

Supplementary Information: Yin et al., 2017, On biases in atmospheric CO inversions assimilating MOPITT retrievals

Figure S1. MOPITT vertical profiles for latitudinal band for four seasons.

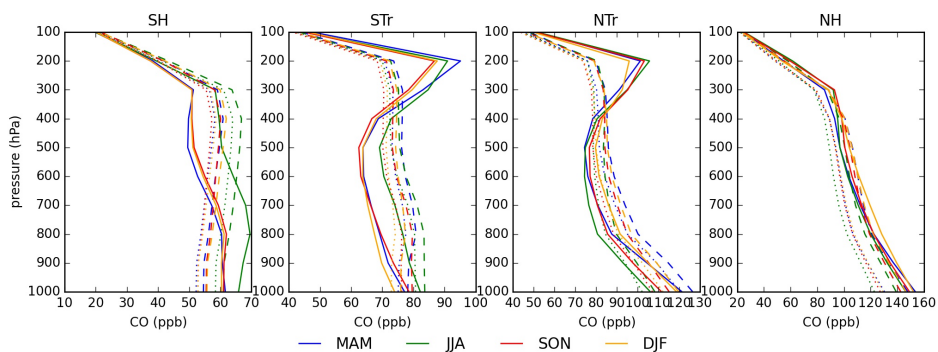


Figure S2. Observed and modelled CO seasonal cycle amplitude. Color scheme shows the simulation type; Marker type indicate observation types (triangle – MOPITT X_{CO} , rectangle – TCCON X_{CO} , dot – surface observations).

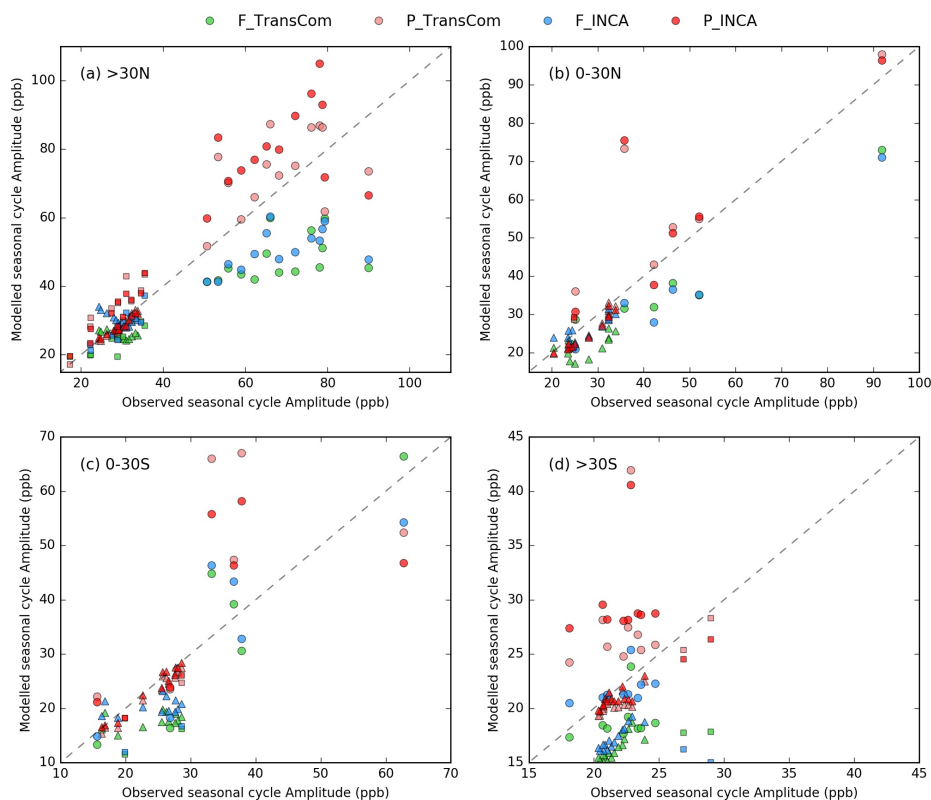


Figure S3. Scatter plot showing relative difference in MOPITT equivalent X_{CO} (x-axis) and surface [CO] (y-axis). (a) and (b) difference between the high-resolution models (HR) and the reference medium-resolution model (MR) for the forward or posterior simulations. (c) and (d) differences between HR1 and HR2 for the forward or posterior simulations.

