Supplement of Earth Syst. Sci. Data, 16, 3973–3991, 2024
https://doi.org/10.5194/essd-16-3973-2024-supplement

Open Access Earth System Science Data

Supplement of

Constructing a measurement-based spatially explicit inventory of US oil and gas methane emissions (2021)

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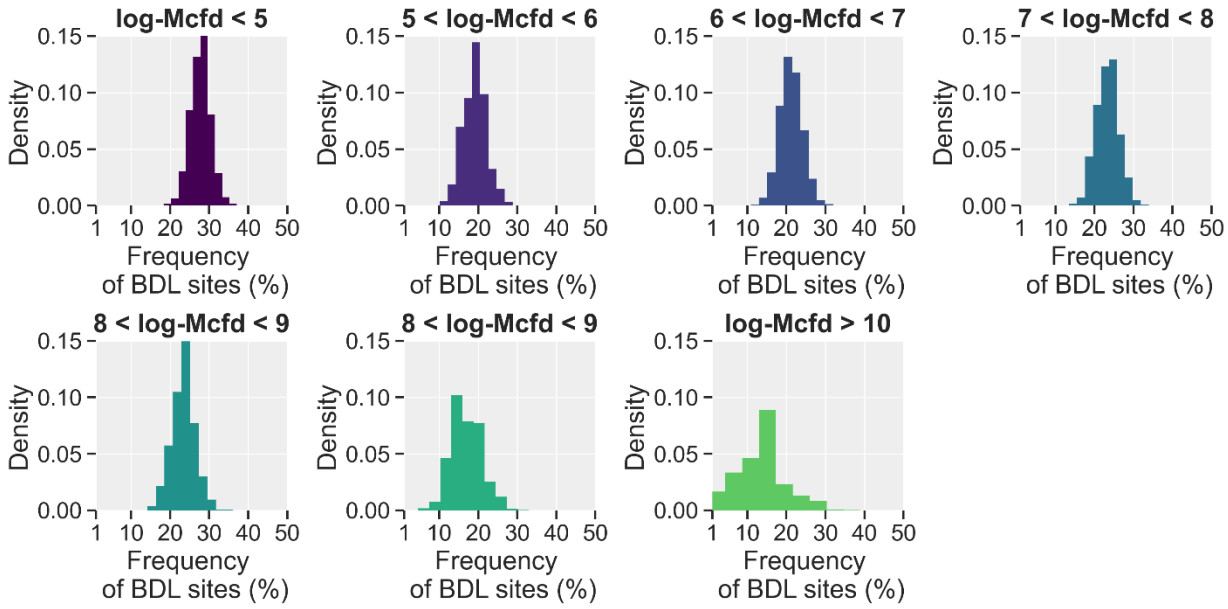


Figure S1. Frequency distribution for sites below the detection limit for different production cohorts of non-low production sites

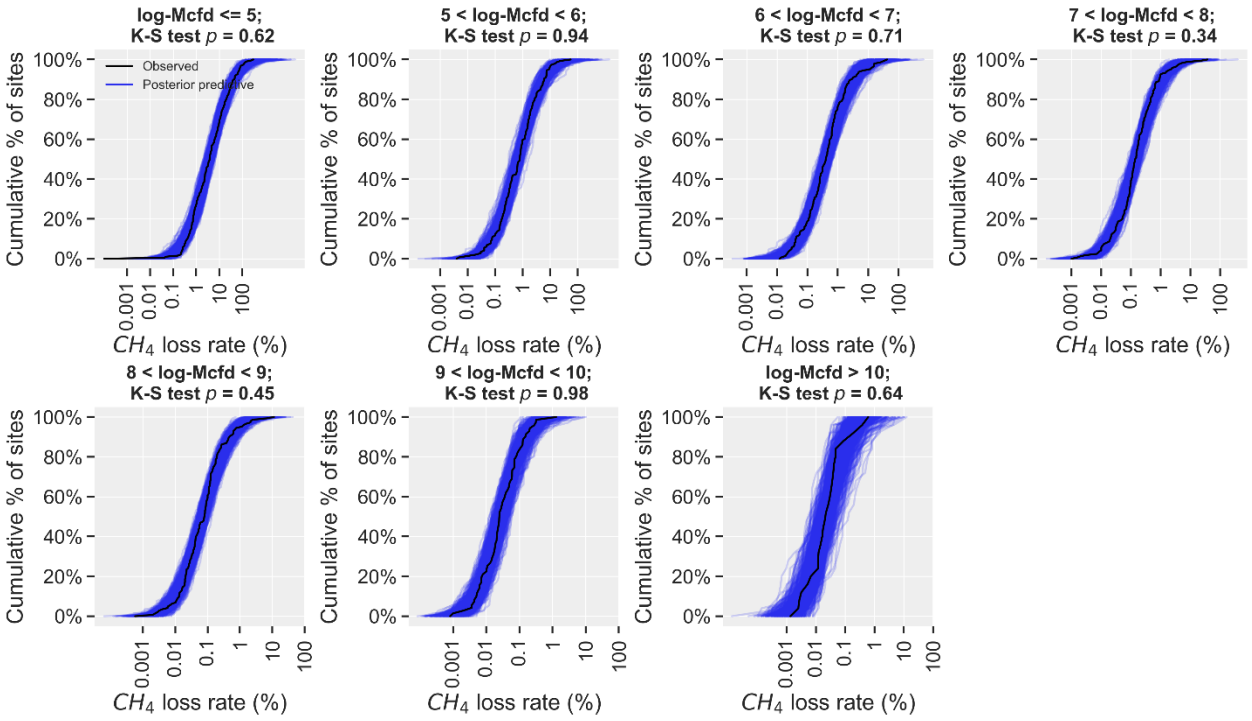


Figure S2: Random samples drawn from the modelled distribution for each production cohort, showing good agreement between modelled and empirical distributions.

