Supplementary Materials of "Duff burning from wildfires in a moist region: different impacts on $PM_{2.5}$ and Ozone"

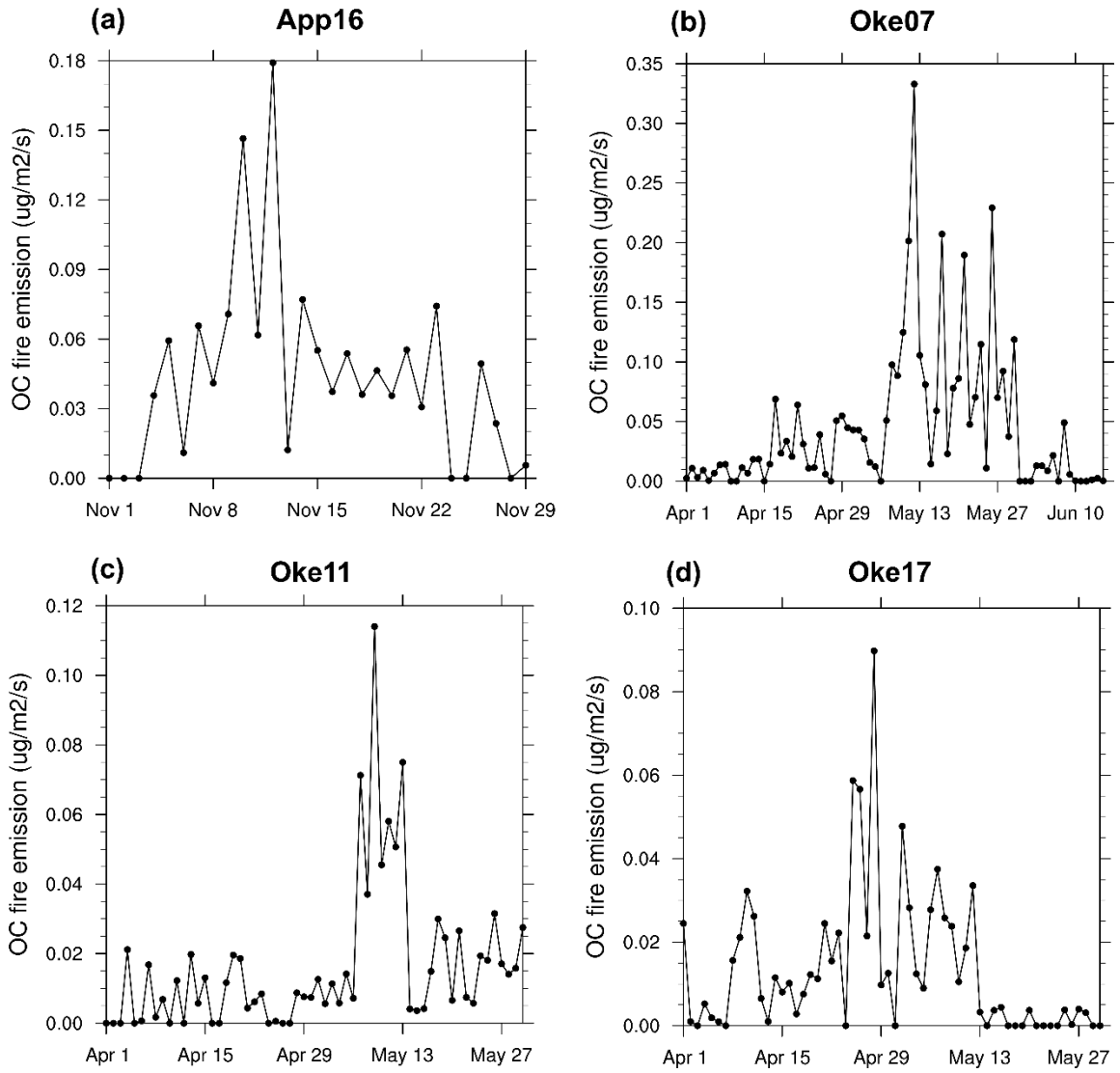

Figure S1. The daily trend of FINN fire emissions of organic carbon (OC) during the fire events. (a) the Southern Appalachian region (34.5° N to 36° N, 82° W to 84° W). (b) - (d) the Okefenokee region (30° N to 32° N, 81° W to 83° W).

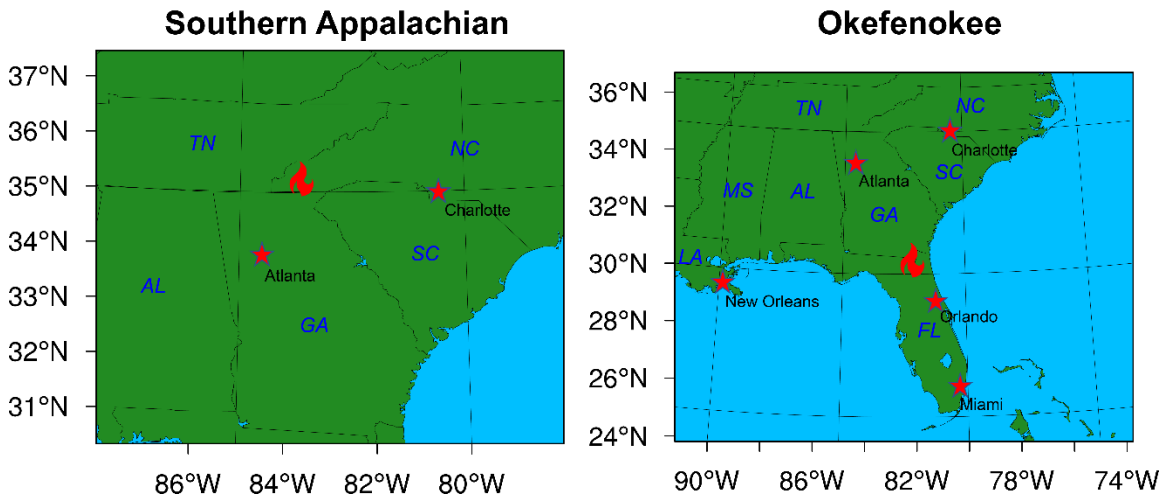

Figure S2. The WRF-Chem domain used in App16la (left) and the Okefenokee cases (right). The fire sites and nearby major cities are marked. The abbreviations of the US state names are Florida (FL), Alabama (AL), Georgia (GA), South Carolina (SC), North Carolina (NC), Tennessee (TN), Mississippi (MS) and Louisiana (LA).

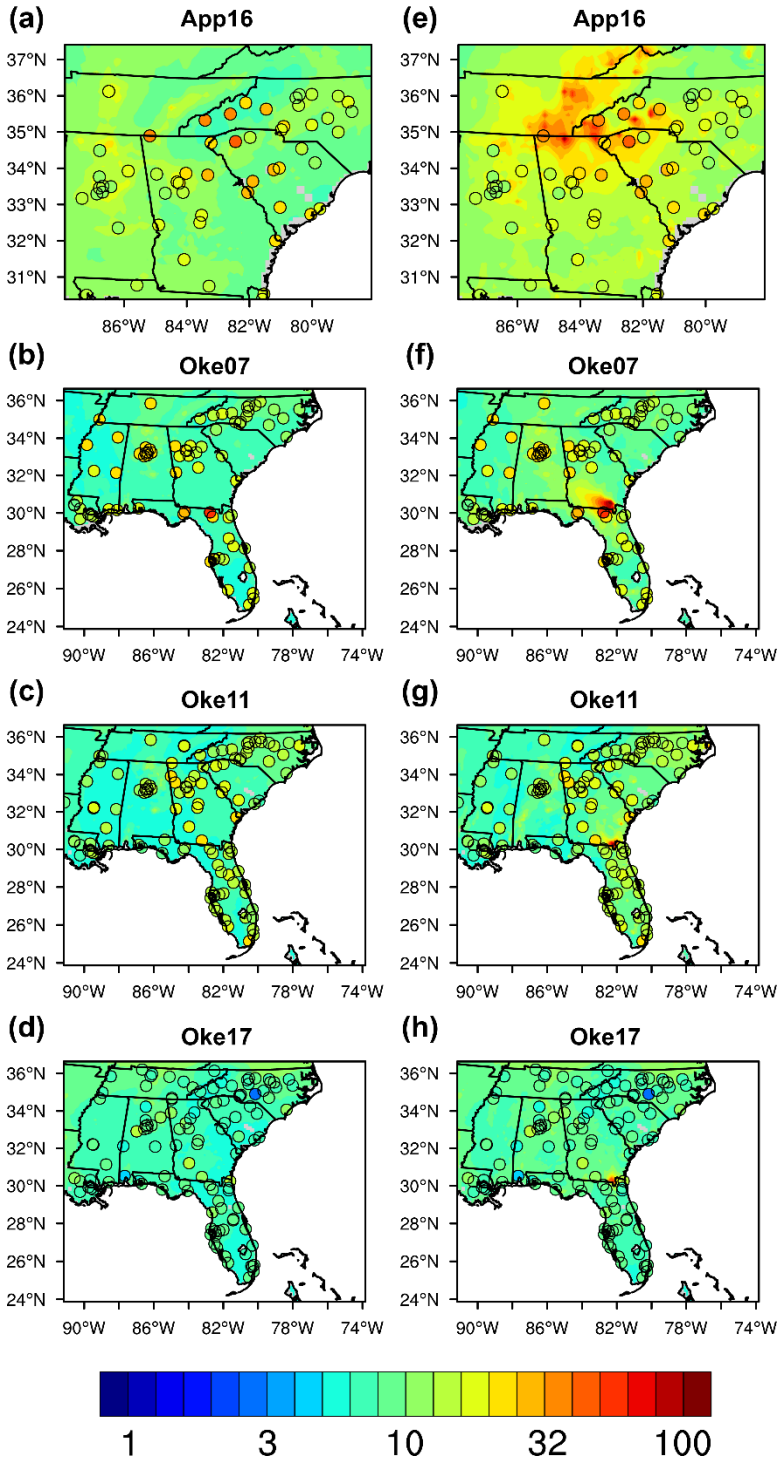

Figure S3. $PM_{2.5}$ mean surface concentration (μg m^{-3}). (a) App16 (November 7-19, 2016), (b) Oke07 (May 6-30, 2007), (c) Oke11 (May 6-15, 2011), and (d) Oke17 (April 19 to May 13, 2017) for sim_nofire. (e-h) are the corresponding fire cases for sim_FINN. The color scatters represent the observed PM2.5.

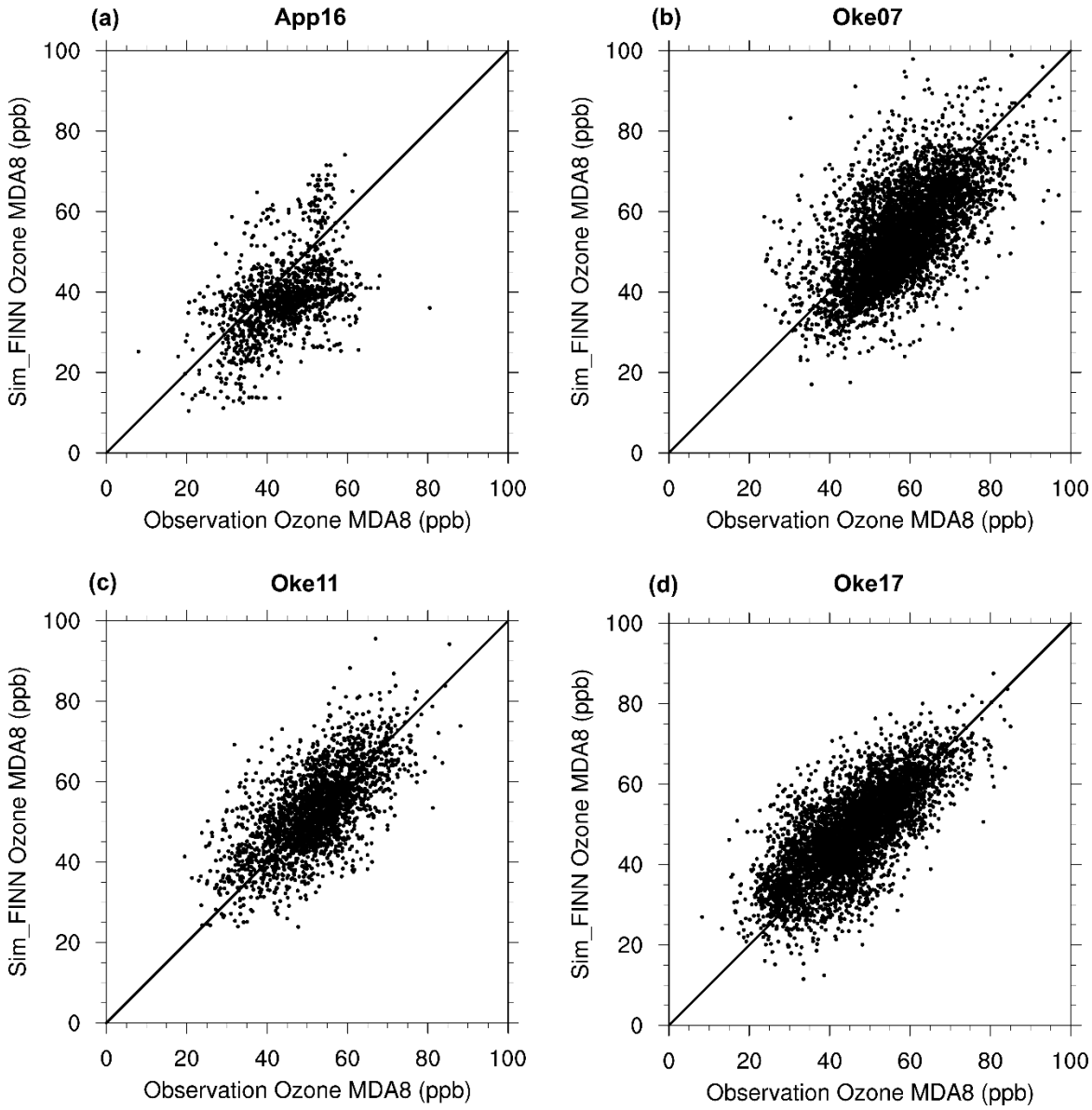

Figure S4. The comparison of MDA8 surface ozone concentrations between the observation and the baseline (sim_FINN) simulations.