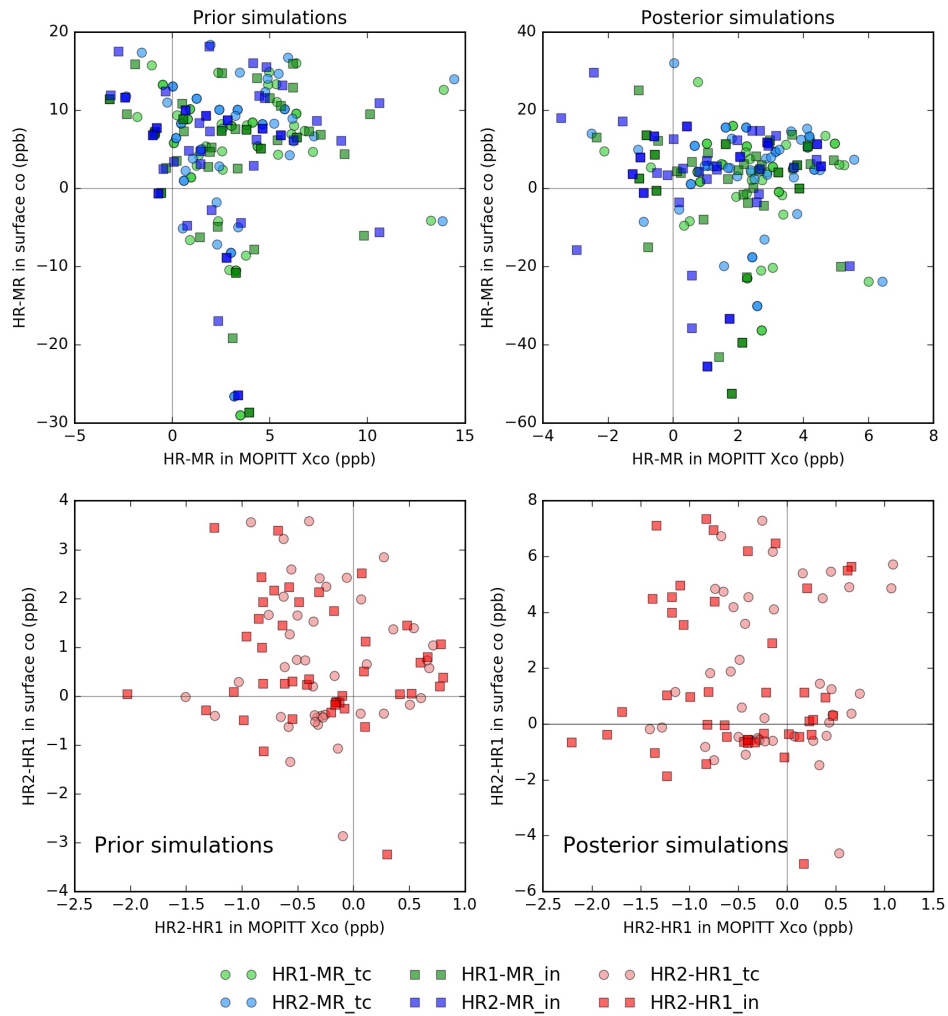


Table S1. TCCON stations and summary of model-data differences and correlation coefficients.

