

How fire emission factor uncertainty relates to inter-inventory differences in modeled atmospheric composition.

R. R. Buchholz, W. Tang, L. K. Emmons, R. Schwantes, F. Lacey, B. Gaubert, M. Park, H. Worden, C. Wiedinmyer

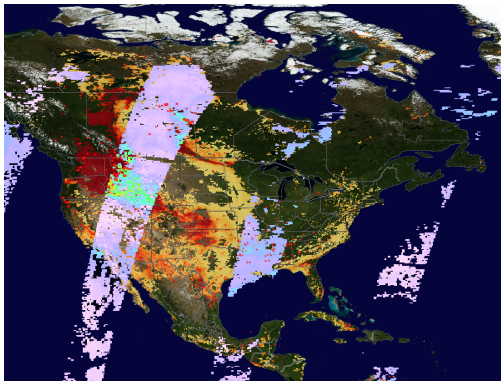


[Wollongong, Australia, October 2013]

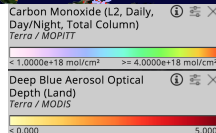
Fires are a large source of atmospheric gases and aerosols

7 September, 2017

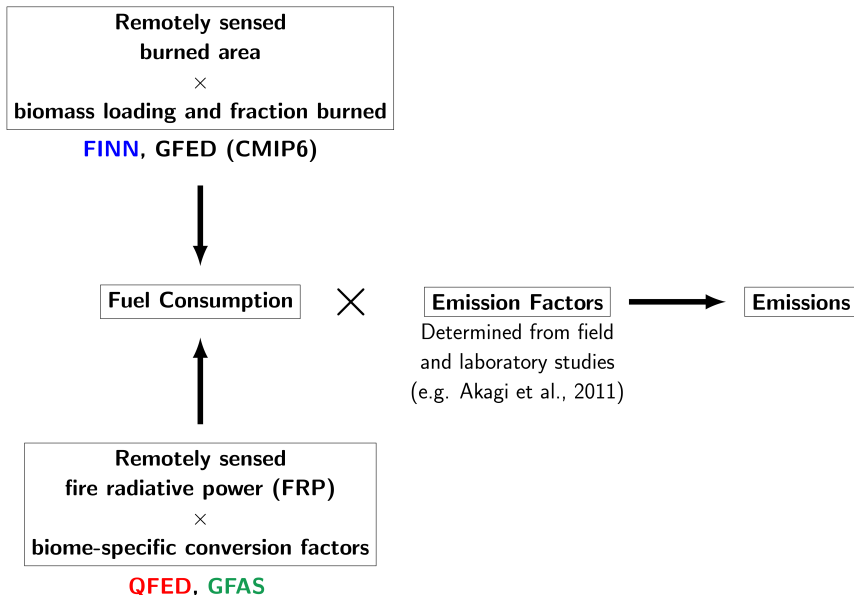
- CO is a major component of fire emissions
- Produced from incomplete combustion
- A criteria pollutant and an ozone precursor
- Can be used to track co-emitted species (e.g. aerosols, black carbon)



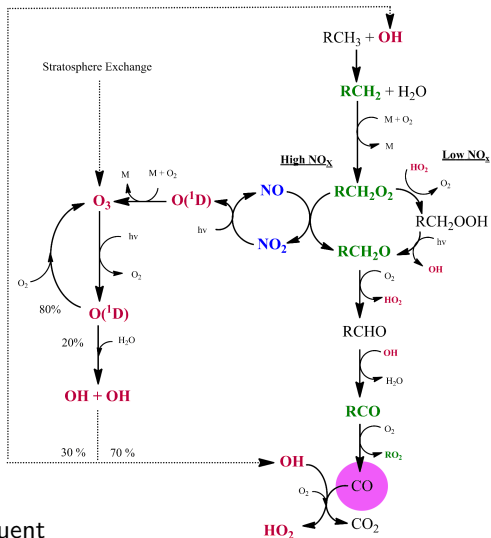
[worldview.earthdata.nasa.gov]



How are fire emission inventories created?



