



Supplement of

Introducing the VIIRS-based Fire Emission Inventory version 0 (VFEIv0)

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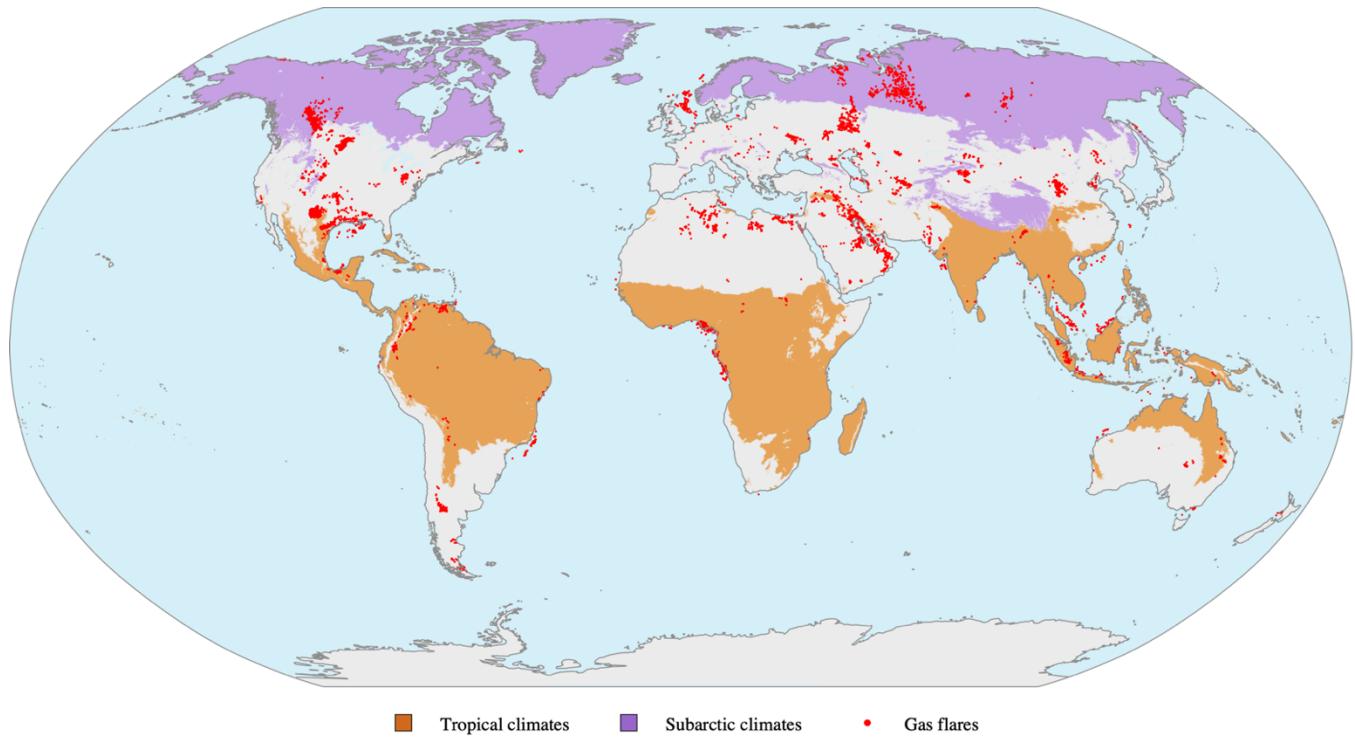
15 **Table S1.** Total carbon emissions (tC: tonnes of carbon) as derived by the Fuel2Fire and VFEI inventories for 14 selected fires sampled during the FIREX-AQ field experiment during the summer 2019 in the Western USA. Fires that have only one date lasted for just one day.

Fire name	Coordinates		Dates		Total emissions tC	
	Latitude	Longitude	Start	End	Fuel2Fire	VFEI
Shady	44.54°N	115.02°W	24-Jul-2019	8-Feb-2019	11100	28078
Sheep	43.57°N	112.80°W		24-Jul-2019	8637	16856
North Hills	46.78°N	111.92°W		29-Jul-2019	4570	5037
Tucker	41.83°N	121.24°W	29-Jul-2019	30-Jul-2019	8003	9433
Left Hand	46.93°N	120.97°W		30-Jul-2019	2256	8108
Lick Creek	47.16°N	115.89°W		2-Aug-2019	3356	19484
Ridge Top	47.48°N	108.27°W		2-Aug-2019	1986	2321
Williams Flats	47.98°N	118.52°W	2-Aug-2019	10-Aug-2019	366036	394943
Horsefly	46.96°N	112.40°W		6-Aug-2019	8614	15342
Castle*	36.51°N	112.28°W	12-Aug-2019	23-Aug-2019	58441	34381
Boulin	35.39°N	112.03°W	15-Aug-2019	16-Aug-2019	3745	7765
Saber	35.02°N	111.91°W		15-Aug-2019	383	431
Sheridan**	34.71°N	112.89°W	15-Aug-2019	21-Aug-2019	23106	29274
Ike***	36.36°N	112.24°W	16-Aug-2019	21-Aug-2019	19878	12920

