Comparison of TCEQ and EPA Nonpoint Oil & Gas 2022 Modeling Inventories

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Abstract

Texas Commission on Environmental Quality (TCEQ) as part of developing its 2022 modeling platform (TCEQ 2022 MP) has developed a preliminary emissions inventory for the Texas nonpoint oil and gas (O&G) sector for the 2022 modeling year. Emissions sources in this sector include drilling, compressor engines, storage tanks, pneumatic pumps and devices, heaters, and hydraulic fracturing pumps. The Environmental Protection Agency (EPA) recently released version 1 of its 2022 Emissions Modeling Platform (2022v1), where O&G emissions are estimated using EPA's Oil and Gas Emissions Estimation Tool. The TCEQ 2022 O&G inventory was developed using TCEQ's own O&G calculator, which estimates emissions differently than the EPA tool for some O&G categories. This work compares modeled O&G emissions within Texas between TCEQ's and EPA's 2022 modeling platforms, and outlines aspects of each platform that may be leading to differences in emissions totals. In addition, TCEQ and EPA's 2023 future year projections are compared from older platforms. Then, the TCEQ's and EPA's 2022 base year O&G emissions totals from their latest modeling platforms are compared to the respective 2023 future year O&G projections totals from previous modeling platforms to draw conclusions about the integrity of the projection methodology used to determine the future year estimates and the nearby base year estimates for 2022.

Methodology

O&G emissions from EPA's 2022v1 modeling platform were obtained from EPA's online data retrieval tool, which allows users to filter and download output emissions totals by county or facility for the various sectors EPA incorporates into its modeling. EPA's estimated 2022 O&G emissions by county for Texas were downloaded by filtering the county-level tab of the retrieval tool to "TX" for the "State" column and "Industrial Processes - Oil & Gas Production" for the "EIS Sector" column.

O&G emissions totals by county from TCEQ's 2022 modeling platform were gathered from modeled emissions files. TCEQ processes O&G emissions based on estimates derived from custom TCEQ emissions calculators. These calculators use year-specific Texas Railroad Commission (RRC) activity data and various factors to derive emissions estimates for 47 different O&G source category codes (SCC). These emissions estimates are then appropriately speciated and spatially and temporally allocated as needed for air quality modeling. TCEQ's 2022 nonpoint O&G emissions used in the comparisons in this work were obtained from emissions reported in tons per day (tpd) from the Emissions Processing System version 3 (EPS3) emissions model used by TCEQ. The tpd emissions for specific seasons reported by EPS3 does not match the units of EPA's 2022 emissions in 2022v1, which is tons per year (tpy). TCEQ emissions were appropriately multiplied by the number of days in each season for a non-leap year (i.e. 92 days in summer where summer is June, July, and August), and the totals for each season were added together to obtain a tpy value for each county.

EPA's previous emissions modeling platform, 2016v3, with a base year of 2016, incorporates emissions projections for the 2023 future year. TCEQ's previous emissions modeling platform with a base year of 2019 (TCEQ 2019 MP) also utilizes 2023 future year emissions projections. An emissions report by county and month, available as part of EPA's 2016v3 platform, was used to obtain tpy values for EPA's estimated 2023 future year O&G emissions. TCEQ's 2023 future year emissions were obtained and appropriately converted to a tpy value using the same methods described above.

2022 and 2023 O&G emissions totals were analyzed and compared by groups of counties that characterize major oil and gas basins, and shale plays and ozone nonattainment areas in Texas **(Figure 11)**. A comparison of EPA's and TCEQ's recent base year 2022 O&G emissions estimates was conducted to characterize any differences between the two modeling inventories. A similar comparison was done for the respective 2023 future year O&G emissions from previous EPA and TCEQ modeling platforms to assess how well previous future year estimates from EPA and TCEQ compared against each other and against the more recently developed base year.

