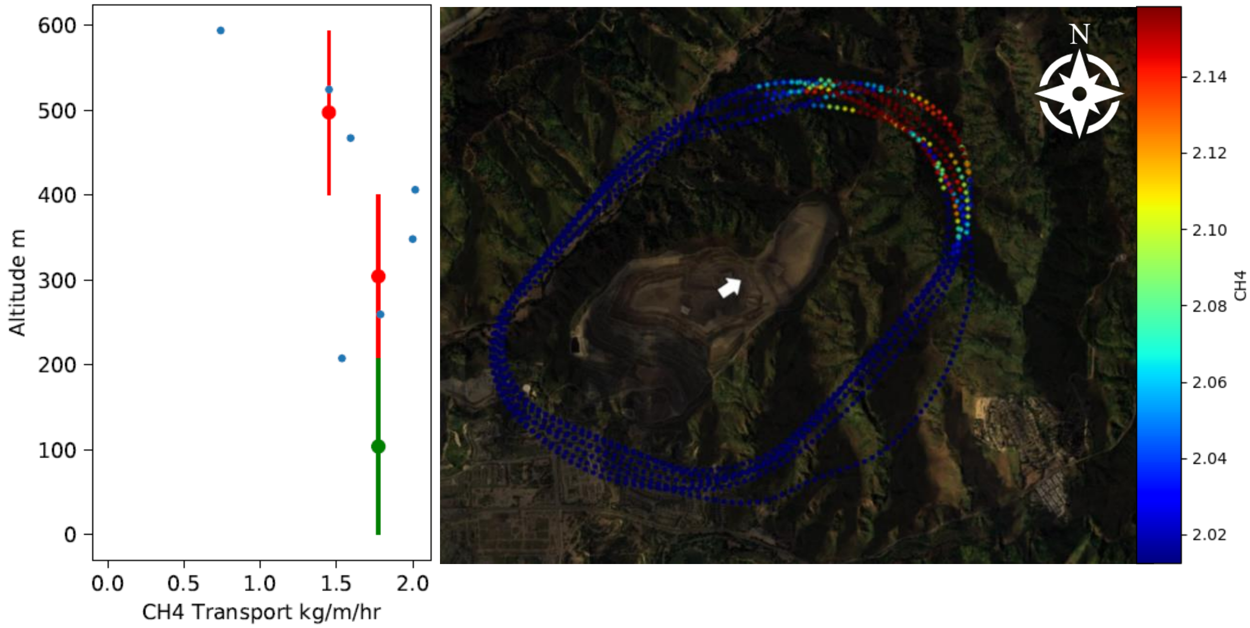

Figure 76. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

75. Ostrom Rd LF, 05-07-20

The aircraft flew laps between 210 and 866 m agl and a methane emission of 531 ± 266 kg h^{-1} was calculated.

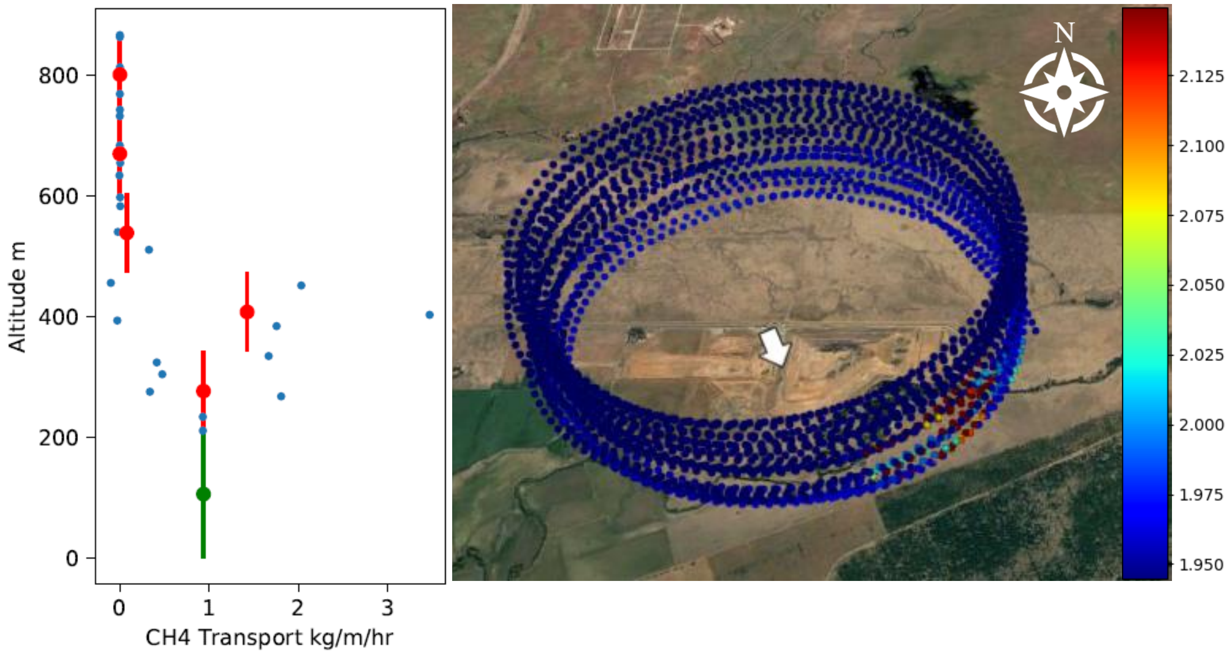

Figure 77. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

76. Ostrom Rd LF, 11-02-20

Laps were flown between 80 and 435 m agl. A methane emission of 1148 ± 483 kg h^{-1} was calculated. No significant ethane was observed.

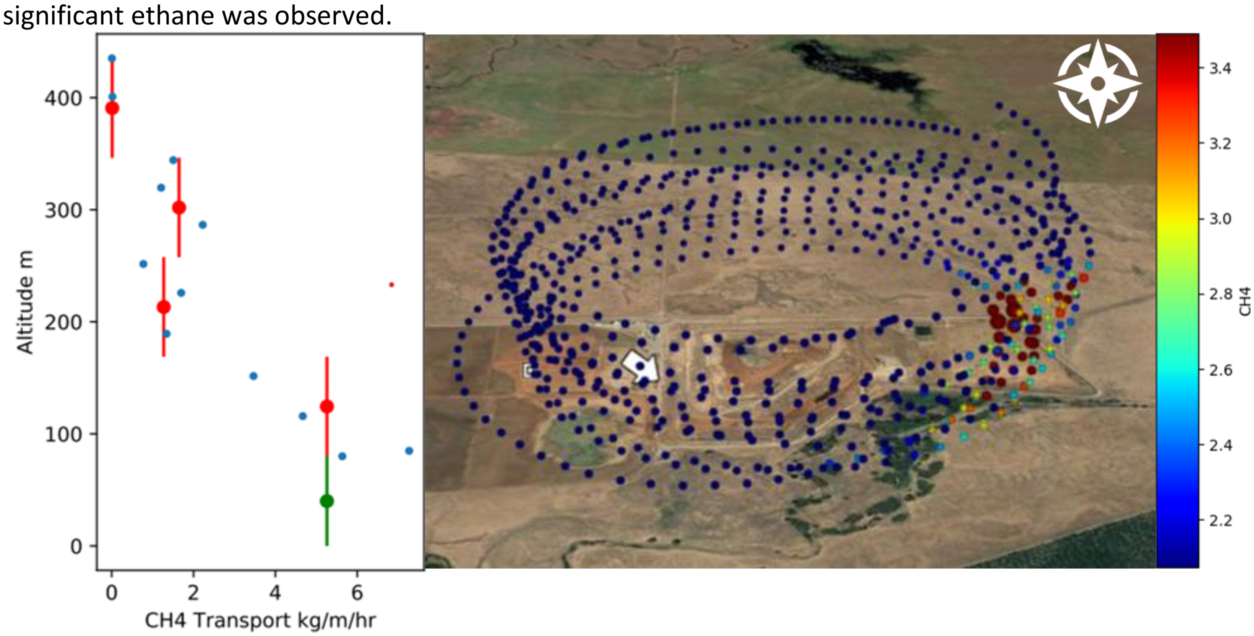

Figure 78. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

77. Otay LF, 05-20-20

Laps were flown at Otay landfill between 218 and 839 m agl, however, an upwind methane source (or sources) precluded a meaningful estimate of methane emissions from this site. The calculated methane emission value was -80 ± 130 kg h^{-1}, but we assign emissions from this site as below the detection limit under the given conditions.

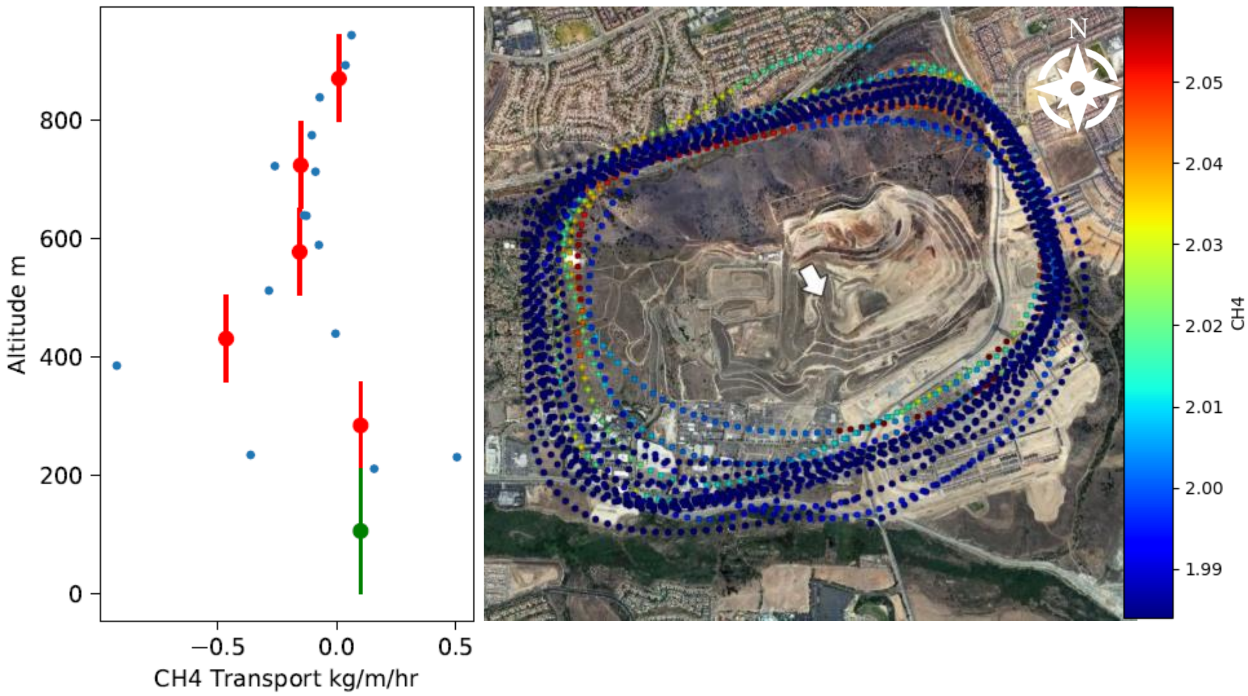

Figure 79. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

78. Ox Mountain LF, 11-23-19

Laps were flown between 267 and 570 m agl. A methane emission of 965 ± 965 kg h^{-1} was calculated.

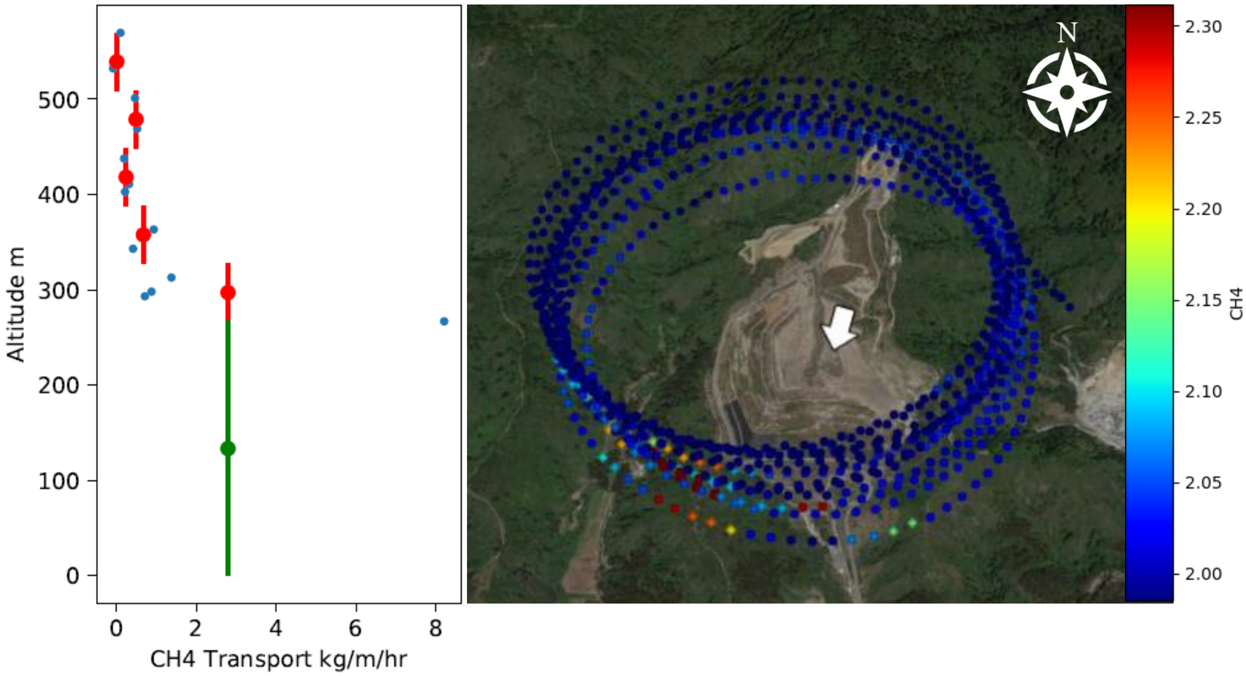

Figure 80. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

79. Ox Mountain LF, 04-22-20

The aircraft flew laps between 360 and 853 m agl and a methane emission of 1689 ± 1141 kg h^{-1} was calculated.

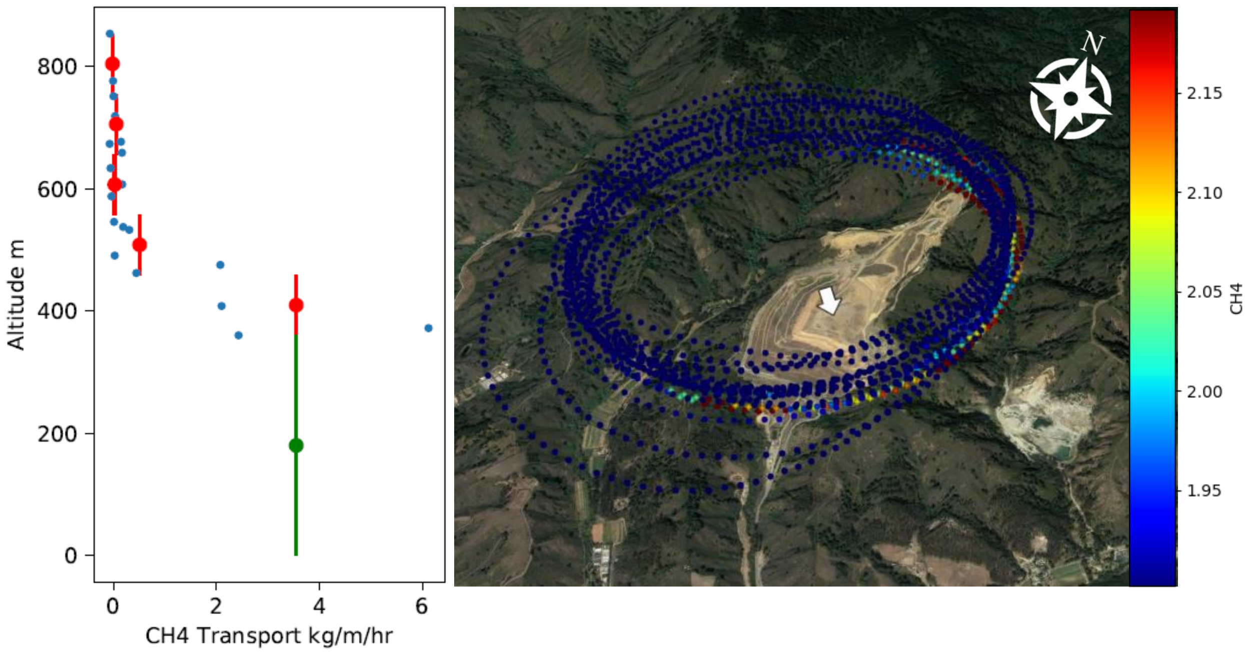

Figure 81. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

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80. Ox Mountain LF, 07-27-20

Laps were flown between 332 and 669 m agl. The highly variable elevation of the terrain where the Ox Mountain site is located raises the lowest safe flight altitude above 500 ft (~150 m). A methane emission of 43 ± 25 kg h^{-1} was calculated.

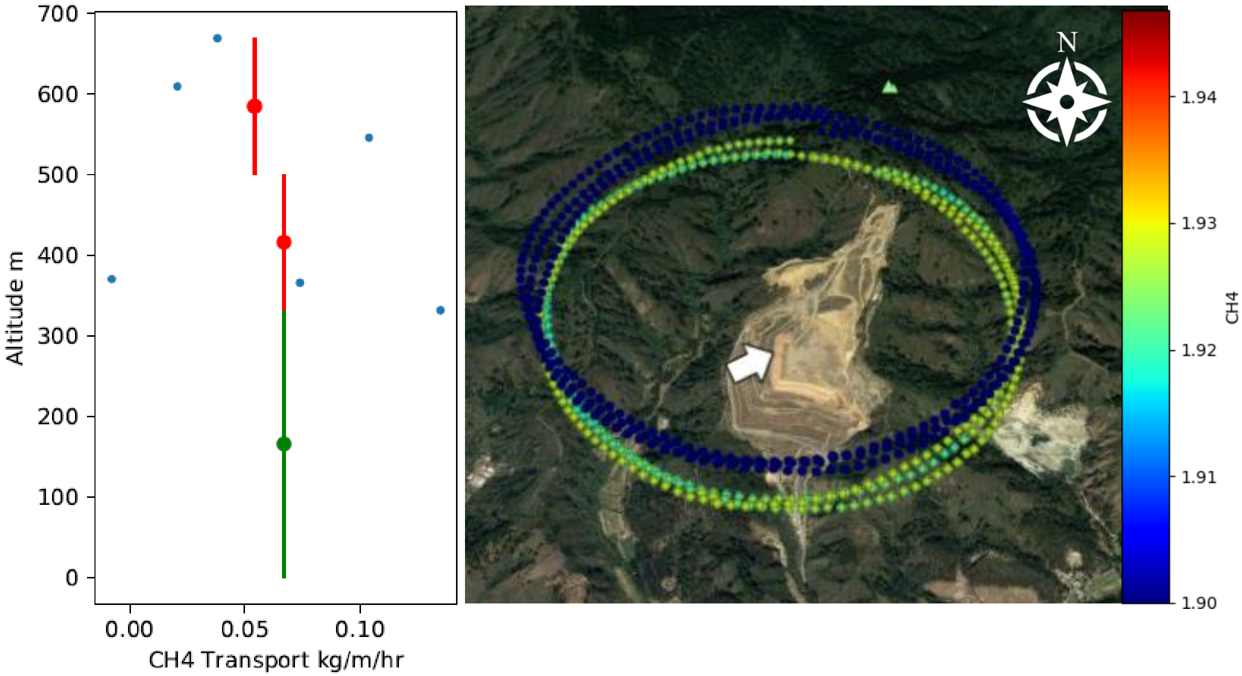

Figure 82. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

81. Ox Mountain LF, 10-31-20

Laps were flown between 142 and 503 m agl. A methane emission of 1808 ± 812 kg h^{-1} was calculated. No significant ethane was observed.

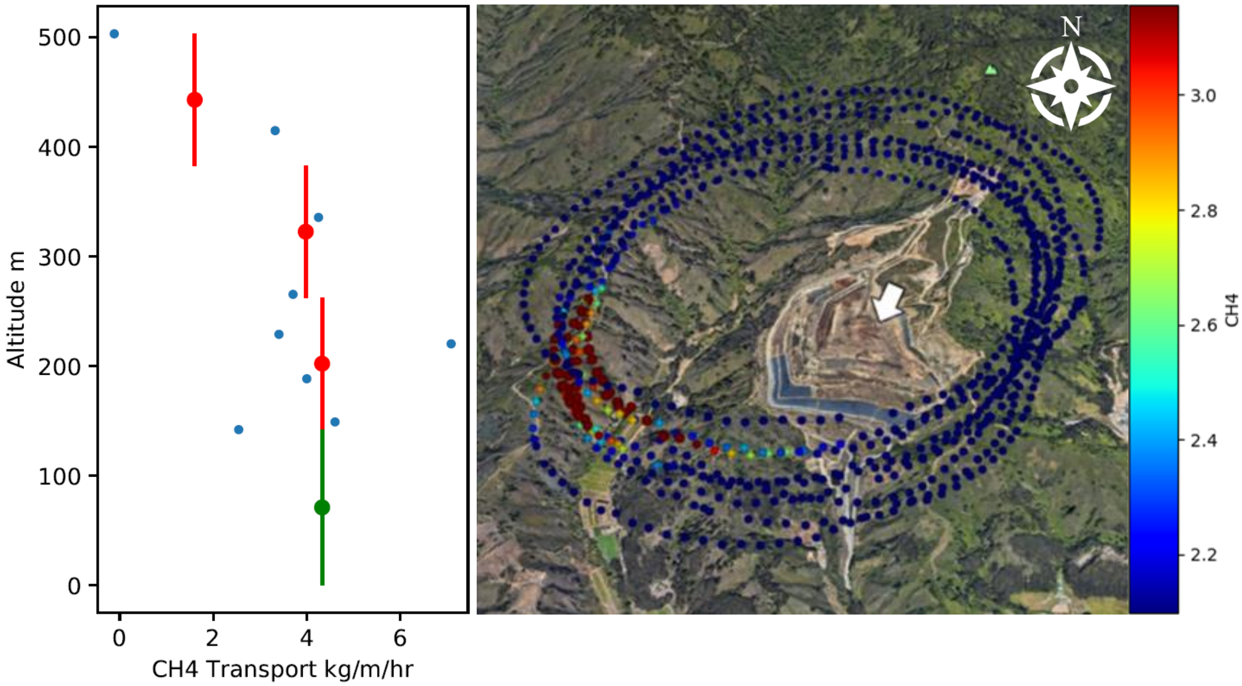

Figure 83. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

82. Ox Mountain LF, 02-26-21

Laps were flown between 301 and 709 m agl; however, most of the laps flown were eliminated due to low (< 0.5 m s^{-1}) winds with inconsistent directions. The remaining laps do not capture the emissions plume. The methane emission obtained, 10 ± 1226 kg h^{-1}, is not representative of the real emissions.

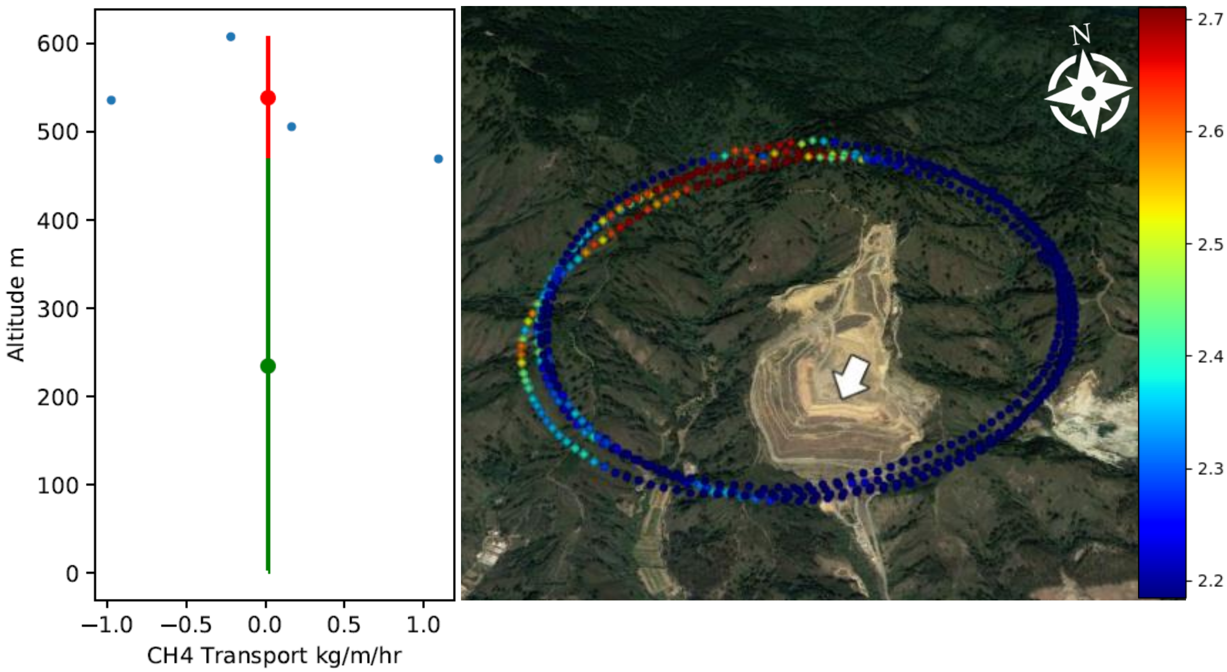

Figure 84. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

83. Potrero Hills LF, 04-15-20

The aircraft flew laps between 169 and 925 m agl and a methane emission of 2116 ± 601 kg h^{-1} was calculated.

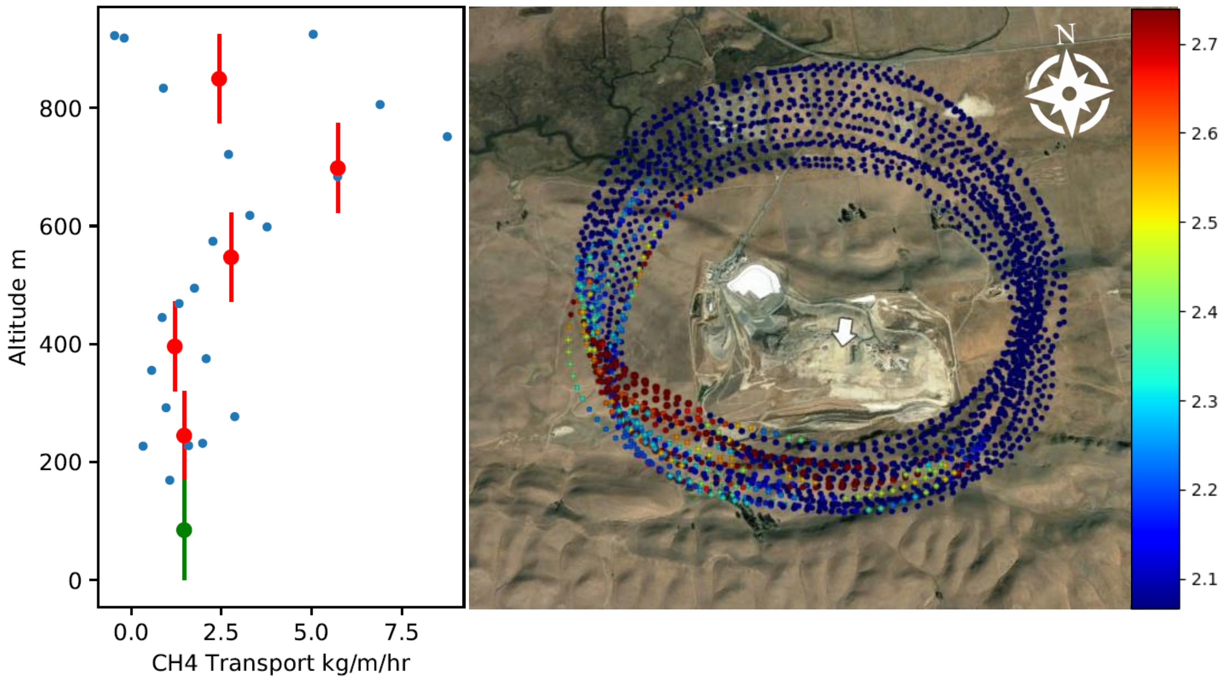

Figure 85. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

84. Potrero Hills LF, 10-09-20

Laps were flown between 85 and 563 m agl. A methane emission of 946 ± 332 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

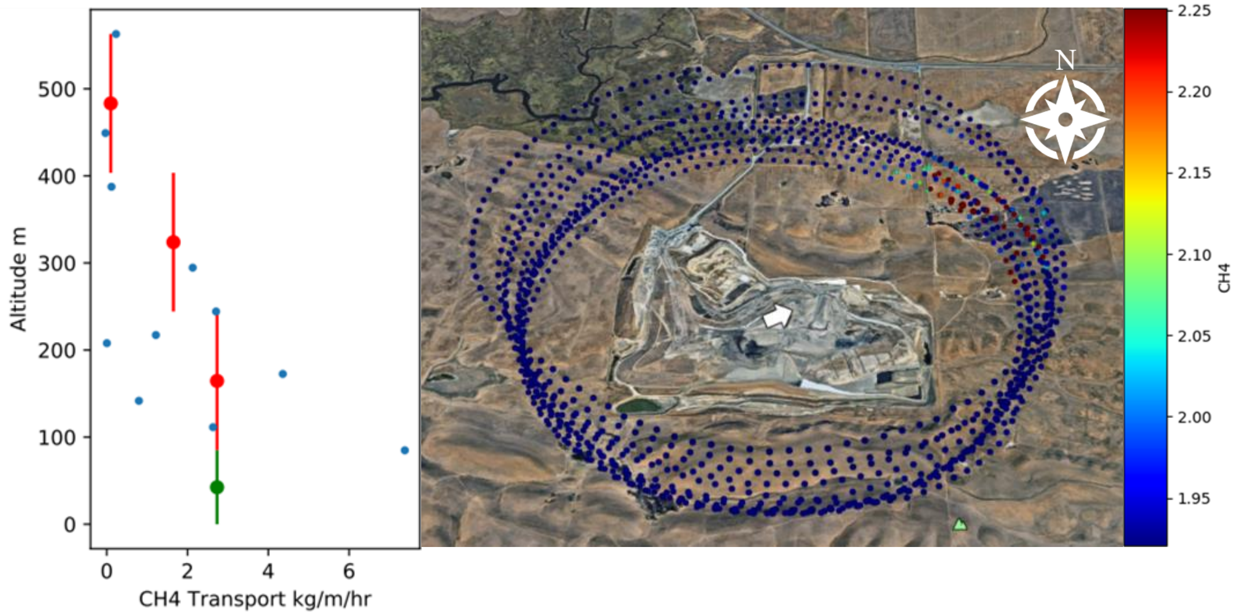

Figure 86. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

85. Potrero Hills LF, 02-26-21

Laps were flown between 124 and 441 m agl and the methane emissions were 997 ± 275 kg h^{-1}.

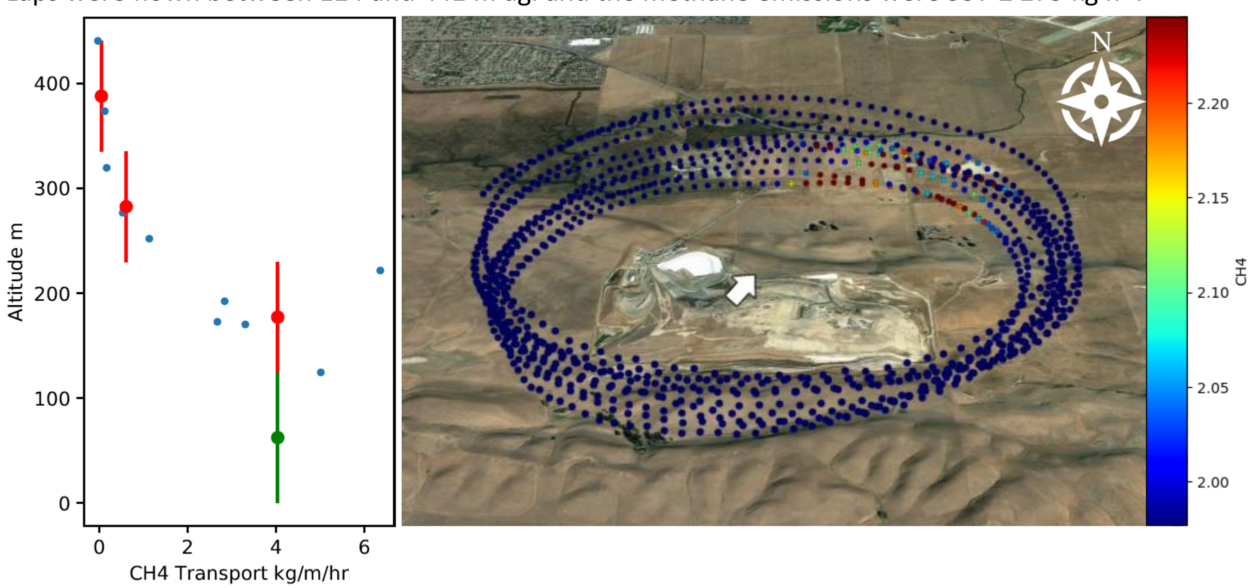

Figure 87. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

86. Puente Hills LF, 05-21-20

Laps were flown between 214 and 730 m agl, and the calculate methane emission was 121 ± 56 kg h^{-1}.

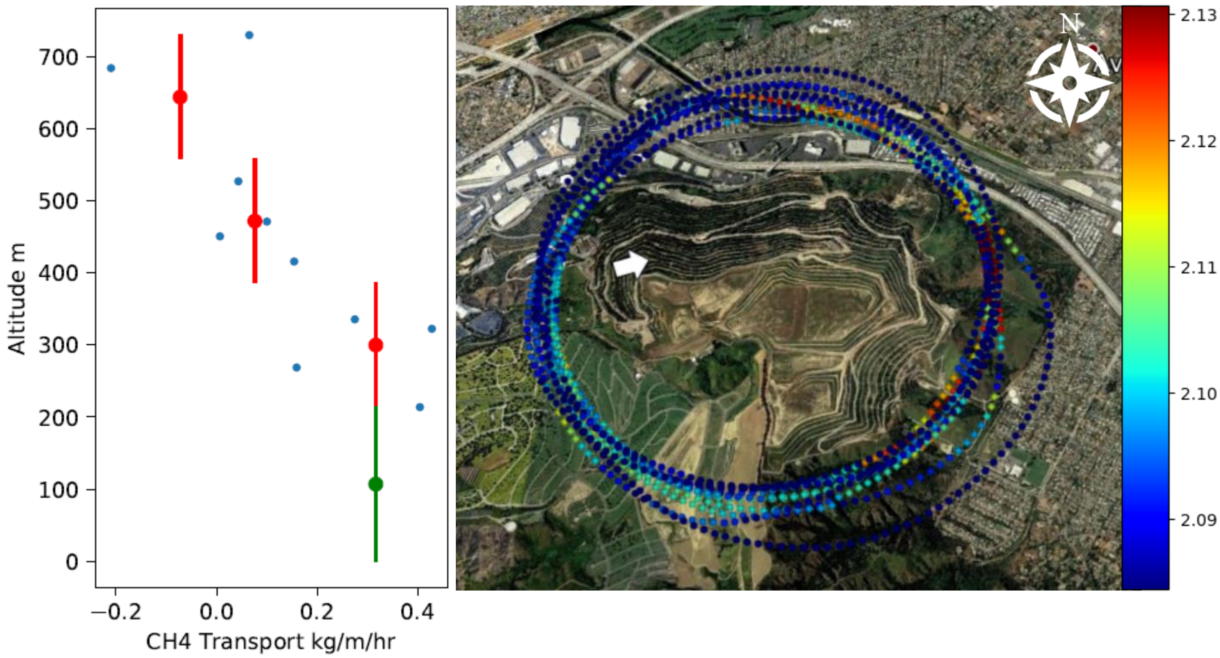

Figure 88. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

87. Puente Hills LF, 07-17-20

Laps were flown between 228 and 429 m agl. The highly variable elevation of the terrain where the site is located raises the lowest safe flight altitude above 500 ft (~150 m). Methane emissions appear to be below our detection limit of 10 kg h^{-1} (measured as 1 ± 37 kg h^{-1}) but this is likely an underestimate because of the absence of flight laps below ~200 m agl.

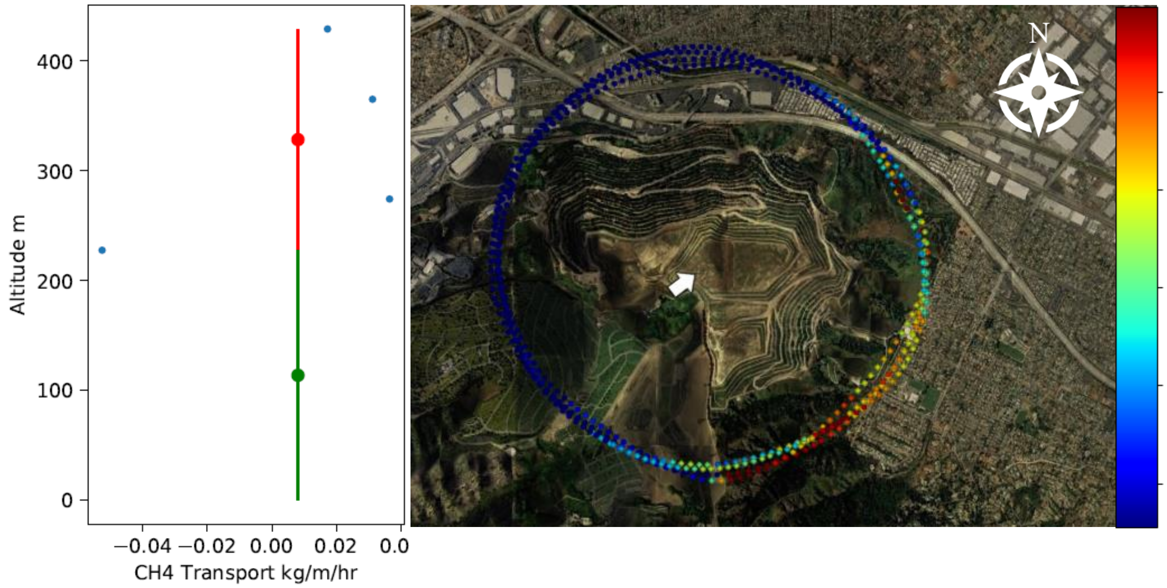

Figure 89. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

88. Puente Hills LF, 10-28-20

Laps were flown between 162 and 606 m agl. A methane emission of 188 ± 61 kg h^{-1} was calculated. No significant ethane emission was observed.

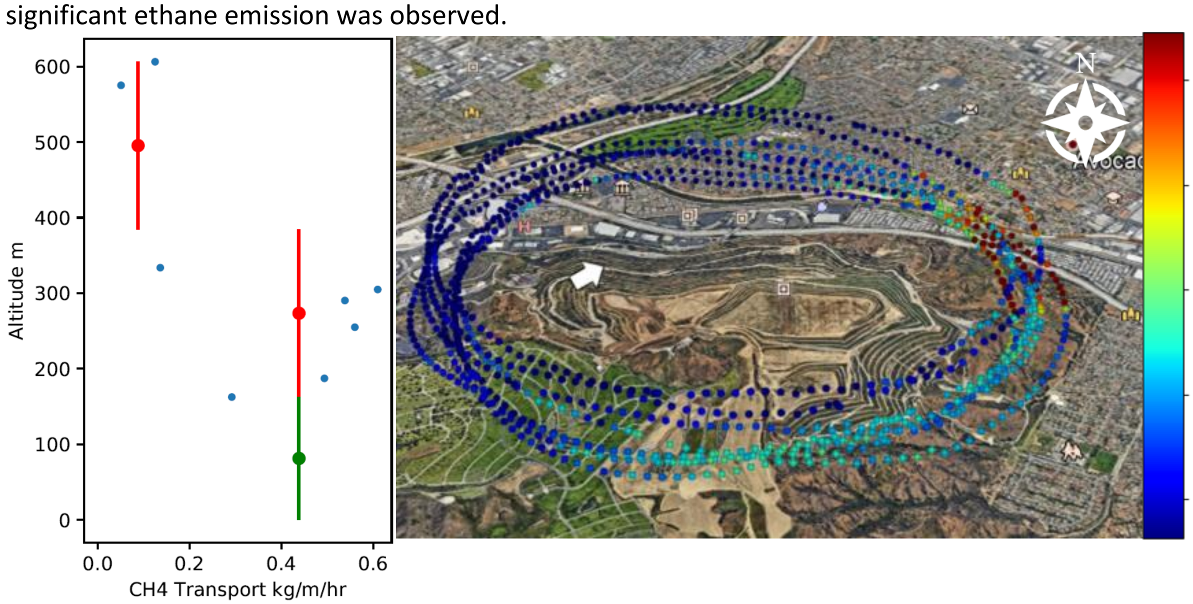

Figure 90. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

89. Redwood LF, 04-15-20

The aircraft flew laps between 174 and 645 m agl and a methane emission of 348 ± 108 kg h^{-1} was calculated.

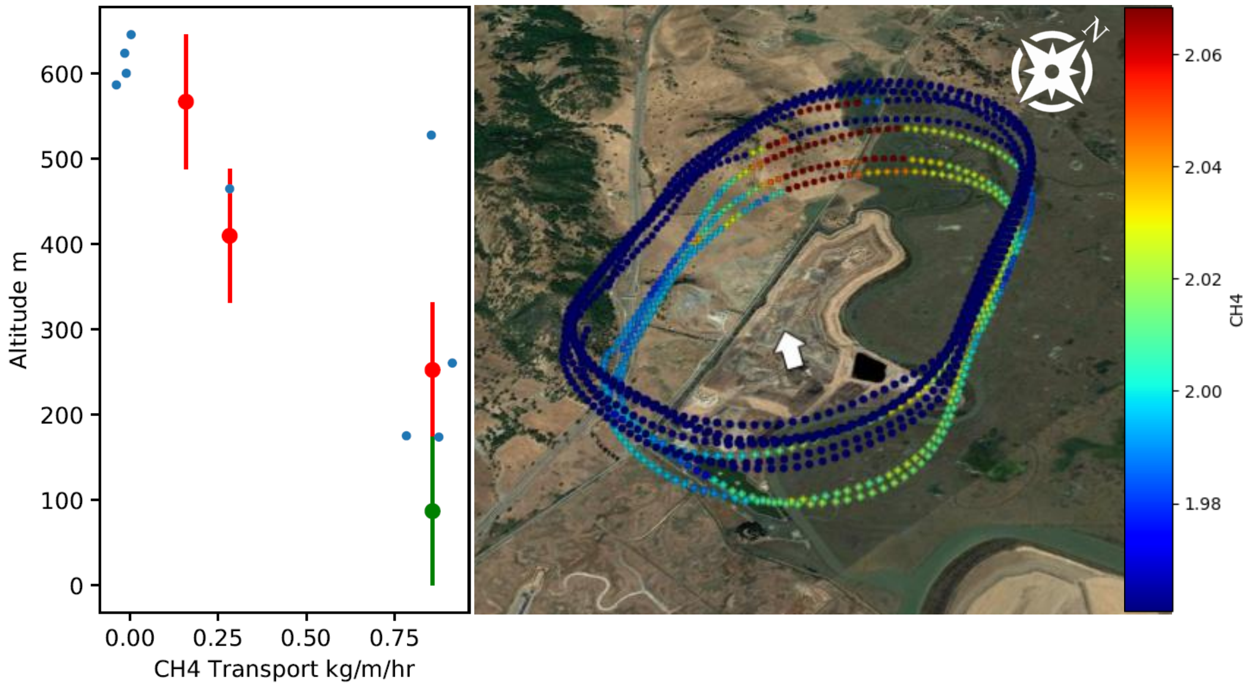

Figure 91. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

90. Redwood LF, 10-09-20

Laps were flown between 94 and 212 m agl. A methane emission of 113 ± 86 kg h^{-1} was calculated, but confidence in this number is very low due to the low and fluctuating winds (0.8 m s^{-1}). No significant ethane (C_2H_6) was measured at this site.