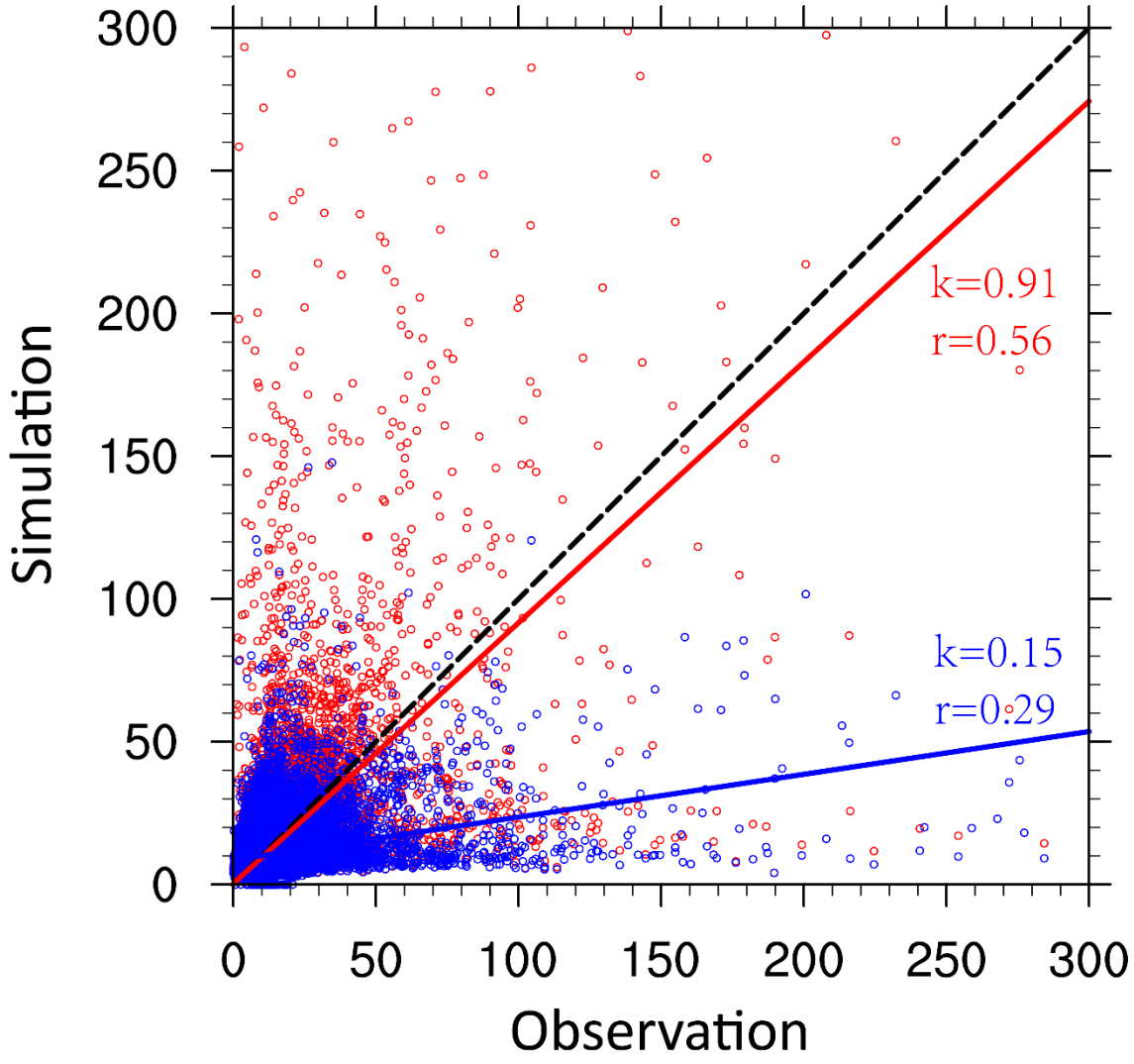

Figure S5. The comparison of Oke07 hourly surface $PM_{2.5}$ concentrations between the observation, the baseline (sim_FINN) simulations (blue), and the best (sim_FINN+duff) simulations (red), in unit of μg m^{-3}. The corresponding correlation coefficient (r) and the regression slope (k) is enclosed.

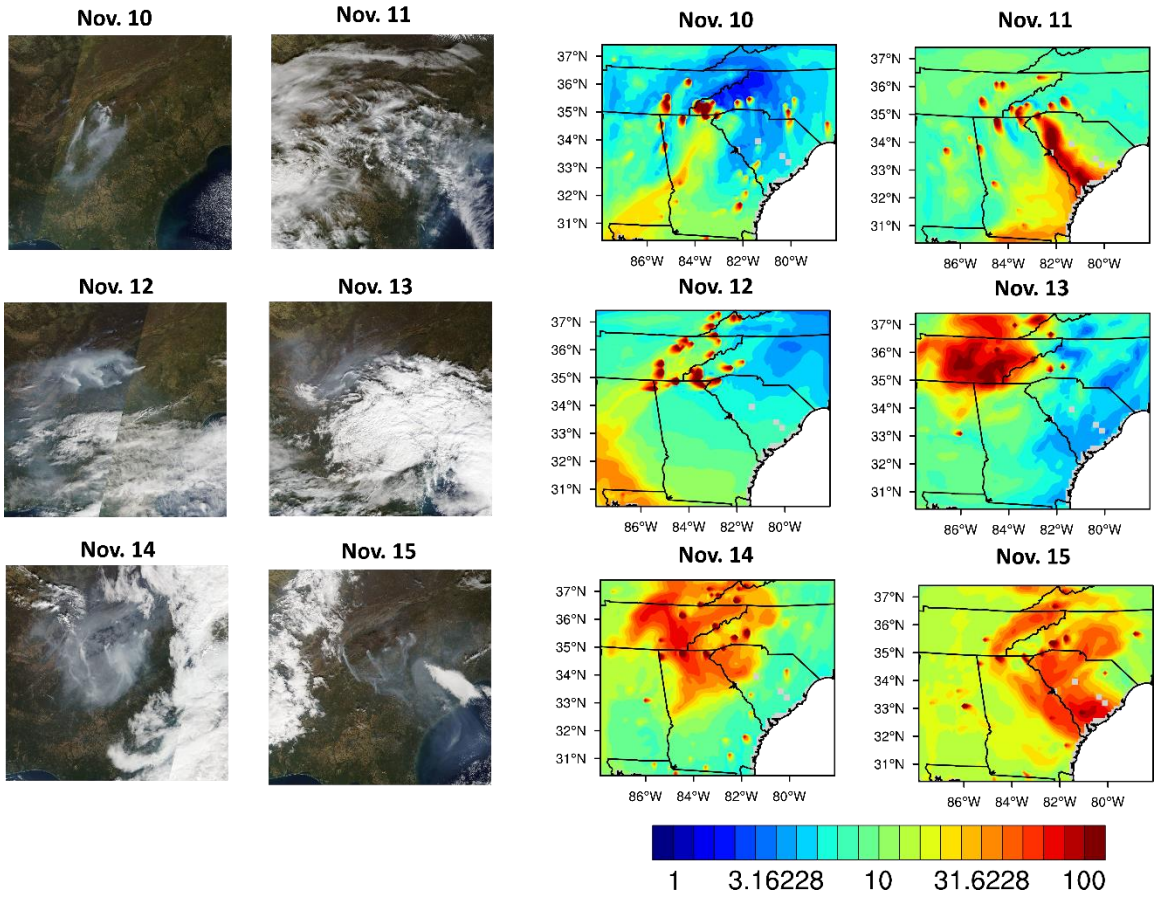

Figure S6. The MODIS Terra satellite image during November 10-15, 2016 over the APP16 fire compared with the corresponding surface $PM_{2.5}$ concentrations ($\mu g\ m^{-3}$) simulated in the sim_FINN+duff run at the hour of the satellite passing.

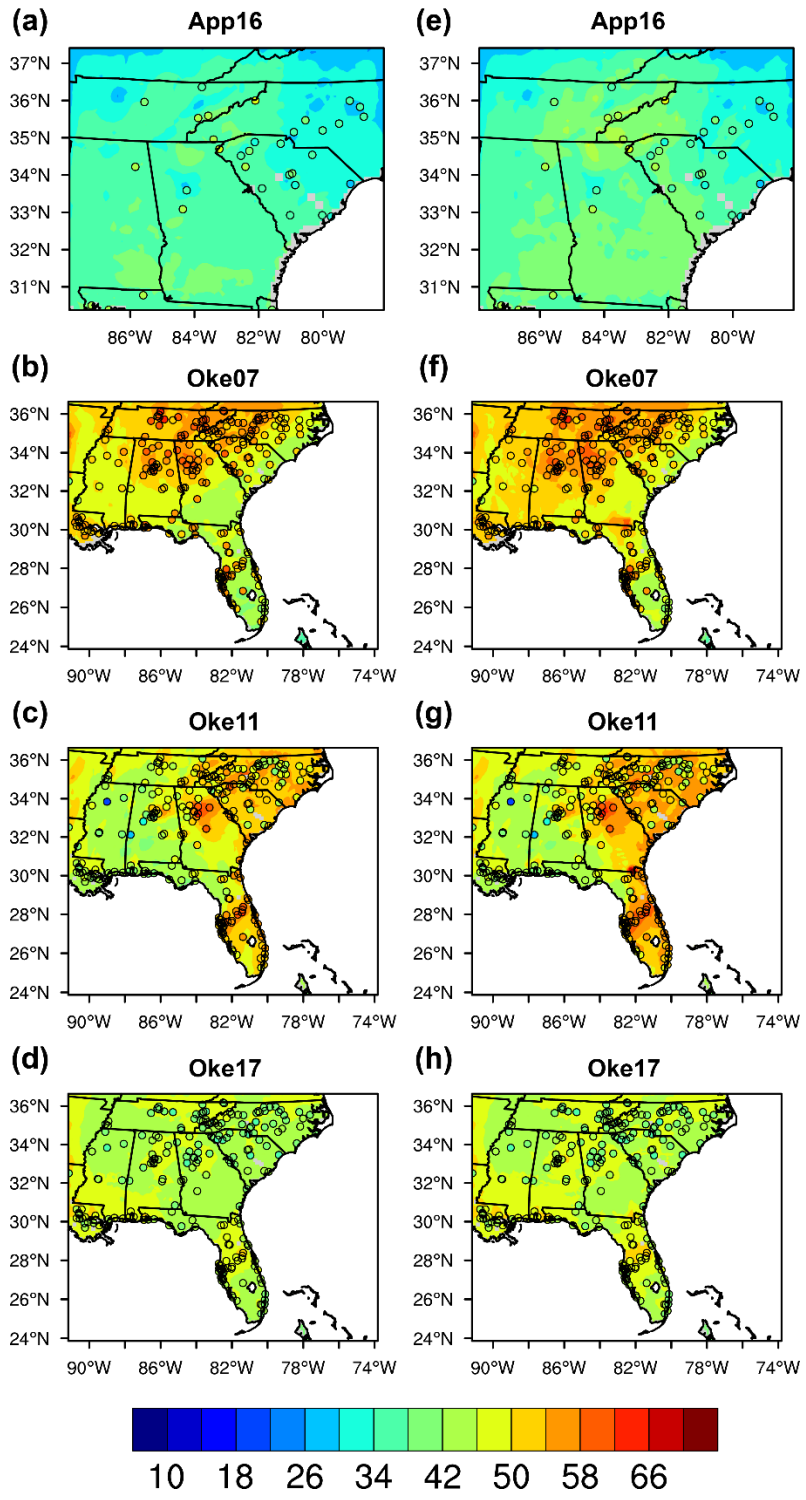

Figure S7. Mean day time (local time 10 am to 6 pm) ozone surface concentration (ppb). (a) App16 (November 7-19, 2016), (b) Oke07 (May 6-30, 2007), (c) Oke11 (May 6-15, 2011), and (d) Oke17 (April 19 to May 13, 2017) for sim_nofire. (e-h) are the corresponding fire cases for sim_FINN. The color scatters represent the observed mean day time surface ozone concentrations.