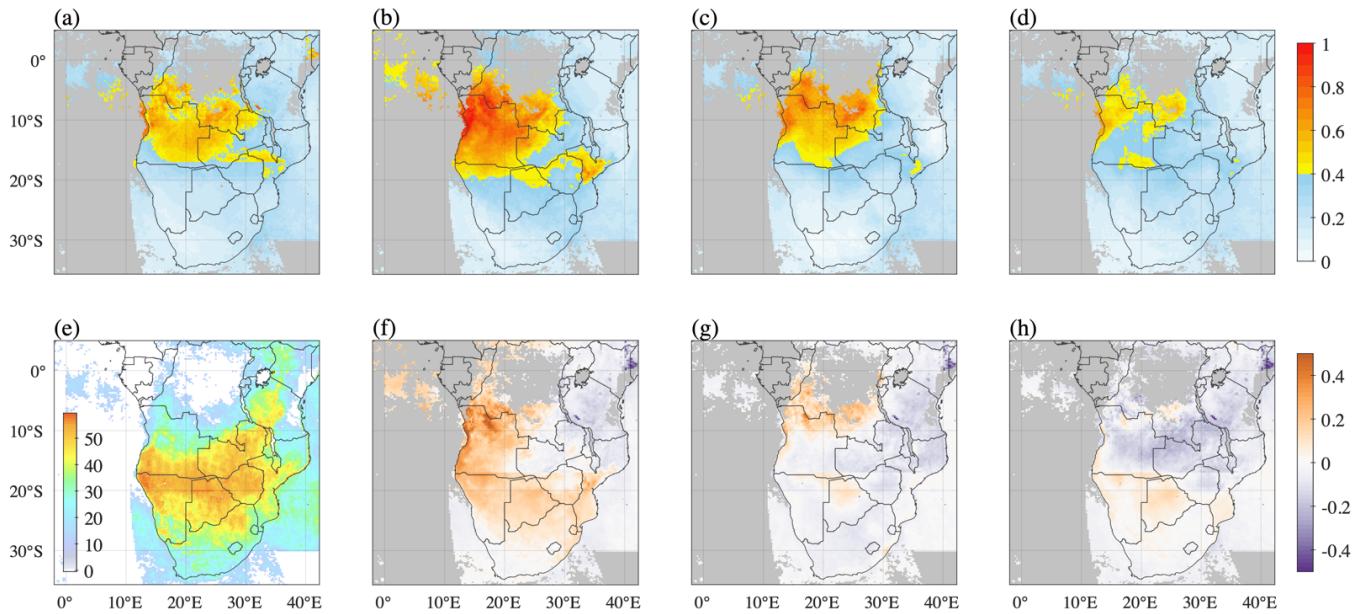
*The Castle fire occurred in two phases: Phase I from 12-Aug-2019 to 16-Aug-2019; Phase II from 20-Aug-2019 to 23-Aug-19.