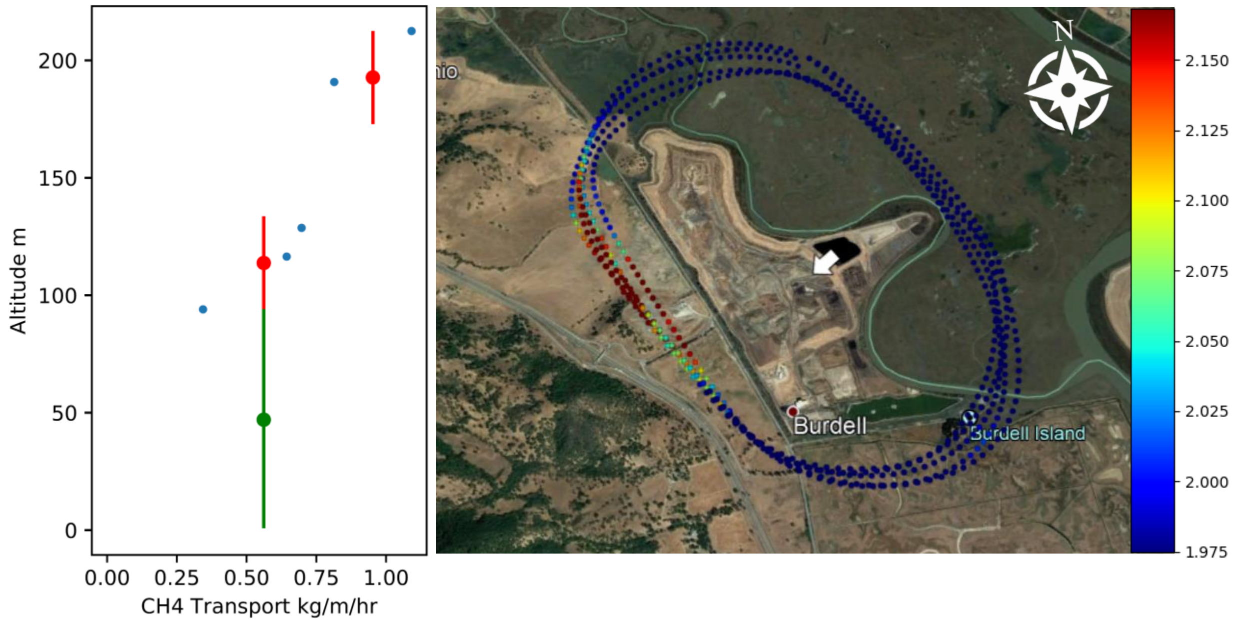

Figure 92. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

91. Redwood LF, 11-02-20

Laps were flown between 86 and 440 m agl. A methane emission of 440 ± 140 kg h^{-1} was calculated. No significant ethane was observed.

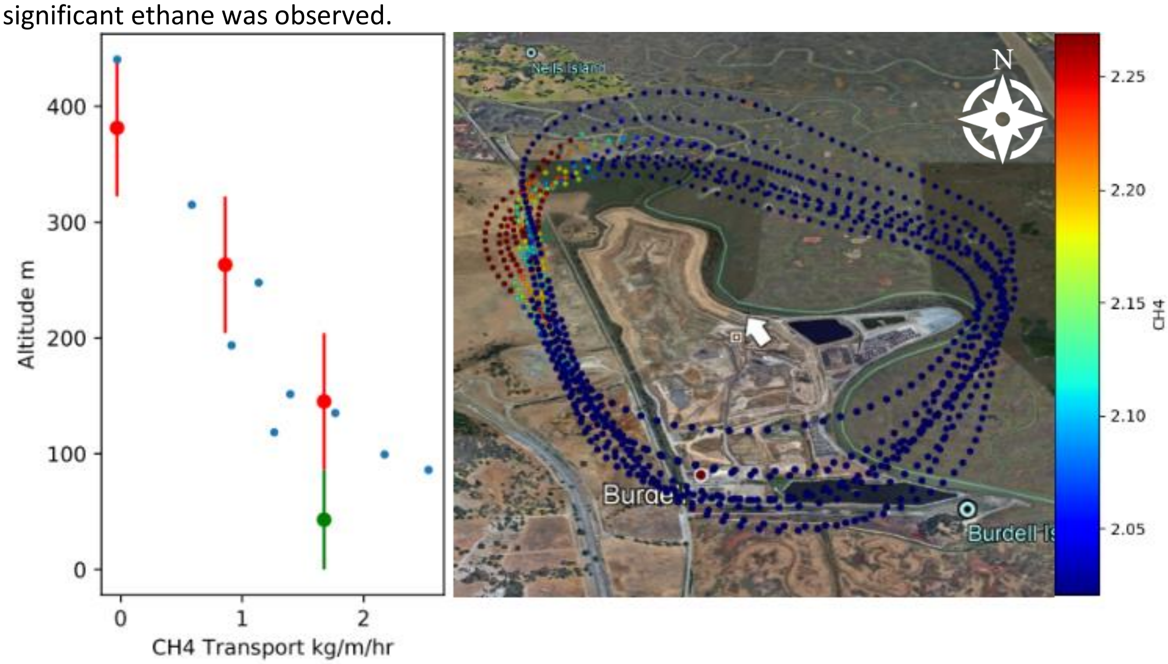

Figure 93. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

92. San Marcos, 05-20-20

Laps between 241 and 334 were flown at San Marcos landfill. Upwind methane sources were observed at the higher altitudes flown (>334) and were therefore eliminated. This estimate is likely an underestimate, as emissions could be present below the lowest flight altitude.

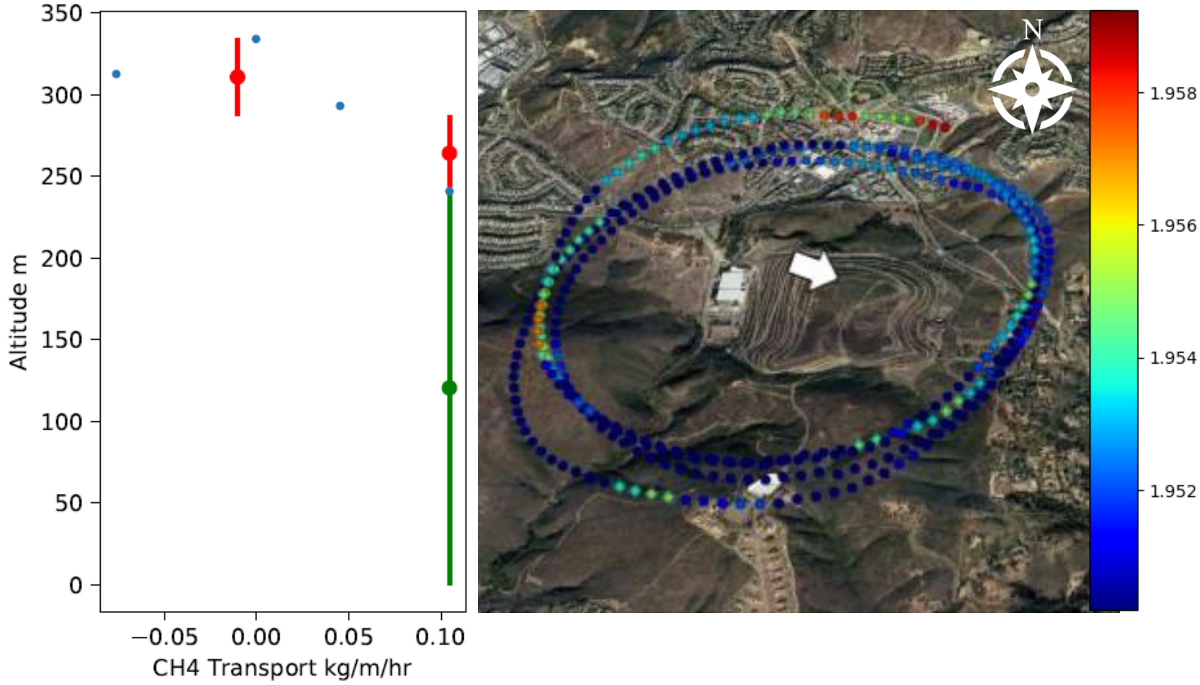

Figure 94. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

93. Scholl Canyon, 05-21-20

The aircraft flew laps between 213 and 969 m agl, and the calculated methane emission was 245 ± 86 kg h^{-1}.

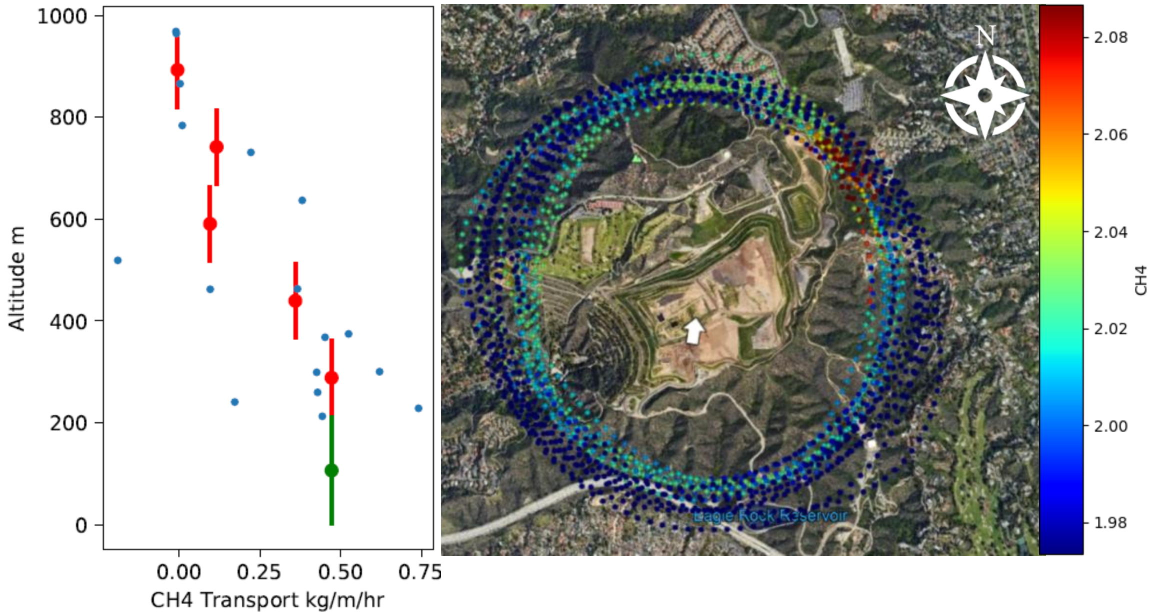

Figure 95. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

94. Scholl Canyon LF, 10-28-20

Laps were flown between 172 and 523 m agl. A methane emission of 338 ± 136 kg h^{-1} was calculated. A small amount of ethane was observed (5.2 ± 4.6 kg h^{-1}) but estimates of < 10 kg h^{-1} should be treated with caution.

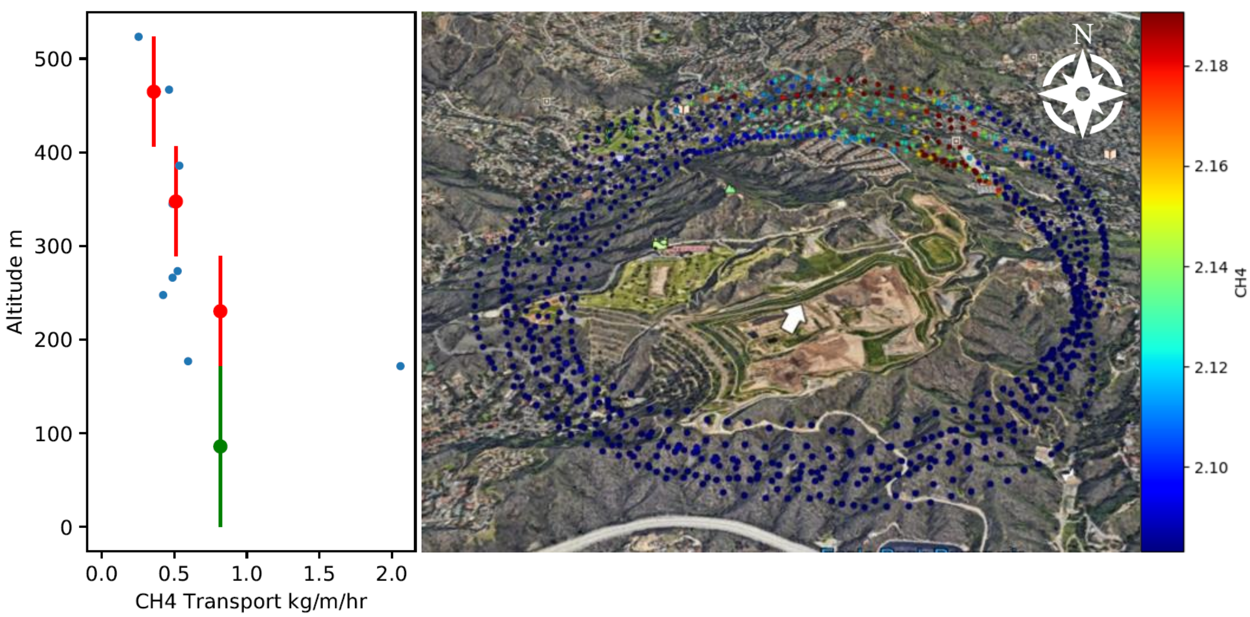

Figure 96. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

95. Shafter Wasco LF, 10-29-20

Laps were flown between 49 and 418 m agl. A methane emission of 285 ± 144 kg h^{-1} was calculated. No significant ethane was observed.

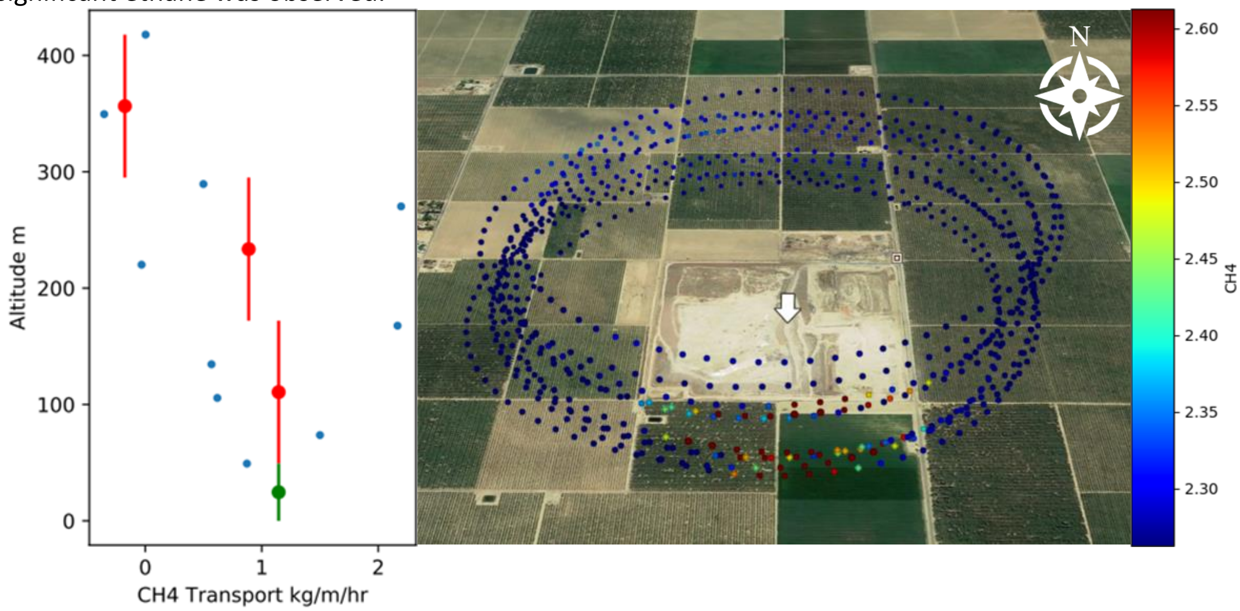

Figure 97. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

96. Simi Valley LF, 11-18-19

Laps were flown between 212 and 645 m agl. A methane emission of 1284 ± 617 kg h^{-1} was calculated.

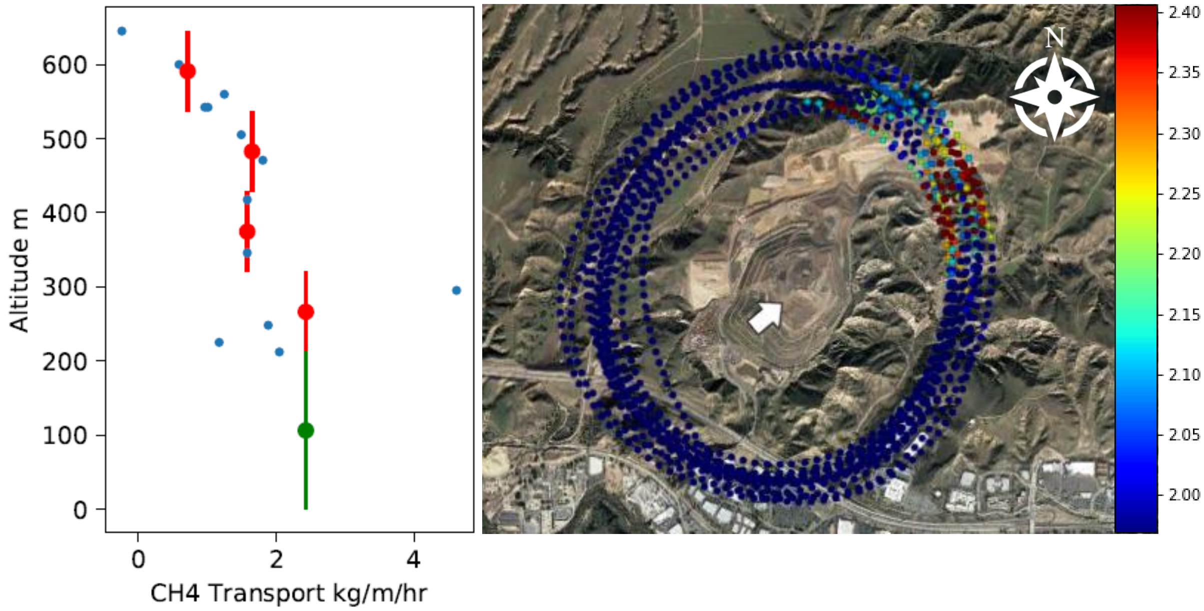

Figure 98. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

97. Simi Valley LF, 05-21-20

Laps were flown between 198 and 783 m agl and the calculated methane emission was 1096 ±427 kg h^{-1}.

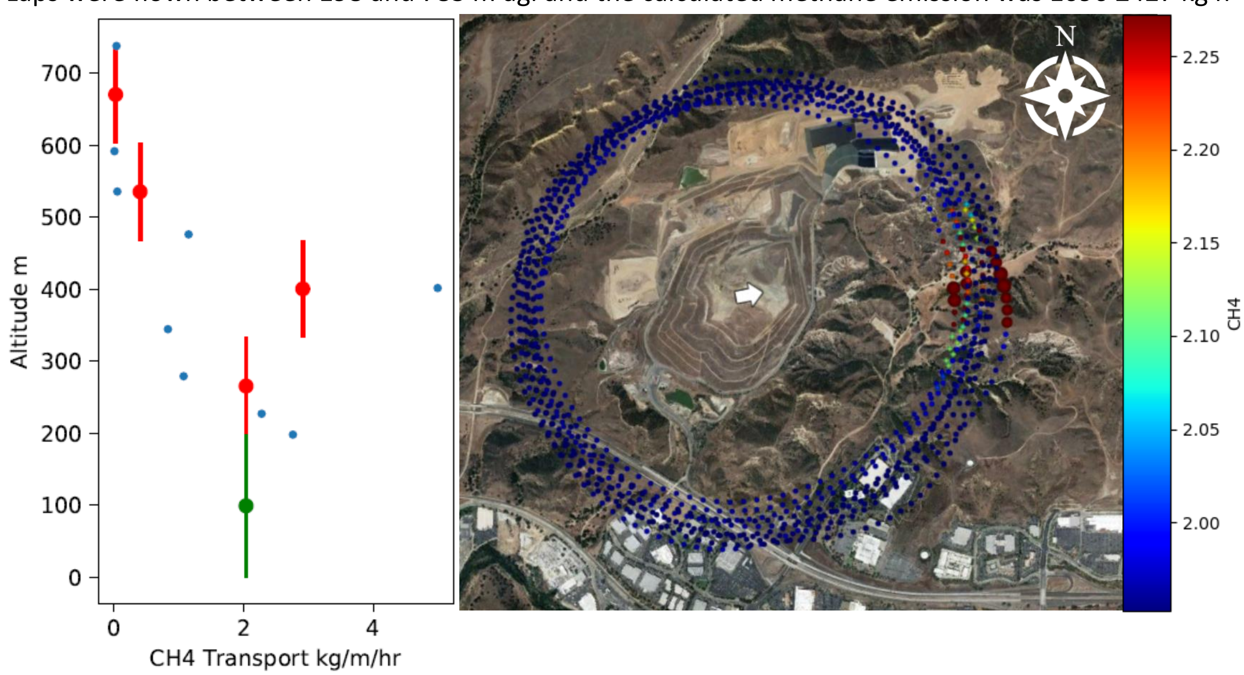

Figure 99. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

98. Simi Valley LF, 10-28-20

Laps were flown between 102 and 405 m agl. A methane emission of 921 ± 330 kg h^{-1} was calculated. No significant ethane emission was observed.

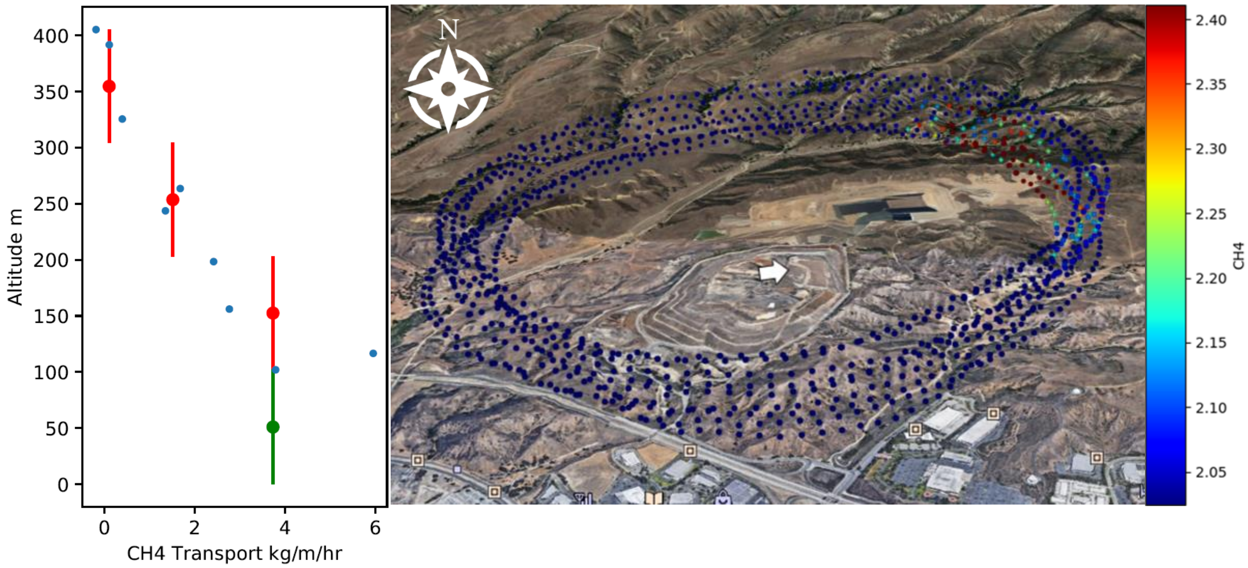

Figure 100. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

99. South Chollas LF, 05-19-20

The aircraft flew laps between 393 and 701 m agl, and a methane emission of 15 ± 3 kg h^{-1} was calculated. This is likely an underestimate because the vertical profile of emissions shows that the entire plume was not fully captured. The aircraft was limited in (high) altitude by clouds (must stay at least 500 ft below cloud cover).

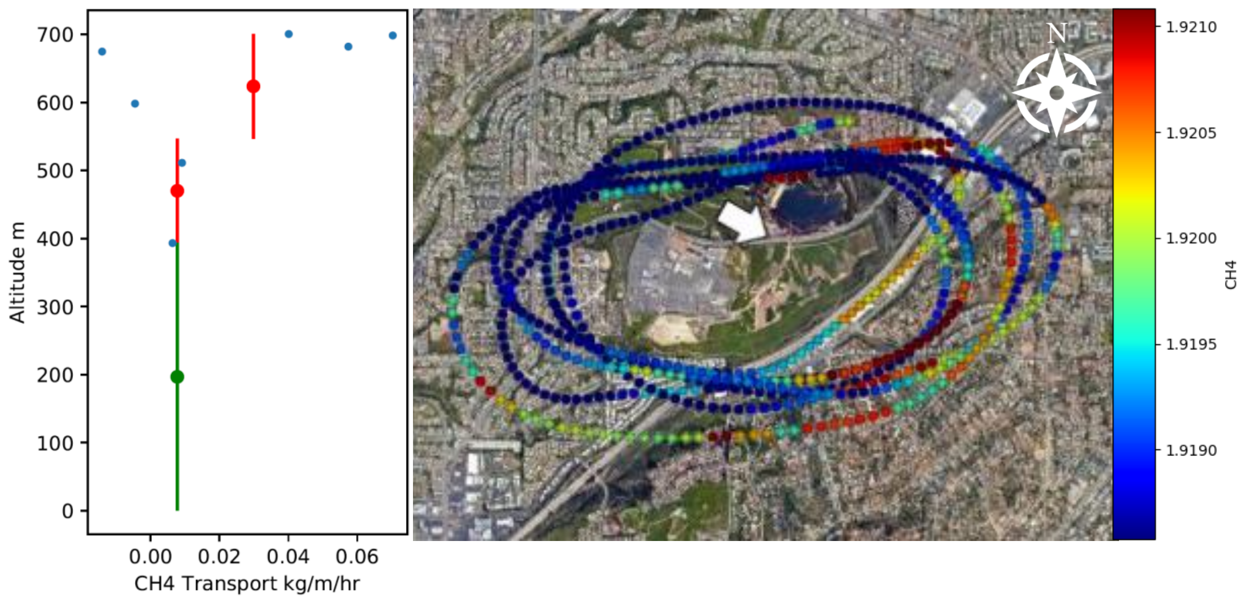

Figure 101. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

100. South Kern Compost/LF, 10-30-20

Laps were flown between 54 and 274 m agl. A methane emission of 240 ± 74 kg h^{-1} was calculated. An ethane emission of 5.2 ± 1.9 kg h^{-1} was observed.

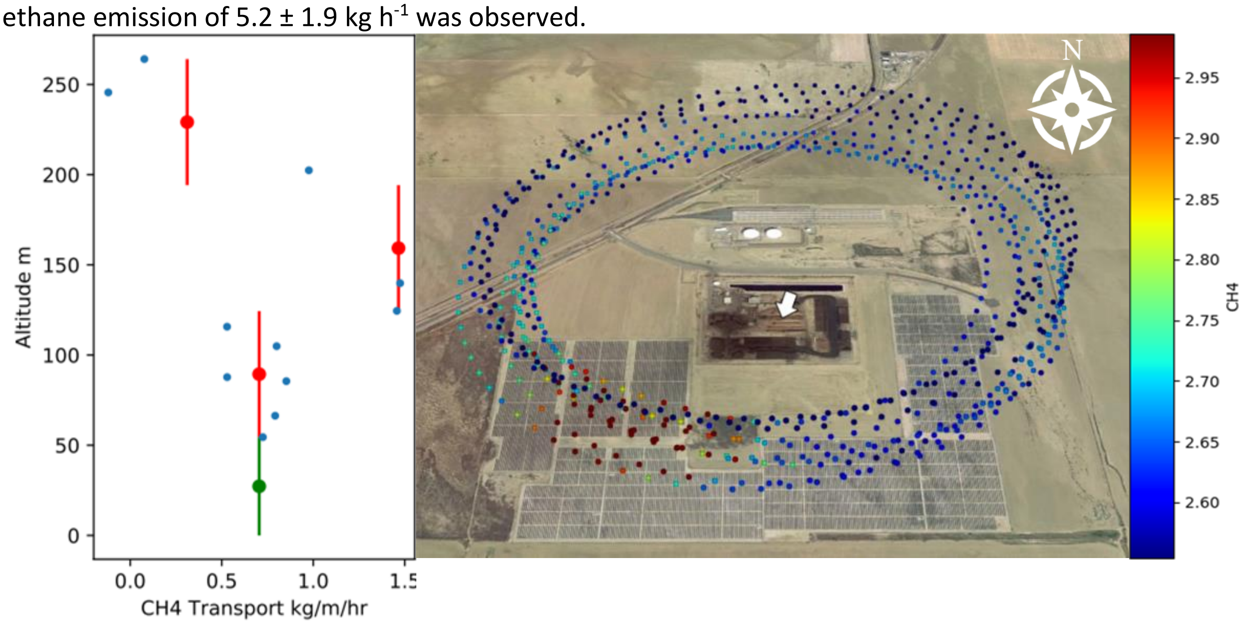

Figure 102. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

101. Spadra LF, 11-19-19

Laps were flown between 170 and 597 m agl. A methane emission of 179 ± 70 kg h^{-1} was calculated.

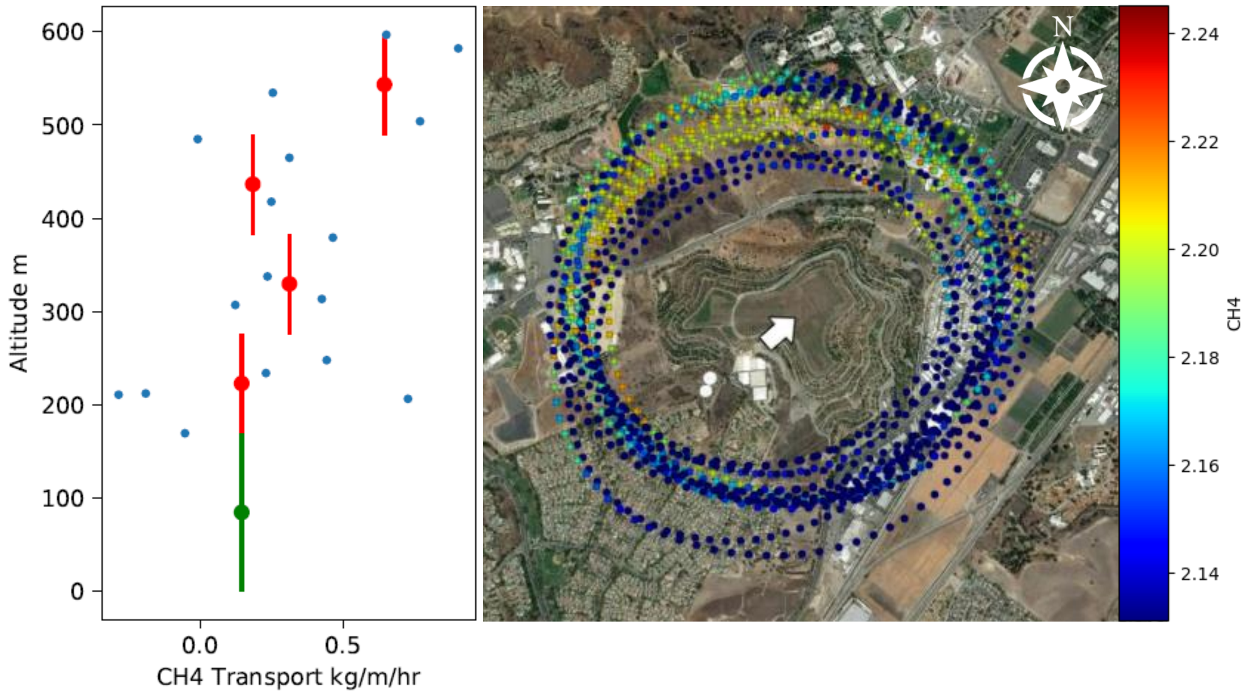

Figure 103. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

102. Spadra LF, 05-21-20

Laps were flown between 200 and 482 m agl, but upwind methane sources contaminated the site and a meaningful emissions estimate could not be obtained. This site was not repeated the following day in the interest of efficient time usage (i.e., it was out of the way for the planned measurements of 5/21).

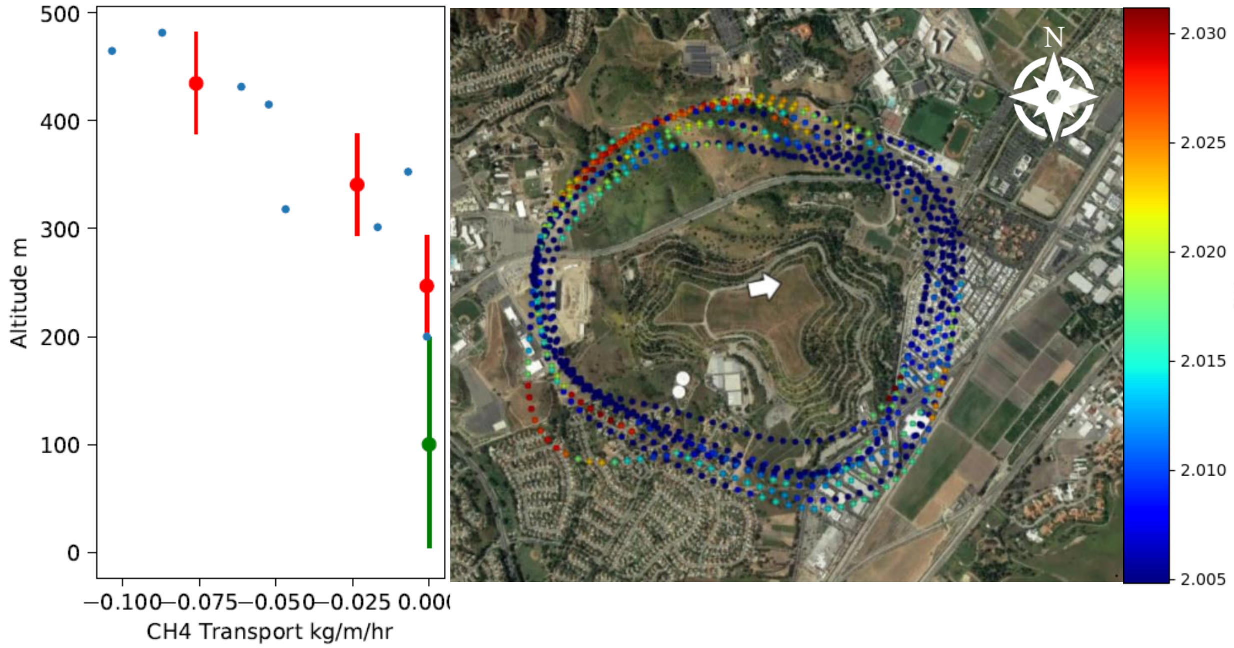

Figure 104. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

103. Spadra LF, 10-28-20

Laps were flown between 116 and 384 m agl. A methane emission of 47 ± 19 kg h^{-1} was calculated. No significant ethane emission was observed.

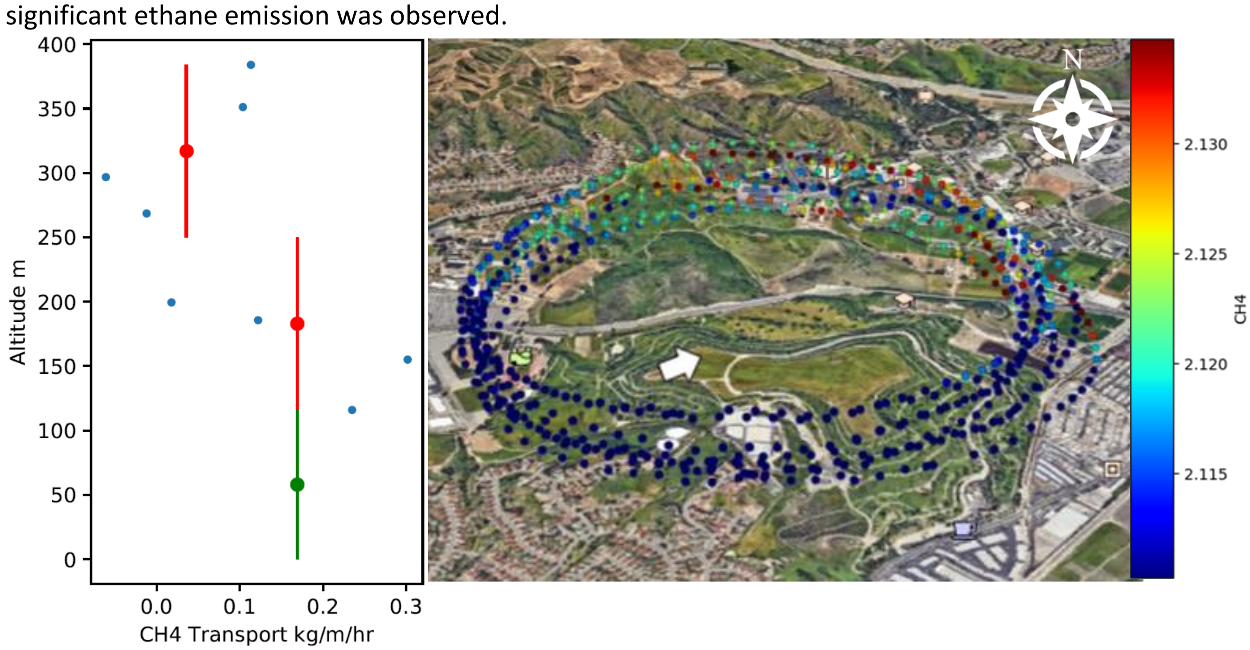

Figure 105. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

104. Sunshine Canyon LF, 11-18-19

Laps were flown between 228 and 569 m agl. A methane emission of 768 ± 385 kg h^{-1} was calculated.

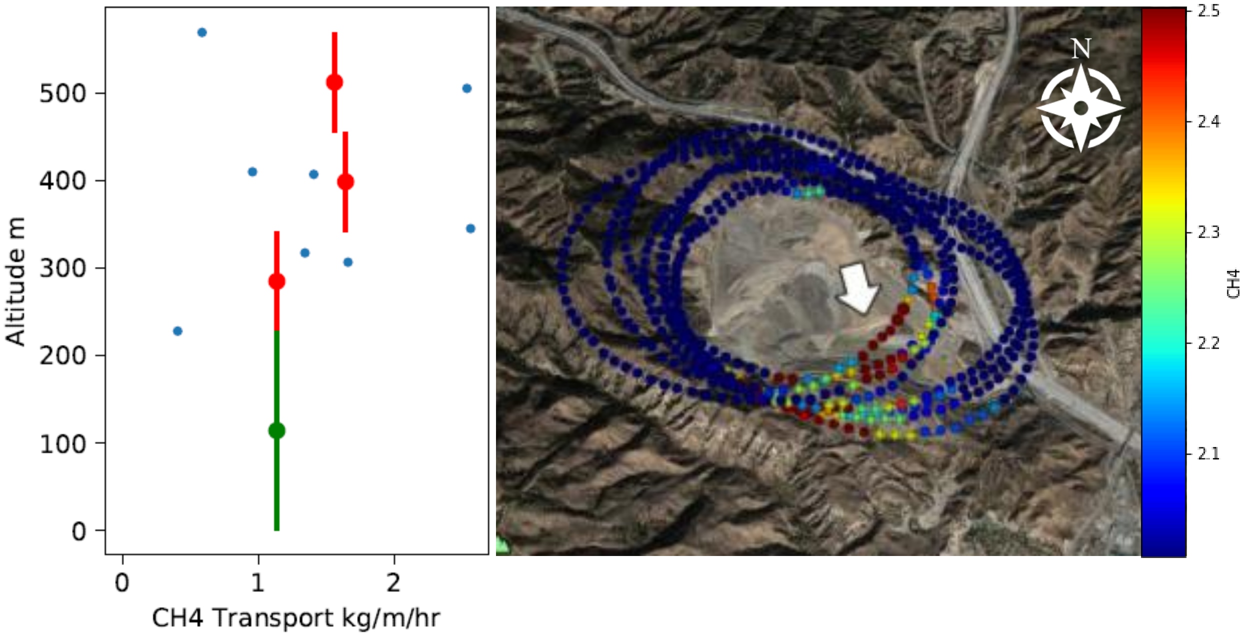

Figure 106. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

105. Sunshine Canyon LF, 01-13-20

The aircraft flew a total of 10 usable circles around the Sunshine Canyon Landfill. Altitudes ranged from 315 magl to 626 magl. Winds were out of the southwest, averaging 0.9 m s^{-1}. Total methane emission is estimated at 1917.8 ± 751.3 kg hr^{-1}.

