Supplemental material

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

Gonzalo A. Ferrada[1], Meng Zhou[2], Jun Wang[1,2], Alexei Lyapustin[3], Yujie Wang[4], Saulo R. Freitas[5], Gregory R. Carmichael[1]

[1]Center for Global and Regional Environmental Research, The University of Iowa, Iowa City, IA, USA
[2]Interdisciplinary Graduate Program in Informatics, The University of Iowa, Iowa City, IA, USA
[3]Laboratory for Atmospheres, NASA Goddard Space Flight Center, Greenbelt, MD, USA
[4]Joint Center for Earth Systems Technology, University of Maryland Baltimore County, Baltimore, MD, USA
[5]Center for Weather Forecast and Climatic Studies, National Institute for Space Research, São José dos Campos, SP, Brazil

Correspondence to: Gonzalo A. Ferrada (gonzalo-ferrada@uiowa.edu)

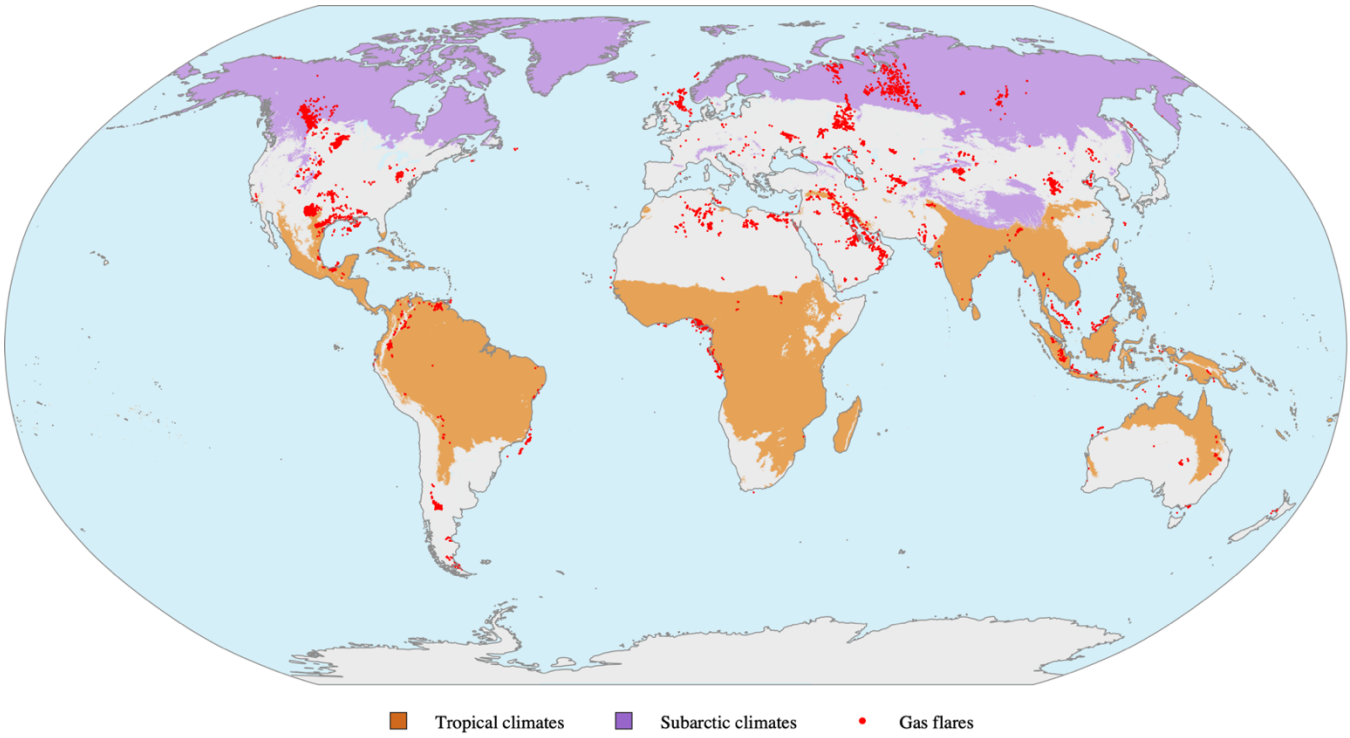

Figure S1. Map showing the tropical and subarctic masks created using selected Köppen climate classifications. These masks were used to differentiate between tropical, temperate and boreal biomes by using MODIS IGBP land categories. The result is shown in figure X. The locations of the gas flares from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

