WeldCo_PHS_EX-002

Exhibit 002

Preliminary Analysis of Northern Colorado Methane and Ethane Trends Using AIRS Satellite Data and Platteville Surface Measurements

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1 Introduction

For a number of reasons, including the fact that a portion of the state has been designated an ozone nonattainment area by the Environmental Protection Agency (EPA), Colorado has implemented regulations to significantly reduce emissions of methane (CH_4) and volatile organic compounds (VOCs) from oil and gas production facilities. The most significant of these regulatory changes was in February 2014 when the Colorado Air Quality Control Commission's (AQCC) fully adopted EPA's New Source Performance Standards (NSPS), 40 CFR Part 60, Subpart OOOO, into AQCC Regulation No. 6, and adopted more stringent control requirements for VOCs and hydrocarbons for a variety of oil and gas sources in AQCC Regulation No. 7. The changes to Regulation No. 7 in early 2014 included expanded control requirements for hydrocarbon liquid storage tanks, pneumatic controllers, glycol dehydrators, and components; implementation of a leak detection and repair program; and limitations to venting associated with maintenance and liquids unloading from storage tanks. Since 2014, the AQCC has continued to adopt additional measures to reduce CH_4 and VOCs from oil and gas sources and this is anticipated to continue through 2021 and beyond.

Importantly, the Denver-Julesburg Basin (DJ Basin) is a significant oil and gas producing region in the northern portion of the State. Oil and gas is estimated to be the largest industrial contributor to CH_4 emissions in the State. Oil and gas production in the DJ Basin has steadily increased over the last decade.

In order to better understand the efficacy of past oil and gas regulations and drivers for future emission control regulations, this preliminary analysis uses satellite and surface measurement data to examine CH_4 trends and reductions over the past decade in an area of Northern Colorado that includes the Denver Metro area and a portion of the DJ Basin north of Denver ("Northern Colorado"). While a variety of government agencies, researchers, and other groups have assessed CH_4 and VOC concentrations in Colorado from surface and aerial measurements, satellite CH_4 data has not been widely used to assess CH_4 in Colorado.

To assess CH_4 trends in Northern Colorado, we selected the Atmospheric Infrared Sounder (AIRS) instrument launched in 2002 on the Aqua Satellite, because of its almost 20-years of data, its ongoing use, and its provision of an accurate estimate of the rates of change in CH_4 from year-to-year. The use of AIRS products to estimate CH_4 trends and relative CH_4 changes is consistent with analyses conducted by other scientists and published in peer-reviewed journals (Wu et al, 2019).

Results of this preliminary analysis indicate that there has been a substantial decrease in CH_4 in northern Colorado since concentrations peaked in 2013 despite the increases in oil and gas production that have occurred since 2013. Importantly, this finding is corroborated by comparison with ground-based measurements which also show significant decreases.

These preliminary findings are significant for upcoming rulemakings in Colorado. In particular, these trends demonstrate that past regulatory changes have effectively reduced local CH_4 emissions from the

oil and gas sector even during a period with substantial production increases. Therefore, additional CH_4 control requirements beyond what is currently being considered for the oil and gas sector may not be warranted.

2 Methods

In this preliminary analysis, we examine two independent measurement methods, and each show significant decreases in CH_4 concentrations in Northern Colorado since 2013. The two categories of measurements assessed in this preliminary analysis are (1) satellite measurements and (2) ground-based, surface measurements.

When assessing CH_4 concentrations it is important to account for global background levels to isolate local and regional CH_4 contributions. These are often referred to as "local" and/or "regional CH_4 enhancements". In this section we describe the rationale for using the AIRS satellite products, how western United States background CH_4 concentrations were estimated, and the data processing steps applied to the publicly available satellite data products. To provide an independent assessment of DJ Basin CH_4 trends and corroborate the satellite-based CH_4 trends, ground-based CH_4 surface measurements at the Platteville monitor were assessed. We explain the measurements collected at the Platteville monitoring site, why this site was selected, and present analyses that demonstrate the Platteville site is representative of Northern Colorado's oil and gas emissions.

2.1 Selection and Application of Satellite Data Products

Satellites and aircraft studies are now common tools for calculating emissions fluxes and the contributions of oil and gas sources to ambient concentrations of CH_4 and VOCs. Recently, de Gouw et al. (2020) published analyses of CH_4 data from the TROPOspheric Monitoring Instrument (TROPOMI) on board the Copernicus Sentinel-5 Precursor satellite, which was launched in October of 2017. In their paper, the authors have identified and quantified CH_4 enhancements over many oil and gas basins in the United States and are currently working on a study of the DJ basin (Dix et al., 2020). TROPOMI has high spatial resolution and greater signal sensitivity than older instruments, but there is not yet a long enough data record to identify long-term trends.

In our study, we use CH_4 data from AIRS on board the Aqua satellite which was launched in 2002. Use of AIRS in this context is common and AIRS has been used by researchers to quantify regional methane trends over reasonably long-time scales (Jet Propulsion Laboratories [JPL], 2021).

2.1.1 AIRS Satellite CH_4 Data Product

The AIRS instrument is on board the Aqua satellite which was launched in 2002[1] and is part of the A-Train, a series of Earth-observing satellites that closely follow one another. AIRS was deployed to monitor the Earth's atmosphere and to collect a variety of data on weather and climate, and trace gases as it passes across the Earth twice a day.