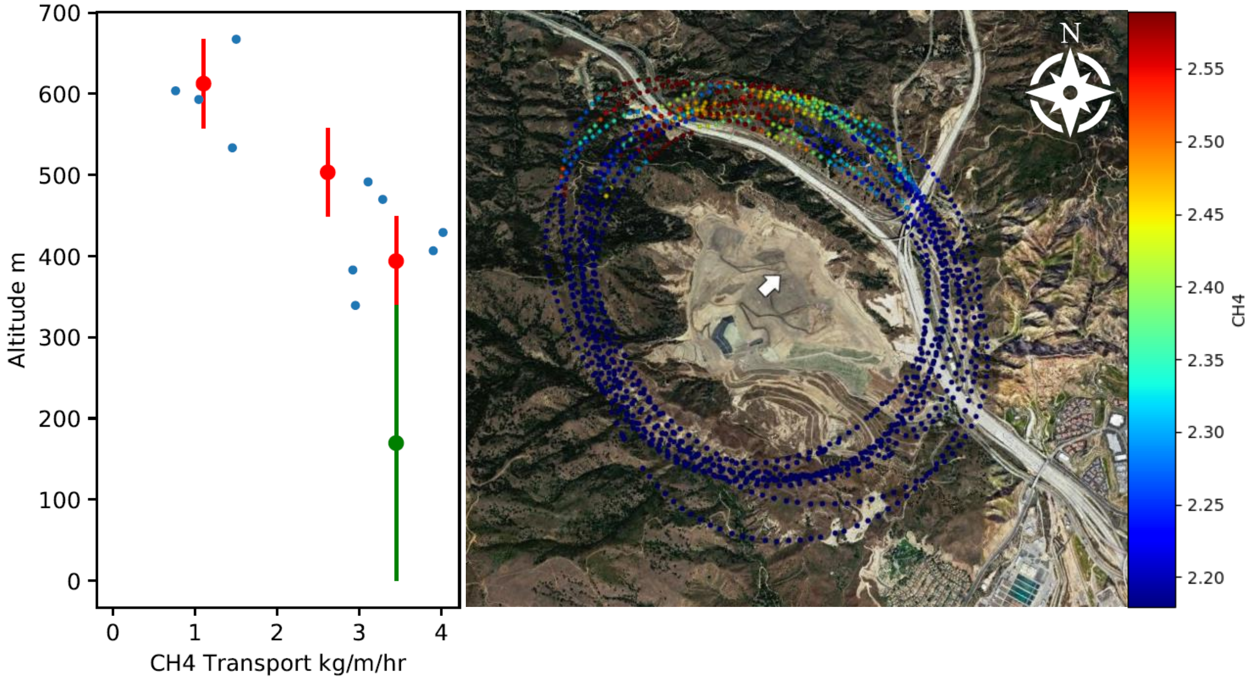

Figure 107. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

106. Sunshine Canyon LF, 05-22-20

Laps were flown between 272 and 1078, and the calculate methane emission was 604 ± 108 kg h^{-1}.

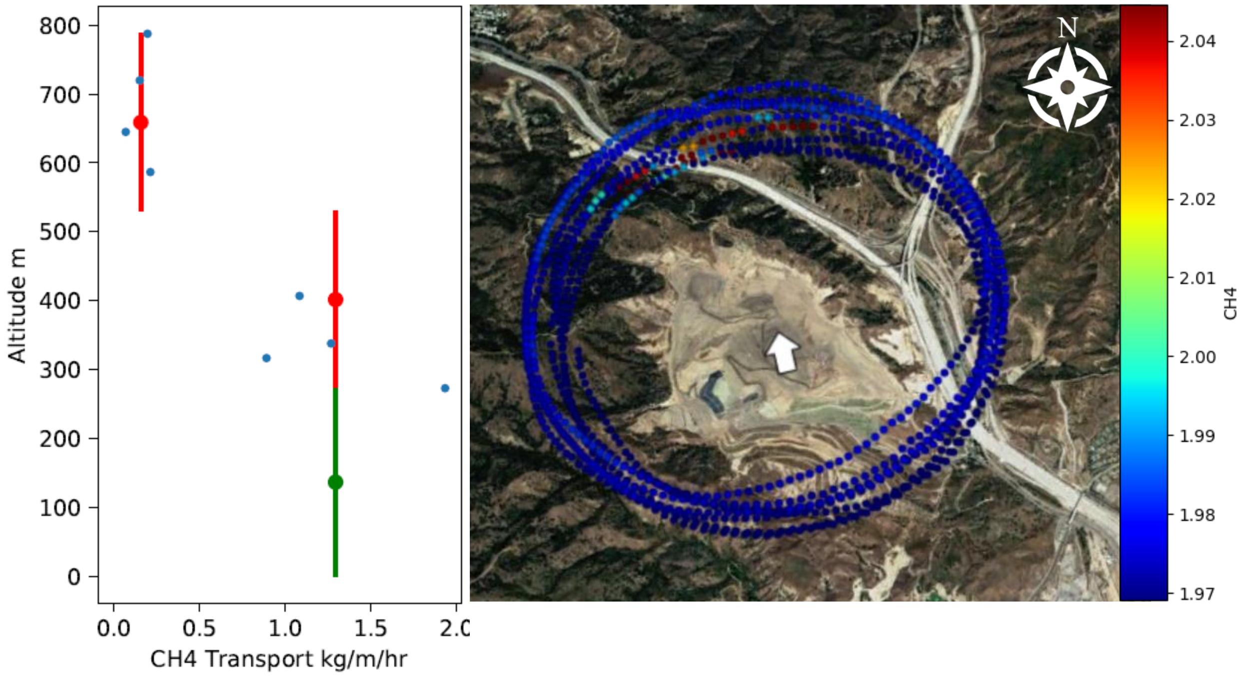

Figure 108. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

107. Sunshine Canyon LF, 07-17-20

Only two useable laps were flown at 283 and 363 m above ground level (agl). An in-flight scientific instrument failure caused the rest of the laps flown to be unusable (this measurement was not invoiced). While an emissions number cannot be determined from these two laps, the data is shown below to demonstrate that there was a clearly visible methane emission peak observed coming from the facility.

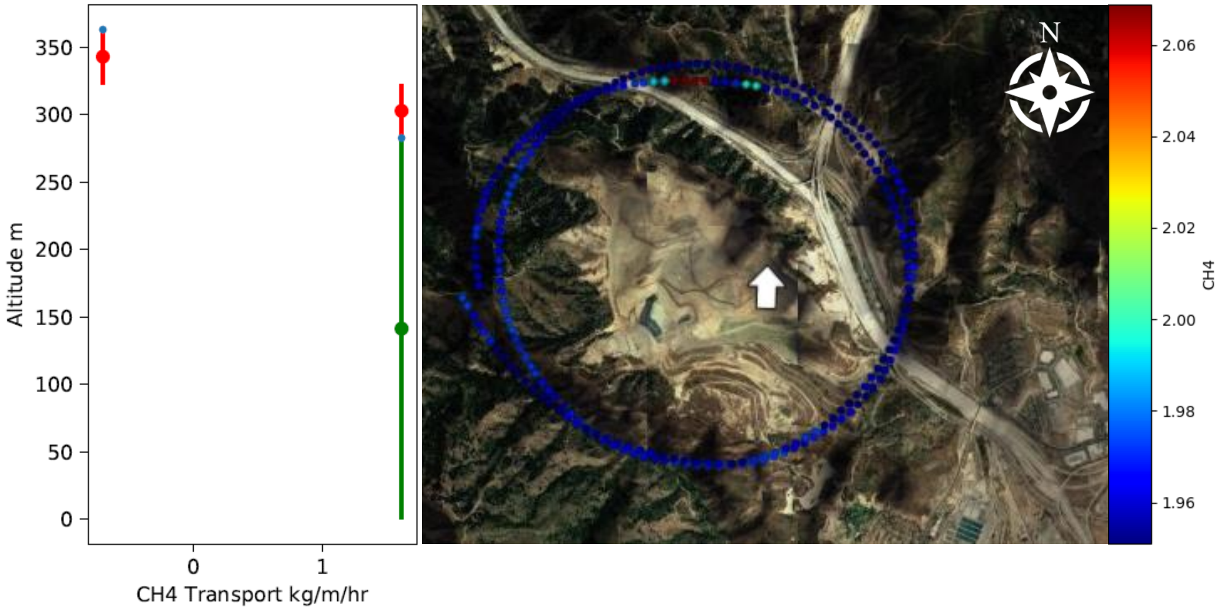

Figure 109. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

108. Sunshine Canyon LF, 10-29-20

Laps were flown between 168 and 895 m agl. A methane emission of 782 ± 235 kg h^{-1} was calculated. No significant ethane emission was observed.

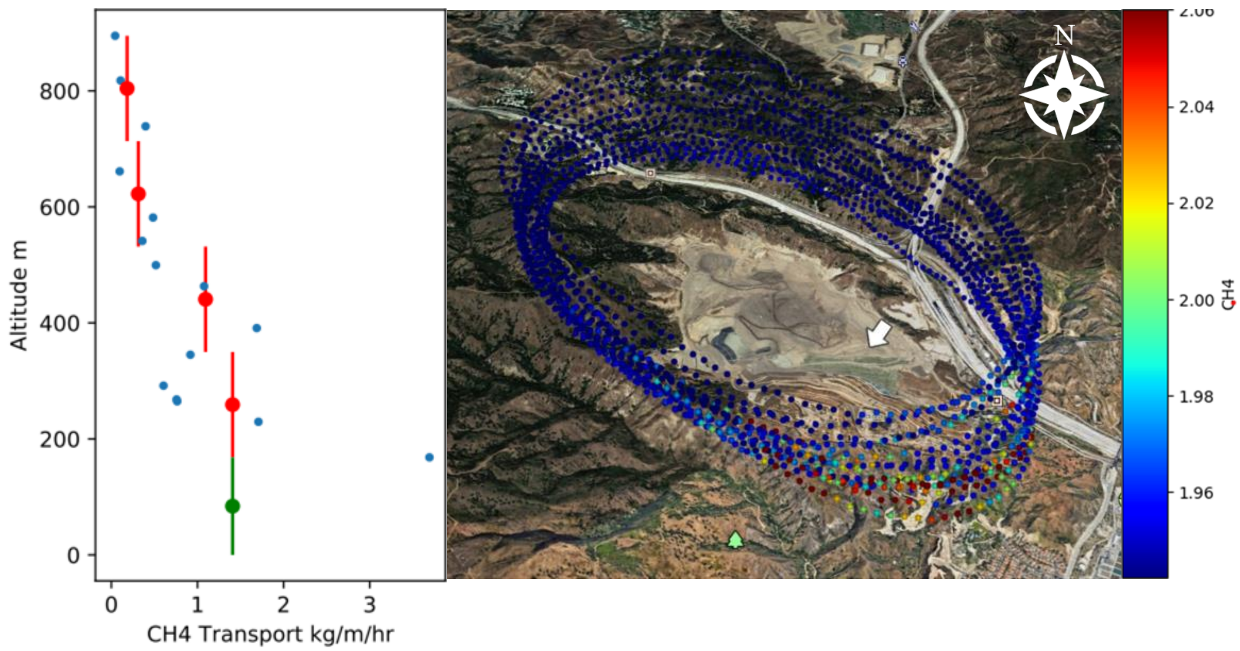

Figure 110. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

109. Sycamore LF, 05-19-20

Laps between 258 and 940 m agl were flown and the measured methane emission was 996 ± 360 kg h^{-1}. The methane plume was fully captured with no complications.

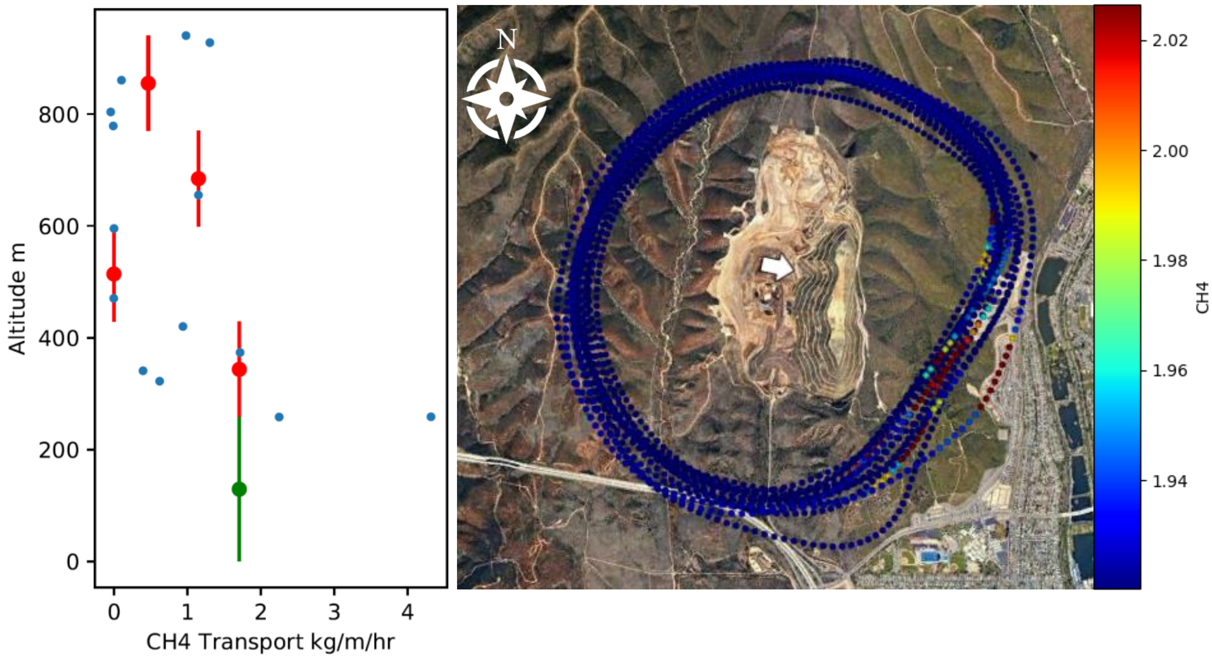

Figure 111. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure.). Arrow = average wind direction.

110. Toland Rd LF, 11-18-19

Laps were flown between 326 and 583 m agl. A methane emission of 780 ± 494 kg h^{-1} was calculated.

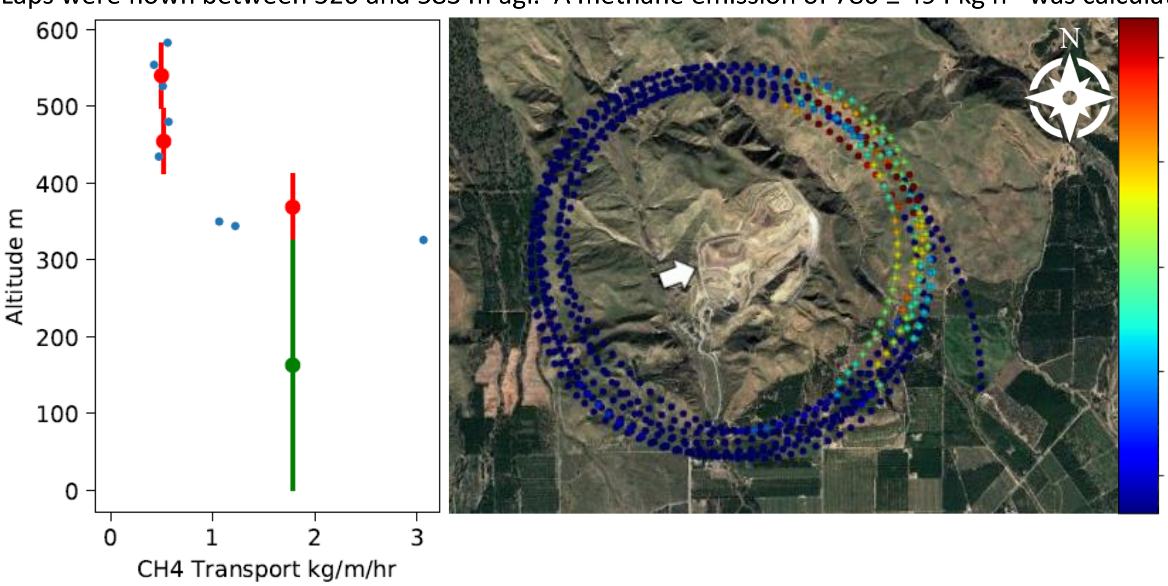

Figure 112. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

111. Toland Rd LF, 05-21-20

Laps were flown between 333 and 930 m agl, but upwind methane sources contaminated the site and meaningful emissions estimate could not be obtained. This site was repeated on 5/22 (see below).

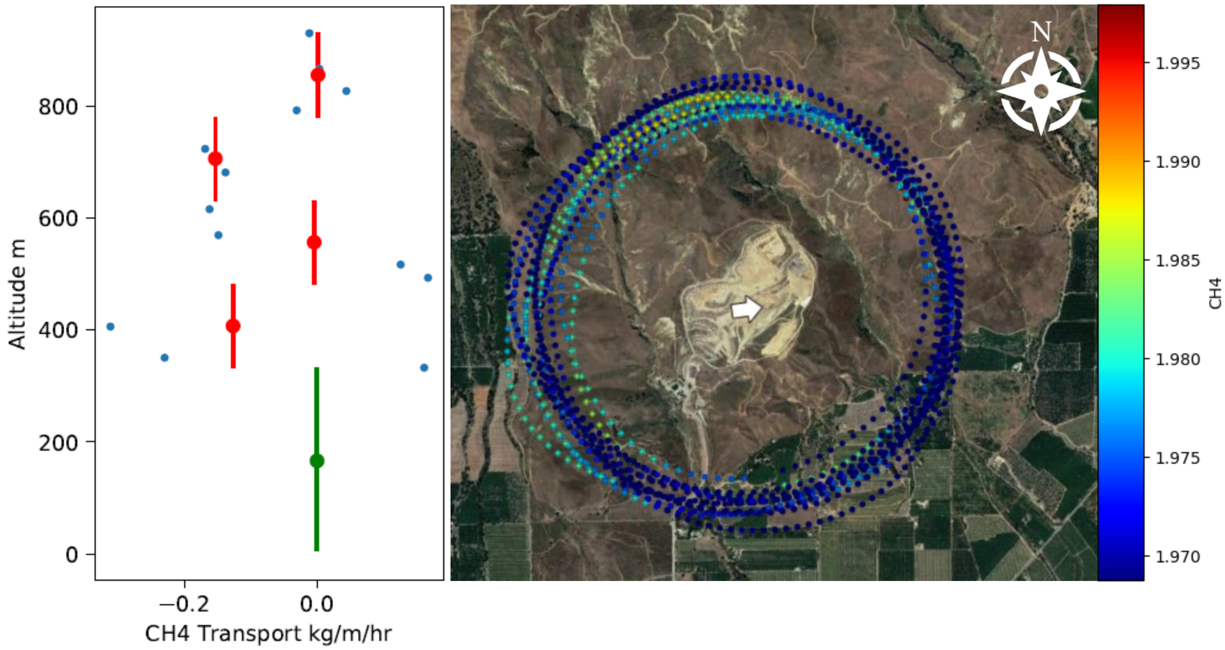

Figure 113. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

112. Toland Rd LF, 05-22-20

Laps were flown between 269 and 705 m agl, and the estimated methane emission was 240 ± 324 kg h^{-1}. The high uncertainty is driven by the presence of upwind sources, and the rapidly changing elevation of the terrain surrounding the landfill (which increases the variability of agl altitude within each lap).

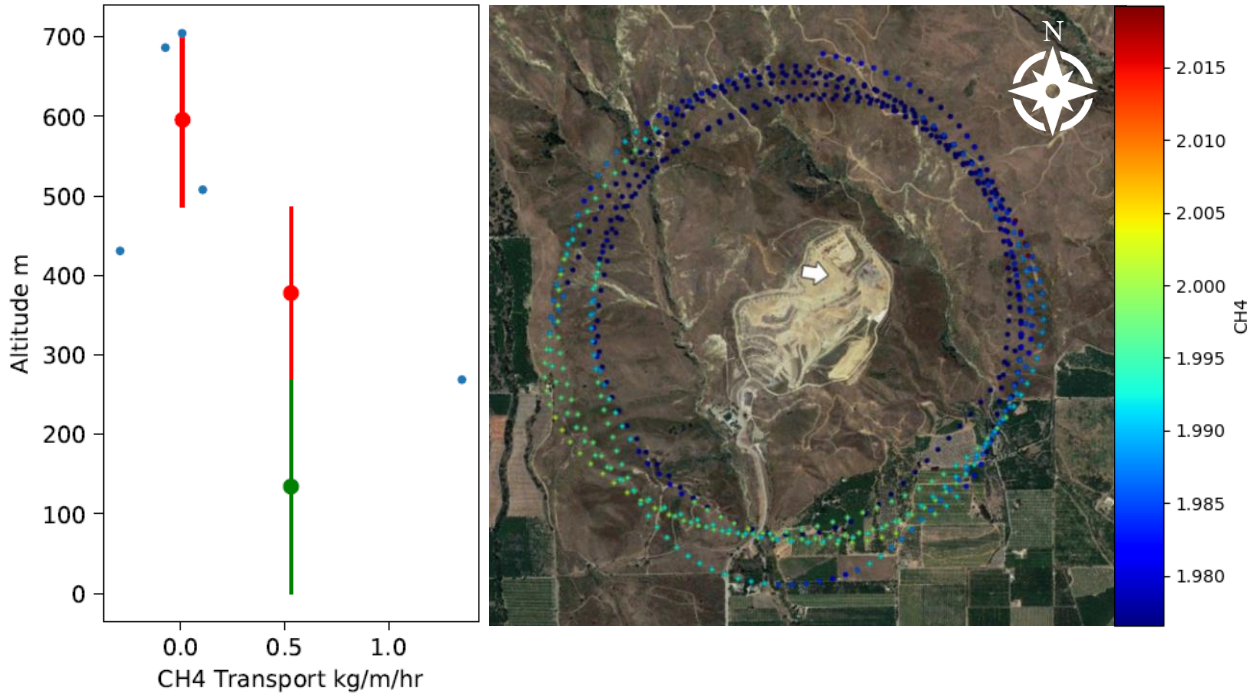

Figure 114. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

113. Toland Rd LF, 10-28-20

Laps were flown between 145 and 410 m agl. A methane emission of 1786 ± 432 kg h^{-1} was calculated. No significant ethane emission was observed.

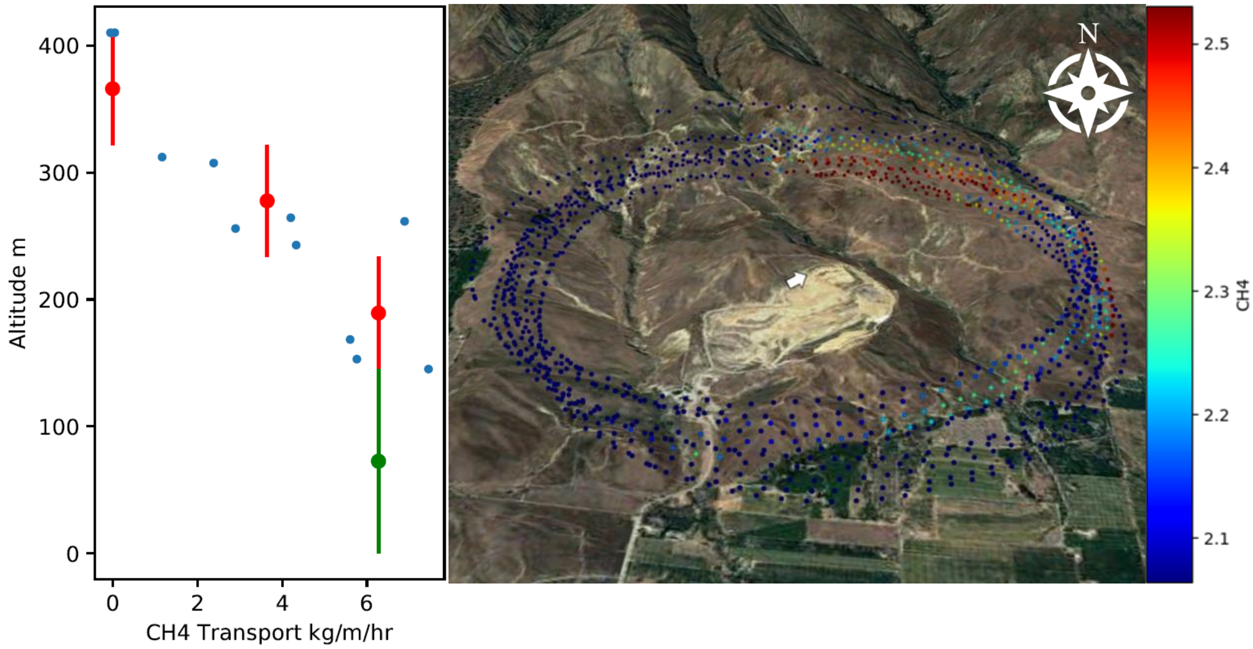

Figure 115. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

114. Vasco LF, 11-22-19

During the measurement of this site, significant quantities of birds flying around the landfill created a hazard to the safety of the aircraft. Therefore, the measurement was abandoned without any useable laps.

115. Vasco LF, 11-23-19

Laps were flown between 269 and 793 m agl. A methane emission of 440 ± 253 kg h^{-1} was calculated.

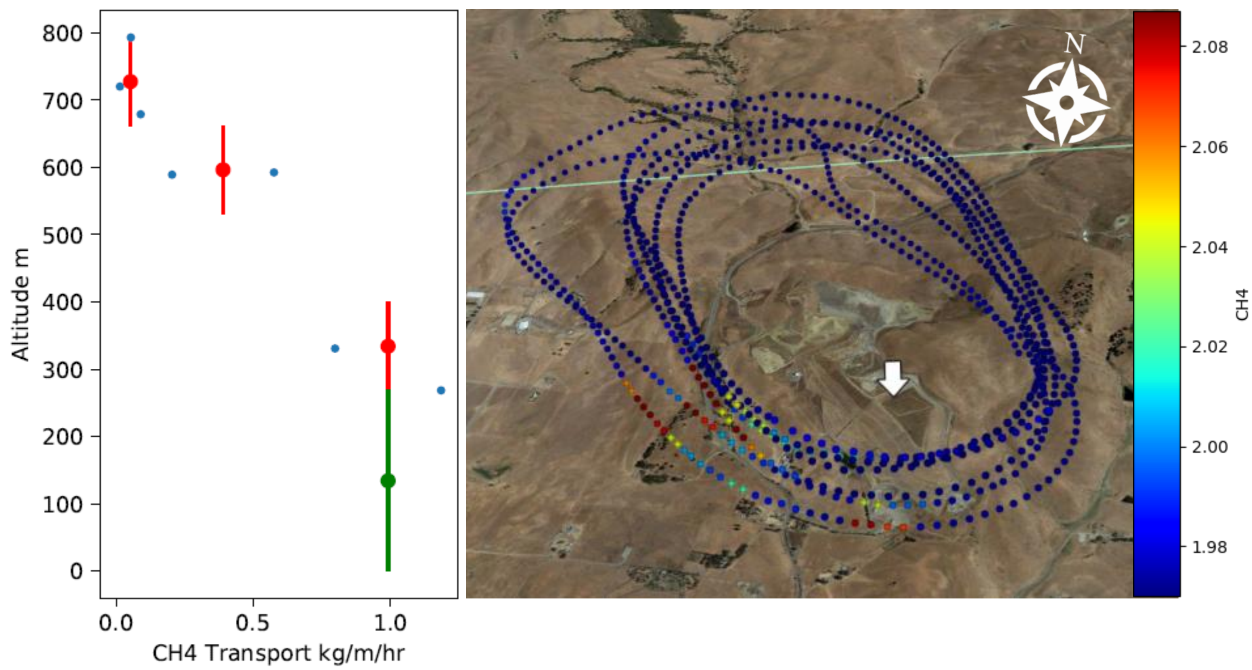

Figure 116. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

116. Vasco LF, 04-21-20

The aircraft flew laps between 221 and 672 m agl and a methane emission of 165 ± 121 kg h^{-1} was calculated.

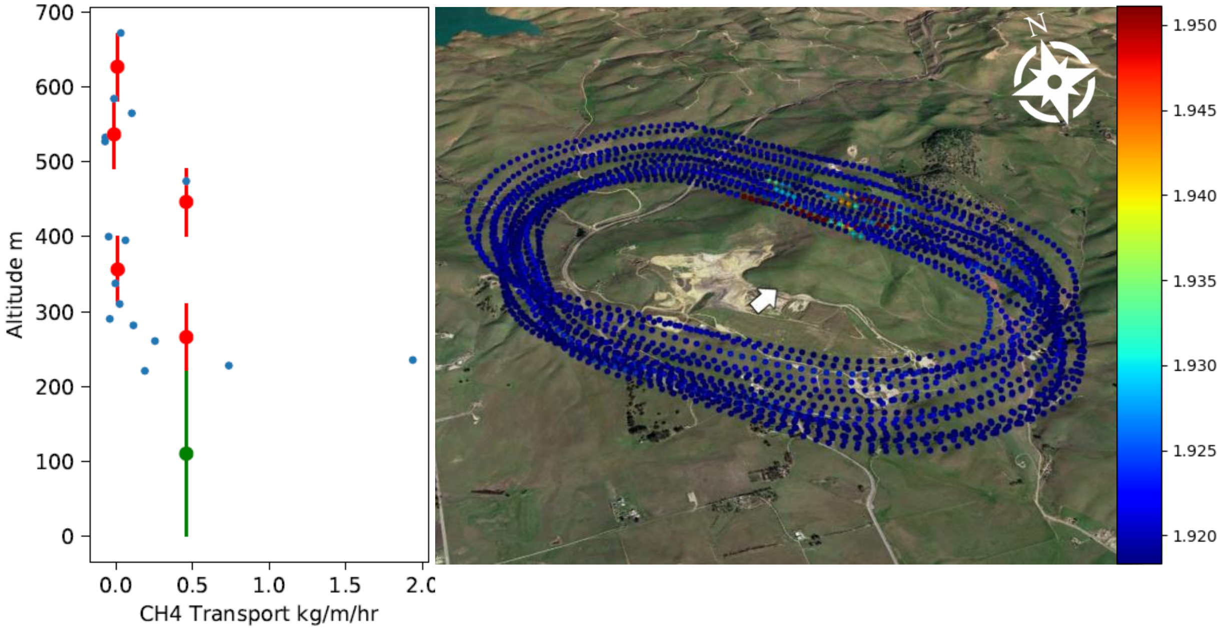

Figure 117. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

117. Vasco LF, 10-31-20

Laps were flown between 128 and 518 m agl. A methane emission of 988 ± 182 kg h^{-1} was calculated. An ethane emission of 10.3 ± 14.3 kg h^{-1} was calculated, although the estimate is highly uncertain.

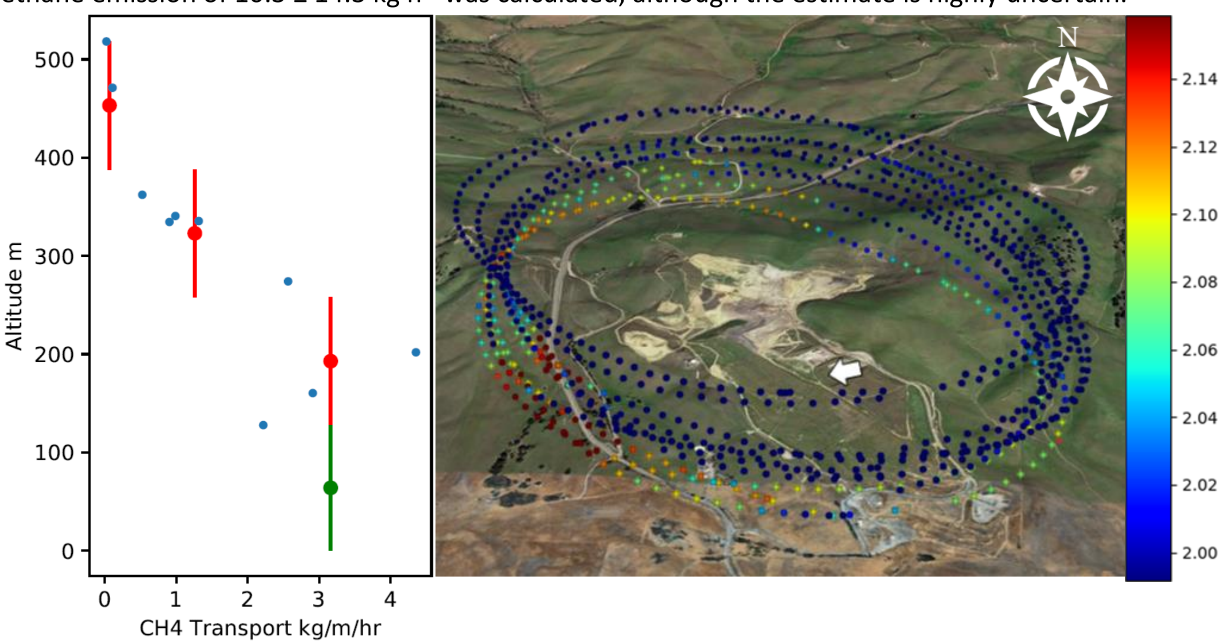

Figure 118. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

118. Visalia LF, 07-27-20

Laps were flown between 137 and 601 m agl and a methane emission of 336 ± 214 kg h^{-1} was calculated.

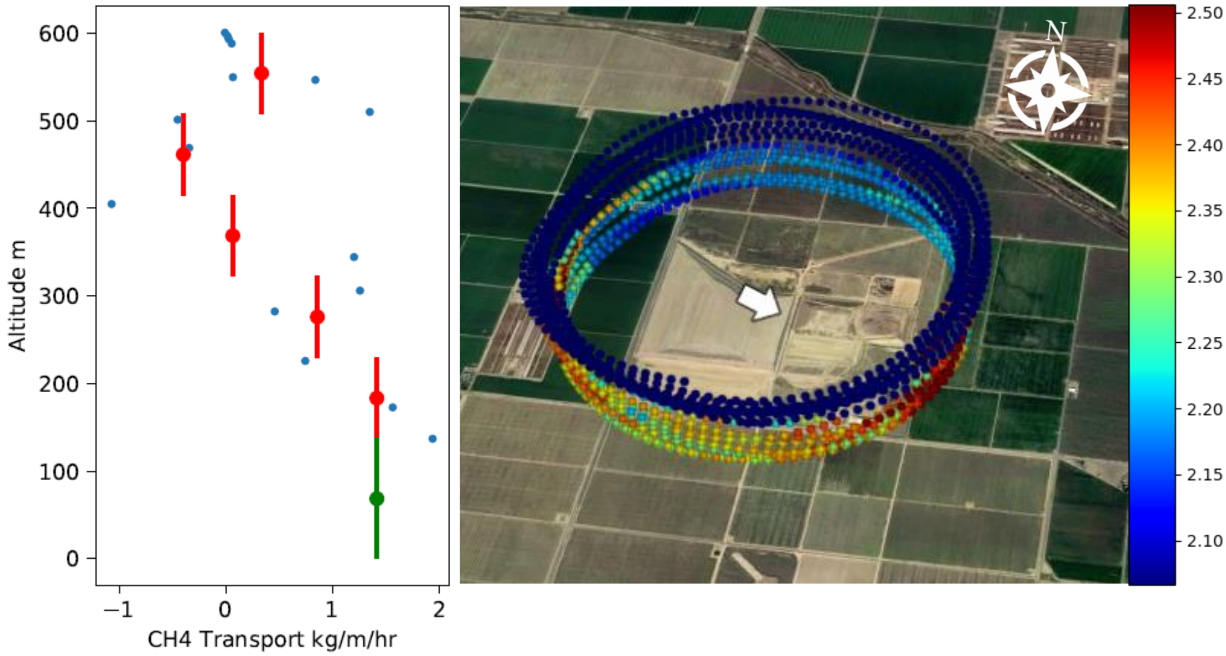

Figure 119. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

119. W Contra Costa LF, 11-22-19

Laps were flown between 154 and 365 m agl. A methane emission of -15 ± 24 kg h^{-1} was calculated.

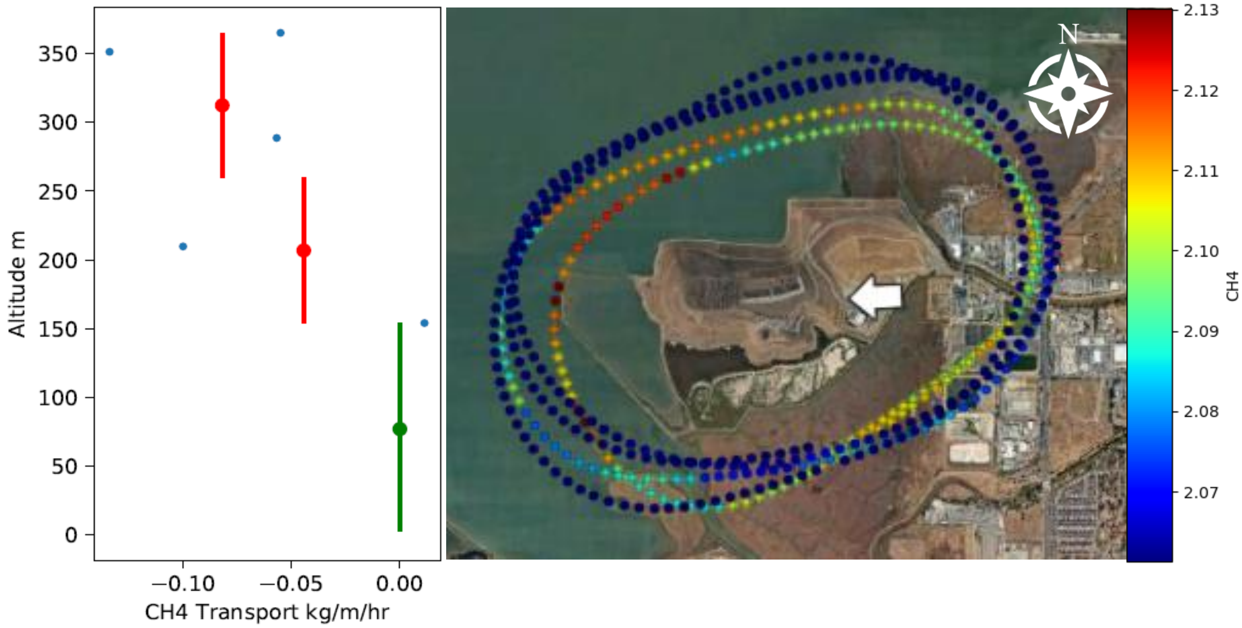

Figure 120. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

120. West Valley Recovery Facility/LF, 10-28-20

Laps were flown between 102 and 141 m agl. A methane emission of -3 ± 45 kg h^{-1} was calculated. Only three laps were flown at this site because large upwind methane emissions were observed which appeared to obscure any smaller methane emissions within the target area.

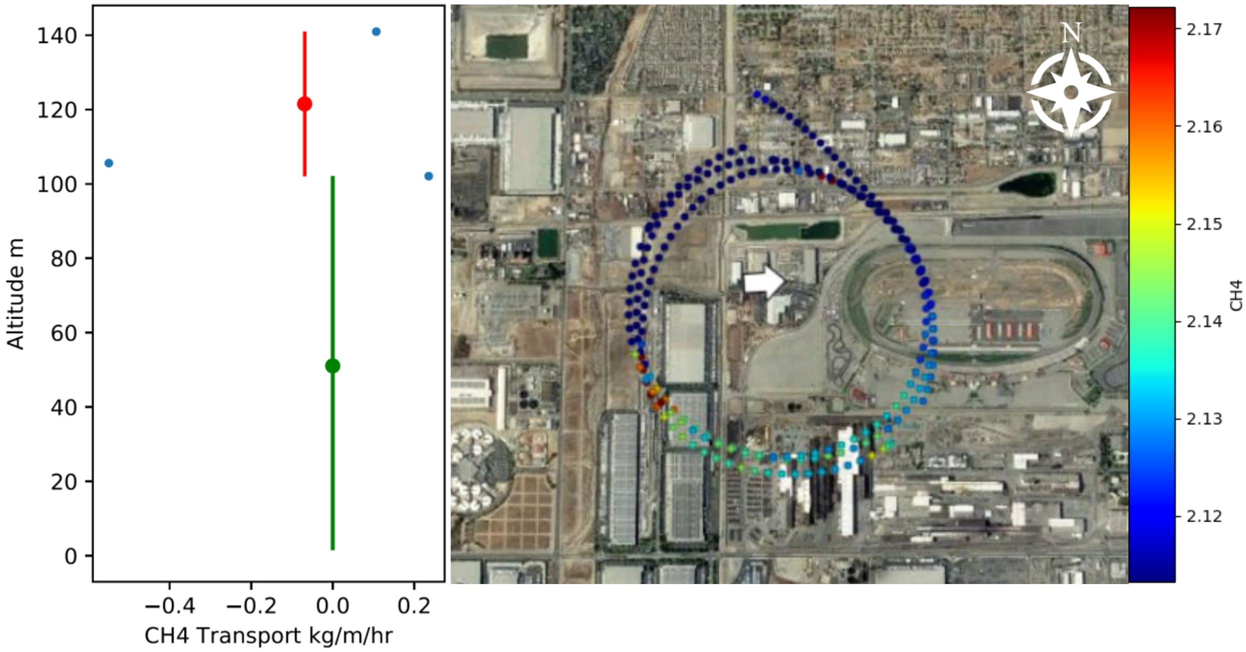

Figure 121. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

121. Western Regional LF, 11-23-19

Laps were flown between 106 and 386 m agl. A methane emission of 815 ± 470 kg h^{-1} was calculated.

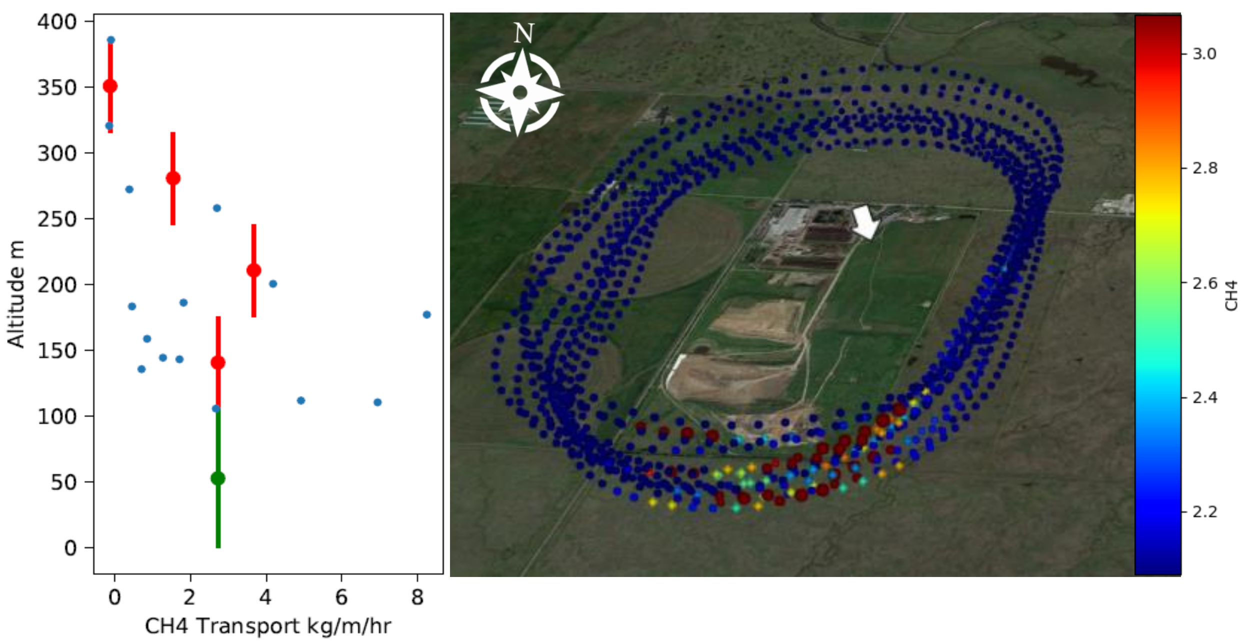

Figure 122. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

122. Western Regional LF, 04-03-20

Laps were flown around the Western Regional landfill between 165 and 731 m above ground level (agl) and a methane emission of 1067 ± 380 kg h^{-1} was calculated.