**The Sheridan fire occurred in two phases: Phase I from 15-Aug-19 to 16-Aug-19; Phase II in 21-Aug-19.

***The Ike fire occurred in two phases: Phase I on 16-Aug-19 and Phase II from 20-Aug-19 to 21-Aug-19.

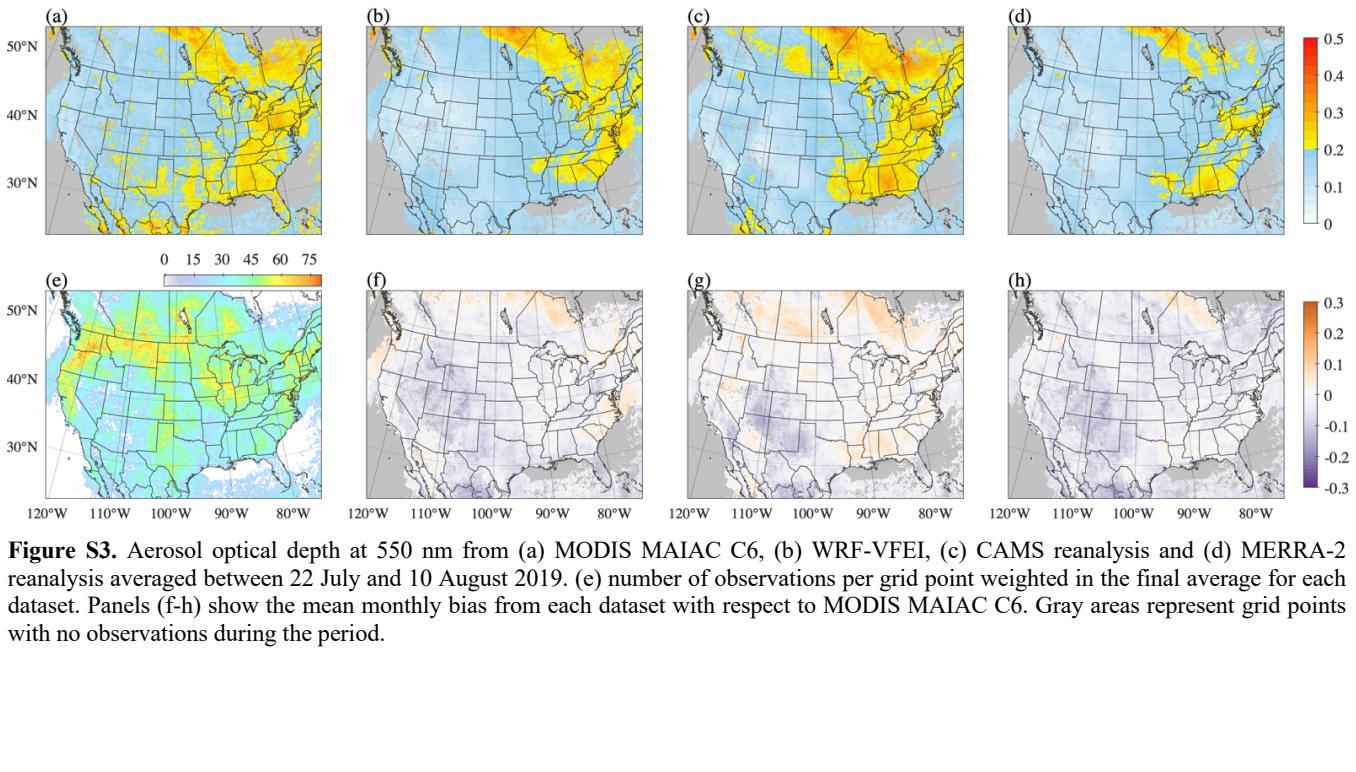


20 **Figure S1.** Map showing the tropical and subarctic masks created using selected Köppen climate classifications. These masks were used to differentiate between tropical, temperate and boreal biomes by using MODIS IGBP land categories. The result is shown in figure 1. The locations of the gas flares from Elvidge et al. (2015) are also shown as red dots. These gas flares are removed from all the hotspot detections from VIIRS.



25 **Figure S2.** Monthly averaged aerosol optical depth at 550 nm from (a) MODIS MAIAC C6, (b) WRF-VFEI, (c) CAMS reanalysis and (d) MERRA-2 reanalysis during September 2016. (e) number of observations per grid point weighted in the final average for each dataset. Panels (f-h) show the mean monthly bias from each dataset with respect to MODIS MAIAC C6. Gray areas represent grid points with no observations during the period.