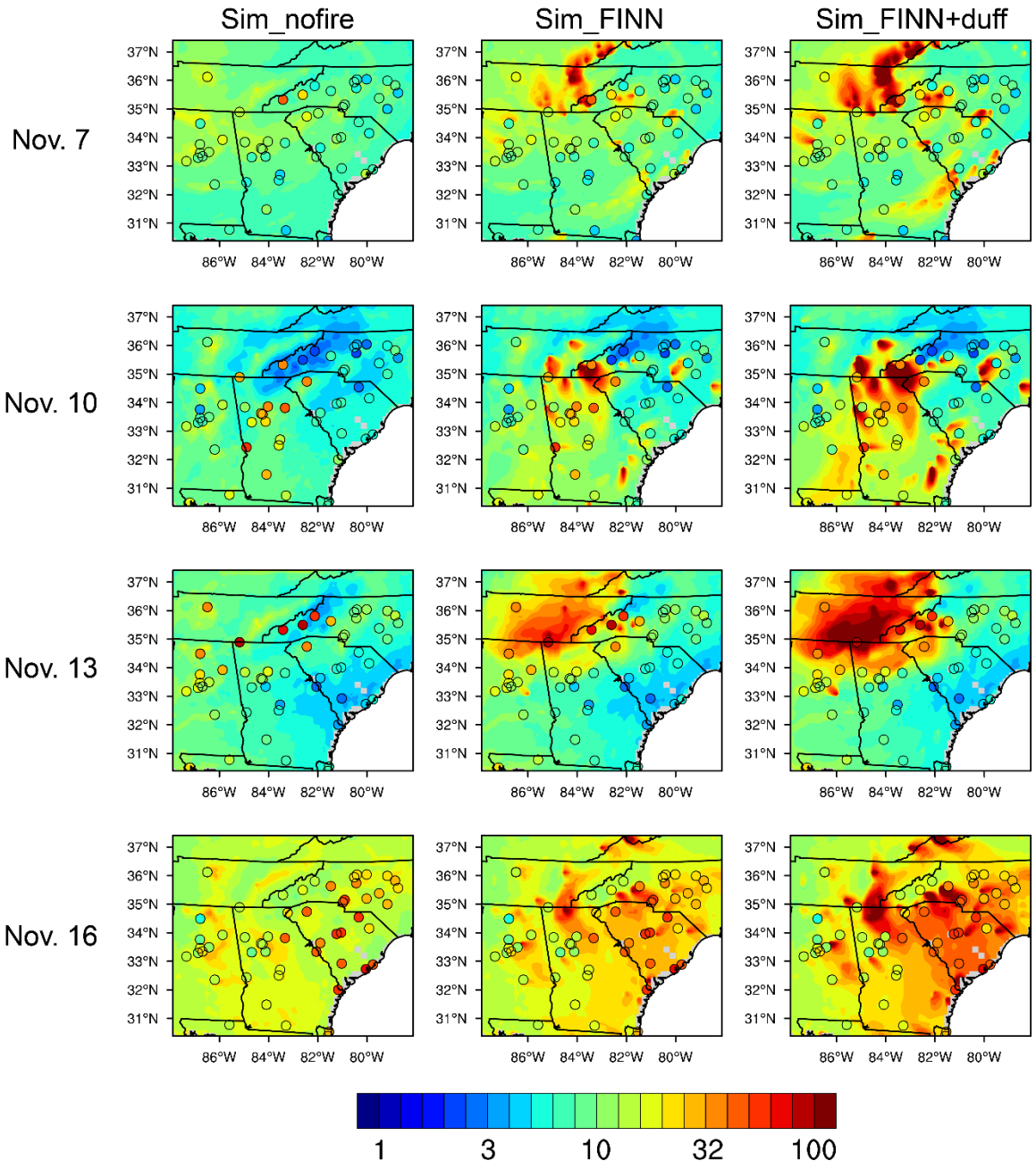

Figure S8. $PM_{2.5}$ daily mean surface concentration (μg m^{-3}) during App16 simulated in sim_nofire, sim_FINN and sim_FINN+duff runs. The colored scatters represent the corresponding observed $PM_{2.5}$ daily mean surface concentrations during the fire event.

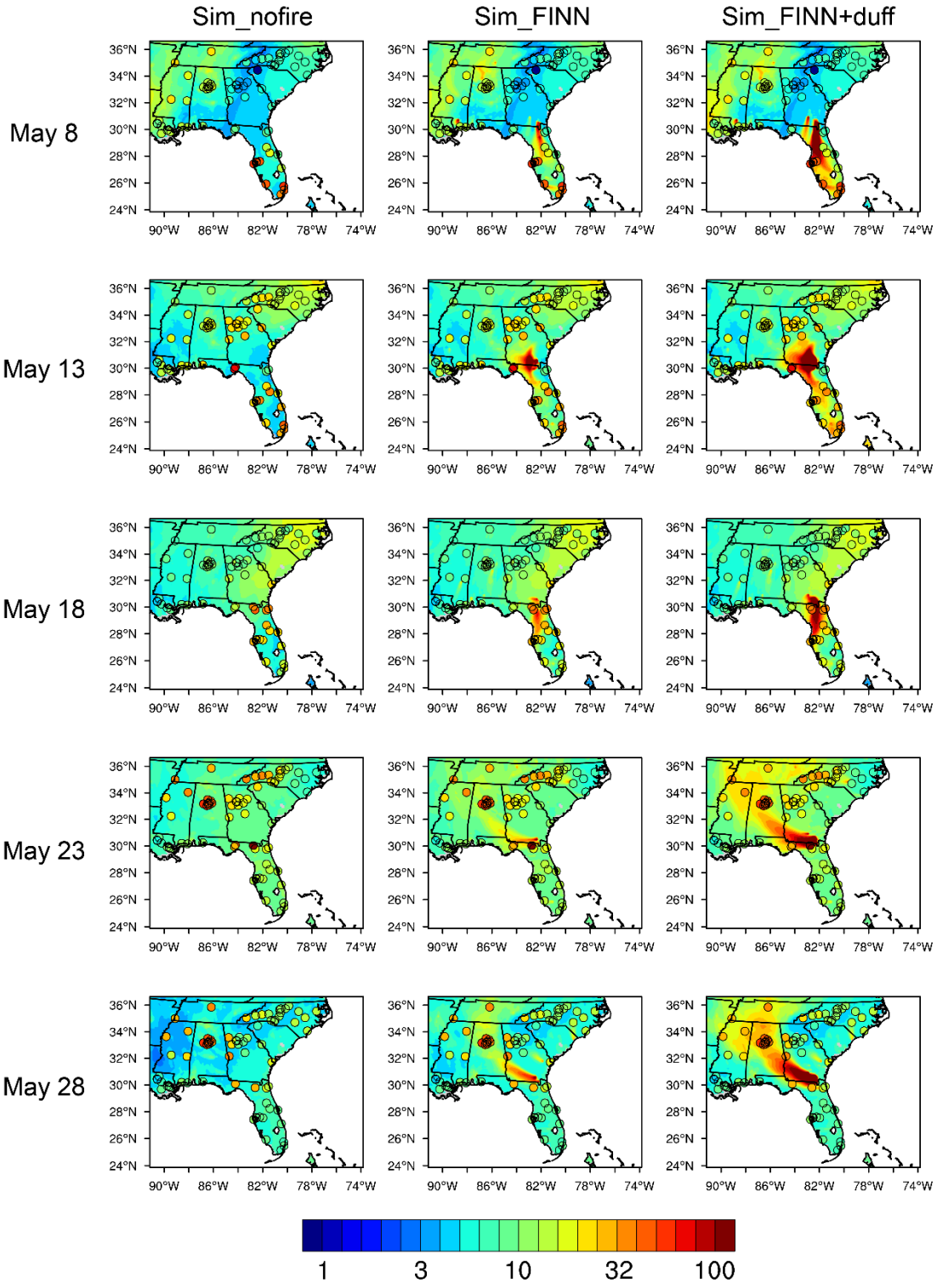

Figure S9. $PM_{2.5}$ daily mean surface concentration (μg m^{-3}) during Oke07 simulated in sim_nofire, sim_FINN and sim_FINN+duff runs. The colored scatters represent the corresponding observed $PM_{2.5}$ daily mean surface concentrations during the fire event.

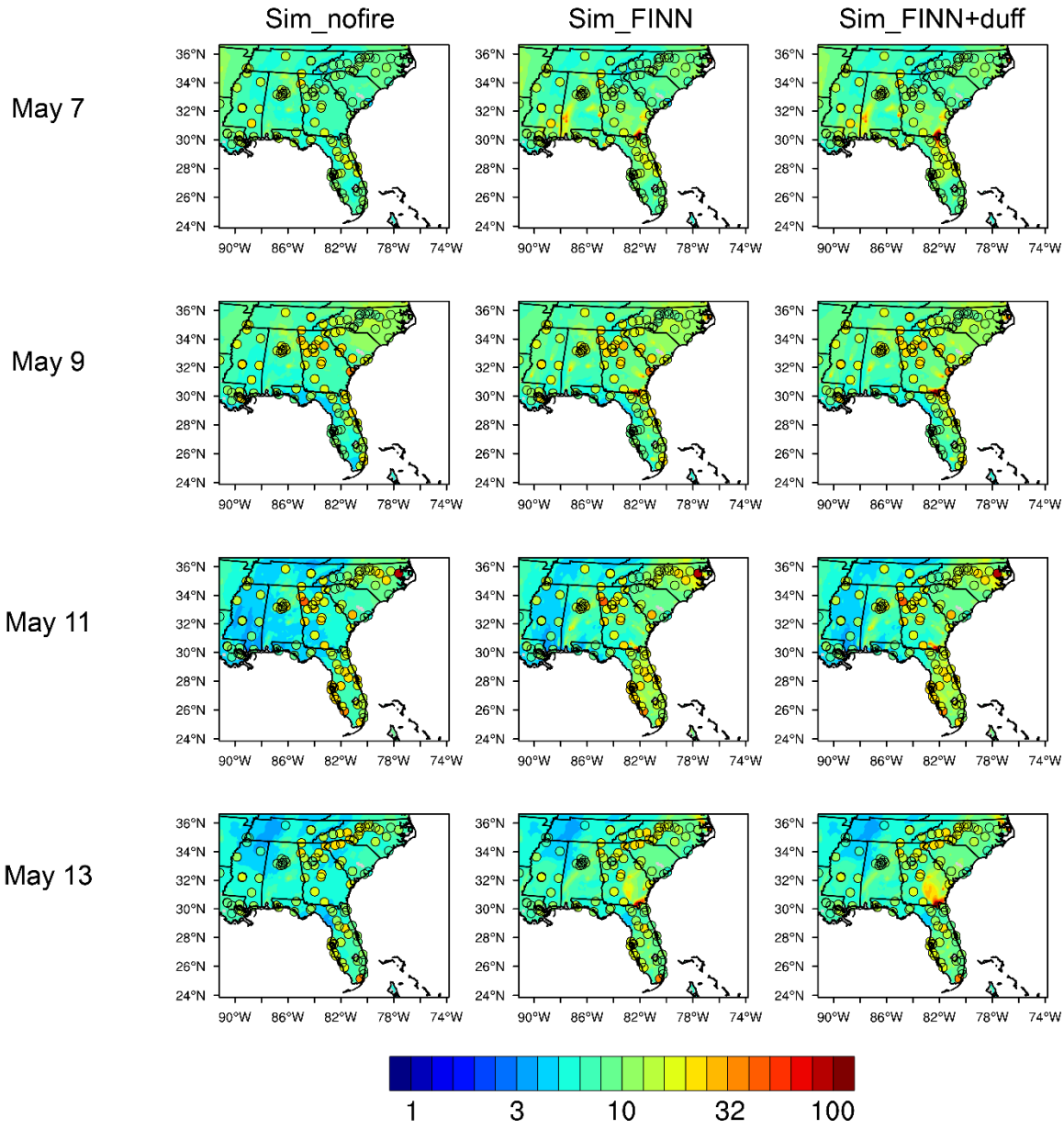

Figure S10. $PM_{2.5}$ daily mean surface concentration (μg m^{-3}) during Oke11 simulated in sim_nofire, sim_FINN and sim_FINN+duff runs. The colored scatters represent the corresponding observed $PM_{2.5}$ daily mean surface concentrations during the fire event.