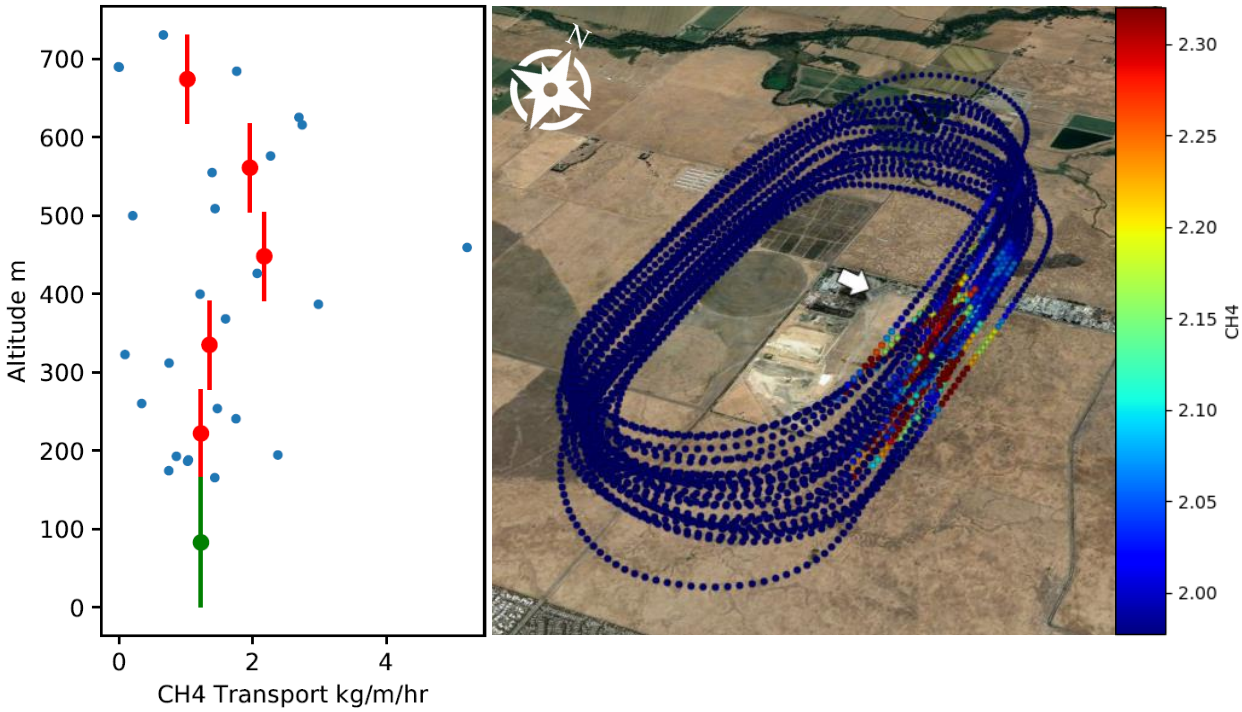

Figure 123. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

123. Western Regional LF, 07-30-20

Laps were flown around the Western Regional landfill between 134 and 783 m agl and a methane emission of 1326 ± 401 kg h^{-1} was calculated.

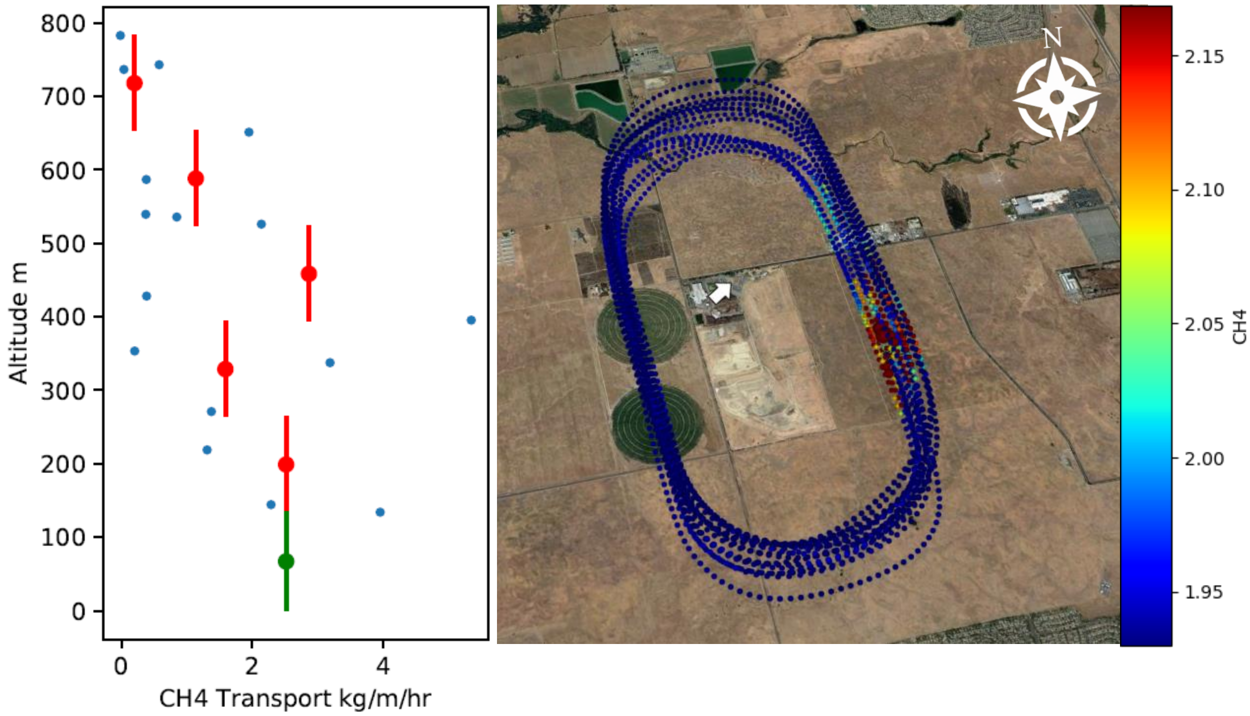

Figure 124. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.y

124. Western Regional LF, 11-02-20

Laps were flown between 78 and 458 m agl. A methane emission of 1709 ± 509 kg h^{-1} was calculated. No significant ethane was observed.

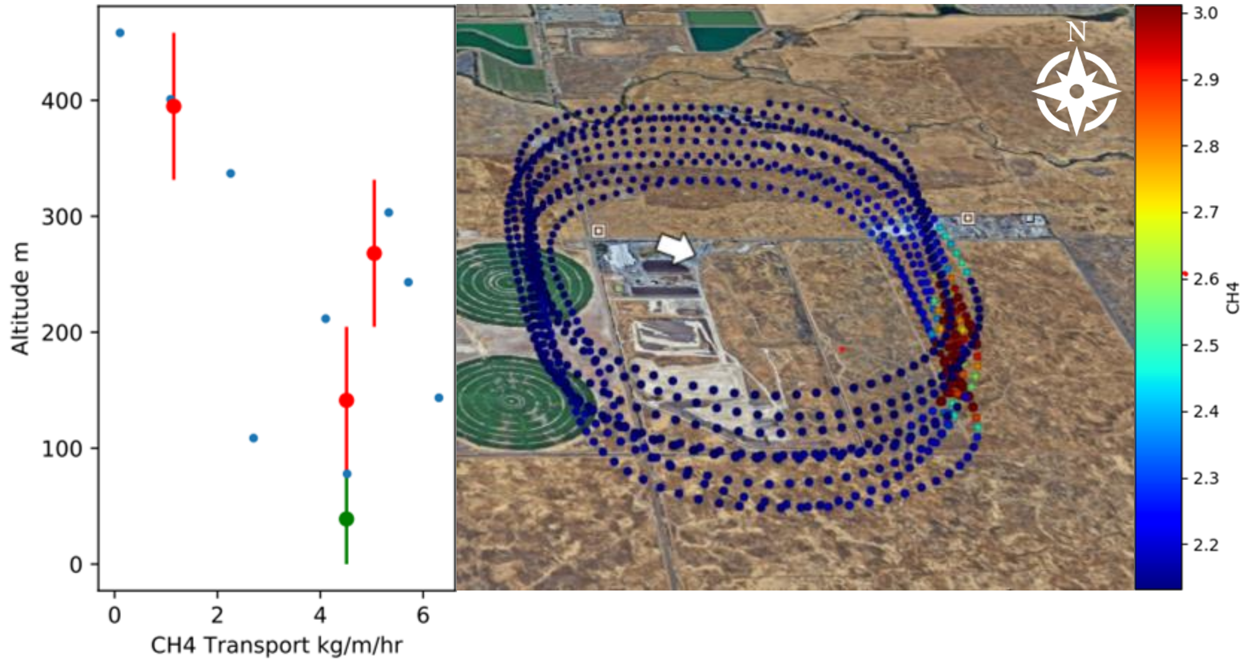

Figure 125. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

125. Western Regional LF, 02-16-21

Laps were flown between 88 and 462 m agl. Clear downwind methane enhancements were observed. No clear downwind ethane was observed.

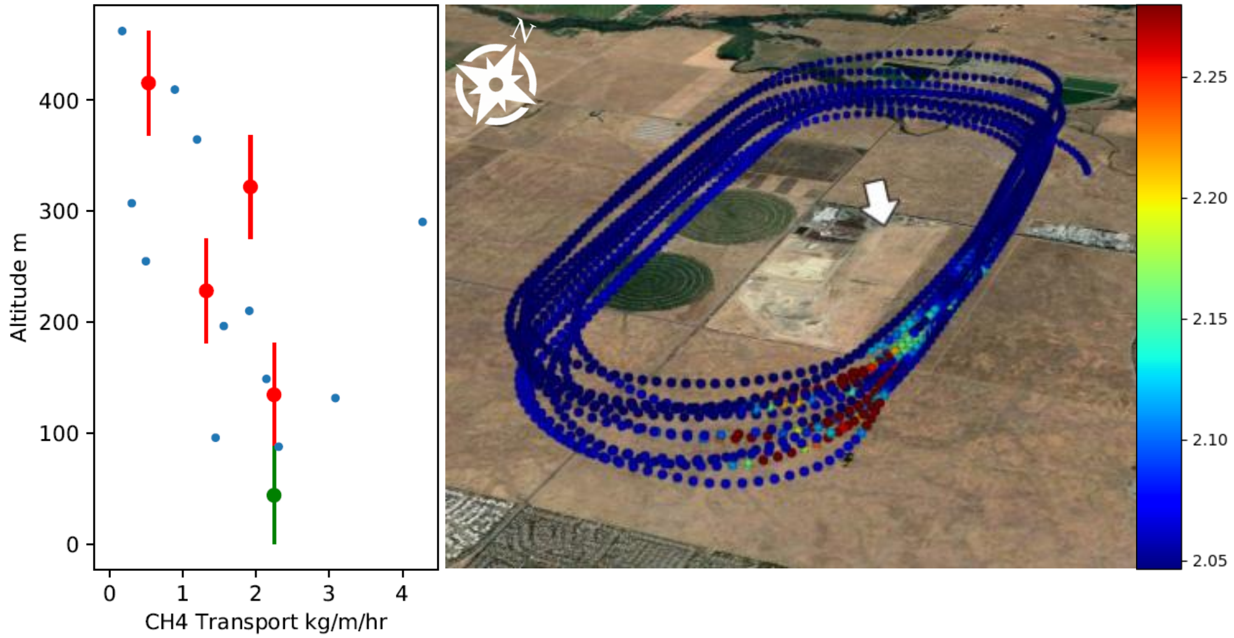

Figure 126. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

126. Yolo LF, 11-22-19

Laps were flown between 114 and 421 m agl. A methane emission of 810 ± 151 kg h^{-1} was calculated.

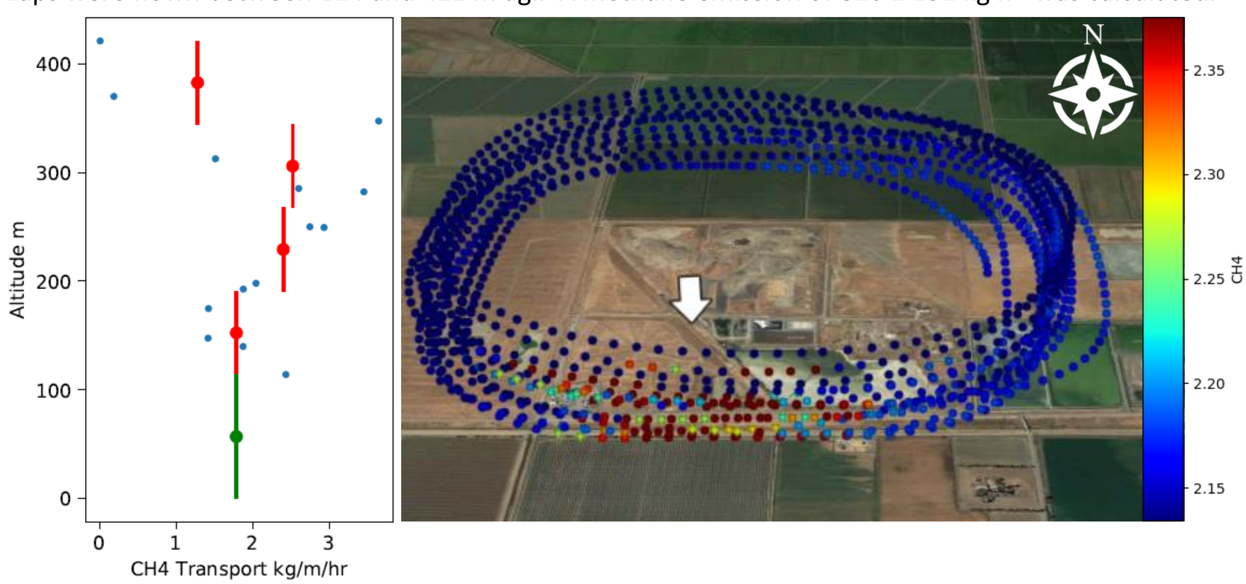

Figure 127. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure.). Arrow = average wind direction.

127. Yolo LF, 04-14-20

The aircraft flew laps between 574 and 170 m agl and a methane emission of 574 ± 170 kg h^{-1} was calculated.

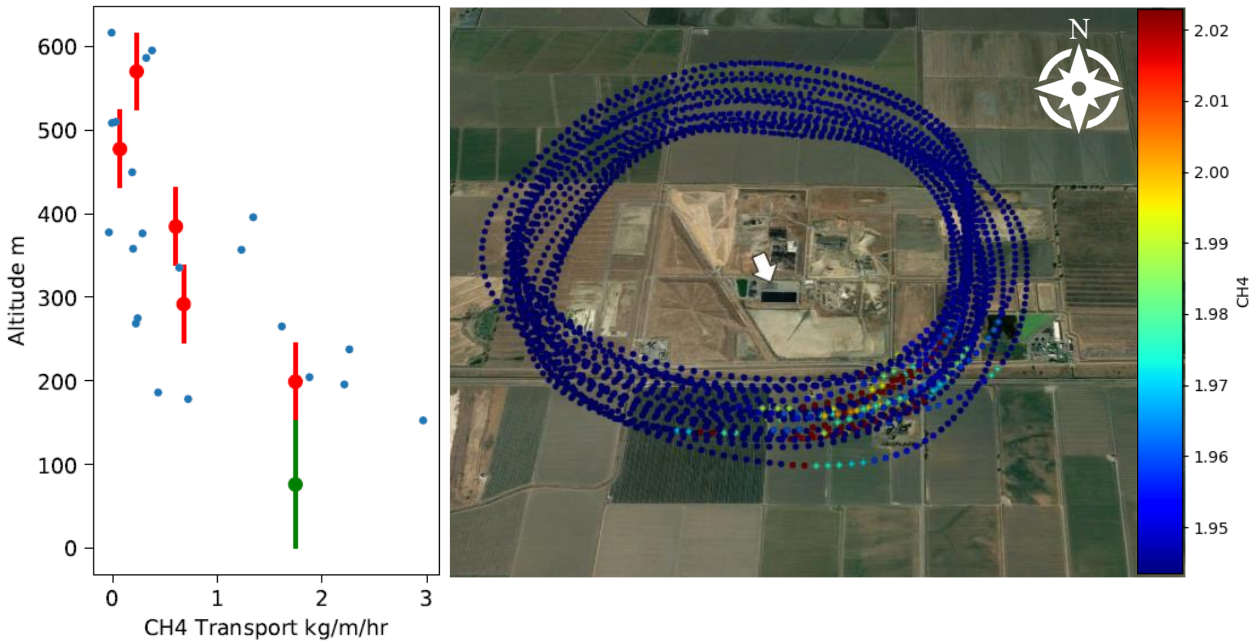

Figure 128. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

128. Yolo LF, 07-30-20

Laps were flown between 133 and 339 m agl and a methane emission of 548 ± 183 kg h^{-1} was calculated.

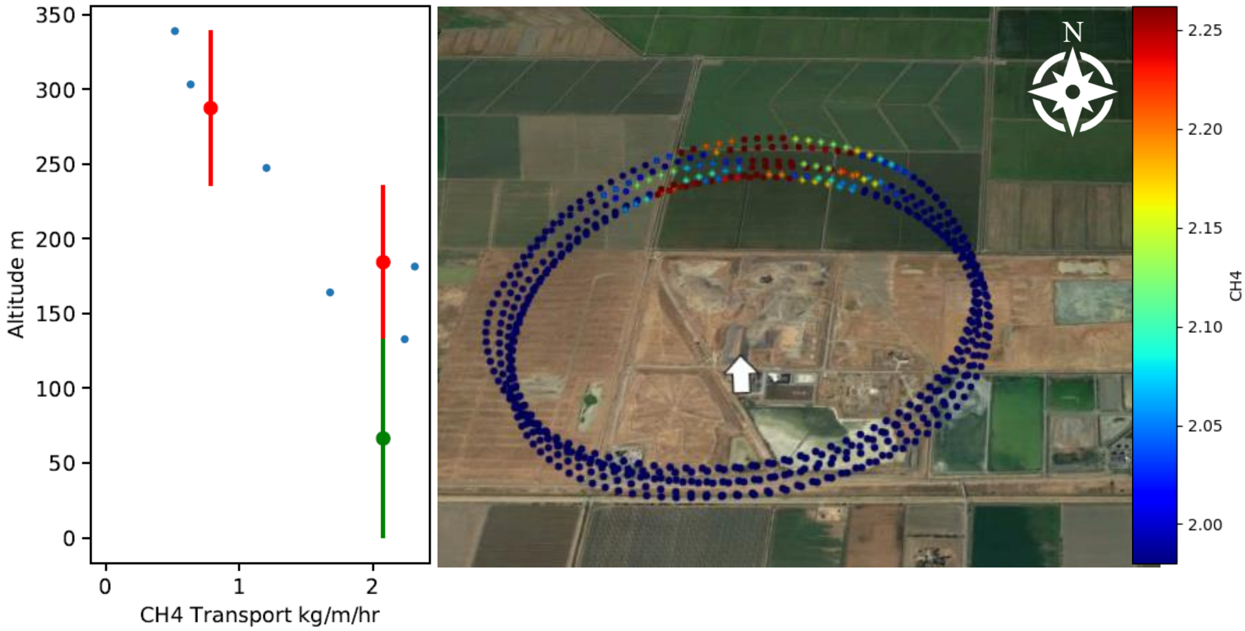

Figure 129. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

129. Yolo LF, 10-09-20

Laps were flown between 74 and 585 m agl. A methane emission of 642 ± 152 kg h^{-1} was calculated. No clear downwind ethane enhancements were observed at this site.

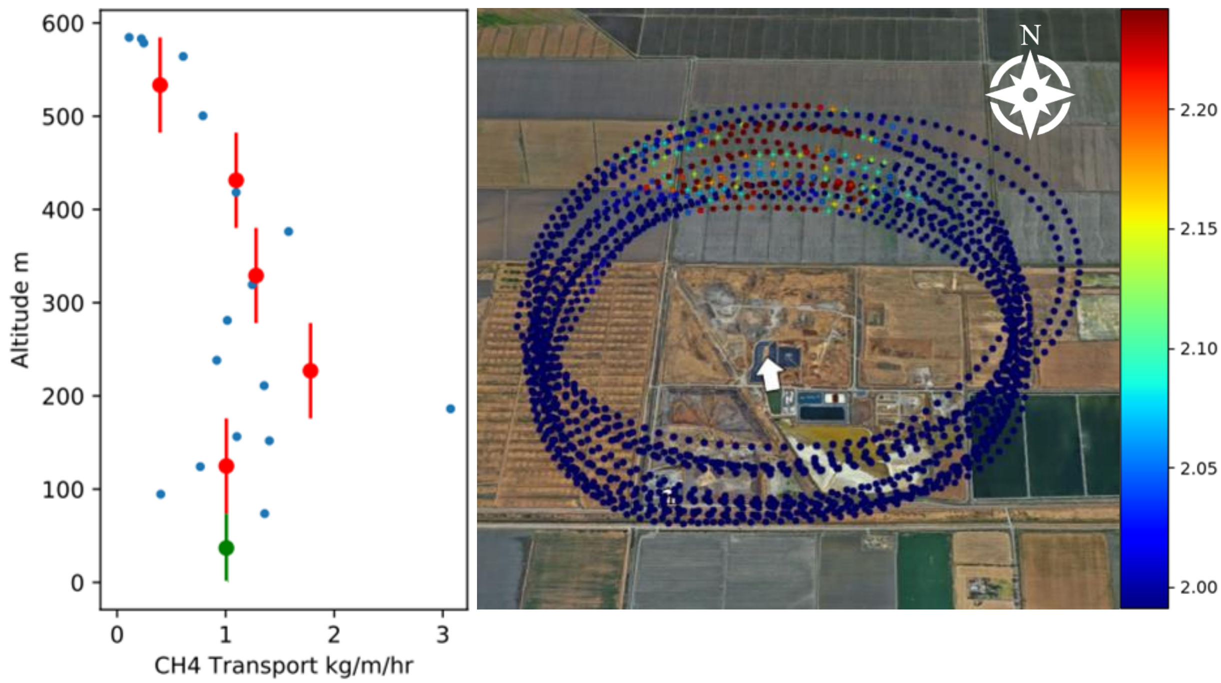

Figure 130. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

130. Yolo LF, 02-26-21

Laps were flown between 182 and 920 m agl, but the winds were too low and variable for a reliable methane estimate. However, methane enhancements were observed, indicating some methane was being emitted.

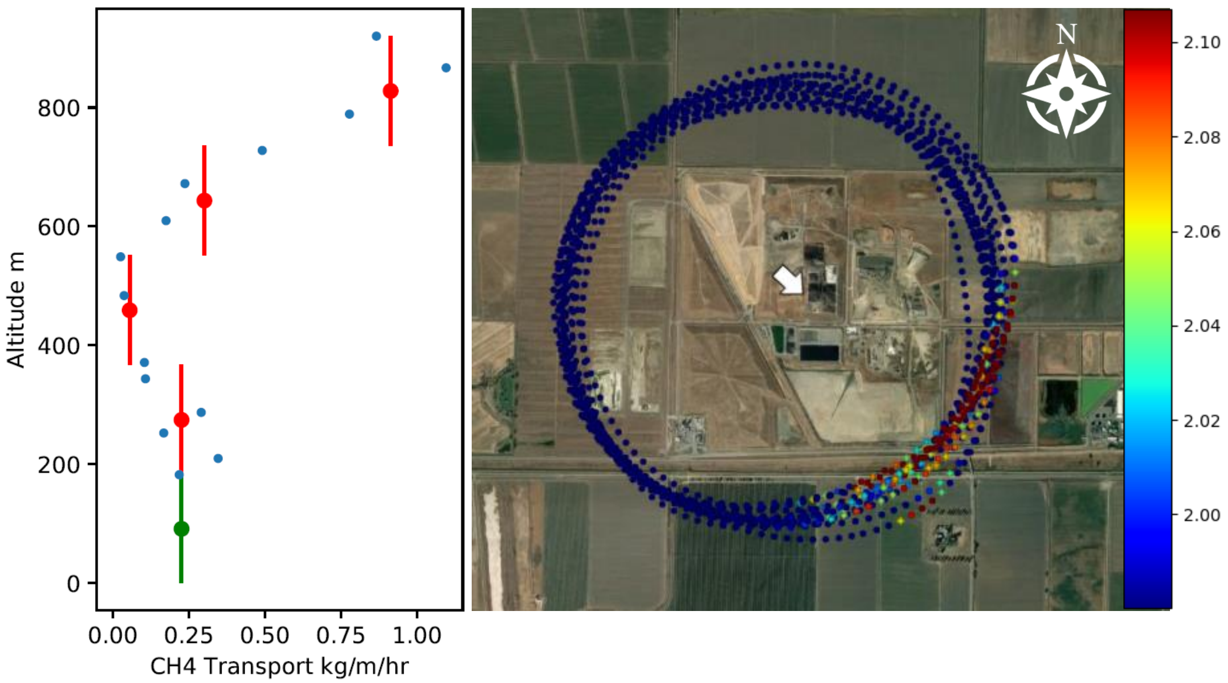

Figure 131. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure.). Arrow = average wind direction.

V.II. Dairies

131. Dairy #1, 10-29-20

Laps were flown between 44 and 311 m agl. A methane emission of 55 ± 17 kg h^{-1} was calculated. No significant ethane was observed.

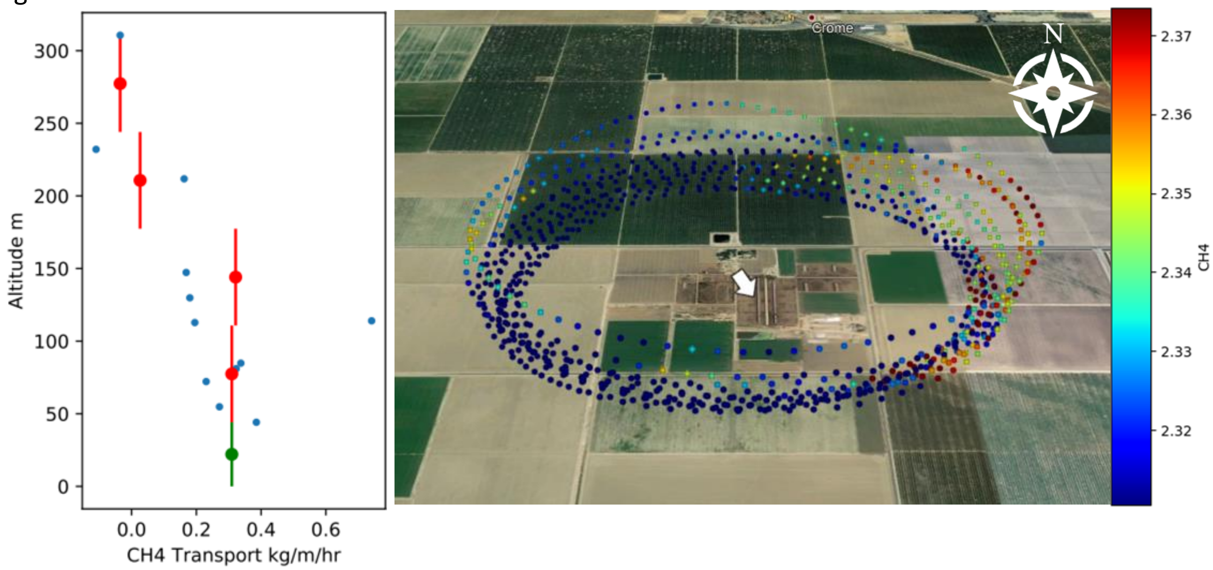

Figure 132. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

132. Dairy #2, 10-29-20

Laps were flown between 50 and 440 m agl. A methane emission of 64 ± 19 kg h^{-1} was calculated. A very low ethane emission of 2.8 ± 1.6 kg h^{-1} was calculated.

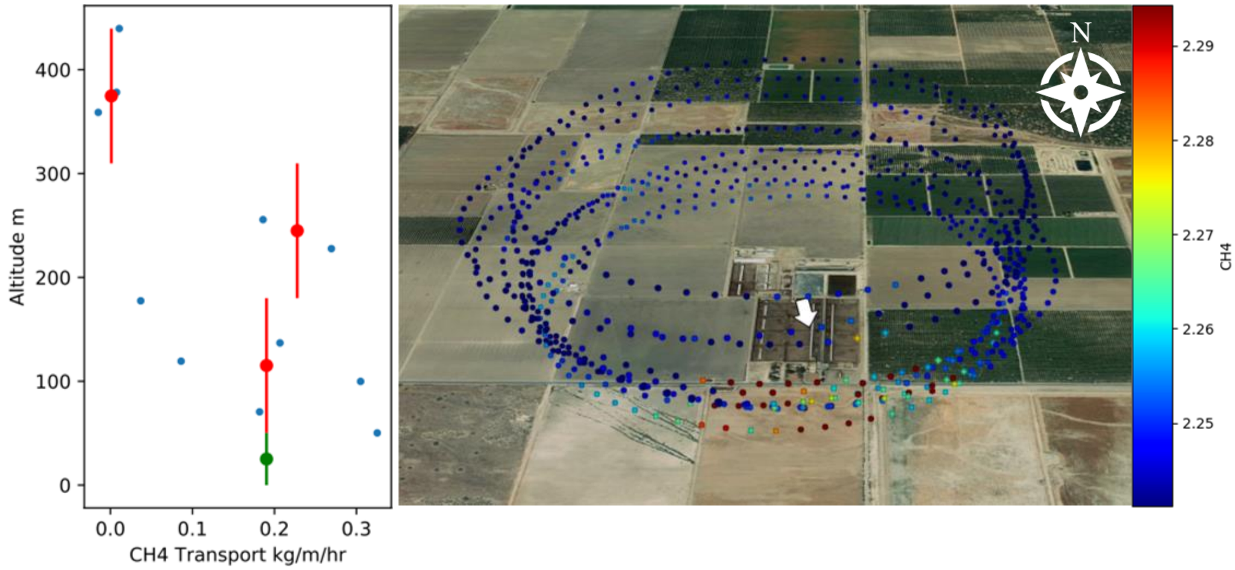

Figure 133. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

133. Dairy #3, 10-13-20

Laps were flown between 212 and 435 m agl. A methane emission of -103 ± 204 kg h^{-1} was calculated. The negative flux number is likely caused by an upwind methane plume transiting the target site. No significant ethane (C_2H_6) was measured at this site.

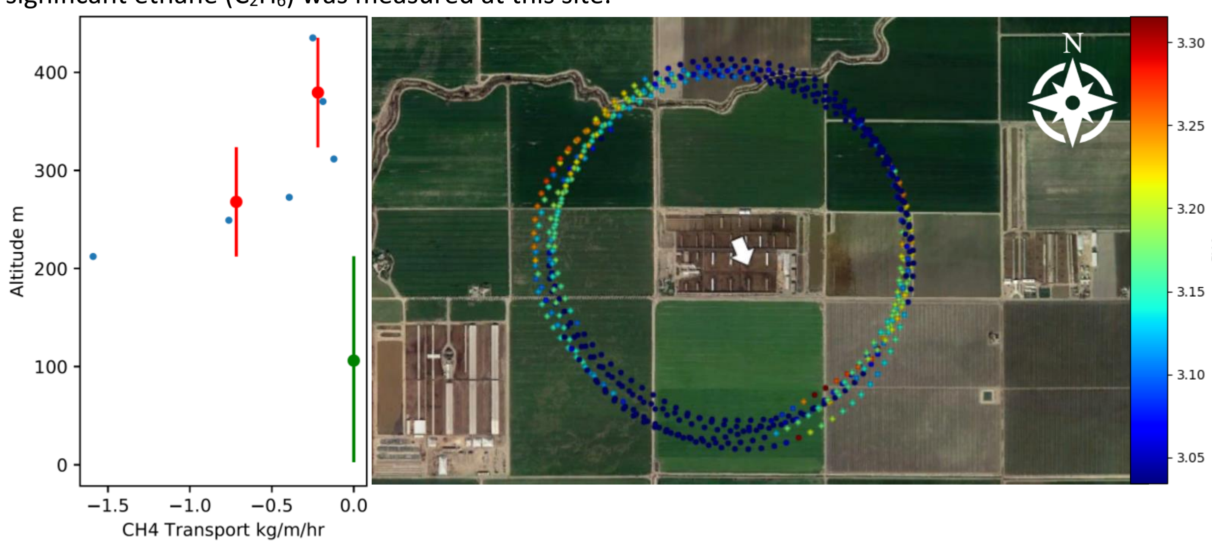

Figure 134. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

134. Dairy #3, 10-30-20

Laps were flown between 44 and 202 m agl. A methane emission of -124 ± 98 kg h^{-1} was calculated. No significant ethane was observed. The negative flux number is likely caused by an upwind methane plume transiting the target site.

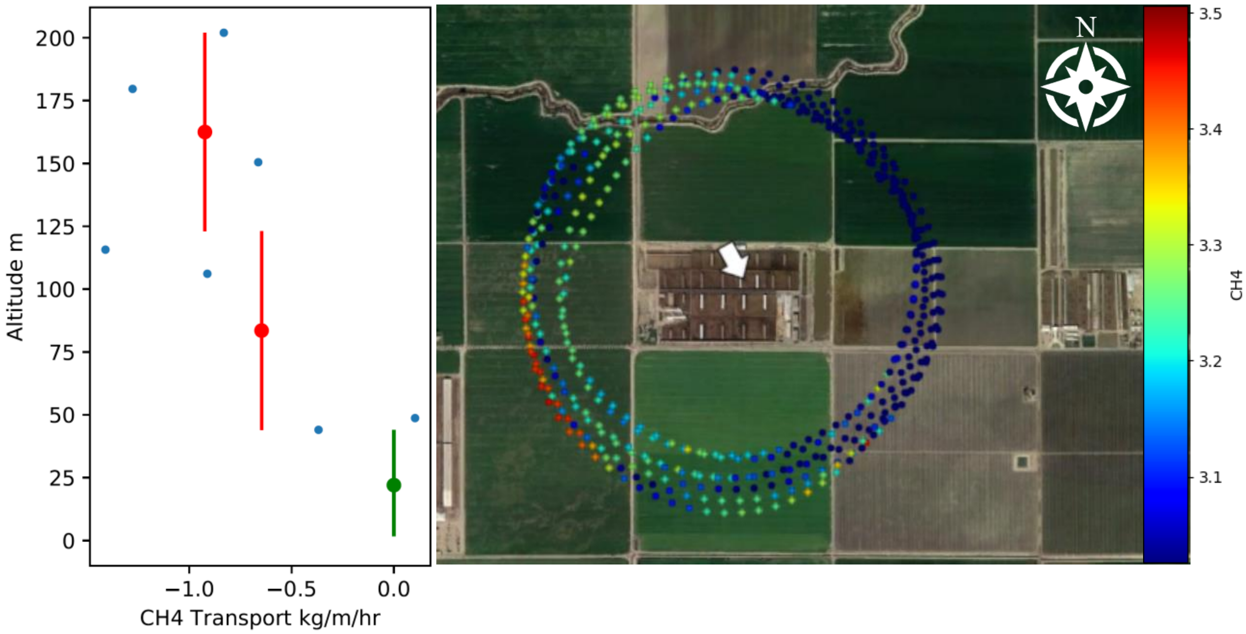

Figure 135. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

135. Dairy #4, 10-31-20

Laps were flown between 52 and 235 m agl. A methane emission of 28 ± 10 kg h^{-1} was calculated. No significant ethane was observed.

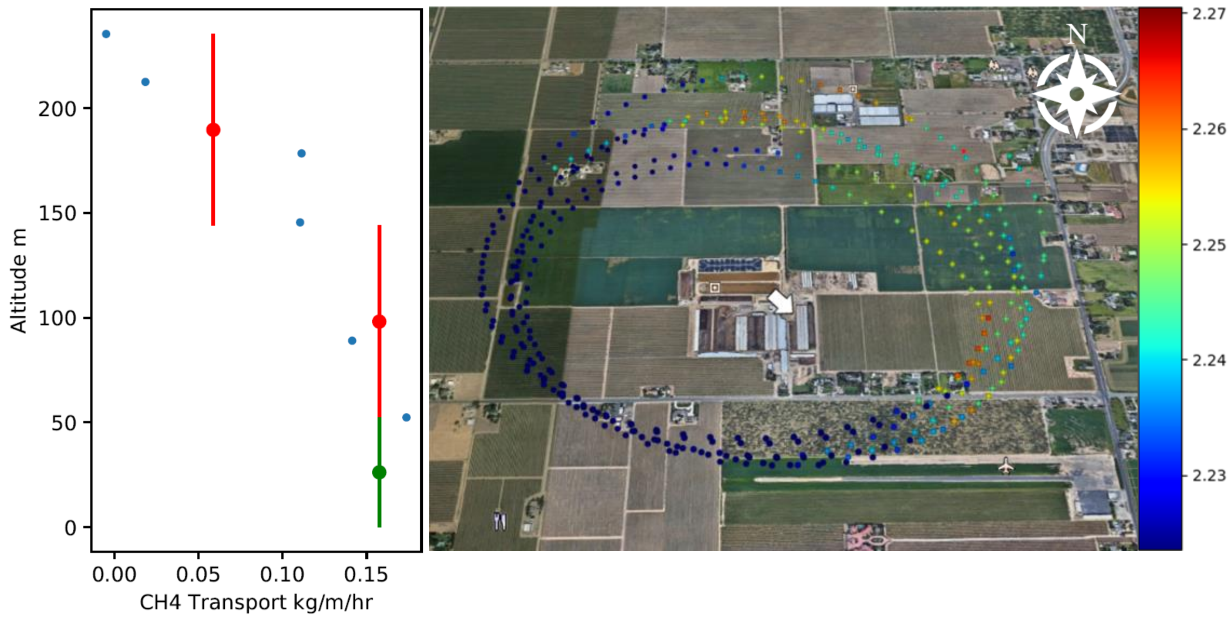

Figure 136. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

136. Dairy #5, 10-13-20

Laps were flown between 71 and 601 m agl. A methane emission of 550 ± 157 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

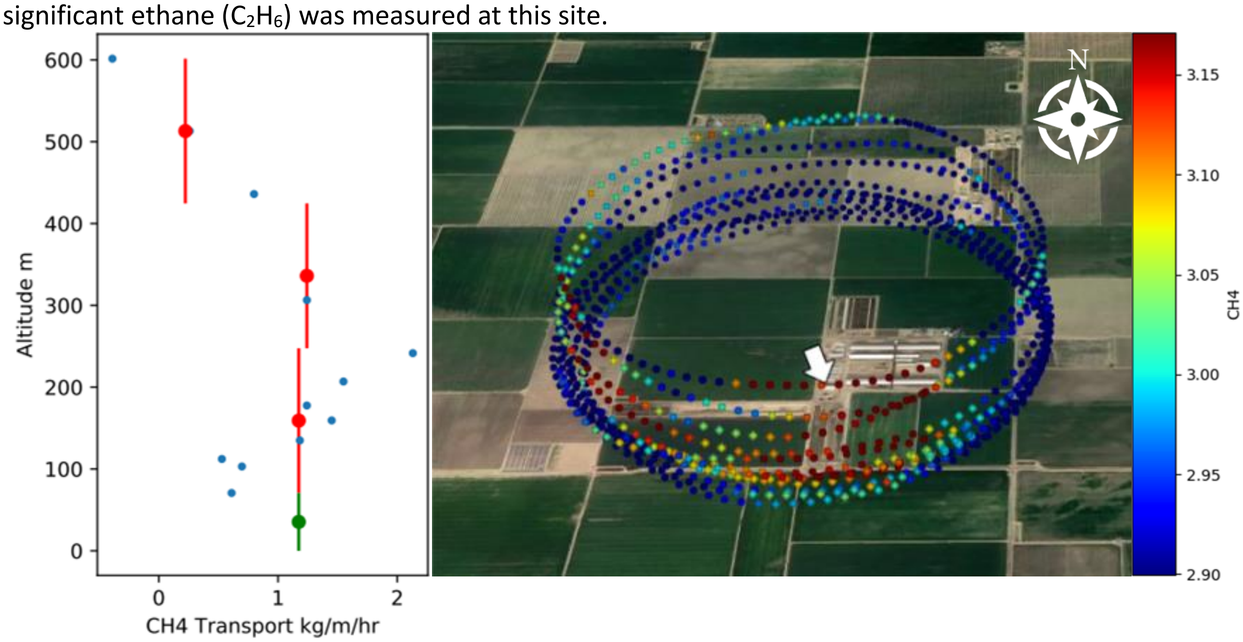

Figure 137. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

137. Dairy #6, 10-13-20

Laps were flown between 76 and 353 m agl. A methane emission of 194 ± 111 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

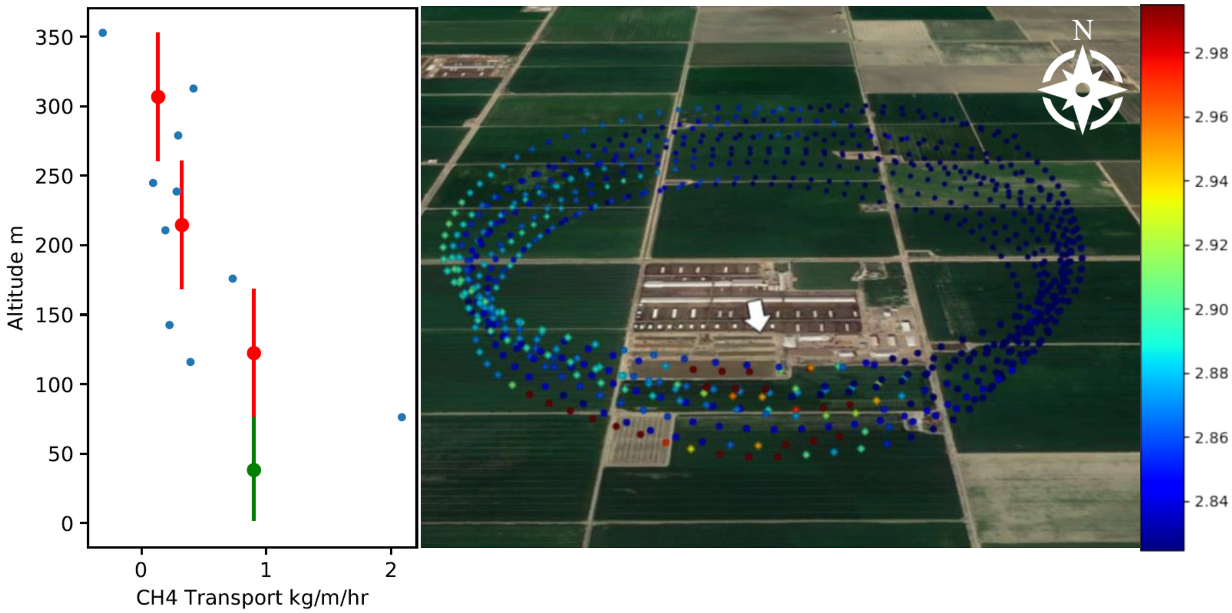

Figure 138. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

138. Dairy #7, 05-23-20

Laps between 147 and 907 m agl were flown, and the methane emission calculated was 365 ± 146 kg h^{-1}.

