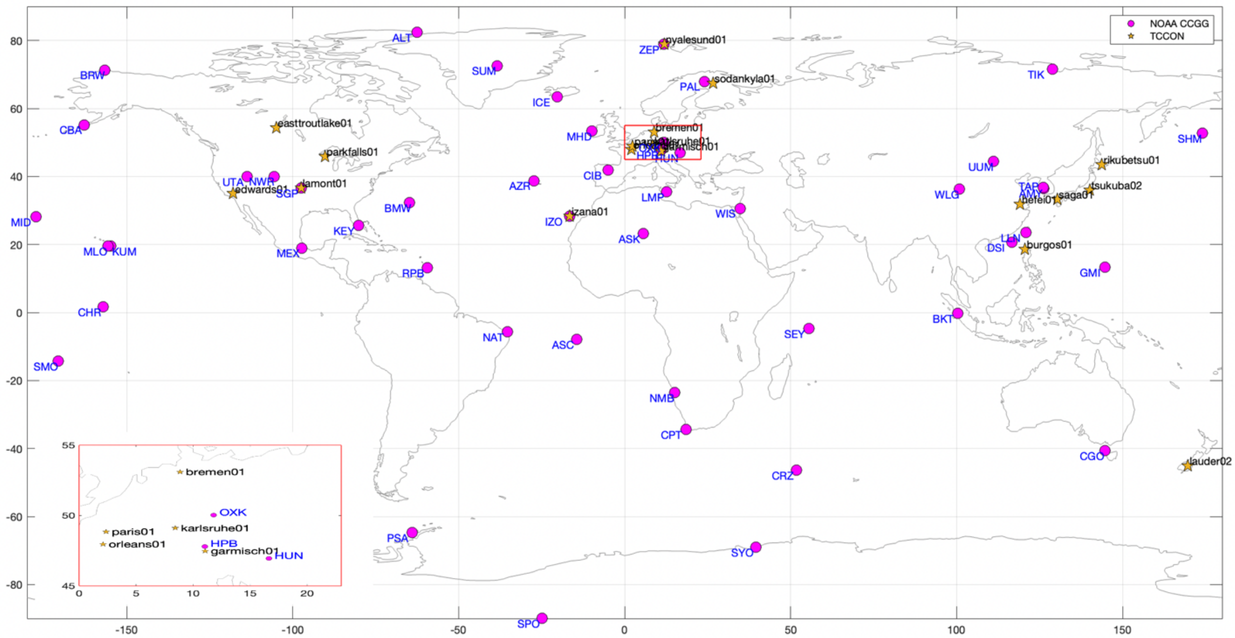

Figure S1. Distributions of Total Carbon Column Observing Network (TCCON) sites and NOAA Carbon Cycle Greenhouse Gases (CCGG) sites. TCCON sites are marked by yellow stars and NOAA CCGG sites are marked by pink circles. The red box on the lower left corner is a zoomed-in version of the red box in the map.

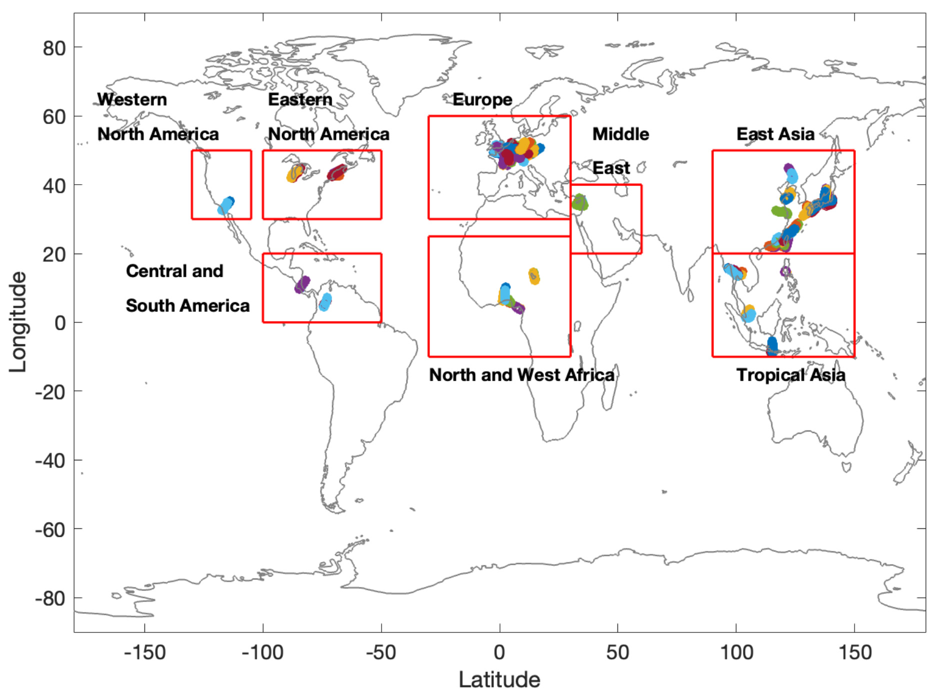

Figure S2. Distributions of the In-service Aircraft for a Global Observing System (IAGOS) CO profiles during Jul 16th, 2018 to Aug 14, 2018 and the region definition.

