Supplement of
An Improved Representation of Fire Non-Methane Organic Gases (NMOGs) in Models: Emissions to Reactivity

Therese S. Carter et al.

Correspondence to: Therese S. Carter (tscarter@mit.edu) and Colette L. Heald (heald@mit.edu)

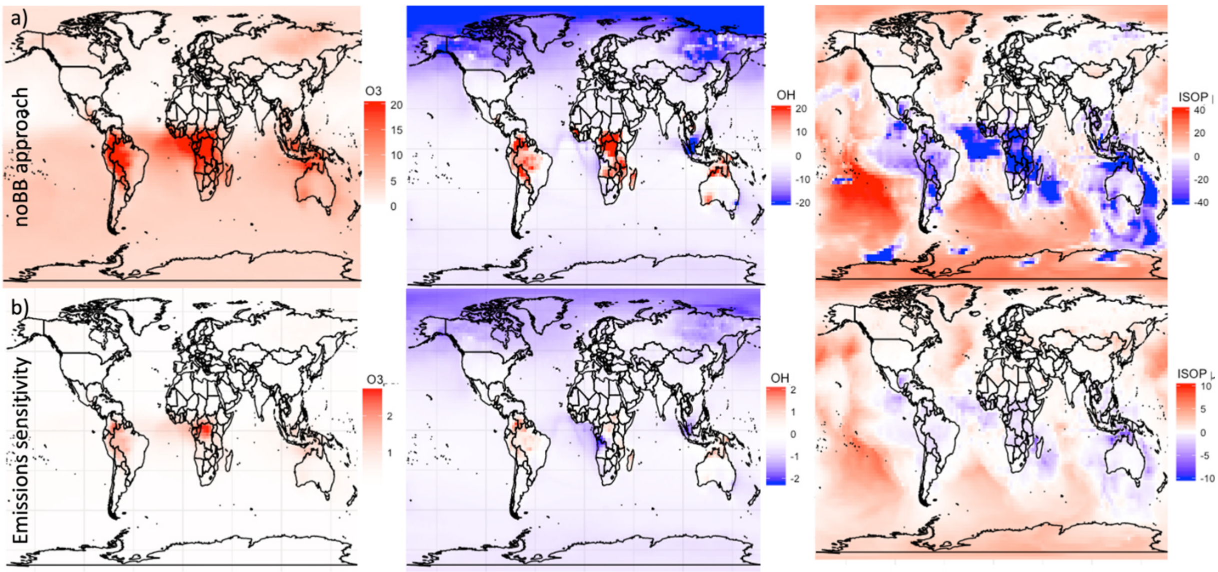


Fig S1: Annual 2019 surface mean ozone, OH, and ISOP (isoprene) concentration percent differences attributed to fires using two approaches a) subtracting out no fire simulation versus b) emissions sensitivity runs of 1.05 and 0.95 times fire emissions scaled up to equal an 100% perturbation

