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Supplement of

How emissions uncertainty influences the distribution and radiative impacts of smoke from fires in North America

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Supplemental Information: How emissions uncertainty influences the distribution and radiative impacts of smoke from fires in North America

Emissions across other large biomass burning regions (Asia, the Amazon, and Africa)

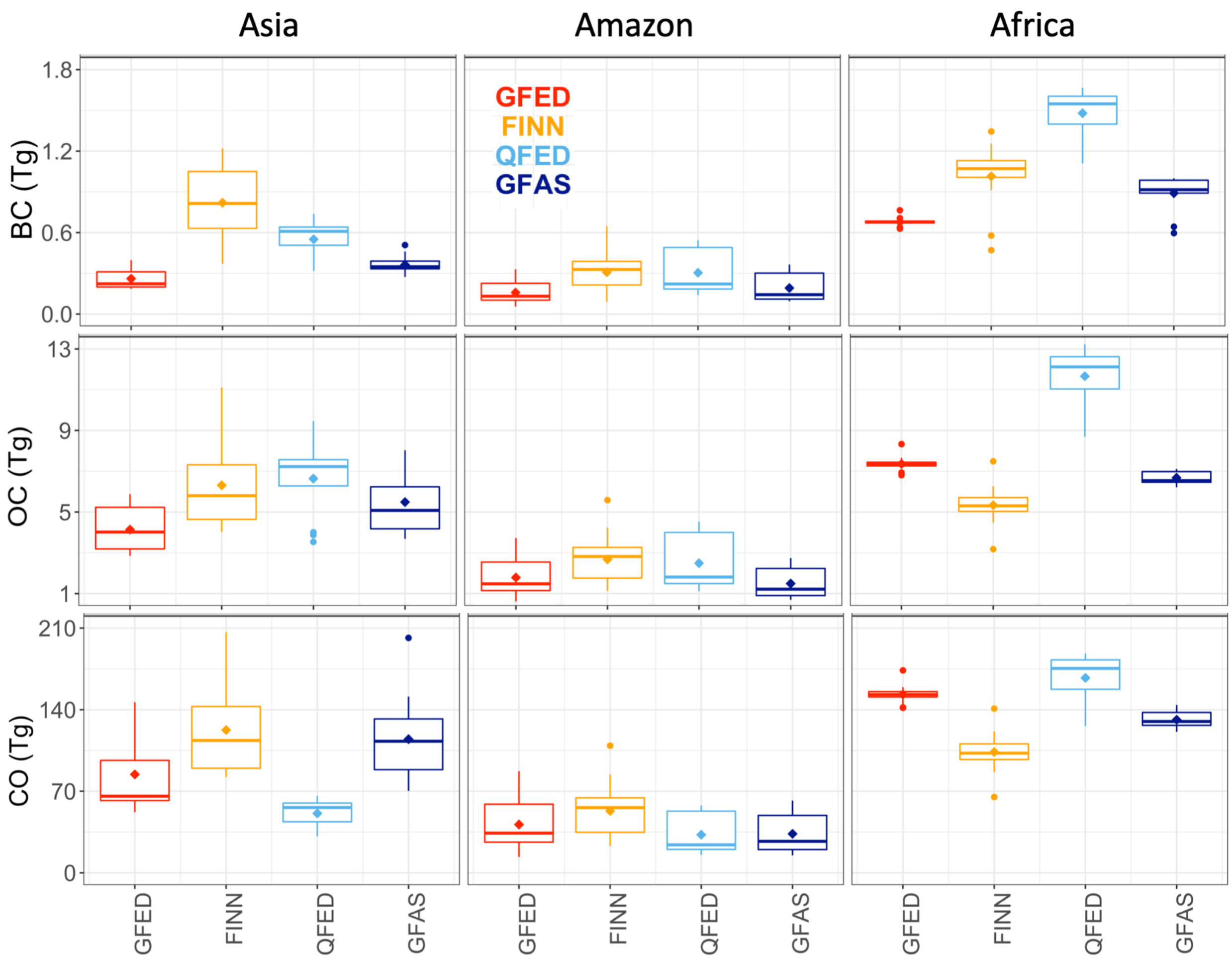


Figure S1: Boxplot summaries of each inventory's total annual emissions of BC, OC, and CO for Asia, the Amazon, and Africa from 2004 to 2016. Diamonds indicate means. The horizontal bar is the median. The box shows the 25th to the 75th percentile, and the whiskers show 1.5 times the interquartile range. Points outside 1.5 times the interquartile range are shown as dots. GFED4s emissions are in red, FINN1.5 in orange, QFED2.4 in light blue, and GFAS1.2 in dark blue.