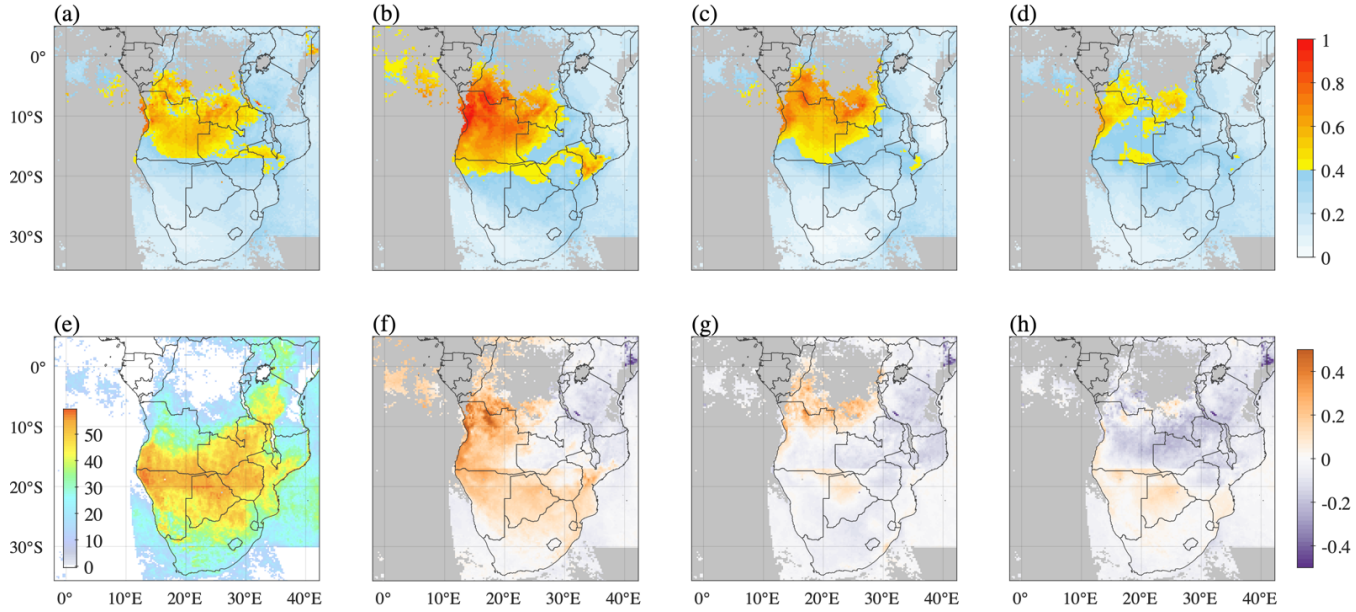

Figure S2. Monthly averaged aerosol optical depth at 550 nm from (a) MODIS MAIAC C6, (b) WRF-VFEI, (c) CAMS reanalysis and (d) MERRA-2 reanalysis during September 2016. (e) number of observations per grid point weighted in the final average for each dataset. Panels (f-h) show the mean monthly bias from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