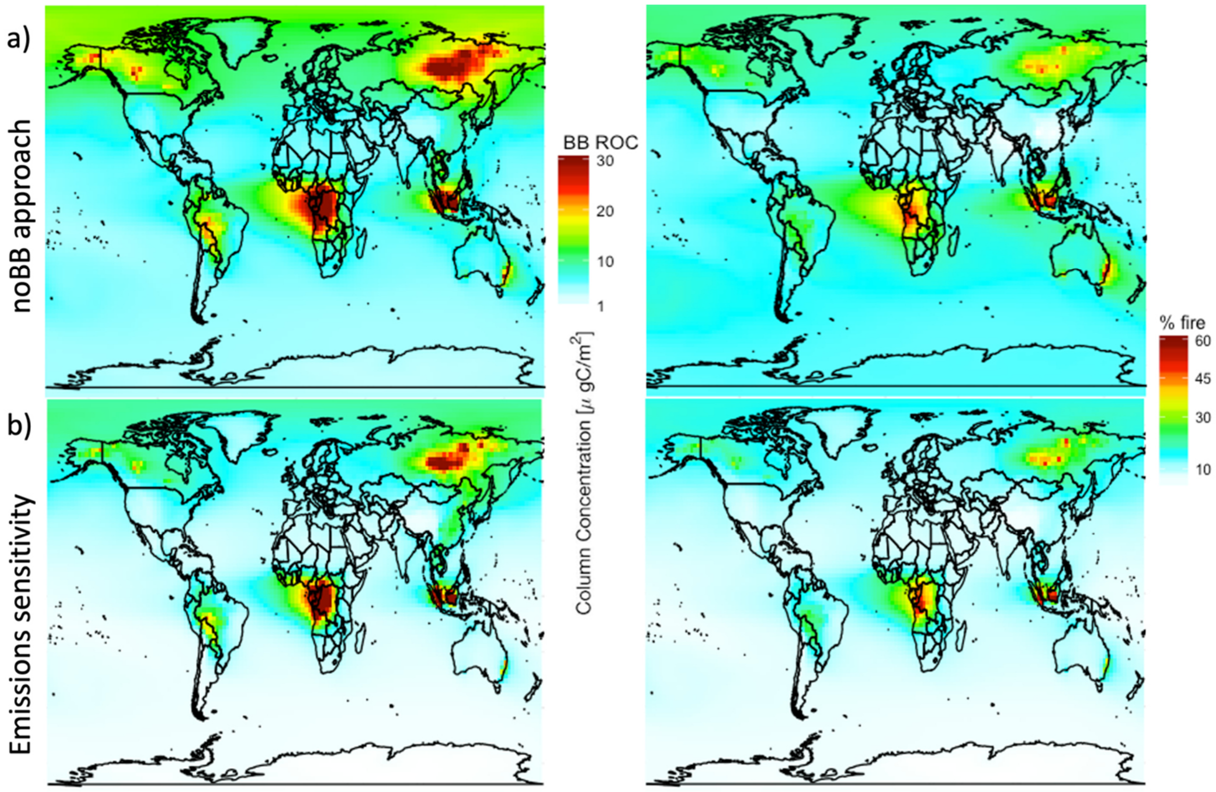


Fig S2: Annual 2019 mean simulated ROC column concentrations and percent ROC attributed to fires using two approaches a) subtracting out no fire simulation versus b) emissions sensitivity runs of 1.05 and 0.95 times fire emissions scaled up to equal an 100% perturbation