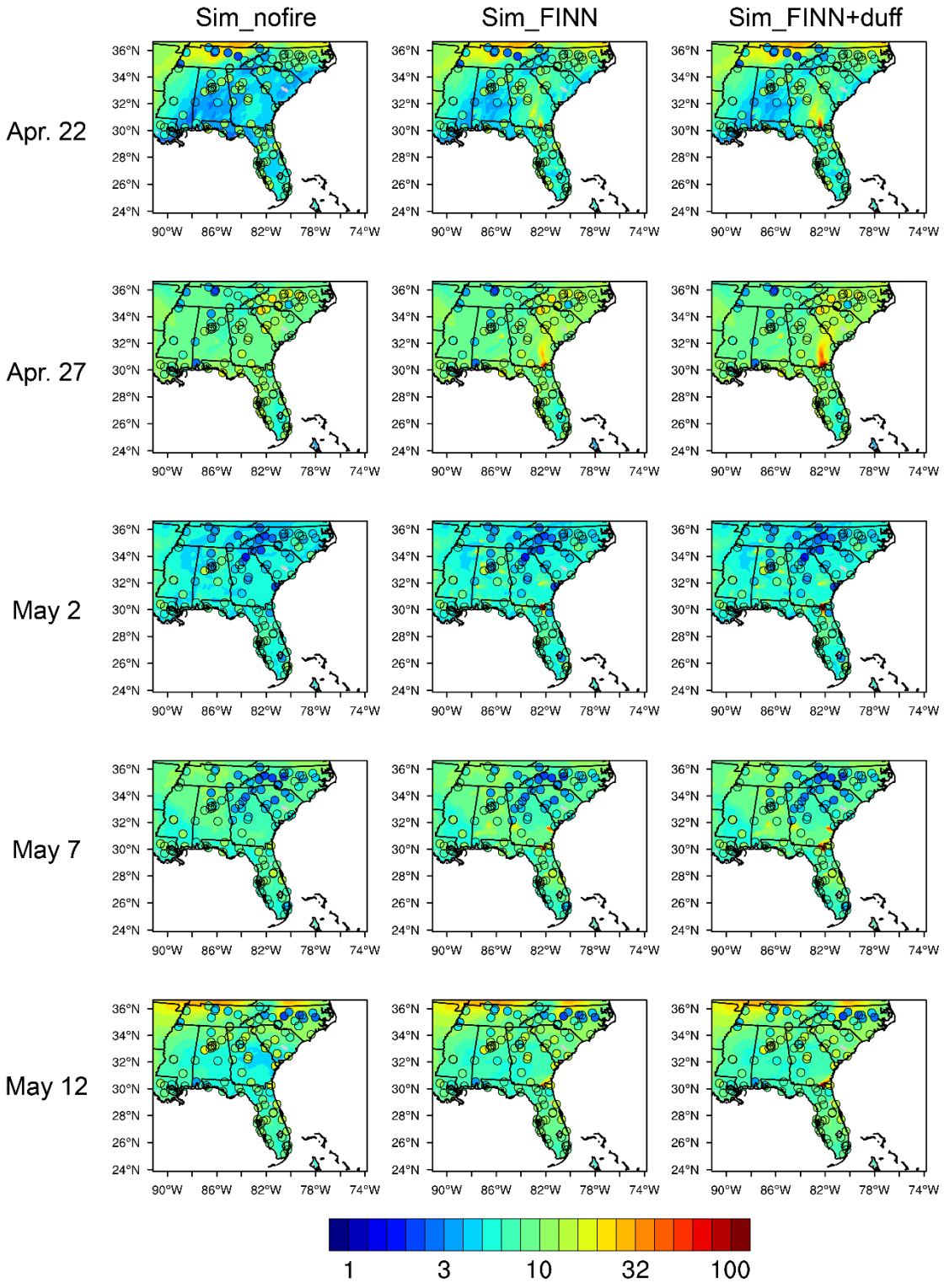

Figure S11. $PM_{2.5}$ daily mean surface concentration (μg m^{-3}) during Oke17 simulated in sim_nofire, sim_FINN and sim_FINN+duff runs. The colored scatters represent the corresponding observed $PM_{2.5}$ daily mean surface concentrations during the fire event.

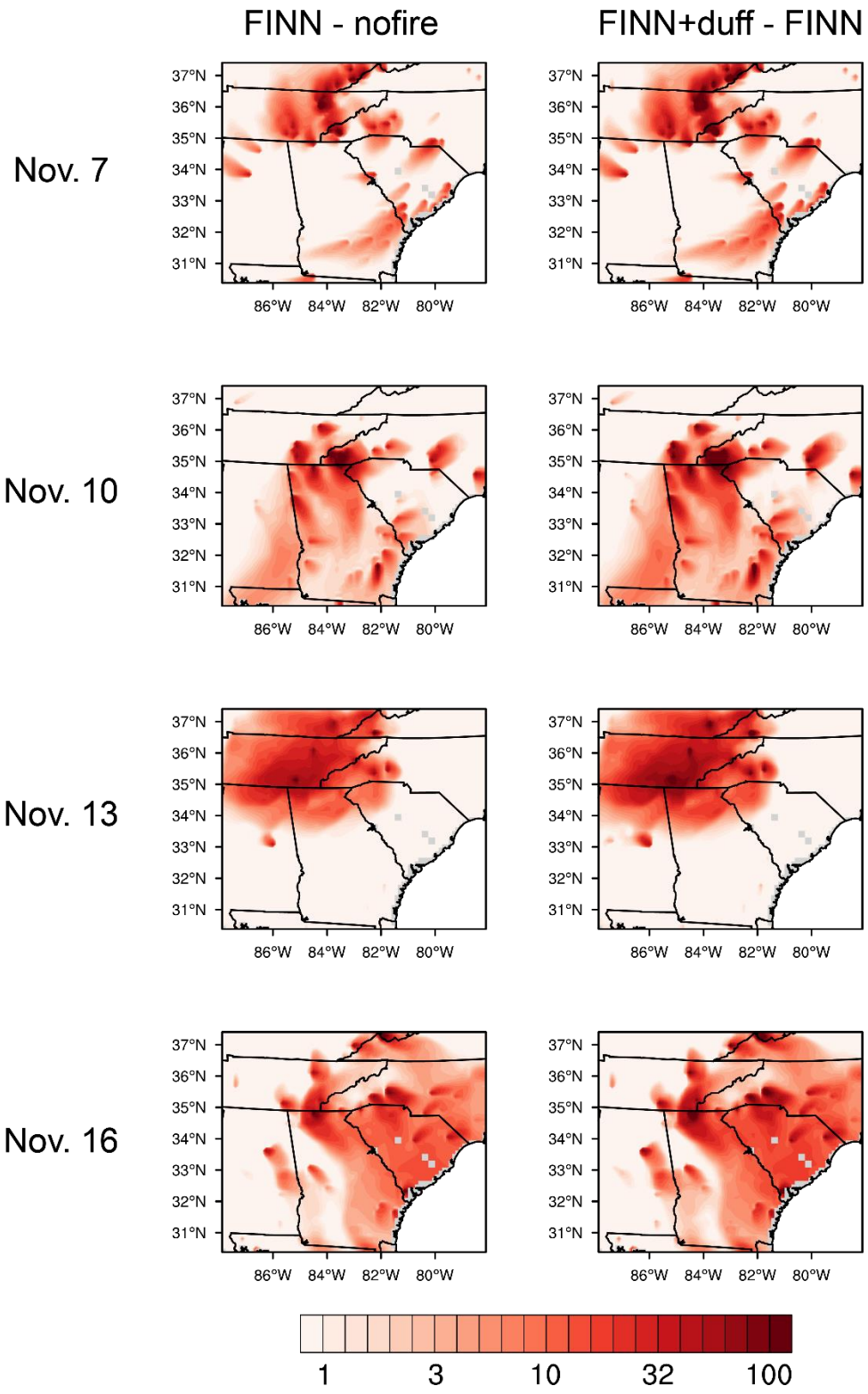

Figure S12. The $PM_{2.5}$ daily surface concentration differences (μg m^{-3}) between sim_FINN and sim_nofire and between sim_FINN+duff and sim_FINN during App16.

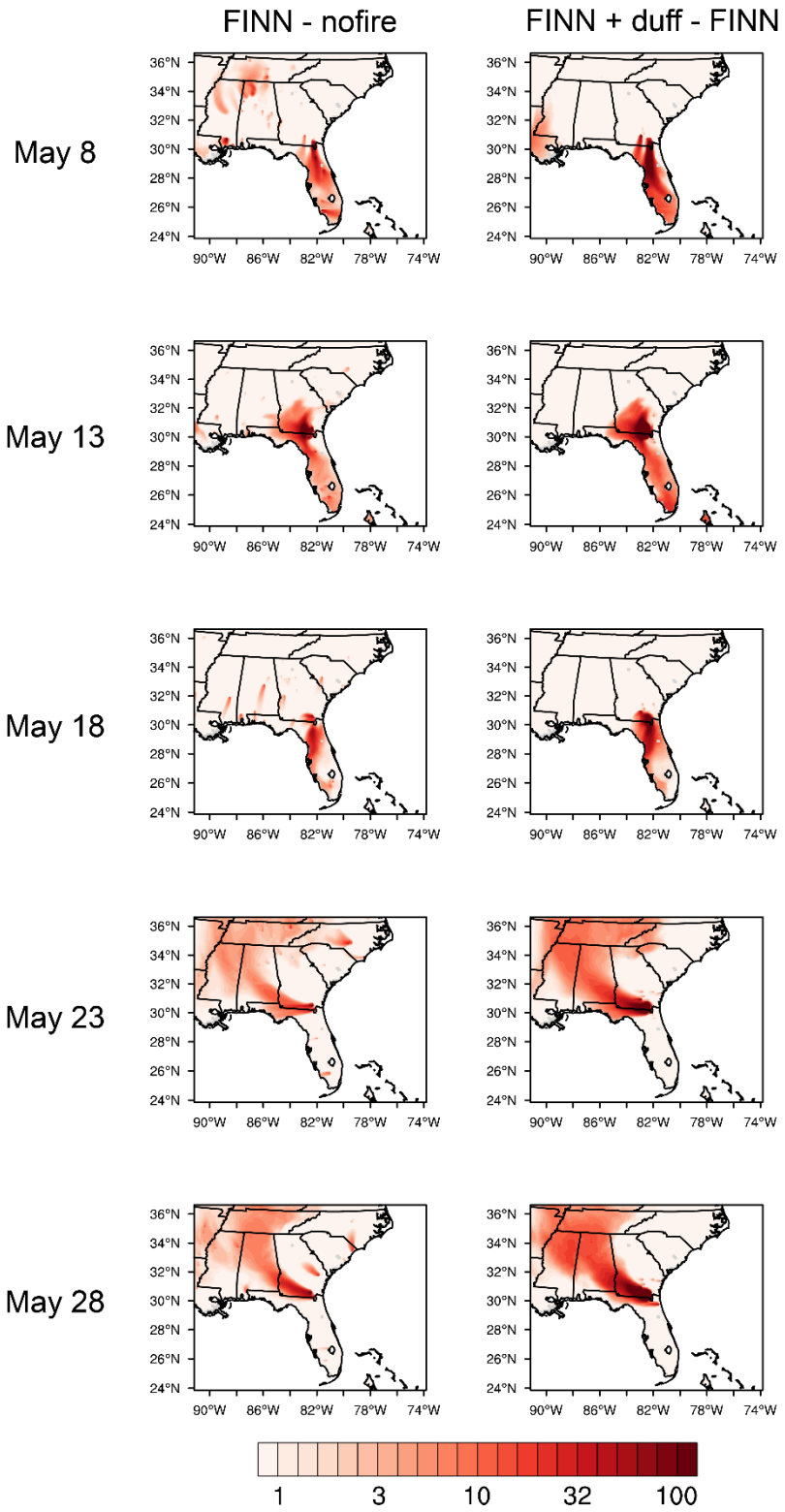

Figure S13. The $PM_{2.5}$ daily surface concentration differences (μg m^{-3}) between sim_FINN and sim_nofire and between sim_FINN+duff and sim_FINN during Oke07.