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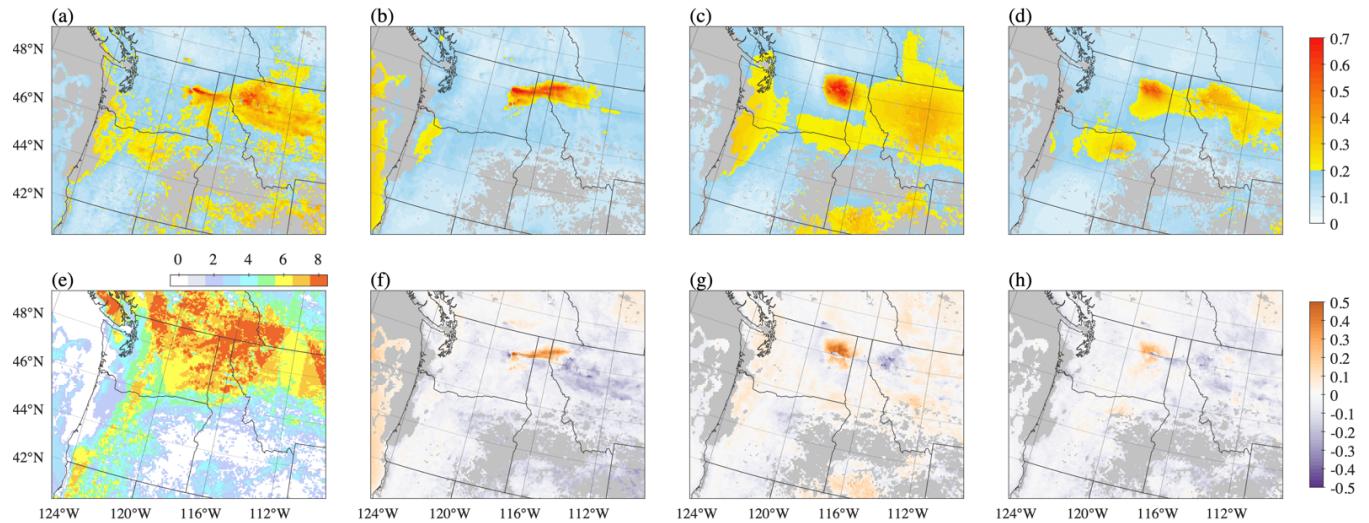