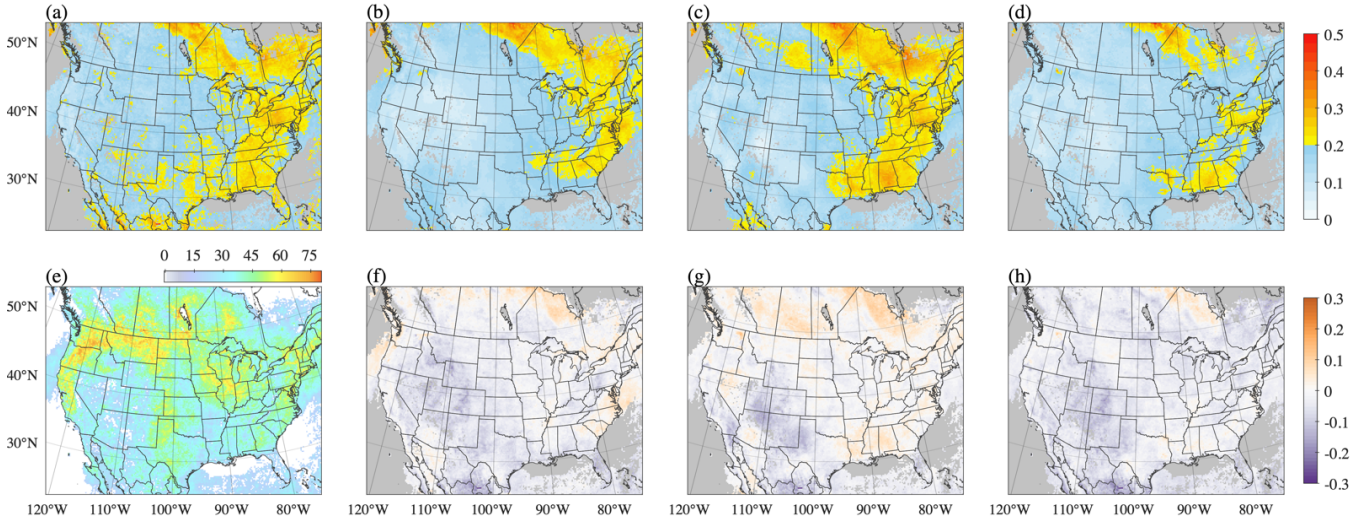

Figure S3. Aerosol optical depth at 550 nm from (a) MODIS MAIAC C6, (b) WRF-VFEI, (c) CAMS reanalysis and (d) MERRA-2 reanalysis averaged between 22 July and 10 August 2019. (e) number of observations per grid point weighted in the final average for each dataset. Panels (f-h) show the mean monthly bias from each dataset with respect to MODIS MAIAC C6. Gray areas represent grid points with no observations during the period.

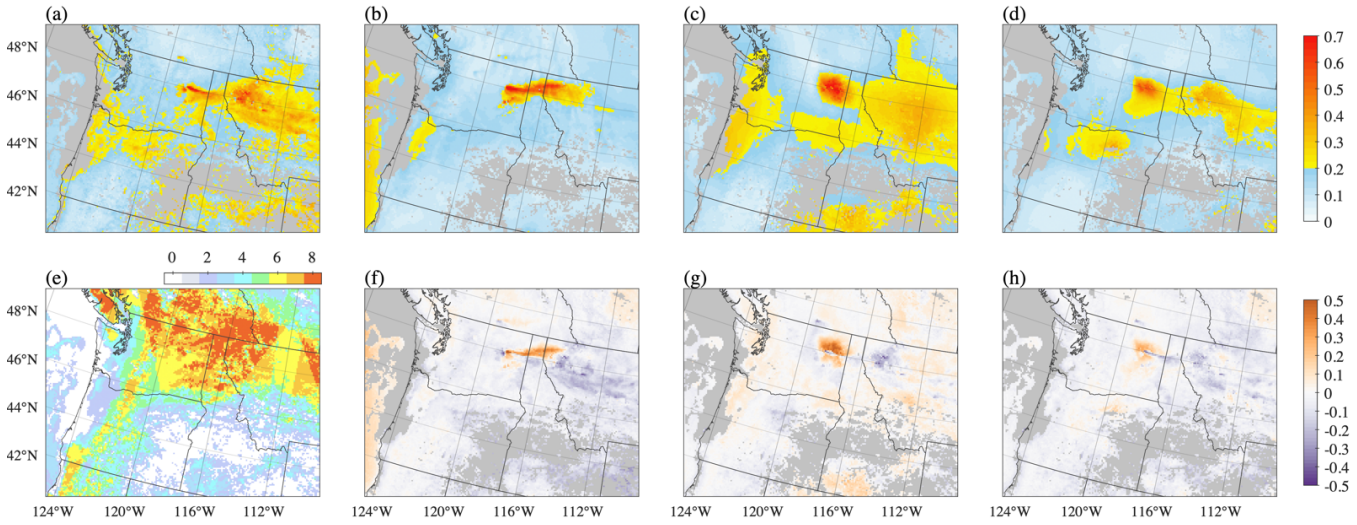

Figure S4. Same as in figure S3 but focusing on the inner domain of the simulation. The period averaged here is 6-9 August 2019, aiming on the Williams Flats fire event.