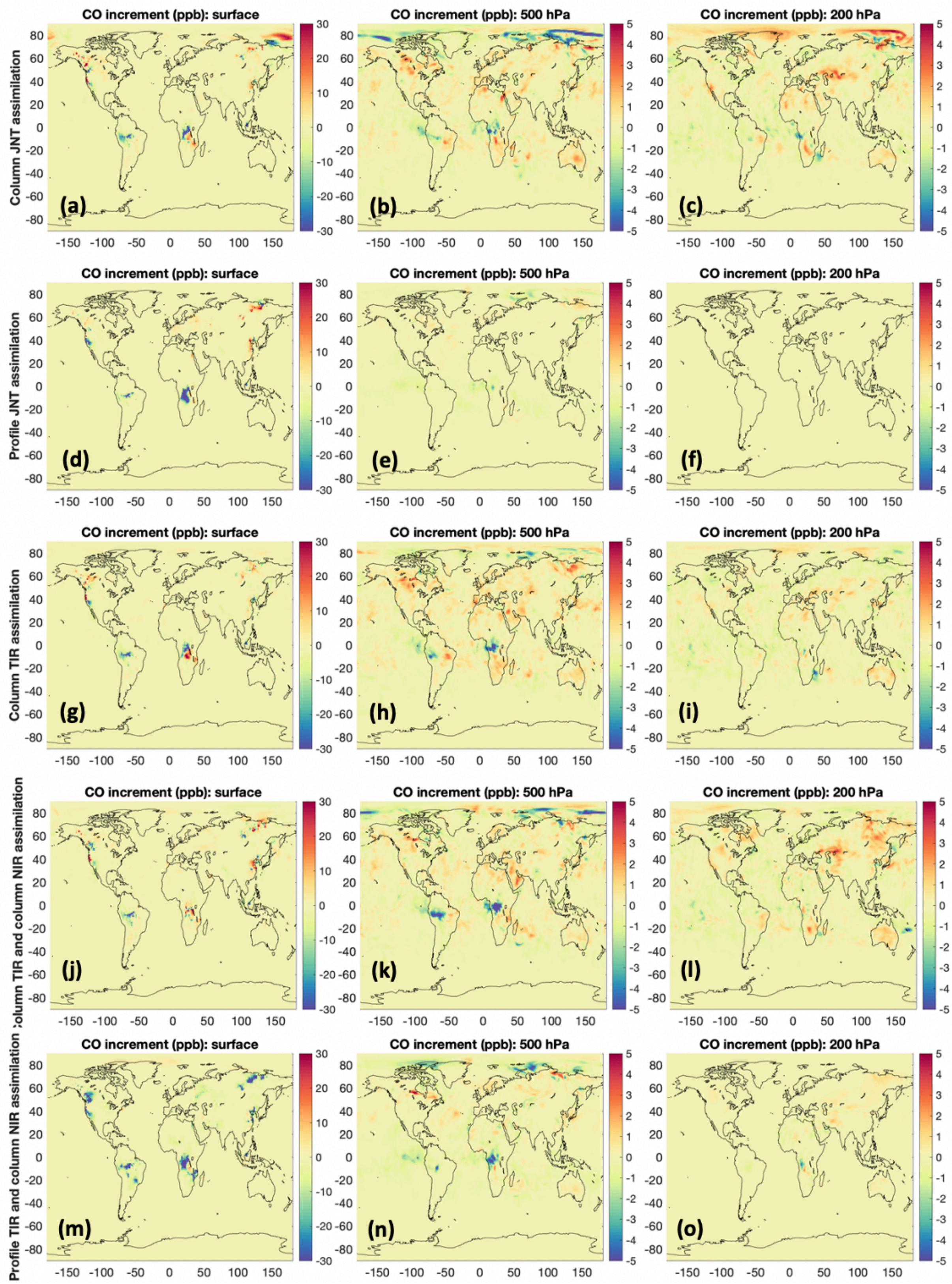

Figure S3. 30-day average increment in CO for the 5 experiments at the model surface, 500 hPa, and 200 hPa. Increment is calculated as analysis minus forecast.

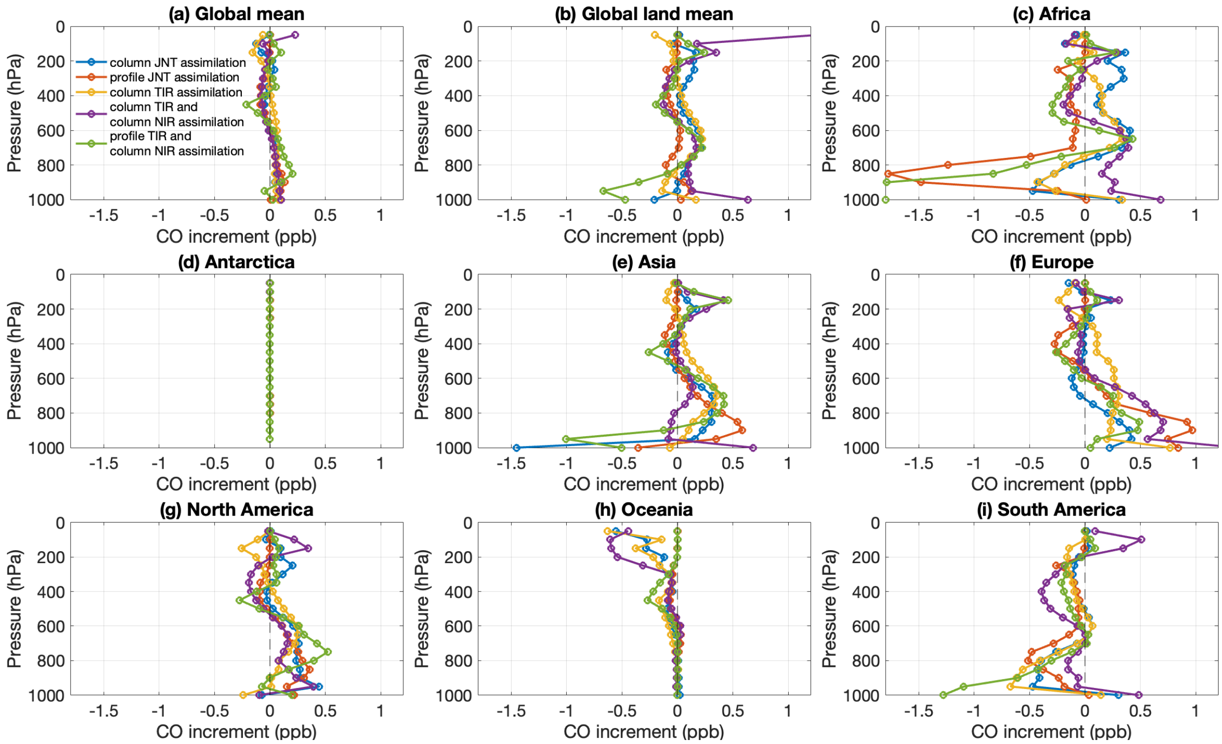

Figure S4. Vertical profile of the 15-day (July 31 - August 14, 2018) average increment in CO. Increment is calculated as analysis minus forecast.

