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Supplement of

Global distribution of methane emissions: a comparative inverse analysis of observations from the TROPOMI and GOSAT satellite instruments

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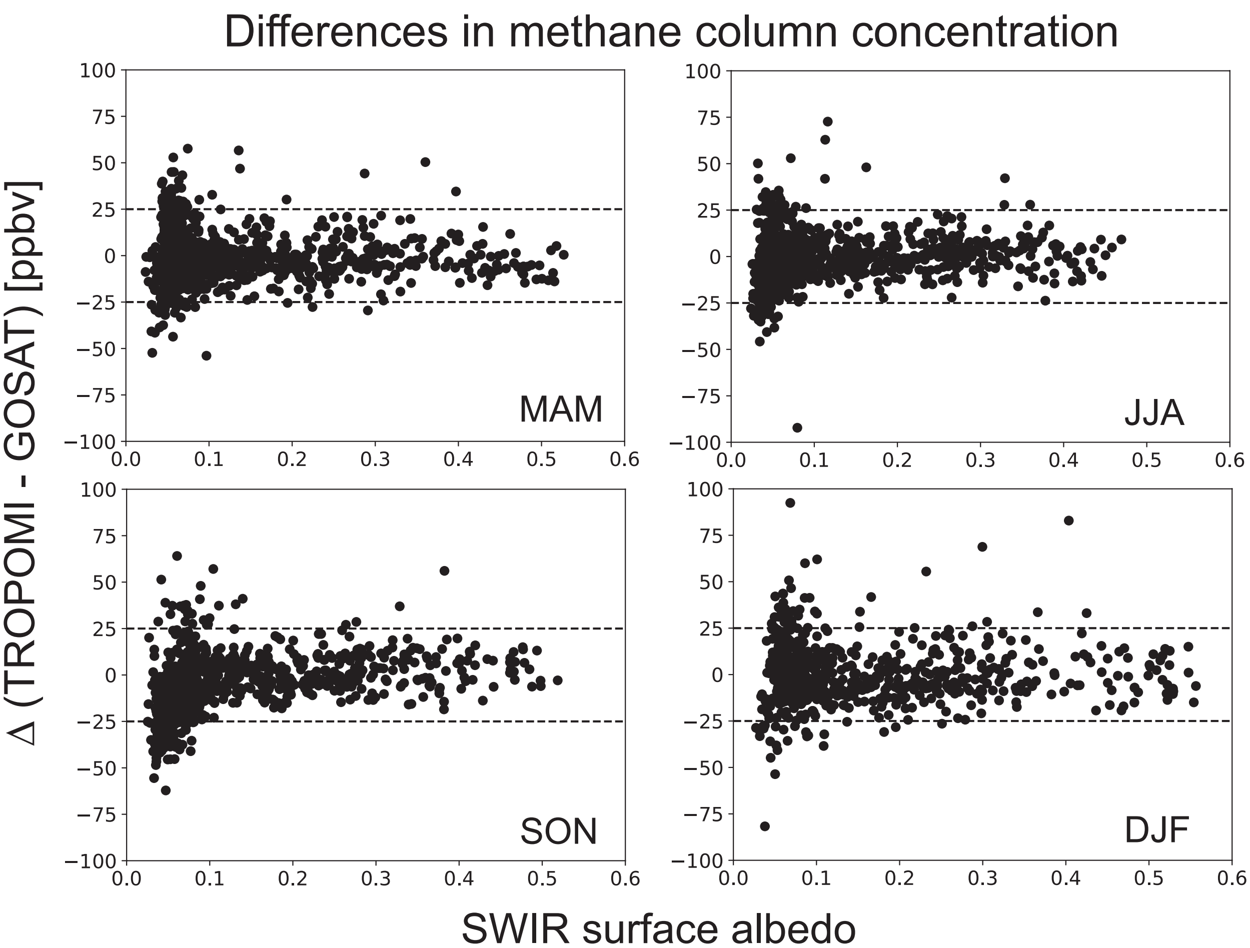

Figure S1. Seasonally averaged differences (Δ) of X_{CH4} between TROPOMI and GOSAT retrievals for May 2018 – April 2019 at different SWIR surface albedo.