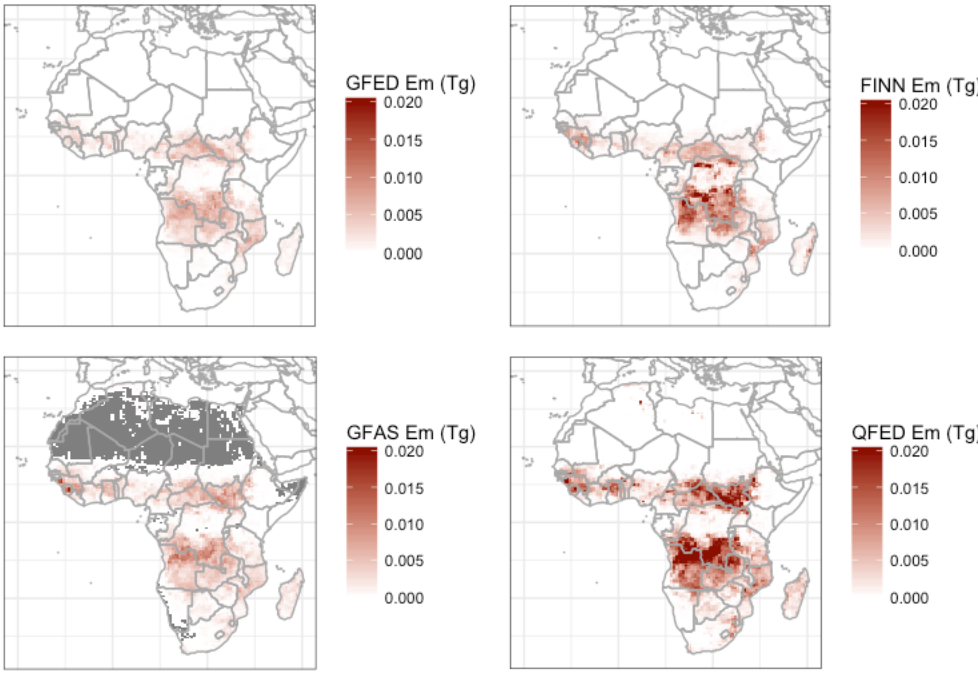


Figure S2a: Because African emissions showed a larger range across inventories than emissions in Asia and the Amazon, we show the spatial extent of African black carbon emissions here summed from 2004-2014 (Fig. S2a) and for OC emissions (Fig. S2b) below.

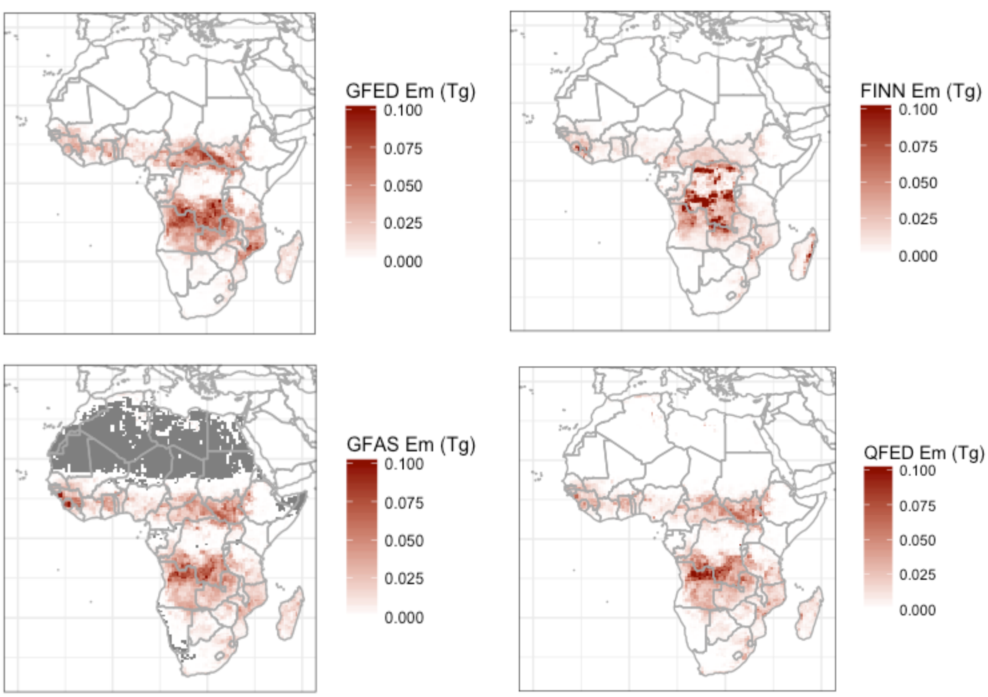


Figure S2b: Spatial extent of African organic carbon emissions summed from 2004-2014. Across both BC and OC emissions, it appears that variability among the inventories is driven more by central African emissions than emissions in the Sahel area with QFED2.4 nearly always much higher than the other three inventories for BC and less so for OC since those emissions have been scaled down to account for our different OM:OC ratio.

Biomass burning injection height scheme sensitivity test

Slight improvements in model-observation agreement, especially aloft and in the most fire-influenced points, are seen when a simple injection height scheme (Fischer et al. 2014) is used. More work is needed on fire injection schemes in chemical transport models.