| Station | lat | lon | Alt (m) | MR | | | | TD | | | | AR4 | | | |
|-----------------------|-------|--------|------------|------------|------|-----------|------|------------|------|-----------|------|------------|------|-----------|------|
| | | | | F_bias | F_r | P_bias | P_r | F_bias | F_r | P_bias | P_r | F_bias | F_r | P_bias | P_r |
| Bialystok, Poland | 53.2 | 23.0 | 180 | -20.4±4.9 | 0.93 | 11.6±6.7 | 0.91 | -17.3±4.5 | 0.95 | 14.1±7.6 | 0.88 | -17.8±4.8 | 0.94 | 13.9±8.0 | 0.87 |
| Bremen, Germany | 53.1 | 8.9 | 27 | -20.2±6.1 | 0.90 | 9.6±7.1 | 0.89 | -16.9±5.7 | 0.92 | 12.3±7.6 | 0.87 | -17.7±6.0 | 0.91 | 11.3±7.9 | 0.85 |
| Darwin, Australia | -12.4 | 130.9 | 30 | -11.6±9.4 | 0.81 | -1.9±7.3 | 0.87 | -13.7±8.8 | 0.84 | -4.3±6.2 | 0.91 | -12.7±8.4 | 0.85 | -3.1±6.1 | 0.91 |
| Eureka, Canada | 80.1 | -86.4 | 610 | -23.2±6.1 | 0.85 | 7.3±8.7 | 0.83 | -17.2±6.2 | 0.86 | 13.4±7.3 | 0.84 | -17.7±6.3 | 0.85 | 13.1±8.2 | 0.82 |
| Garmisch, Germany | 47.5 | 11.1 | 740 | -17.1±6.8 | 0.84 | 9.5±6.7 | 0.88 | -13.1±6.5 | 0.85 | 14.4±7.4 | 0.86 | -13.6±6.7 | 0.84 | 13.7±7.8 | 0.84 |
| Izana, Tenerife | 28.3 | -16.5 | 2370 | -8.9±8.4 | 0.31 | 9.6±6.5 | 0.63 | -4.9±8.2 | 0.32 | 13.7±6.0 | 0.67 | -5.9±7.7 | 0.30 | 11.4±5.1 | 0.70 |
| JPL, USA | 34.1 | -118.1 | 230 | -22.9±9.9 | 0.53 | -7.5±8.4 | 0.70 | -20.0±10.2 | 0.54 | -4.3±9.0 | 0.70 | -19.7±10.0 | 0.54 | -3.8±8.7 | 0.70 |
| Kalsruhe, Germany | 49.1 | 8.4 | 116 | -20.8±5.8 | 0.90 | 7.6±5.4 | 0.91 | -17.7±5.1 | 0.92 | 11.9±6.2 | 0.89 | -18.5±5.4 | 0.92 | 10.8±6.4 | 0.88 |
| Lamont, USA | 36.6 | -97.5 | 320 | -15.3±8.2 | 0.78 | 8.6±8.9 | 0.85 | -14.3±8.5 | 0.78 | 8.4±10.6 | 0.84 | -14.9±8.5 | 0.76 | 8.0±10.0 | 0.83 |
| Lauder, New Zealand | -45.0 | 169.7 | 370 | -4.5±5.7 | 0.90 | 4.2±5.1 | 0.91 | -4.2±5.3 | 0.92 | 4.6±5.2 | 0.90 | -4.5±5.4 | 0.92 | 3.9±5.2 | 0.90 |
| Orleans, France | 48.0 | 2.1 | 130 | -17.2±6.6 | 0.90 | 9.1±6.8 | 0.92 | -12.7±5.8 | 0.93 | 13.6±7.1 | 0.92 | -13.1±6.0 | 0.92 | 13.2±7.5 | 0.91 |
| Parkfalls, USA | 48.5 | 2.4 | 60 | -17.1±7.5 | 0.80 | 14.4±10.8 | 0.77 | -14.6±6.7 | 0.84 | 18.2±11.1 | 0.76 | -15.0±6.9 | 0.82 | 17.9±11.4 | 0.75 |
| Reunion Island | -20.9 | 55.5 | 87 | -14.0±11.8 | 0.26 | 5.9±9.4 | 0.61 | -16.9±10.0 | 0.46 | 2.6±6.3 | 0.84 | -16.0±10.5 | 0.42 | 4.0±6.5 | 0.82 |
| Saga, Japan | 33.2 | 130.3 | 7 | -14.0±11.7 | 0.42 | 1.6±10.2 | 0.50 | -12.3±9.5 | 0.56 | 5.3±9.4 | 0.56 | -12.6±7.8 | 0.64 | 4.7±7.6 | 0.65 |
| Sodankyla, Finland | 67.4 | 26.6 | 188 | -21.2±7.1 | 0.74 | 5.4±8.5 | 0.72 | -16.4±6.5 | 0.80 | 10.6±9.0 | 0.70 | -16.6±6.5 | 0.80 | 10.8±9.5 | 0.70 |
| Tsukuba, Japan | 36.1 | 140.1 | 30 | -21.3±15.1 | 0.32 | -2.2±13.6 | 0.45 | -19.0±13.4 | 0.42 | 2.5±12.3 | 0.55 | -19.6±12.9 | 0.47 | 1.4±11.3 | 0.64 |
| Wollongong, Australia | -34.4 | 150.9 | 30 | -9.8±9.5 | 0.68 | -0.4±8.9 | 0.72 | -10.4±9.5 | 0.69 | -1.1±9.2 | 0.70 | -10.3±9.5 | 0.69 | -1.4±9.1 | 0.71 |