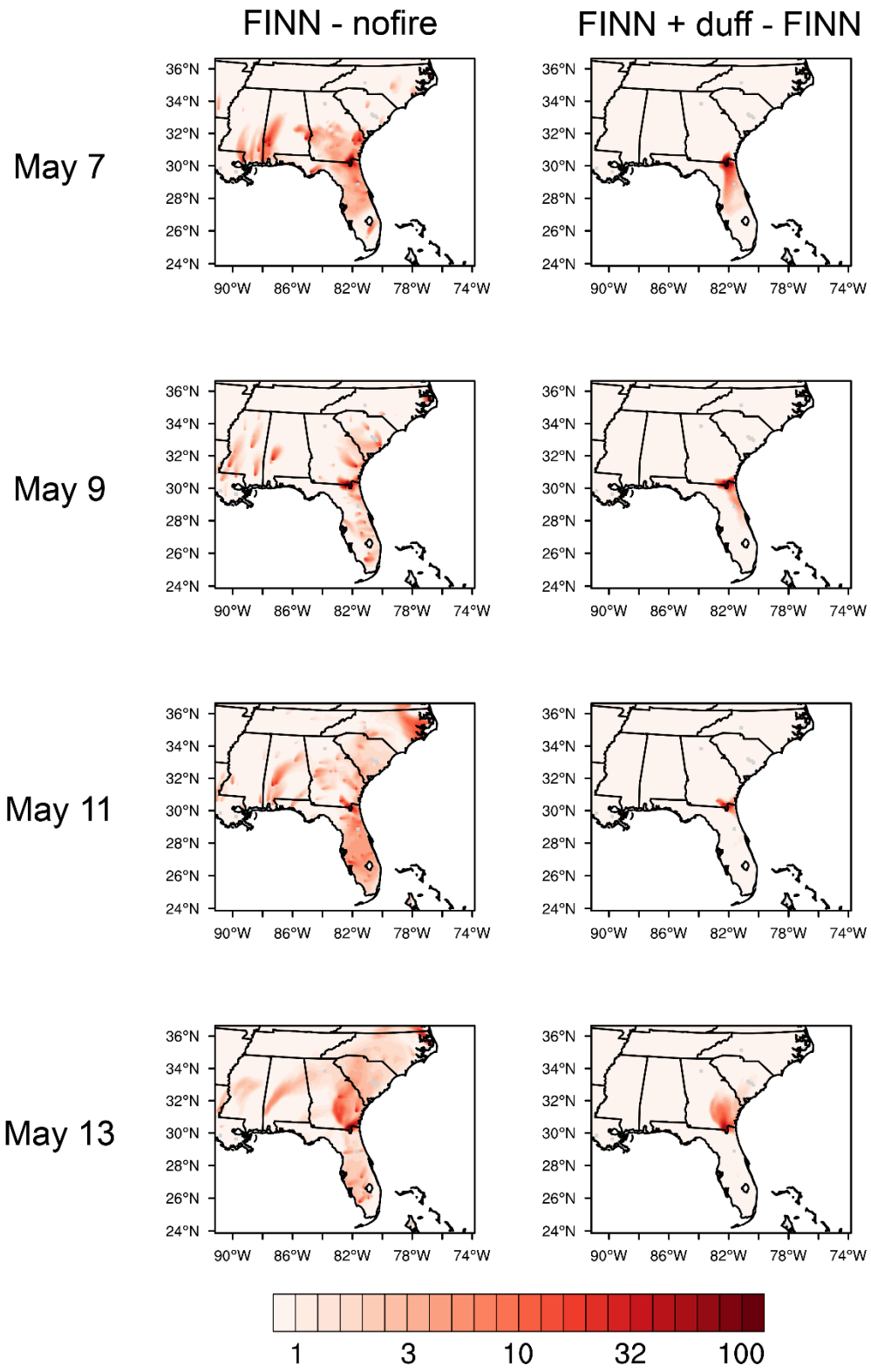

Figure S14. The $PM_{2.5}$ daily surface concentration differences (μg m^{-3}) between sim_FINN and sim_nofire and between sim_FINN+duff and sim_FINN during Oke11.

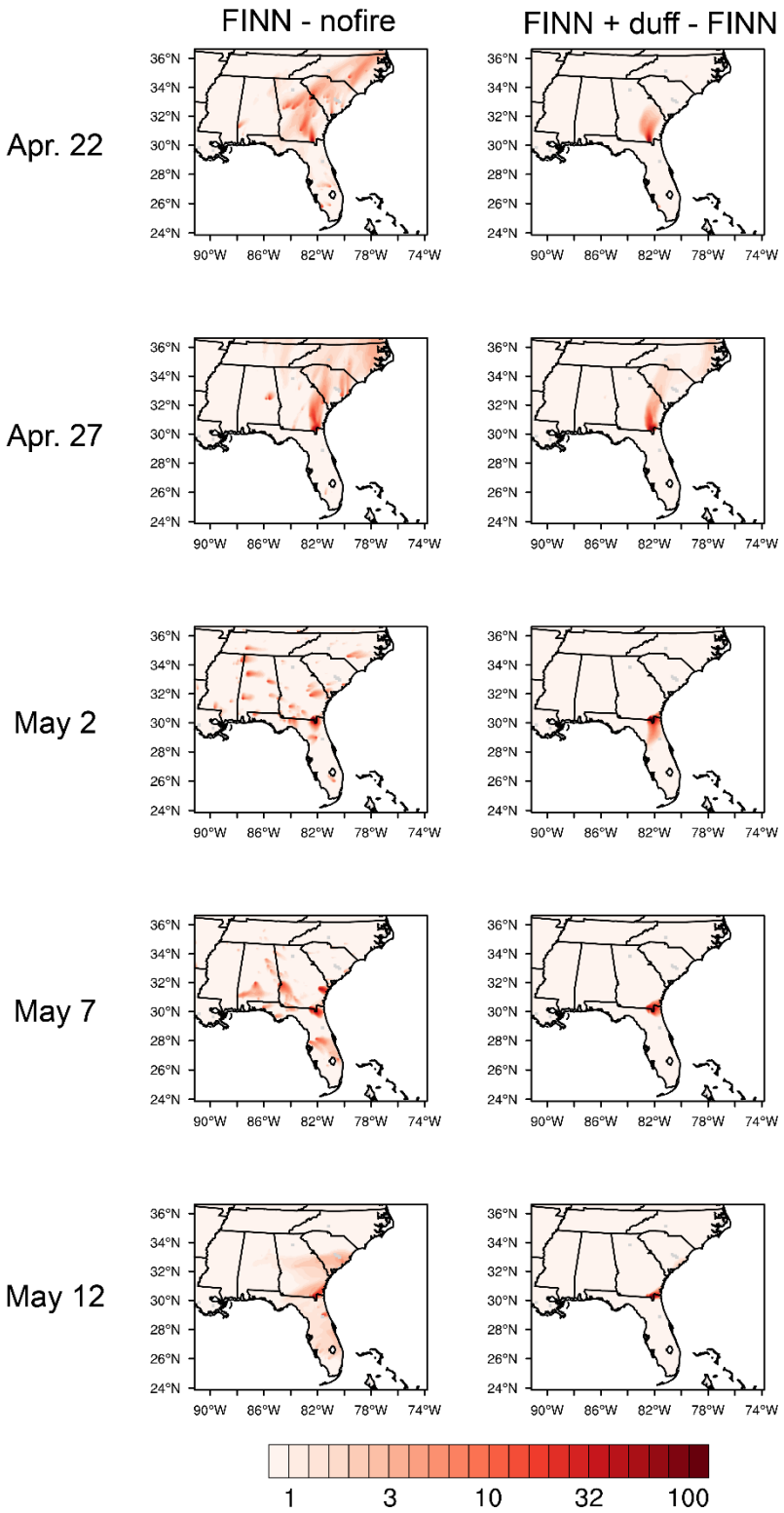

Figure S15. The $PM_{2.5}$ daily surface concentration differences (μg m^{-3}) between sim_FINN and sim_nofire and between sim_FINN+duff and sim_FINN during Oke17.

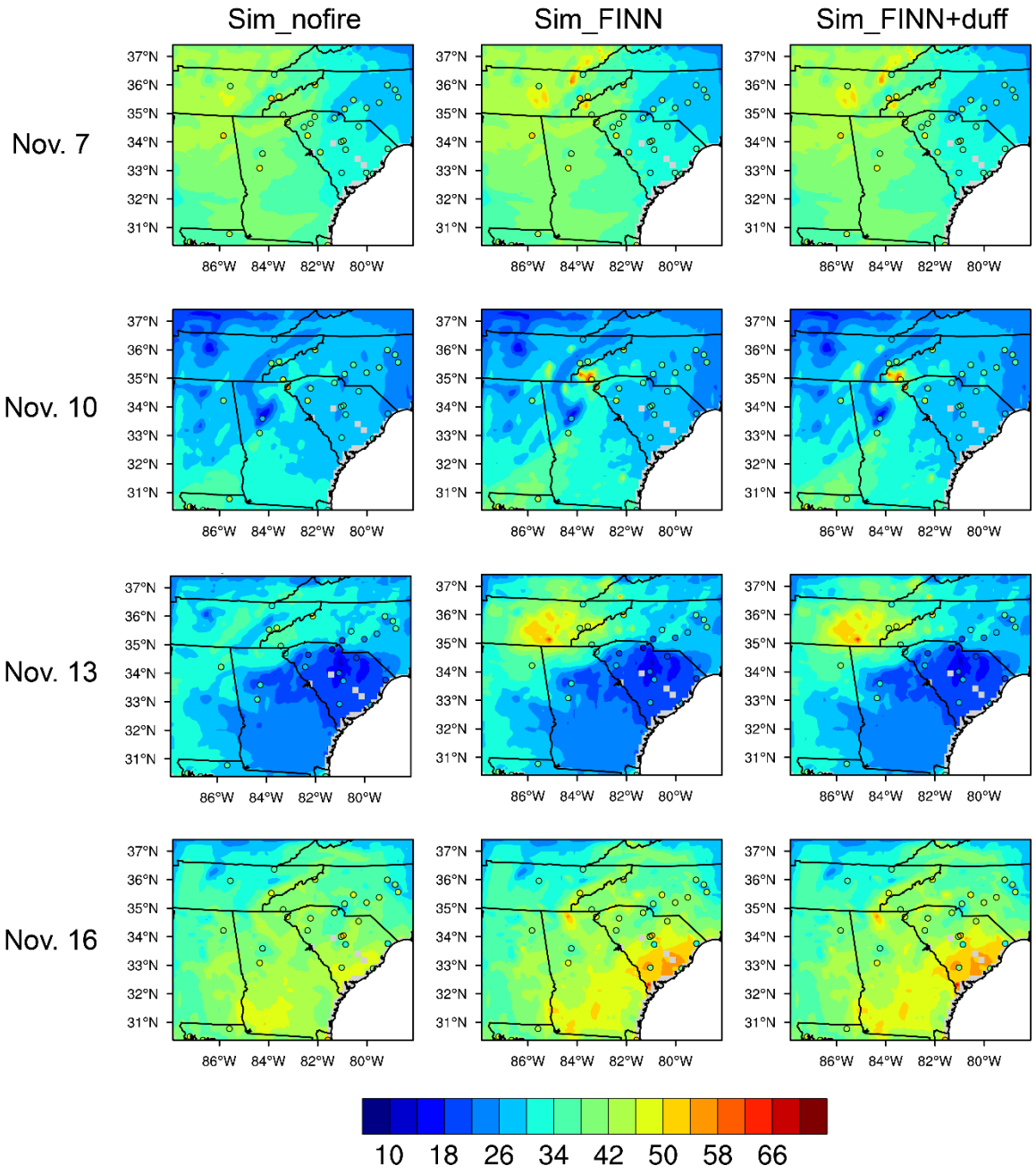

Figure S16. The ozone daytime surface concentration (averaged from local time 10 am to 6 pm; ppb.) during App16 simulated in sim_nofire, sim_FINN and sim_FINN+duff runs. The colored scatters represent the corresponding observed Ozone daytime surface concentrations during the fire event.