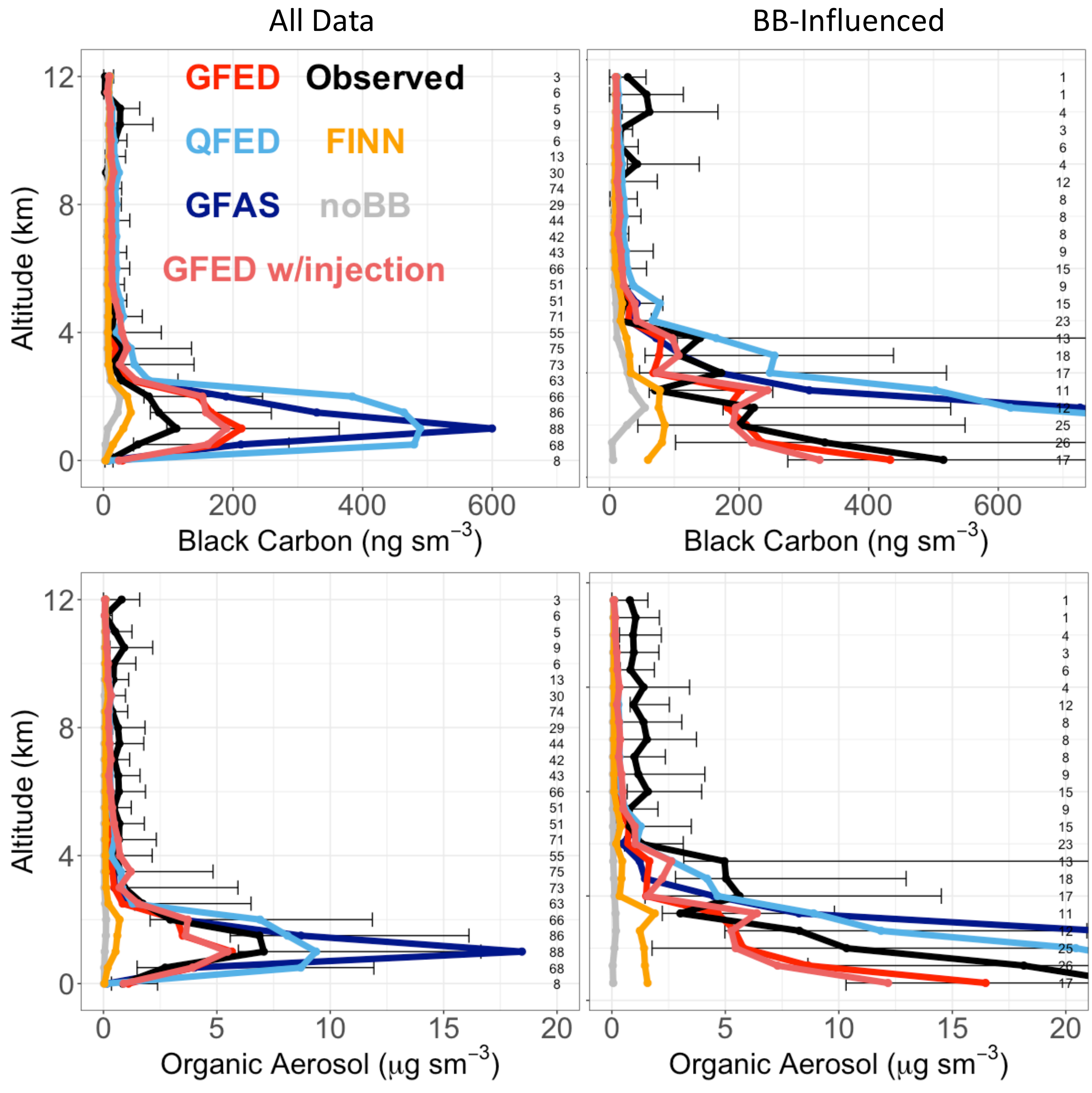


Figure S3: Boreal ARCTAS vertical profiles (shown in 0.5km bins) with injection height scheme (65% into PBL and 35% into the free troposphere). Observations (black) are compared with the five inventory simulations – "GFED4s with injection height scheme" (pink), "GFED4s" (red), "FINN1.5" (orange), "QFED2.4" (light blue), and "GFAS1.2" (dark blue) and a noBB simulation in grey. Error bars show the 25th to 75th percentiles of measurements and simulations averaged in each vertical bin. The left column shows medians of the total results from the campaign while the right column is filtered by the top 25th percentile observed acetonitrile. This sensitivity test was run at 2x2.5°.

Inventory effect on model agreement with aerosol optical depth (AOD)