Table S2. Surface stations of CO for trend study and cross validation.

| Station | Contributor | Lat | Lon | Alt | Country/ Territory | Category |
|-------------------|-------------|-------|--------|-------|-----------------------|--------------|
| Alert | CSIRO | 82.5 | -62.5 | 210 | Canada | Global |
| Alert | EC | 82.5 | -62.5 | 210 | Canada | Global |
| Alert | NOAA | 82.5 | -62.5 | 210 | Canada | Global |
| Arrival Heights | NIWA | -77.8 | 166.7 | 184 | New Zealand | Regional |
| Ascension Island | NOAA | -7.9 | -14.4 | 54 | UK | Regional |
| Assekrem | NOAA | 23.3 | 5.6 | 2710 | Algeria | Global |
| Baltic Sea | NOAA | 55.4 | 17.2 | 28 | Poland | Regional |
| Baring Head | NIWA | -41.4 | 174.9 | 85 | New Zealand | Regional |
| Baring Head | NOAA | -41.4 | 174.9 | 85 | New Zealand | Regional |
| Barrow | NOAA | 71.3 | -156.6 | 11 | USA | Global |
| Black Sea | NOAA | 44.2 | 28.7 | 3 | Romania | Regional |
| Bukit Koto Tabang | NOAA | -0.2 | 100.3 | 864.5 | Indonesia | Global |
| Cape Ferguson | CSIRO | -19.3 | 147.1 | 2 | Australia | Regional |
| Cape Grim | CSIRO | -40.7 | 144.7 | 94 | Australia | Global |
| Cape Grim | NOAA | -40.7 | 144.7 | 94 | Australia | Global |
| Cape Kumukahi | NOAA | 19.5 | -154.8 | 3 | USA | Regional |
| Cape Point | NOAA | -34.4 | 18.5 | 230 | South Africa | Global |
| Cape Rama | CSIRO | 15.1 | 73.8 | 60 | India | Contributing |
| Casey Station | CSIRO | -66.3 | 110.5 | 60 | Australia | Regional |
| Christmas Island | NOAA | 1.7 | -157.2 | 3 | Kiribati | Regional |
| Cold Bay | NOAA | 55.2 | -162.7 | 25 | USA | Regional |
| Crozet | NOAA | -46.5 | 51.9 | 120 | France | Regional |
| East Trout Lake | EC | 54.4 | -105.0 | 492 | Canada | Regional |
| Easter Island | NOAA | -27.1 | -109.5 | 50 | Chile | Regional |
| Egbert | EC | 44.2 | -79.8 | 253 | Canada | Regional |
| Fraserdale | EC | 49.9 | -81.6 | 210 | Canada | Regional |
| Guam | NOAA | 13.4 | 144.8 | 2 | USA | Regional |
| Halley Bay | NOAA | -75.6 | -26.5 | 33 | UK | Global |
| Hegyhatsal | NOAA | 47.0 | 16.7 | 248 | Hungary | Regional |
| Heimaey | NOAA | 63.4 | -20.3 | 100 | Iceland | Regional |
| Izana (Tenerife) | NOAA | 28.3 | -16.5 | 2367 | Spain | Global |
| Jungfrauoch | Empa | 46.5 | 8.0 | 3580 | Switzerland | Global |
| Key Biscayne | NOAA | 25.7 | -80.2 | 3 | USA | Regional |
| Kollumerwaard | RIVM | 53.3 | 6.3 | 0 | Netherlands | Regional |
| Mace Head | AGAGE | 53.3 | -9.9 | 8 | Ireland | Global |
| Mace Head | NOAA | 53.3 | -9.9 | 8 | Ireland | Global |
| Macquarie Island | CSIRO | -54.5 | 159.0 | 12 | Australia | Regional |
| Mahe Island | NOAA | -4.7 | 55.2 | 7 | Seychelles | Regional |
| Mauna Loa | CSIRO | 19.5 | -155.6 | 3397 | USA | Global |
| Mauna Loa | NOAA | 19.5 | -155.6 | 3397 | USA | Global |

