

Fire emission estimates for Australian extreme fire season 2019/2020 using FLEXPART

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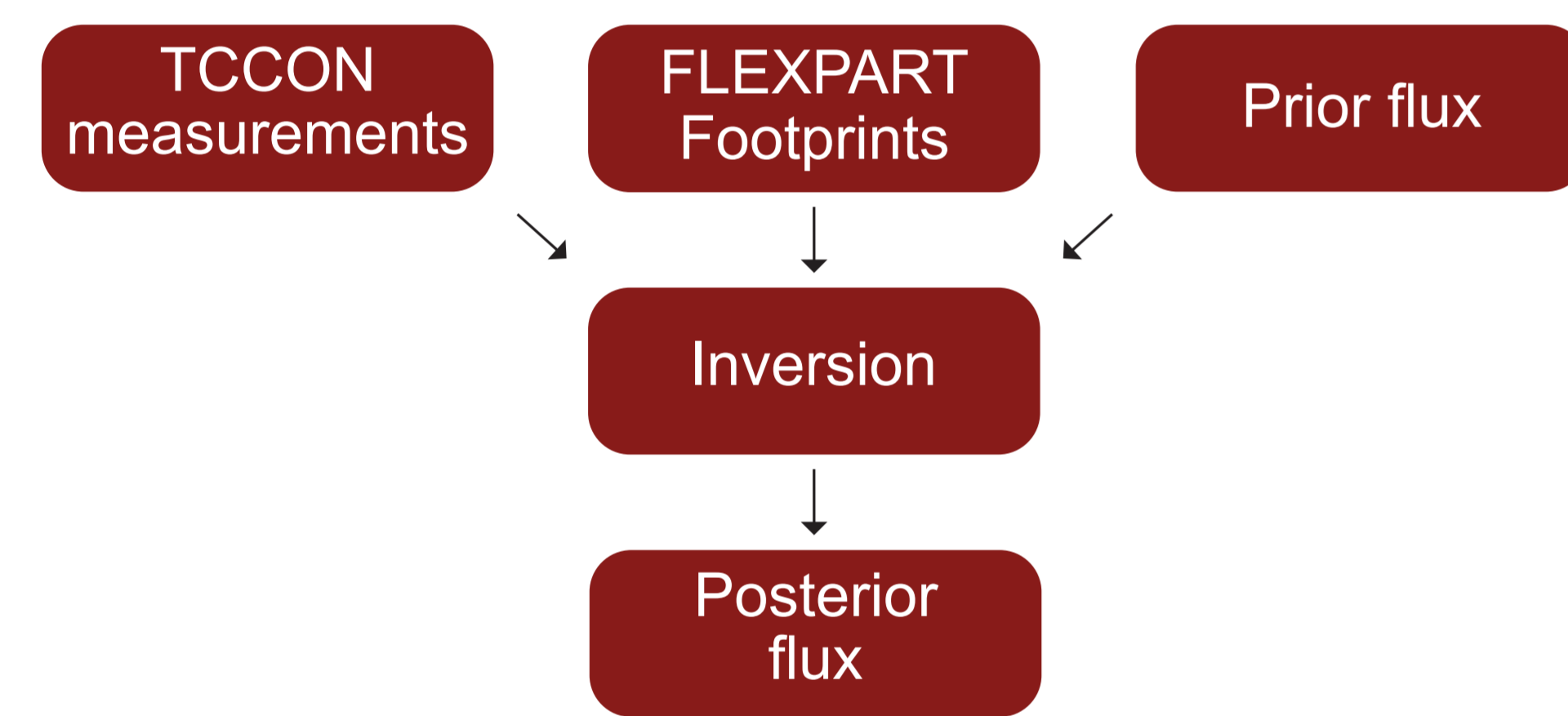
Motivation

- Extreme wildfires 2019/2020 in southeast Australia¹
- CO and CO₂ emissions estimates presented by conventional fire emission databases GFAS and GFED deviate significantly¹

Methods

For December 2019 CO and CO₂ flux estimates from TCCON measurements at Wollongong were inversely retrieved using footprints and backward trajectories from the Lagrangian Particle Dispersion Model FLEXPART.