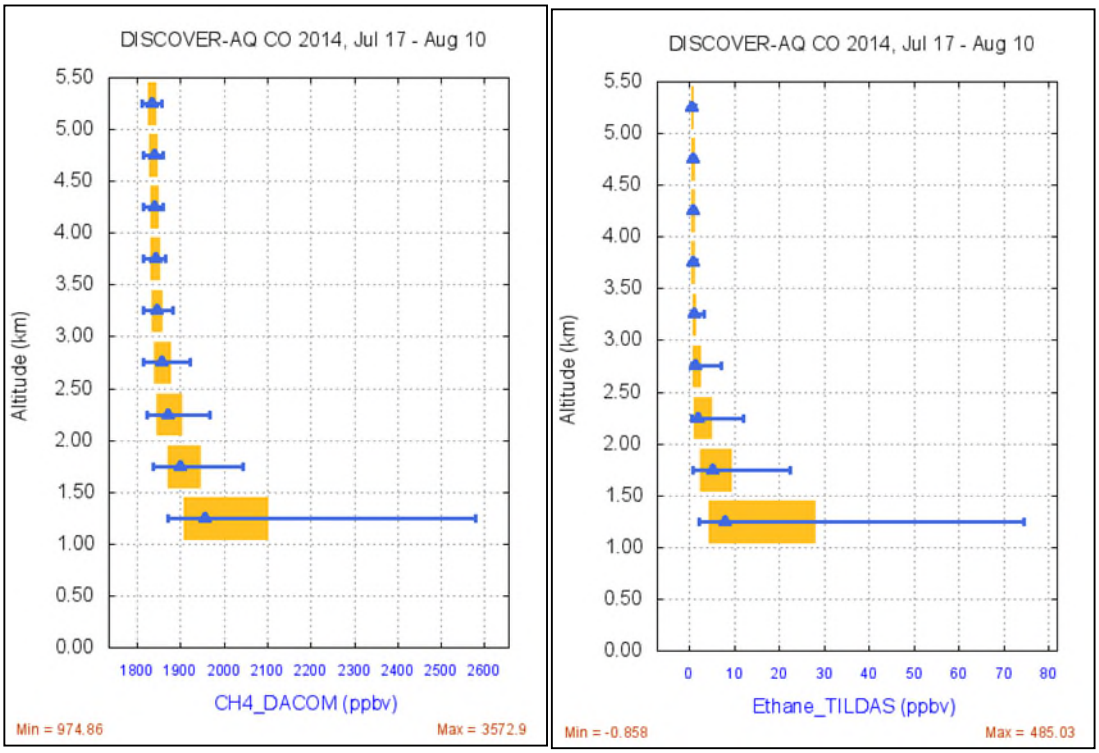
[1]The data are available from NASA (https://giovanni.gsfc.nasa.gov/giovanni/).

The AIRS instrument does not measure CH_4 directly. Instead the satellite sensor measurements and additional information about the atmosphere are combined and processed using computational algorithms. The derivation of CH_4 concentrations from satellites is referred to as a "data retrieval". When selecting the specific satellite retrieval product, it is important to consider the questions the data is intended to answer relative to the goal of the study. Our goal is to use this data to assess long-term trends and relative changes in CH_4 emissions. The AIRS product is particularly well suited for this goal for a number of reasons. Specifically, we selected the AIRS data for this preliminary analysis due to its long period of record, the frequency and timing of overflights, and relatively low uncertainty for CH_4 (JPL, 2021). A variety of AIRS CH_4 data products are publicly available. We selected the 2020 AIRS Version 7, CH_4 700 millibar (mb) data product, which is the most current version. The 700 mb data product was selected because of its sensitivity to surface conditions and low bias and errors.

2.1.2 AIRS CH_4 Representativeness, Accuracies, and Biases

AIRS CH_4 retrieval concentrations for specific levels of the atmosphere are not independent of concentrations at other levels in the atmosphere. The AIRS CH_4 retrievals in the mid-latitudes in the northern hemisphere are most sensitive to CH_4 concentrations at 400 mb. The AIRS 400 mb CH_4 retrieval concentrations also have the greatest independence from CH_4 elsewhere in the atmosphere (Xiong et al., 2015). The AIRS 400 mb CH_4 retrievals, however, are not as sensitive to surface mixed layer concentrations as retrievals at lower levels of the atmosphere. Therefore, for this study, we selected AIRS CH_4 700 millibar (mb) data for the lower troposphere (approximately 10,000 feet above mean sea level [MSL]). At this level, the effective weighting of concentrations in the vertical is described by a relatively flat curve. While the CH_4 retrieval for the 700 mb level is influenced by CH_4 concentrations from the surface all the way into the stratosphere, the 700 mb data are anticipated to be strongly correlated with concentrations at the surface.

The sensitivity of AIRS 700 mb CH_4 to surface conditions was evaluated and confirmed using aircraft data collected by the DISCOVER-AQ campaign in 2014. As shown in Figure 1, the median CH_4 concentration measured by DISCOVER-AQ within the area of interest at the 1,750-meter MSL level was 1900 ppb which is very close to the June-August 2014 average AIRS 700 mb CH_4 of 1892 ppb shown in Figure 2. This suggests that the AIRS 700 mb retrieval concentrations were representative of median CH_4 in the lower portion of the mixed layer in 2014. The 700 mb level is also at approximately the same altitude as the National Oceanic and Atmospheric Administration (NOAA) Niwot Ridge monitor and, as described in Section 2.1.3, Niwot Ridge is used to estimate background CH_4 for this study.



Source: National Aeronautics and Space Administration (2021)

Figure 1. Percentile plots of CH4 (left) and ethane (right) for all flights and spirals of the DISCOVER-AQ P3-B in July and August 2014. Blue triangles are medians, orange bars represent the 25th through 75th percentile range, and horizontal blue lines represent the 5th through 95th percentile range.