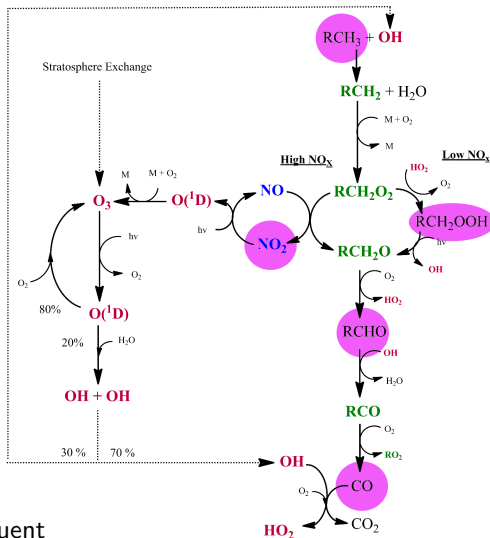
What is emitted?



R=organic substituent

Emitted species

What is emitted?



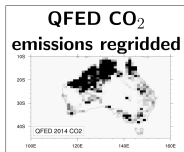
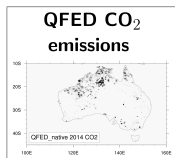
R=organic substituent

Emitted species

Test the impact of emission factor uncertainty

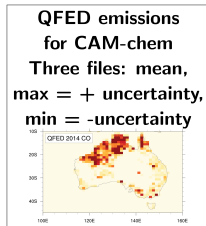
Creating a composite QFED/FINN inventory

- **Experiment 1:** Assess impact of uncertainty in CO emissions
- **Experiment 2:** Uncertainty in all CAM-chem fire emissions



Emission Ratios:
 $\frac{\text{Species E.F.} \pm \sigma_s}{\text{CO}_2 \text{ E.F.} \pm \sigma_{\text{CO}_2}}$

E.F. = emission factor
 σ = uncertainty



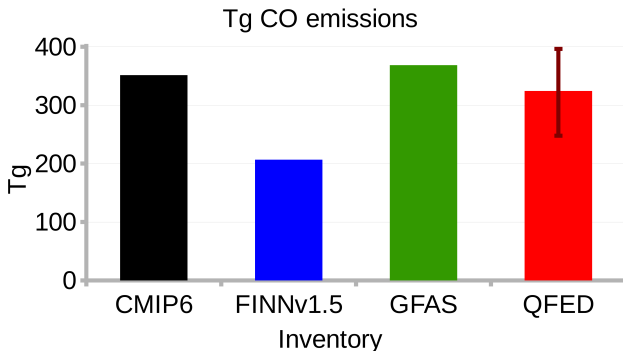
Created using emission factors
compiled for FINN.

Applied separately over four biomes.

Model Framework

- CESM2.0 full chemistry (FCSD) Dec 2013 to Nov 2015
- $0.92^\circ \times 1.25^\circ$ horizontal resolution
- 32 level vertical resolution
- Specified dynamics: MERRA2 nudged at 1%
- MEGAN coupled to CLM biogenic emissions
- CMIP6 anthropogenic emissions
- CMIP6 fire emissions where they are not replaced
FINN CO, GFAS CO, QFED CO, QFED all

Experiment 1: Global CO emissions 2014 in Tg CO



Fire emission inventories:

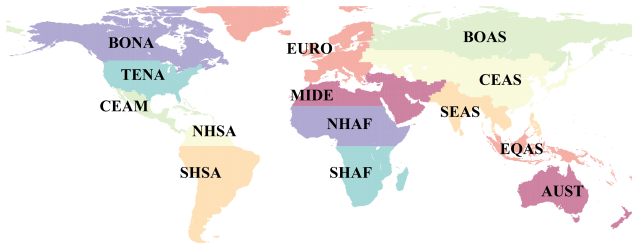
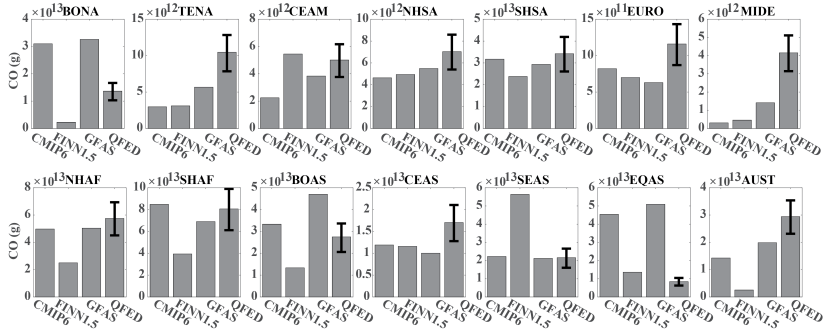
Global Fire Assimilation System – GFAS v1.2

