The background image shows a dense forest of tall, thin pine trees. In the foreground, there is a ground fire, with visible orange flames and smoke. The overall atmosphere is hazy due to the smoke.

Impacts of improved burned area estimates on biomass burning emissions

Holly K. Nowell, Christopher D. Holmes *Florida State University*

Biomass burning is important in the US and globally

Southeast US contains half of fire area of the contiguous US

Florida accounts for 10% of US fire area

(Melvin, 2015; Short, 2014)

Wildland fire

Wildfire mitigation

Land conservation

Forestry

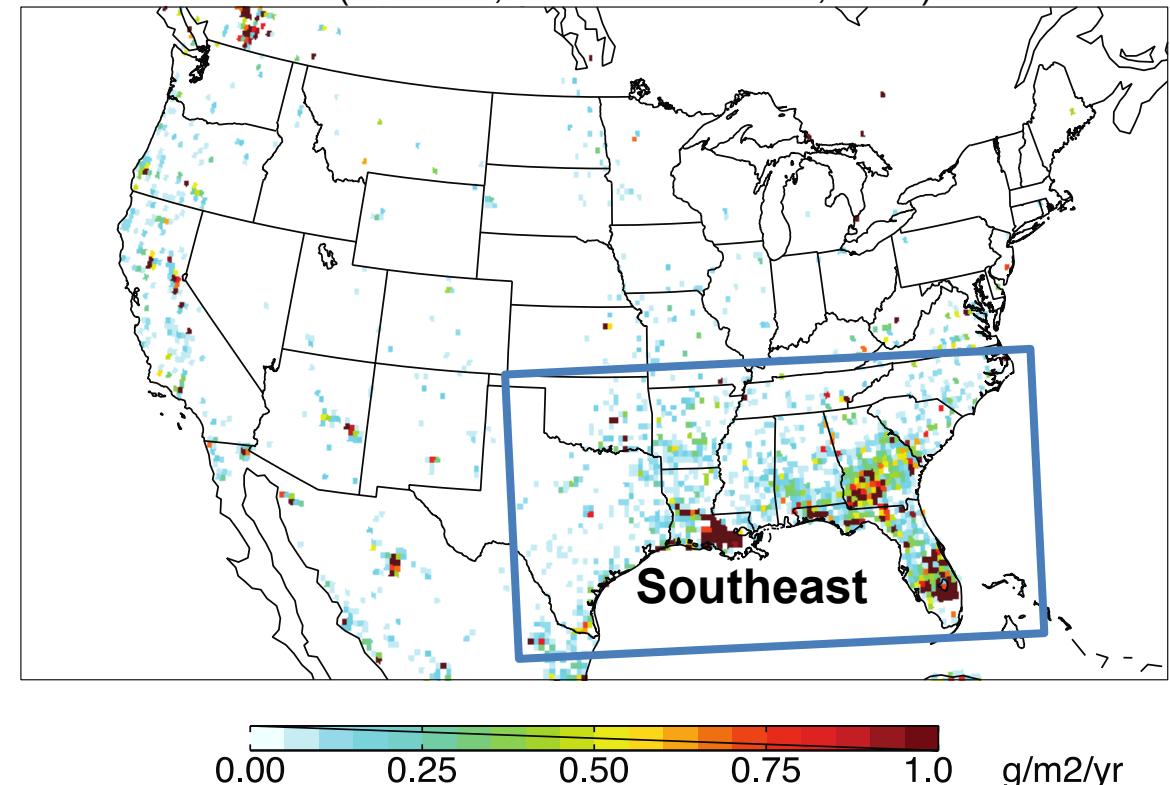


Agricultural fire



Fuel consumption in fires, 1997-2015 mean

(GFED4s, van der Werf et al., 2017)



Satellites are critical for quantifying fire, but validation data is limited

(Photo credit: USFS SRS; Mark Randall, Sun-Sentinel)

Atlas of Florida fires, 2004-2015

We combine government reports...