The AIRS CH_4 uncertainty depends on a variety of factors. Uncertainty for an individual pixel and a given day will be much greater than for monthly or seasonal averages or gridded data sets that include data from multiple pixels. Xiong et al. (2015) report a bias of 0.27 % and a root mean square error (RMS) of 0.87 % for AIRS CH4 data for 555 mb to 777 based on intercomparisons aith aircrafta data, these uncertainties reflect variable spatial and temporal averaging. For a CH_4 concentration of 1850 ppb (which is a common global background CH_4 concentration), this equates to a bias of 5 mb and a RMS of 16 ppb. Strow and DeSouza-Machado (2020) compared AIRS CH_4 against NOAA Global Monitoring Division global in situ measurements from 2002-2018. They found AIRS CH_4 measurements had a small, variable, increasing bias during this period, and this bias is typically less than +10 ppb.

Wu et al. (2019) recently completed a comprehensive, long-term, analysis of CH_4 trends across China using AIRS data. They conclude that AIRS CH_4 concentrations "showed good consistency with the ground measurements of surface CH_4 concentration from the World Data Centre for Greenhouse Gases (WDCGG) ($R2 = 0.83$, $p < 0.01$), indicating that the remotely-sensed CH_4 reflected the spatial and temporal variations of surface CH_4 concentration".

2.1.3 Estimating and Accounting for Background CH4

In order to estimate and isolate the influence of local and regional sources on long-lived gases that are well-mixed in the atmosphere, such as CH_4, it is necessary to remove background concentrations. In the

case of CH_4 this process is complicated by the fact that background concentrations are increasing globally. To estimate background CH_4 conditions, we analyzed CH_4 data reported by the NOAA Global Monitoring Division[2] for two sites: Niwot Ridge (NWR) west of Boulder (11,560 feet above MSL) and Mauna Loa Observatory (MLO) (11,145 feet MSL) located in Hawaii.

Figure 2 shows the CH_4 long-term trends in June through August as measured at NWR and MLO. For informational purposes, the June through August AIRS 700 mb CH_4 concentrations for the Denver Metro and DJ Basin region (DDJB) are also shown in Figure 2. As shown in Figure 2, from 2005-2013, CH_4 increases at rates of 5.3 ppb/year, 4.1 ppb/year, and 5.6 ppb/year for DDJB, NWR, and MLO, respectively. For 2013-2019 the rates of increase are 6.8, 9.9, and 8.2 ppb/year for DDJB, NWR, and MLO, respectively. Zou et al. (2019) confirm that globally annual rates of CH_4 concentration increases have accelerated after 2013.

NWR and MLO trend inflections and changes in slopes are similar and synchronized. In addition, a linear regression between NWR and MLO, which is shown in Figure 3, shows a robust correlation between the two sites with an R-squared values of 0.97. The bottom line is that CH_4 concentrations measured at Niwot Ridge track well with MLO, which means that NWR CH_4 concentrations can be used to represent background.

The representativeness of NWR CH_4 concentrations for background conditions is further supported by comparison of NWR to aircraft CH_4 measurements. In July and August of 2014, NASA completed 16 flights with repeated vertical spirals over the DDJB as a part of the "Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality" (DISCOVER-AQ) field campaign in Colorado. All of the 16 DISCOVER-AQ vertical spiral sites were in the AIRS DDJB grid cell, except for the Ft Collins spiral site. Figure 1 shows percentile plots of CH_4 and ethane by flight altitude for the entire campaign. Above 3 kilometers (km), CH_4 drops to background levels and ethane approaches zero indicating that this level is generally free from strong influences from boundary layer emissions from oil and gas sources. The median CH_4 concentration measured by DISCOVER-AQ at 3,250 meters MSL is about 1840 ppb which is very comparable to both the elevation of NWR at approximately 3,500 meters MSL and NWR June-August 2014 average CH_4 concentrations of 1854 ppb. This is additional evidence that NWR is a reasonable choice for background CH_4 in our study.

When boundary layer or surface layer background is estimated in aircraft studies, the upwind boundary layer concentrations are typically the basis for the estimate. Because we are using NWR measurements which are representative of a well-mixed troposphere, our background estimates may not remove all of the impacts of upwind biogenic and oil and gas sources outside the study area. Our calculated changes in DDJB CH_4 may be smaller than the actual changes resulting from reductions in oil and gas emissions alone, since changes in upwind contributions are not directly addressed. In addition there may be biases introduced by comparing AIRS retrievals with surface measurements at NWR. Our calculated percent changes discussed later in this preliminary analysis seem reasonable, and further analyses are expected to clarify uncertainties in our results.

[2] Data available at: https://www.esrl.noaa.gov/gmd/ccgg/arc/?id=132.