Observations and Conclusions

TCEQ's 2022 O&G NO_X statewide emissions were about 42% higher than the corresponding EPA emissions (280,000 tpy compared to 183,000 tpy, almost 100,000 tpy difference). Large differences were seen in the Eagle Ford Shale (with 103,000 tpy in TCEQ's estimates compared to 44,000 tpy in EPA's inventories), Haynesville Shale (54,000 for TCEQ, 9,000 tpy for EPA) and the Permian Basin (93,000 tpy versus 66,000 tpy for TCEQ and EPA platforms respectively) **(Figure 1).** Smaller differences were seen in 2022 O&G VOC emissions, with only a 5% difference in total statewide VOC tpy emissions (1,272,000 tpy for TCEQ's compared to 1,339,000 tpy for EPA's datasets). The biggest difference is in the Eagle Ford shale (55,000 tpy, a difference of 26%) with TCEQ estimating 183,000 tpy and EPA estimating 239,000 tpy **(Figure 2)**. $PM_{2.5}$ total TX statewide emissions for TCEQ is 3,000 tpy and EPA is 3,580 tpy, a difference of around 15%. Though EPA estimated greater statewide $PM_{2.5}$ emissions, in the Eagle Ford shale, TCEQ estimated significantly higher emissions (1,220 tpy versus EPA 850 tpy, a difference of 35%) **(Figure 3)**.

There might be several reasons for why TCEQ and EPA exhibit a variety of differences between emissions totals in Texas for the nonpoint oil and gas sector for the year 2022. For example, for the allocation of compressor engine emissions, TCEQ uses 13 SCCs while EPA uses five. Ultimately, for reasons including differences in how emissions are controlled in some areas of the state as well as a difference in calculation methodology, this results in about 75,000 fewer tons per year (tpy) of NO_X in the EPA inventory.

Similarly, the EPA tool uses basin-specific factors for blowdowns and liquids unloading from a 2012 Central States Air Resources Agencies (CenSARA) study (Environ, 2012) for the Permian Basin and averages for the other basins, while TCEQ uses basin-specific factors for these based on a 2008 Central Regional Air Planning Association (CENRAP) study (Environ, 2008). There are also adjustments for crude oil loading to trucks versus directly piped to refineries using 2012 CenSARA factors as well as updated control factors for well completions from hydraulically fractured wells. These three adjustments would result in a 3,650 tpy reduction in statewide VOC emissions in the EPA data. TCEQ has more recently made updates to its own oil and gas calculator for NO_X and VOC emissions from hydraulic fracturing pumps and VOC emissions from pneumatic devices, oil and condensate loading, and gas well blowdowns that result in an increase of 19,600 tpy VOC and a decrease of 1,650 tpy NO_X in the TCEQ 2022 inventory.

Specifically for the 2022 modeling efforts, TCEQ utilized year-specific oil and gas drilling and production metrics from a Texas agency, while EPA used emissions from a run of the 2020 National Emissions Inventory (NEI) oil and gas tool updated with 2022 activity. It is not reasonable to say that one set of estimates is "better" than the other without also having detailed results of modeled ozone concentrations from an air quality model.

For 2023 future year O&G emissions in Texas, TCEQ estimated more emissions than EPA in the more active shale plays (Permian Basin and Eagle Ford Shale) while EPA estimated more emissions in the less active shale plays and ozone nonattainment areas. TCEQ statewide O&G NO_X emissions for TX were about 57,000 tpy higher than the corresponding EPA estimate (257,000 and 200,000 tpy, respectively, a 25% difference) **(Figure 4)**, while TCEQ statewide O&G VOC emissions for TX were about 200,000 tpy lower than EPA's TX total (1,070,000 and 1,275,000 tpy, respectively, an 18% difference) **(Figure 5)**. TCEQ 2023 NO_X emissions for the Permian Basin make up almost 53% of the statewide O&G NO_X emissions for Texas (136,000 tpy), and the Permian Basin VOC emissions make up 67% of the TCEQ-derived statewide O&G VOC emissions for TX (717,000 tpy). EPA NO_X emissions in the Permian Basin (70,000 tpy) are only about 35% of the EPA-derived statewide O&G NO_X emissions in TX, while EPA's estimate of VOC emissions in the Permian Basin (660,000 tpy) is only about 52% of the statewide O&G VOC emissions in TX. El Paso has zero emissions estimated by both EPA and TCEQ for 2023.