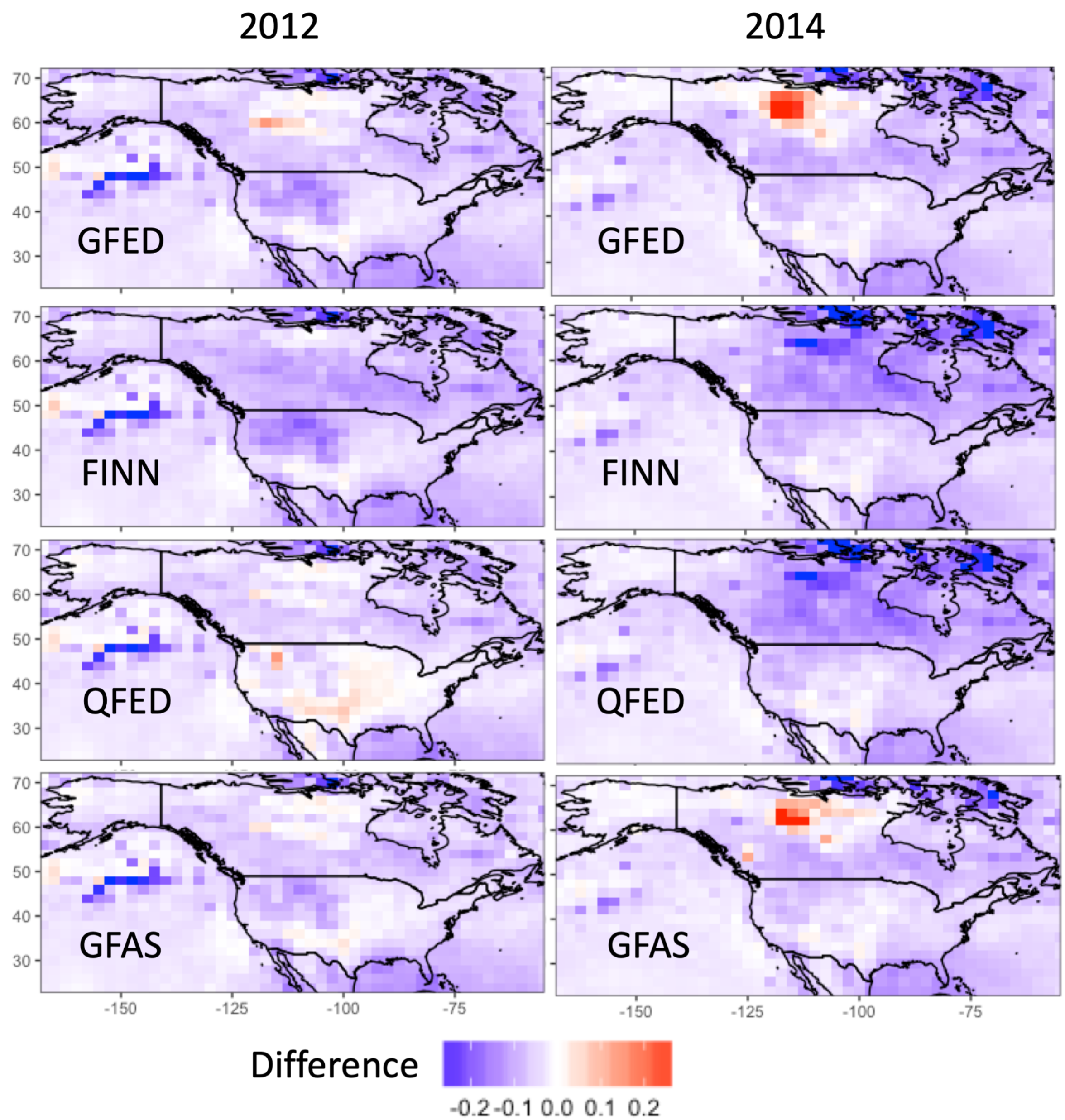


Figure S4: Maps of the difference between the simulated AOD driven by each inventory and MODIS-observed AOD from the Aqua satellite during the