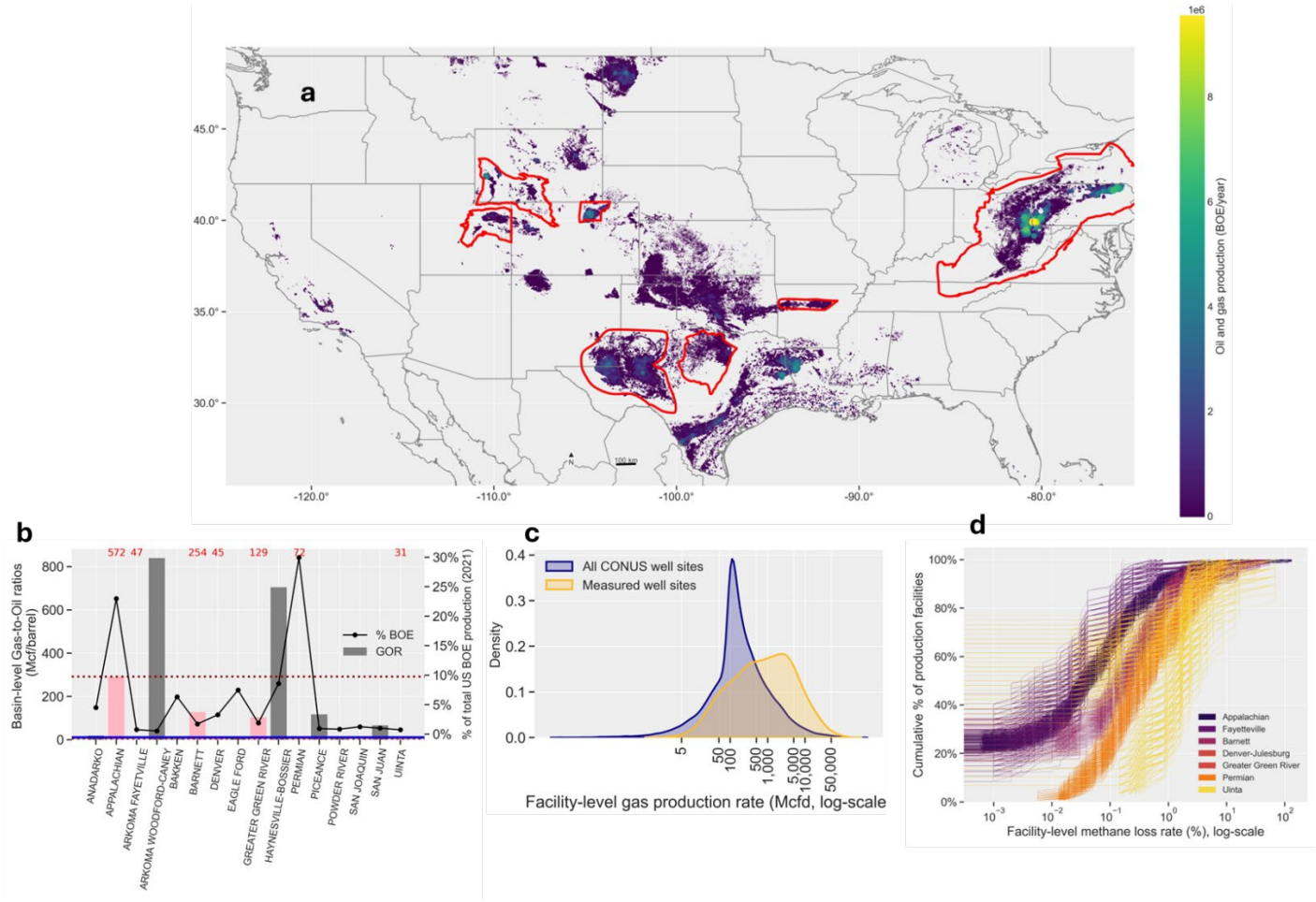


Figure S3: Geographical coverage, distribution of facility-level production rates, and emission rates for well site measurements used in this study. **a.** The heatmap shows the well site oil and gas production data for 2021, color-coded by combined oil and gas production rates (boe/year). Major basins for which substantial measurement-based data on oil and gas methane emissions are available are highlighted in red. **b.** Assessment of the basin-level production characteristics, based on average gas-to-oil ratios in Mcf/barrel in 2021. The bar plots show the basin-level GOR ratios, light pink bars correspond to basins for which measurement-based data (see Main Text on criteria) are available. The number of samples are shown in top x axis in red. The solid blue line shows the average GOR ratio for all sites in the US in 2021 (average of 11 Mcf/bbl) and the dotted dark red lines show the minimum (5 Mcf/barrel) and maximum (230 Mcf/barrel) for all the basins for which we have measurement-based data. The right y-axis shows the % of total US onshore BOE production that is accounted for by each major US basin. **c.** Histogram of gas production rates comparing the distribution for the sampled non-low production sites with that for the population of non-low production sites in the US. **d.** Comparison of empirical distribution of facility-level production-normalized methane loss rates for the major basins for which measurements are available. We performed non-parametric bootstrap resampling, with replacement, of the data for each basin, repeated 10^4 times to generate the likely extent or uncertainties of the distributions conditional on empirical observations. For each basin, we plot the distributions based on the 10^4 bootstrap results. Map credit: ESRI, 2023.