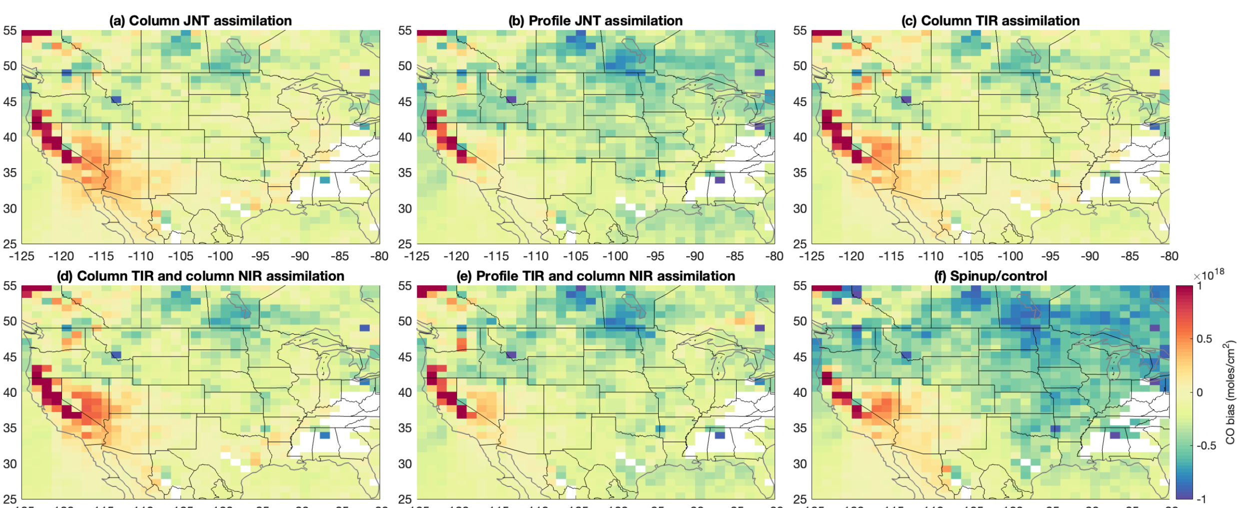

Figure S5. Similar to Figure 7 but zoomed in to North America.

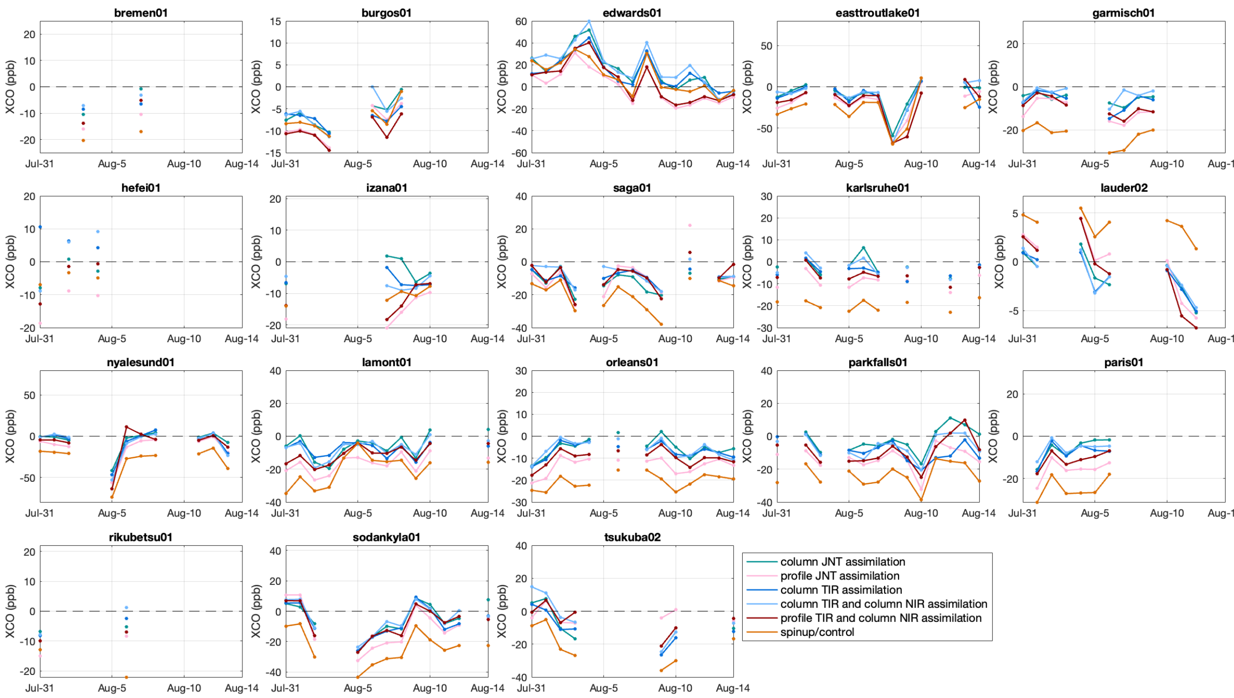

Figure S6. Time series of the bias in CO from the control run and experiments (forecast) compared to TCCON column CO.