mean Northern Hemispheric fire season (May – September) in 2012 and 2014.

Impacts on air quality

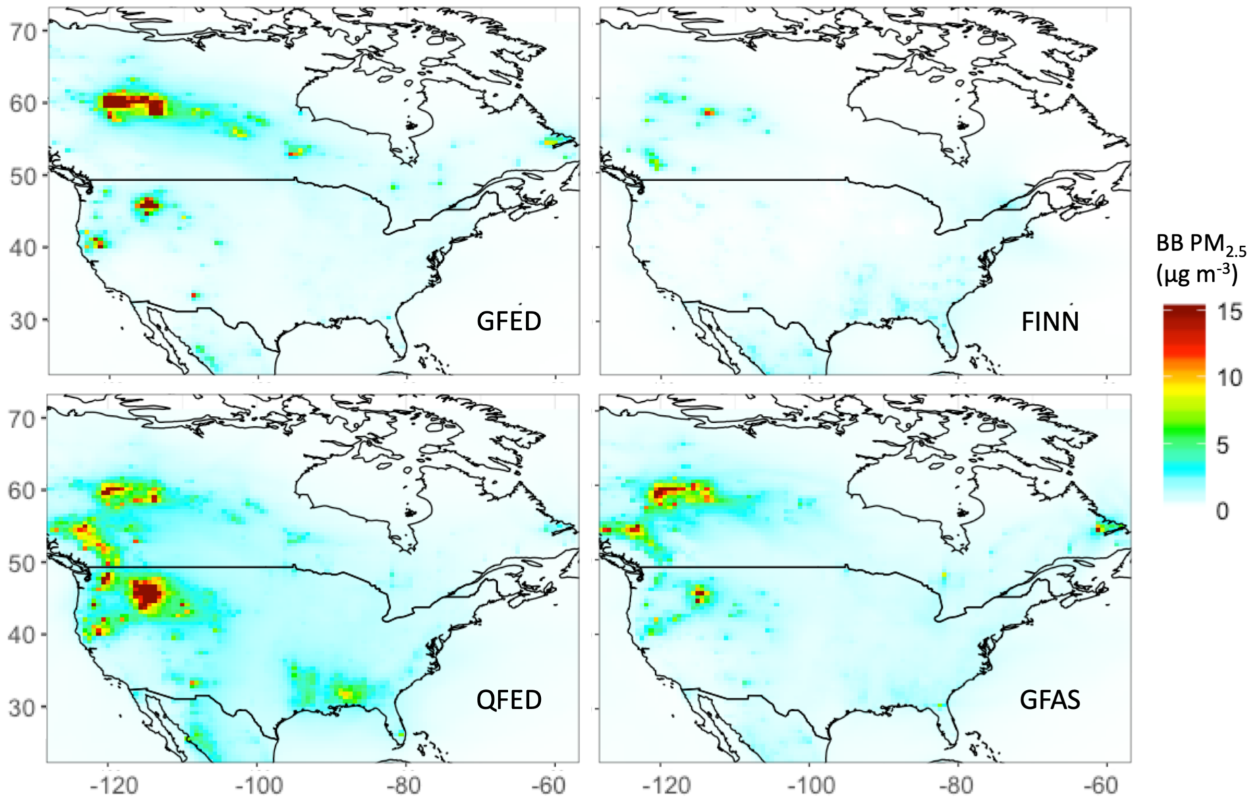
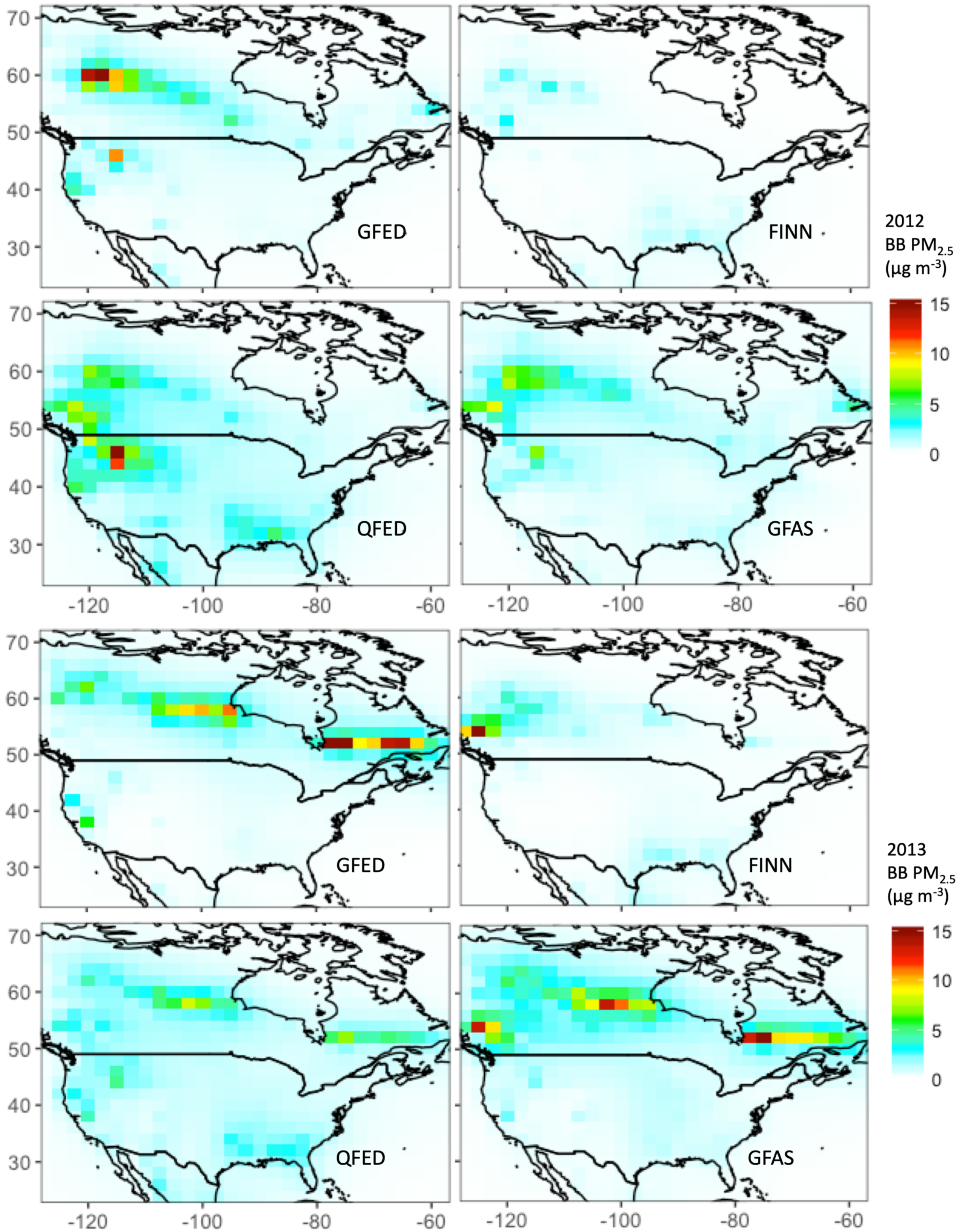