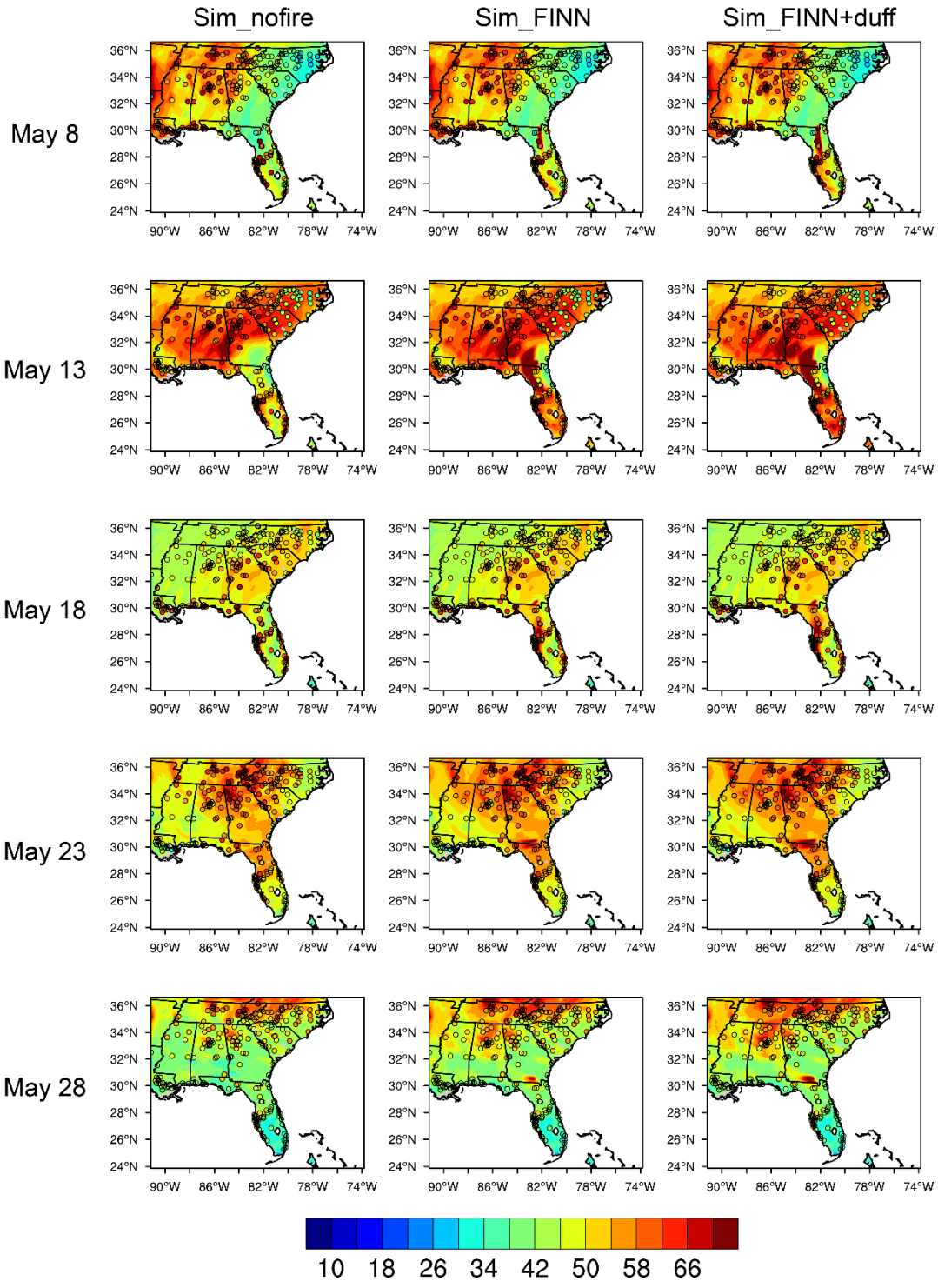

Figure S17. The ozone daytime surface concentration (averaged from local time 10 am to 6 pm; ppb.) during Oke07 simulated in sim_nofire, sim_FINN and sim_FINN+duff runs. The colored scatters represent the corresponding observed Ozone daytime surface concentrations during the fire event.

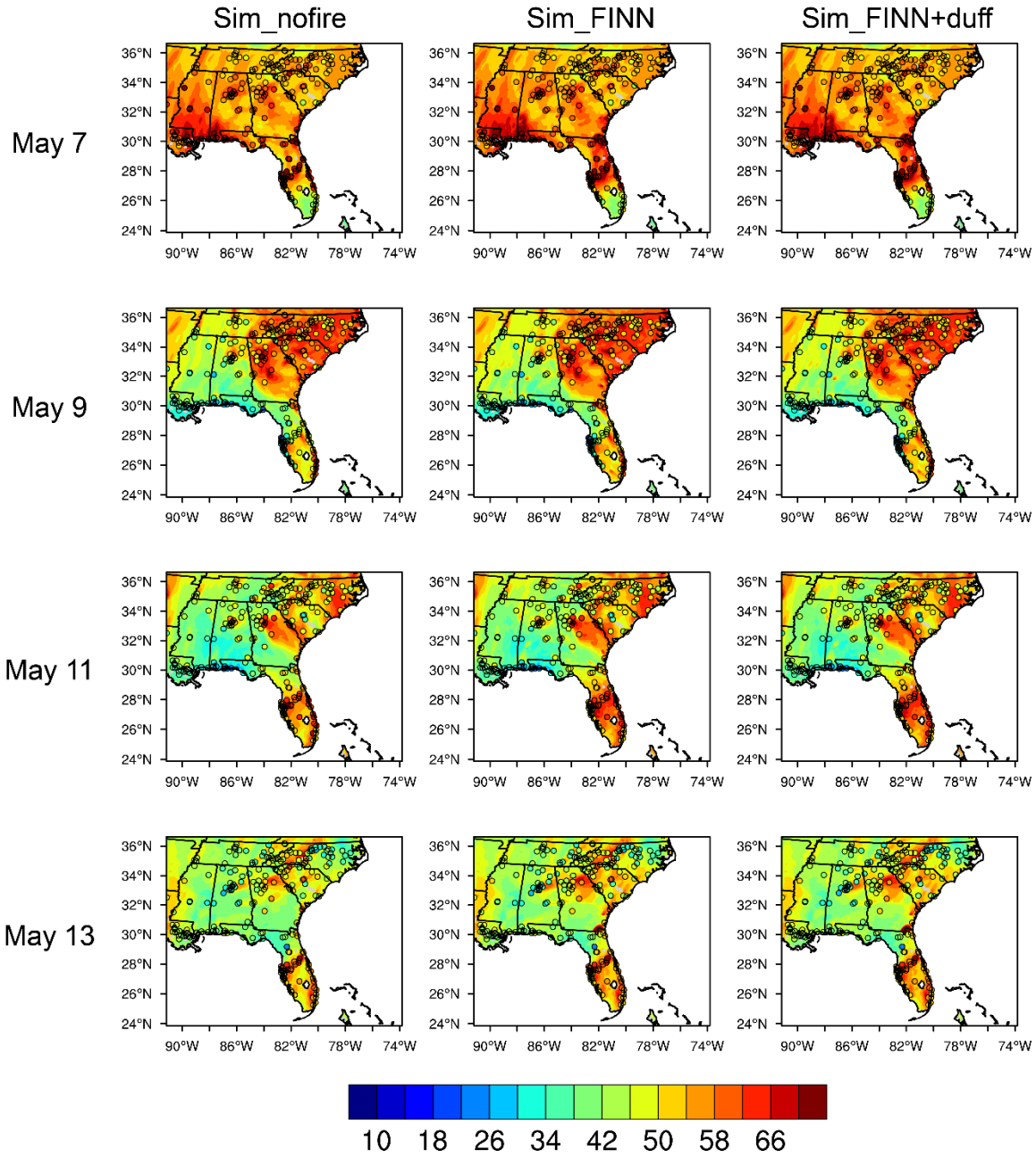

Figure S18. The ozone daytime surface concentration (averaged from local time 10 am to 6 pm; ppb.) during Oke11 simulated in sim_nofire, sim_FINN and sim_FINN+duff runs. The colored scatters represent the corresponding observed Ozone daytime surface concentrations during the fire event.

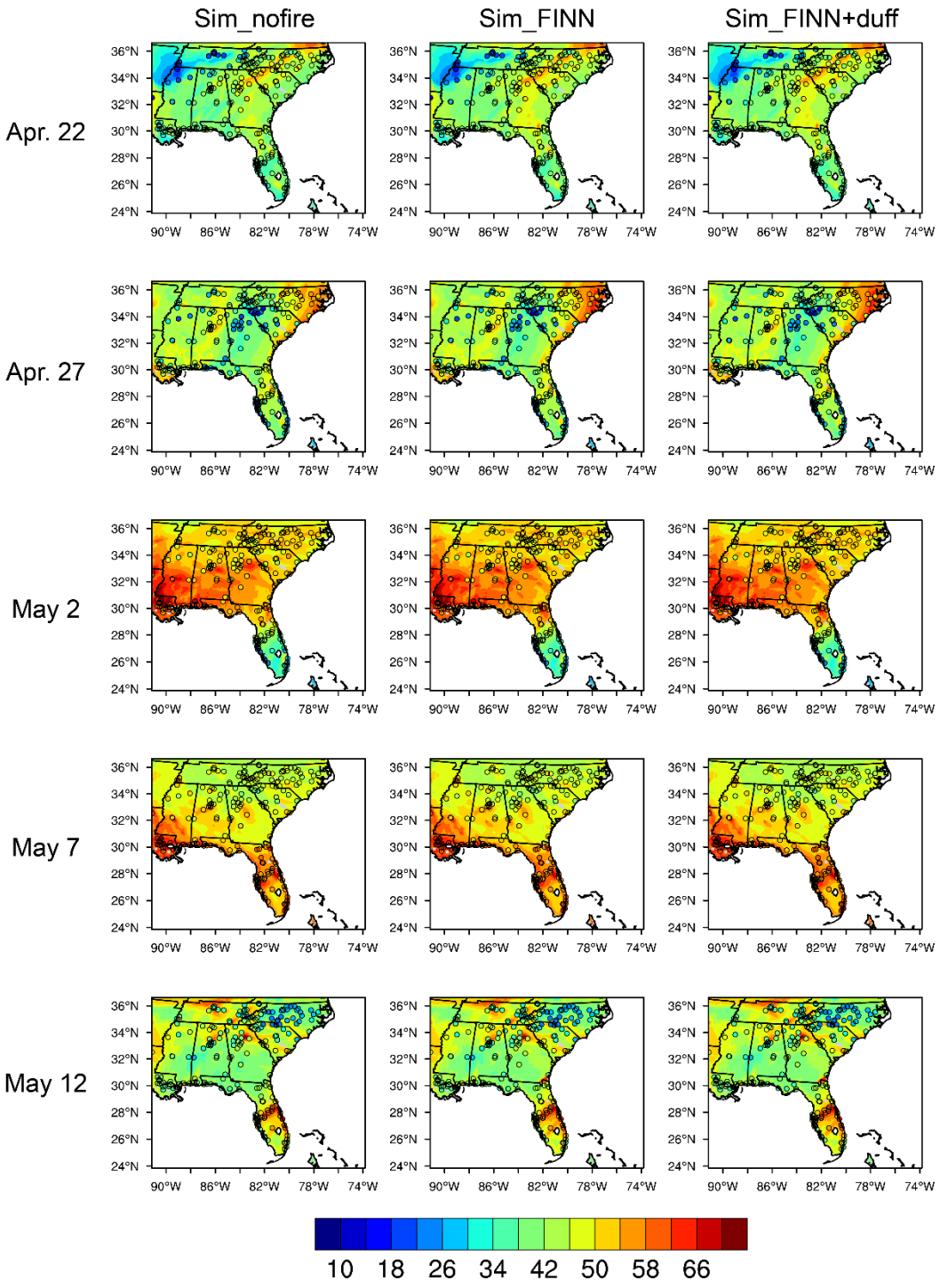

Figure S18. The ozone daytime surface concentration (averaged from local time 10 am to 6 pm; ppb.) during Oke17 simulated in sim_nofire, sim_FINN and sim_FINN+duff runs. The colored scatters represent the corresponding observed Ozone daytime surface concentrations during the fire event.