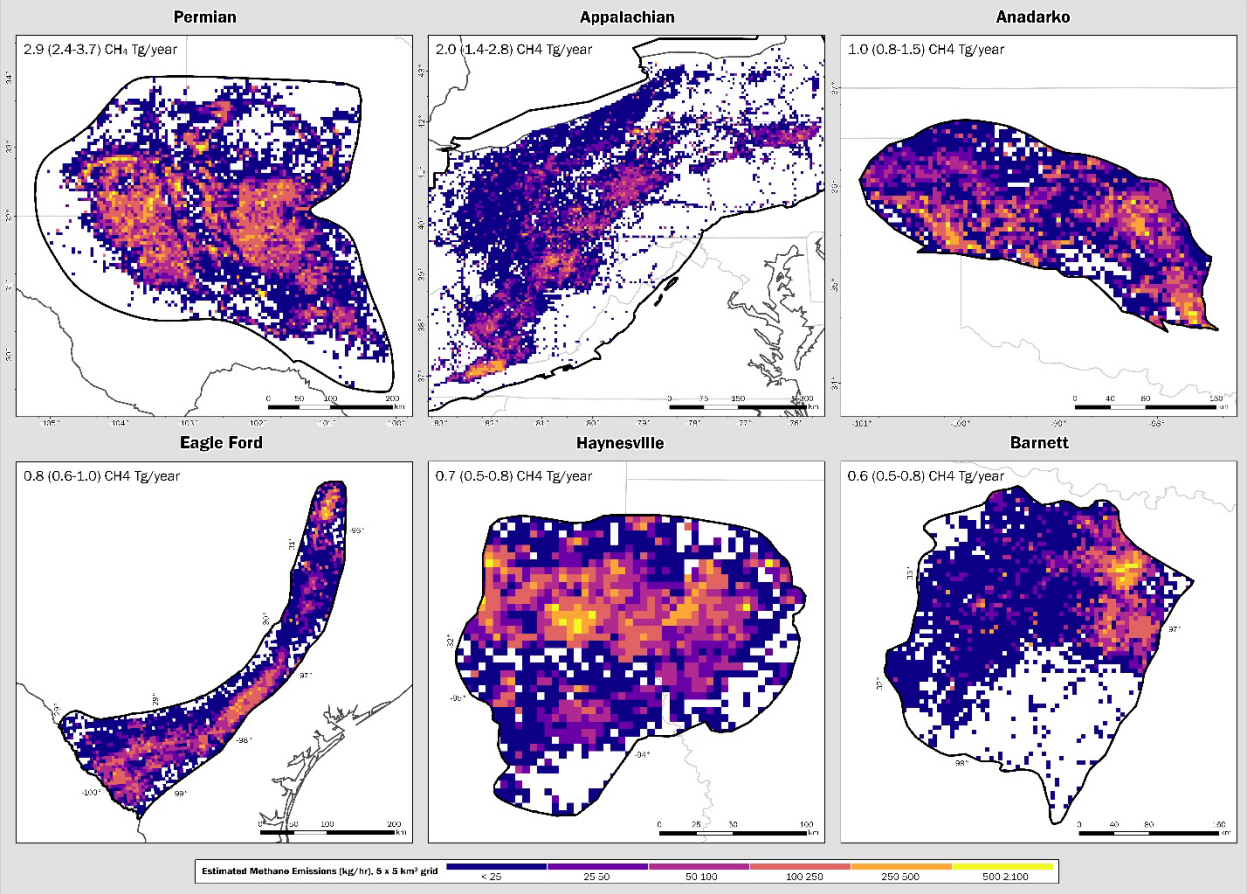


Figure S4. Top six methane emitting basins in EI-ME. Map credit: ESRI, 2023.