- Prescribed fire permits (Florida Forest Service)
- Wildfire FPA FOD (Short et al., 2014, 2017)

Accuracy assessed with landowner records

Prescribed fires dominate

Annual fire activity:

25,000 fires

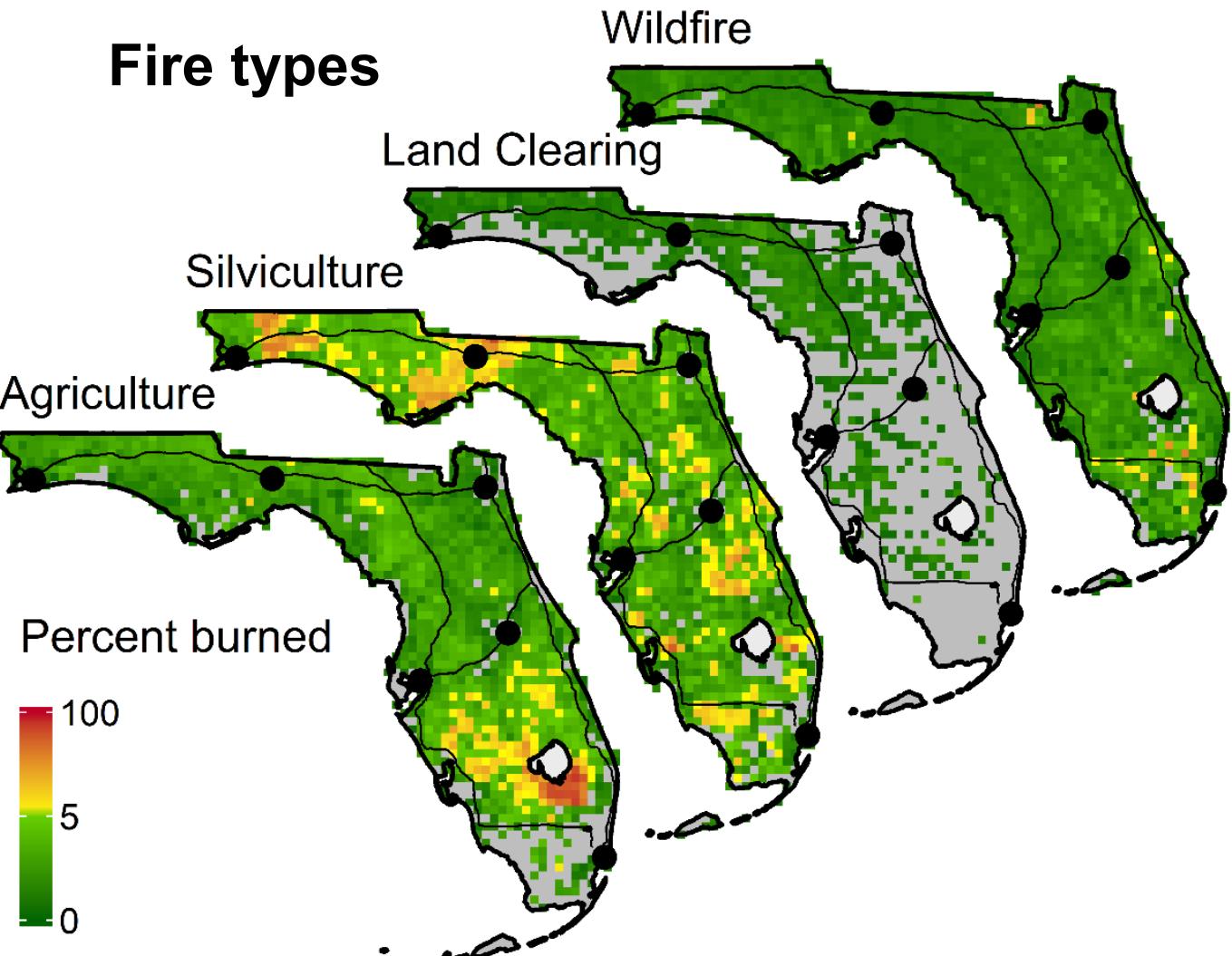
987,000 ha (7% of land area)

56% silviculture + land clearing

36% agriculture

8% wildfire

Other Southeast US states are similar, but have less comprehensive fire reporting



Evaluation of satellite fire products

We expect some under-detection

(e.g. Giglio et al., 2003; Al-Saadi et al., 2008; Hawbaker et al., 2008; McCarty et al., 2009; Soja et al., 2009)