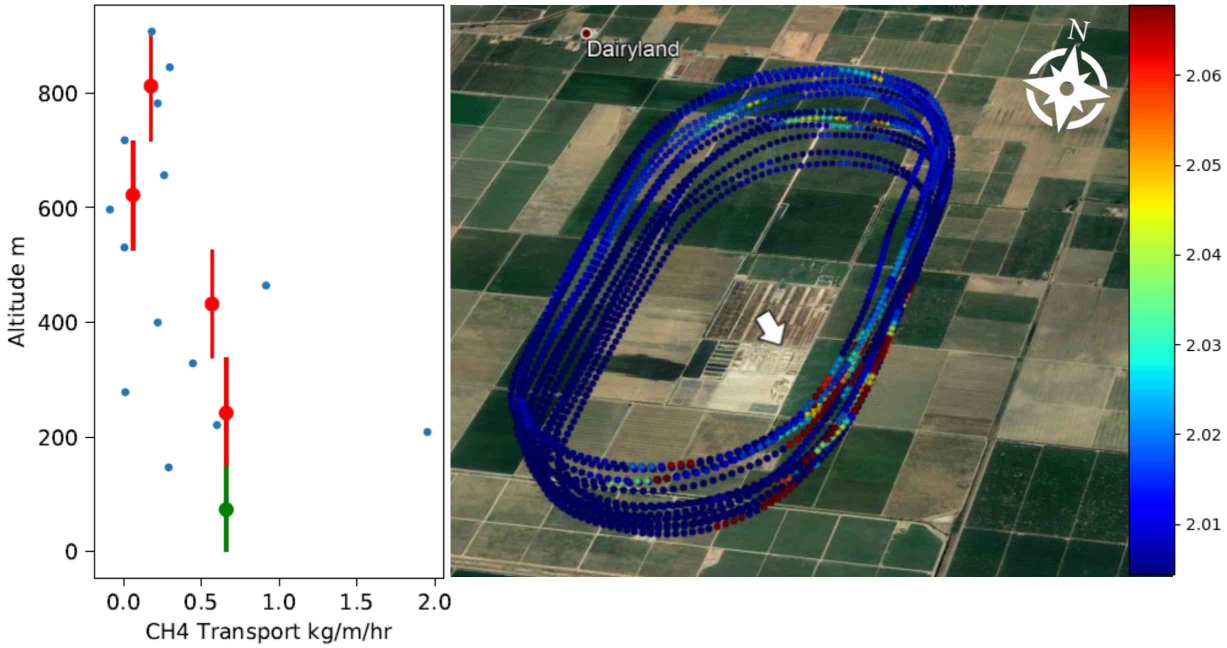

Figure 139. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

139. Dairy #8, 10-30-20

Laps were flown between 60 and 299 m agl. A methane emission of 69 ± 24 kg h^{-1} was calculated. No significant ethane was observed.

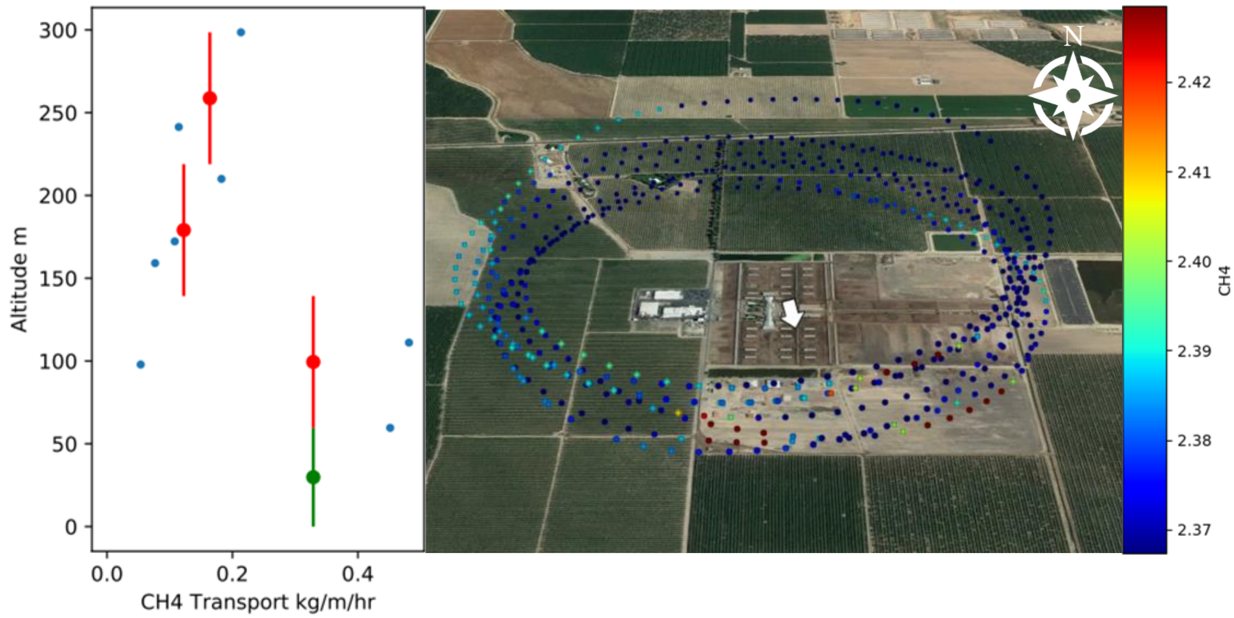

Figure 140. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

140. Dairy #9, 10-13-20

Laps were flown between 56 and 556 m agl. A methane emission of 149 ± 131 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

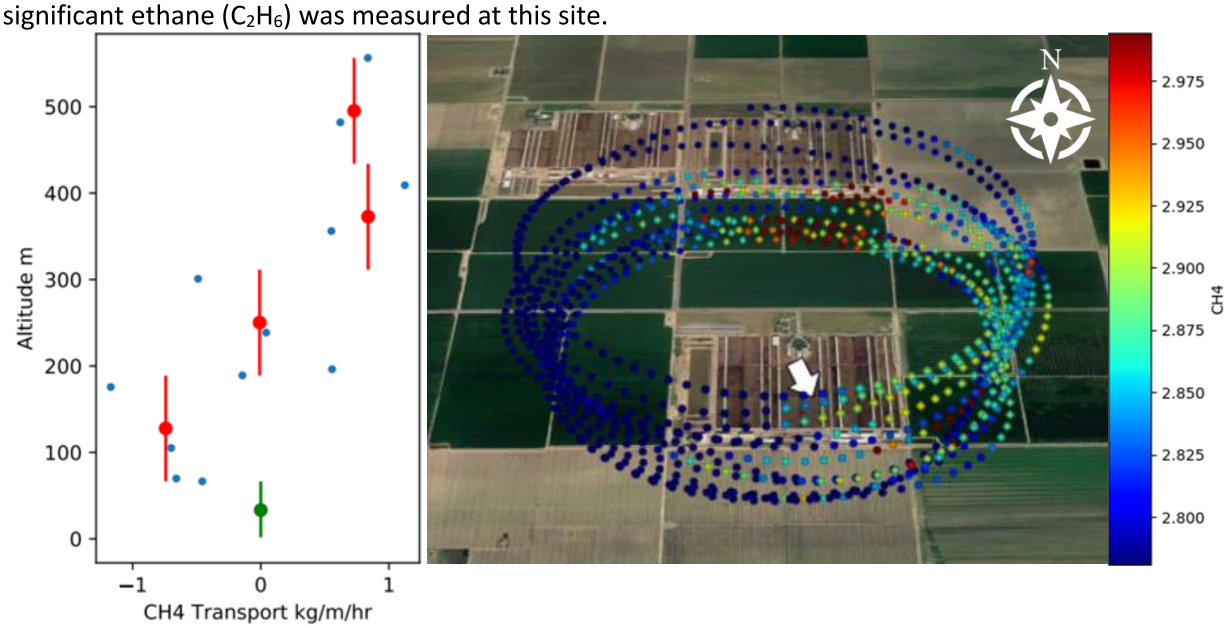

Figure 141. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

141. Dairy #10, 10-13-20

Laps were flown between 84 and 186 m agl. A methane emission of 42 ± 71 kg h^{-1} was calculated. Some upwind methane (northwest of the site) was evident, leading to increased uncertainty. No significant ethane (C_2H_6) was measured at this site.

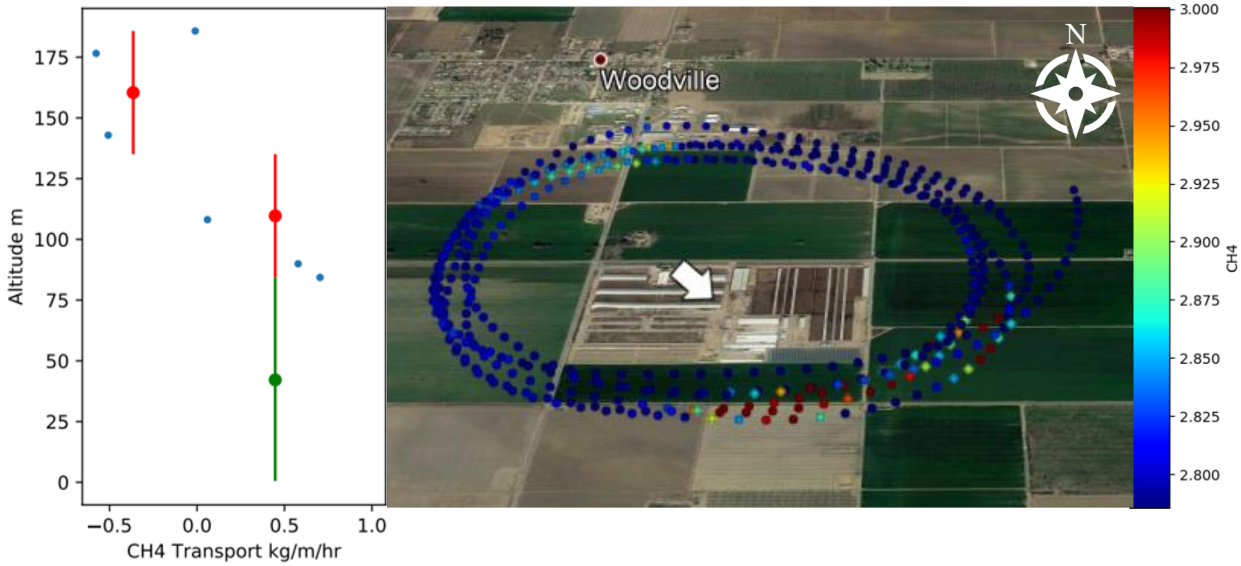

Figure 142. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

142. Dairy #11, 10-13-20

Laps were flown between 56 and 307 m agl. A methane emission of 455 ± 153 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

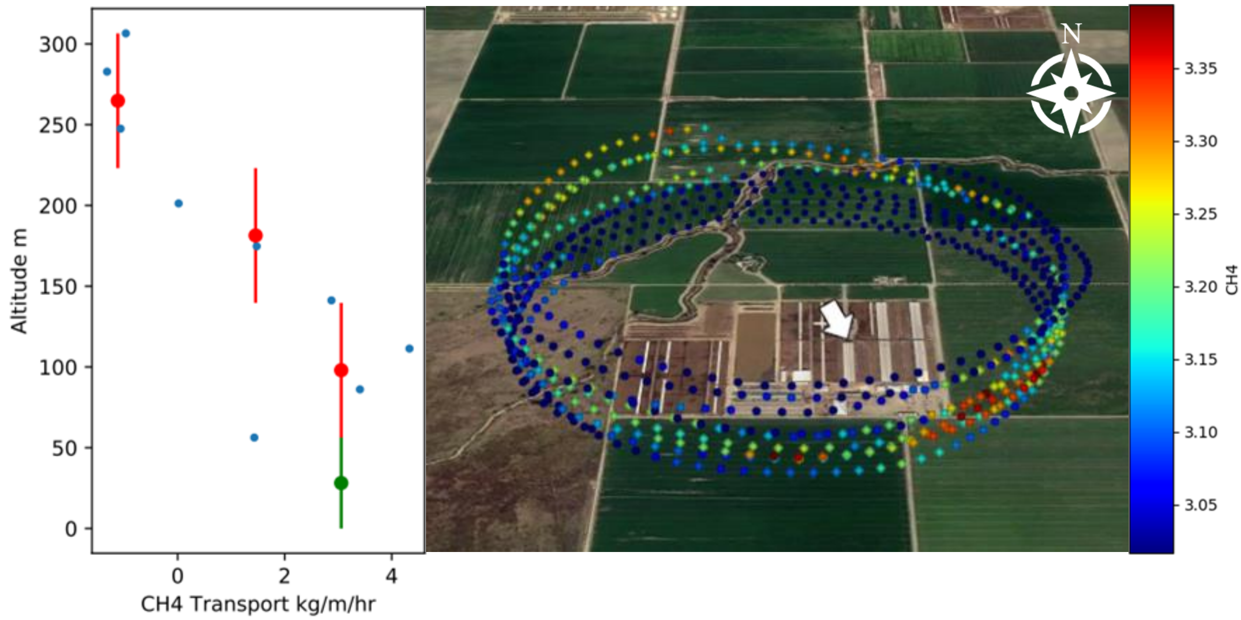

Figure 143. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

143. Dairy #12, 05-23-20

The aircraft flew laps between 158 and 495 m agl, and the calculated methane emission was 116 ± 58 kg h^{-1}.

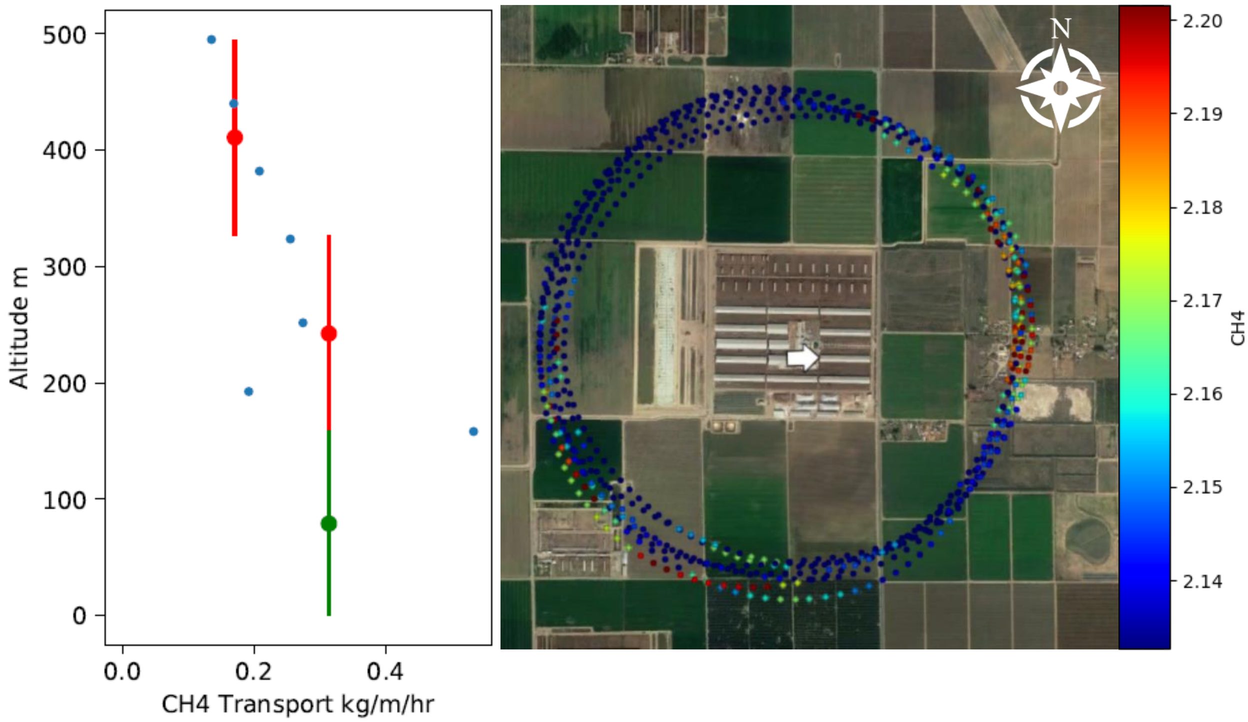

Figure 144. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

144. Dairy #12, 10-30-20

Laps were flown between 61 and 418 m agl. A methane emission of 663 ± 165 kg h^{-1} was calculated. A small ethane emission of 4.4 ± 2.1 kg h^{-1} was calculated.

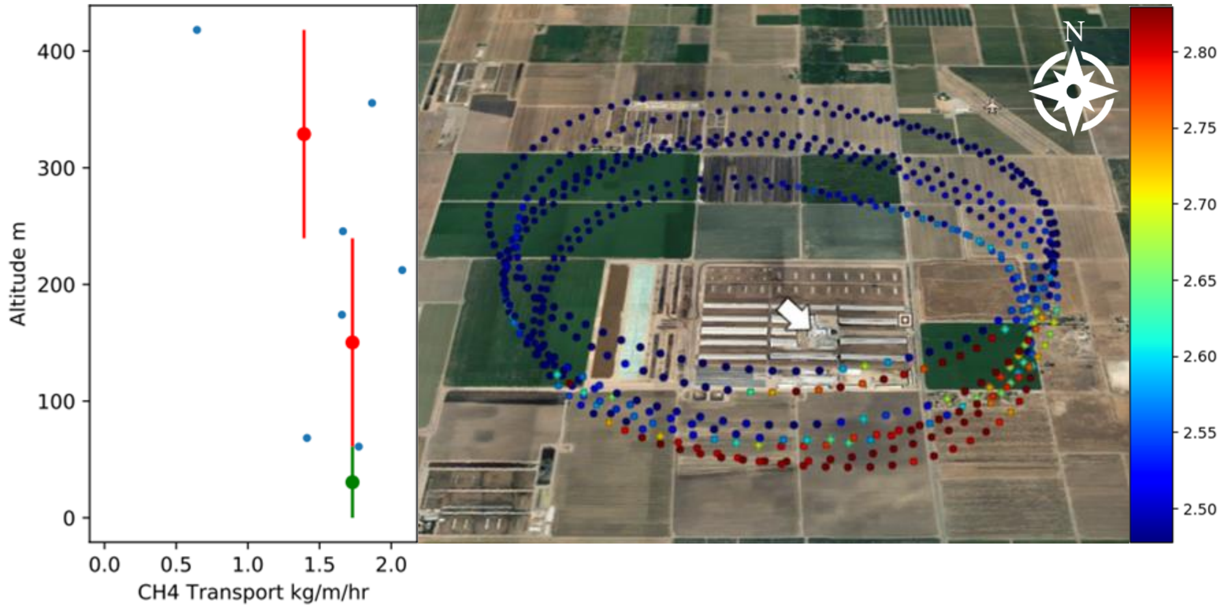

Figure 145. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

145. Dairy #13, 10-13-20

Laps were flown between 200 and 437 m agl. A methane emission of 8 ± 95 kg h^{-1}, below our methane detection limit of < 10 kg h^{-1}, was calculated. There may be a small methane emission from this site, as there are a few downwind methane peaks observed, but the low winds and fluctuating background methane lead to high uncertainty. No significant ethane (C_2H_6) was measured at this site.

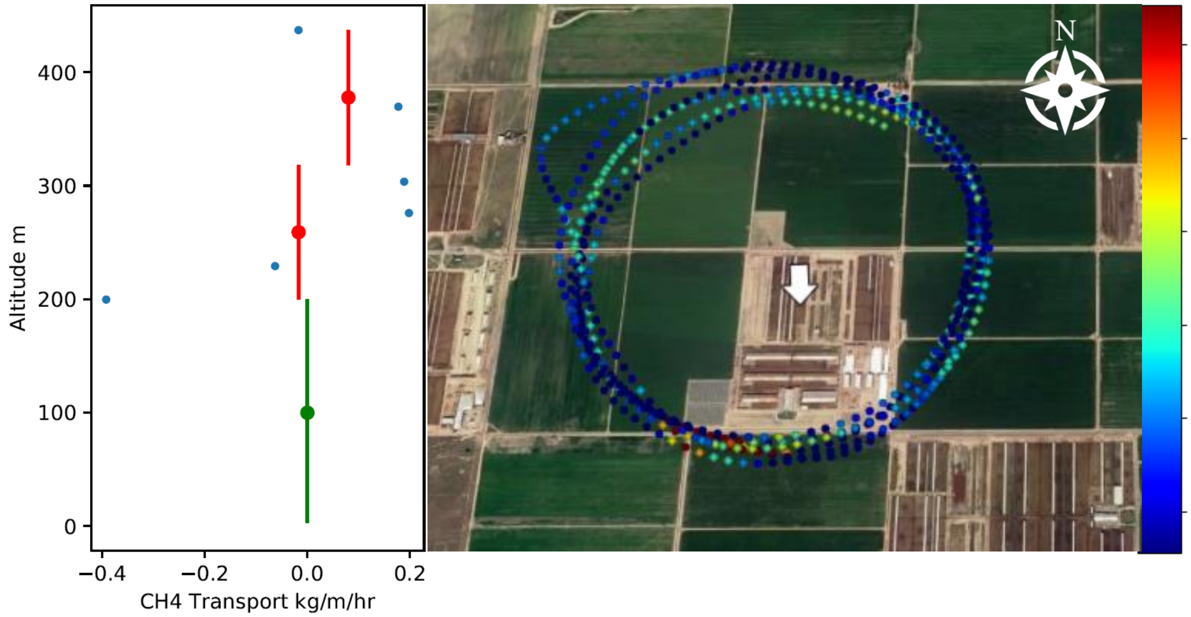

Figure 146. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

146. Dairy #14, 10-31-20

Laps were flown between 52 and 596 m agl. A methane emission of 166 ± 53 kg h^{-1} was calculated. No significant ethane was observed.

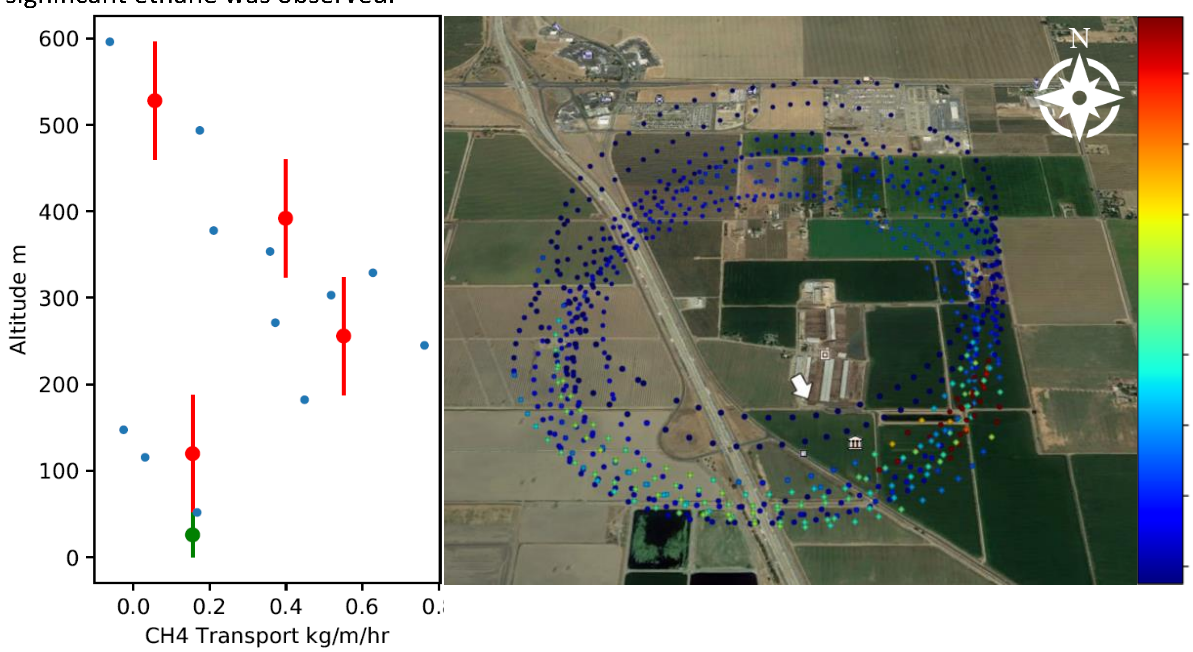

Figure 147. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

147. Dairy #15, 10-13-20

Laps were flown between 67 and 436 m agl. A methane emission of 534 ± 217 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

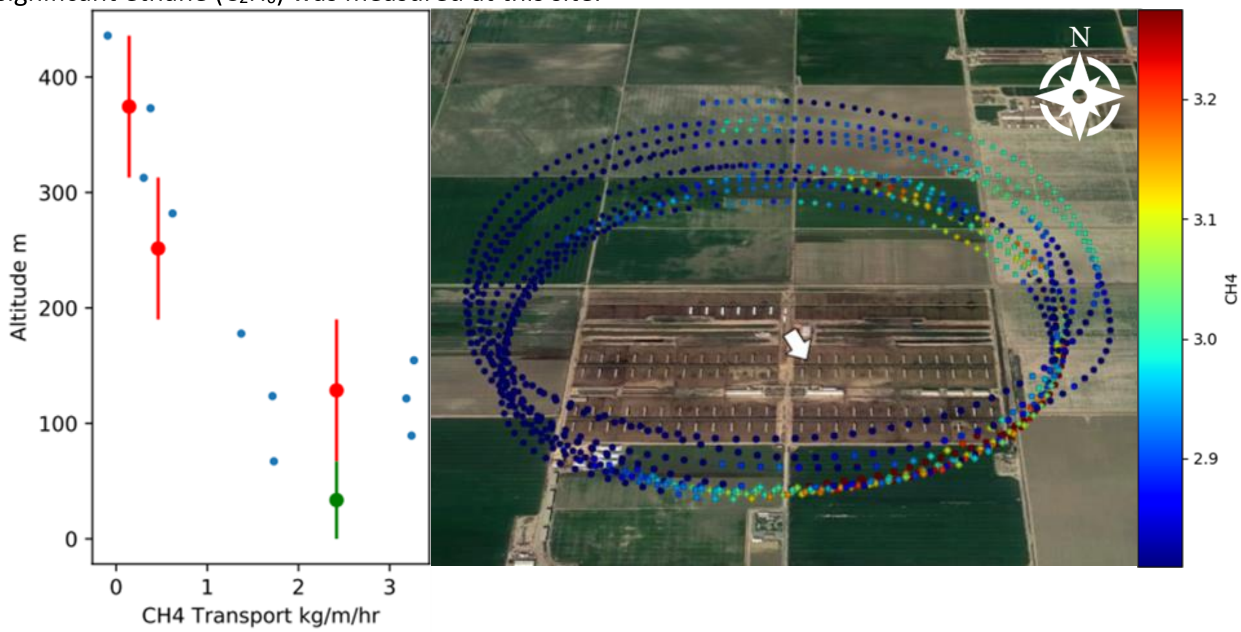

Figure 148. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

148. Dairy #16, 10-30-20

Laps were flown between 44 and 341 m agl. A methane emission of 230 ± 81 kg h^{-1} was calculated. No significant ethane was observed.

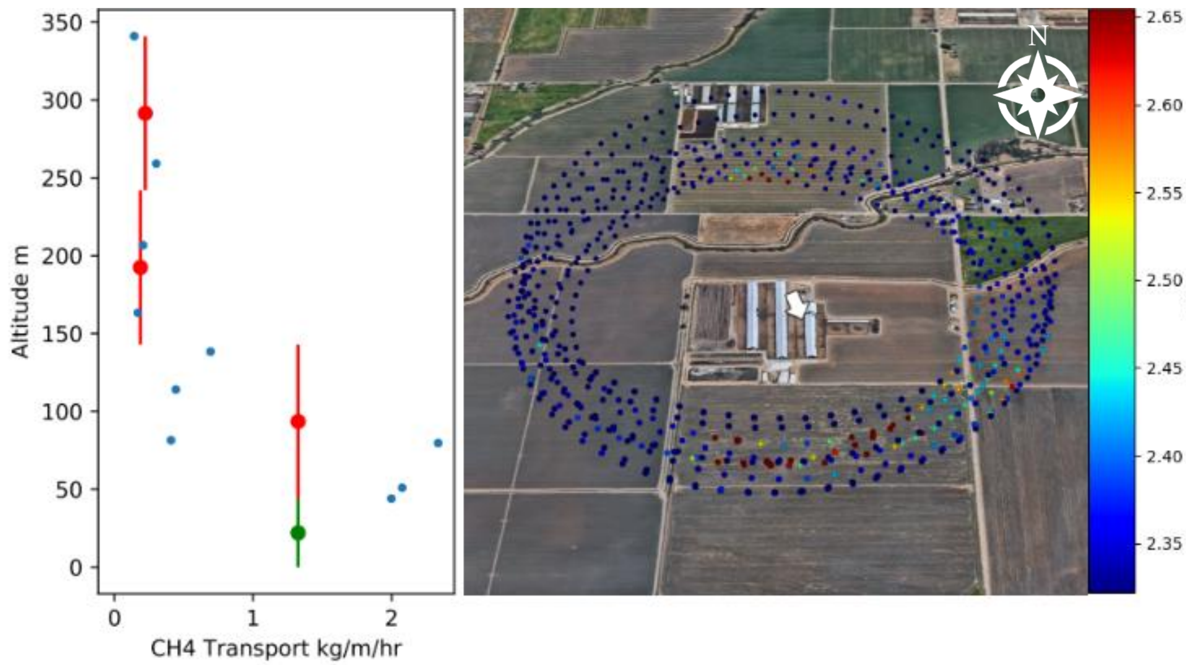

Figure 149. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

149. Dairy #17, 10-30-20

Laps were flown between 73 and 312 m agl. A methane emission of 29 ± 14 kg h^{-1} was calculated. No significant ethane was observed.

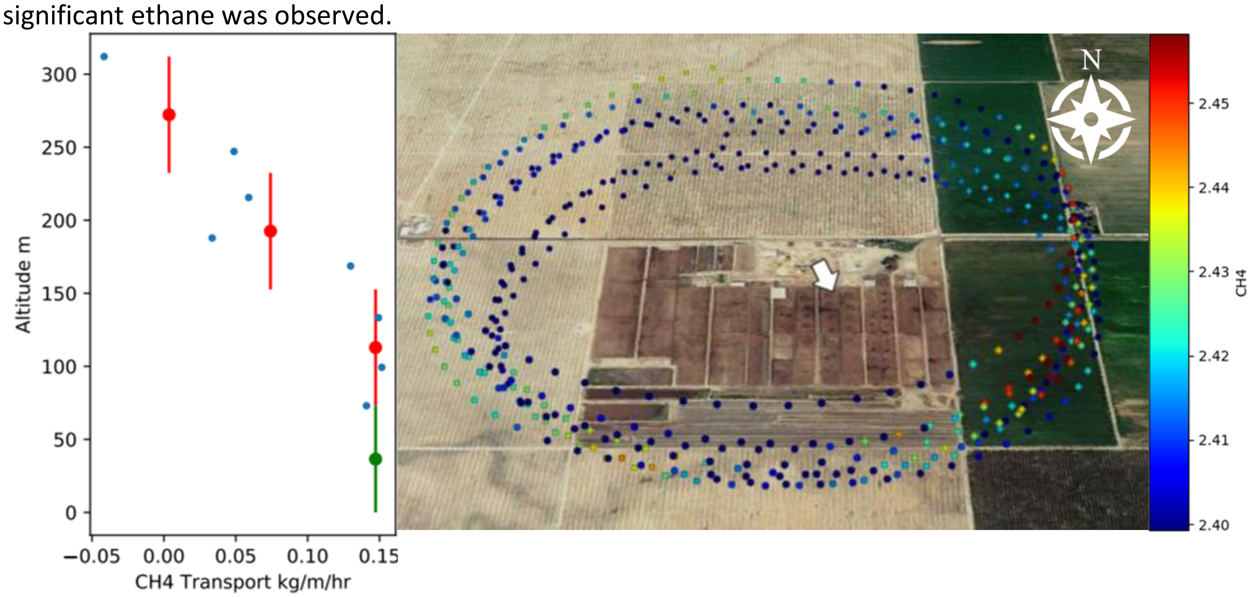

Figure 150. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

150. Dairy #18, 10-13-20

Laps were flown between 64 and 548 m agl. A methane emission of 352 ± 134 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

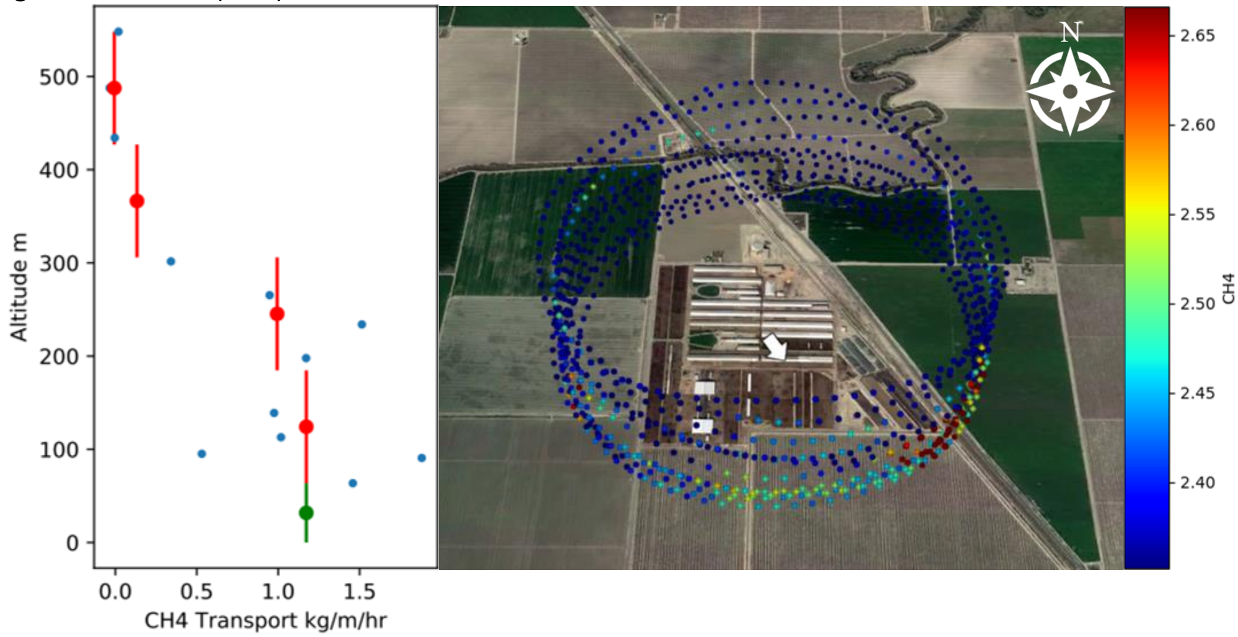

Figure 151. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

151. Dairy #19, 10-13-20

Laps were flown between 72 and 305 m agl. A methane emission of 80 ± 54 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

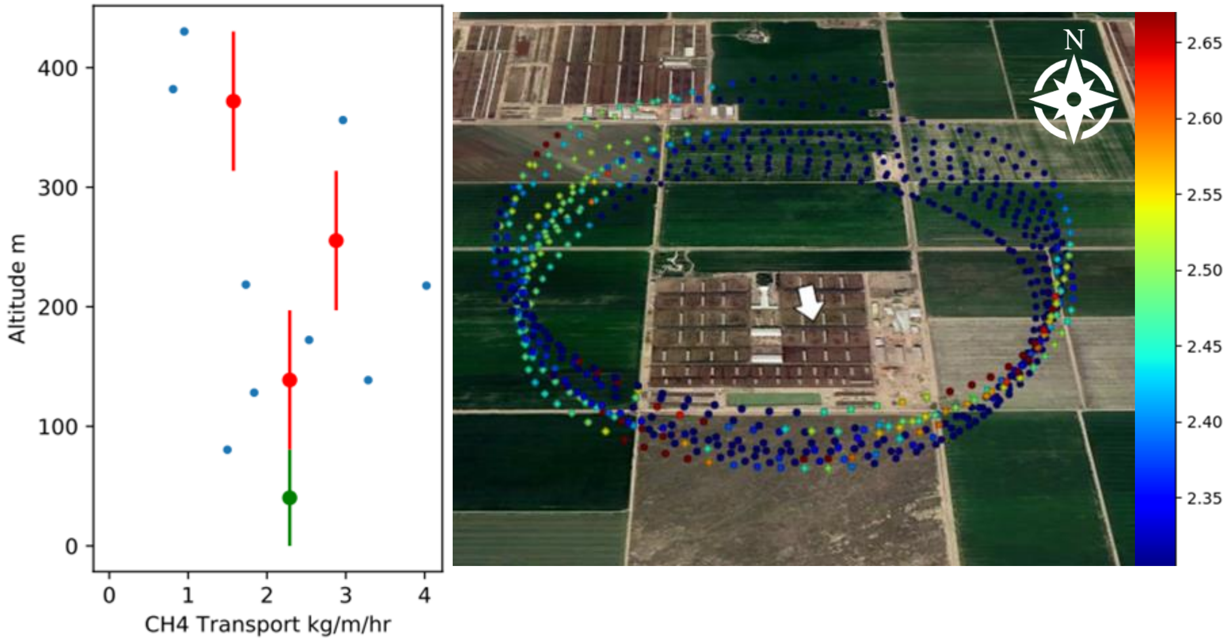

Figure 152. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

152. Dairy #20, 10-13-20

Laps were flown between 75 and 470 m agl. A methane emission of 338 ± 83 kg h^{-1} was calculated. No significant ethane (C_2H_6) was measured at this site.

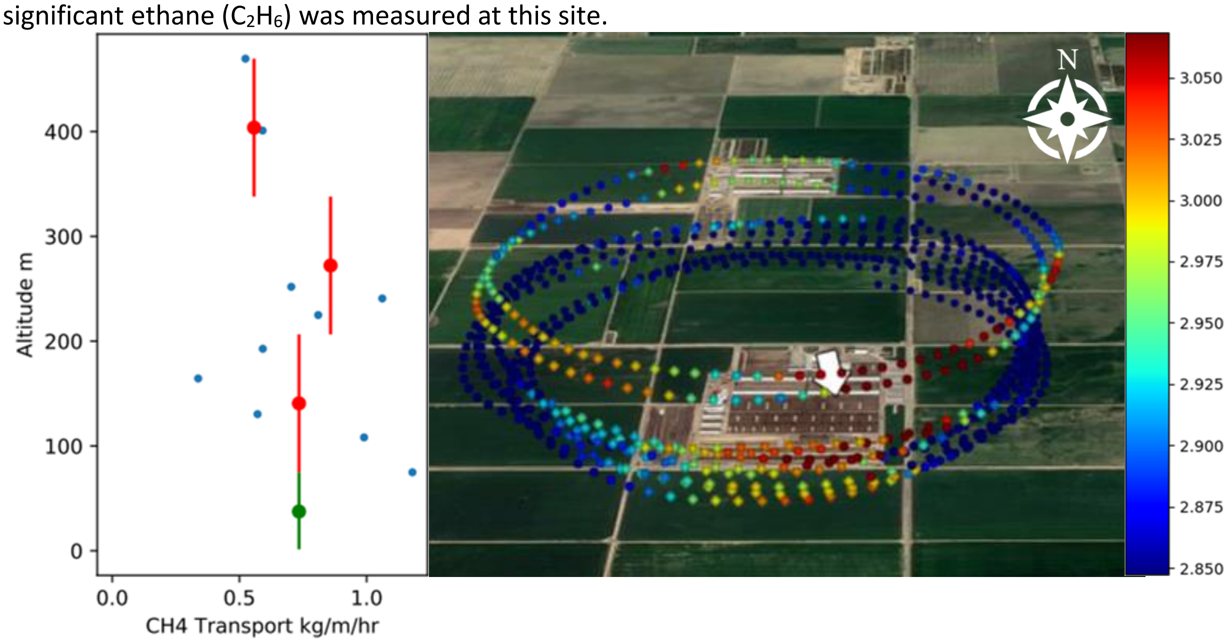

Figure 153. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

153. Dairy #21, 05-23-20

Laps were flown between 159 and 906 m agl, and the methane emission estimate was 488 ± 155 kg h^{-1}.

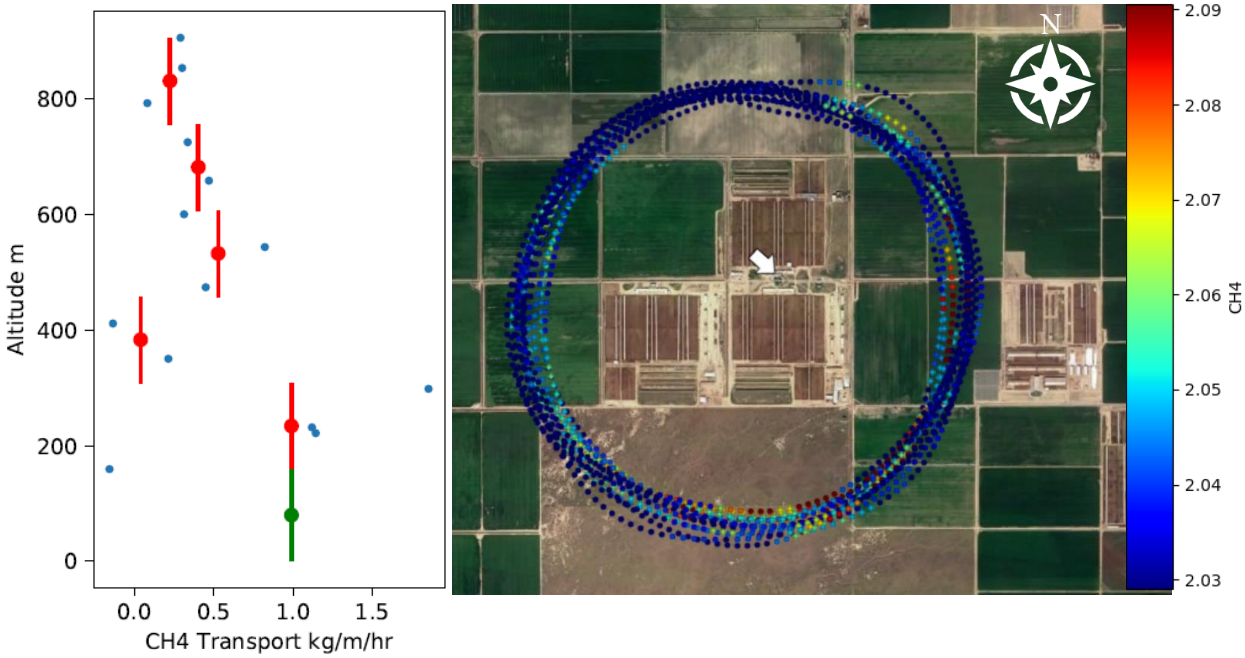

Figure 154. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

154. Dairy #22 10-30-20

Laps were flown between 43 and 390 m agl. A methane emission of 107 ± 52 kg h^{-1} was calculated. A small ethane emission of 2.0 ± 1.6 kg h^{-1} was calculated.