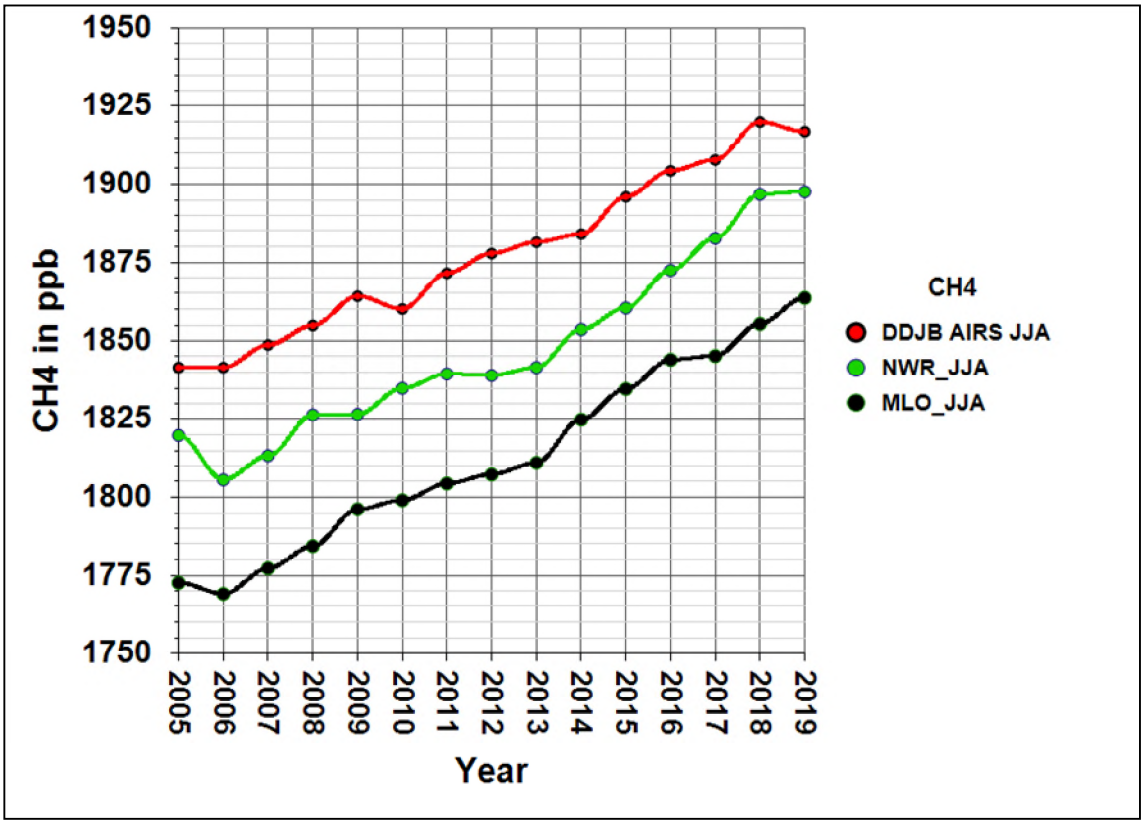


Figure 2. June-August DDJB AIRS 700 mb CH4, NWR CH4, and MLO CH4.

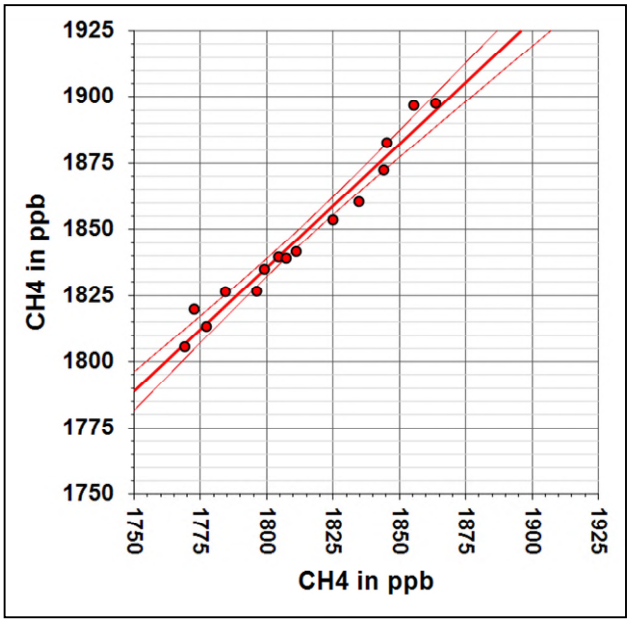


Figure 3. 2005-2019 Linear regression between June-August NWR CH4 and MLO CH4, R-squared of 0.97.

2.1.4 AIRS Data Processing Methods

The AIRS satellite flies over the DDJB region twice every day. The afternoon overflights occur at 13:30 MST and are referred to as ascending mode overflights. We used ascending mode data for 2005-2019 for a one degree by one degree grid cell centered at 40 N and 105 W. This is a standard grid cell from the NASA AIRS methane product.[3] Data for mulitiple AIRS pixels are regridded into this area. A map of the area and the grid cell is presented in Figure 4. The grid cell covers much of the Wattenberg field, an oil and gas field located in the DJ Basin, and the Boulder-Denver metro area. The geographic location of the Wattenberg field is generally consistent with the high density of oil and gas wells in the northeast corner of the AIRS grid cell shown in Figure 4. We know that thermally driven uplsope flows prevail in this region at 13:30 MST during the summer (Toth and Johnson, 1985; Reddy and Pfister, 2016; Pfister et al., 2017; Flocke et al., 2019). These flows will usually transport methane from the oil and gas fields into and across the grid cell.

We used AIRS monthly average data from 2005 to 2019. We computed June-August averages from these monthly means and then subtracted June-August mean NWR CH_4 concentrations from the AIRS DDJB CH_4 values. This represents an estimate of the CH_4 "enhancement" from local and regional sources.