Retrieval scheme for CO and CO₂:



- **TCCON measurements:** independent column-average mole fractions of CO and CO₂ from the site Wollongong, hourly averaged
- **Prior flux (anthropogenic, biogenic, fire):** CO CAMS, CO₂ CT2022
- **Inversion:** weekly output resolution, 1°x1° grid spatial resolution
Regularization: chosen for CO and CO₂ such that CO posterior contains mainly positive CO fluxes

Discussion

- Criteria for choice of regularization parameter too vague
- Large uncertainty for mean $\Delta\text{CO}/\Delta\text{CO}_2$ (e.g. week 52: 66 ± 198 ppb/ppm), but comparable to literature 69.4 ppb/ppm¹
- Information content of measurements is not sufficient for 1°x1° resolution
- Next steps: Coarsen spatial output resolution

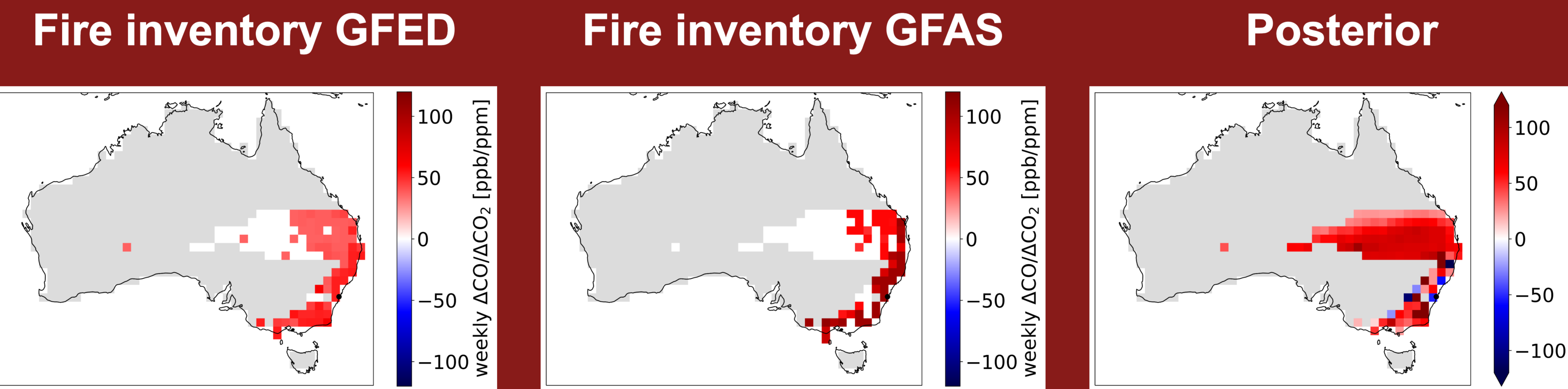
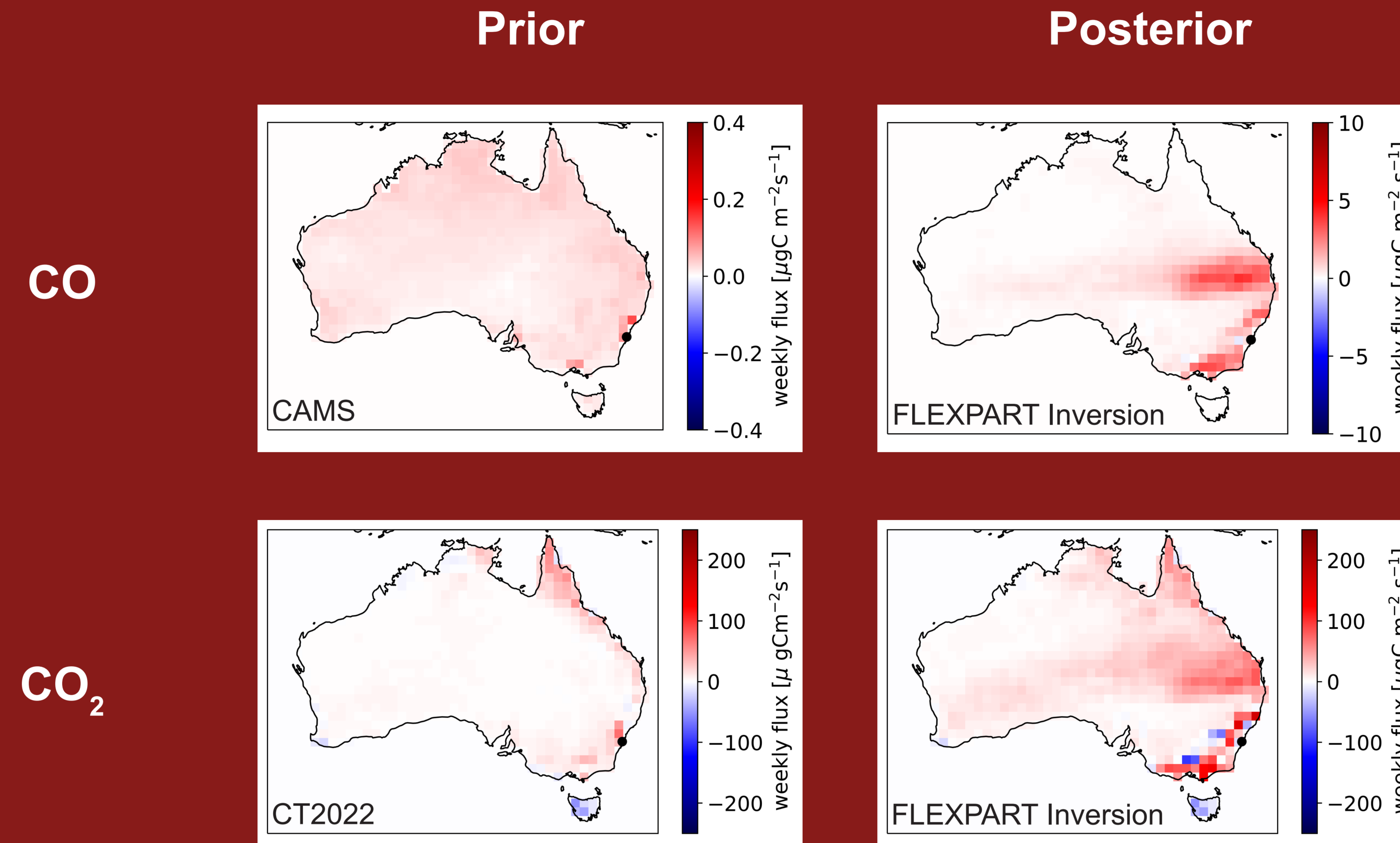
References