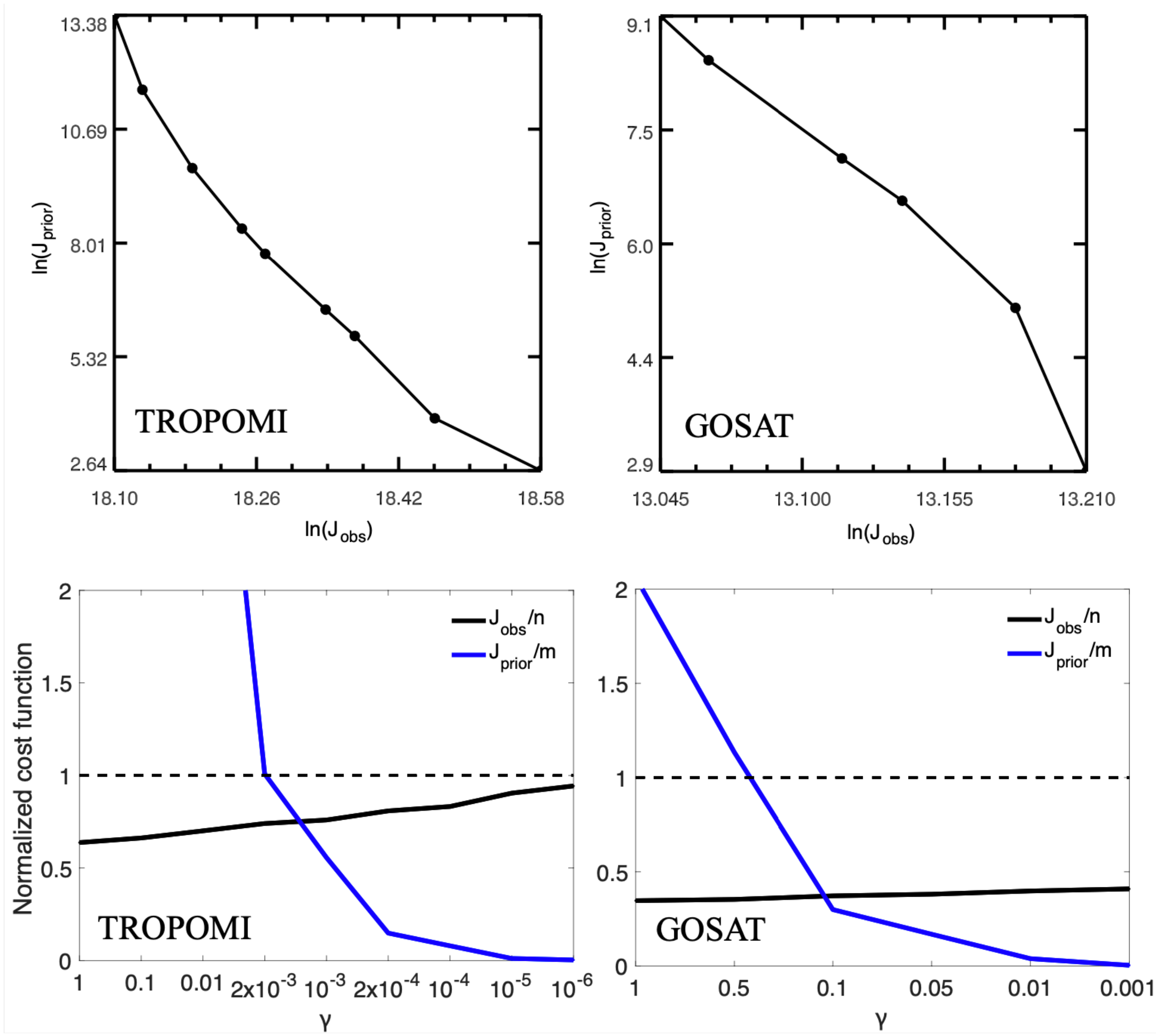

Figure S2. Dependence of the inverse modeling solution on the regularization parameter γ for TROPOMI (left column) and GOSAT (right column). J_{obs} and J_{prior} stand for the prior term $(\boldsymbol{x}-\boldsymbol{x}_a)^T\mathbf{S_a}^{-1}(\boldsymbol{x}-\boldsymbol{x}_a)$ and the observation term $(\boldsymbol{y}-\mathbf{K}\boldsymbol{x})^T\mathbf{S_o}^{-1}(\boldsymbol{y}-\mathbf{K}\boldsymbol{x})$ in the cost function. m and n are