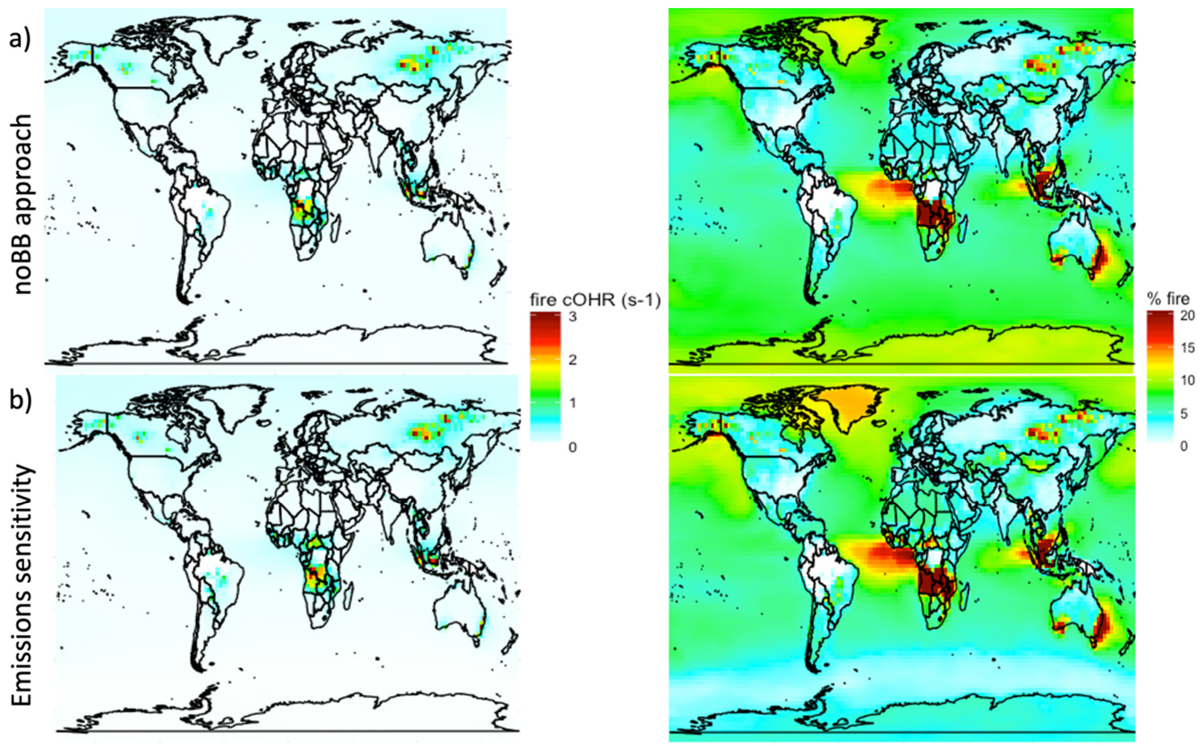
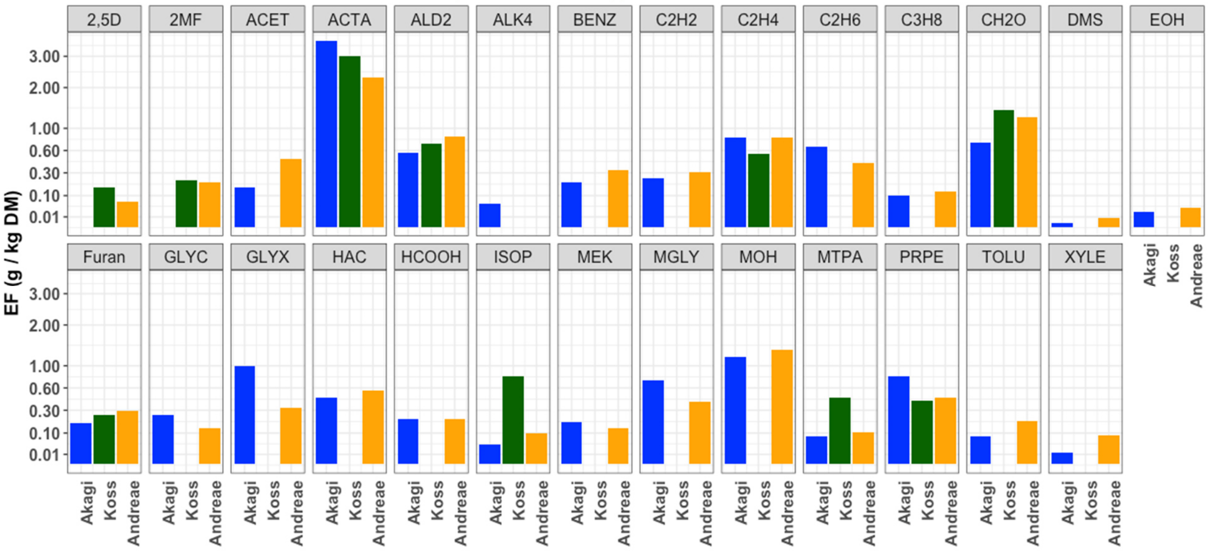
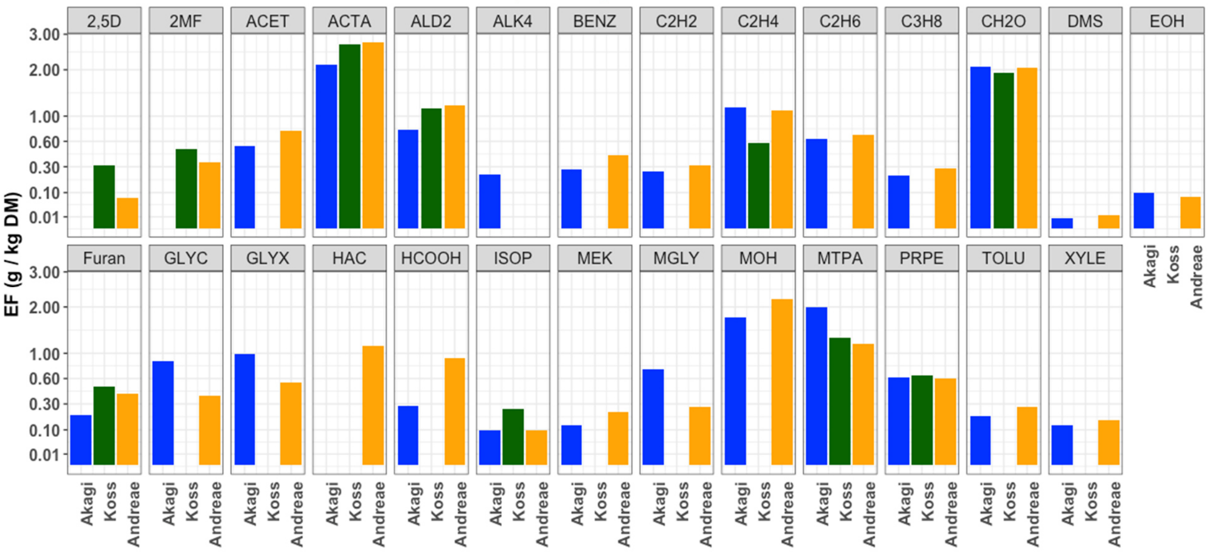