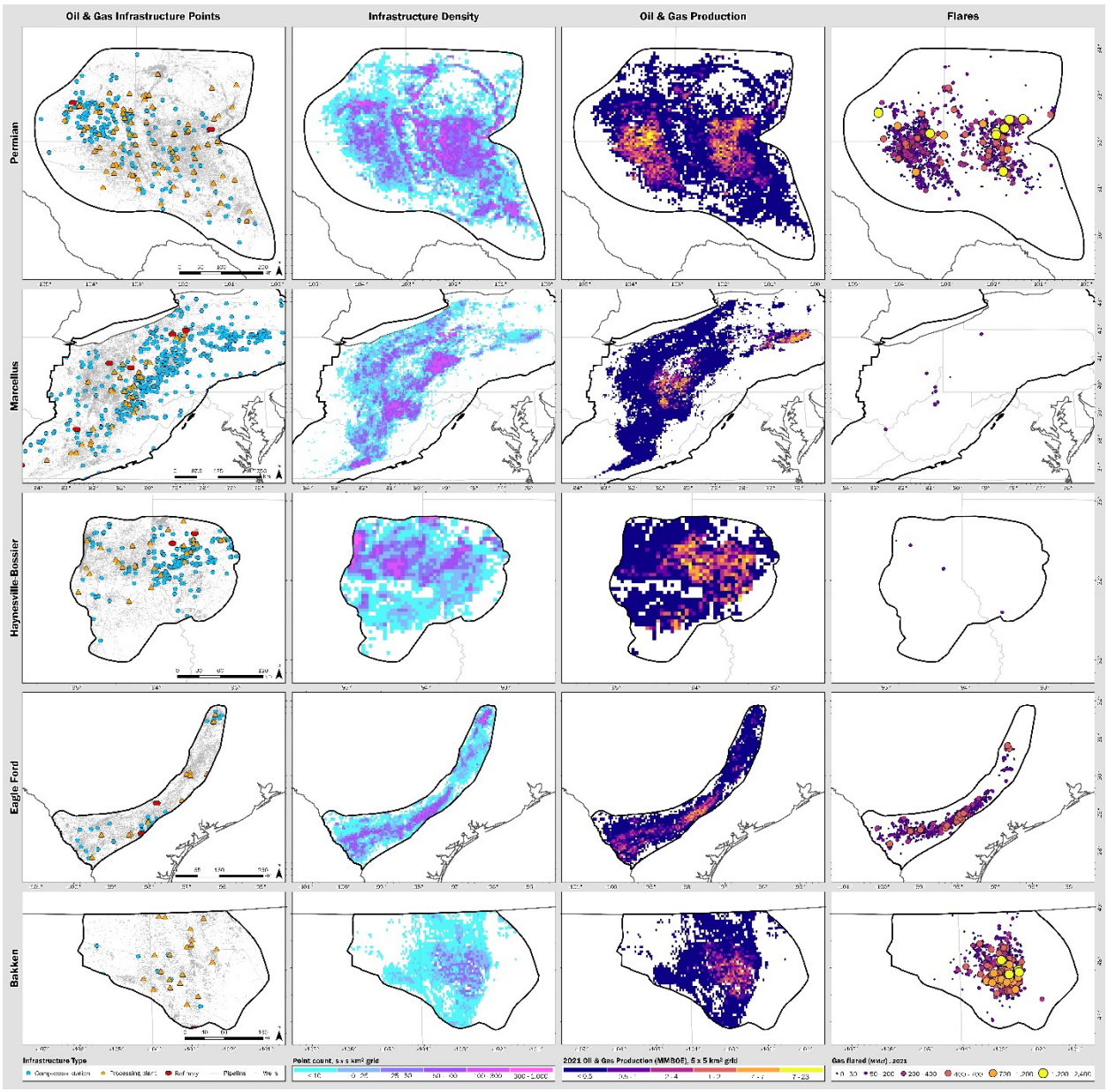


Figure S5. Comparison of oil and gas activity data for the top five contiguous US oil and gas production basins in 2021. Map credit: ESRI, 2023.