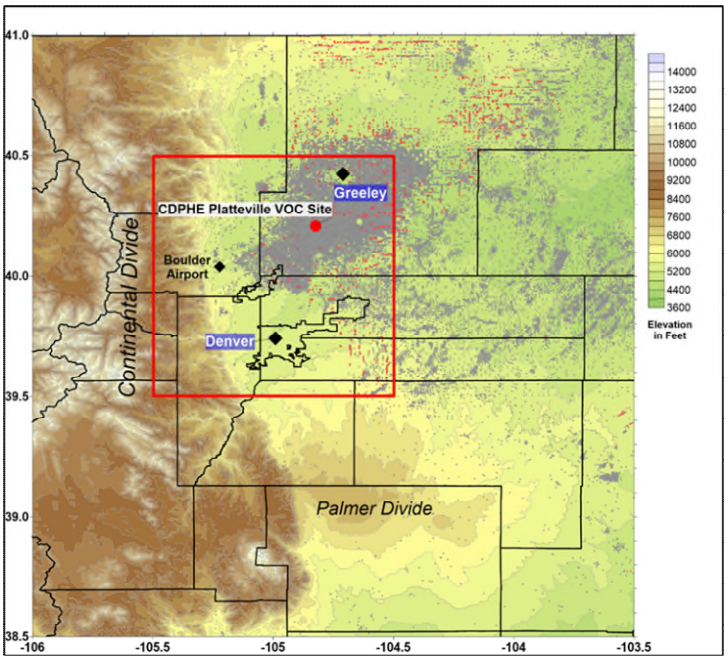


Figure 4. Grid cell for the NASA AIRS CH4 product which includes most of the Denver-Boulder metro area and most of the oil and gas wells in the southern portion of the DJ Basin.

[3] The Aqua/AIRS L3 Monthly Standard Physical Retrieval (AIRS-only) 1 degree x 1 degree V7.0, ascending mode, https://disc.gsfc.nasa.gov/datasets/AIRS3STM_7.0/summary.

2.2 Ground-based Measurements

To provide an independent method to assess the DDJB CH_4 trends, ground-based measurements within the DDJB region were analyzed. For the ground-based, surface measurements, we used data from the Platteville, Colorado, site operated by the Colorado Department of Public Health and Environment (CDPHE) because of its location in the Wattenberg oil field area; its long, historical measurement record dating back to 2012; and because of the availability of hydrocarbon measurements. The monitor at Platteville, Colorado collects a three-hour average sample with a Summa canister from 6 AM to 9 AM MST once every six days. The sample is analyzed at a laboratory to quantify concentrations of CH_4, ethane, and other speciated VOCs.

A prior analysis used HYSPLIT back trajectories to show that the Platteville site is representative of emissions and ambient concentrations in the southern Wattenberg field (Ramboll 2020). Figure 5 presents a map of the 3-hour back trajectory points for 6-9 AM MST which indicates that Platteville methane and VOC samples are representative of a large area that extends far beyond the local footprint of the monitoring site. This is clear evidence that even under the reduced wind speed regimes expected in the early morning, the Platteville site is representative of emissions in the DJ Basin between Denver and Greeley.

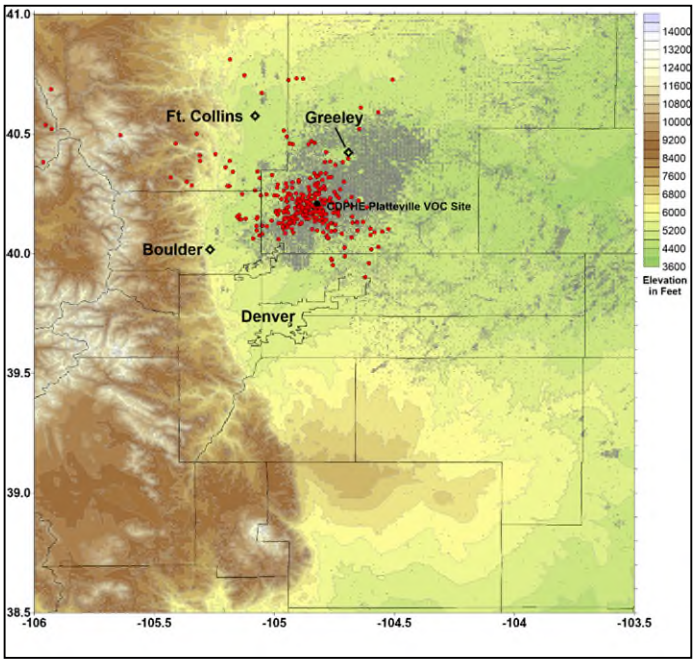


Figure 5. HYSPLIT back trajectory points (shown in red dots) for the CDPHE Platteville monitor in 2018. Oil and gas wells are plotted as grey dots.

Reported CH_4 and ethane concentrations collected at Platteville were averaged by year for 2012 through 2019. The standard deviation and 95% confidence interval was also computed for CH_4 and ethane. Importantly, we included Platteville ethane since this is more accurately reflects oil and gas emissions than CH_4 alone. There are few other sources of ethane while methane is also emitted by biogenic and agricultural sources in the region. Therefore, comparison of AIRS CH_4 data to Platteville CH4 and ethane provides useful information, particularly in combination. First of all, comparison of AIRS CH_4 and Platteville CH_4 provides an indication of how sateillite to ground-based measurements may vary due to

spatial and data processing differences. Note that we subtracted NWR CH_4 concentrations from the Platteville CH_4 6-9 AM MST data to provide background-adjusted CH_4 estimates for Platteville prior to comparison to AIRS background-adjusted CH_4. Secondly, comparison of AIRS CH_4 to Plateville ethane provides an indication of the influence of oil and gas sources on the AIRS CH_4 measurements.

3 Results and Implications

Figure 6 shows the estimated long-term trend in local and regional CH_4 enhancement based on AIRS measurements in the DDJB grid cell (shown in Figure 4). A steep downward trend begins after 2013, which is attributed to DJ Basin oil and gas emissions reductions.