Fire INventory from NCAR – FINN v1.5

Quick Fire Emissions Dataset – QFED v2.5

Climate Model Intercomprison Project – CMIP6 v1.2 (based on GFED)

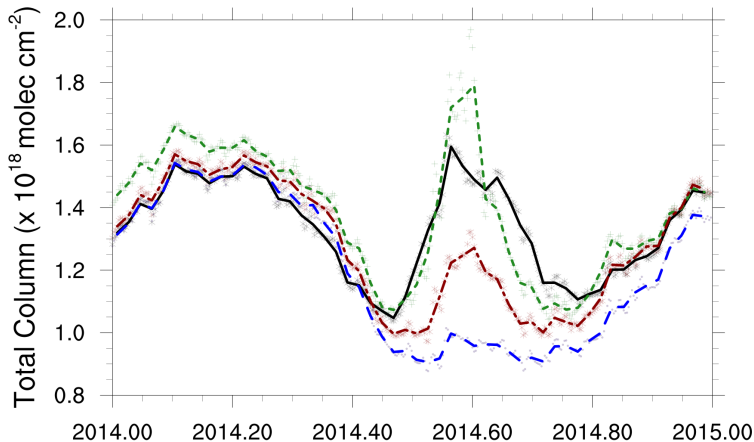
Experiment 1: Regional CO emissions 2014



[W. Tang]

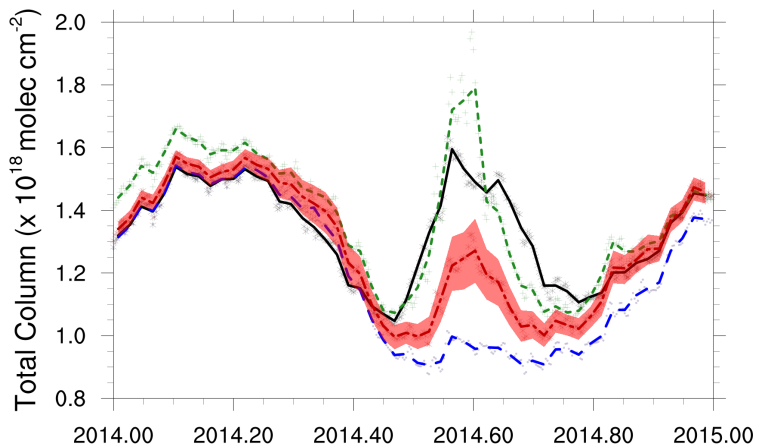
Experiment 1: Modeled CO total column

Example in Boreal North America (BONA): QFED FINN GFAS CMIP6



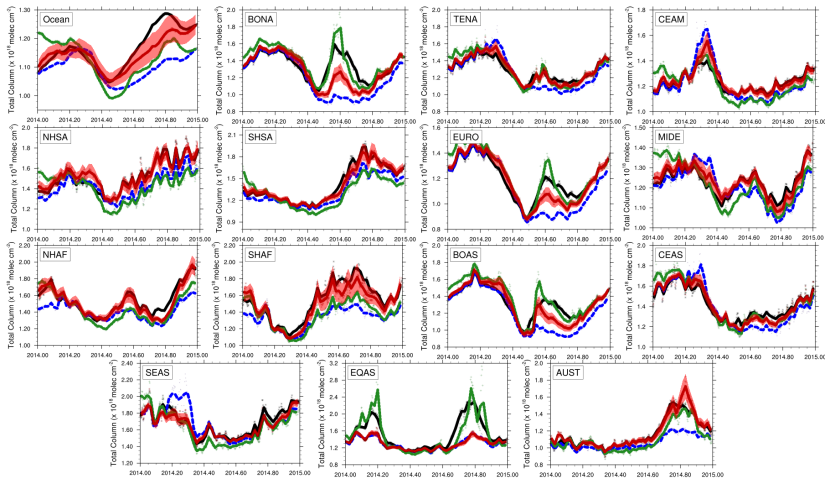
Experiment 1: Modeled CO total column + uncertainty