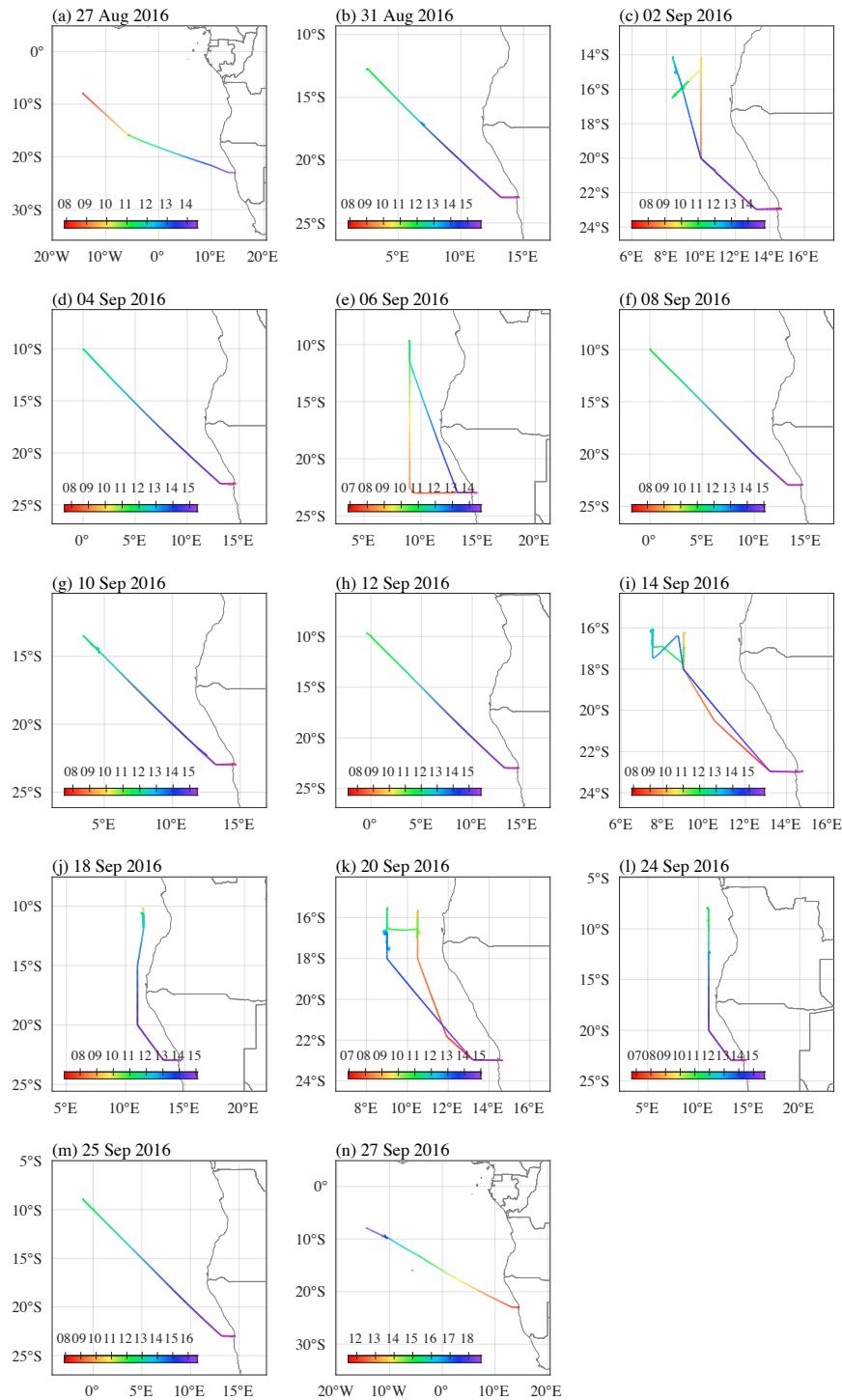
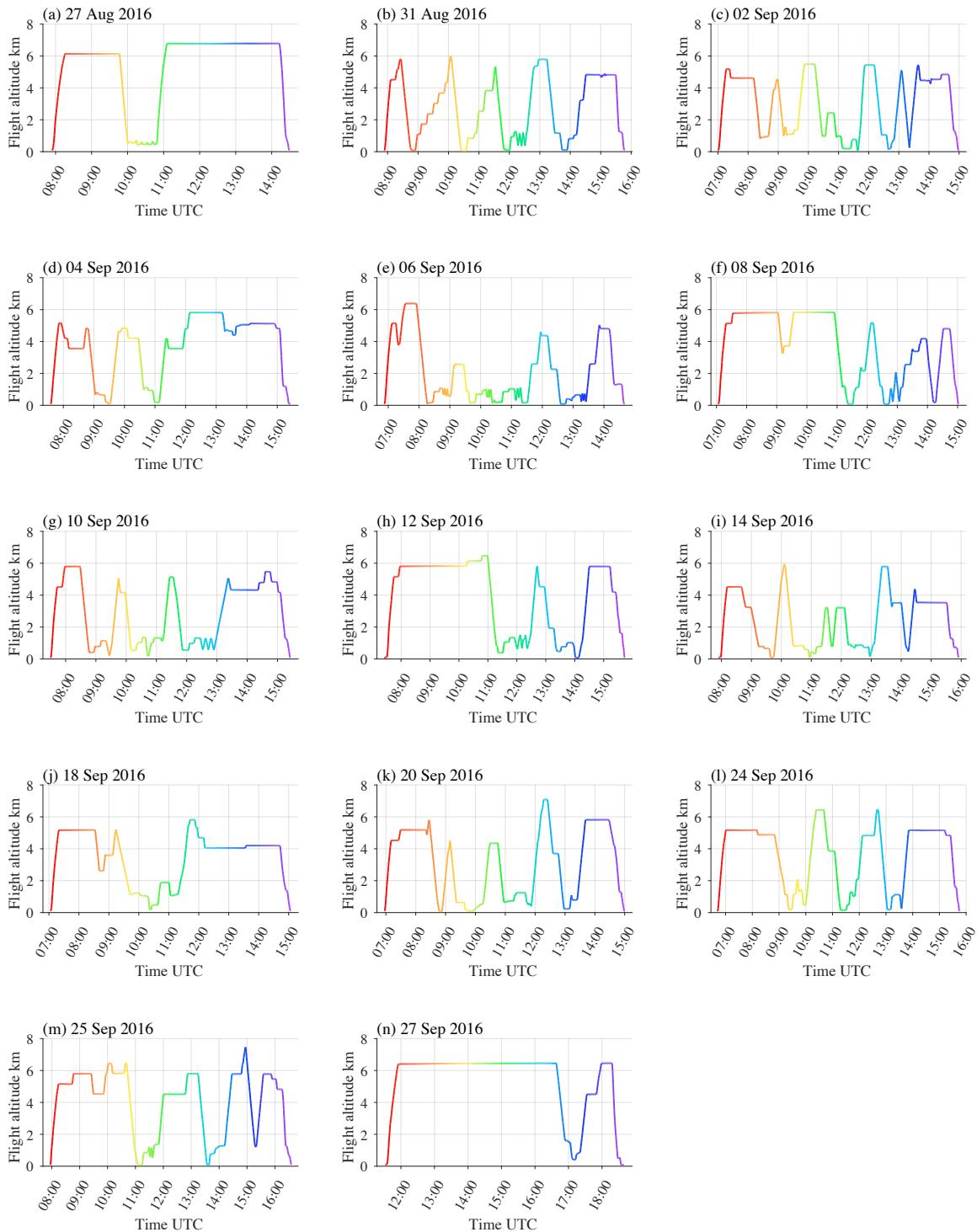