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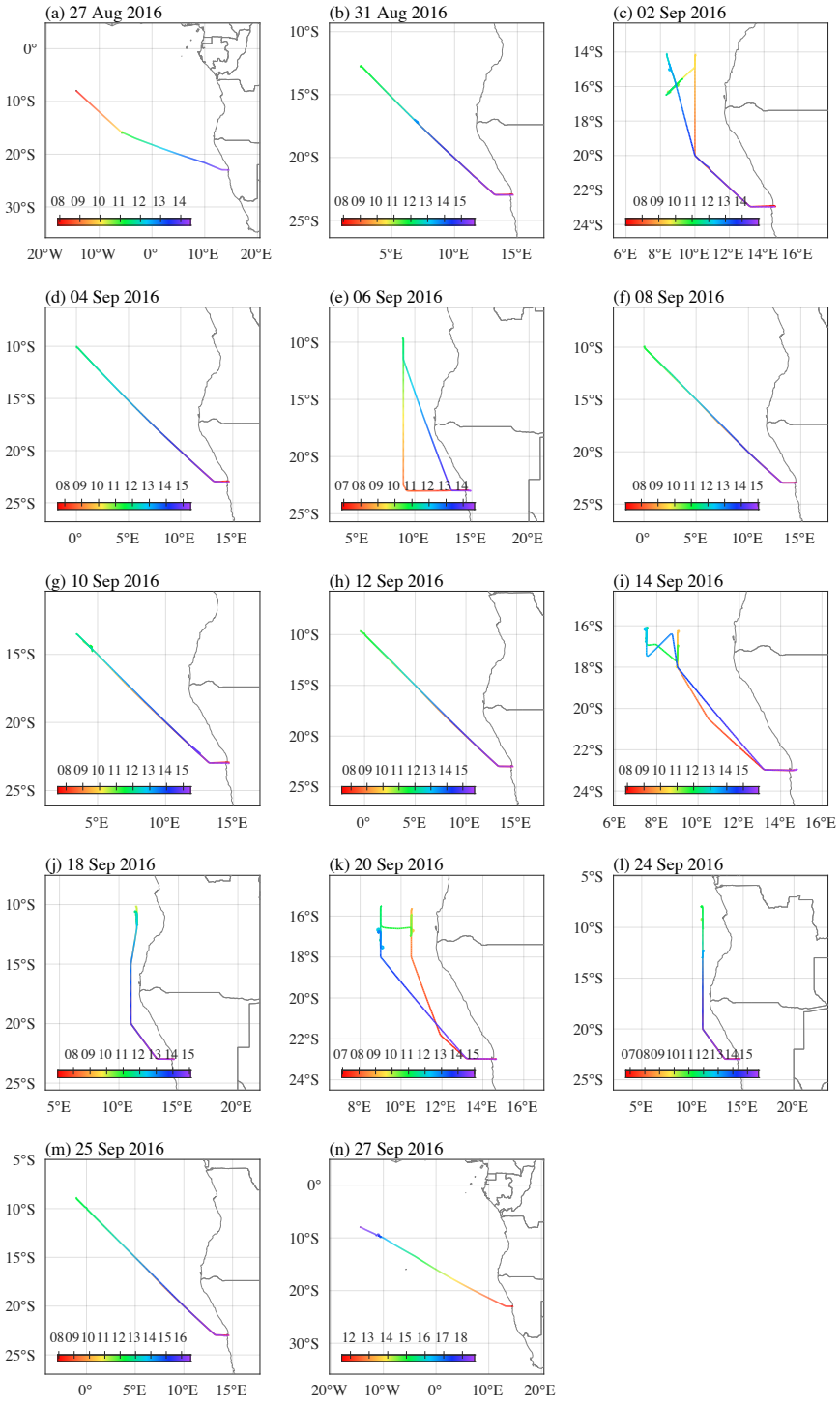


Figure S5. Tracks of the flights conducted during ORACLES 2016 using the P-3 plane used to evaluate the model simulations in this study. Colors represent the time (UTC) of each flight. Most of these flights were "routine" flights that consisted of a fixed track (in- and outbound). E.g.: 31 August, 04,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