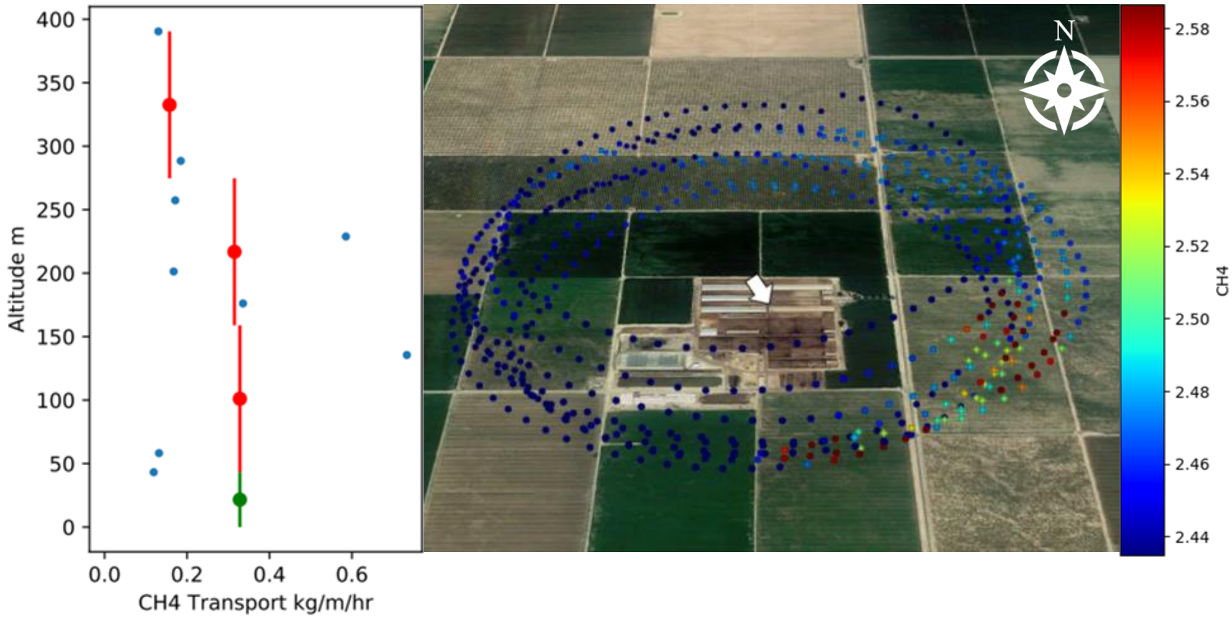

Figure 155. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

155. Dairy #23, 05-23-20

The aircraft flew laps between 159 and 886 m agl, and the estimated methane emission was 431 ± 102 kg h^{-1}.

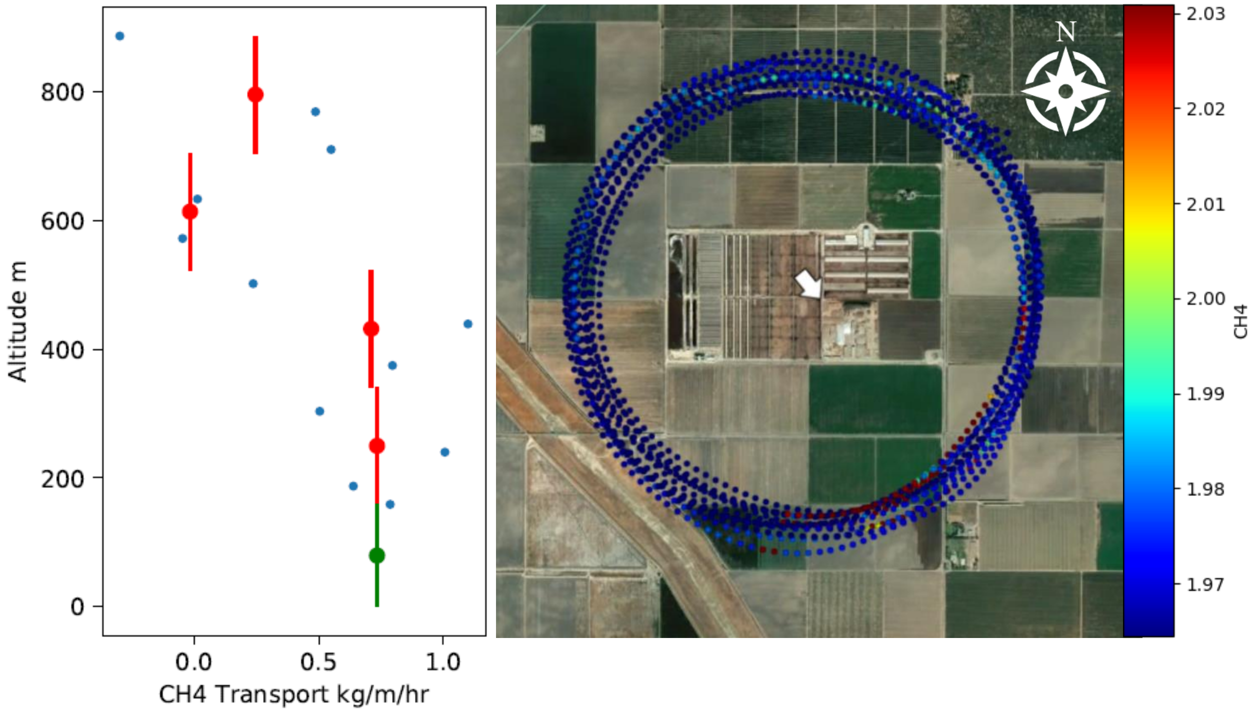

Figure 156. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

156. Dairy #24, 05-23-20

Laps were flown between 148 and 771 m agl, and methane emissions were estimated to be 915 ± 356 kg h^{-1}.

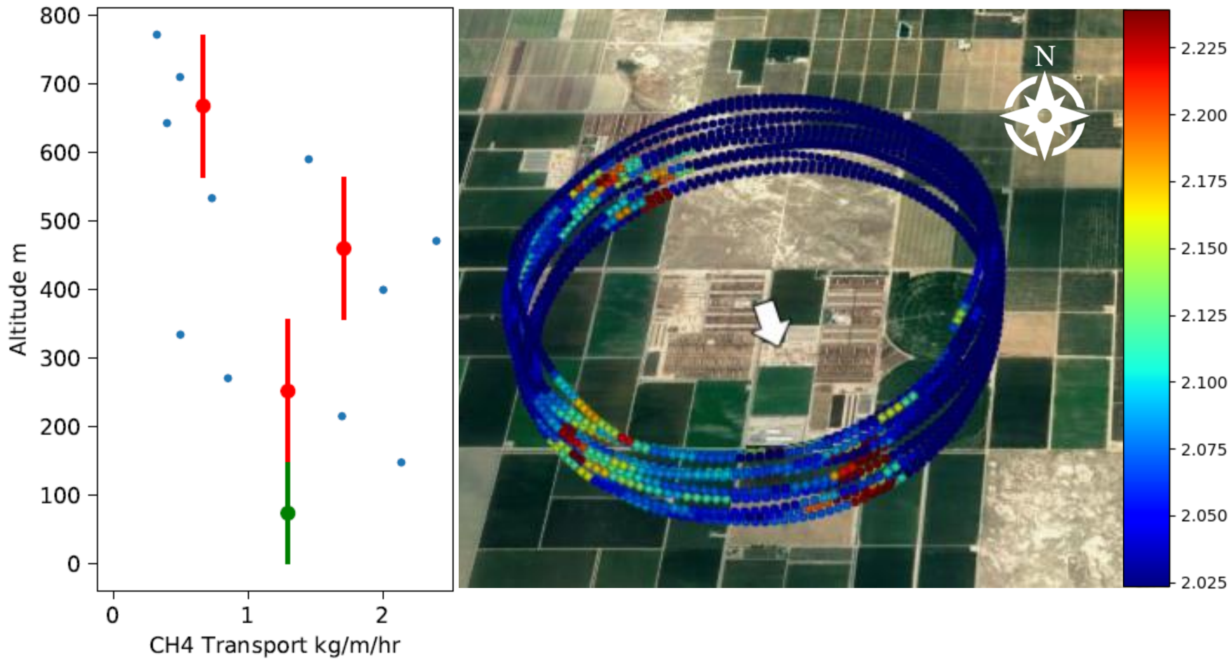

Figure 157. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

157. Dairy #25, 10-30-20

Laps were flown between 137 and 406 m agl. A methane emission of 87 ± 70 kg h^{-1} was calculated. No significant ethane was observed.

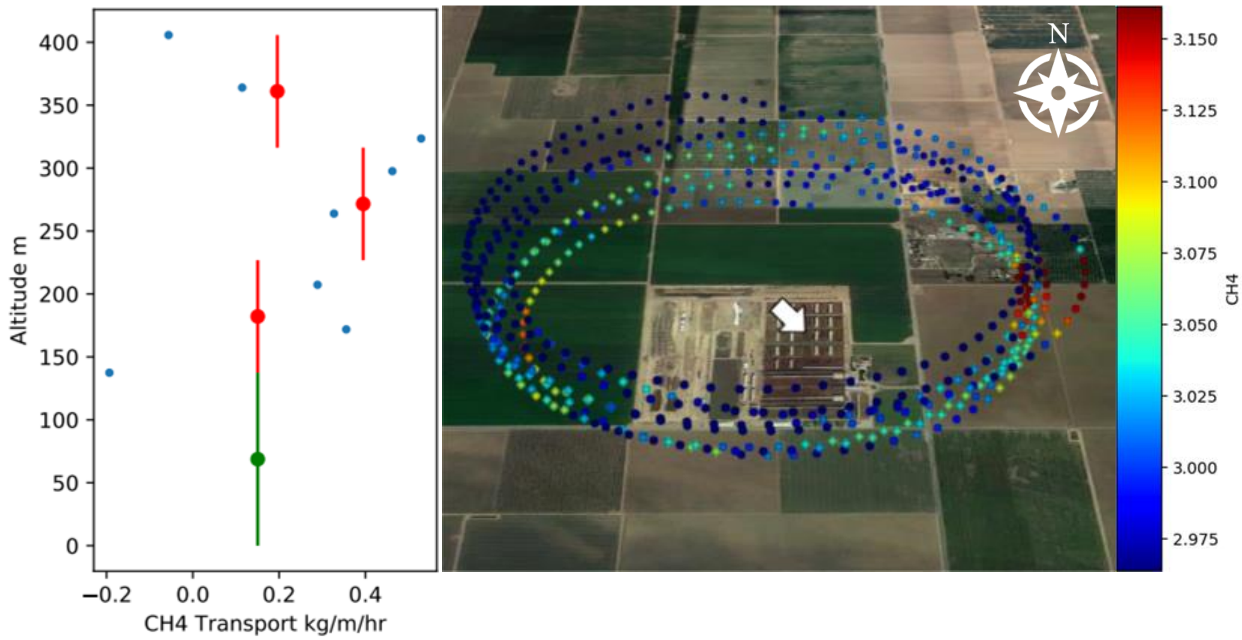

Figure 158. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

V.III. Oil and Gas

158. Adelanto Compressor Station, 10-16-20

Laps were flown between 104 and 624 above ground level (agl). A methane emission of 12 ± 5 kg h^{-1} was calculated. No significant ethane emission was observed.

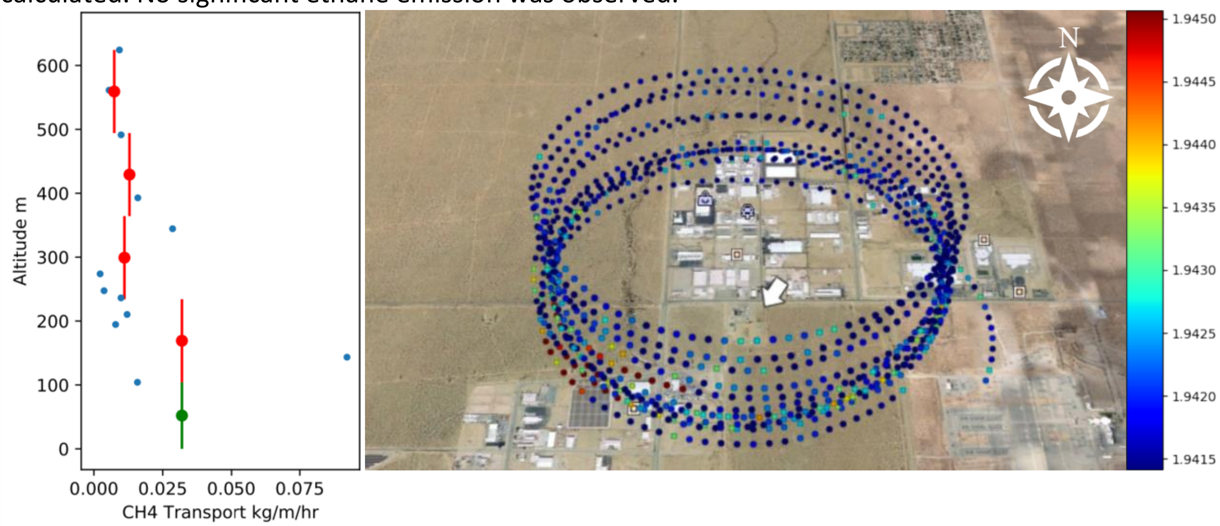

Figure 159. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

159. Aliso Canyon Gas Storage, 01-13-20

The wind during sampling was weak and inconsistent throughout the measurement. The wind also shifted significantly during the measurement, which contributed to the enhancements being observed at different points along the flight path. Thus, a quantification is not possible from these measurements. However, the site is likely emitting some methane, as enhancements can be seen downwind on some of the (southeast) of the laps.

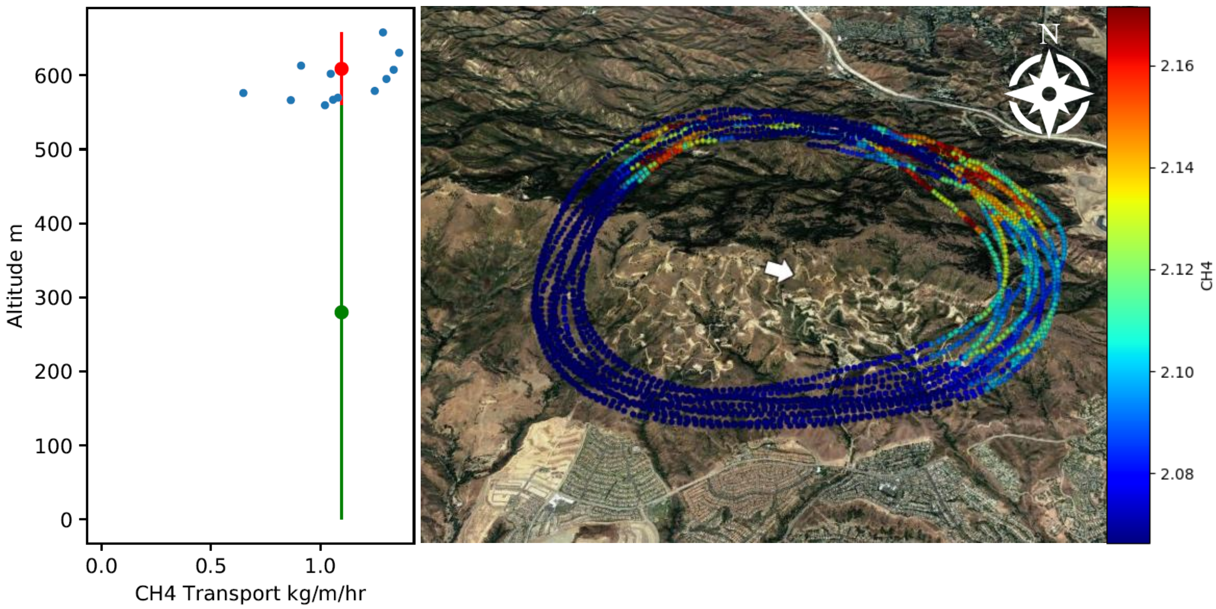

Figure 160. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

160. Aliso Canyon Gas Storage, 07-15-20

Laps were flown between 343 and 973 m agl. The lowest laps of the measurements show an identifiable, significant methane enhancement on the downwind portion of the flight path, but methane contamination from upwind sources is evident in all laps, and skews the estimates for each lap, for the most part, to negative flux values. This problem will likely be mitigated as winds shift to north or east orientations, where there are fewer possible sources for upwind methane contamination. With north/northeast winds, the aircraft will also be able to measure at lower altitudes because straight transects on the downwind side can be flown over flat terrain (see Conley et al, 2016, Science), rather than along a mountain ridge. Flying along or over the mountain ridge necessitates higher altitudes (i.e., a higher safety margin between aircraft and ground) because of increased turbulence.

The estimate given of 15 ± 115 kg h^{-1} methane, derived from the lowest two laps, is almost certainly an underestimate. For reference, the measured laps at higher altitudes are also shown.

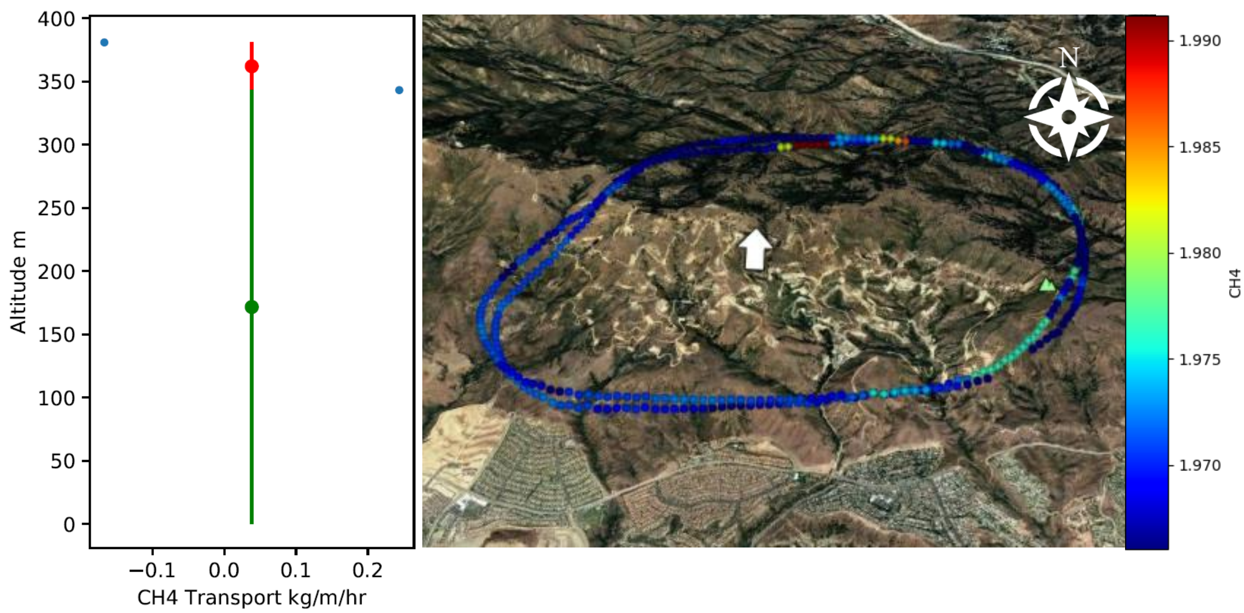

Figure 161. The two laps around Aliso with clear downwind peaks and minimal upwind methane. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

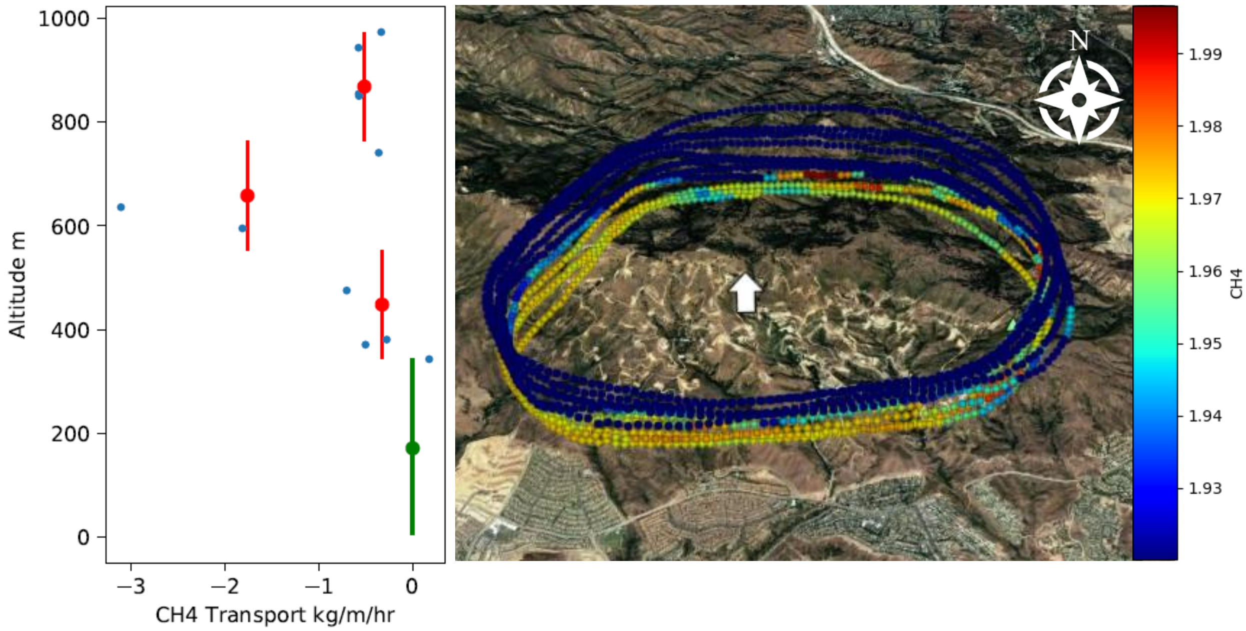

Figure 162. Full Aliso measurement showing some downwind enhancements but also significant upwind methane. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

161. Aliso Canyon Gas Storage, 10-29-20

Laps were flown between 303 and 985 m agl. A methane emission of 34 ± 13 kg h^{-1} was calculated. A highly uncertain ethane emission of 5.2 ± 15.1 kg h^{-1} was calculated. Downwind transects were used for this measurement because the aircraft can get a closer to the ground when not having to navigate the steep terrain. Additionally, north/northeast winds, as observed for this measurement, are ideal for Aliso Canyon measurements because there are negligible upwind sources of methane.

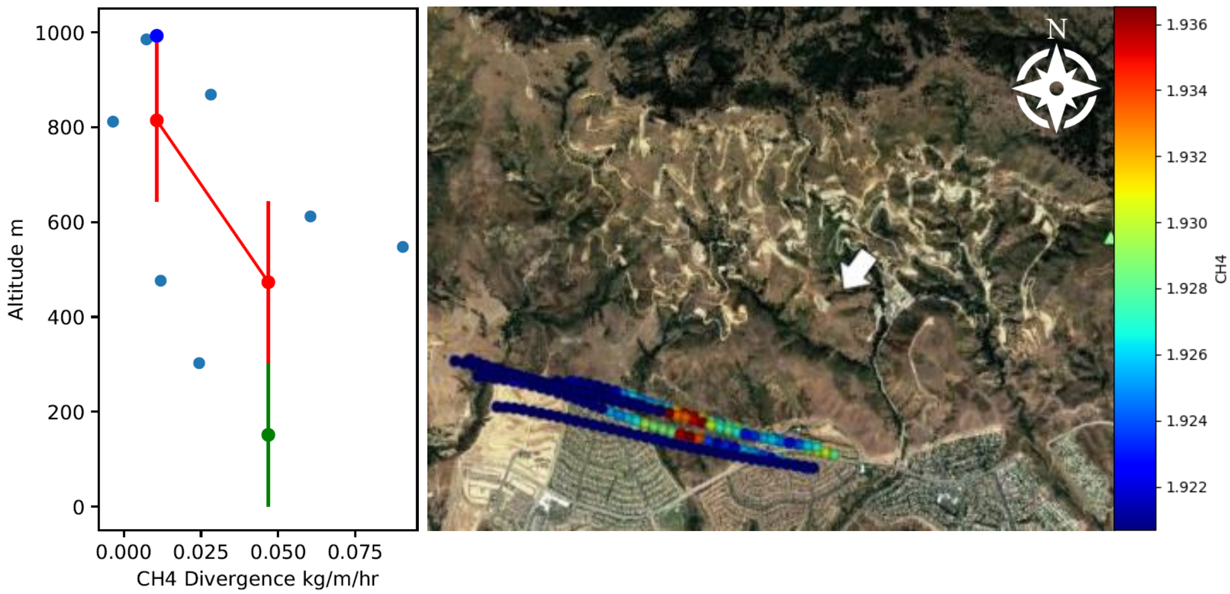

Figure 163. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

162. Allen Co, 07-16-20

Laps were flown between 205 and 484 m agl. A methane emission of 13 ± 7 kg h^{-1} was calculated.

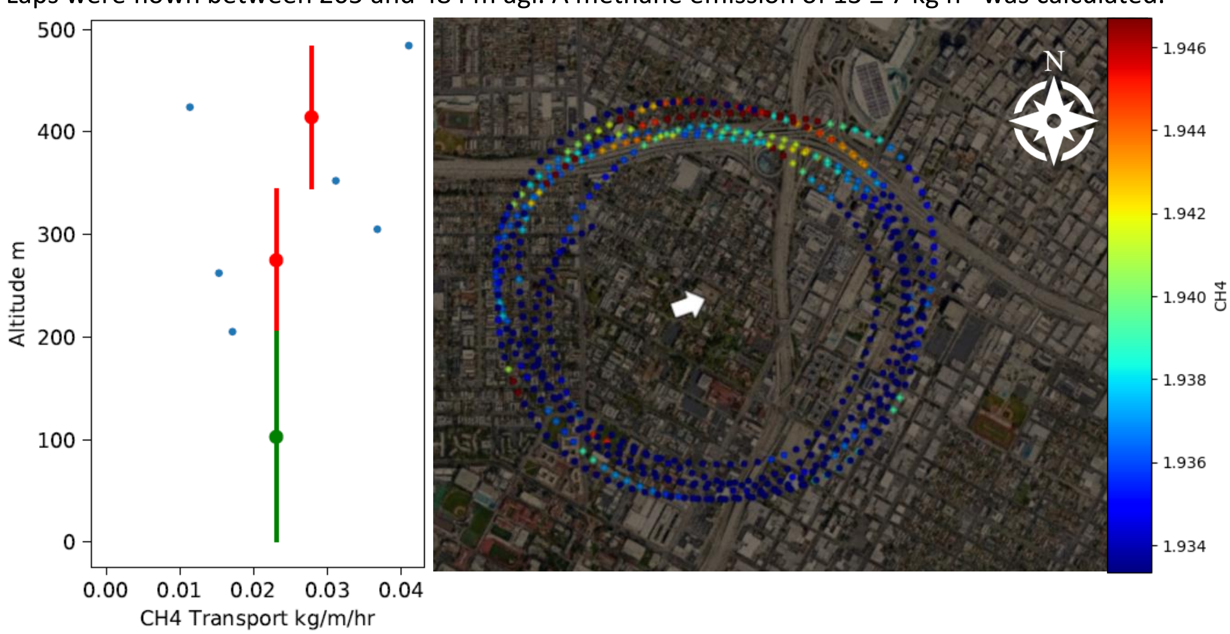

Figure 164. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

163. Belridge North, 10-14-20

Laps were flown between 69 and 597 m agl. A methane emission of -196 ± 49 kg h^{-1} was calculated. Broad upwind methane entering the target area cause the negative emissions number.

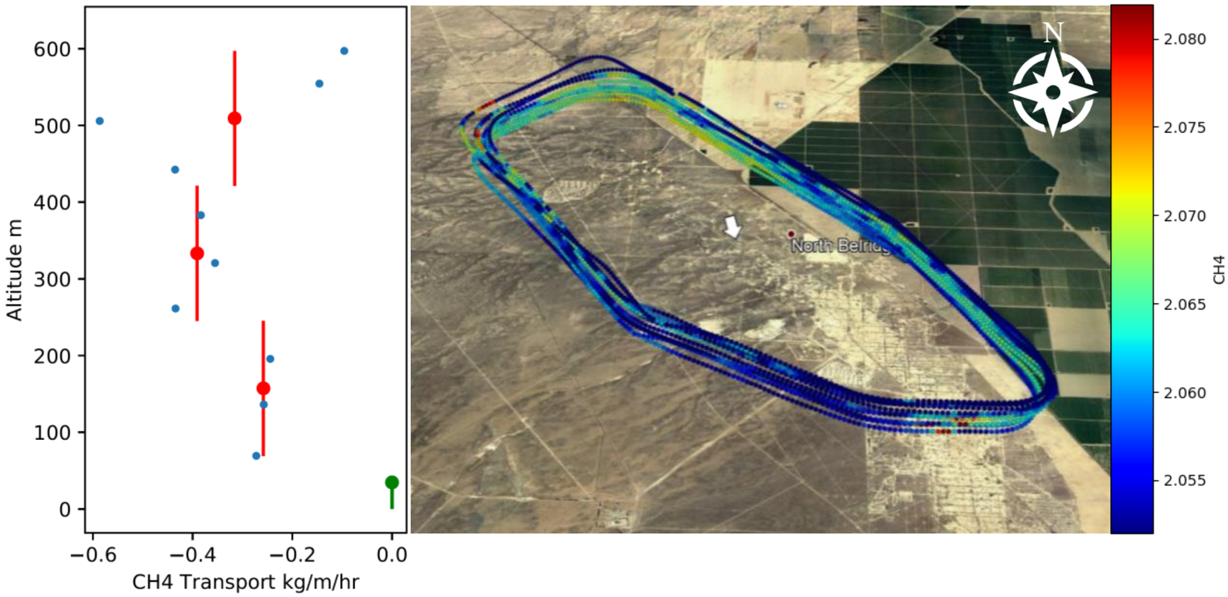

Figure 165. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

164. Belridge North, 10-30-20

Laps were flown between 50 and 256 m agl. A methane emission of 151 ± 49 kg h^{-1} was calculated. An ethane emission of 3.0 ± 2.6 kg h^{-1} was observed.

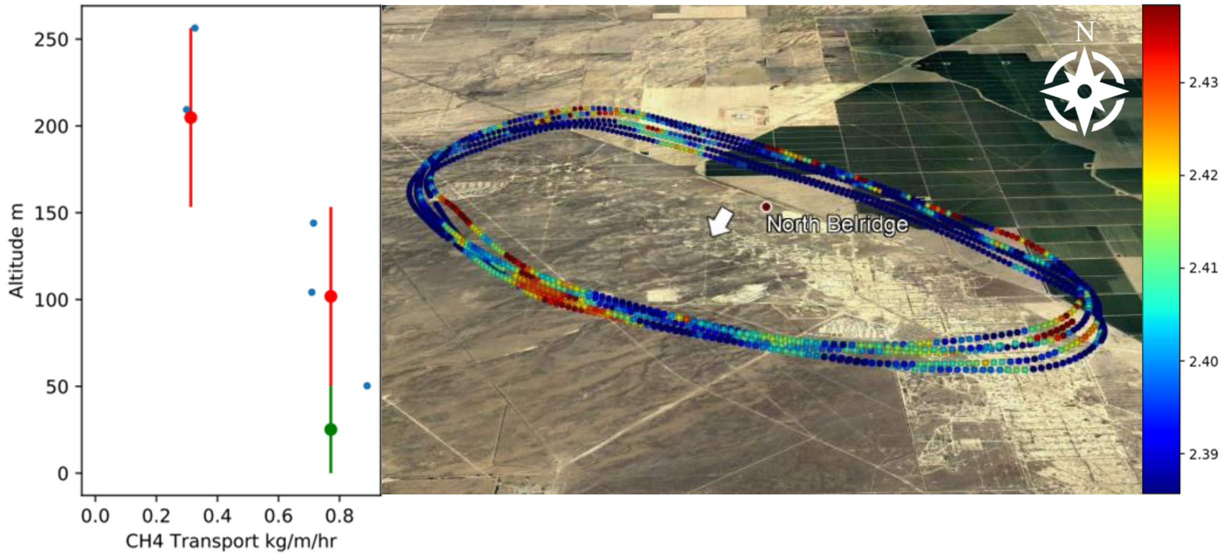

Figure 166. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

165. Belridge South, 10-14-20

Laps were flown between 72 and 249 m agl. A methane emission of 400 ± 128 kg h^{-1} was calculated. An ethane emission of 5.7 ± 2.3 kg h^{-1} was calculated. Although the ethane estimate is below our detection limit as defined as 10 kg h^{-1}, the central estimate is greater than zero based on the uncertainty.

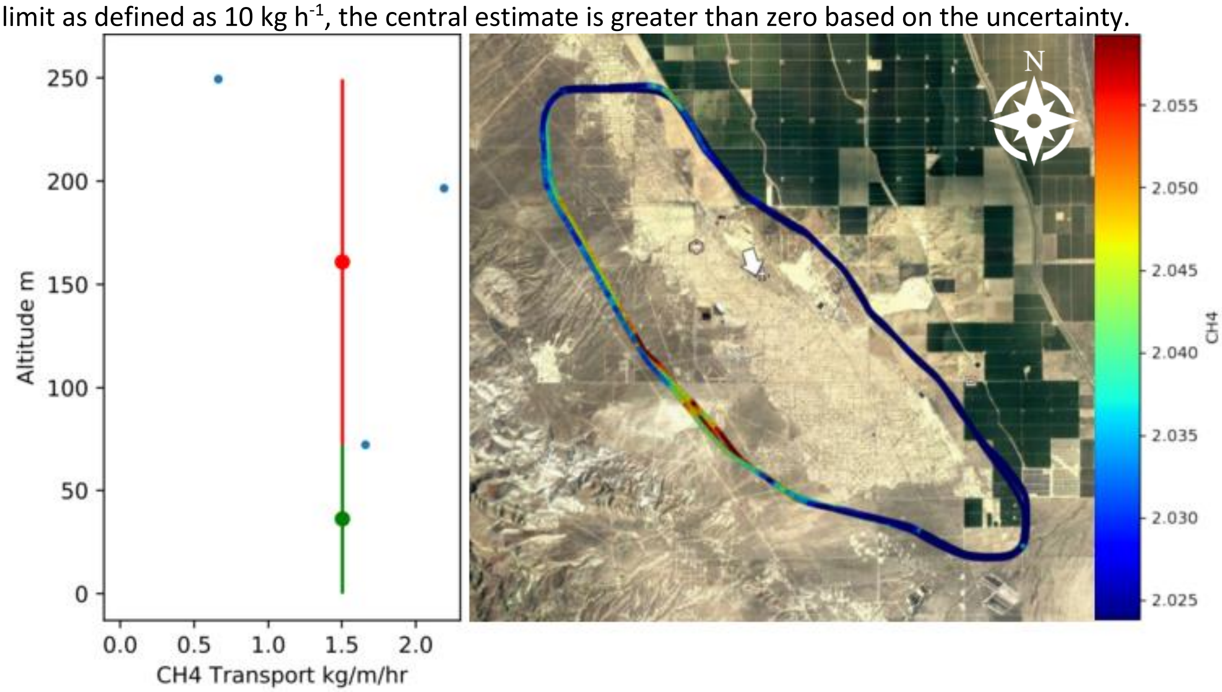

Figure 167. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

166. Blythe CS, 10-15-20

Laps were flown between 76 and 543 m agl. A methane emission of 208 ± 53 kg h^{-1} was calculated. Significant ethane was also observed: 15.3 ± 6.7 kg h^{-1}.

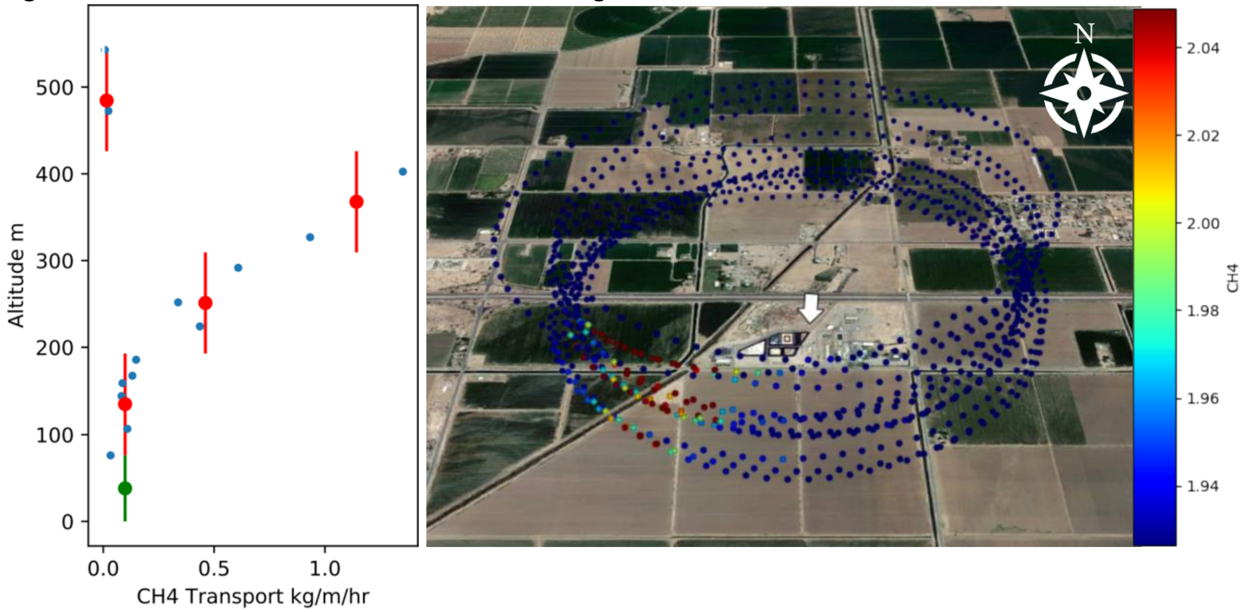

Figure 168. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

167. Brea Olinda Oil Field, 02-18-21

Laps were flown between 257 and 413 m agl. Small methane enhancements are clear on the downwind side of the path in the east, but a large, broad methane enhancement can be seen along the upwind and downwind sides of the western part of the flight path. The elevated methane in the west, originating from a broad source, or collection of sources, upwind increased the uncertainty and prevented a meaningful methane emission calculation. Ethane was calculated at 13.6 ± 8.6 kg h^{-1}, indicating the presence of fossil fuel-related emissions from this area.

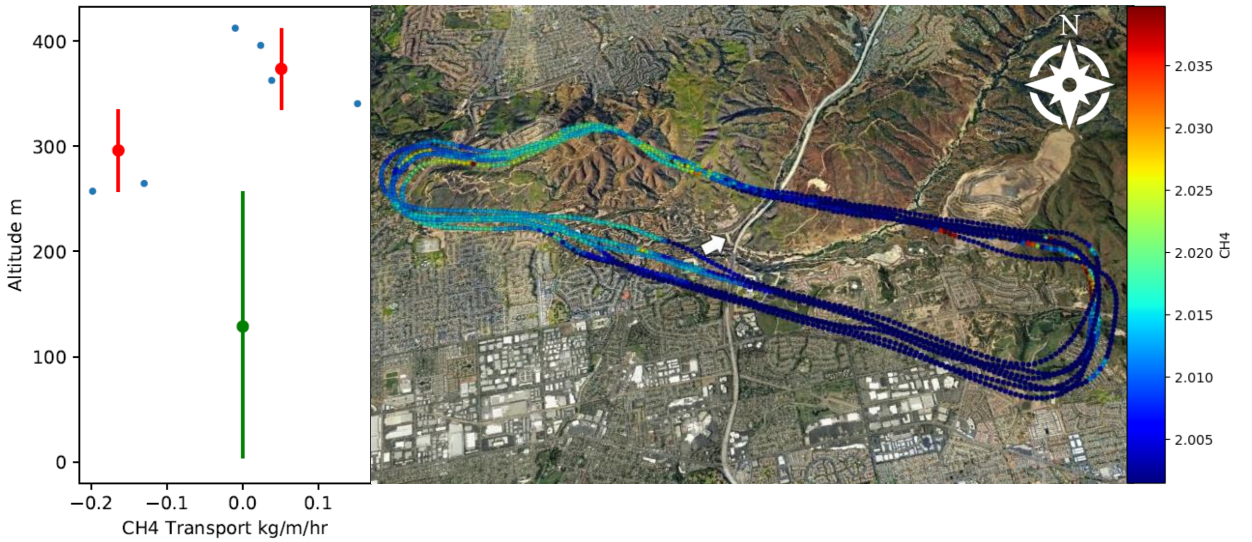

Figure 169. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

168. CRC Elk Hills 1, 05-23-20

Laps were flown between 160 and 761 m agl, and estimated methane emission was 41 ± 39 kg h^{-1}. However, winds were low (1 to 2 m s^{-1}) and inconsistent, so we assign low confidence to this measurement.