Figure S4. Same as in figure S3 but focusing on the inner domain of the simulation. The period averaged here is 6-9 August 2019, aiming on the Williams Flats fire event.



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Figure S5. Tracks of the flights conducted during ORACLES 2016 using the P-3 plane used to evaluate the model simulations in this study. Colors represent the time (UTC) of each flight. Most of these flights were “routine” flights that consisted of a fixed track (in- and outbound). E.g.: 31 August, 04, 08,10, 12 and 25 September. The altitude of each of these flights is shown in figure S2.



45 **Figure S6.** Altitudes (km.a.s.l.) of the flights conducted during ORACLES 2016 using the P-3 plane. These flights were used to evaluate the model simulations from this study. Colors represent the time (UTC) of each flight. The track of each flight is shown in figure S5.

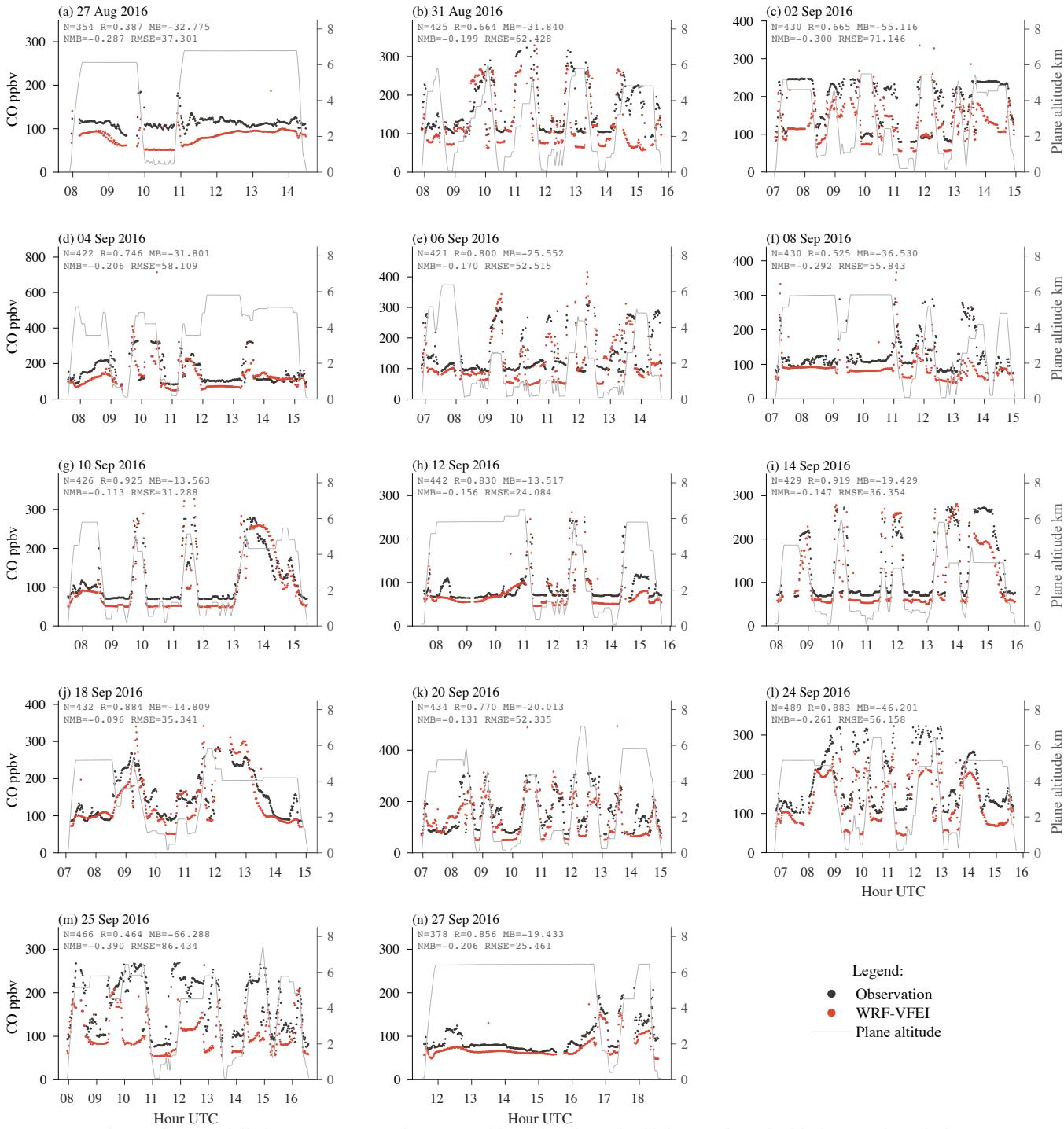


Figure S7. Observed vs. modelled (WRF-VFEI) carbon monoxide (ppbv) from the flights conducted with the P-3 plane during ORACLES 2016 shown as time series. Each plot shows a different flight day. Some statistics are presented in the corner top left of each plot: number of points (N), correlation coefficient (R), mean bias (MB), normalized mean bias (NMB) and root-mean-squared error (RMSE). The continuous gray line represents the flight altitude in km that can be read in the right axis.