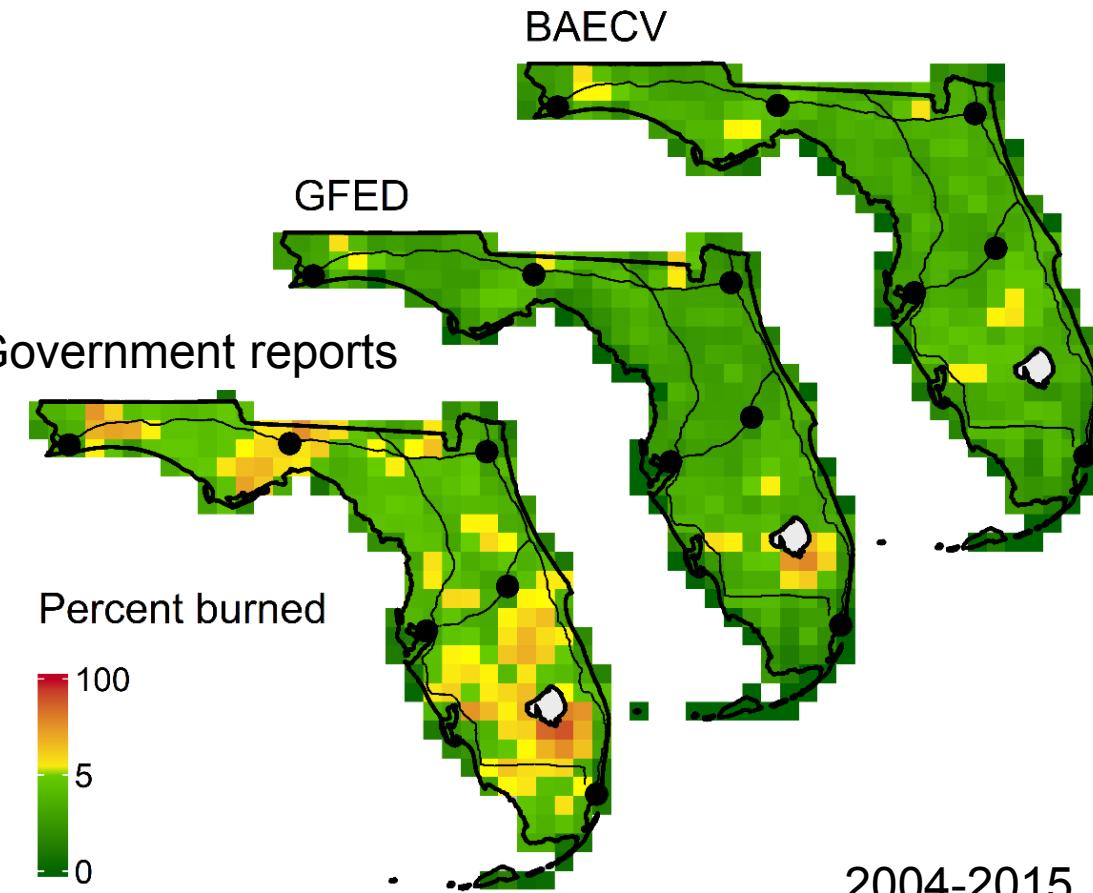
- Small size (most under 20 ha)
- Short duration (hours or less)
- Low intensity
- Hidden by frequent clouds, tree canopy
- Rapid vegetation regrowth in humid climate

Overall, 70-80% of Florida fire area is undetected in four satellite products:

GFED4s/MODIS, BAECV1.1/Landsat, HMS, HMS/NEI Agriculture

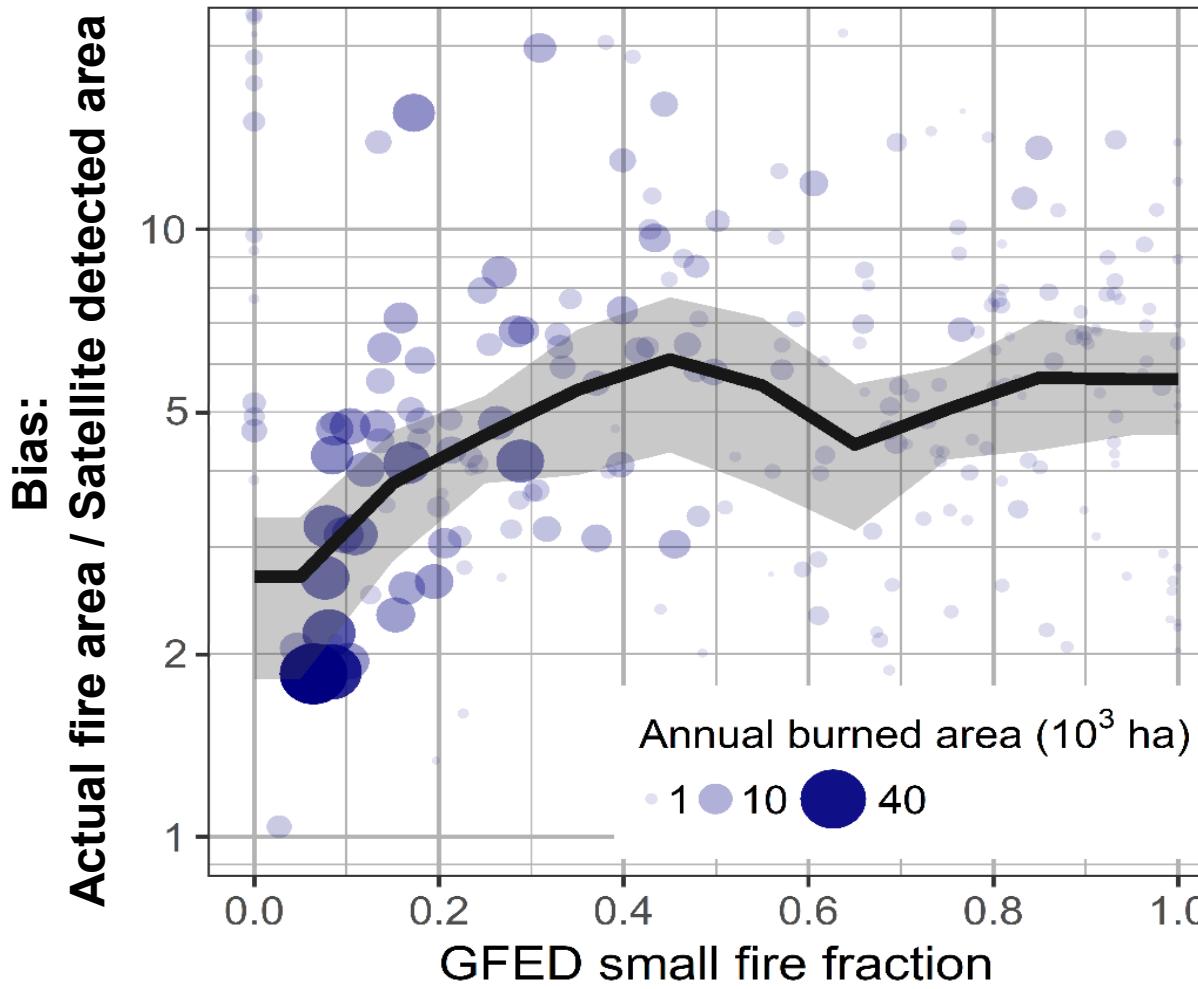
Consistent with the high end of past literature
(40-80% undetected; Hu et al., 2016; Huang et al., 2018)

Satellites vs. Government records



(van der Werf et al., 2017; Hawbaker et al., 2017; Pouliot et al., 2017)

Effect of fire size on satellite detection



Similar detection biases likely occur elsewhere.
Southeast US... beyond?