Figure S5: Maps of surface 2012 annual mean fire (BC+OA) PM2.5 concentrations driven by each inventory at nested resolution. GFED4s is top left, FINN1.5 top right, QFED2.4 bottom left, and GFAS1.2 bottom right. The color bar is saturated at 15 ug m^{-3} for all panels. See below for an analysis of each year from 2012 – 2014.


GFED
FINN
QFED
GFAS
2012
BB $PM_{2.5}$
($\mu g\ m^{-3}$)
GFED
FINN
QFED
GFAS
2013
BB $PM_{2.5}$
($\mu g\ m^{-3}$)
0
5
10
15
70
60
50
40
30
-120
-100
-80
-60

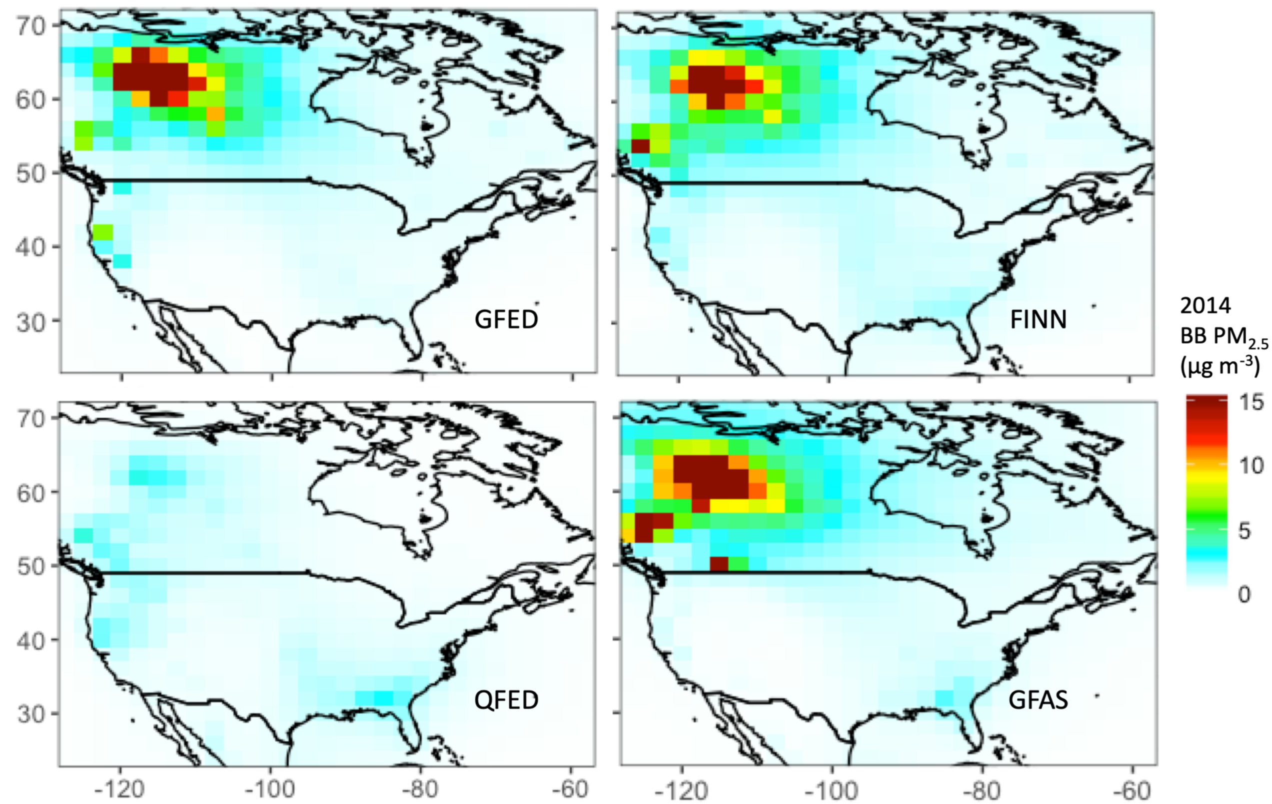


Figure S6: Maps of surface annual mean fire (BC+OA) PM2.5 concentrations from 2012 to 2014 driven by each inventory at 2x2.5°. GFED4s is top left, FINN1.5 top right, QFED2.4 bottom left, and GFAS1.2 bottom right. The color bar is saturated at 15 ug/m^3 for all panels.

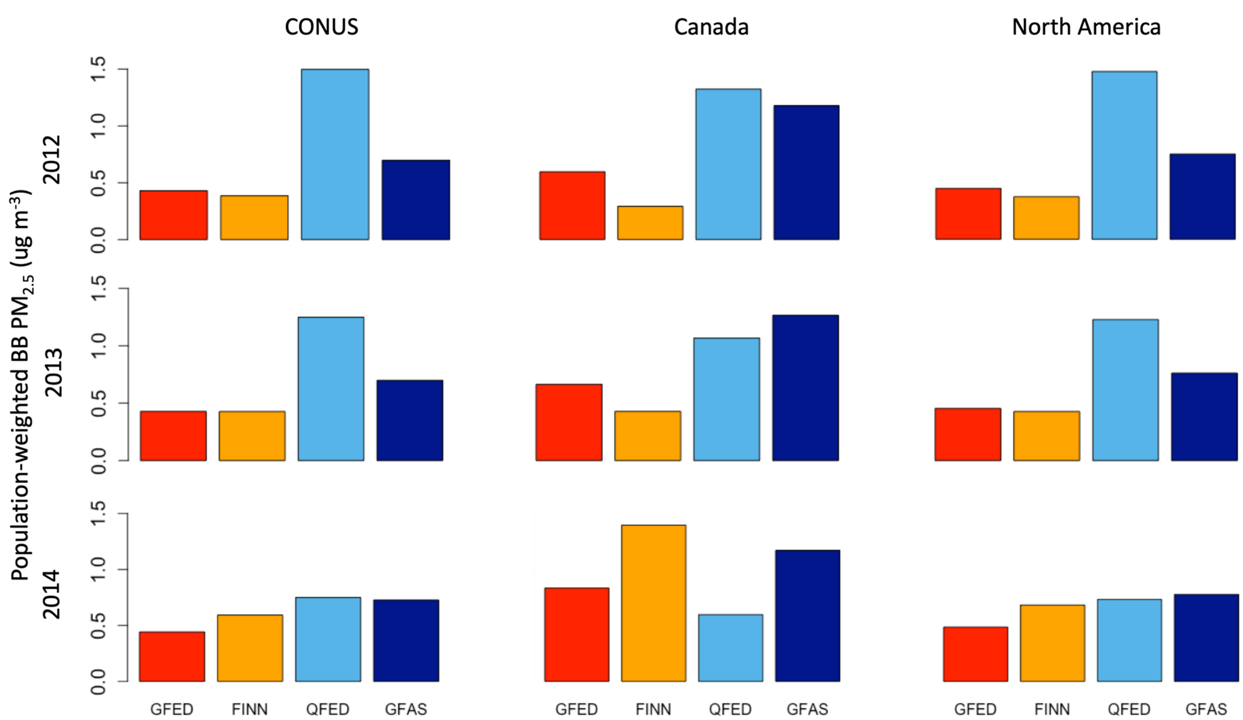


Figure S7: Bar plots of the annual mean population-weighted fire PM2.5 exposure across the four inventories (GFED4s in red, FINN1.5 in orange, QFED2.4 in light blue, and GFAS1.2 in dark blue) for the US (left panel), Canada (middle panel), and North America (right panel) at 2x2.5° from 2012 - 2014.