Fig S3: Annual 2019 mean surface OHR and percent OHR attributed to fires using two approaches a) subtracting out no fire simulation versus b) emissions sensitivity runs of 1.05 and 0.95 times fire emissions scaled up to equal an 100% perturbation

a) Savanna, grassland, shrub



b) Temperate forest



c) Agricultural

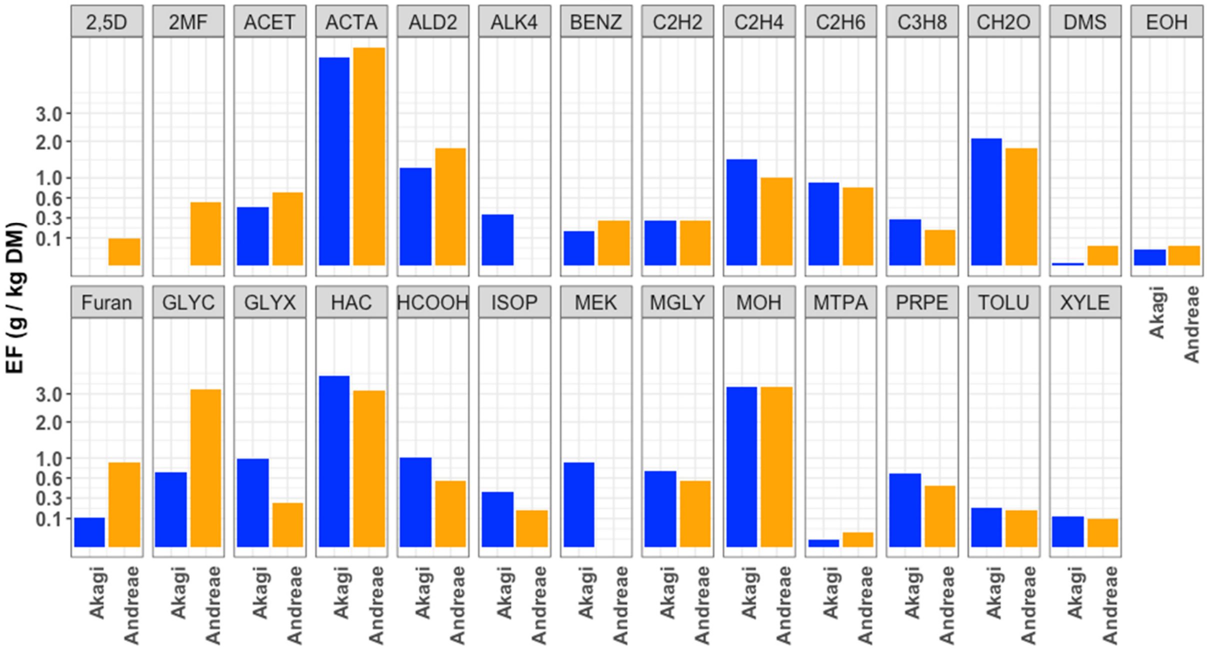


Fig S4: Emission factors of common NMOGs from the Akagi et al. (2011) in dark blue, Koss et al. (2018) in green, and Andreae 2019 paper in orange for a) savanna, grassland, shrub fuel types, b) temperate forests, and c) agricultural fires