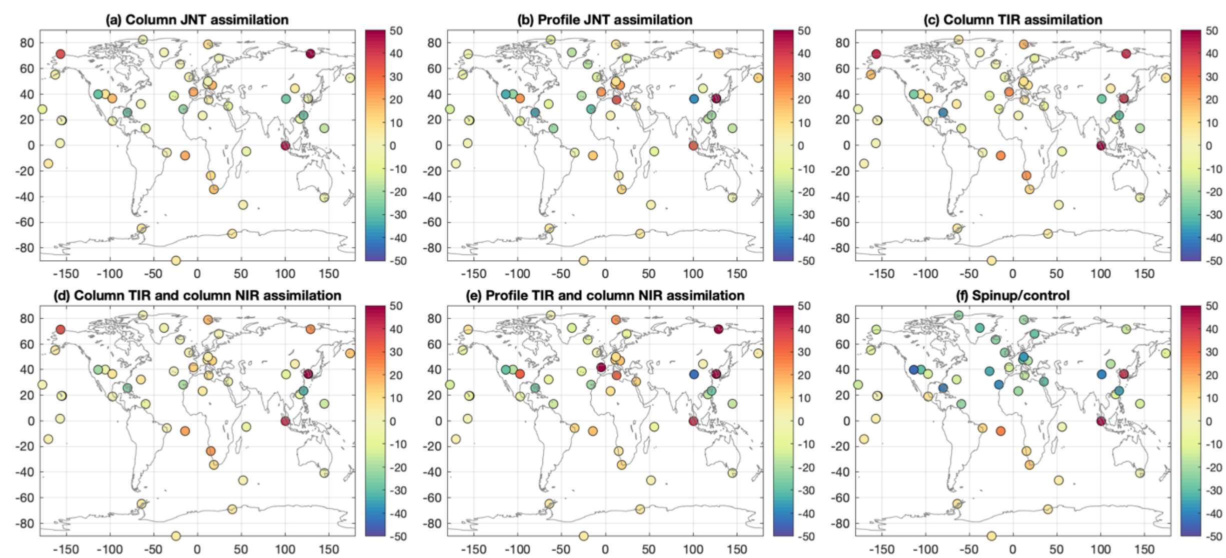

Figure S7. Spatial distribution of model bias in CO (ppb) against CO observations from CCGG sites. The model bias is averaged from July 31st, 2018 to August 14th, 2018.

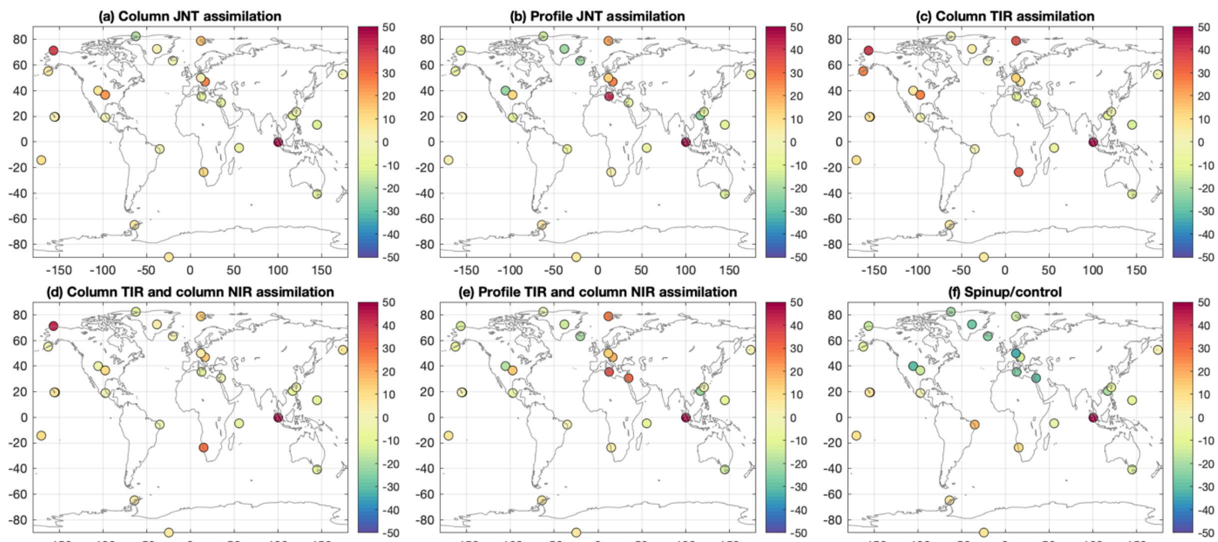

Figure S8. Spatial distribution of model bias in CO (ppb) against CO observations from CCGG sites. The model bias is averaged from July 31st, 2018 to August 04th, 2018.

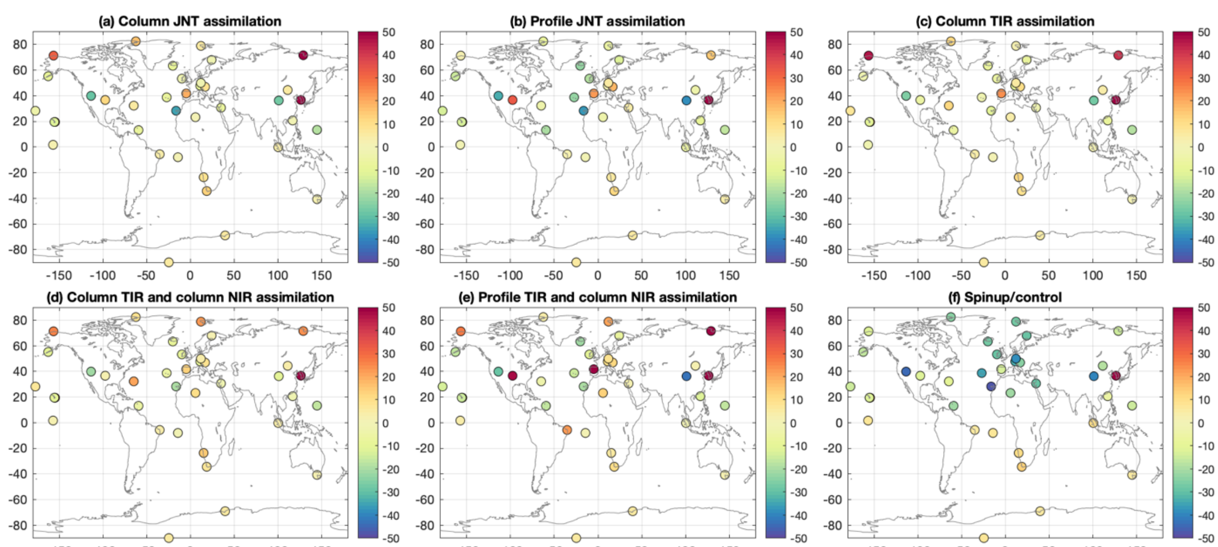

Figure S9. Spatial distribution of model bias in CO (ppb) against CO observations from CCGG sites. The model bias is averaged from August 05th, 2018 to August 09th, 2018.