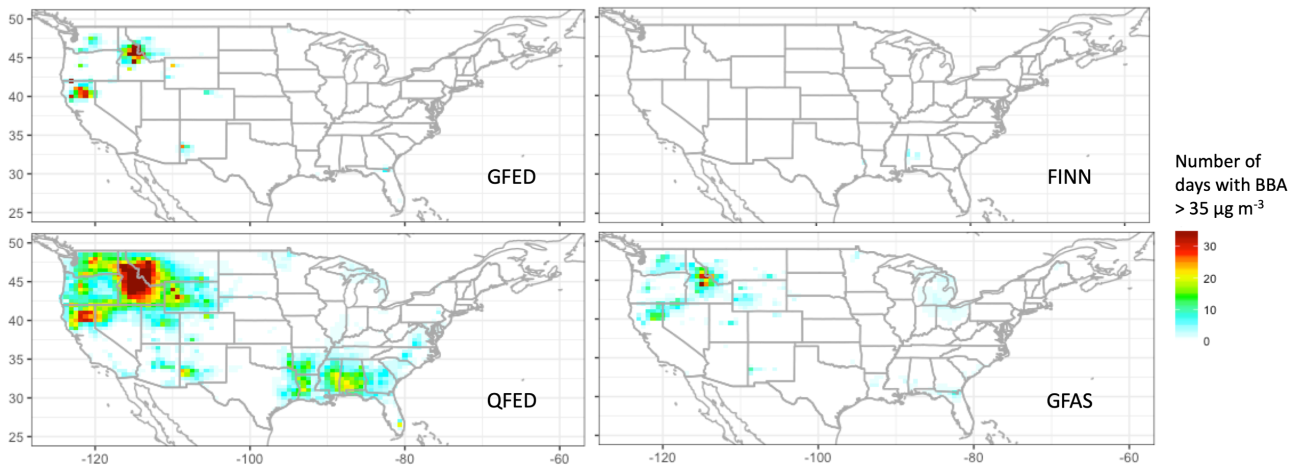
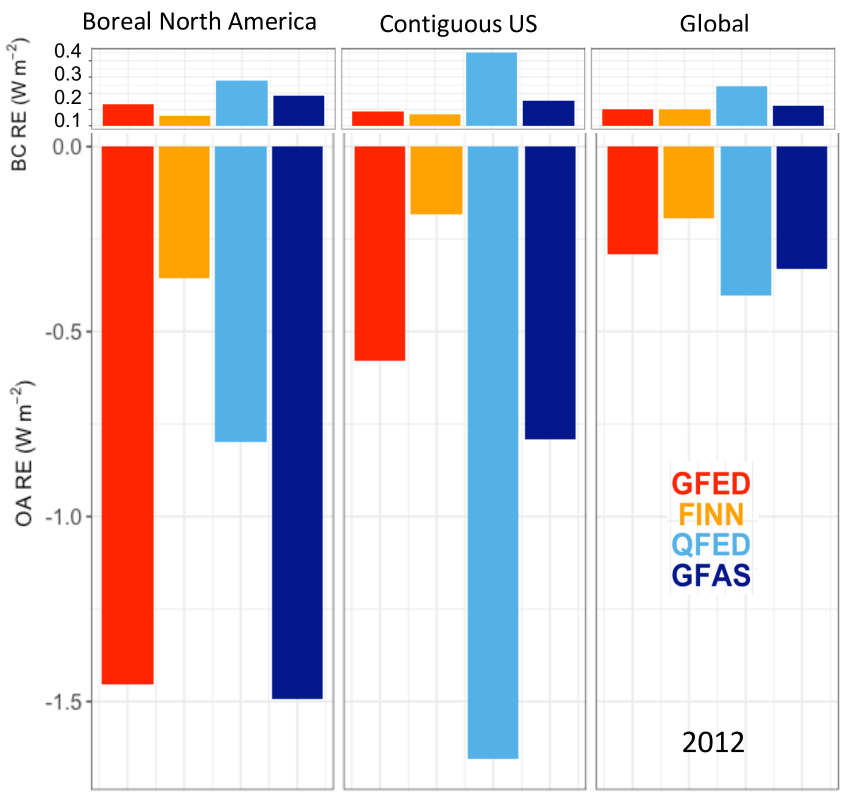
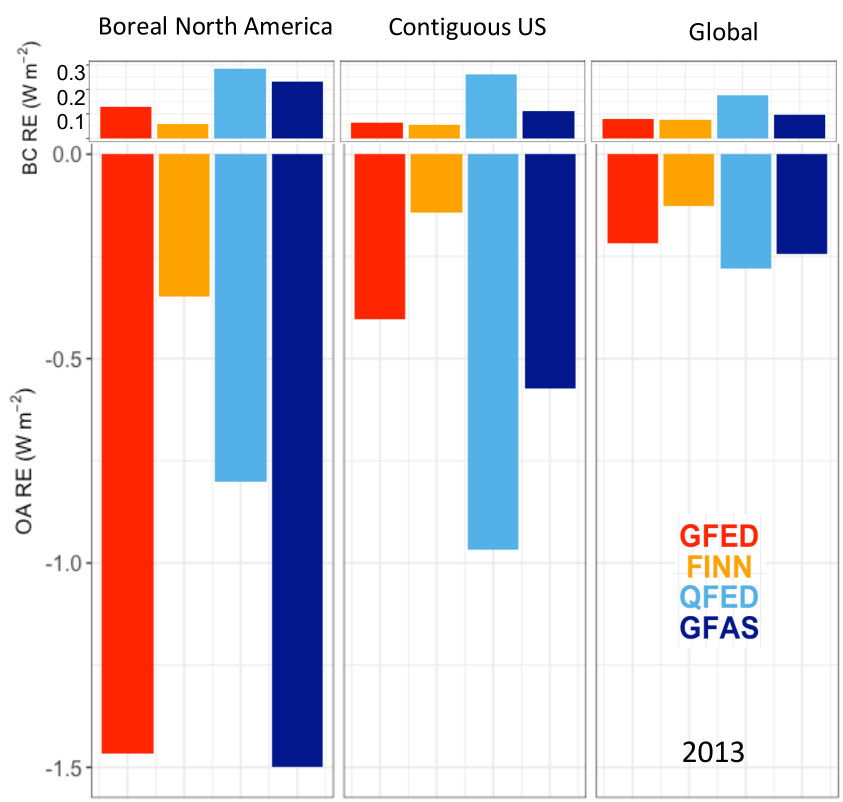