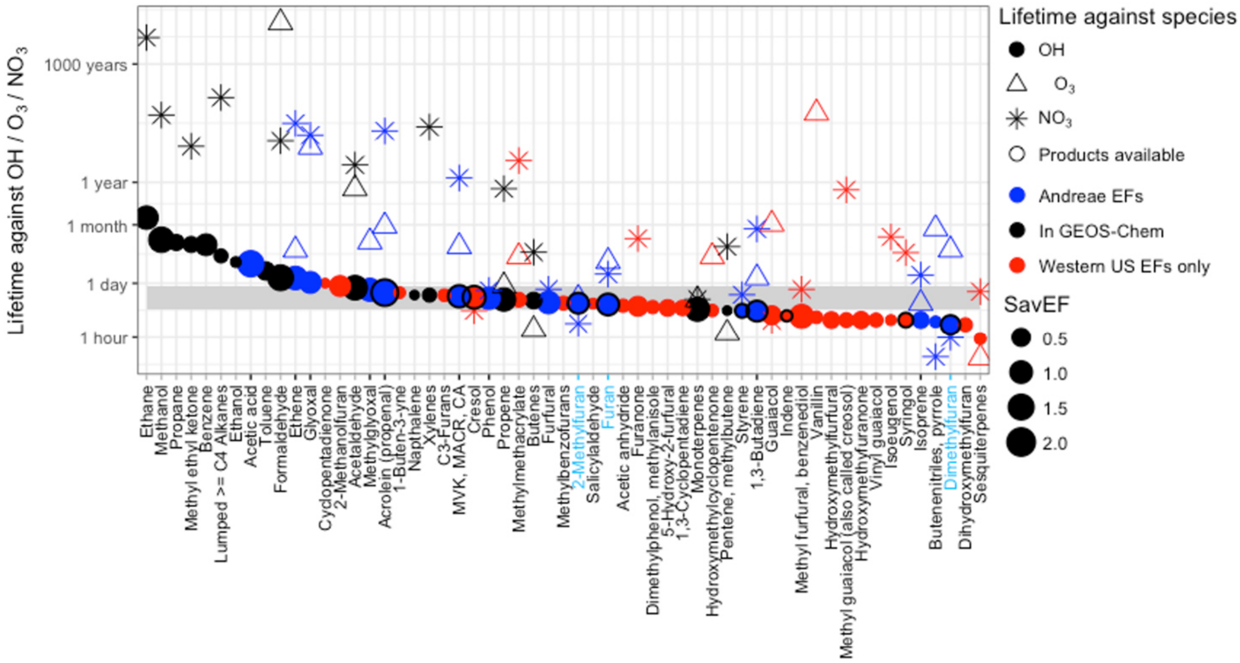


Fig S5: Following Coggon et al. (2019), the species responsible for 95% of OHR in addition to species already represented as emitted from fires in GFED4s in GEOS-Chem are plotted in descending order of their lifetime against OH, NO_3, and O_3. Those already in GEOS-Chem are in black, species not yet in GEOS-Chem but where emissions factors were available in Andreae 2019 are in blue, and species that are only available for western US fuel types from Koss et al. (2018) are in red. The circles are sized by their relative savanna and grassland emission factor in g species / kg DM burned. The grey horizontal box represents an approximate physical lifetime against transport out of a nested 0.5° × 0.625° grid box (~5 hours) and a 2x2.5 grid box (~20 hours).

