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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Seasonal variability of surface and column carbon monoxide over megacity Paris, high altitude Jungfraujoch and Southern Hemispheric Wollongong stations" *by* Y. Té et al.

Anonymous Referee #2

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General Comments

This manuscript presents CO measurements from three ground-based FTIR spectrometers, surface in-situ sensors, and two satellite instruments, along with simulations from the GEOS-Chem model. The seasonal variability of CO total columns, tropospheric columns, and boundary layer mixing ratios is examined. GEOS-Chem simulations are used to identify causes of this season variability and to show how it differs between urban, high-altitude, and Southern Hemisphere sites.

This work presents a new FTIR dataset from Paris and provides an interesting com-

parison between CO measurements at three very different locations. However, the analysis and interpretation should be significantly revised to strengthen the discussion of the results. The manuscript also has many distracting technical and grammatical errors that need to be corrected. I recommend publication after the issues below are carefully addressed.

Specific Comments

Page 1, line 2 – This sentence ("altitude-dependent seasonal variability") implies that seasonal variability will be examined as a function of altitude, e.g., as vertical profiles. This is not the case, so this sentence should be revised to clarify that the study examines total and partial columns and surface measurements.

Section 1, Introduction – The first paragraph is rather simplistic. This whole section should be revised to provide a more comprehensive review of CO chemistry, sources and sinks including current best quantitative estimates, drivers of seasonal variability, and outstanding questions, to provide a clear motivation for the present work. Don't we already know a lot about CO seasonal variability? What does this work aim to add to current knowledge?

Pages 2-3, lines 47-67 – Inconsistent information is provided for each of the three sites and some material is repeated in Section 2. The paragraph for Paris describes the location and CO trends; the paragraph for Jungfraujoch describes the instrument and air sampled; the paragraph for Wollongong just describes the site. Revise to provide the same information for each site and avoid duplication with information later provided in Section 2.

Sections 2.1, 2.2, 2.3 – These more detailed instrument descriptions are also inconsistent with regard to the information provided. Provide the same information about all three FTIR instruments. Some of this information could also be summarized more efficiently in a table.

Sections 3.1, 3.2, 3.3 – Similarly, review these three sections to ensure the same level of detail is provided for each data set. e.g., DOFS, source of a priori data, etc. What terms are included in the random uncertainty error estimates? Are they the same terms for all three sites? What are the systematic errors?

Page 7, Figure 1 – Include averaging kernels for all three sites and comment on similarities and differences. Add total column averaging kernels and sensitivity. Could show the seasonal average AVKs used for smoothing (as described on page 11, line 290). Also plot the AVKs for IASI and MOPITT. Page 9 – give DOFS for IASI and MOPITT.

Page 7, line 198 and page 9, lines 219 and 222 – WACCM v6 is the current version being used by the NDACC IRWG. Is v4 correct?

Page 10, lines 295-305 – Why are the in-situ data daily for Paris, but monthly averages for Wollongong and Jungfraujoch? Are the Paris data used to generate monthly averages too? Clarify.

Page 12, line 318 – Is a simple sine function the most appropriate function to use to fit the time series? Explain in the text.

Page 12, lines 327 – Is 184 +- 4 days the period for some combination of Paris and Jungfraujoch data? Why is no uncertainty given for 191 days? Line 335 – what is the period for Wollongong?

Page 12, lines 347-349 – Was the MOPITT vertical resolution really increased by interpolating between the pressure levels? Correct this sentence.

Page 13, line 365 – Did these inverse modeling studies use GEOS-Chem?

Page 14, Figure 4 – Give the correlation coefficient R^2, as was done in Figure 3. Why combine the data from the two satellite instruments in these correlation plots?

Page 14, line 369 – Since GEOS-Chem, and presumably other models, capture the seasonal variability of CO, this implies that we have good knowledge of the processes

controlling it. So what new knowledge is this study contributing? This needs to be better articulated in the Introduction and Conclusions.

Page 14, lines 380-381 – Why exclude the data influenced by local processes, since the study is evaluating causes of variability? Line 384 then says that local CO emissions still affect the variability. This should be better explained.

Page 15, Figure 5 – This caption is incorrect (only shows Paris) and provides insufficient information about what is shown.

Page 15, line 390 – It is difficult to do a meaningful comparison of seasonal cycles just by inspection of Figures 2 and 5.