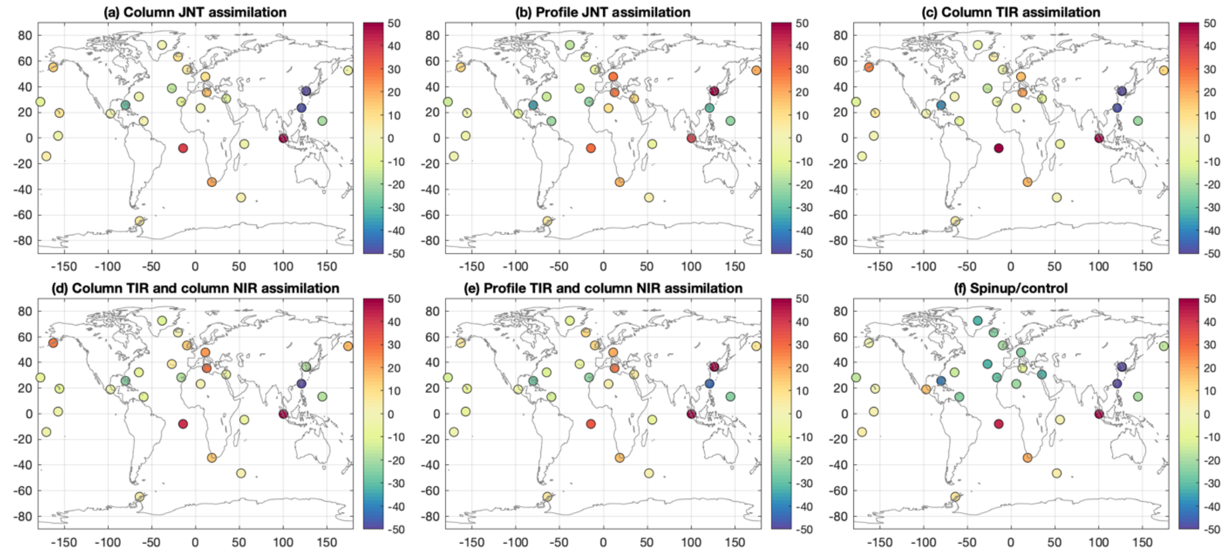

Figure S10. Spatial distribution of model bias in CO (ppb) against CO observations from CCGG sites. The model bias is averaged from August 10th, 2018 to August 14th, 2018.

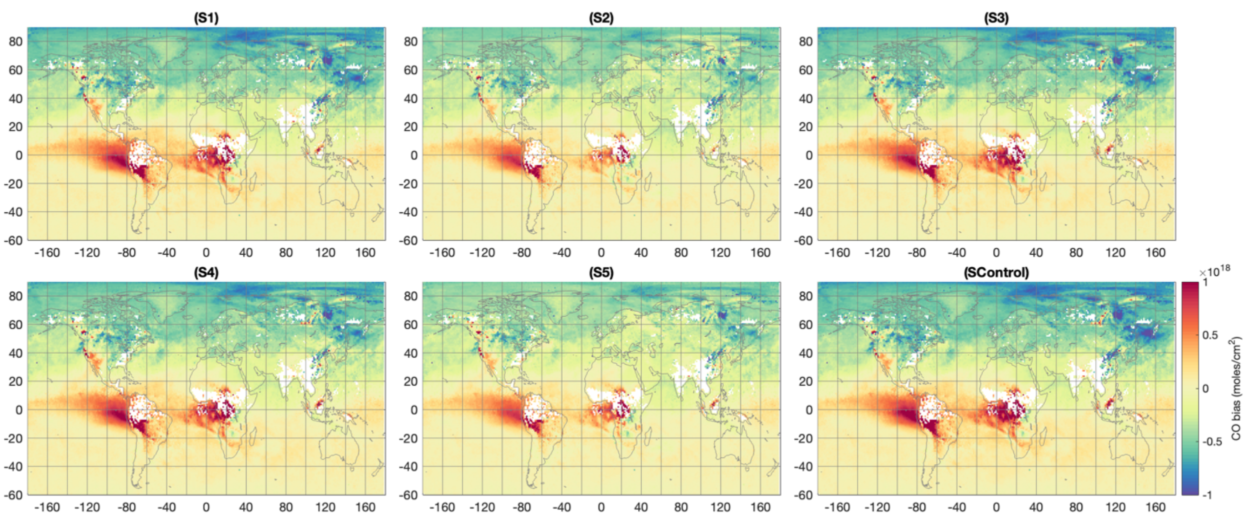

Figure S11. 15-day mean biases (July 31st – August 14th, 2018) of modeled CO against CO columns from the TROPOspheric Monitoring Instrument (TROPOMI) for the CAM-chem simulations with updated emissions and original emissions. TROPOMI averaging kernels are applied to model CO for the comparisons. (S1) Simulation with emissions from (1) Column JNT assimilation; (S2) Simulation with emissions from (2) Profile JNT assimilation; (S3) Simulation with emissions from (3) Column TIR assimilation; (S4) Simulation with emissions from (4) Column TIR and column NIR assimilation; (S5) Simulation with emissions from (5) Profile TIR and column NIR assimilation; (SControl) Simulation with original CAMS and FINN emissions.