Comparing the differences in NO_X emissions in the 2023 future year estimates to the 2022 estimates, TCEQ exhibits an 8% greater emissions total in 2022, while EPA shows 9% greater emissions in 2023 **(Figures 7 and 10)**. For VOC emissions, both TCEQ and EPA estimated lower emissions for 2023 than those calculated for 2022, with differences of 203,000 tpy and 63,000 tpy (17%, 5%) respectively **(Figures 8 and 10)**. There are, again, many possibilities for differences between the two future year O&G emissions estimates from TCEQ and EPA and the subsequent differences between the respective 2022 base years.

EPA's O&G Tool used for the development of the nonpoint O&G inventory for the 2016v3 platform has similar issues and methodology differences to the version used for the 2022 EMP. The base years for the respective emissions modeling platforms also differ (EPA projected from 2016, TCEQ from 2019). TCEQ uses projection factors specifically developed for each O&G shale play and basin in Texas, while EPA uses factors more general to regional activity. This could explain why TCEQ shows higher emissions than EPA in the very active shale plays, while EPA shows higher emissions in the smaller shale plays and ozone nonattainment areas (i.e., EPA future year emissions are more "spread out" across Texas).

TCEQ has suggested updates for nonpoint oil and gas emissions for EPA's 2022v1 inventory, with a mix of direct emissions and updates to the factors used in the EPA tool. Comparisons of future/updated versions of these platforms are warranted to investigate if the recommended updates bring these estimates closer.

Results

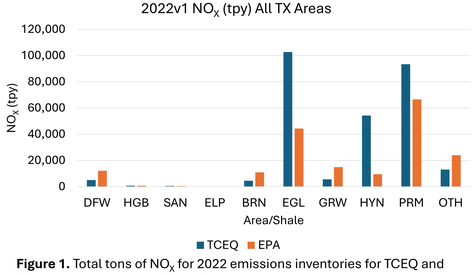

Figure 1. Total tons of NO_X for 2022 emissions inventories for TCEQ and EPA, separated by area. Eagle Ford, Permian and Haynesville are dominant.

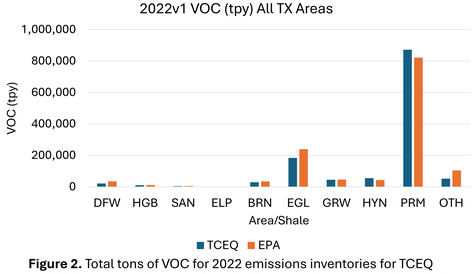

Figure 2. Total tons of VOC for 2022 emissions inventories for TCEQ and EPA, separated by area. Permian Basin dominates more than in the 2023 projections, followed by Eagle Ford.

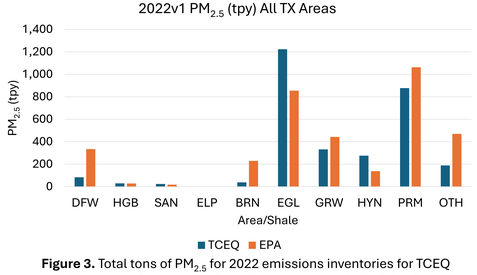

Figure 3. Total tons of $PM_{2.5}$ for 2022 emissions inventories for TCEQ and EPA, separated by area. Eagle Ford is higher with TCEQ data relative to EPA and 2023 data.

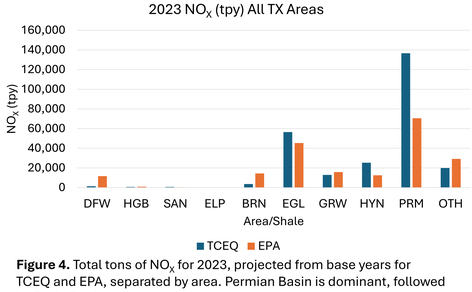

Figure 4. Total tons of NO_X for 2023, projected from base years for TCEQ and EPA, separated by area. Permian Basin is dominant, followed by Eagle Ford.

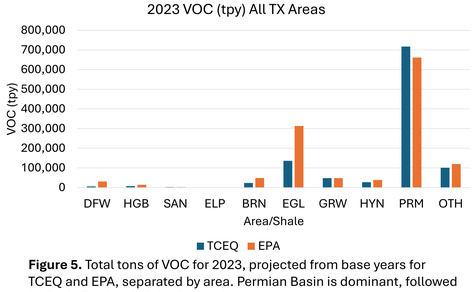

Figure 5. Total tons of VOC for 2023, projected from base years for TCEQ and EPA, separated by area. Permian Basin is dominant, followed by Eagle Ford and "Other" counties.