Fire landscapes found in Florida are globally widespread

Grassland



Agriculture



Savanna

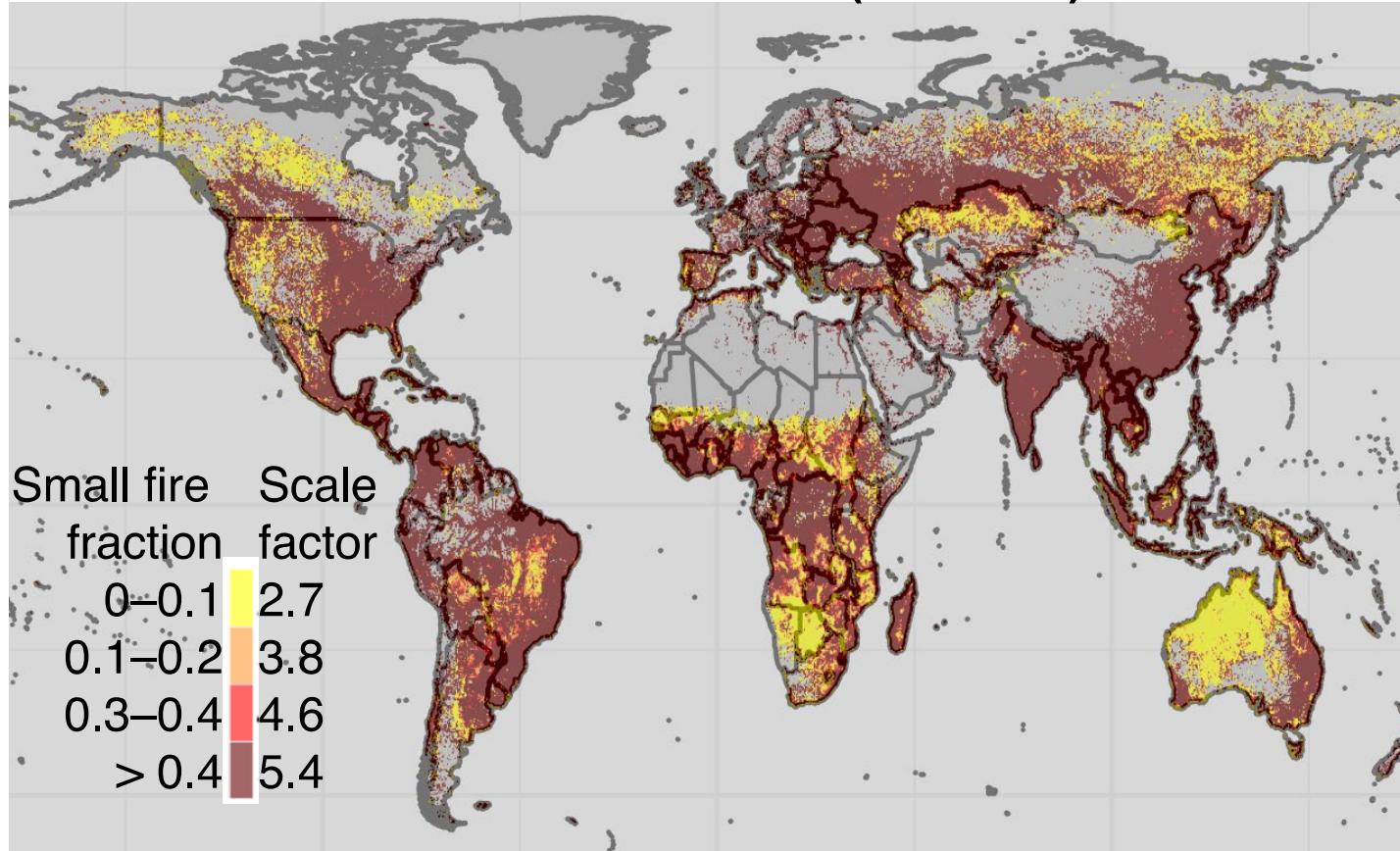


Shrubland



Size-dependent scale factor applied globally

Fire size & scale factor (GFED4s)