number of parameters and observations. Selected γ values in the test are: 1, 0.1, 0.01, 0.002, 0.001, 0.0002, 0.0001, 10^{-5}, 10^{-6} for the TROPOMI inversion and 1, 0.5, 0.1, 0.05, 0.01, and 0.001 for the GOSAT inversion. We chose $\gamma = 0.002$ (TROPOMI) and 0.5 (GOSAT) based on the corner of L-curve and the ratio between J_{prior} and n.

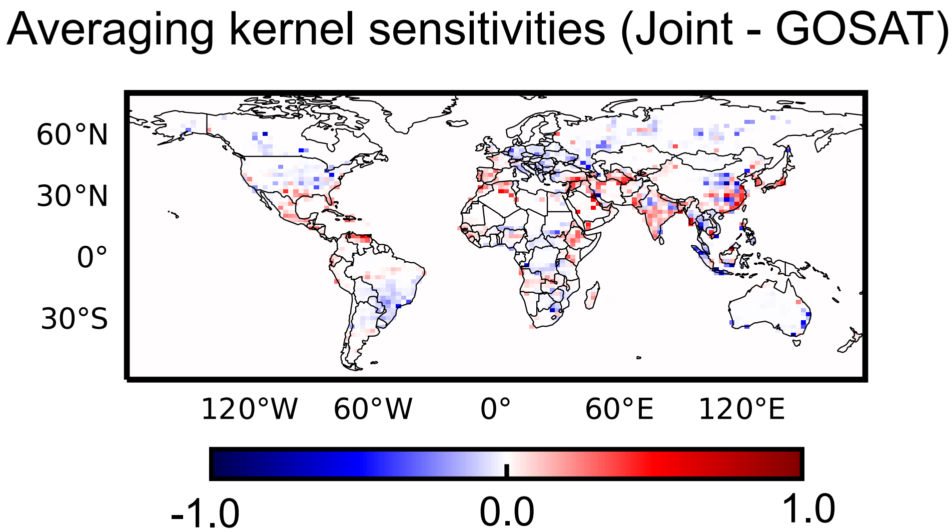

Figure S3. Differences between averaging kernel from the joint inversion and GOSAT inversion.