¹ van der Velde, I.R., van der Werf, G.R., Houweling, S. et al. Vast CO₂ release from Australian fires in 2019–2020 constrained by satellite. Nature 597, 366–369 (2021). <https://doi.org/10.1038/s41586-021-03712-y>
² Possell, M., Jenkins, M., Bell, T. L., and Adams, M. A.: Emissions from prescribed fires in temperate forest in south-east Australia: implications for carbon accounting, Biogeosciences, 12, 257–268, <https://doi.org/10.5194/bg-12-257-2015>, 2015

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FLEXPART inversion at TCCON stations yields independent $\Delta\text{CO}/\Delta\text{CO}_2$ ratio for fire emissions

Results shown for week 52 in 2019

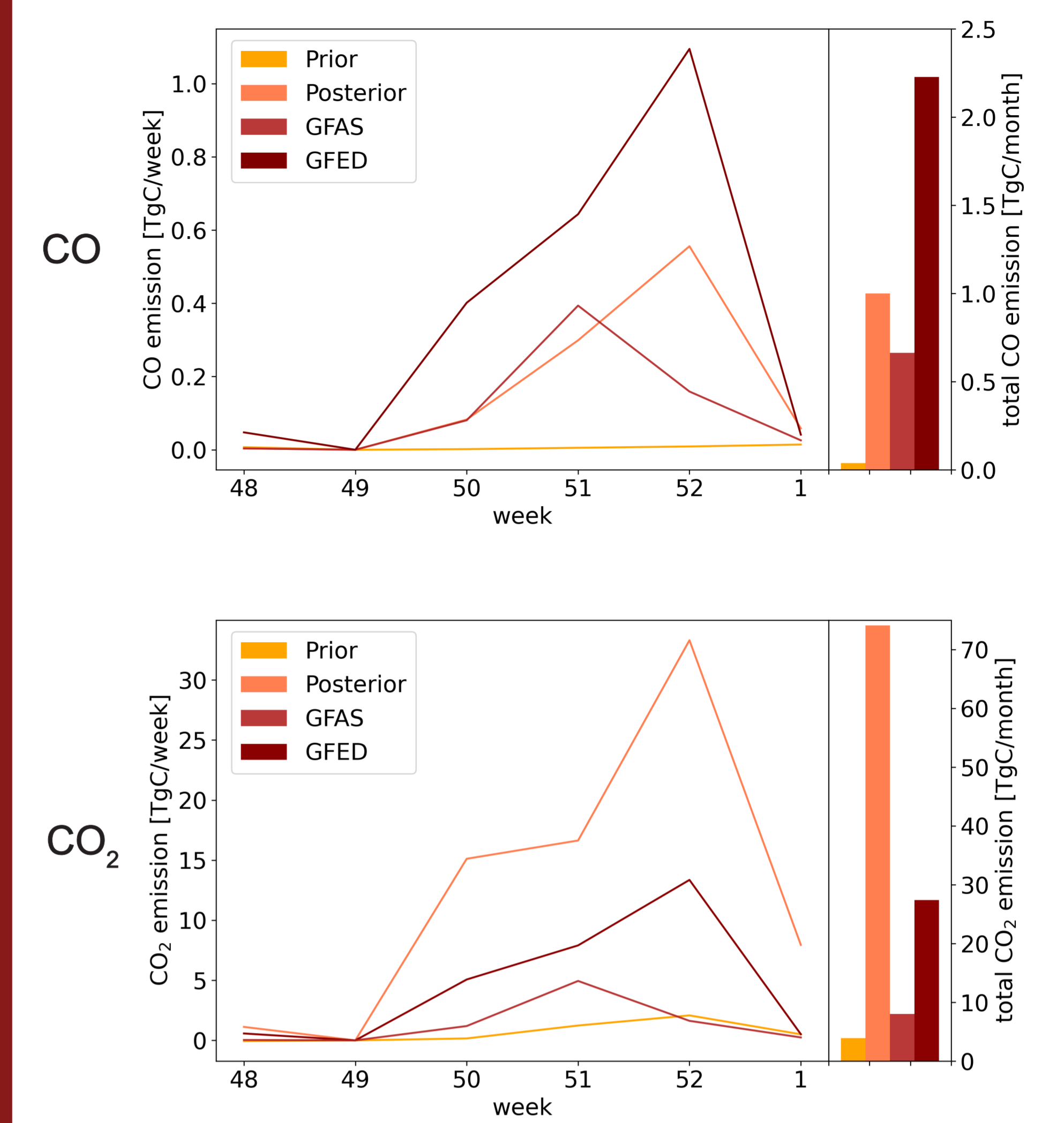


All ratios retrieved where CO > 0.5 µgC/(m²s) and the averaging kernel diagonal > 10⁻³

Fire region results:

1. TCCON based CO emission estimates in range of GFAS and GFED
2. TCCON based CO₂ emission estimates greater than GFED and GFAS
Possible reason: Other sources convolved into inverse estimate
3. $\Delta\text{CO}/\Delta\text{CO}_2$ independently retrieved

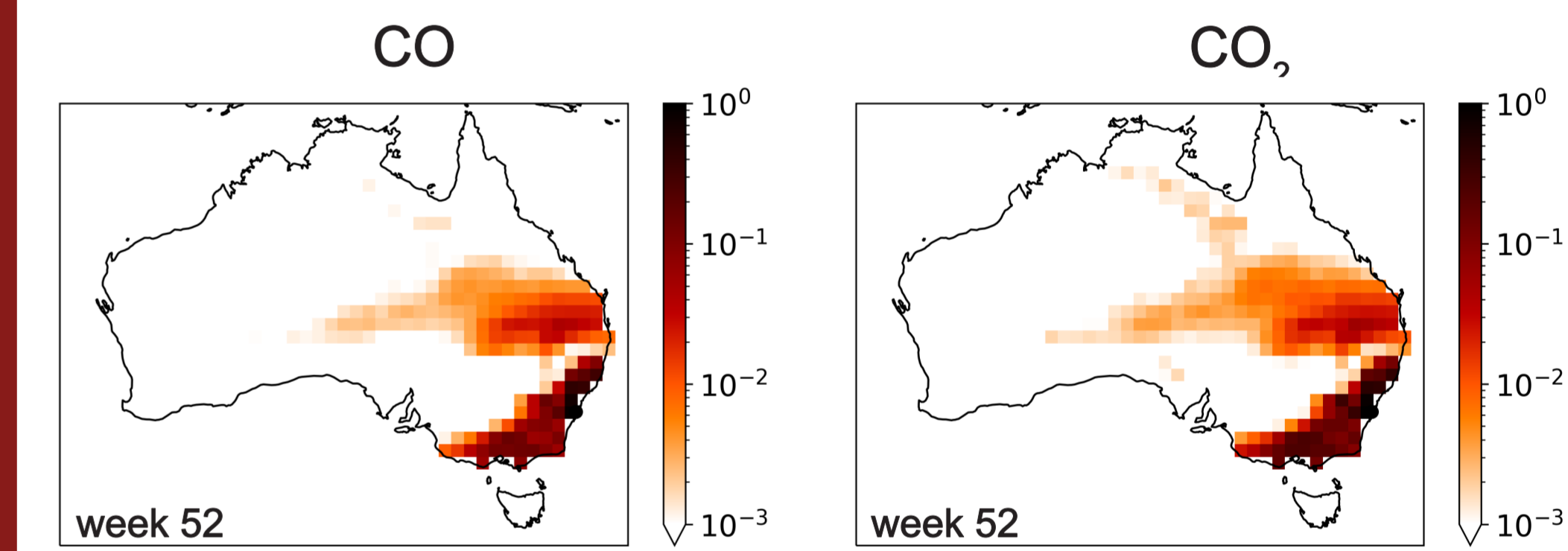
Comparison to GFED & GFAS for selected fire region