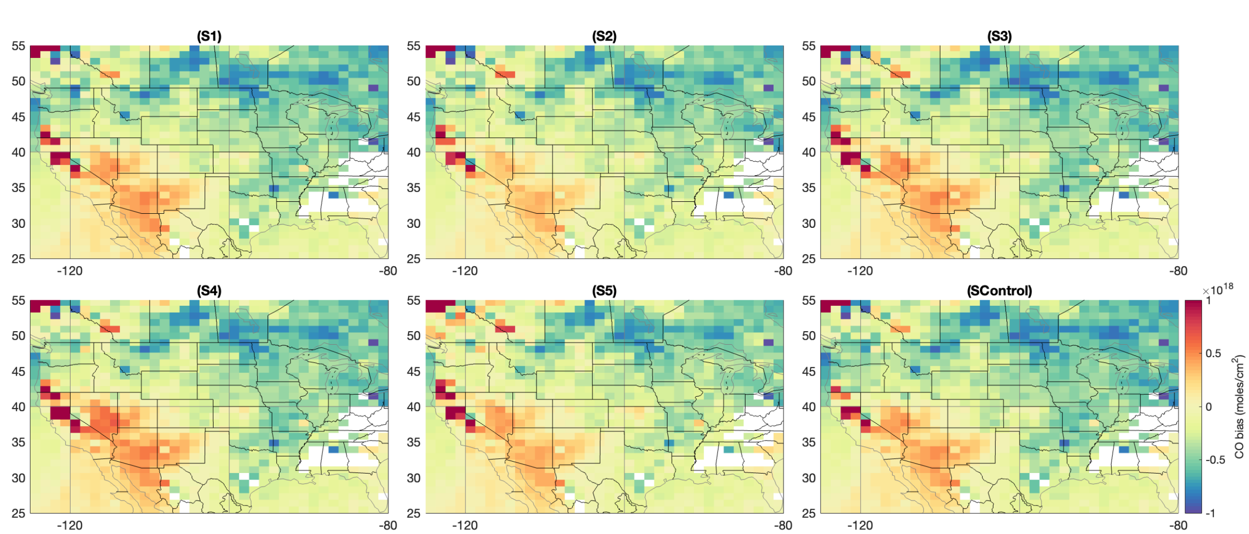

Figure S12. Similar to Figure S11 but zoomed in to North America.

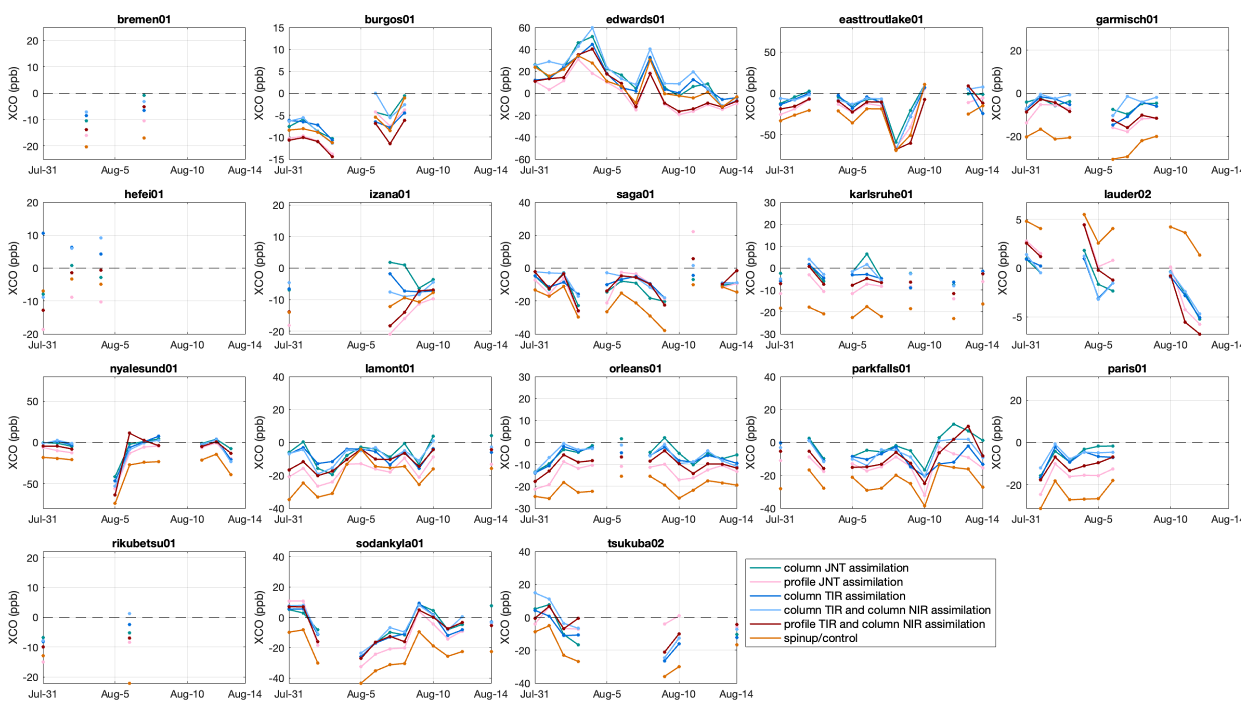

Figure S13. Time series of the bias in CO from the CAM-chem simulations with updated emissions and original emissions compared to TCCON column CO. (S1) Simulation with emissions from (1) Column JNT assimilation; (S2) Simulation with emissions from (2) Profile JNT assimilation; (S3) Simulation with emissions from (3) Column TIR assimilation; (S4) Simulation with emissions from (4) Column TIR and column NIR assimilation; (S5) Simulation with emissions from (5) Profile TIR and column NIR assimilation; (SControl) Simulation with original CAMS and FINN emissions.

Figure S14. Mean biases (ppb) of modeled CO against CO columns from the Total Carbon Column Observing Network (TCCON) for the CAM-chem simulations with updated emissions and original emissions. TCCON averaging kernels are applied to model CO for the comparisons. Spatial locations of TCCON sites can be found in Figure 2 and Figure S1. (S1) Simulation with emissions from (1) Column JNT assimilation; (S2) Simulation with emissions from (2) Profile JNT assimilation; (S3) Simulation with emissions from (3) Column TIR assimilation; (S4) Simulation with emissions from (4) Column TIR and column NIR assimilation; (S5) Simulation with emissions from (5) Profile TIR and column NIR assimilation; (SControl) Simulation with original CAMS and FINN emissions.