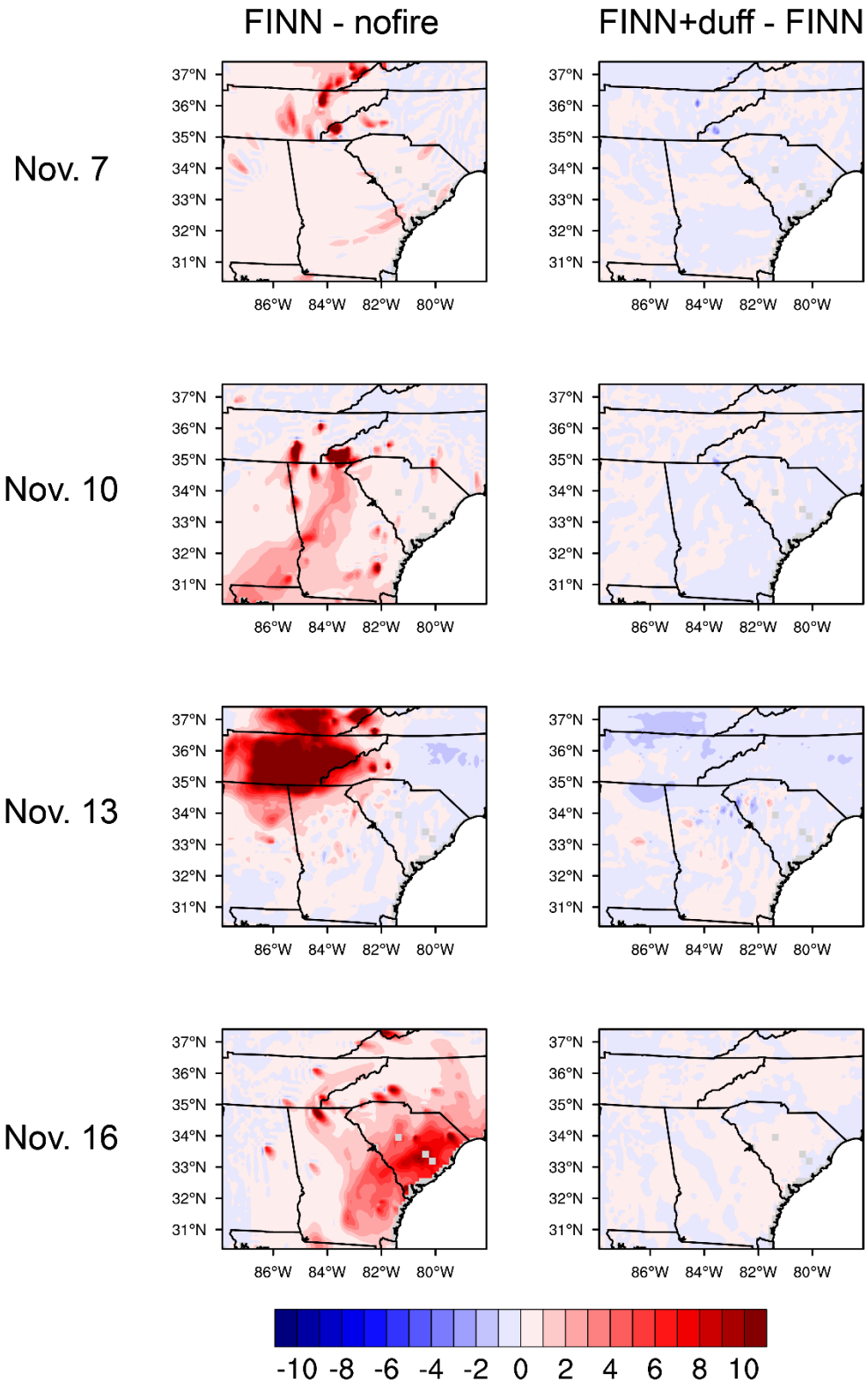

Figure S20. The ozone daytime surface concentration differences (ppb) between sim_FINN and sim_nofire and between sim_FINN+duff and sim_FINN during App16.

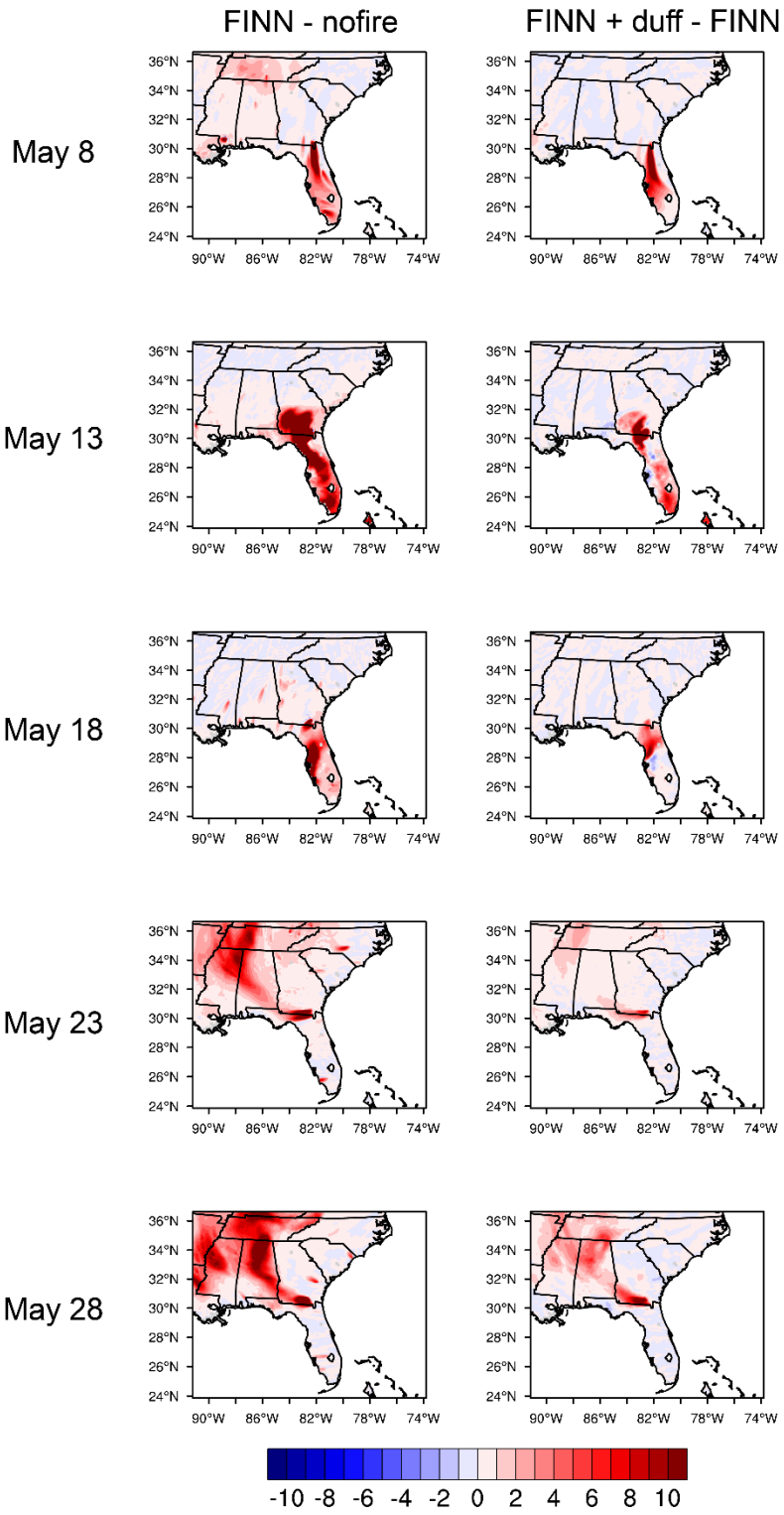

Figure S21. The ozone daytime surface concentration differences (ppb) between sim_FINN and sim_nofire and between sim_FINN+duff and sim_FINN during Oke07.

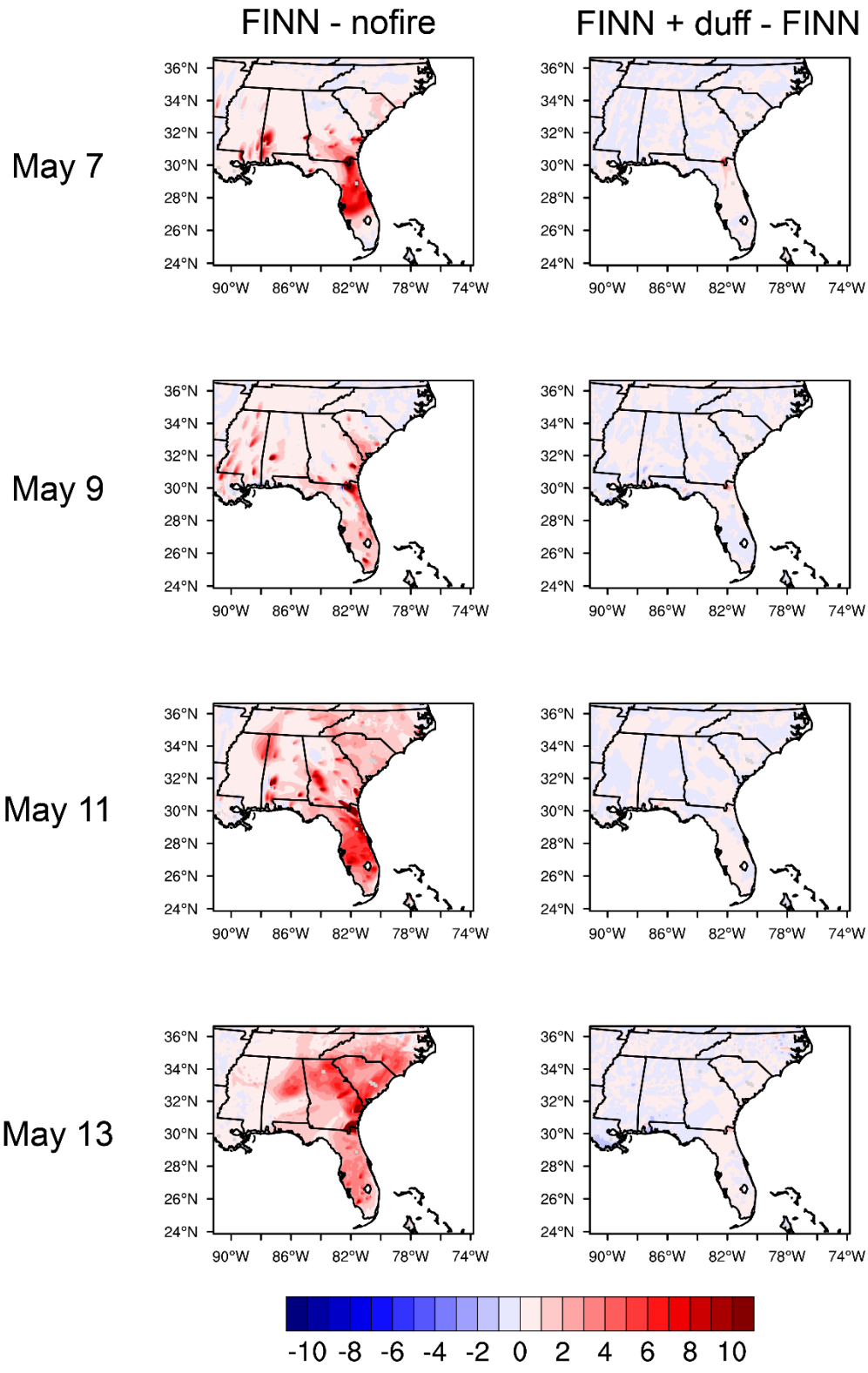

Figure S22. The ozone daytime surface concentration differences (ppb) between sim_FINN and sim_nofire and between sim_FINN+duff and sim_FINN during Oke11.

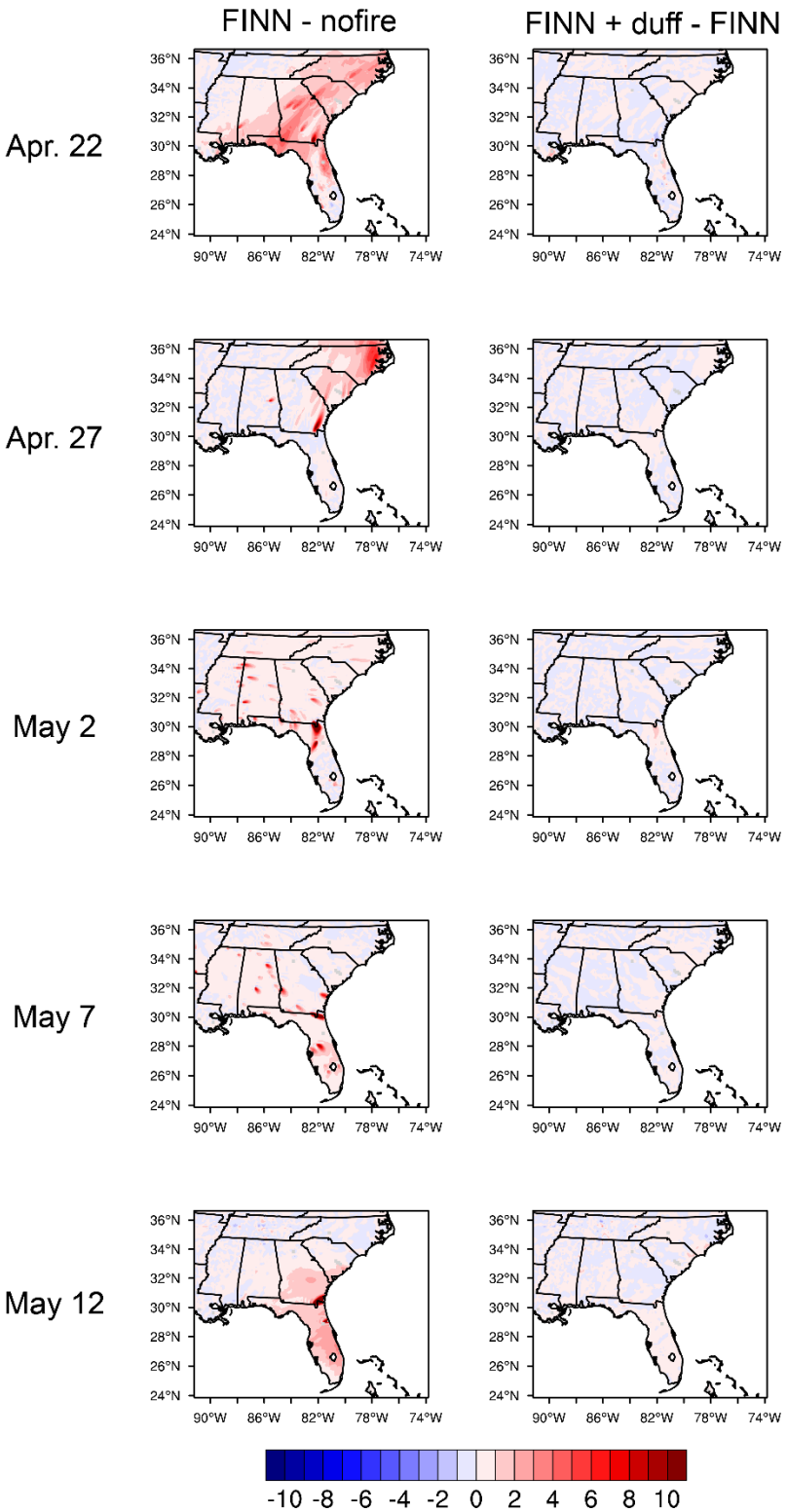

Figure S23. The ozone daytime surface concentration differences (ppb) between sim_FINN and sim_nofire and between sim_FINN+duff and sim_FINN during Oke17