QFED \pm CO uncertainty FINN GFAS CMIP6

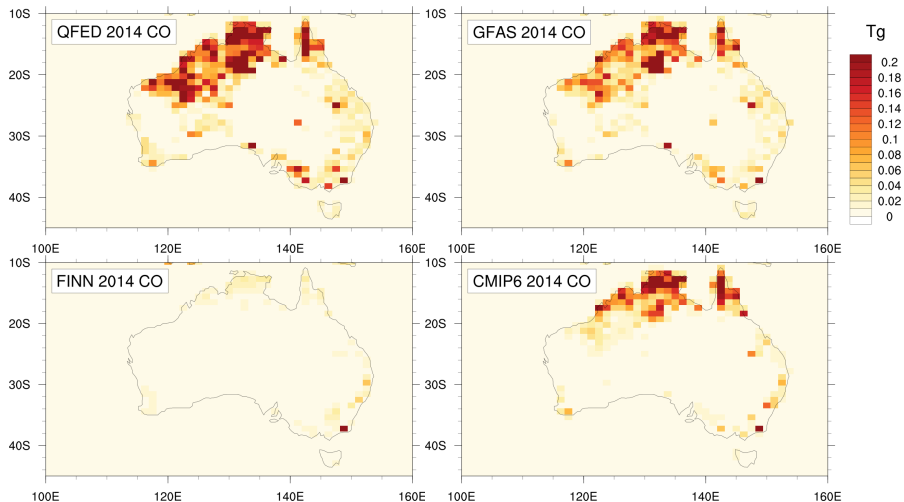


Experiment 1: CO total column in GFED Regions

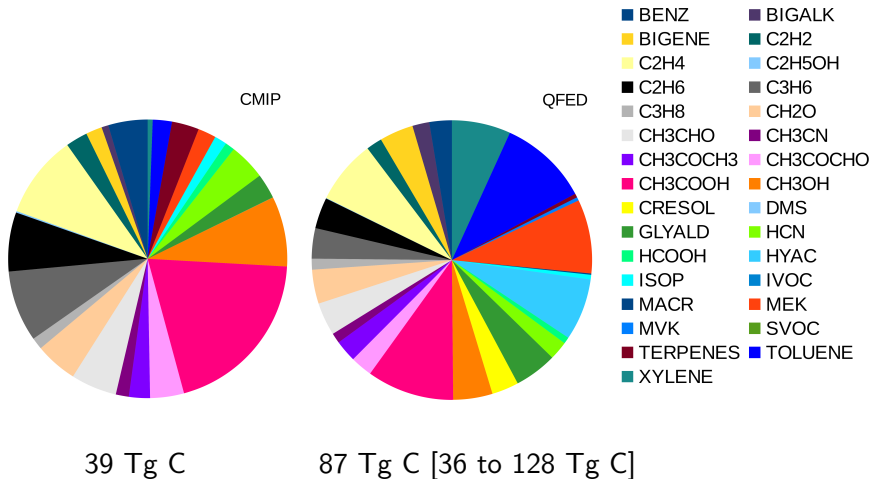
QFED \pm CO uncertainty FINN GFAS CMIP6