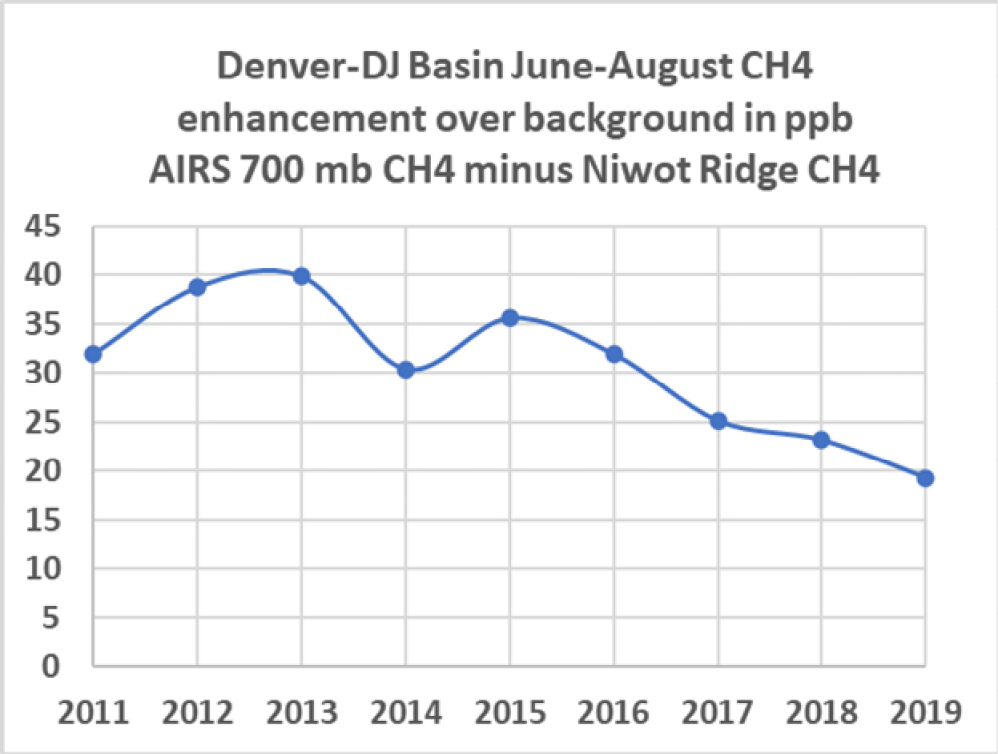


Figure 6. Local and regional enhancement in AIRS 700 mb CH4 DDJB grid cell.

To further corroborate the AIRS CH_4 trends, the annual Platteville CH_4 and ethane concentrations were calculated for 2012-2019. Table 1 lists the annual CH_4 and ethane averages, standard deviations, uncertainties at the 95% confidence level, and sample counts for each year.[4] Table 2 lists the DDJB AIRS 700 mb CH_4, NWR CH_4, Platteville CH_4, Platteville local enhancement in CH_4, Platteville ethane, and AIRS 700 mb DDJB enhancement.

The DDJB AIRS CH4 summer enhancement is highly correlated with annual Platteville CH_4 (see Figure 7) and ethane (see Figure 8), with R-squared values of 0.71 and 0.67, respectively. The large correlation between the background-adjusted AIRS 700 mb CH_4 and background-adjusted Platteville CH_4 may be an artifact of issues associated with laboratory analyses of these samples which occurred after 2016. We

[4] Platteville data was obtained from: https://www.colorado.gov/airquality/tech_doc_repository.aspx

believe, however, that the correlation between AIRS 700 mb CH_4 and Platteville ethane indicates that the AIRS 700 mb CH4 is strongly influenced by oil and gas emissions.

Table 1. Platteville CH_4 and ethane annual means and statistics for 2012-2019.

Year	Mean Methane (ppb)	Standard Deviation (ppb)	95% Confidence Level (ppb)	Number of Samples	Mean Ethane (ppb)	Standard Deviation (ppb)	95% Confidence Level (ppb)	Number of Samples
2012	2940.0	688.0	161.7	72	213.9	154.5	32.2	91
2013	3548.8	938.1	263.8	51	277.4	250.5	70.5	51
2014	2881.3	666.1	178.4	56	187.5	222.0	59.4	56
2015	2744.0	481.5	139.8	48	155.0	108.9	31.6	48
2016	3090.3	598.0	157.2	58	155.3	117.5	30.9	58
2017	2746.3	1077.0	275.8	58	177.3	358.4	91.8	61
2018	2383.4	511.5	131.0	61	100.7	77.8	19.9	61
2019	2182.5	430.3	111.2	60	97.5	90.0	23.3	60

Table 2. DDJB AIRS CH_4, NWR CH_4, Platteville CH_4, Platteville local enhancement in CH_4, Platteville ethane, and AIRS DDJB enhancement.

Year	Mean July-August AIRS 700 mb CH4 Denver-DJ Basin (ppb)	Number of Samples	Mean July-August Niwot Ridge CH4 (ppb)	Annual Platteville CH4 minus June-August Niwot Ridge (ppb)	Annual Platteville Ethane (ppb)	Denver DJ-Basin AIRS 700 mb CH4 minus Niwot Ridge (ppb)
2005	1841.6	24	1819.8			21.7
2006	1841.6	44	1805.6			36.0
2007	1848.8	27	1813.3			35.4
2008	1854.9	22	1826.4			28.5
2009	1864.2	27	1826.6			37.6
2010	1860.1	21	1834.9			25.2
2011	1871.5	20	1839.5			32.0
2012	1877.8	29	1839.0	1101.0	213.9	38.8
2013	1881.4	30	1841.6	1707.2	277.4	39.8
2014	1884.0	26	1853.6	1027.6	187.5	30.4
2015	1896.0	38	1860.4	883.5	155.0	35.6
2016	1904.3	32	1872.4	1217.9	155.3	31.9
2017	1907.8	28	1882.7	863.6	177.3	25.1
2018	1920.0	33	1896.8	486.6	100.7	23.2
2019	1916.9	28	1897.6	284.9	97.5	19.3
Percent Reduction 2013 to 2019				**83%**	**65%**	**52%**

Importantly, a closer review of Figure 2 which provides the DDJB 700 mb AIRS CH_4 data before background concentrtions are removed shows that after 2013 the rate of increase in CH_4 has decreased significantly relative to the background monitoring sites. This is attributed to reductions in local oil and gas emissions that effectively minimize increases in northern hemispheric CH_4 background that would otherwise have occured.