Pages 15 – There is insufficient discussion of the role of sunlight and OH oxidation on the seasonal cycle of CO.

Page 15, especially lines 400-405 – Various statements about attribution are made in this paragraph but without a clear justification, e.g., “At Paris, the seasonality introduced by these distant sources outweighs the contribution of the local surface.” This paragraph should be strengthened. Same comment for lines 421-422 – what is the basis for the statement “The surface CO seasonal variation is deeply impacted and driven by local anthropogenic emissions.”? No back-trajectory, Lagrangian, or adjoint modelling is done to back up statements about transported sources. A stronger case needs to be made for all attribution statements.

Page 16, Figure 6 – This caption is completely incorrect.

Pages 18-19 – The discussion of the relative importance of different sources to the seasonal variability of CO at the three sites should also be strengthened. Source strengths should be compared to the underlying seasonal cycle due to oxidation of CO by OH, which ultimately depends on sunlight. Results should be put in context with references to the literature, including some of those cited in the manuscript. A few other possible examples: Derwent et al., Obs and interpretation of seasonal cycles of ...

ozone and carbon monoxide ... Atmos. Env. 1998. Holloway et al., Global distribution of carbon monoxide, JGR, 2000. Duncan et al., Global budget of CO, 1988–1997: Source estimates and validation with a global model, JGR 2007. Zellweger et al., Intercomparison of four different carbon monoxide measurement techniques and evaluation of the long-term carbon monoxide time series of Jungfraujoch, ACP 2009. etc.

Conclusions – State clearly what new information this work contributes to our understanding of atmospheric CO abundance and variability.

Technical Corrections

Page 1, line 1 – a key atmospheric species

Page 1, line 2 – altitude-dependent

Page 1, line 3 – at three different sites: Paris

Page 1, line 9 – by the IASA-MetOp

Page 1, line 9 – define FTIR

Page 1, line 12 – near-surface

Page 1, line 14 – identification

Page 1, line 15 – delete “on top of”

Page 2, line 18 – Revise “between the surface and above the boundary layer” – between the surface and the free troposphere?

Page 2, line 21 – delete “of”

Page 2, line 30 – defective

Page 2, line 33 – energy-related

Page 2, line 35 – CO

Page 2, line 42 – high-resolution

Page 2, line 43 – define FTIR here, not on line 68

Page 3, line 50 – has been continuously

Page 3, line 70 – and have monitored the

Page 4, line 85 – FTS-Paris is a model

Page 4, line 95 – signal-to-noise ratio

Page 4, line 96 – detector provides coverage of the spectral

Page 4, line 110 – delete “network”

Page 6, line 161 – were recorded over 3 min intervals at the

Page 6, line 162 – were analyzed.

Page 6, line 169 – using the HITRAN 2008 . . . delete “as”

Page 6, line 178 – Figure 1 shows

Page 7, line 187 – in Dils et al. (2011).

Page 8, line 202 – down to the

Page 8, line 209 – Barrett et al. (2003),

Page 8, lines 202, 210, 211 – inconsistent dashes for number ranges

Page 9, line 221 – signal-to-noise ratio

Page 9, line 230 – delete “from the IASI sounder on the MetOp satellite”

Page 9, line 238 – profiles

Page 9, line 242 – using version 6 retrievals

Page 10, line 252 – can be used to simulate global

Page 10, lines 251-252 – (Bey et al., 2011; Park et al., 2004; etc.)

Page 11, line 312 – regular basis

Page 11, line 316-317 – delete “the low altitude . . . here.”

Page 12, line 339 – delete “satellite”

Page 12, line 343 – high-altitude

Page 12, line 345 – footprint not only includes the site, but

Page 13, Figure 3 caption – ground-based. Also describe panels in order from top to bottom, not top, middle, bottom.

Page 13, line 354 – Text says satellite data for Jungfraujoch is shown in Figure 3, but so are data for Paris and Wollongong.

Page 14, line 384 – due to anthropogenic

Page 15, line 401 – what is meant by “warming system”?

Page 16, line 410 – at the end of

Page 16, line 411 – at the end of

Page 16, line 419 – low-altitude sites

Page 16, line 420 – variability to the

Page 17, line 434 – The increases after March

Page 19, line 484 – which confirm

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