Spatial differences in emission - e.g. Australia

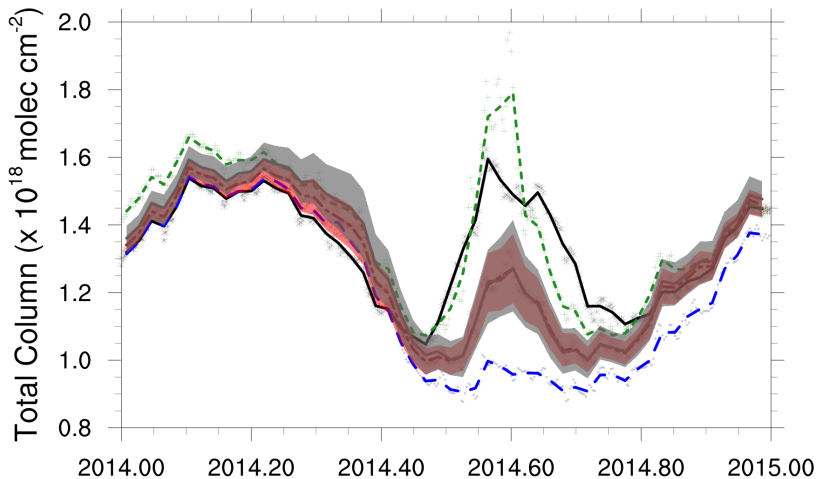


Experiment 2: Global VOC emissions 2014 in Tg C



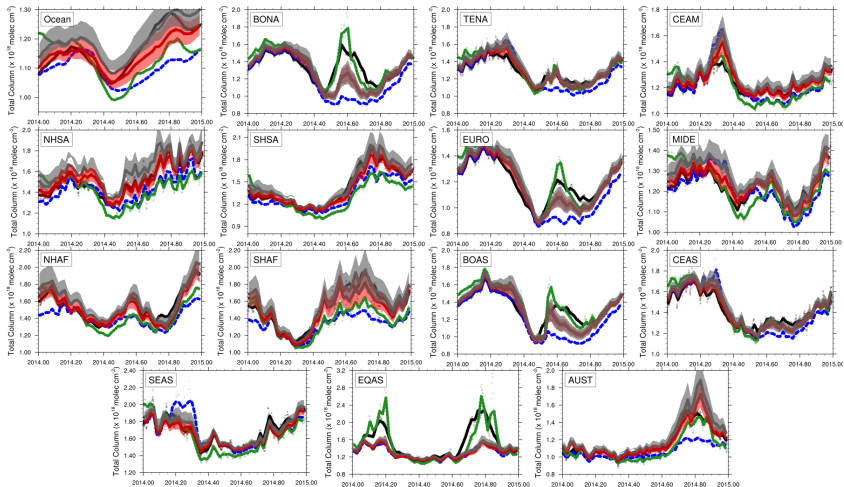
Experiment 2: CO Column including all VOC uncertainties