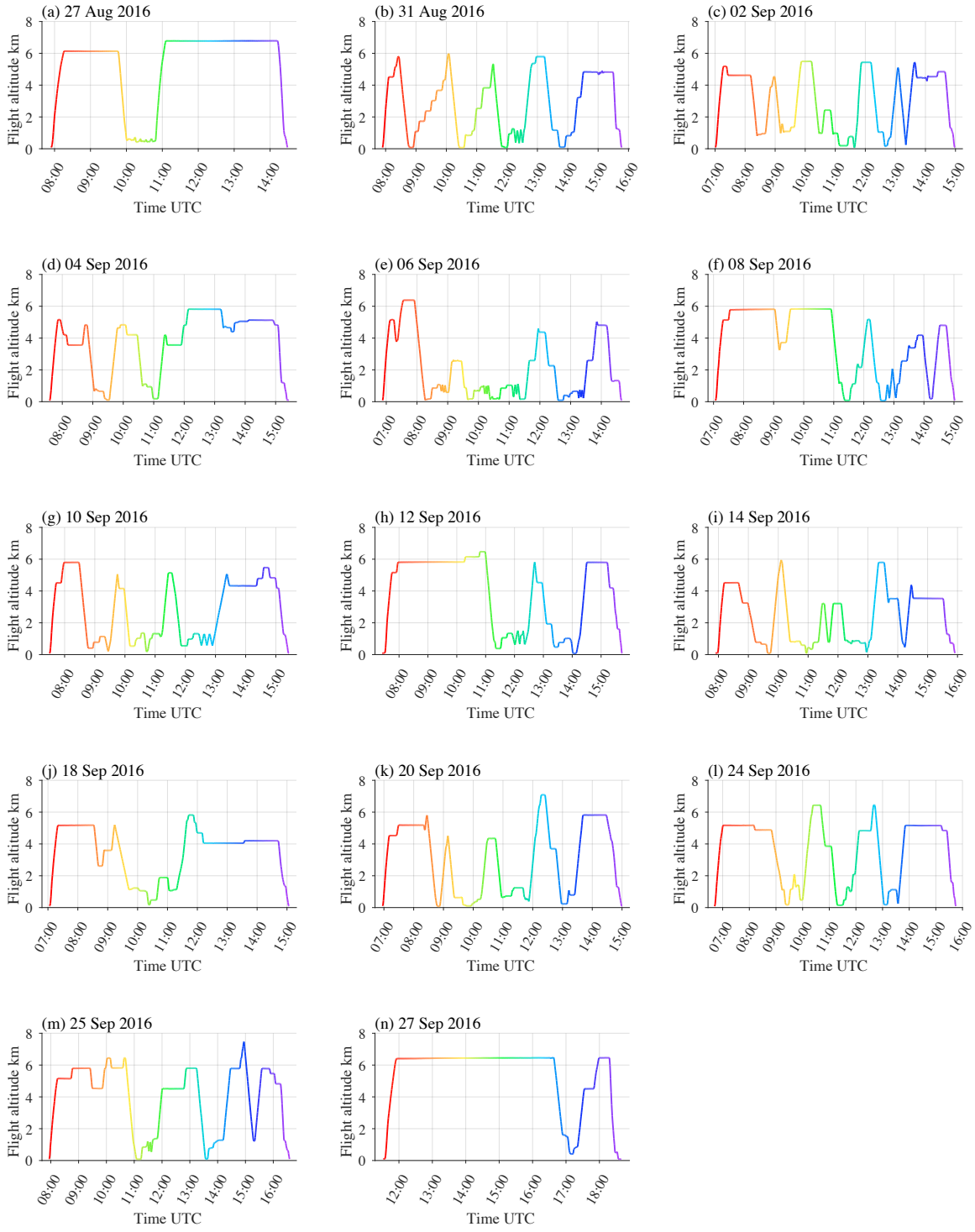


Figure S6. Altitudes (km.a.s.l.) of the flights conducted during ORACLES 2016 using the P-3 plane. These flights were used to evaluate the model simulations from this study. Colors represent the time (UTC) of each flight. The track of each flight is shown in figure S5.

