The effect of variability in fire emission factors on inter-inventory differences


[Wollongong, Australia, October 2013]
Carbon monoxide is an important atmospheric trace gas

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

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[worldview.earthdata.nasa.gov]
Regions of interest

North America

Siberia

Maritime SEA

Southern Africa

Australasia

% Burned Area in 2014
Regional CO emissions 2014

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 off GFED)
Fires impact atmospheric composition: 2014 CO emissions in Australasia
How are fire emissions created?

**Remotely sensed**
- burned area
  \[ \times \]
- biomass loading and fraction burned
  - **FINN**, **GFED (CMIP6)**

\[ \text{Fuel Consumption} \times \text{Emission Factors} \Rightarrow \text{Emissions} \]

**Remotely sensed**
- fire radiative power (FRP)
  \[ \times \]
- biome-specific conversion factors
  - **QFED**, **GFAS**

**Emissions**
Determined from field and laboratory studies
Test the impact of emission factor uncertainty

R=organic substituent

Emitted species
Test the impact of emission factor uncertainty

$R =$ organic substituent

Emitted species

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Test the impact of emission factor uncertainty

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

Emission Ratios:

\[
\frac{\text{Species E.F.}}{\text{CO}_2 \text{ E.F.}} \pm \sigma
\]

E.F. = emission factor
\(\sigma = \text{uncertainty}\)

Created using emission factors compiled for FINN.
Applied separately over four biomes.
Model Framework

- CESM2.0 full chemistry (FCSD) 2014
- $0.92^\circ \times 1.25^\circ$ 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

**Experiments:**
1. CO emission factor uncertainty: QFED CO, CO min & CO max
2. All emission factor uncertainty: QFED, min & max

Other inventories: FINN CO, GFAS CO
CO total column with CO emission factor uncertainty range

QFED ± CO uncertainty

Maritime SEA

Australasia

Southern Africa

South America

Siberia

North America
... relative to the different inventories

QFED FINN GFAS

Maritime SEA

Australasia

Southern Africa

South America

Siberia

North America
Including all species uncertainties

QFED QFED–all species ± uncertainty FINN GFAS

Maritime SEA

Australasia

Southern Africa

South America

Siberia

North America
Summary

Emission factor uncertainty explains some inter-inventory differences. Remaining differences likely have a different source, 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

- Impact on other species such as O₃
- Comparison with measurements (e.g. MOPITT)
- Include in data assimilation
- Potential to create model output as ensemble

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