QFED \pm CO uncertainty QFED: all \pm uncertainty FINN GFAS CMIP6

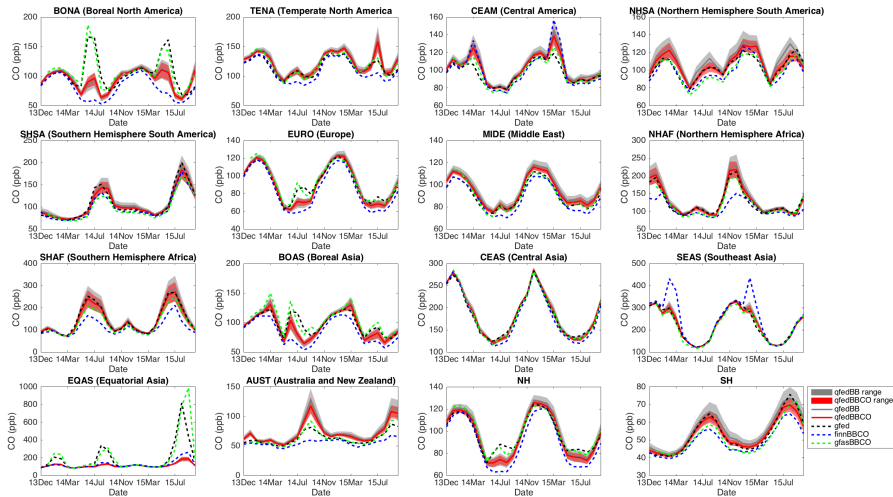


Experiment 2: CO Column in GFED regions

QFED \pm CO uncertainty QFED: all \pm uncertainty FINN GFAS CMIP6

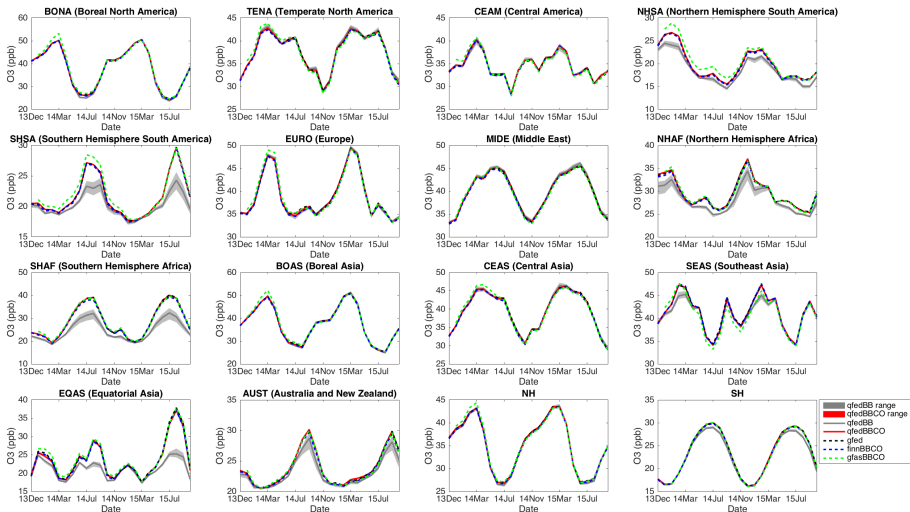


Impacts on surface CO



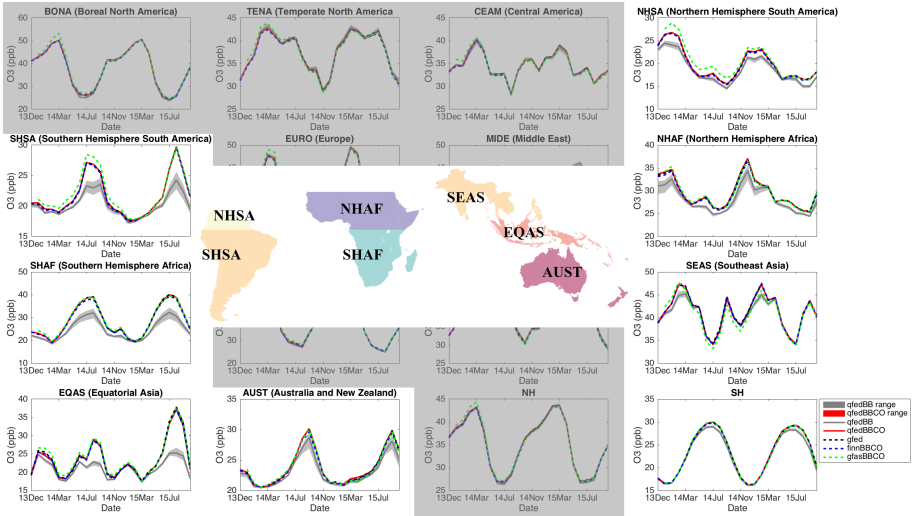
[W. Tang]

Impacts on surface ozone



[W. Tang]

Impacts on surface ozone



[W. Tang]

Summary

Emission factor uncertainty is potentially important in some regions and can explain some inter-inventory differences.

Remaining differences due to a different reason, for example:

- fire detection
- land cover definition
- below cloud handling (e.g. GFAS accounts for clouds)
- persistence algorithm (e.g. FINN assumes persistence at 50%)

Next Steps

- VOC simulation with updated emission factors
- Determine CO uncertainty relative to VOC uncertainty
- Compare with measurements

Acknowledgments:

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References



Akagi, S. K., et al. (2011), *Atmos. Chem. Phys.* 11, 4039–4072

Extra:

Comparison against MOPITT CO

Smoothed model versus Satellite Observations

QFED: all \pm uncertainty