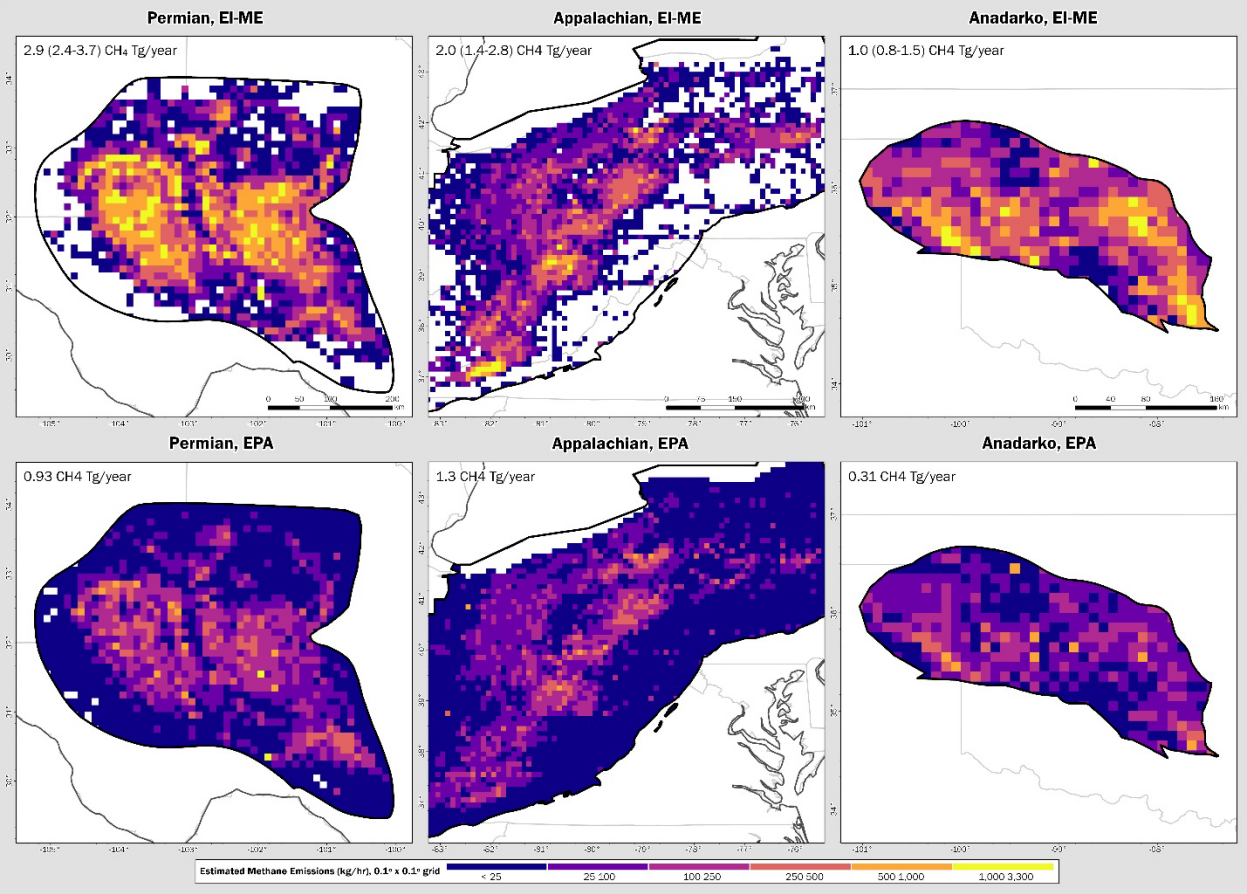
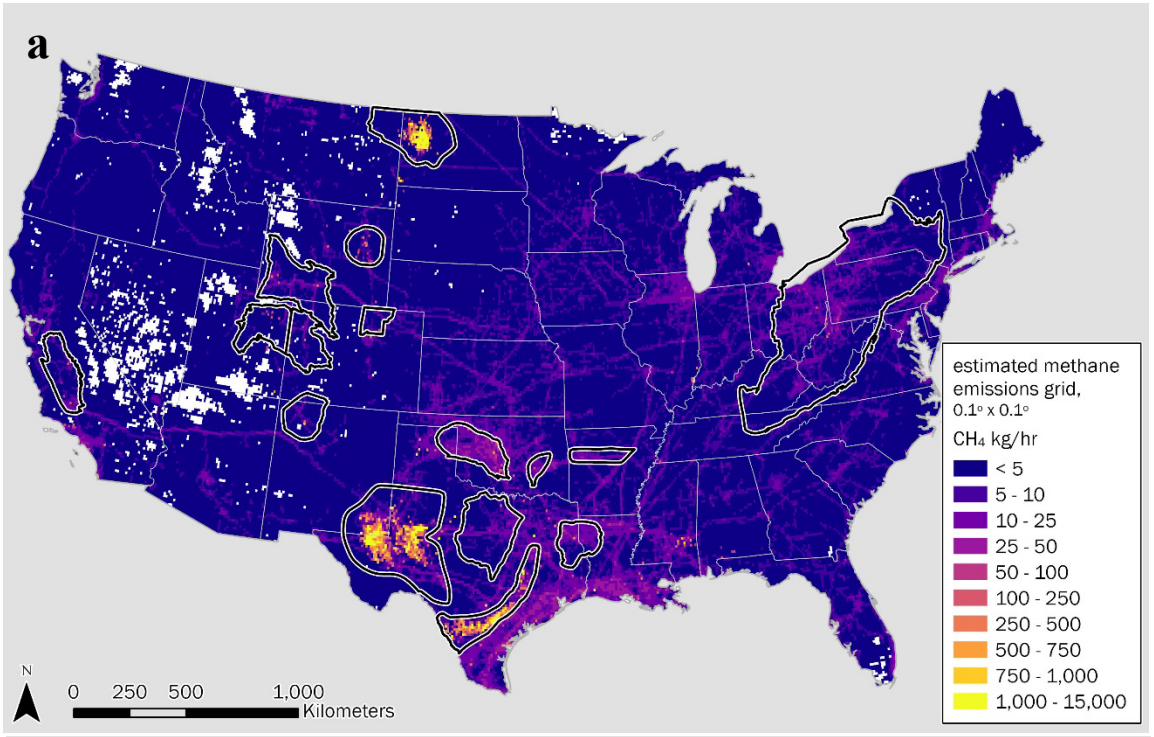


Figure S6. Spatial distribution comparison of top 3 emitting basins in EI-ME and EPA GHGI estimates. Map credit: ESRI, 2023.