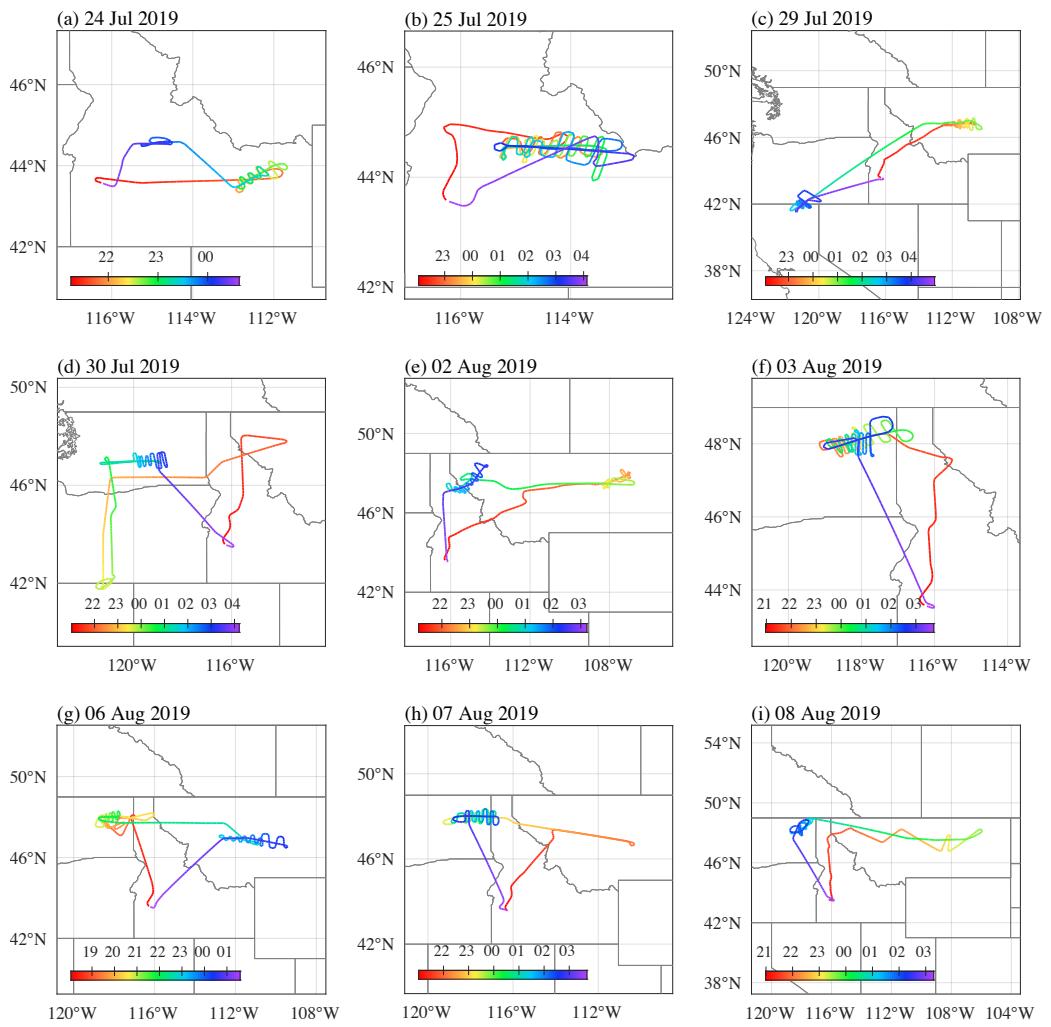


Figure S8. Tracks of the flights conducted during FIREX-AQ using the DC-8 plane used to evaluate the model simulations in this study.
55 Colors represent the time (UTC) of each flight. The date shown at the top of each plot represents the begin date (UTC) of each flight. The altitude of each of these flights is shown in figure S9.