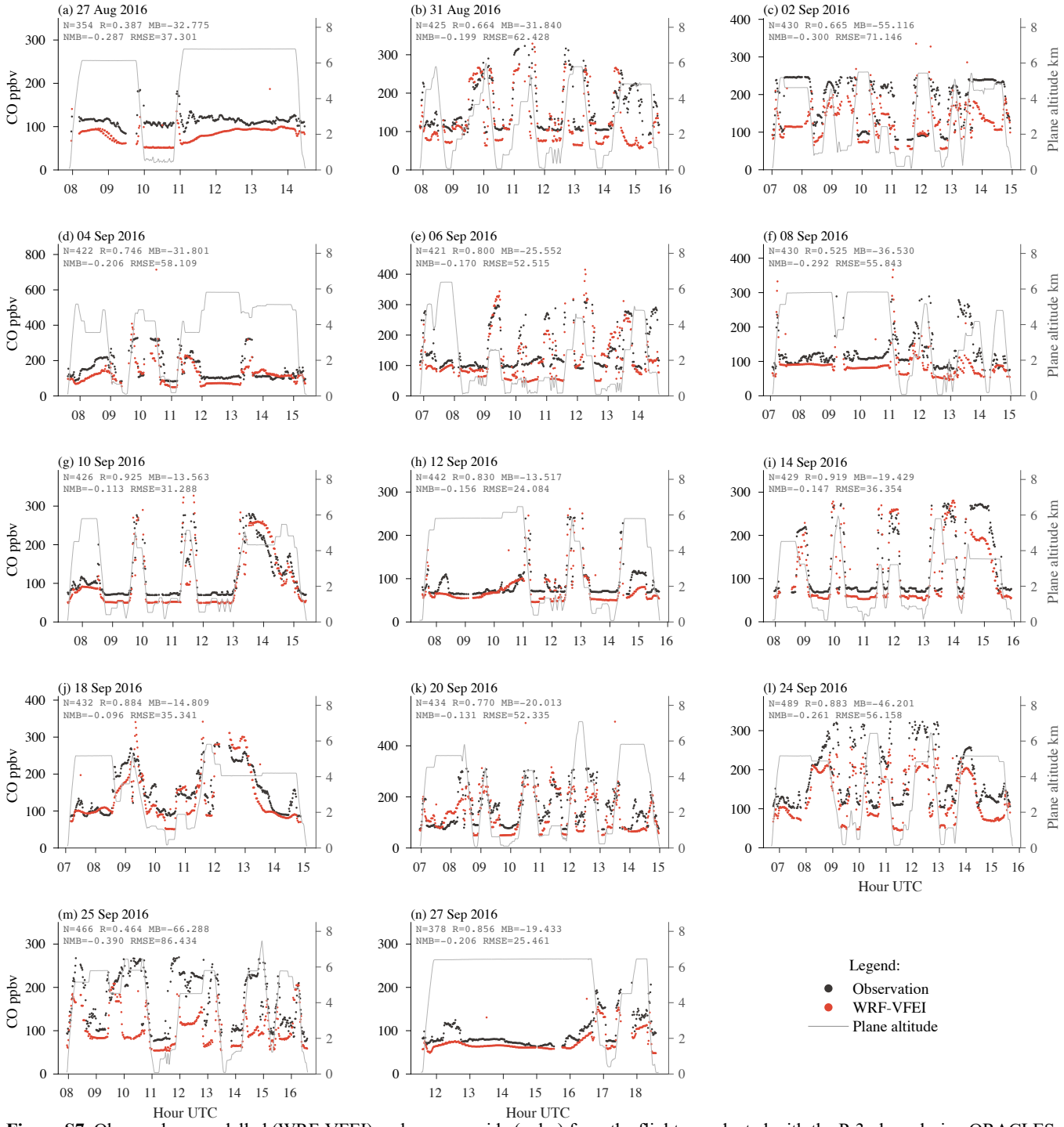


Figure S7. Observed vs. modelled (WRF-VFEI) carbon monoxide (ppbv) from the flights conducted with the P-3 plane during ORACLES 2016 shown as time series. Each plot shows a different flight day. Some statistics are presented in the corner top left of each plot: number of points (N), correlation coefficient (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.