Global emissions

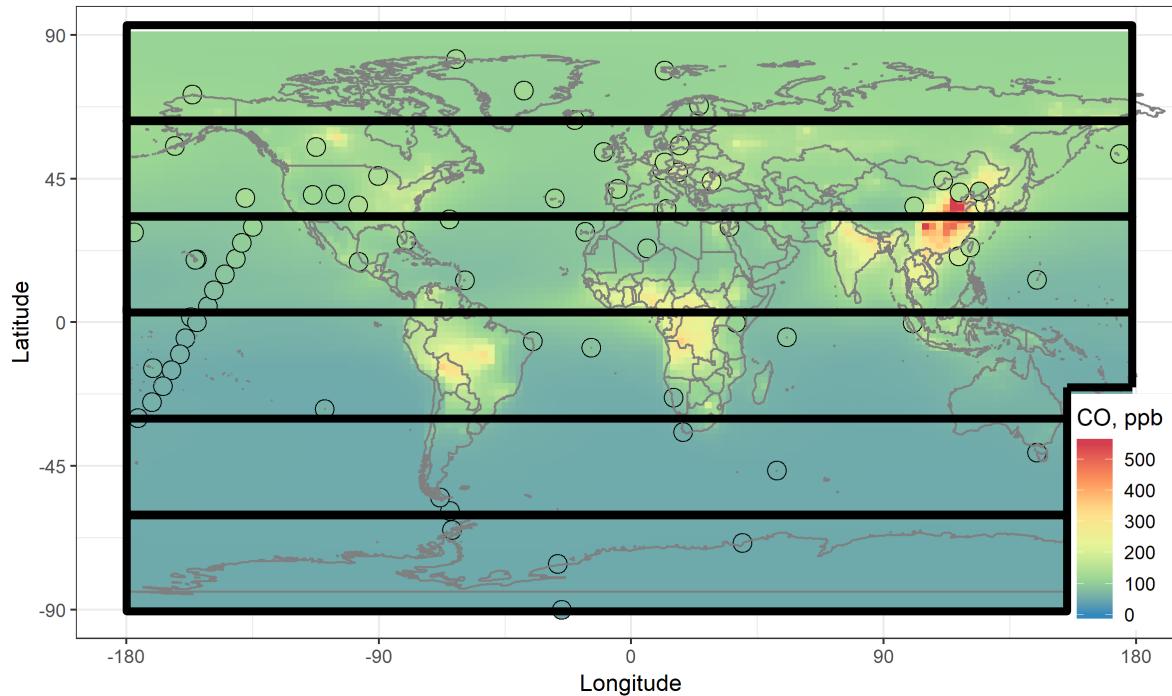
	GFED4s, Tg yr ⁻¹	Bias scaled, Tg yr ⁻¹	Ratio
CO ₂	7000	23000	3.3
CO	330	990	3.0

Scaling applied only to landscapes found in Florida (Agriculture, Savanna, Shrub, Grass, Temperate forest)