| | | | | | | |
|-----------------------|-------|-------|--------|------|-------------|--------------|
| Mawson | CSIRO | -67.6 | 62.9 | 32 | Australia | Regional |
| Minamitorishima | JMA | 24.3 | 154.0 | 8 | Japan | Global |
| Neuglobsow | UBA | 53.2 | 13.0 | 65 | Germany | Regional |
| Niwot Ridge | NOAA | 40.1 | -105.6 | 3523 | USA | Regional |
| Ocean Station "M" | NOAA | 66.0 | 2.0 | 5 | Norway | Regional |
| Ochsenkopf | NOAA | 50.0 | 11.8 | 1185 | Germany | Contributing |
| Pacific Ocean | NOAA | 0.0 | -155.0 | 10 | USA | Mobile |
| Pallas-Sammaltunturi | NOAA | 68.0 | 24.1 | 560 | Finland | Global |
| Park Falls | NOAA | 45.9 | -90.3 | 868 | USA | Regional |
| Parmer Station | NOAA | -64.9 | -64.0 | 10 | USA | Regional |
| Payerne | Empa | 46.8 | 7.0 | 490 | Switzerland | Regional |
| Plateau Assy | NOAA | 43.3 | 77.9 | 2519 | Kazakhstan | Regional |
| Point Arena | NOAA | 39.0 | -123.7 | 17 | USA | Regional |
| Ragged Point | NOAA | 13.2 | -59.4 | 45 | Barbados | Regional |
| Rigi | Empa | 46.1 | 8.5 | 1031 | Switzerland | Regional |
| Ryori | JMA | 39.0 | 141.8 | 260 | Japan | Regional |
| Sable Island | EC | 43.9 | -60.0 | 5 | Canada | Regional |
| Sand Island | NOAA | 28.2 | -177.4 | 7.7 | USA | Regional |
| Sary Taukum | NOAA | 44.5 | 75.6 | 412 | Kazakhstan | Regional |
| Schauinsland | UBA | 47.9 | 7.9 | 1205 | Germany | Regional |
| Sede Boker | NOAA | 31.1 | 34.9 | 400 | Israel | Regional |
| Shemya Island | NOAA | 52.7 | 174.1 | 40 | USA | Regional |
| Sonnblick | UBA | 47.1 | 13.0 | 3106 | Austria | Regional |
| South Pole | CSIRO | -90.0 | -24.8 | 2810 | USA | Global |
| South Pole | NOAA | -90.0 | -24.8 | 2810 | USA | Global |
| Southern Great Plains | NOAA | 36.8 | -97.5 | 314 | USA | Contributing |
| St. David's Head | NOAA | 32.4 | -64.7 | 30 | UK | Regional |
| Syowa Station | NOAA | -69.0 | 39.6 | 16 | Japan | Regional |
| Tae-ahn Peninsula | NOAA | 36.7 | 126.1 | 20 | Korea | Regional |
| Terceira Island | NOAA | 38.8 | -27.4 | 40 | Portugal | Regional |
| Tierra del Fuego | NOAA | -54.9 | -68.5 | 20 | Argentina | Regional |
| Trinidad Head | NOAA | 41.1 | -124.2 | 120 | USA | Global |
| Tudor Hill | NOAA | 32.3 | -64.9 | 30 | UK | Regional |
| Tutuila | NOAA | -14.2 | -170.6 | 42 | USA | Global |
| Ulaan Uul | NOAA | 44.5 | 111.1 | 914 | Mongolia | Regional |
| Waliguan | NOAA | 36.3 | 100.9 | 3810 | China | Global |
| Wendover | NOAA | 39.9 | -113.7 | 1320 | USA | Regional |
| Yonagunijima | JMA | 24.5 | 123.0 | 30 | Japan | Regional |
| Zeppelinfjellet | NOAA | 78.9 | 11.9 | 475 | Norway | Global |