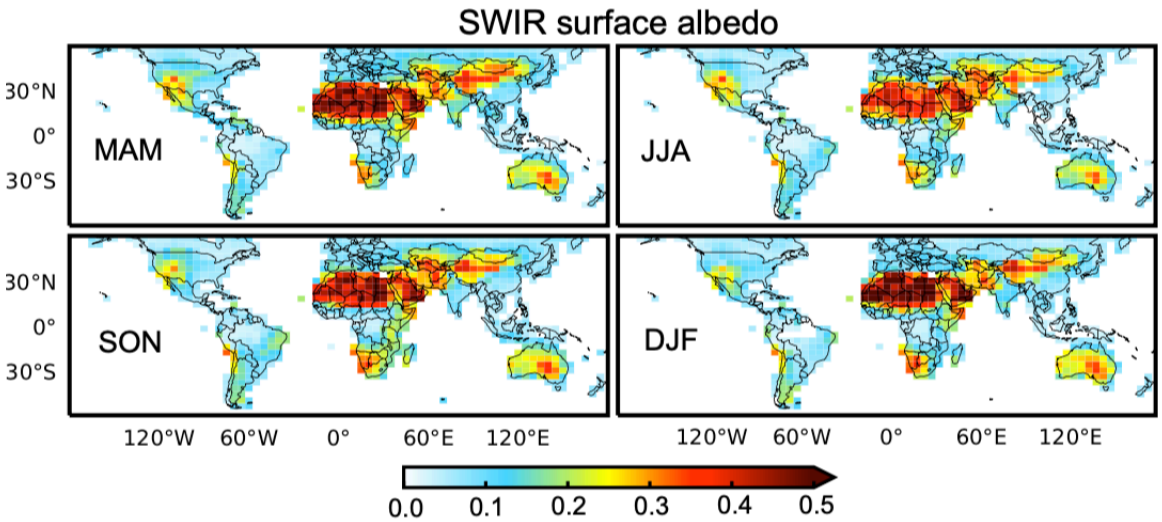

Figure S4. Seasonally averaged SWIR surface albedo for May 2018 – April 2019.

Table S1. Global methane budget in 2019 from the TROPOMI sensitivity inversions.

	Base inversion [Tg a^{-1}]	$\gamma = 0.02$ [Tg a^{-1}]	$\gamma = 0.5$ [Tg a^{-1}]	$\gamma = 0.002$, no weighting [Tg a^{-1}]	$\gamma = 0.002$, weight = 1 for wetland [Tg a^{-1}]	$\gamma = 0.002$, weight = 2010 for OH [Tg a^{-1}]
Total sources	**556**	**577**	**593**	**479**	**571**	**574**
Non-wetland	361	357	391	348	389	375
Wetland	195	220	202	131	182	199
Total sinks	**543**	**546**	**559**	**471**	**555**	**560**
OH oxidation	468 [a]	471 [b]	484 [c]	396 [d]	479 [e]	485 [f]
Other losses	75	75	75	75	76	75
Imbalance	**13**	**31**	**34**	**8**	**16**	**14**

[a] Posterior methane has a lifetime of 11.1 years against oxidation by tropospheric OH.
[b] Posterior methane has a lifetime of 11.0 years against oxidation by tropospheric OH.
[c] Posterior methane has a lifetime of 10.7 years against oxidation by tropospheric OH.
[d] Posterior methane has a lifetime of 13.0 years against oxidation by tropospheric OH.
[e] Posterior methane has a lifetime of 11.1 years against oxidation by tropospheric OH.
[f] Posterior methane has a lifetime of 10.7 years against oxidation by tropospheric OH.

Table S2. Global methane budget in 2019 from the GOSAT sensitivity inversions.

	Base inversion	$\gamma = 0.002$ [Tg a^{-1}]	$\gamma = 0.02$ [Tg a^{-1}]	$\gamma = 0.5$, no weighting [Tg a^{-1}]	$\gamma = 0.5$, weight = 1 for wetland [Tg a^{-1}]	$\gamma = 0.5$, weight = 2010 for OH [Tg a^{-1}]
Total sources	**562**	**569**	**569**	**575**	**583**	**551**
Non-wetland	399	403	398	391	404	395
Wetland	163	166	171	184	179	156
Total sinks	**543**	**559**	**556**	**545**	**555**	**533**
OH oxidation	468 [a]	484 [b]	481 [c]	470 [d]	480 [e]	458 [f]
Other losses	75	75	75	75	75	75
Imbalance	**19**	**10**	**13**	**30**	**33**	**18**

[a] Posterior methane has a lifetime of 11.1 years against oxidation by tropospheric OH.
[b] Posterior methane has a lifetime of 10.7 years against oxidation by tropospheric OH.
[c] Posterior methane has a lifetime of 10.8 years against oxidation by tropospheric OH.
[d] Posterior methane has a lifetime of 11.1 years against oxidation by tropospheric OH.
[e] Posterior methane has a lifetime of 10.8 years against oxidation by tropospheric OH.
[f] Posterior methane has a lifetime of 10.8 years against oxidation by tropospheric OH.