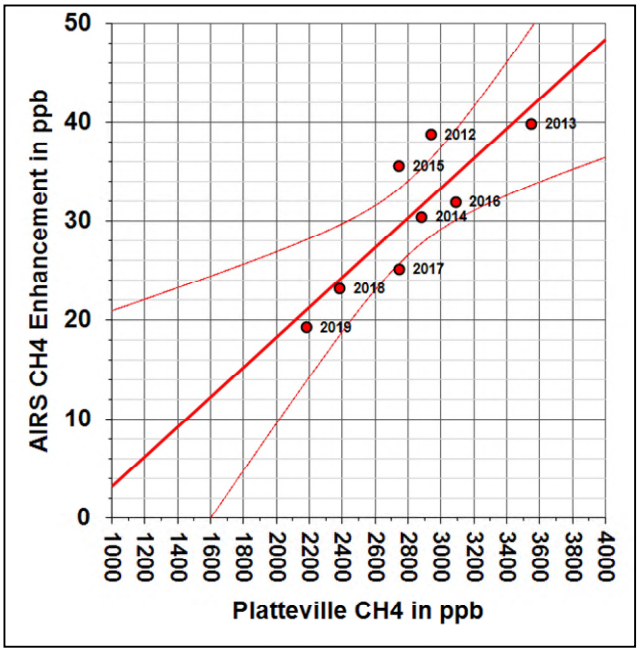


Figure 7. AIRS 700 mb CH4 enhancement versus Platteville CH4, R-squared of 0.71.

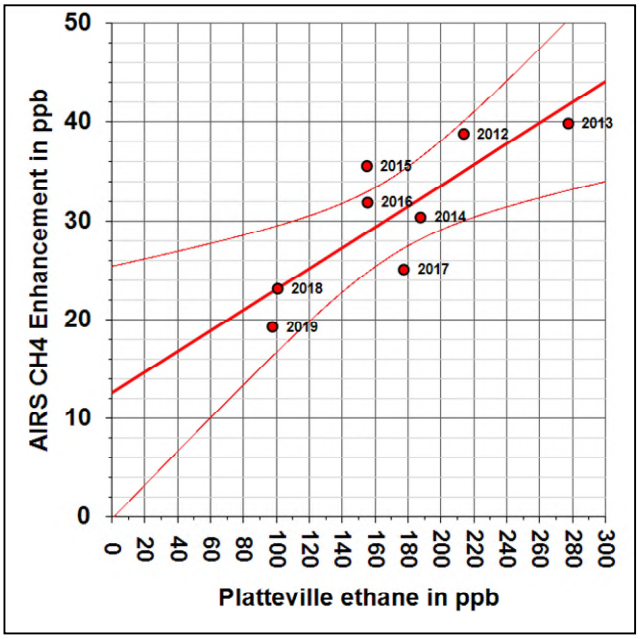


Figure 8. AIRS 700 mb CH4 enhancement versus Platteville ethane, R-squared of 0.682.

Table 2 lists the estimated percent reductions in Platteville local CH_4 enhancement, Platteville ethane, and DDJB AIRS local enhancement. These reductions are 83%, 65%, and 52%, respectively. Ethane concentrations are an excellent indicator for oil and gas sources, while CH_4 has both biogenic and oil and gas sources in this region. Figures 9 and 10 are plots of the Platteville CH_4 enhancement relative to background, Platteville ethane, and AIRS 700 mb CH_4 enhancement relative to background for 2012-2019.

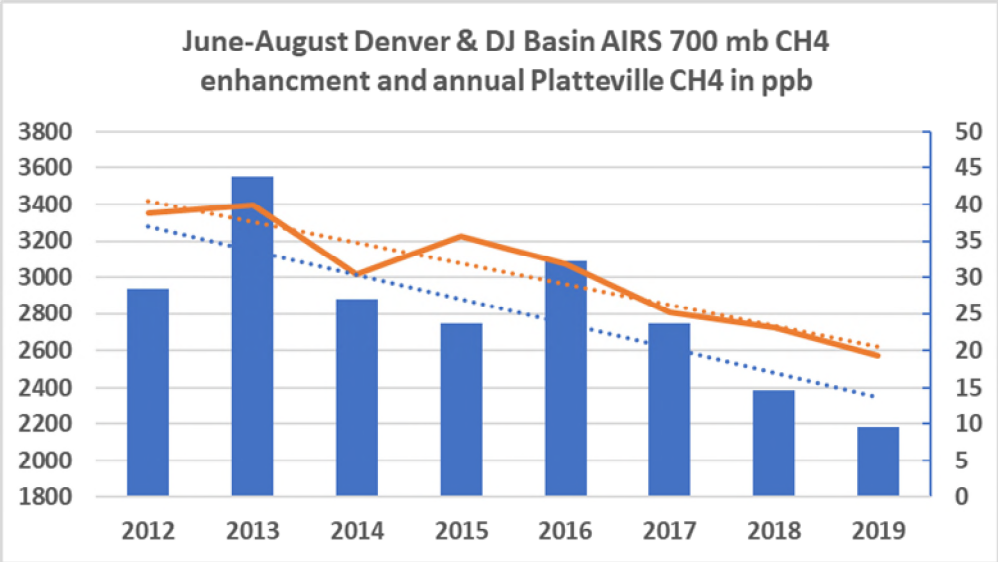


Figure 9. Platteville CH4 enhancements (blue bars), AIRS 700 mb DDJB CH4 enhancement (solid orange line), and linear regression trend lines for each.