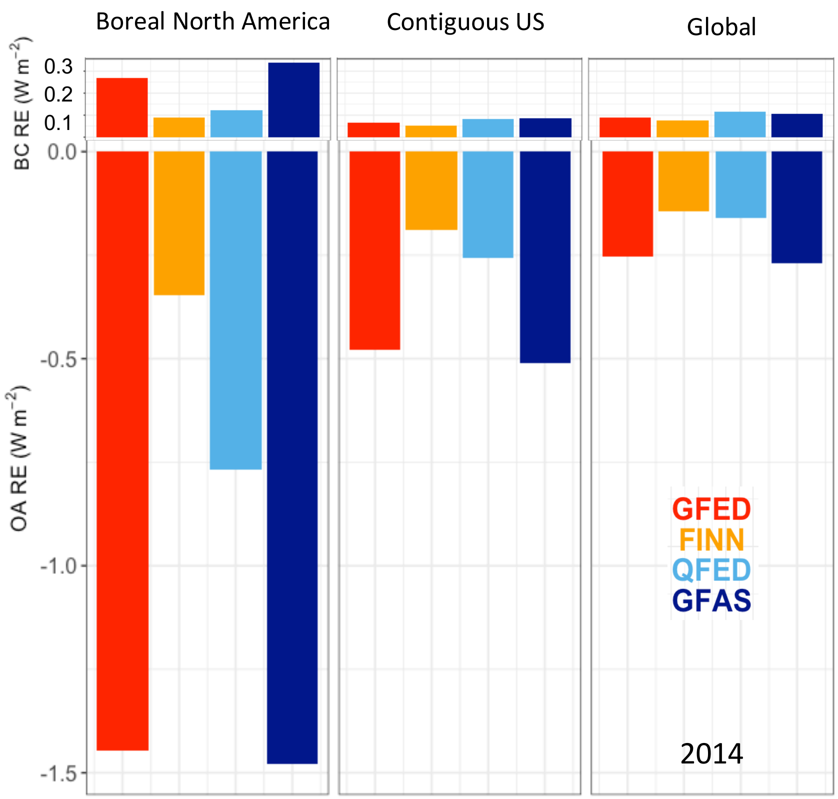
Figure S8: Number of exceedances of the 24-hour average $PM_{2.5}$ standard (35 ug m^{-3}) from only surface BBA in 2012. Note that the color bar is saturated at 35 days.

Impacts on the direct radiative effect

Differences in emissions carry over to the DRE of both BC and OA with QFED2.4 generally the largest and FINN1.2 the smallest. Significant variability across the inventories is seen across years, especially in the OA DRE in boreal North America.


Boreal North America
Contiguous US
Global
BC RE (W m⁻²)
OA RE (W m⁻²)
0.4
0.3
0.2
0.1
0.0
-0.5
-1.0
-1.5
GFED
FINN
QFED
GFAS
2012


Boreal North America
Contiguous US
Global
BC RE (W m⁻²)
OA RE (W m⁻²)
0.3
0.2
0.1
0.0
-0.5
-1.0
-1.5
GFED
FINN
QFED
GFAS
2013


Boreal North America
Contiguous US
Global
BC RE (W m^{-2})
OA RE (W m^{-2})
0.3
0.2
0.1
0.0
-0.5
-1.0
-1.5
GFED
FINN
QFED
GFAS
2014

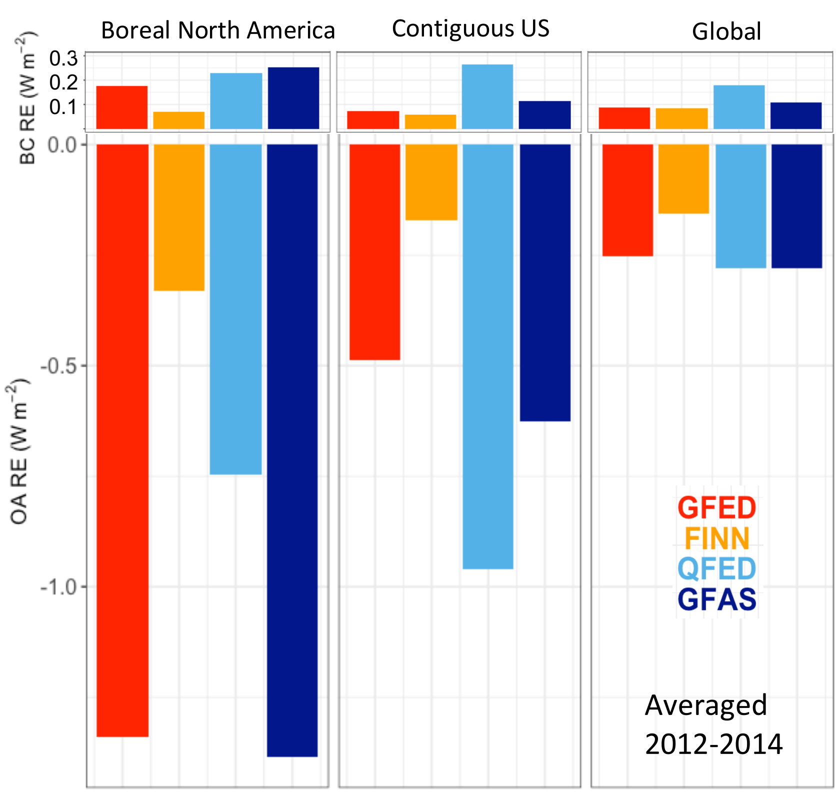

Boreal North America
Contiguous US
Global
BC RE (W m^{-2})
OA RE (W m^{-2})
0.3
0.2
0.1
0.0
-0.5
-1.0
GFED
FINN
QFED
GFAS
Averaged
2012-2014

Figure S9: Northern Hemisphere fire season (May – September) top of atmosphere (TOA) all-sky direct radiative effect of BB-only BC and OA for each year from 2012-2014 individually and averaged over the three years in BONA, CONUS, and globally. GFED4s is shown in red, FINN1.5 orange, QFED2.4 light blue, and GFAS1.2 dark blue. (The size of BC versus OA panels is not to scale).

Table S1: Biomass burning aerosol (BC and OA) mean 2012 DRE in boreal North America, CONUS, and globally

	BONA		CONUS		Global		Global BBA DRE
	BC	OA	BC	OA	BC	OA	
GFED4s	0.08	-0.42	0.058	-0.27	0.072	-0.16	-0.088
FINN1.5	0.057	-0.11	0.063	-0.14	0.082	-0.13	-0.048
QFED2.4	0.15	-0.43	0.23	-0.82	0.18	-0.28	-0.10
GFAS1.2	0.11	-0.43	0.093	-0.40	0.095	-0.20	-0.11