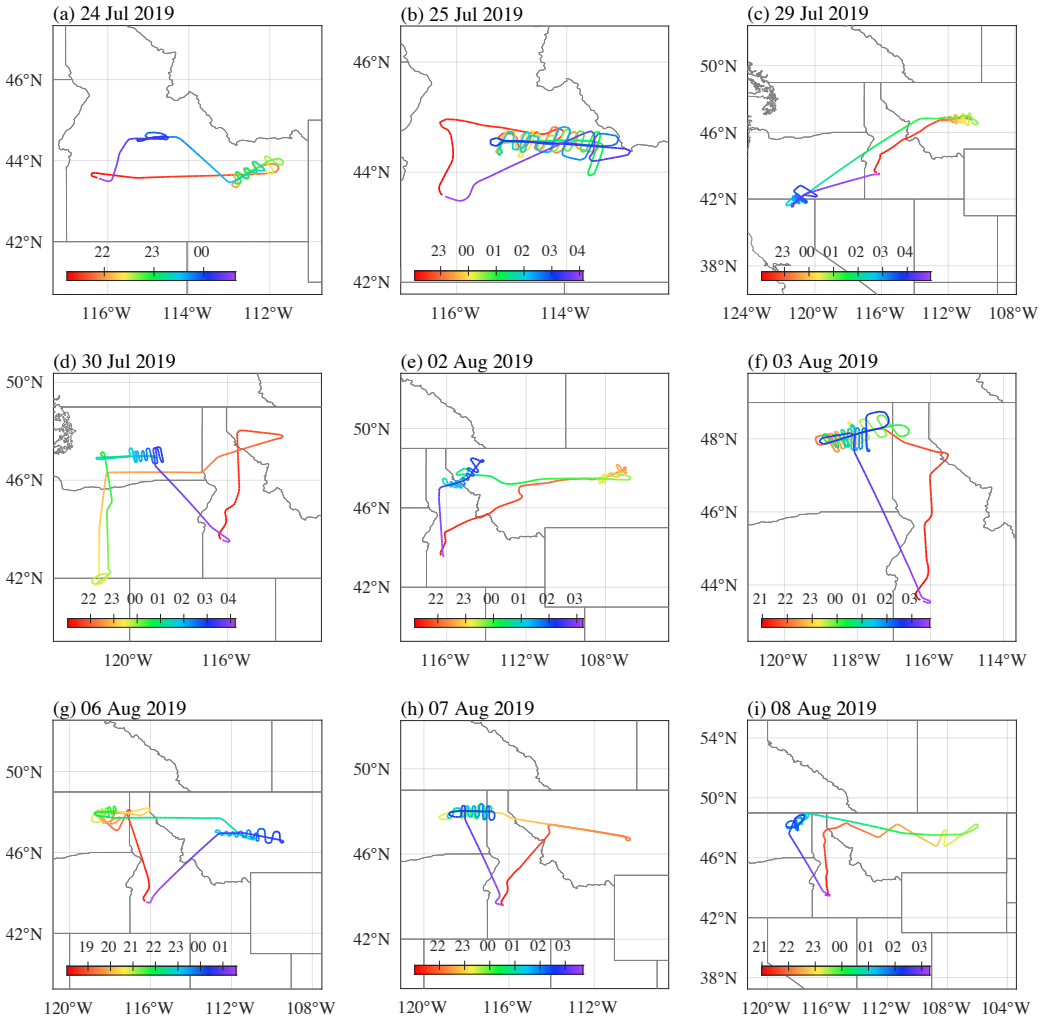
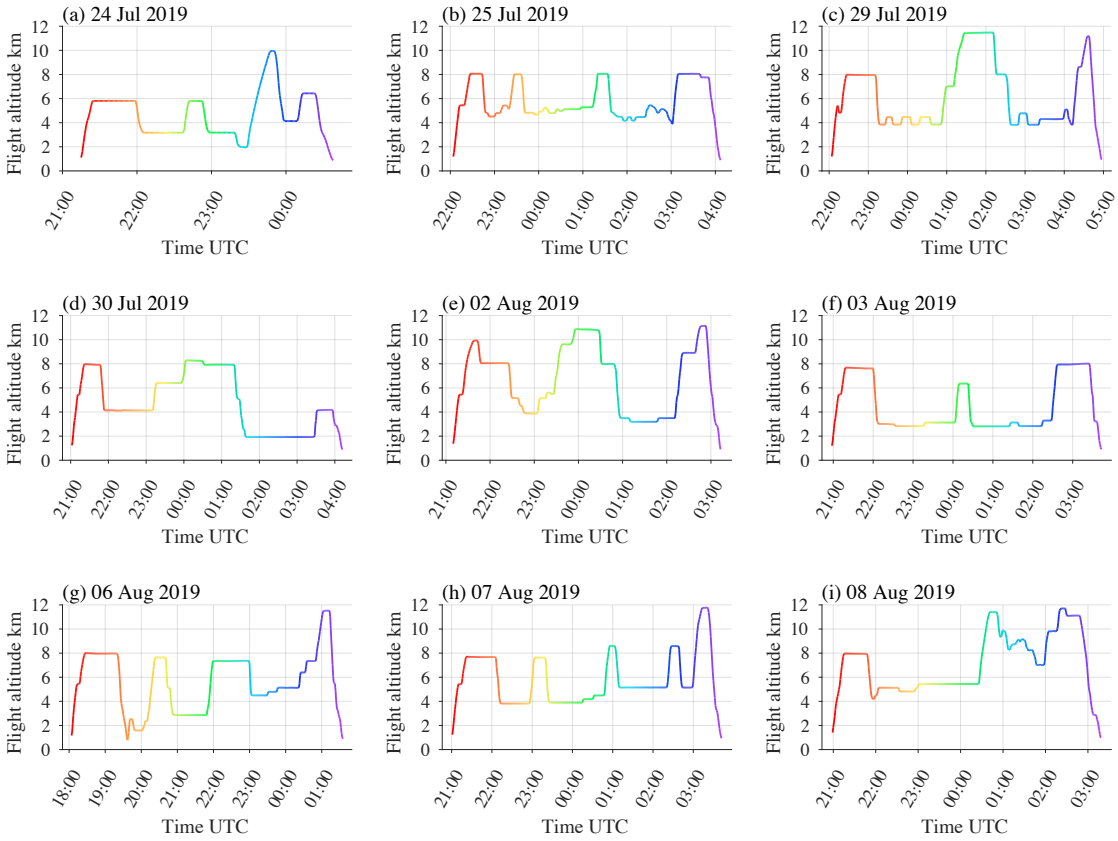


Figure S8. Tracks of the flights conducted during FIREX-AQ using the DC-8 plane used to evaluate the model simulations in this study. Colors represent the time (UTC) of each flight. The date shown at the top of each plot represents the begin date (UTC) of each flight. The altitude of each of these flights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



55 **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.