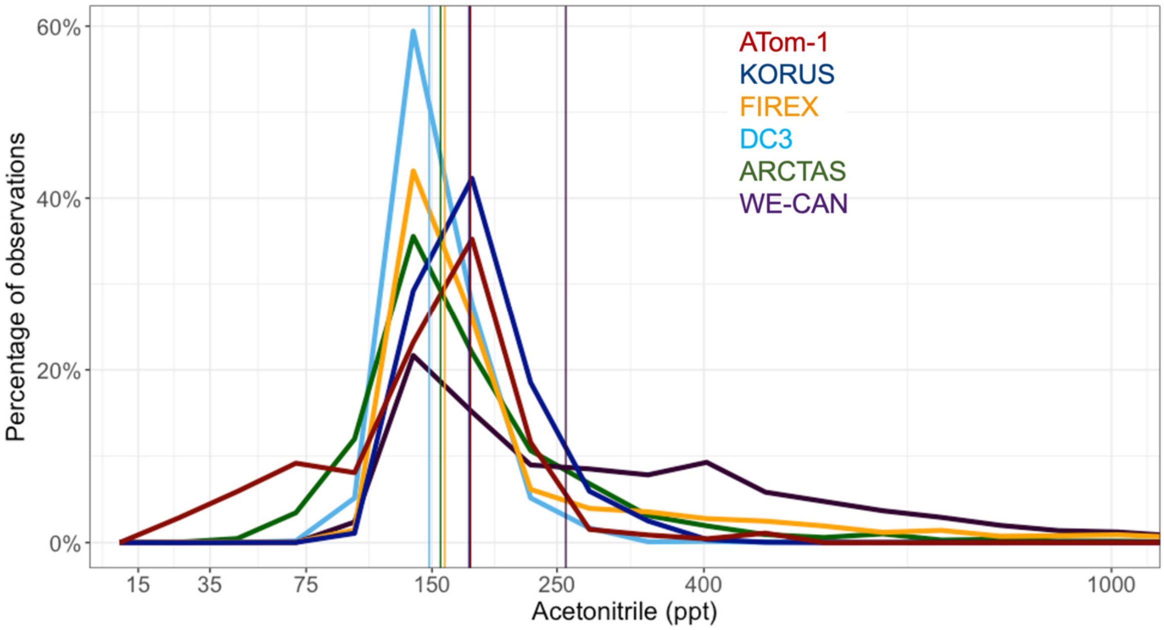


Figure S6: Percentage of observations by their acetonitrile concentrations for the first intensive of ATom from July to August 2016 (dark red), KORUS from April to June 2016 (dark blue), FIREX from July to September 2019 (orange), DC3 in May to June 2012 (light blue), ARCTAS in June to July 2008 (green), and WE-CAN in July to September 2018 (purple).

The Atmospheric Tomography Mission deployment 1 (ATom-1) took place from 29 July to 23 August 2016, originated in Palmsdale, CA, and sampled around the globe, including in the east Atlantic off the coast of Africa. In our analysis, we focus on this area since previous work has documented its fire influence (Travis et al., 2020; Strode et al., 2018), and we include points between 35° N and 50° S and greater than 32° W to focus on this fire outflow region. Table 2 in (Travis et al., 2020) describes the OHR and NMOG measurements used to calculate observed cOHR. We follow the convention established in Travis et al. (2020) of including species in cOHR where at least 20% of possible available measurements below 3km are not missing.

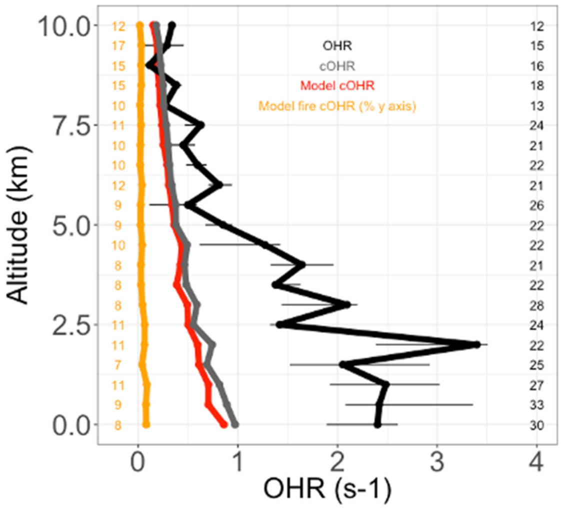


Figure S7: Vertical profile of measured total OHR in black, calculated observed OHR in grey, modeled calculated OHR in red, and modeled calculated OHR from fires in orange. Horizontal bars show the 25th–75th percentile range of measurements in each vertical 0.5-km bin. The number of observations in each bin is shown on the right side of each panel.