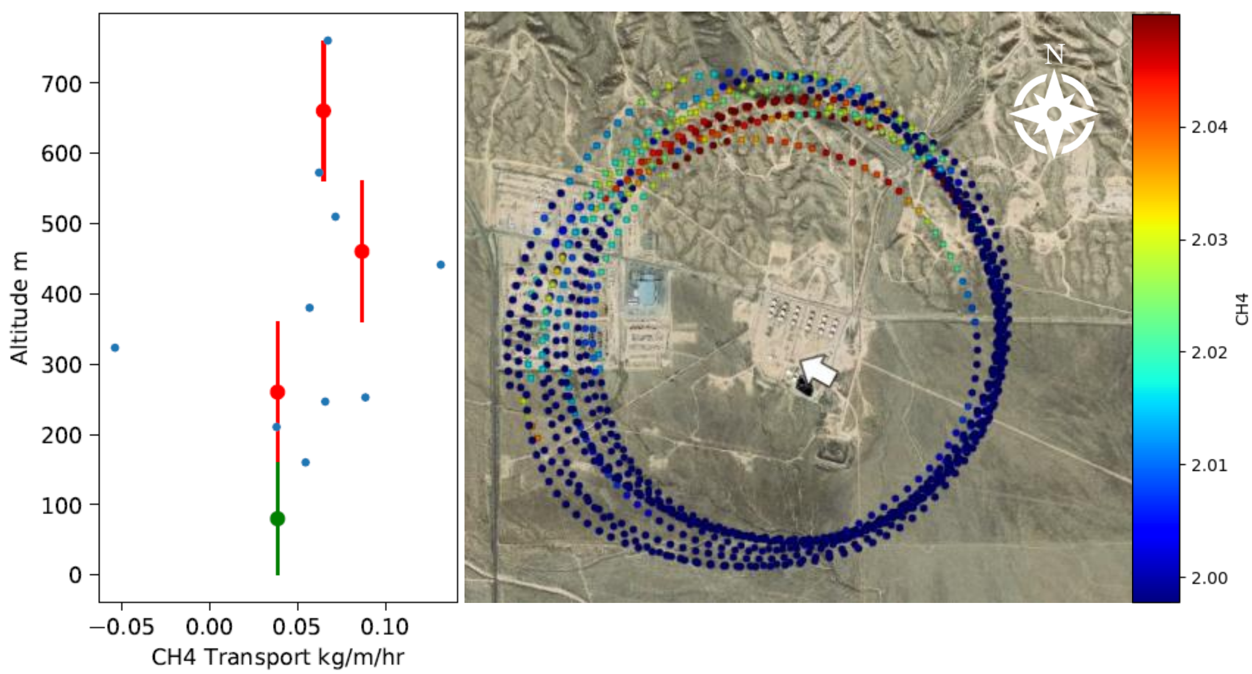

Figure 170. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

169. CRC Elk Hills 2, 05-23-20

Laps were flown between 226 and 542 m agl, and estimated methane emission was 5 ± 12 kg h^{-1}, which is below our typical detection limit of 10 kg h^{-1}. Additionally, winds were low (1 to 2 m s^{-1}) and inconsistent, so we assign low confidence to this measurement.

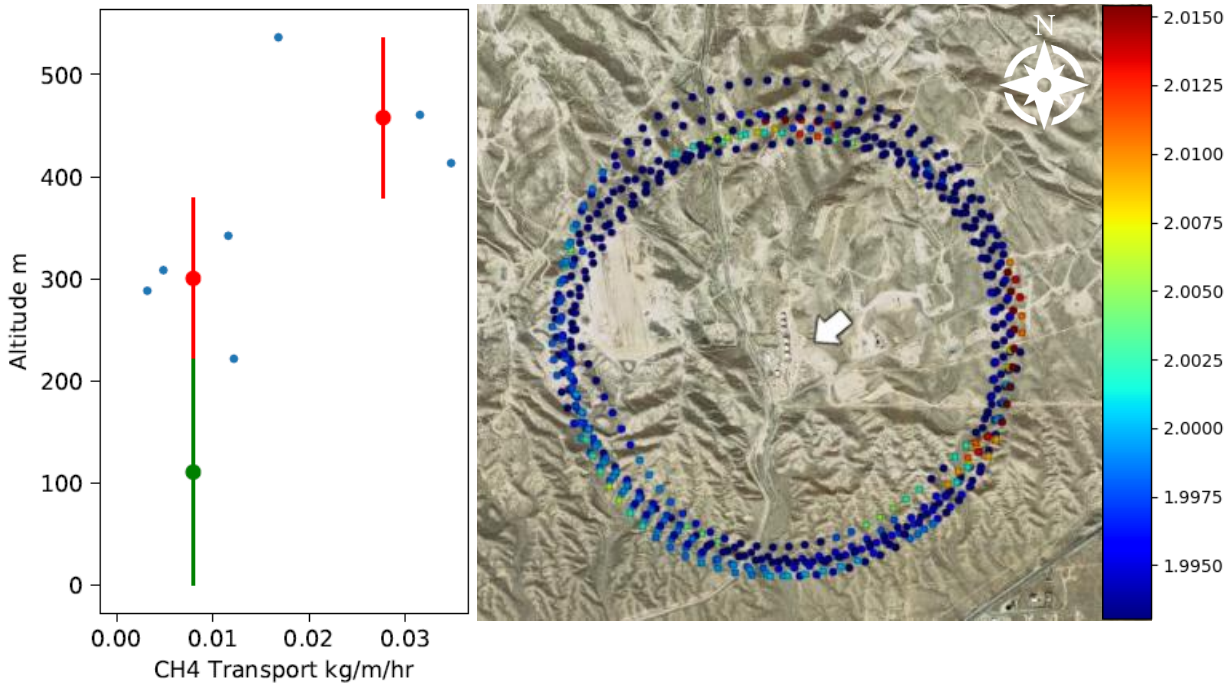

Figure 171. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

170. CRC Elk Hills 3, 05-23-20

Laps were flown between 156 and 927 m agl, and the methane emissions estimate was 56 ± 15 kg h^{-1}.

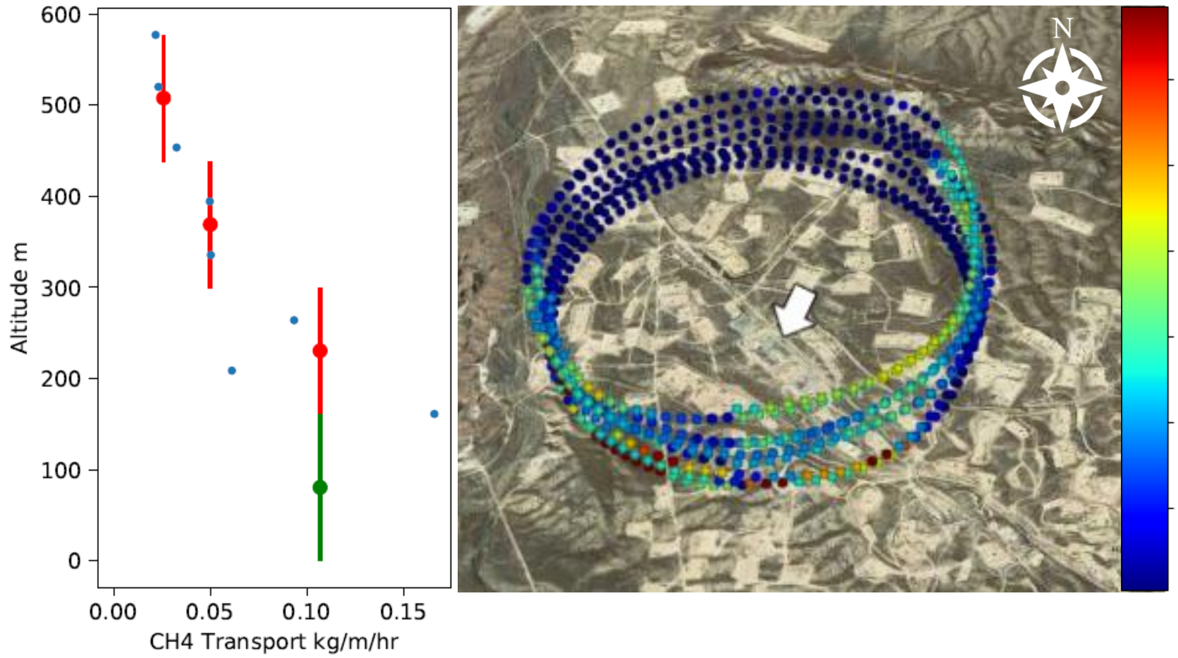

Figure 172. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

171. CRC Elk Hills Power, 05-22-20

Laps were flown between 168 and 889 m agl, and the estimated methane emission was 161 ± 53 kg h^{-1}.

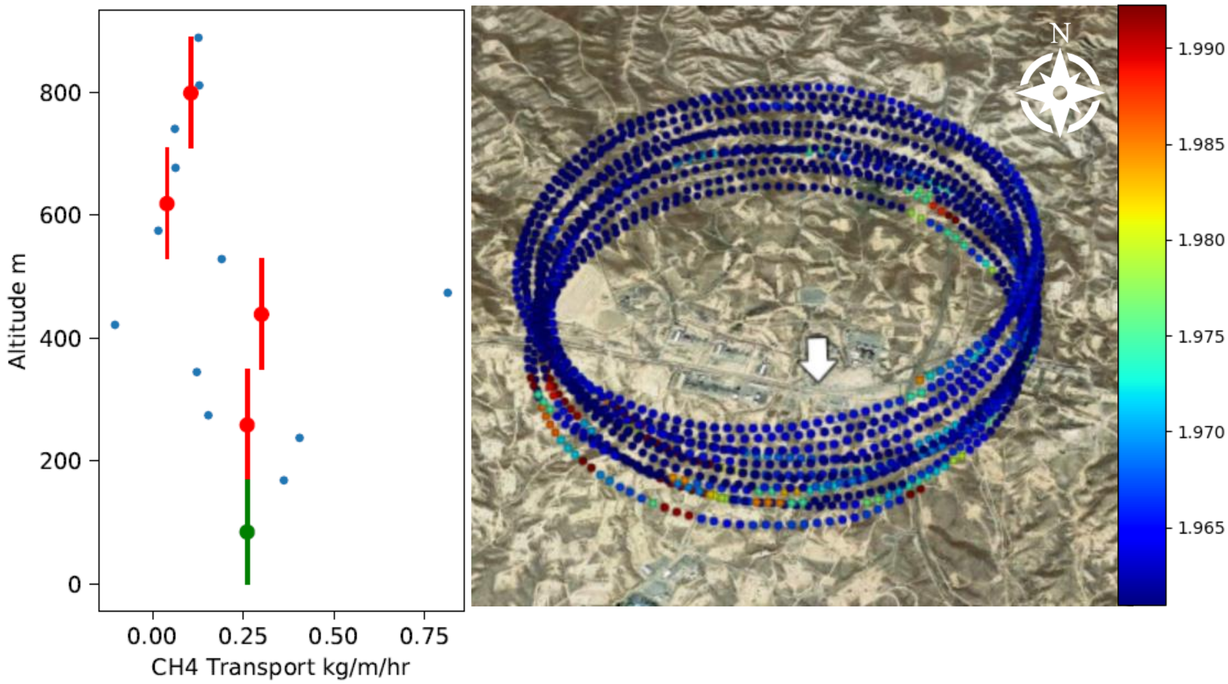

Figure 173. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

172. CRC Grimes, 07-30-20

Laps were flown between 126 and 482 m agl and a methane emission of 79 ± 35 kg h^{-1} was calculated.

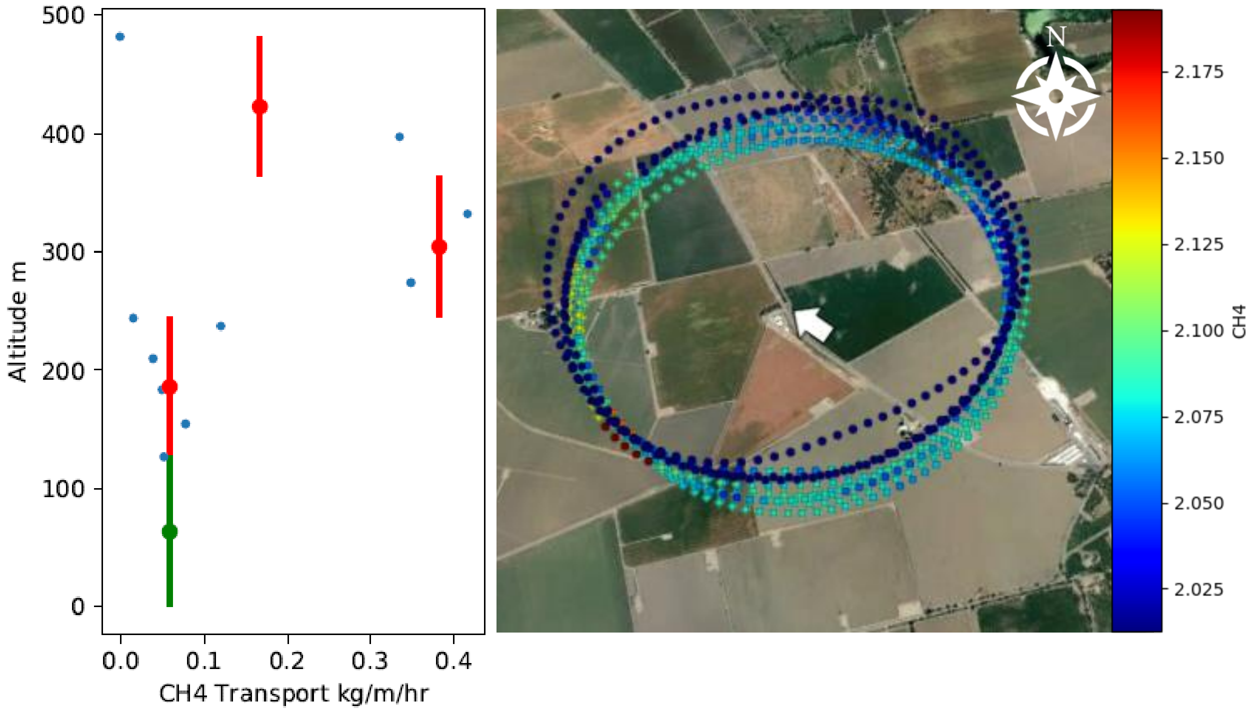

Figure 174. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

173. CRC Rio Vista 1, 07-29-20

Laps were flown between 127 and 397 m agl and a methane emission of -1 ± 12 kg h^{-1} was calculated. This is below our detection limit of 10 kg h^{-1} methane and indicates very low emissions.

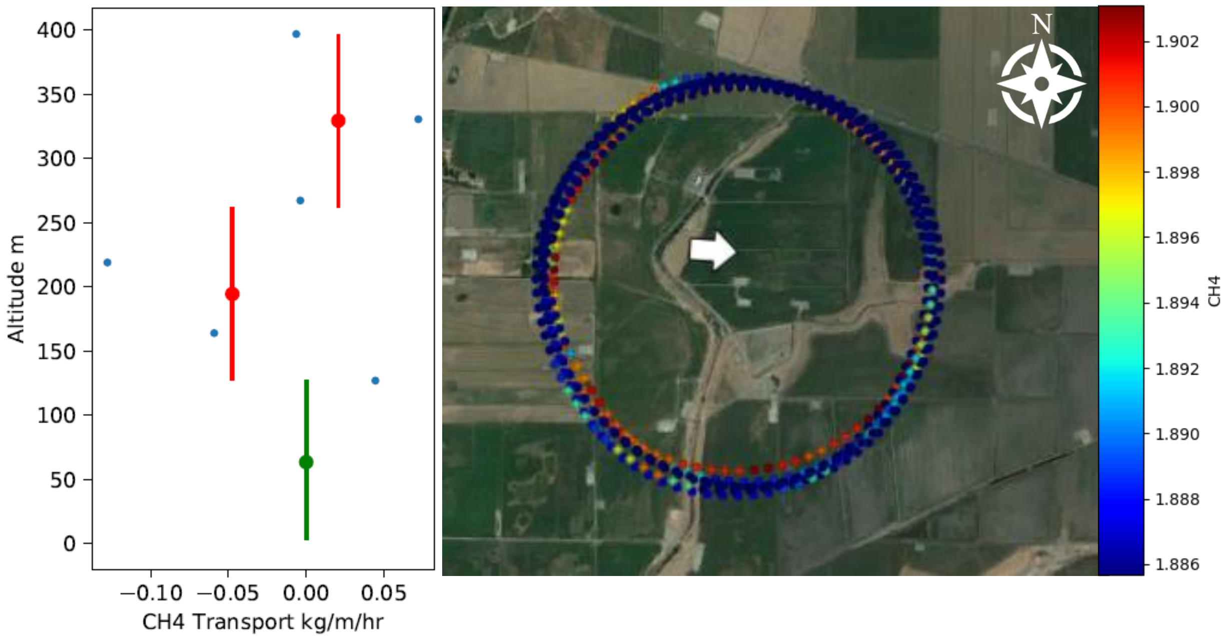

Figure 175. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

174. CRC Rio Vista 2, 07-29-20

Laps were flown between 149 and 620 m agl and a methane emission of -13 ± 16 kg h^{-1} was calculated. The negative flux value indicates emissions are low, and below our detection limit of 10 kg h^{-1} methane.

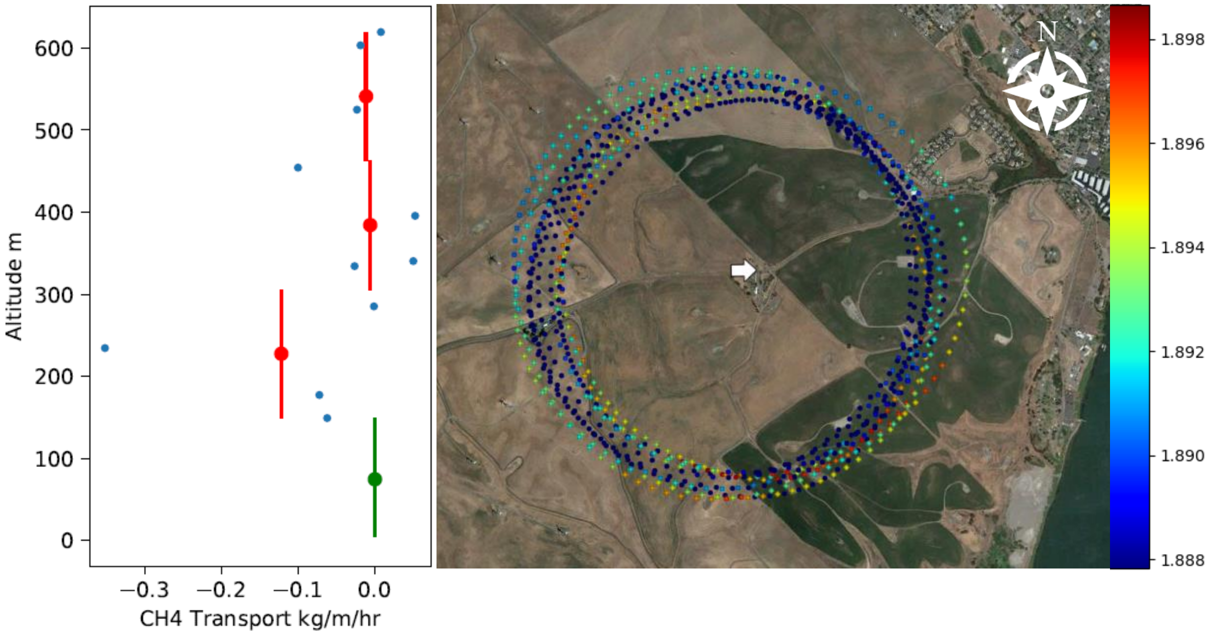

Figure 176. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

175. CRC Willows Central 1, 07-28-20

Laps were flown between 143 and 601 m agl and a methane emission of 76 ± 48 kg h^{-1} was calculated.

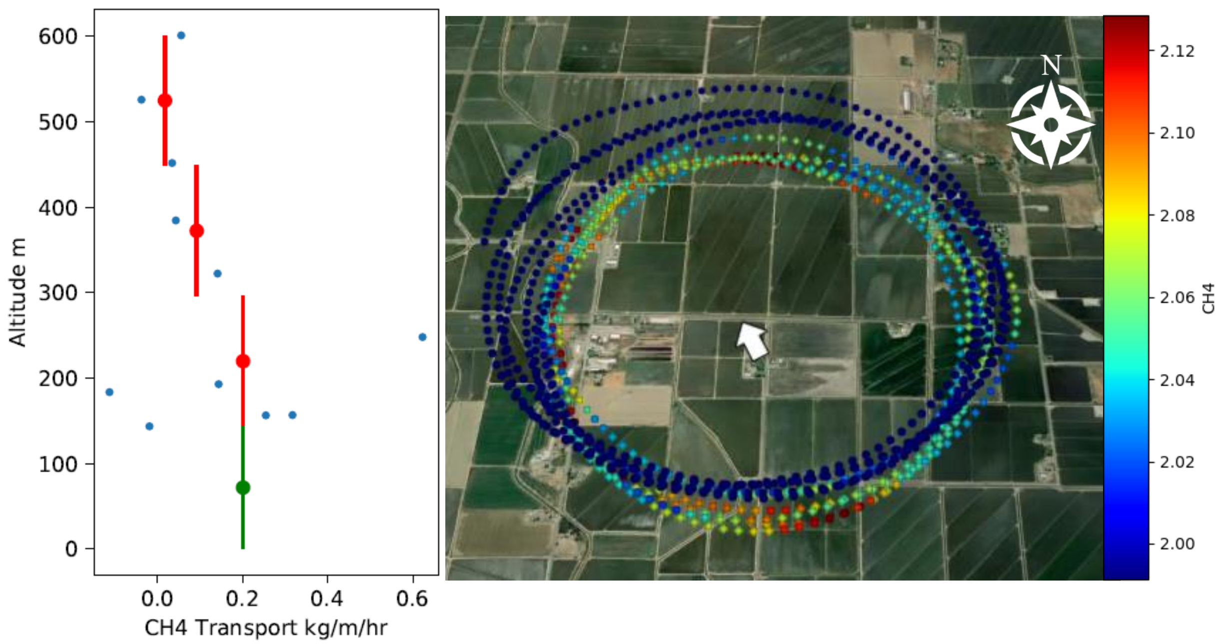

Figure 177. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

176. CRC Willows Central 2, 07-28-20

Laps were flown between 109 and 573 m agl and a methane emission of 135 ± 56 kg h^{-1} was calculated.

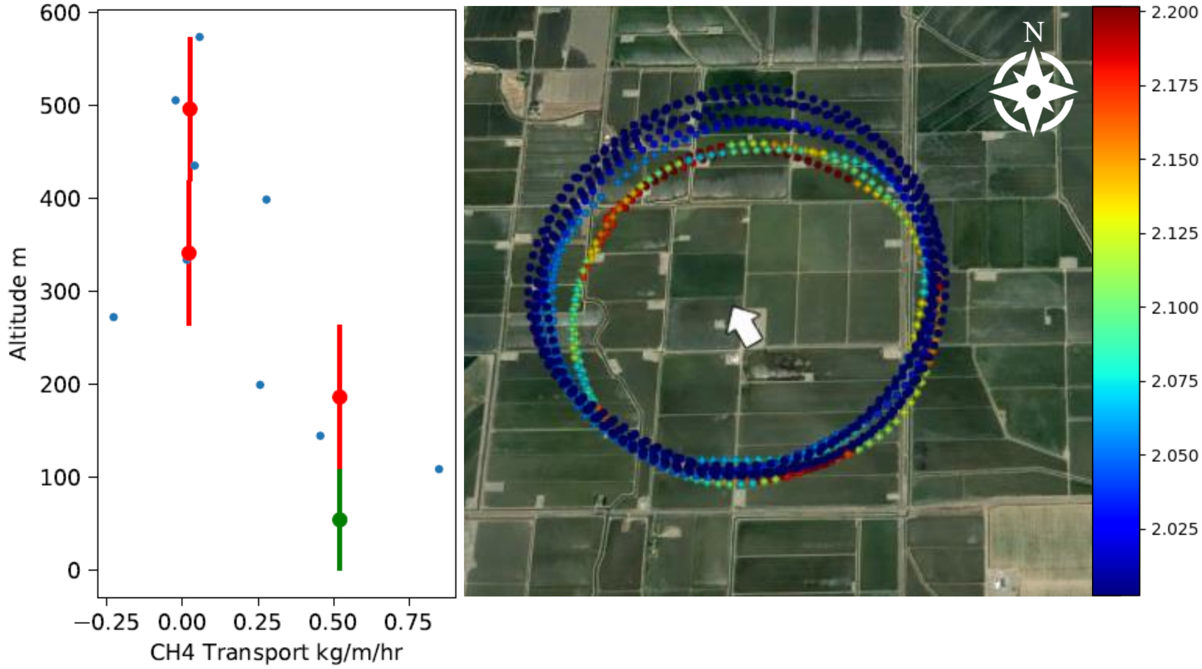

Figure 178. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

177. El Poso Creek 1, 10-29-20

Laps were flown between 106 and 462 m agl. A methane emission of 343 ± 67 kg h^{-1} was calculated. An ethane emission of 3.6 ± 3.2 kg h^{-1} was observed.

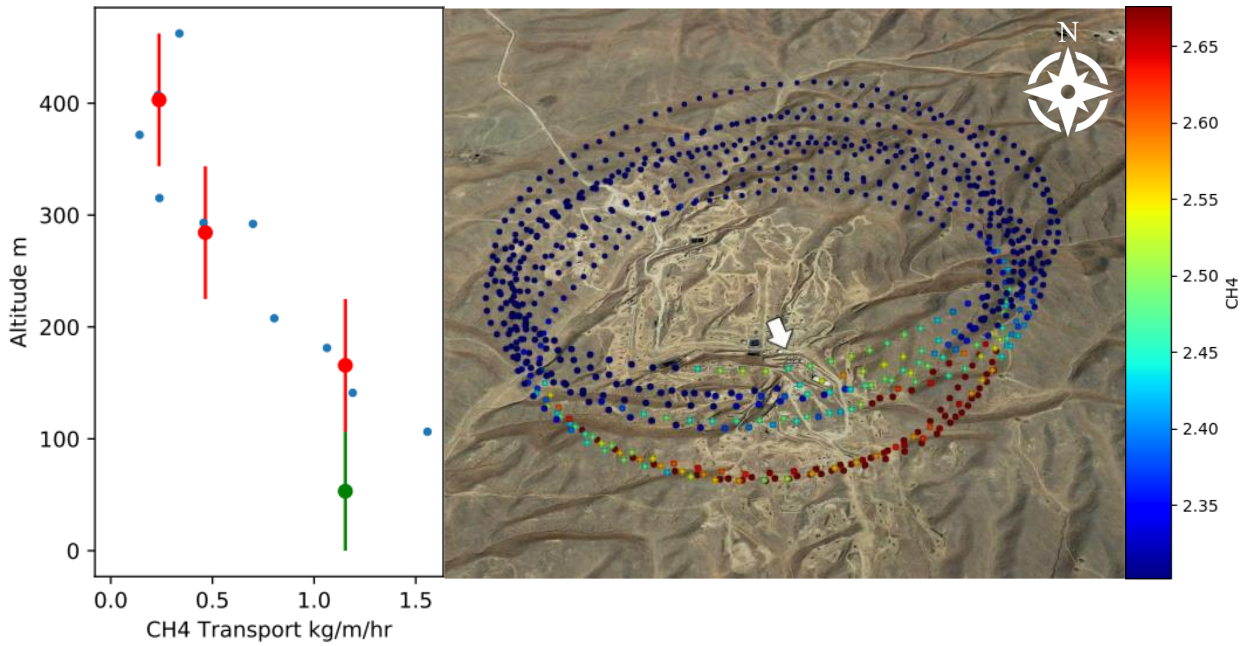

Figure 179. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

178. El Poso Creek 2, 10-29-20

Laps were flown between 80 and 430 m agl. A methane emission of 970 ± 193 kg h^{-1} was calculated. An ethane emission of 11.9 ± 5.5 kg h^{-1} was observed.

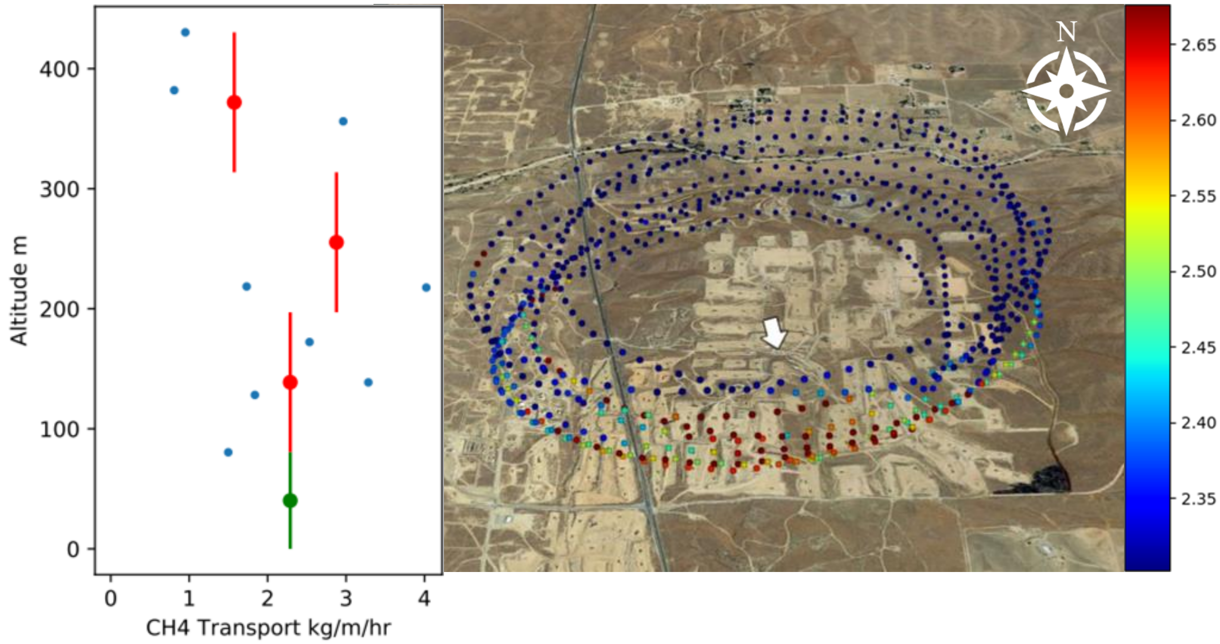

Figure 180. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

179. El Poso Creek 3, 10-29-20

Laps were flown between 97 and 379 m agl. A methane emission of 388 ± 107 kg h^{-1} was calculated. No significant ethane was observed.

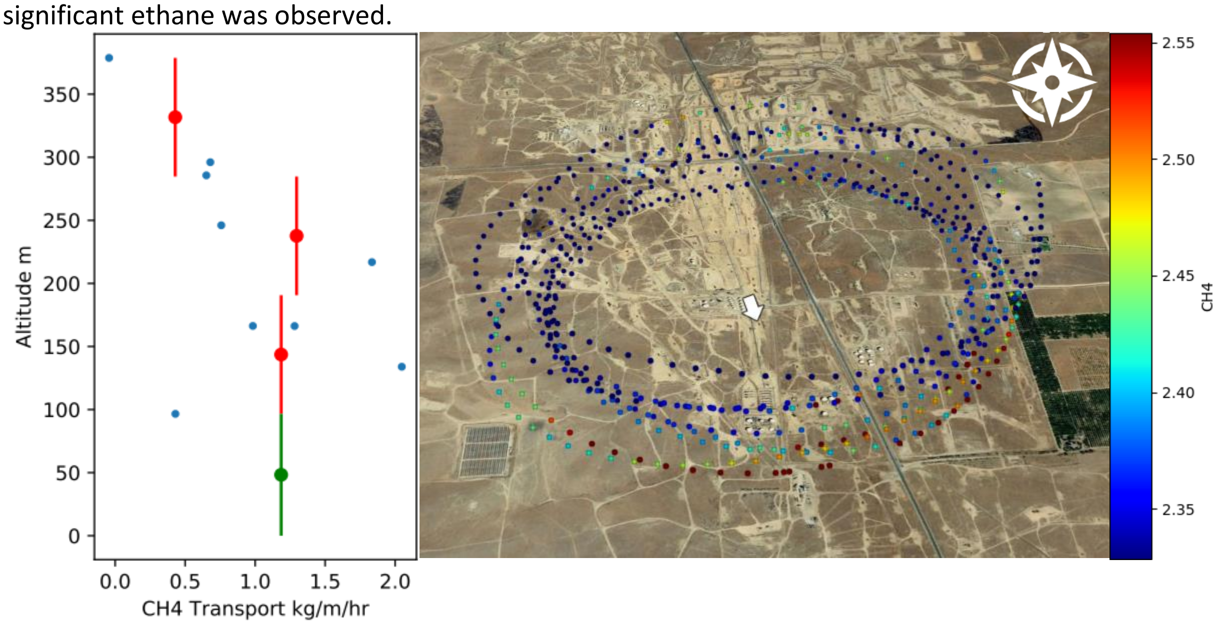

Figure 181. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

180. Elk Hills 4a, 07-15-20

Laps were flown between 185 and 500 m above ground level (agl). Laps at higher altitudes were flown but eliminated from the calculation due to unfavorable wind conditions at altitudes > 500 m agl. The measurements below 500 m agl were extrapolated to the top of an estimated boundary layer of 1000 ±200 m agl to obtain the final estimate. A methane emission of 1929 ± 1223 kg h^{-1} was calculated.

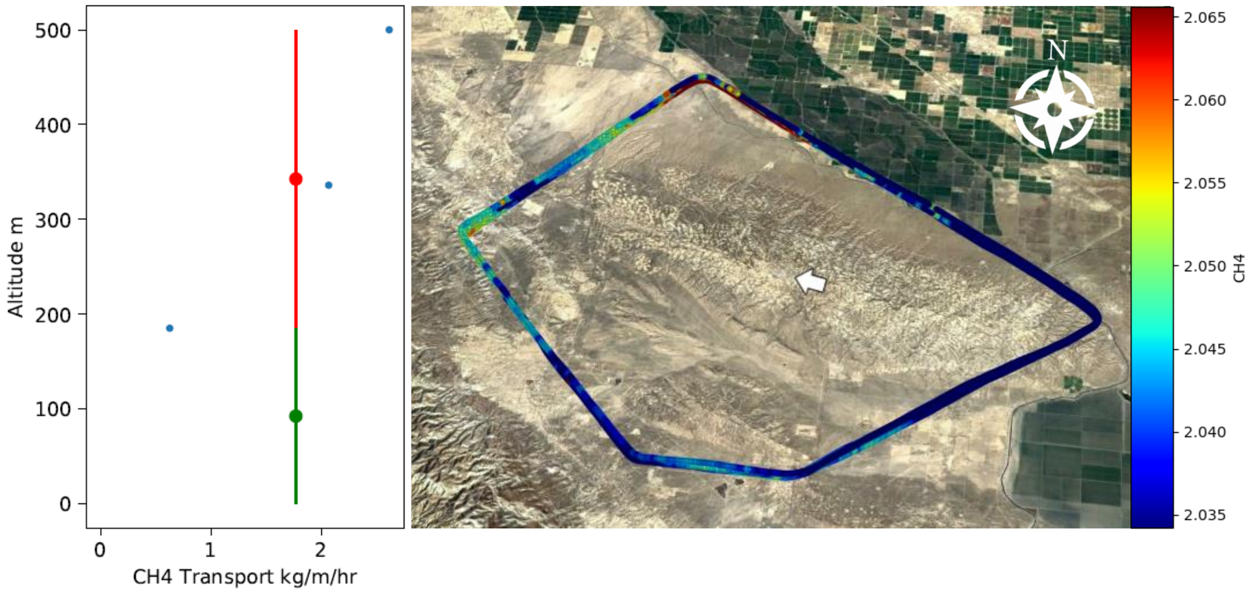

Figure 182. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

181. Elk Hills 4a, 07-17-20

Four laps taking ~ 20 minutes each were flown between 153 and 644 m agl. A methane emission of 2849 ± 1217 kg h^{-1} was calculated.

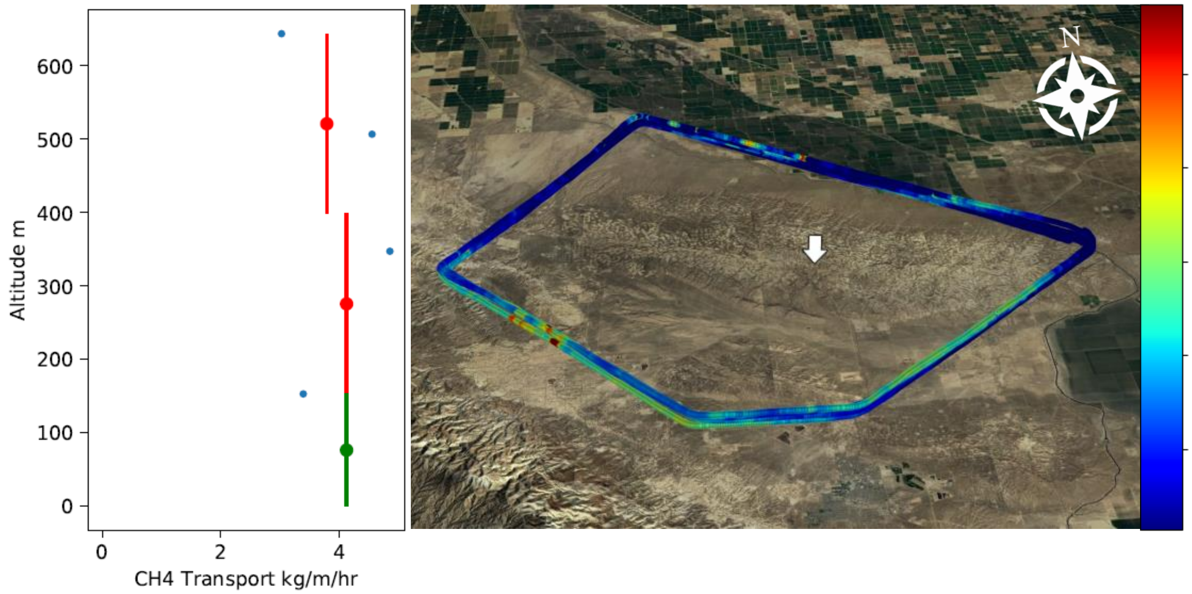

Figure 183. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

182. Fourth Avenue, 07-16-20

Laps were flown between 198 and 475 m agl. A methane emission of 22 ± 7 kg h^{-1} was calculated.

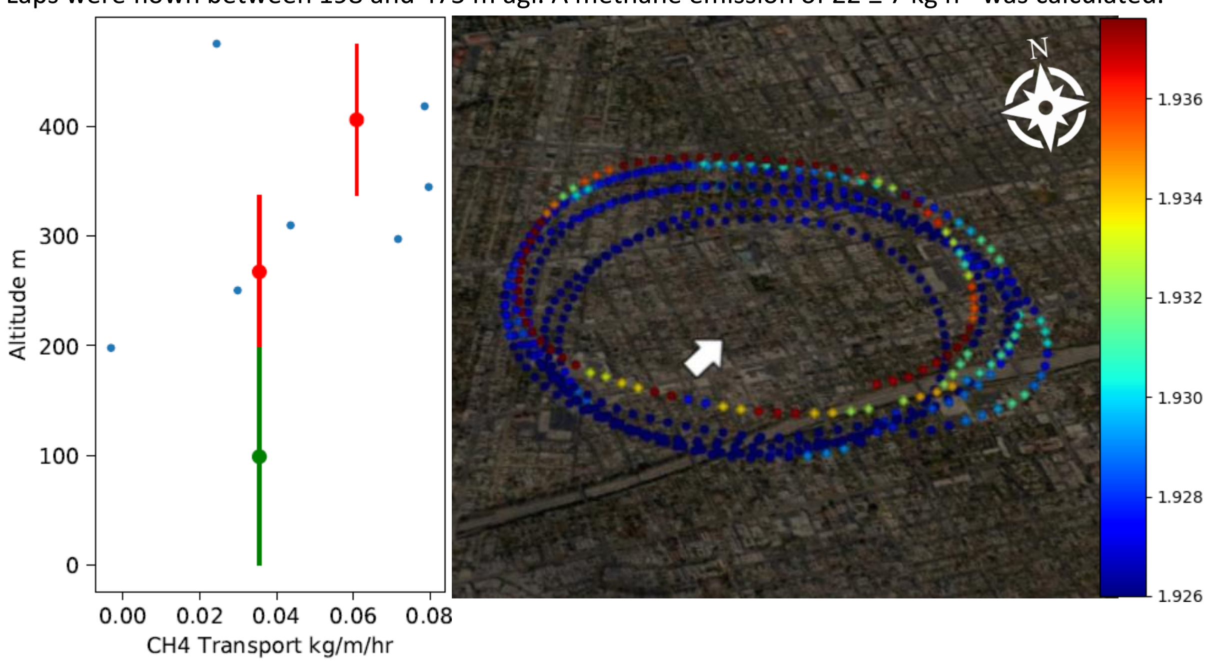

Figure 184. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

183. Honor Rancho GS, 01-13-20

The aircraft flew a total of 13 circles around the Honor Rancho Gas Storage facility. Altitudes ranged from 248 m agl to 607 m agl. Winds were out of the southwest, averaging 3.0 m s^{-1}. Total methane emission is estimated to be 12.3 ± 182.7 kg h^{-1}.

No significant or obvious enhancements were observed downwind of the site during sampling. The enhancements observed on the top of circle illustrated below are likely from the Chiquita Canyon Landfill located just upwind. This upwind interference contributes to the high uncertainty of this measurement.

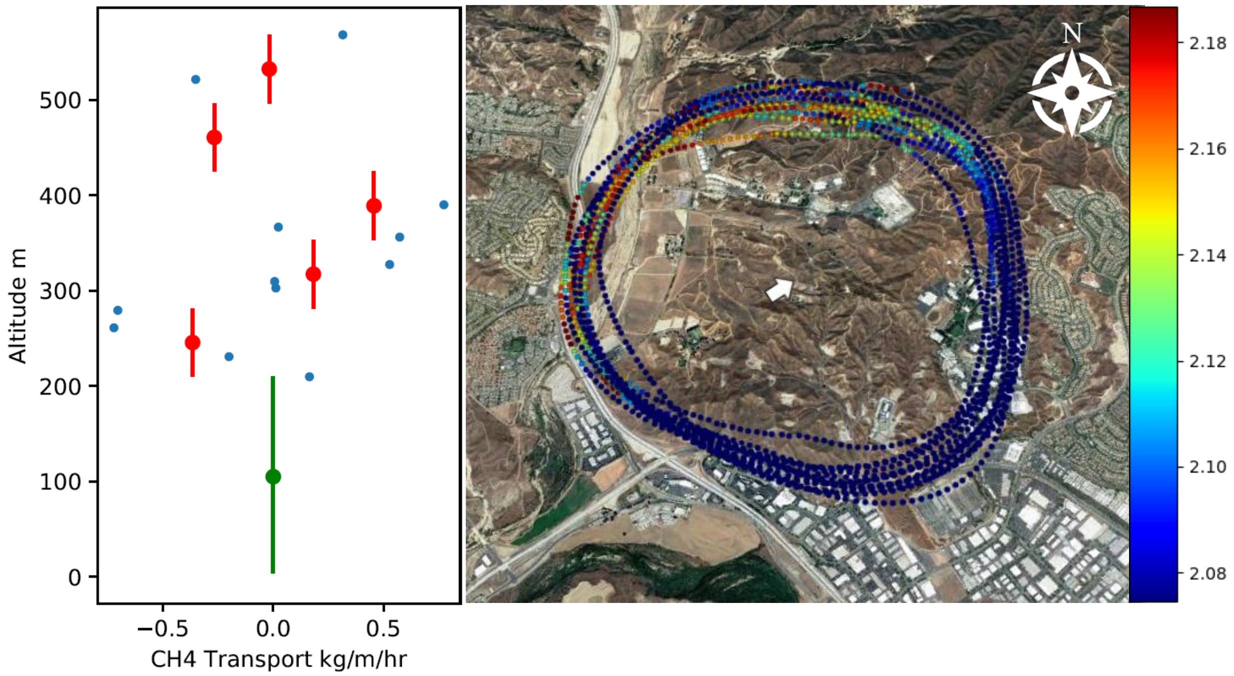

Figure 185. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

184. Inglewood, 07-16-20

Laps were flown between 176 and 492 m agl. A methane emission of 99 ± 43 kg h^{-1} was calculated.