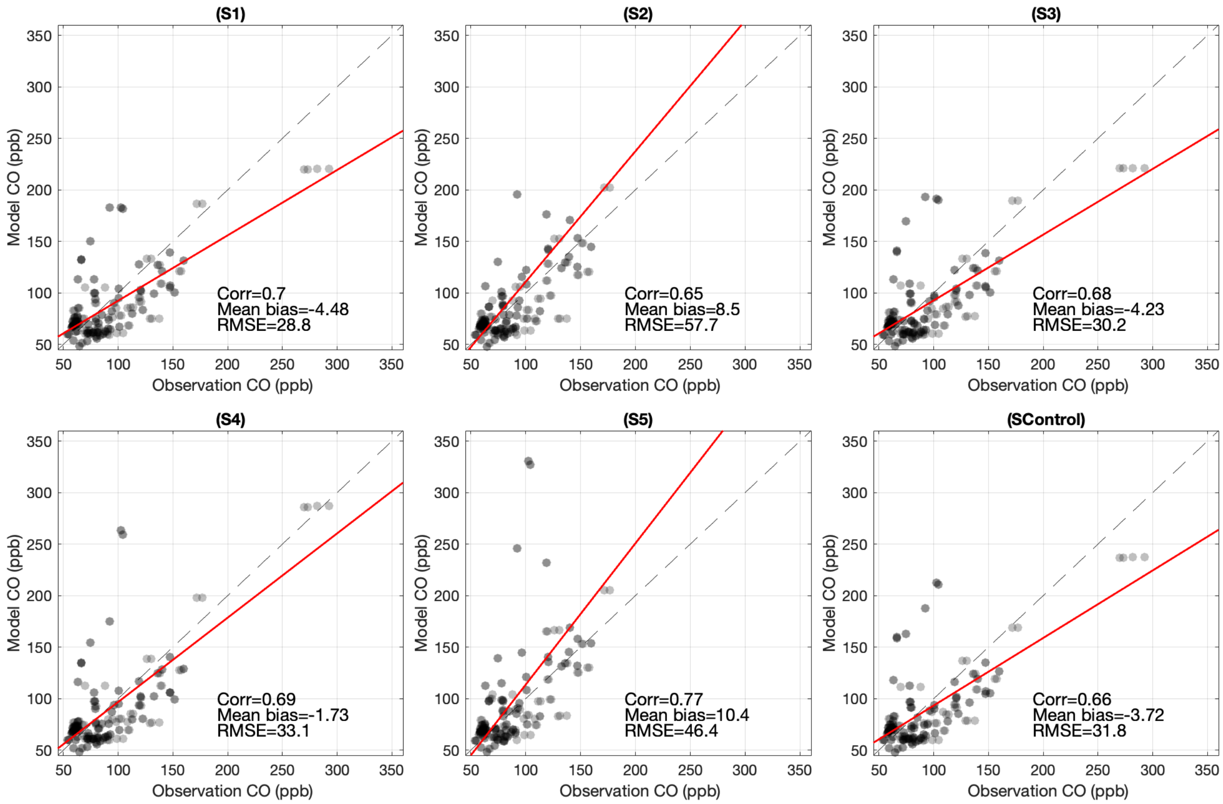

Figure S15. Comparisons of modeled CO (ppb) and CO observations from the NOAA Carbon Cycle Greenhouse Gases (CCGG) sites (ppb) during July 16th, 2018 to August 14th, 2018 for the the CAM-chem simulations with updated emissions and original emissions. Spatial locations of CCGG sites can be found in Figure 2 and Figure S1. A spatial distribution of model bias in CO against CO observations from CCGG sites can be found in Figure S5. (S1) Simulation with emissions from (1) Column JNT assimilation; (S2) Simulation with emissions from (2) Profile JNT assimilation; (S3) Simulation with emissions from (3) Column TIR assimilation; (S4) Simulation with emissions from (4) Column TIR and column NIR assimilation; (S5) Simulation with emissions from (5) Profile TIR and column NIR assimilation; (SControl) Simulation with original CAMS and FINN emissions.

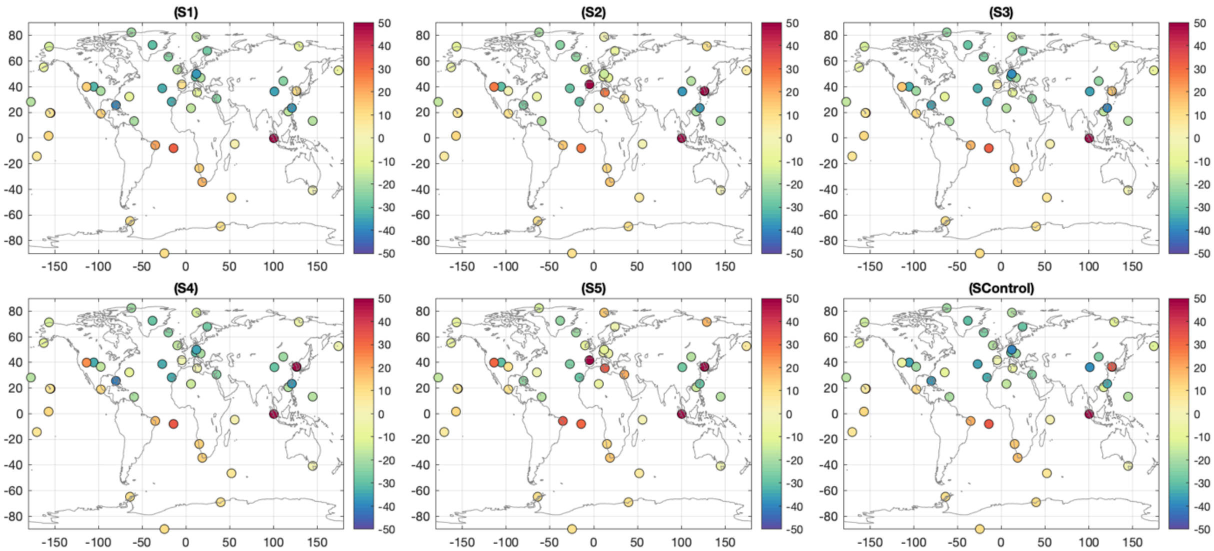

Figure S16. Spatial distribution of model bias in CO (ppb) against CO observations from CCGG sites for the CAM-chem simulations with updated emissions and original emissions. The model bias is averaged from July 31st, 2018 to August 14th, 2018. (S1) Simulation with emissions from (1) Column JNT assimilation; (S2) Simulation with emissions from (2) Profile JNT assimilation; (S3) Simulation with emissions from (3) Column TIR assimilation; (S4) Simulation with emissions from (4) Column TIR and column NIR assimilation; (S5) Simulation with emissions from (5) Profile TIR and column NIR assimilation; (SControl) Simulation with original CAMS and FINN emissions.