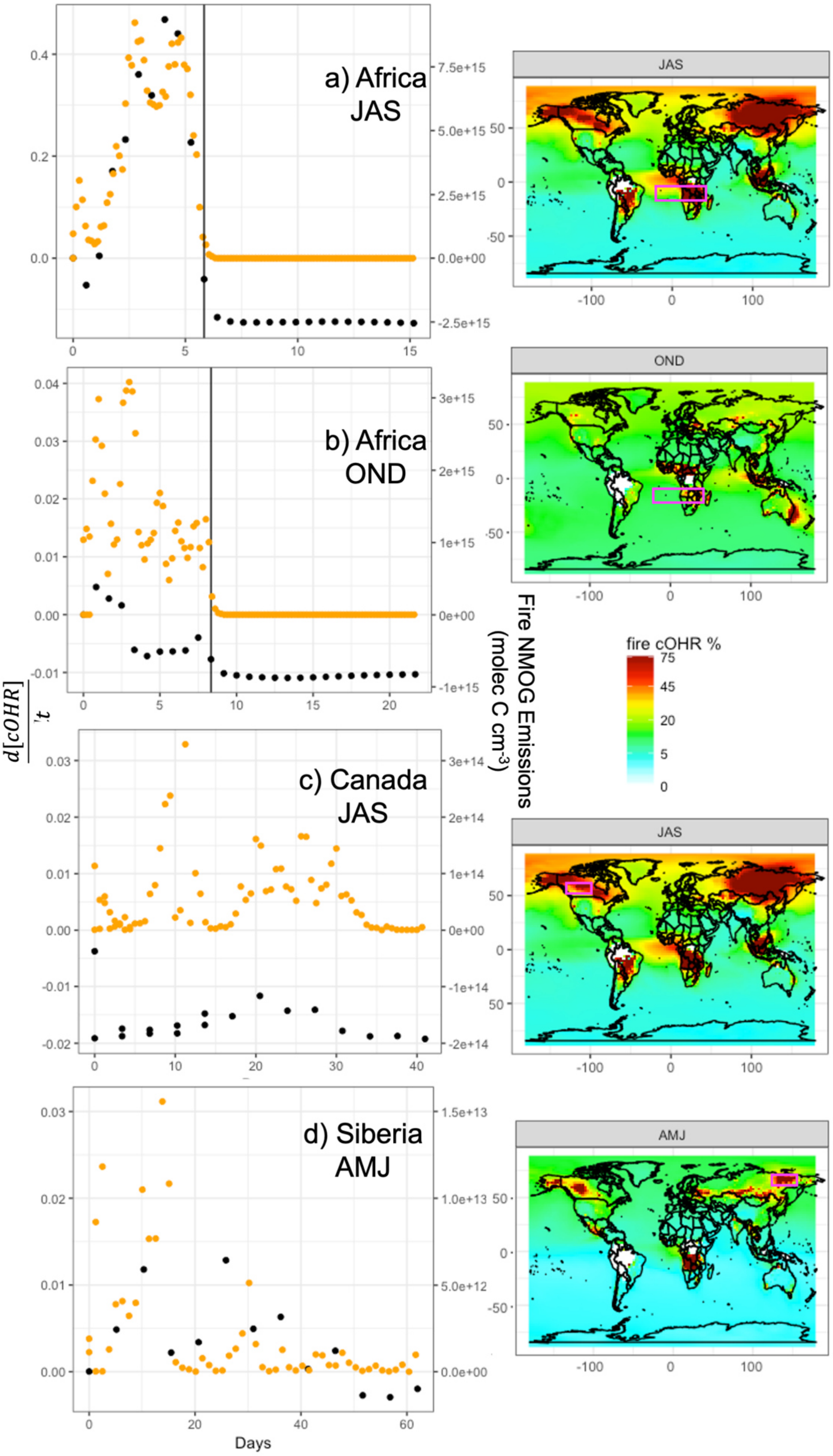

a) Africa JAS
b) Africa OND
c) Canada JAS
d) Siberia AMJ
JAS
OND
AMJ
fire cOHR %
75
45
20
5
0
Fire NMOG Emissions (molec C cm-3)
d[cOHR]/t
Days

Figure S8: The simulated decay of cOHR (black) in outflow from fires in (a) Africa during July, August, September (JAS), (b) Africa during October, November, December (OND), (c) Canada in JAS, and (d) Siberia in April, May, June (AMJ). Distance is converted to time using zonal average wind speeds. Fire NMOG emissions are also plotted in orange. For the Africa plots, the approximate Atlantic coastline edge is indicated with a black vertical line. In the right column, we show the seasonal average contribution from fires to cOHR and box the regions of interest in magenta.