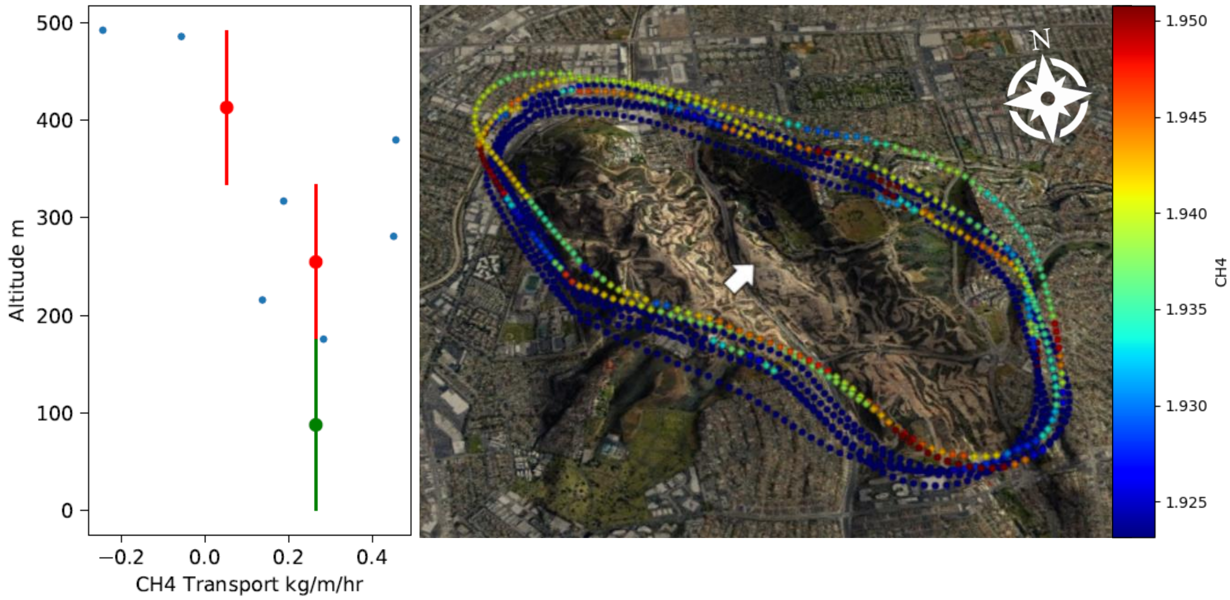

Figure 186. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

185. Jefferson, 07-16-20

Laps were flown between 183 and 392 m agl. A methane emission of 8 ± 7 kg h^{-1} was calculated. This is below our detection limit of ~ 10 kg h^{-1}.

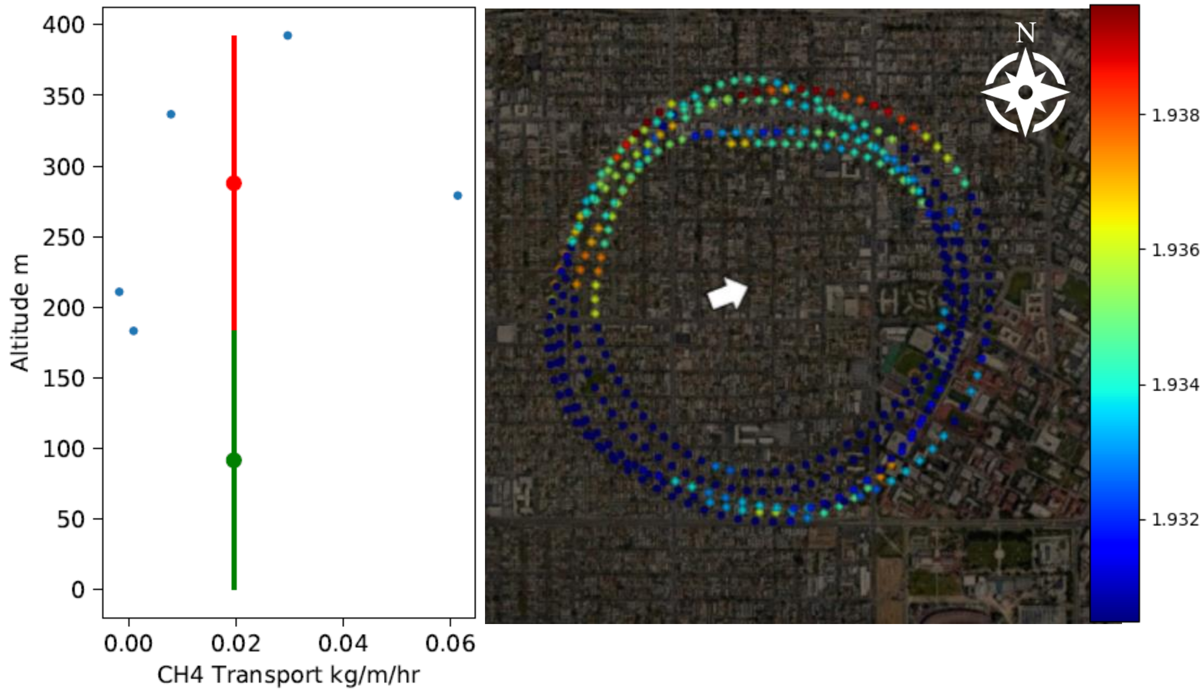

Figure 187. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

186. La Goleta GS 1, 10-29-20

Laps were flown between 81 and 167 m agl. A methane emission of 8 ± 12 kg h^{-1} was calculated, and no significant ethane was observed.

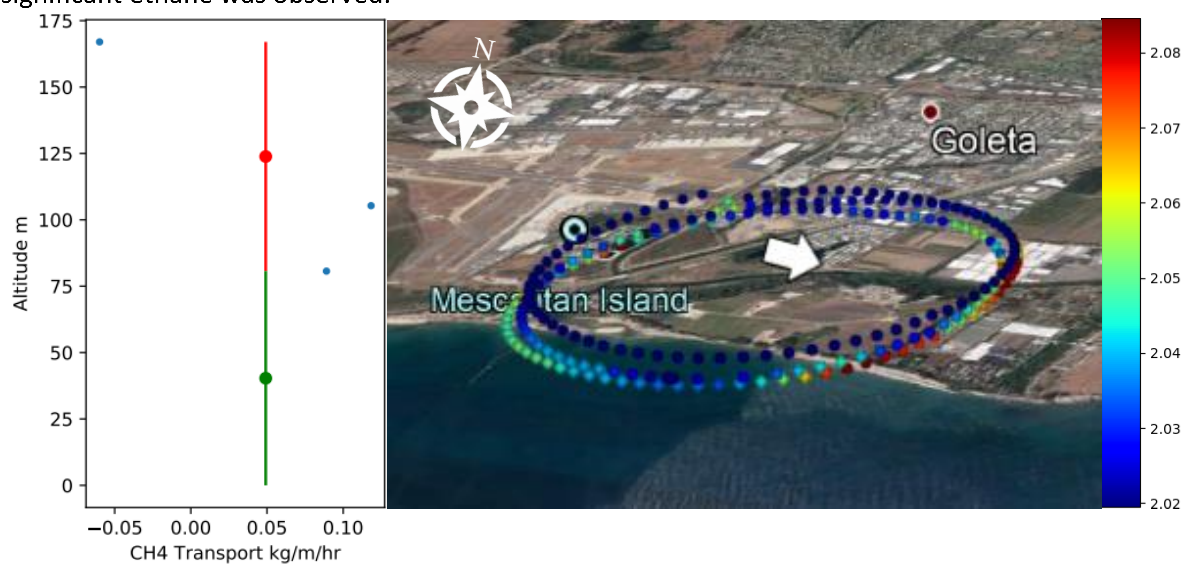

Figure 188. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

187. La Goleta GS 2, 10-29-20

Laps were flown between 75 and 230 m agl. A methane emission of 14 ± 11 kg h^{-1} was calculated. No significant ethane was observed.

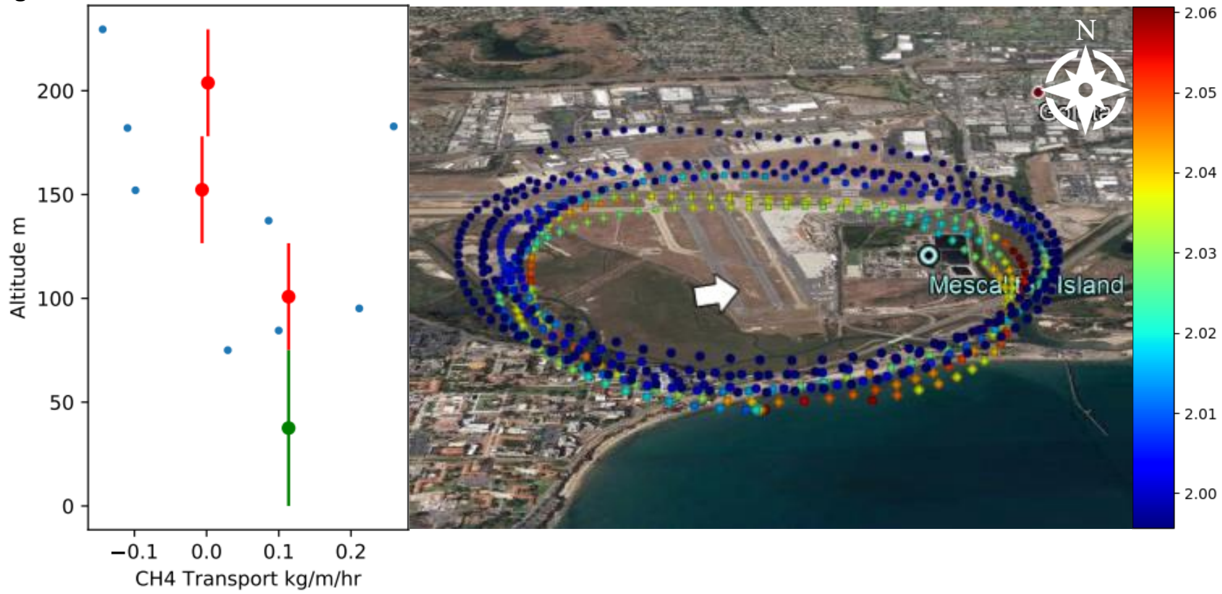

Figure 189. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

188. McDonald Island, 01-12-20

The aircraft flew a total of 20 usable circles around the McDonald Island Gas Storage facility. Altitudes ranged from 129 m agl to 373 m agl. Winds were out of the west, averaging 2.9 m s^{-1} . Total methane emission is estimated at 69 ± 25 kg h^{-1}.

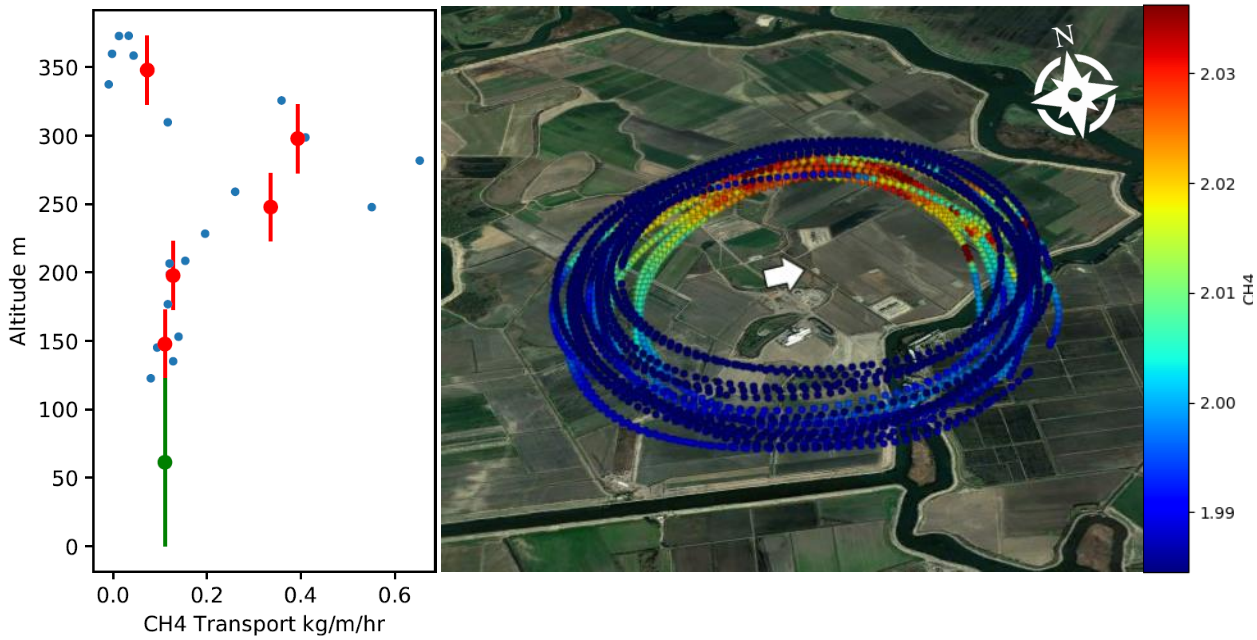

Figure 190. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

189. McDonald Island, 04-17-20

The aircraft flew laps between 151 and 819 m agl and a methane emission of 192 ± 129 kg h^{-1} was calculated.

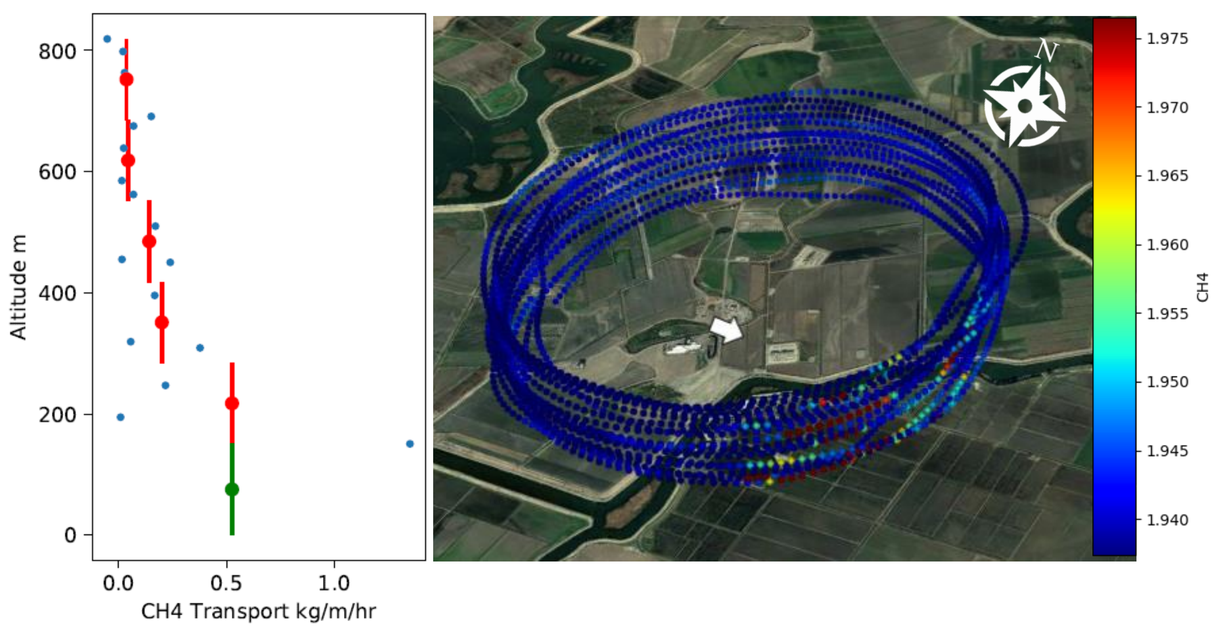

Figure 191. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

190. McDonald Island, 07-29-20

Laps were flown between 123 and 510 m agl and a methane emission of 96 ± 35 kg h^{-1} was calculated.

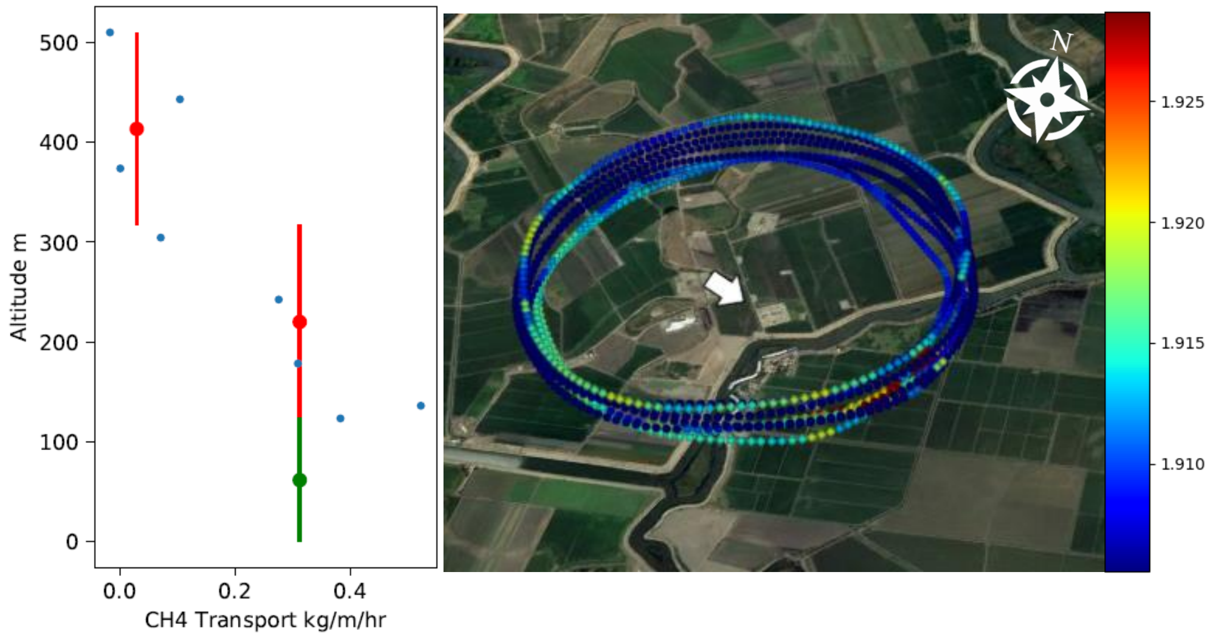

Figure 192. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

191. Mojave-Daggett CS, 10-15-20

Laps were flown between 100 and 237 m agl. A methane emission of 0 ± 1 kg h^{-1} was calculated. No clear enhancements in either methane or ethane were observed.

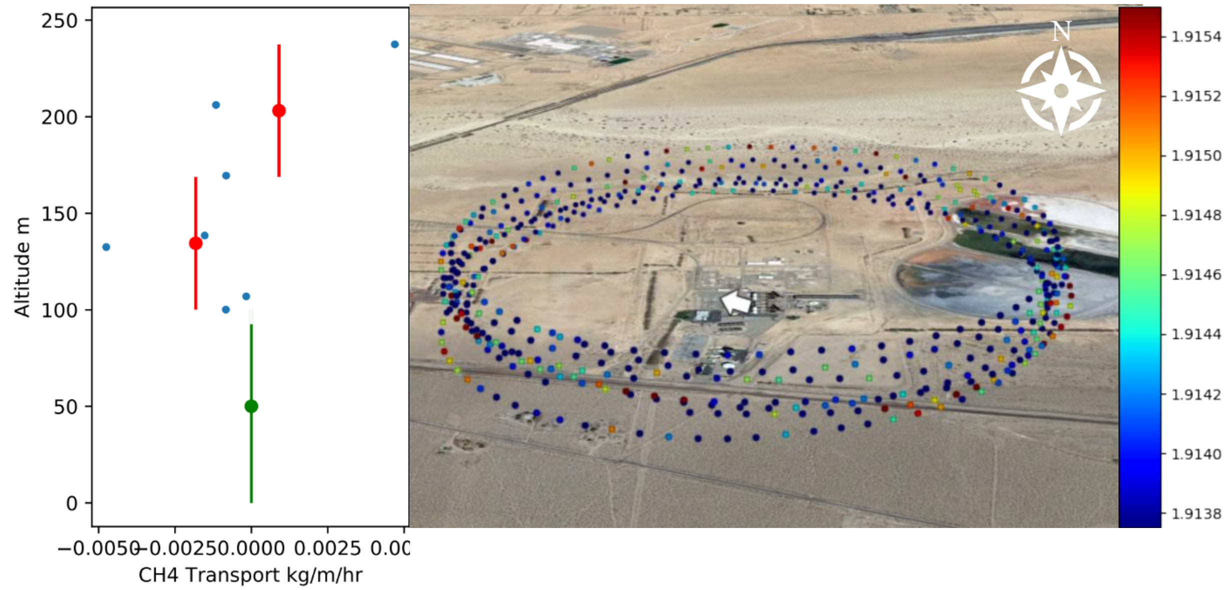

Figure 193. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

192. Murphy, 07-16-20

Laps were flown between 189 and 448 m agl. A methane emission of 4 ± 8 kg h^{-1} was calculated. This is below our detection limit of ~ 10 kg h^{-1}.

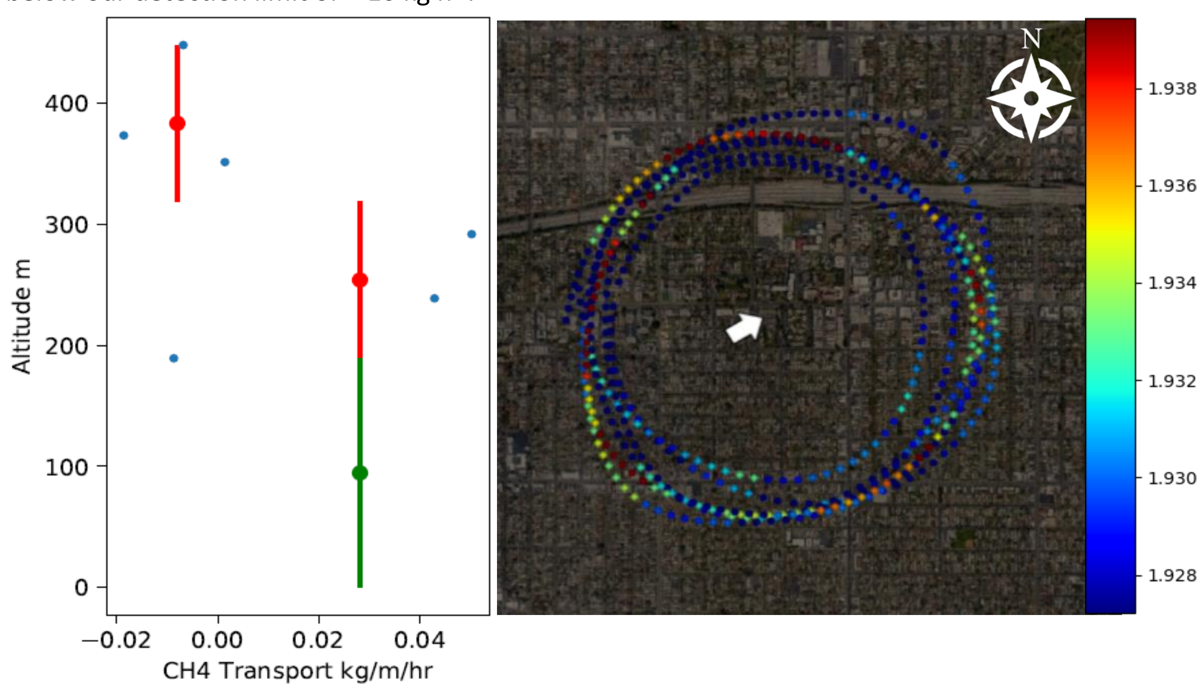

Figure 194. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

193.	Newbery Springs CS, 10-15-20

Laps were flown between 84 and 592 m agl. A methane emission of 9 ± 3 kg h^{-1} was calculated. No significant ethane was observed.

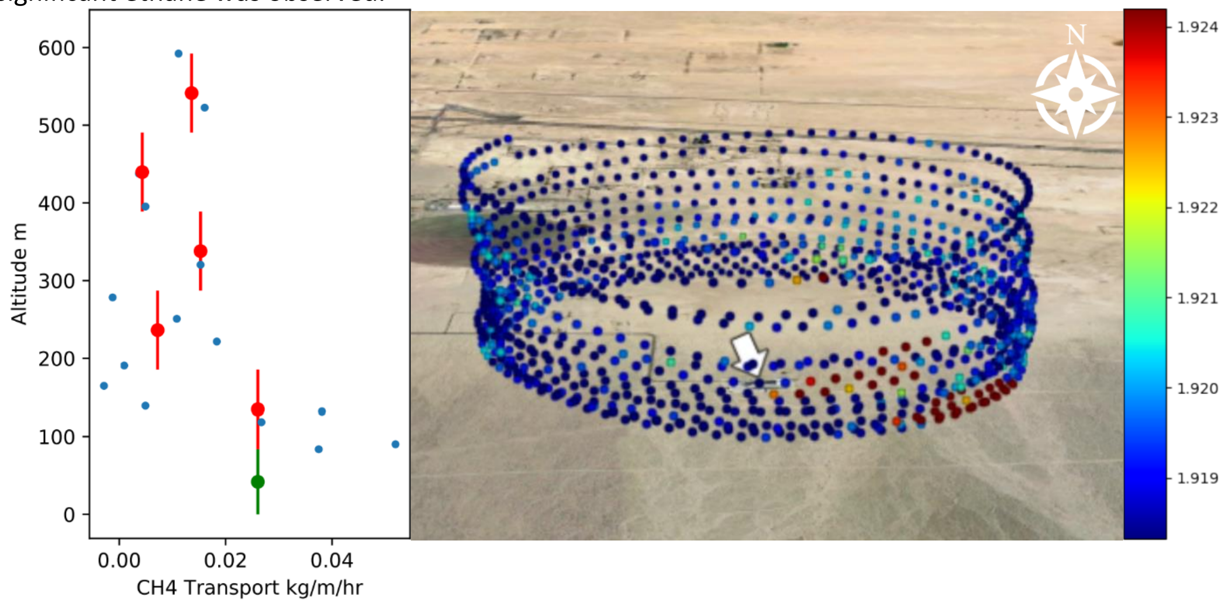

Figure 195. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

194.	North Needles CS, 10-15-20

Laps were flown between 102 and 198 m agl. A methane emission of 6 ± 2 kg h^{-1} was calculated. The calculated ethane emission was 1.3 ± 5.3 kg h^{-1}, which is not statistically different from zero.

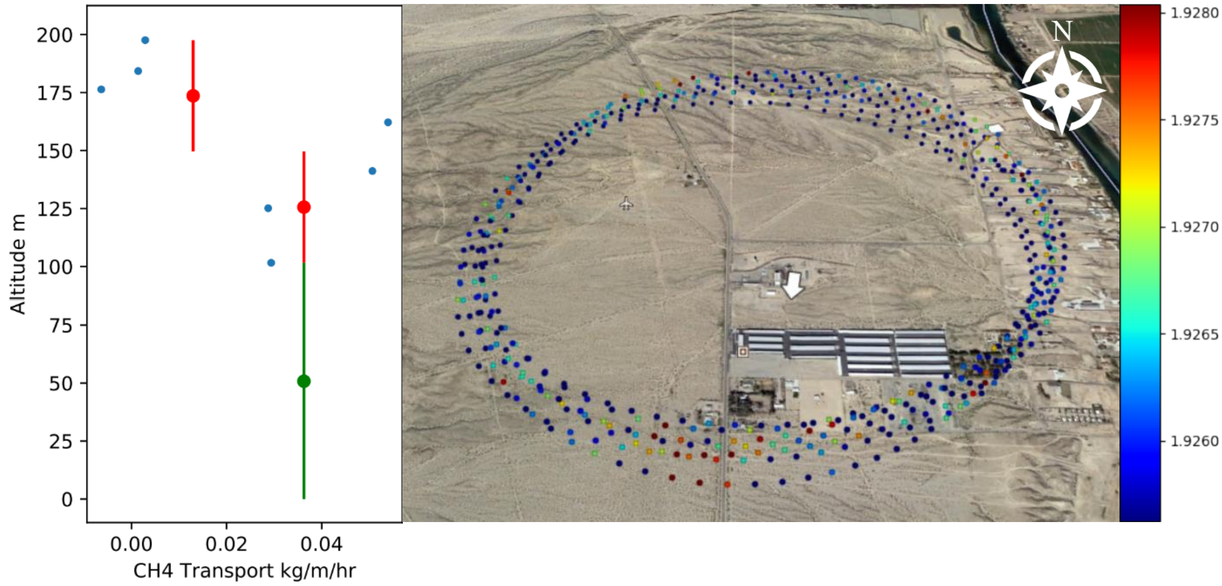

Figure 196. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

195. PGE Hinkley CS, 10-15-20

Laps were flown between 186 and 430 m agl. A methane emission of 169 ± 540 kg h^{-1} was calculated. Ethane emission was 7.6 ± 8.1 kg h^{-1}. The high uncertainty on the emissions estimates is due to the low and variable winds at low altitude, where the majority of emissions are localized.

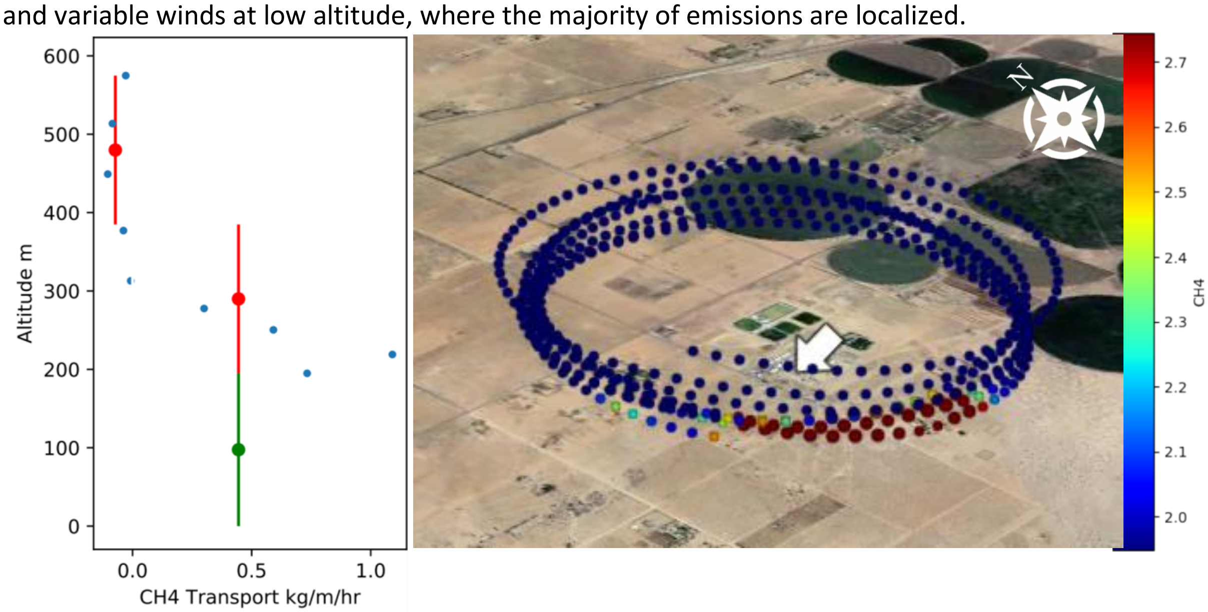

Figure 197. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

196. PGE Topock CS, 10-15-20

Laps were flown between 224 and 563 m agl. A methane emission of 14 ± 14 kg h^{-1} was calculated. Ethane emission was not distinguishable from zero (4.8 ± 14 kg h^{-1}). Both the methane and ethane calculations are likely underestimates because the aircraft was not able to descend below 224 m agl due to variable terrain and high winds/turbulence. However, there are clear methane enhancements at the lowest altitudes measured.

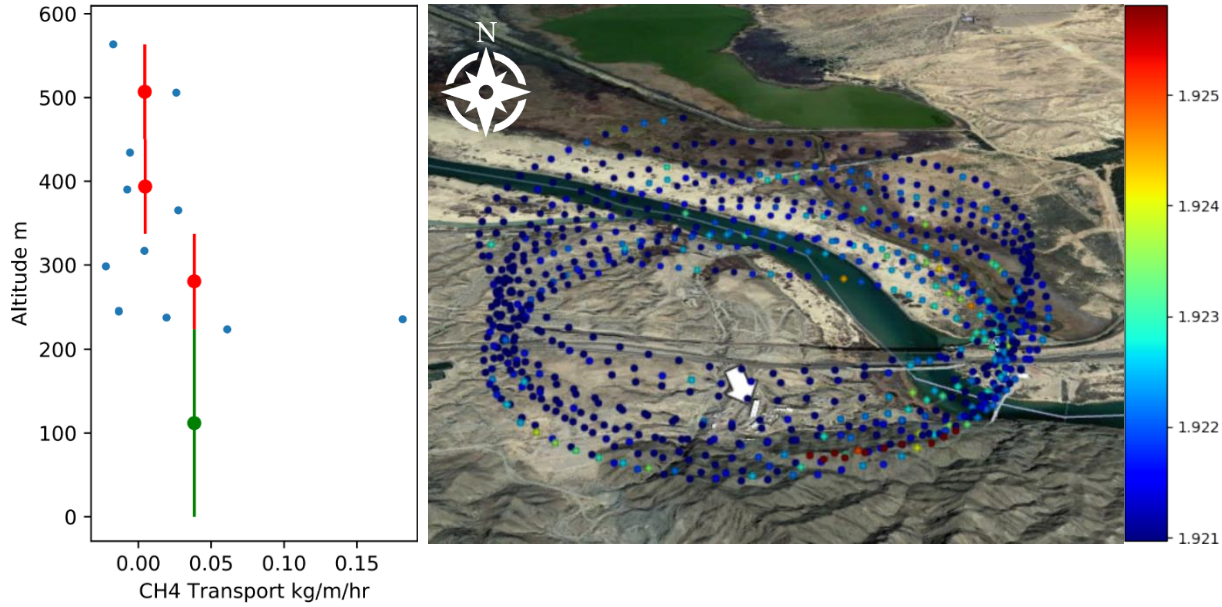

Figure 198. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

197. South Needles CS, 10-15-20

Laps were flown between 163 and 364 m agl. A methane emission of 19 ± 21 kg h^{-1} was calculated. No significant ethane was observed.

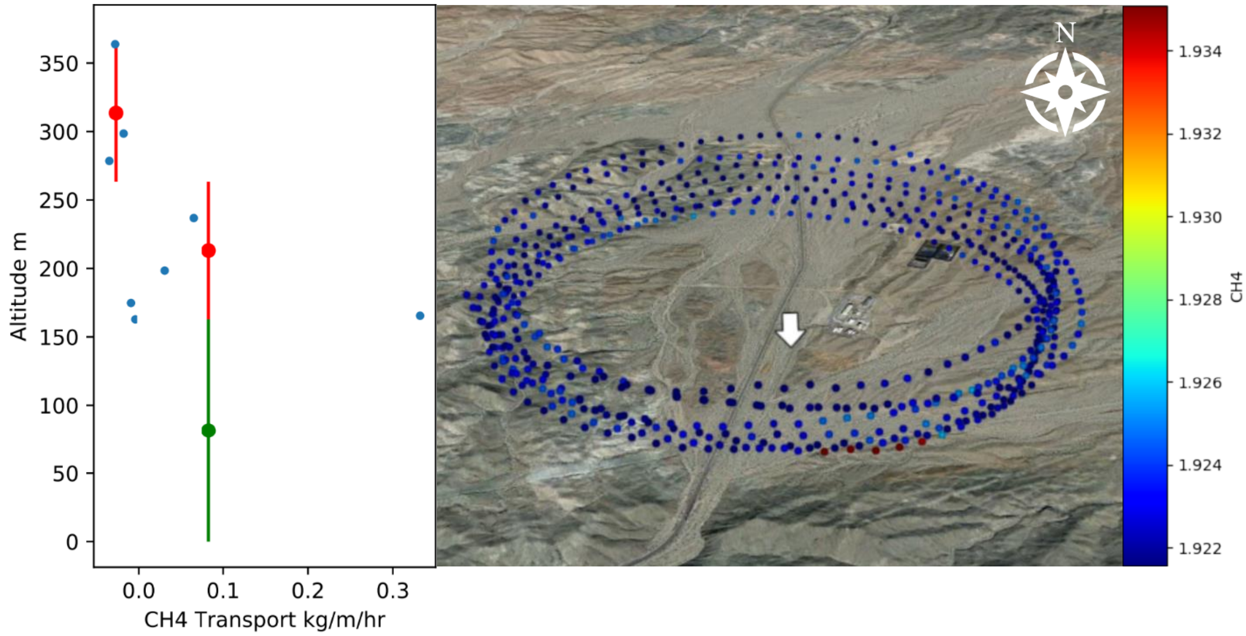

Figure 199. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

198. Wild Goose GS 1, 07-28-20

Laps were flown between 116 and 349 m agl and a methane emission of 32 ± 19 kg h^{-1} was calculated.

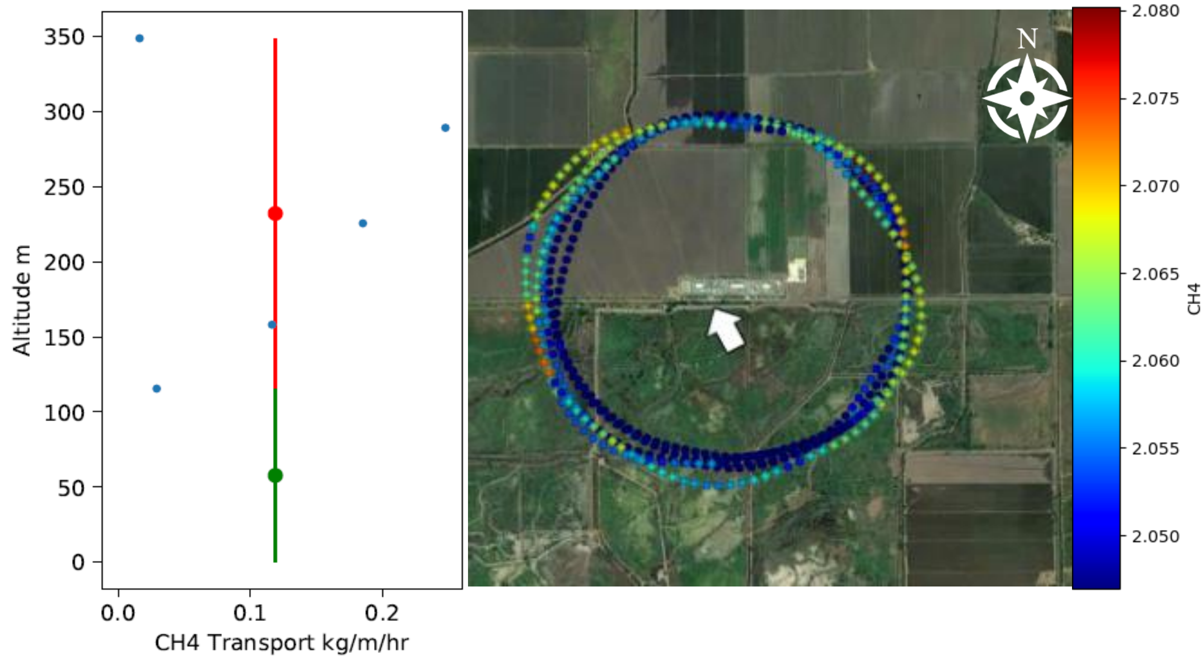

Figure 200. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure. Arrow = average wind direction.

199. Wild Goose GS 2, 07-28-20

Laps were flown between 115 and 615 m agl and a methane emission of 166 ± 66 kg h^{-1} was calculated.

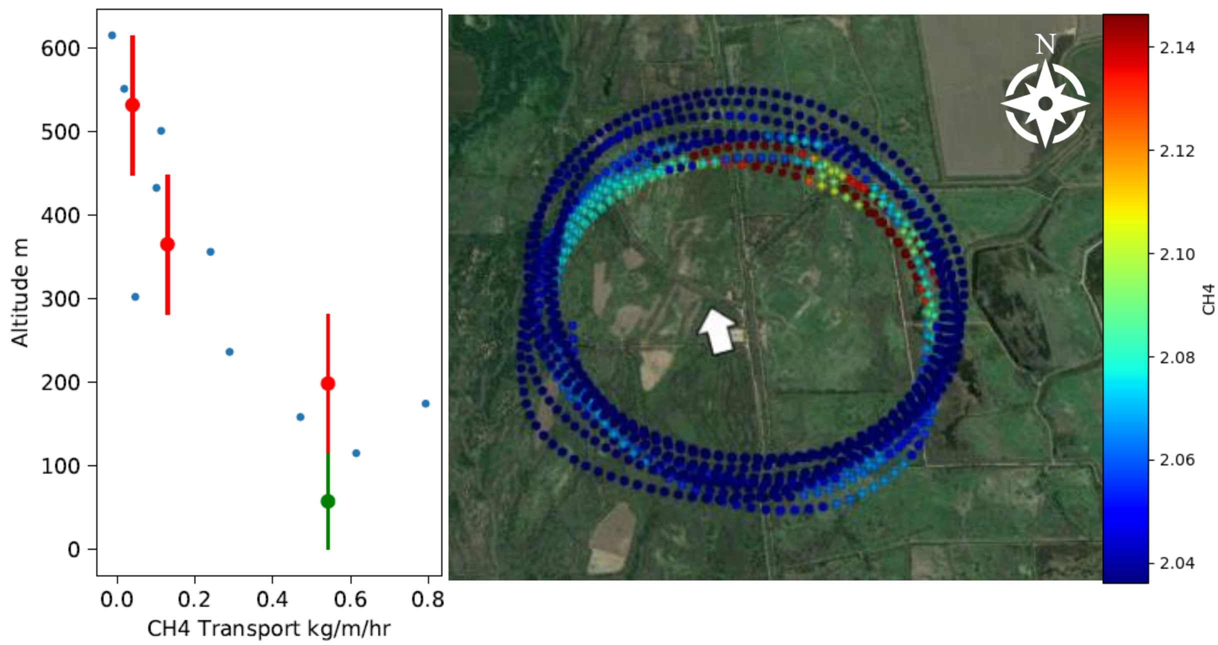

Figure 201. Left: Vertical profiles of horizontal methane flux divergences. Altitude bins (red lines) and data averages within bins (red dots) are shown. Green bin is extrapolation from lowest measured altitude to the surface. Right: Flight path colored by methane concentration. Concentration scales represent the range of observed methane concentrations for the measurement and vary for each figure.). Arrow = average wind direction.