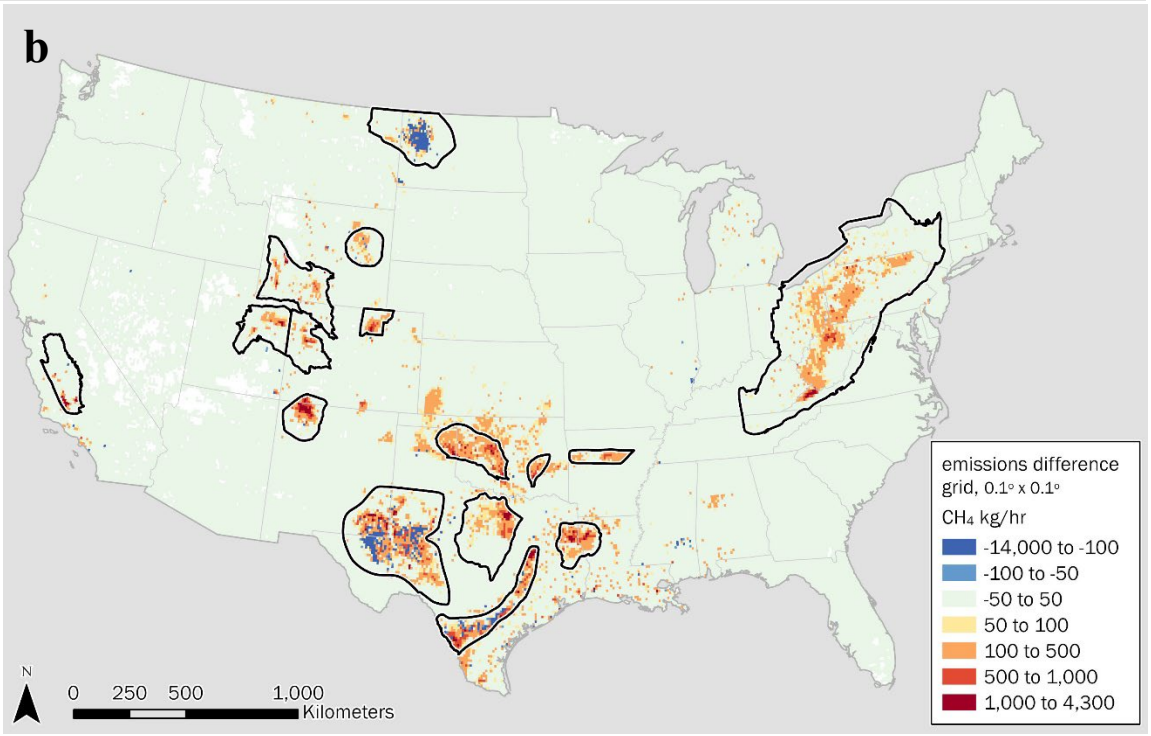


Figure S7. Difference in estimated spatial distribution of methane emissions between this study and the EDGAR v8 inventory **a.** Estimated spatial distribution of methane emissions in the EDGAR v8 inventory, showing large methane hotspots in the oil-dominant basins of the Permian, Eagle Ford, and the Bakken. **b.** Difference in spatially explicit methane emissions between this study's measurement-based inventory and the EDGAR v8 inventory, showing large differences in all of the major oil and gas basins. Map credit: ESRI, 2023.

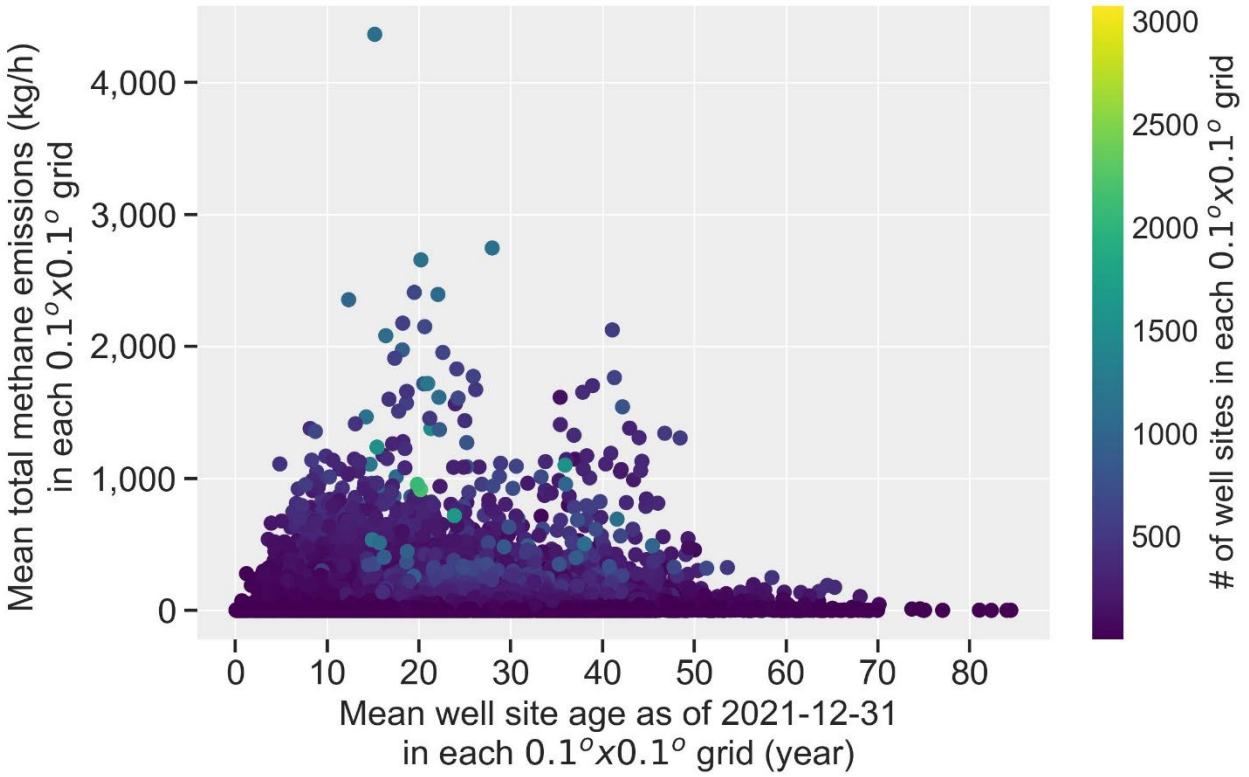


Figure S8. Assessment of mean total methane emissions within each 0.1º × 0.1º grid (~10 km × 10 km) and correlation with mean well site age.

