A Bayesian framework for deriving sector-based methane emissions from top-down fluxes

D.H. Cusworth, A.A. Bloom, J.R. Worden et al. (Oct 2021).

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Background:

- In atmospheric inversions, partitioning net fluxes to underlying sector-based emissions often scale fluxes based on the relative weight of sectors in a prior inventory. However, this approach imposes correlation between emission sectors which may not exist.

Methods/Findings:

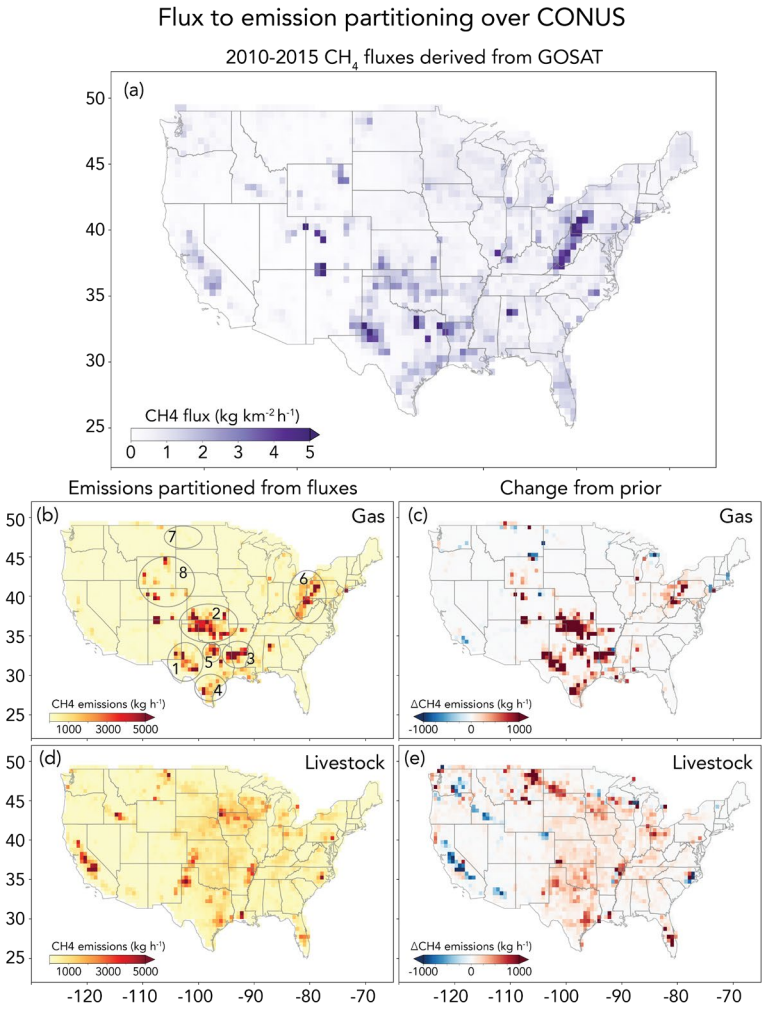
- Here we present a Bayesian optimal estimation method that projects inverse methane fluxes directly to emission sectors while accounting uncertainty structure and spatial resolution of prior fluxes and emissions and apply it to GOSAT and TROPOMI-based fluxes over the entire U.S. and in the Permian Basin

$$\hat{\mathbf{z}} = \mathbf{z}_A + \hat{\mathbf{Z}}\mathbf{M}^T\hat{\mathbf{S}}^{-1}\left[\left(\mathbf{I} - \hat{\mathbf{S}}\mathbf{S}_A^{-1}\right)\left(\mathbf{x}_A - \mathbf{M}\mathbf{z}_A\right) + \left(\hat{\mathbf{x}} - \mathbf{x}_A\right)\right]$$

$$\hat{\mathbf{Z}} = \left(\mathbf{M}^T\left(\hat{\mathbf{S}}^{-1} - \mathbf{S}_A^{-1}\right)\mathbf{M} + \mathbf{Z}_A^{-1}\right)^{-1}$$

Significance:

- This Bayesian approach allows for much improved testing/comparison of top-down results with prior inventories and allows for more direct comparisons of independent top-down fluxes.



Optimized total CH4 emissions at 1x1 resolution over CONUS using 2010-2015 0.5x0.625 GOSAT inverse fluxes. Emission results and change from the prior for the gas and livestock sector are shown.

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