Global fire emissions could be 3X larger than currently thought

Comparison with ground CO

Normal GEOS-Chem

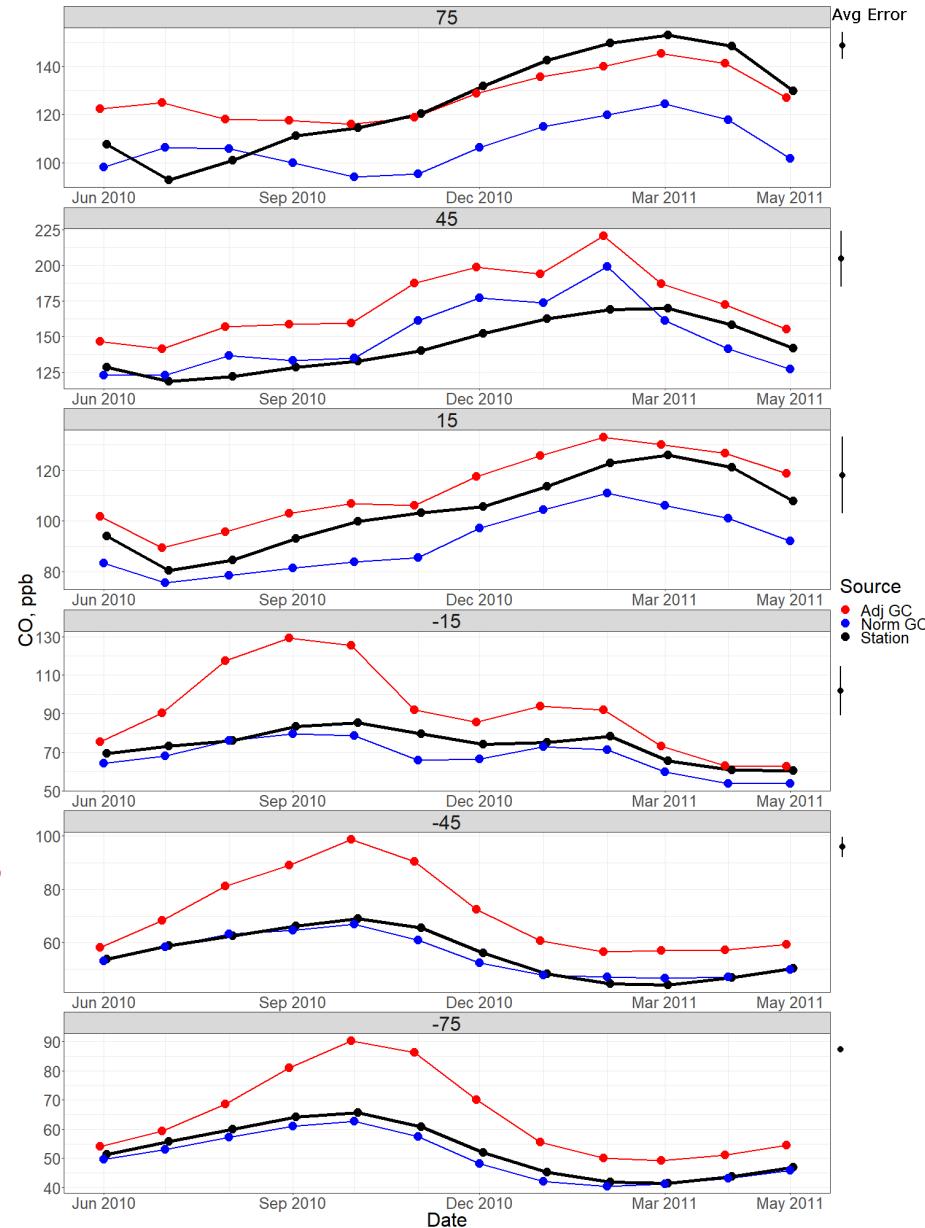


GEOS-Chem

- Version 12.1.1
- $2^\circ \times 2.5^\circ$ resolution
- Tropospheric chemistry
- MERRA2 reanalysis data
- GFED4
- 6 month spin-up
- Evaluation from June 2010 – May 2011

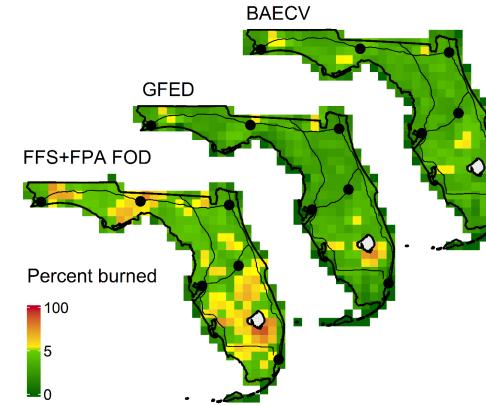
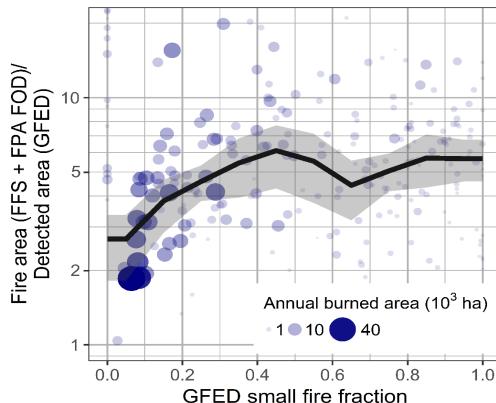
Improved CO estimates

Overestimates CO



Important messages

Fire area in Florida is underestimated (70-80%) by multiple satellite products over many years



Applying size-dependent bias factors to similar landscapes elsewhere increases global fire CO emissions by 3X

Scaled up emissions in GEOS-Chem...

- reduces CO bias in the Northern Hemisphere
- overestimates CO in the Southern Hemisphere
- could improve further with fire types and duration