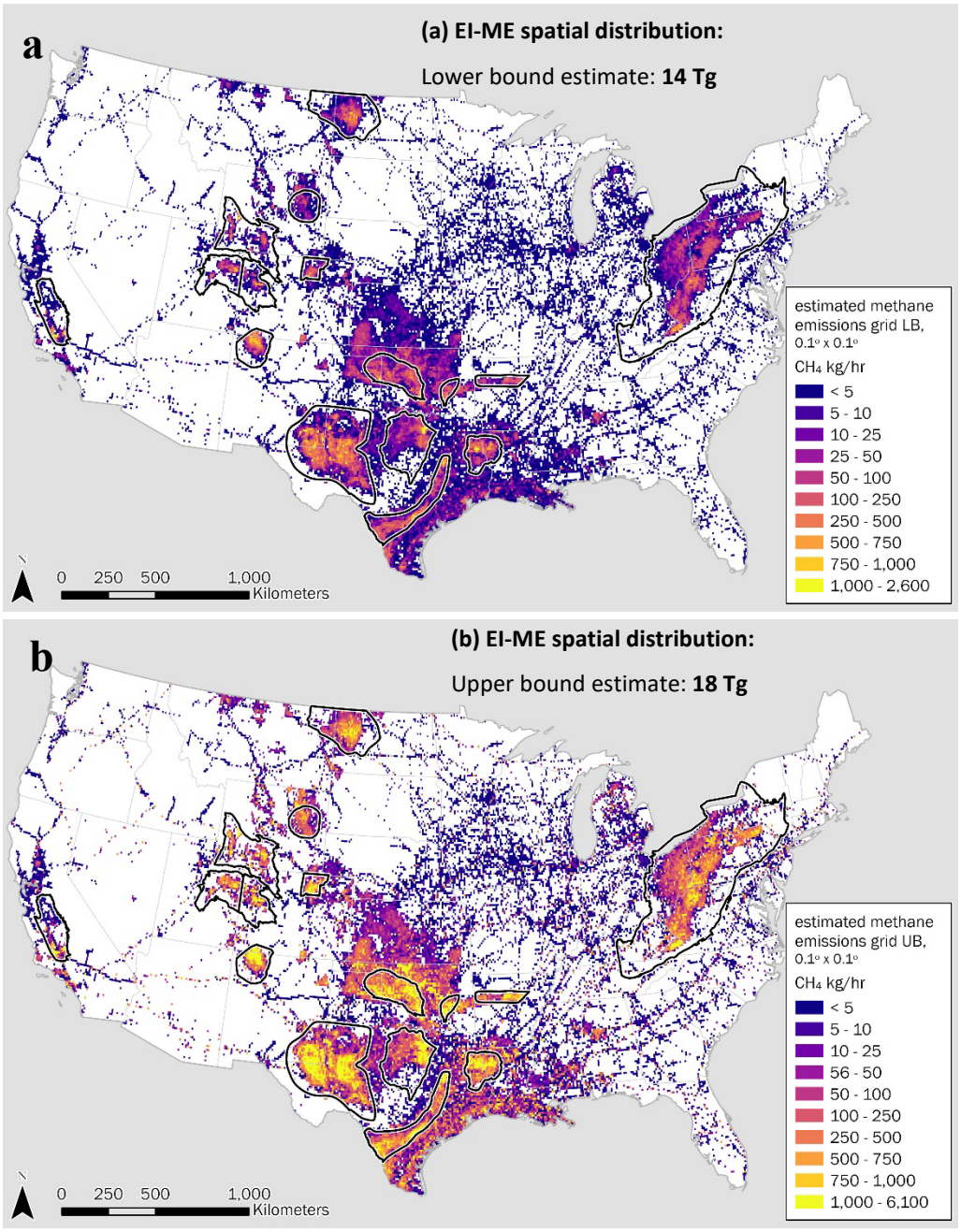


Figure S9. Estimated spatial distribution of national methane emissions showing the confidence bounds on the mean total methane emissions: **a.** lower bound estimate representing the 2.5th percentile within each 0.1º × 0.1º grid and **b.** upper bound representing the 97.5th percentile within each 0.1º × 0.1º grid. The confidence bounds are based on 500 model simulations of each facility's methane emissions as described in the Main Text. Map credit: ESRI, 2023