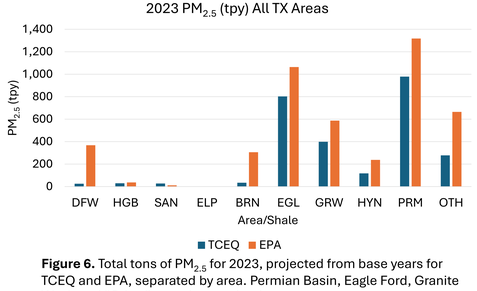

Figure 6. Total tons of $PM_{2.5}$ for 2023, projected from base years for TCEQ and EPA, separated by area. Permian Basin, Eagle Ford, Granite Wash and "Other" counties are dominant.

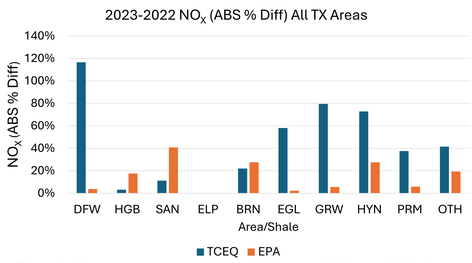

Figure 7. Absolute percentage difference between 2022 and 2023 NO_X tons per year, per area. DFW shows high difference due to low total values. Overall, TCEQ is showing more difference.

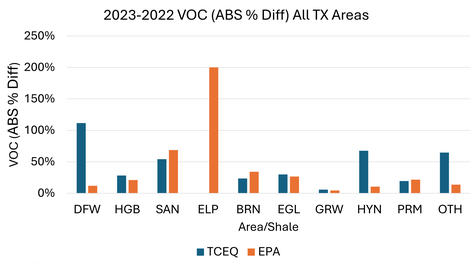

Figure 8. Absolute percentage difference between 2022 and 2023 VOC tons per year, per area, for TCEQ and EPA. In the O&G areas, TCEQ and EPA differences are similar; Barnett and Permian are lower for TCEQ, though Haynesville is higher.

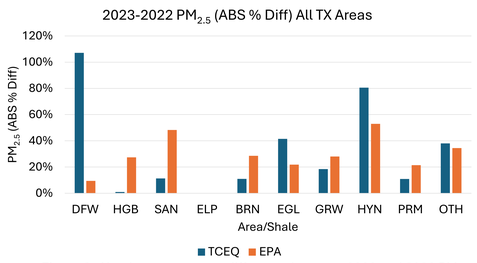

Figure 9. Absolute percentage difference between 2022 and 2023 $PM_{2.5}$ tons per year, per area, for TCEQ and EPA. Differences are lower in Barnett, Permian, and Granite Wash for TCEQ, but higher in Eagle Ford.

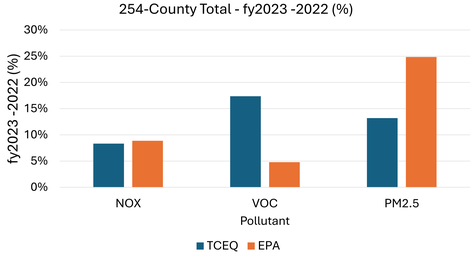

Figure 10. Texas statewide absolute percent difference between the 2023 projections and the 2022 emissions inventories for TCEQ and EPA, for the three pollutants.

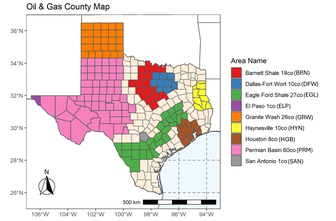

Figure 11. Texas county map color-coded by areas. Areas include Barnett Shale (BRN), Dallas-Fort Worth (DFW), Eagle Ford Shale (EGL), El Paso (ELP), Granite Wash (GRW), Haynesville (HYN), Houston (HGB), Permian Basin (PRM), San Antonio (SAN). "Other" (OTH) is not listed in the legend but is color-coded light brown.

Acknowledgements & References

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