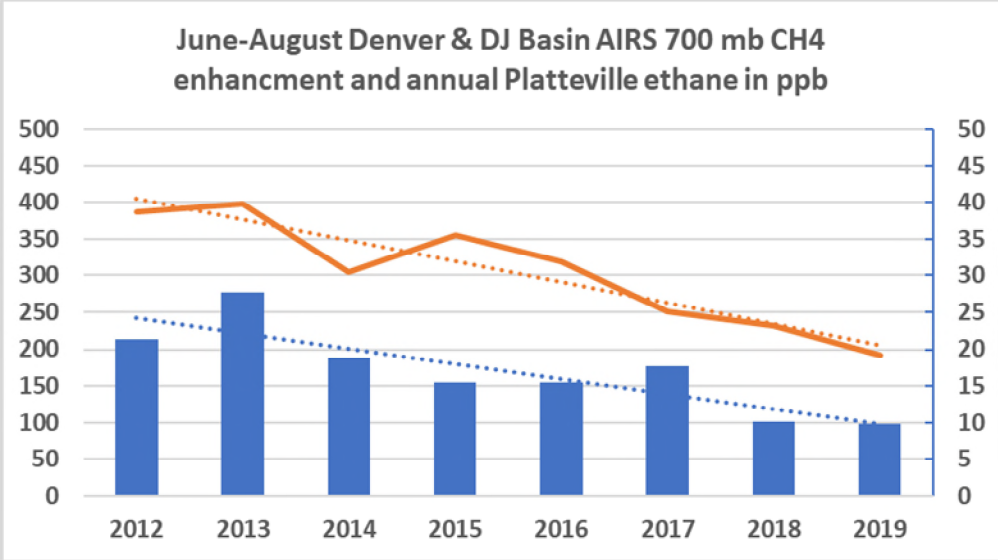


Figure 10. Platteville ethane enhancements (blue bars), AIRS 700 mb DDJB CH4 enhancement (solid orange line), and linear regression trend lines for each.

A recent paper by Lyu et al. (2021) reports a reduction in nonmethane hydrocarbons at the Platteville site. In reference to the oil and gas contributions, they report that "new regulations implemented by the state as well as changes in operating practices made by the industry for other reasons might explain the observation that NMHC mixing ratios at the Platteville site were lower in 2016 than in 2013." While their analysis focused on nonmethane hydrocarbons, their findings corroborate our assessment that downward trends in CH_4 and ethane can be attributed to reductions in oil and gas emissions.

4 Limitations and Uncertainties

This is a prelminiary assessment of the AIRS CH_4 data and further data analyses could affect the findings and conculsions; however, the signficance and implications of these trends create an urgency to initate a public disclosure and discourse on this topic. Both satellite measurements and ground-based measurements have limitations and uncertainties.

Peischl et al. (2018) conclude that oil and gas sources account for 75% of local CH_4 and biogenic sources 25% in 2015. They concur with the local proportion of CH_4 from biogenic sources reported by Maasakkers et al. (2016). We do not have information on trends in biogenic sources, but if these emissions do not change much from year-to-year, we would expect reductions in oil and gas emissions to lead to lower percent declines in CH_4 than ethane as oil and gas emissions are reduced. This is because oil and gas is the only significant source of ethane at Platteville.

Because we are using NWR measurements which are representative of a well-mixed troposphere, our background estimates may not remove all of the impacts of upwind biogenic and oil and gas sources outside the study area. In addition, there may be biases introduced by comparing AIRS retrievals with surface measurements at NWR. Our calculated percent changes seem reasonable if you assume that roughly 25% of the observed CH_4 is from biogenic sources and/or surface background transported into the study area. In this case, a 52% reduction in DDJB CH_4 is close to what would be expected if oil and gas emissions were reduced by 65%. Further analyses are expected to clarify uncertainties in our results.

5 Summary and Conclusions

We conclude that the AIRS CH_4 data is an effective tool for tracking trends and estimating percent reductions in oil and gas emissions in this area. Based on satellite data, DDJB CH_4 concentrations are estimated to have decreased by 52% from the peak in 2013. This 52% reduction in CH_4 emissions is substantial and can likely be attributed to decreasing oil and gas emissions in the DJ Basin, which are likely due to regulatory controls enacted by the AQCC and changes in operating practices. In addition, since 2013, ethane concentrations monitored at Platteville were reduced by 65%. This is particularly indicative of reductions in oil and gas emissions since ethane is a better tracer for oil and gas emissions than CH_4.

To summarize, we conclude the following:

- The monitored concentrations of CH_4 and NMHC species at Platteville, Colorado is representative of oil and gas emissions in the southern Wattenberg field.

- Enhancements in CH_4 over background concentrations, as calculated with NASA AIRS satellite CH_4 data for an area that includes the Denver-Boulder metro area and most of the Wattenberg oil and gas field, are highly correlated with CH_4 and ethane data from the Platteville monitor. Both ethane measurements and AIRS CH_4 can be reliably used to track progress in oil and gas emissions reductions.

- AIRS CH_4 concentrations have declined by about 50% since 2013. Ethane emissions, as reflected by measurements at the Platteville monitor, have been reduced by 65% since 2013.

Both trends suggest that regulatory emissions controls and changes in operational practices have been effective in reducing emissions from the oil and gas industry in the DJ Basin.

6 References

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