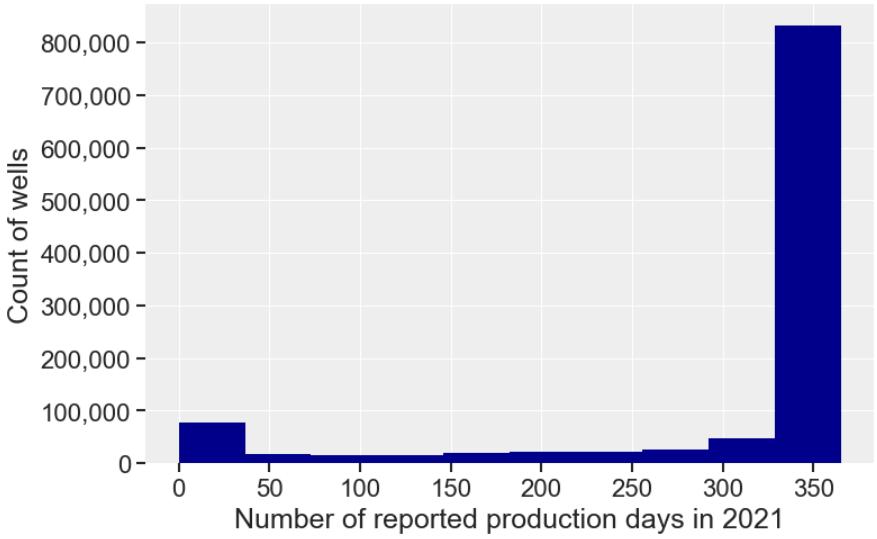


Figure S10. Reported number of production days per actively producing well in 2021. Onshore US wells only. Analysis based on data from Enverus Prism (www.enverus.com).

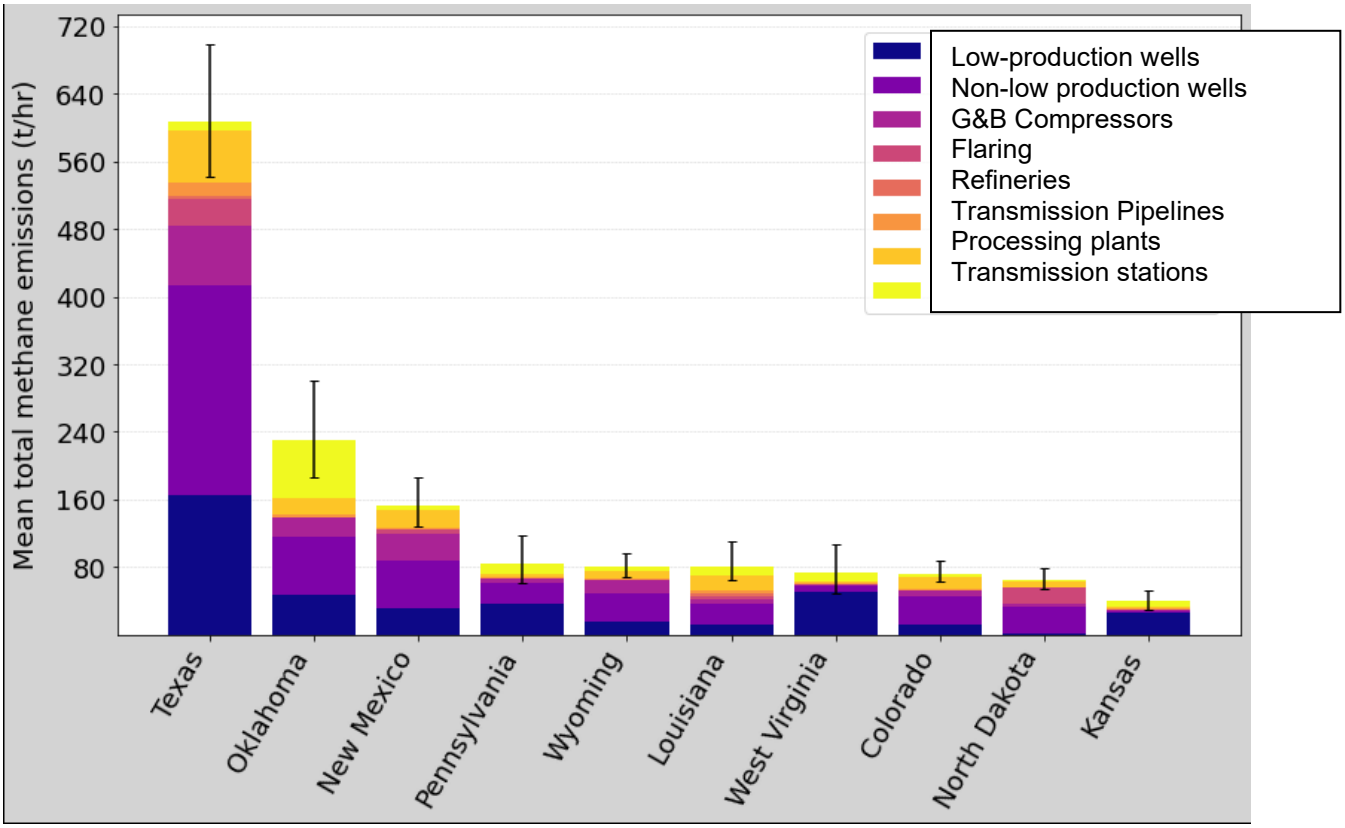


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Figure S11. Estimated total methane emissions at the state level showing the top 10 states based on EI-ME data and analysis. Error bars represent the 95% confidence intervals.