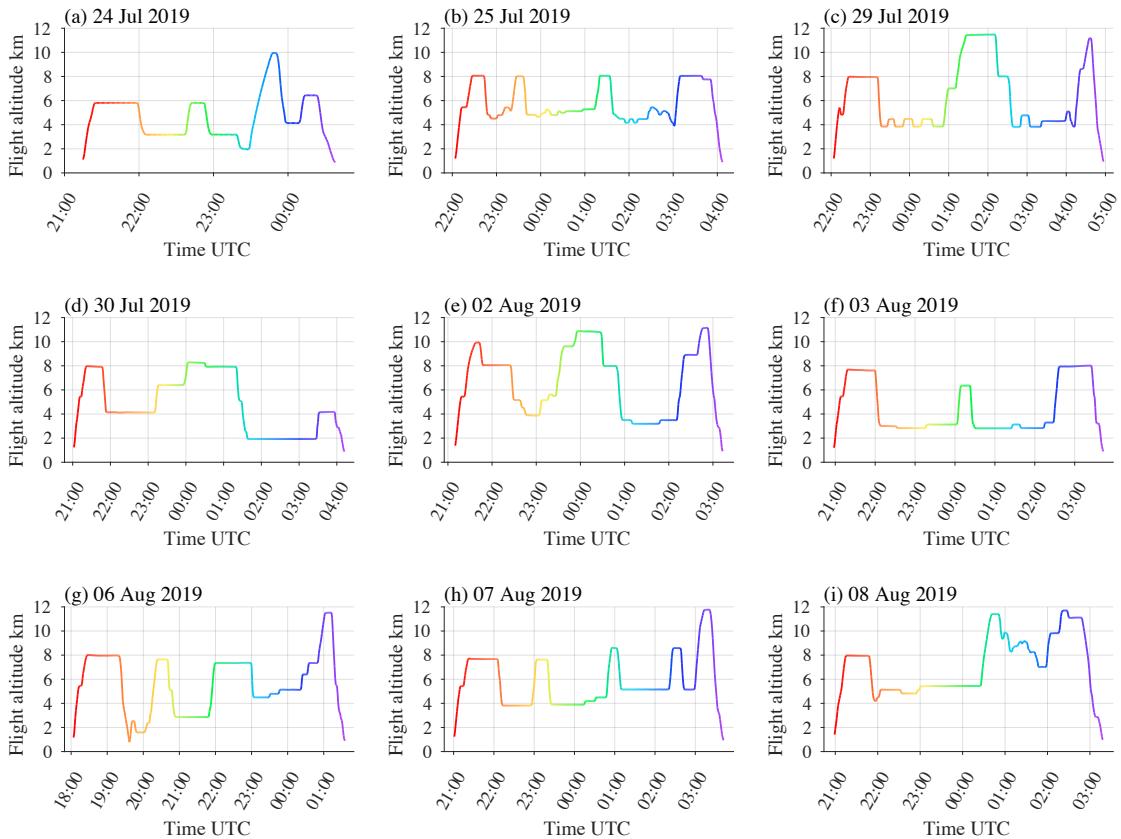
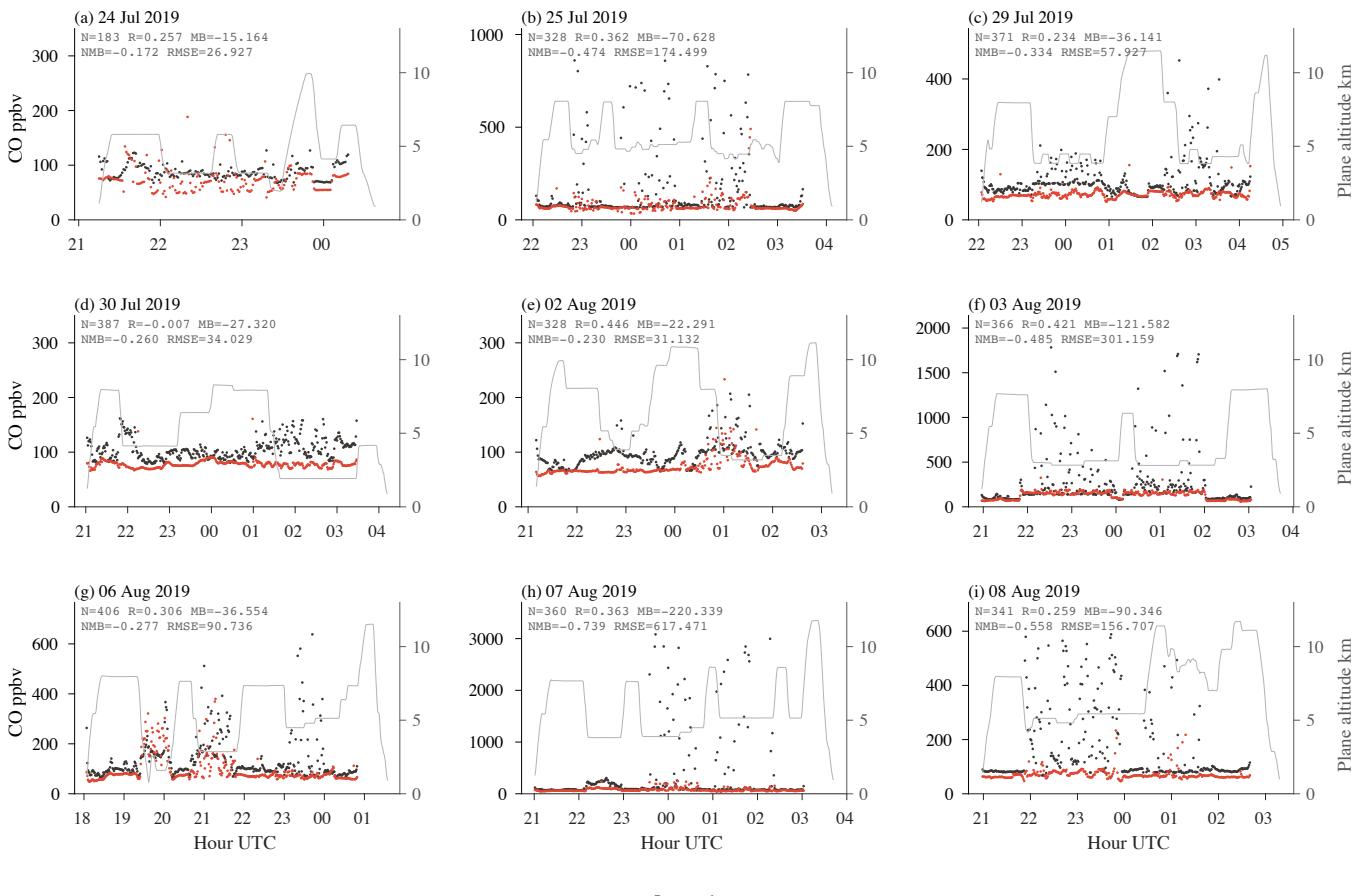


Figure S9. Altitudes (km.a.s.l.) of the flights conducted during FIREX-AQ using the DC-8 plane. These flights were used to evaluate the model simulations from this study. Colors represent the time (UTC) of each flight. The date shown at the top of each plot represents the begin date (UTC) of each flight. The track of each of these flights is shown in figure S8.

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65 **Figure S10.** Observed vs. modelled (WRF-VFEI) carbon monoxide (ppbv) from the flights conducted with the DC-8 plane during FIREX-AQ shown as time series. Each plot shows a different flight day. Some statistics are presented in the corner top left of each plot: number of points (N), correlation coefficient (R), mean bias (MB), normalized mean bias (NMB) and root-mean-squared error (RMSE). The continuous gray line represents the flight altitude in km that can be read in the right axis.