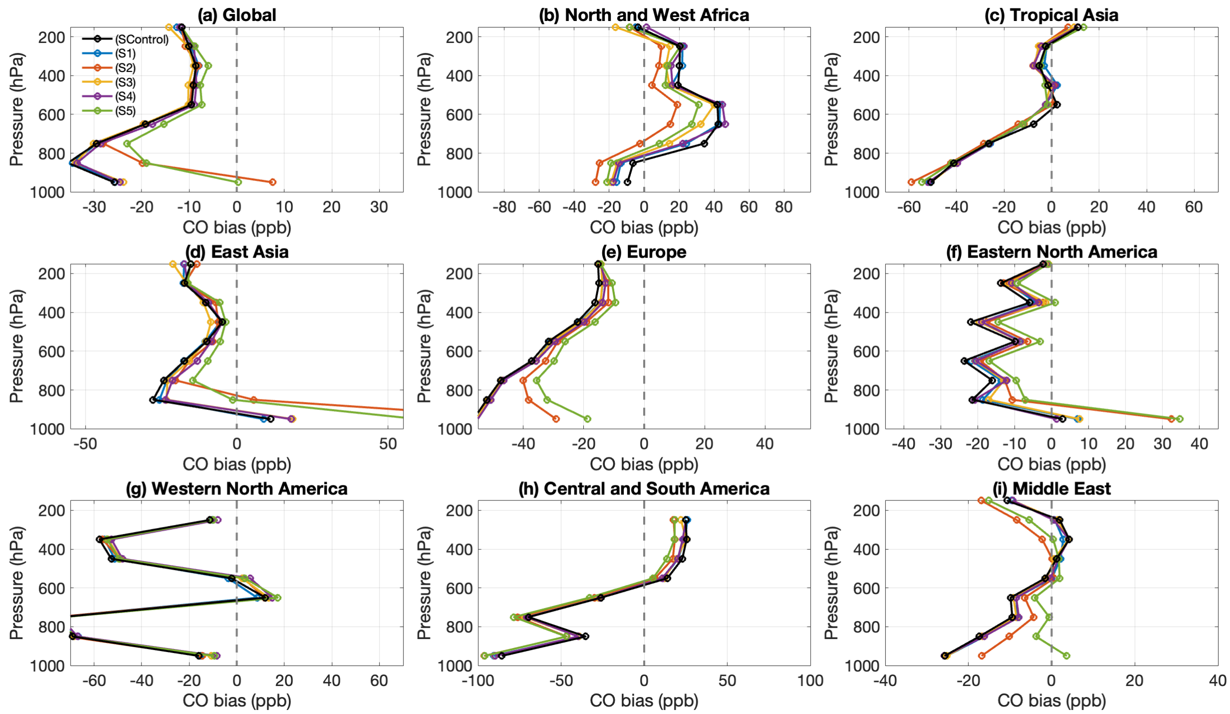

Figure S17. Mean biases (ppb) of modeled CO against CO profiles from the In-service Aircraft for a Global Observing System (IAGOS) measurements for the CAM-chem simulations with updated emissions and original emissions at different vertical levels. Locations of IAGOS CO profiles can be found in Figure S2. (S1) Simulation with emissions from (1) Column JNT assimilation; (S2) Simulation with emissions from (2) Profile JNT assimilation; (S3) Simulation with emissions from (3) Column TIR assimilation; (S4) Simulation with emissions from (4) Column TIR and column NIR assimilation; (S5) Simulation with emissions from (5) Profile TIR and column NIR assimilation; (SControl) Simulation with original CAMS and FINN emissions.

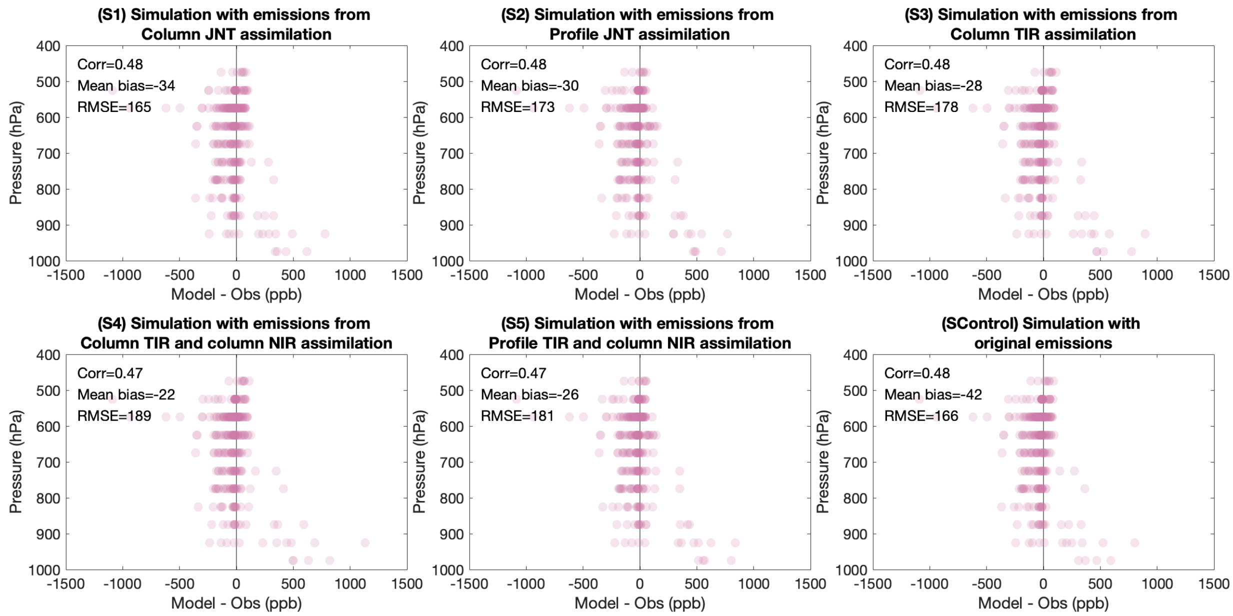

Figure S18. Mean biases (ppb) of modeled CO against airborne CO observations from the Western wildfire Experiment for Cloud chemistry, Aerosol absorption and Nitrogen (WE-CAN) field campaign for the CAM-chem simulations with updated emissions and original emissions at different vertical levels.