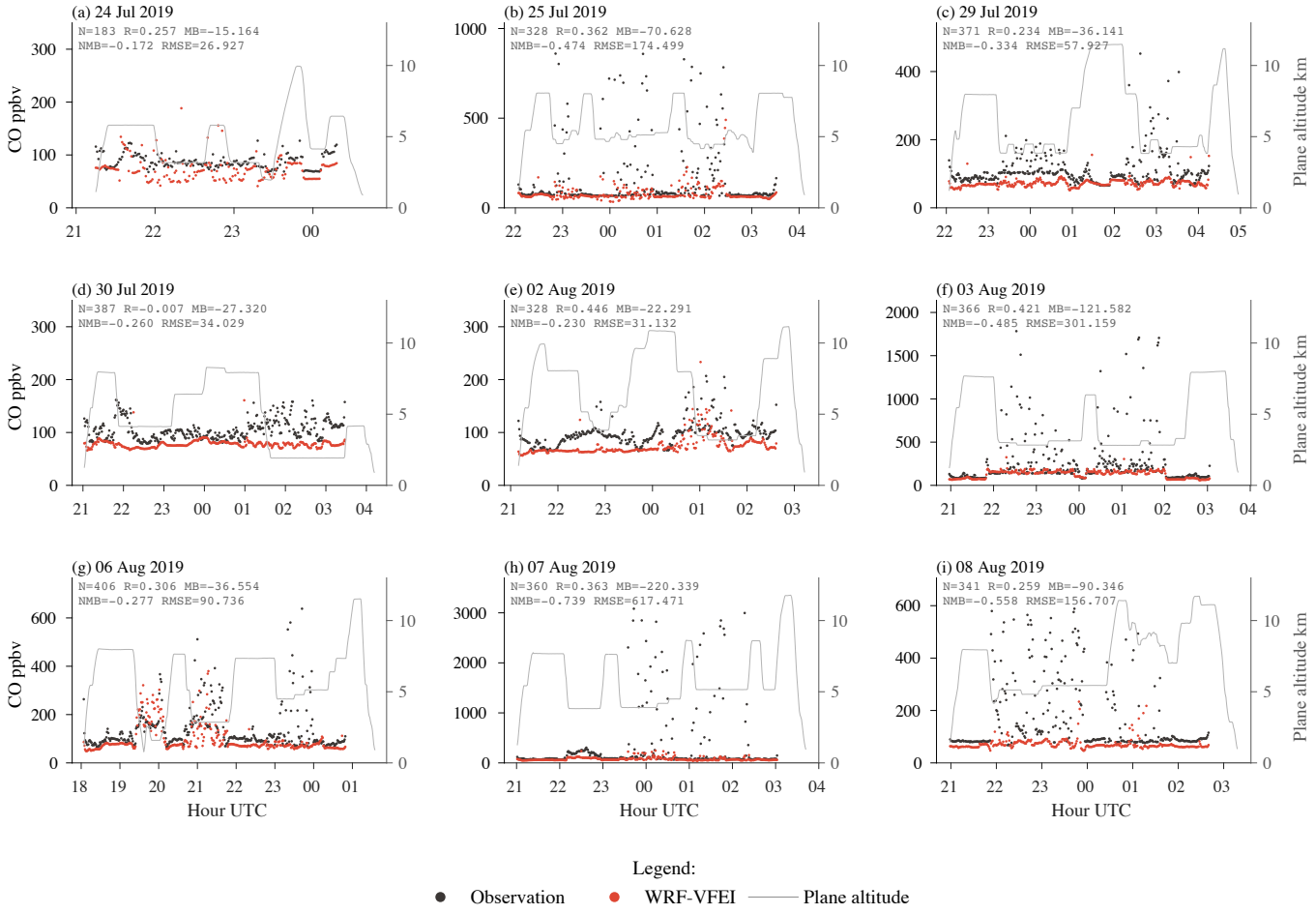


Figure S10. Observed vs. modelled (WRF-VFEI) carbon monoxide (ppbv) from the flights conducted with the DC-8 plane during FIREX-AQ shown as time series. Each plot shows a different flight day. Some statistics are presented in the corner top left of each plot: number of points (N), correlation coefficient (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.