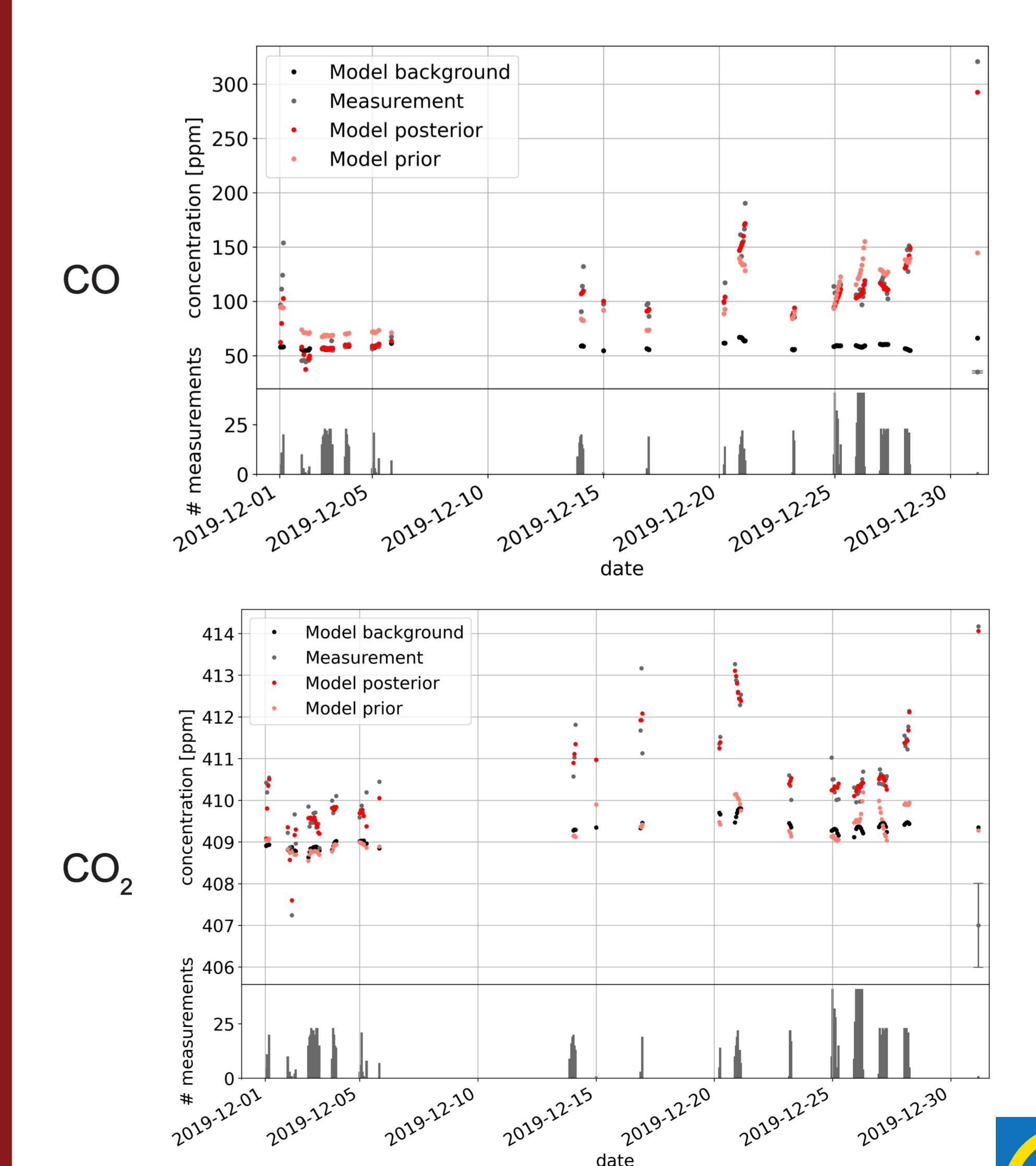
Monthly portion of spatially selected fluxes to total fluxes

	GFAS [%]	GFED [%]
CO	18.4	35.2
CO ₂	17.2	33.8

Averaging kernel diagonal



Concentration records



Model posterior agrees with measurements, particularly good agreement if data coverage is high