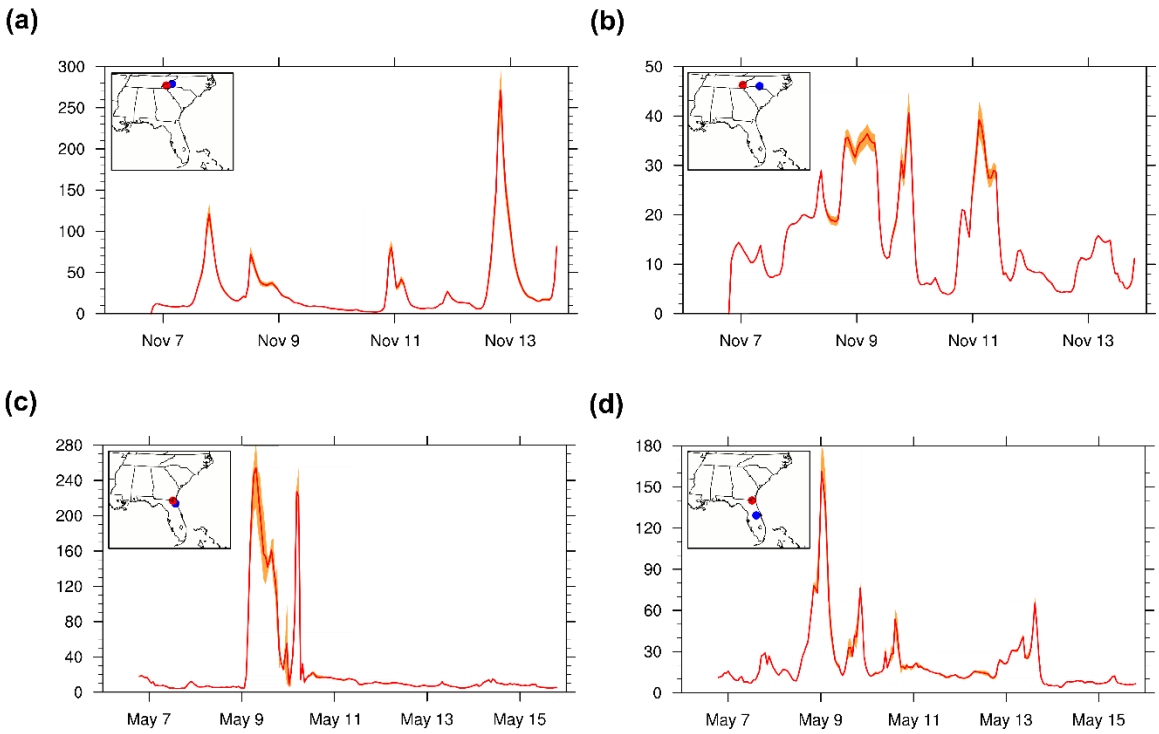

Figure S24. Comparisons of in-situ hourly surface $PM_{2.5}$ (μg m^{-3}) concentrations among the observation (black) and sim_FINN+duff (red) simulations. (a, b) App16. (c, d) Oke07. The shaded red represents the $PM_{2.5}$ variation from the sensitivity runs changing the duff emission by ± 20%. The fire location (red) and site location (blue) are shown in the map attached to each panel. The studied sites are located in (a) Buncombe county, North Carolina, (b) Fulton county, Georgia, (c) Duval county, Florida and (d) Orange county, Florida.

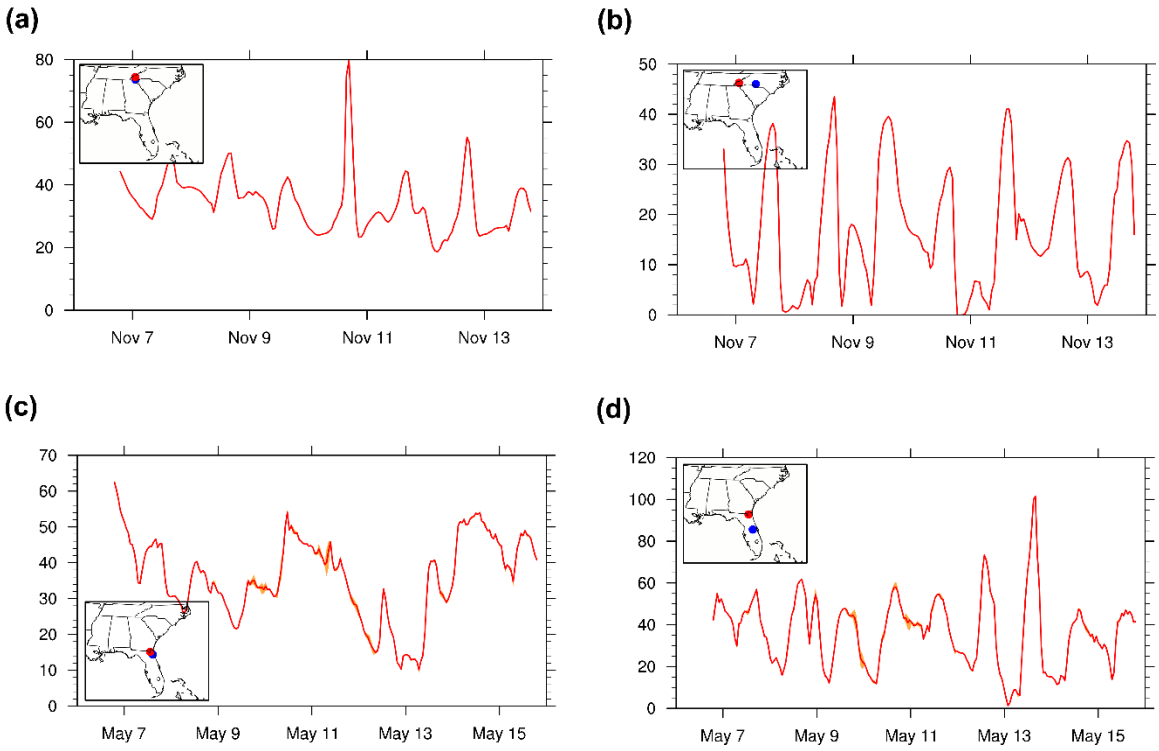

Figure S25. Comparisons of in-situ hourly surface ozone (ppb) concentrations among the observation (black) and sim_FINN+duff (red) simulations. (a, b) App16. (c, d) Oke07. The shaded red represents the $PM_{2.5}$ variation from the sensitivity runs changing the duff emission by ± 20%. The fire location (red) and site location (blue) are shown in the map attached to each panel. The studied sites are located in (a) Macon county, North Carolina, (b) Fulton county, Georgia, (c) Duval county, Florida and (d) Orange county, Florida.

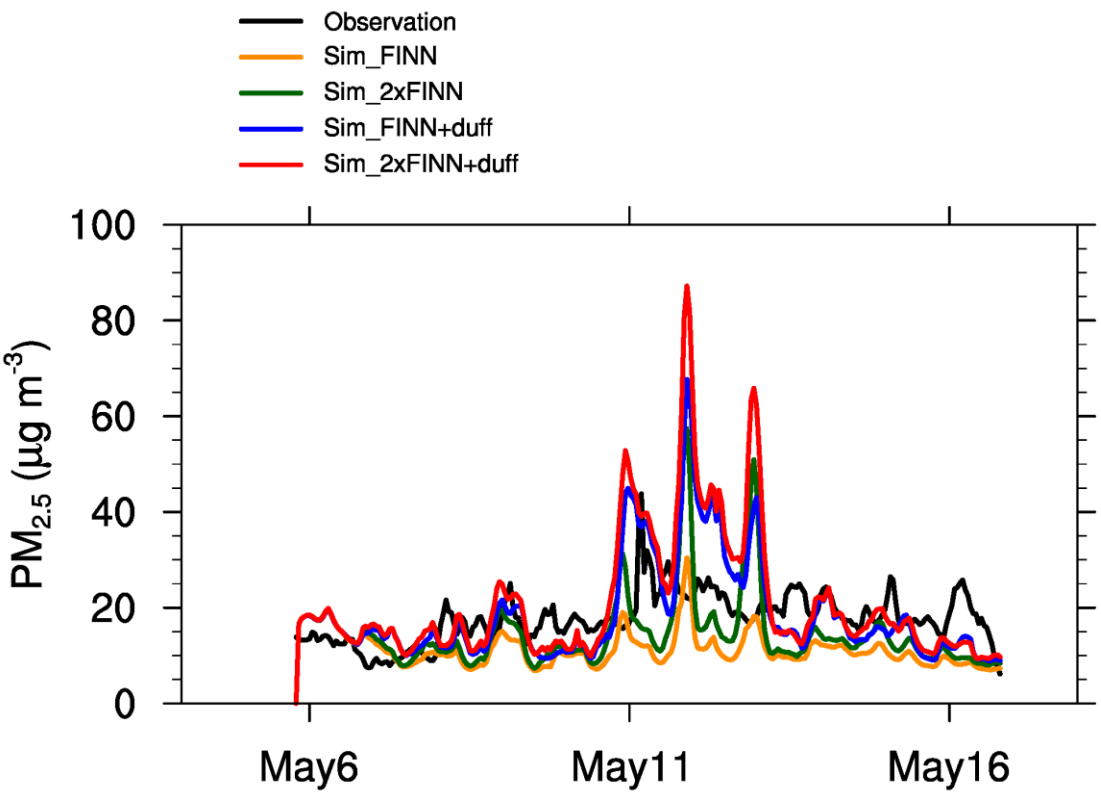

Figure S26. The time series of hourly surface $PM_{2.5}$ concentrations from May 6 – 16, 2017 in the observations, sim_FINN, sim_FINN+duff, and corresponding simulations with FINN emission doubled (sim_2xFINN and sim_2xFINN+duff) in the simulated region.

Table S1. Summary of previous studies of the PM emission factors of duff/peat/organic soil burnings.

Source	Region	Fuel type	Emission Factor (g/kg)	Note
Geron and Hays (2013)	Southeastern US	Peat/Organic soil	34 - 79	34-79 g/kg for ground fire; 9-16 g/kg for prescribed fire
Black et al. (2016)	Southeastern US	Peat	7.1 and 5.9	
Benner (1977)	Southeastern US	Peat/Organic soil	44 ± 9	Total suspended particulate (TSP) is measured.
McMahon et al. (1980)	Southeastern US	Peat	30 ± 20	
Urbanski (2014)	US	Duff/Organic soil	50 ± 16	Average of ground fire values by Geron and Hays (2013)
Yokelson et al. (2013)	US	Organic soil	20	prescribed burning
Kiely et al. (2020)	Equatorial Asia	Peat	22.3	Summarized from previous studies, used in model simulations
Roulston et al. (2018)	Southeast Asia	Peat	8 - 58	Average 24 g/kg; newly ignited fire has higher emission factor.
Jayarathne et al. (2018)	Indonesia	Peat	17	
Stockwell et al. (2016)	Indonesia	Peat	15.7-29.6	
May et al. (2014)	Indonesia	Peat	34.9	PM1 emission factor from lab burns
Bertschi et al. (2003)	Africa	Duff	6 - 16	
Andreae (2019)	Global	Peat	18.9 ± 2.3	Summarized from previous studies
Akagi et al. (2011)	Global	Peat	9.92	Summarized from previous studies
Giglio et al. (2013)	Global	Peat	9.1	Used in GFED4

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