**Atmospheric
Chemistry
and Physics
Discussions**

Interactive comment on "CO at 40–80 km above Kiruna observed by the ground-based microwave radiometer KIMRA and simulated by the whole atmosphere community climate model" *by* C. G. Hoffmann et al.

Anonymous Referee #3

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1/ General Remarks This paper gives a good comparison of model simulation output with 2 forms of observation (ground based profile and Satellite data) for a difficult single point observational dataset situation. The use of the 'forced' ground to lower thermosphere model is a relatively new and powerful tool, this version using simple relaxation with analyses appears to achieve good results for creating model data for specific dates/events.

The paper is reasonably well written and constructed with diligence. The figures are in my opinion well designed and produced.

I recommend that the paper should be published, subject to only a few minor corrections and clarifications. Most of my comments below are intended as information seeking questions hoping to enhance the papers content rather than critiques per se.

2/ Specific Remarks

Page 563 the phrase 'essentially the same numeric' is rather vague can this be clarified.

Page 566 Rather than keep stating the 'smallest space scale and time scale currently simulated' I think it would be better to say the resolution specifics.

Page 567 I would be interested to know more of the filter characteristics of a relaxation of this kind upon the various model scales as this incorporates all analysis scales both good and bad from the assimilation/analysis product. Also since analyses are usually 6 hourly products what is done in between the analysis times for the GEOS-5 data? More sophisticated assimilation techniques used in anlysis production all will filter the input data as part of the process to achieve a representation of the data for specific dates. Has any work been done on the way the relaxation 'filter' character on the dynamical information and the model state, namely what wave processes/scales are damped and to what degree?

Page 567 line 12: The limit of relaxation at 50km is persumably the top of the GEOS-5 data? Are there any concerns with use of the upper level analyses based on another models near-lid representation?

Page 568/569 The majority of gravity wave(GW) drag is not part of the analysis as its parameterized as is pointed out and so GW forcing therefore will be largely a forcing outside of the relaxation mechanism. However some resolved GW information is part of the relaxed state and so is added by the relaxation process. Any 'assimilation' adds GWs, so even since most GWs are parameterized and as such independent of the relaxed state how does this extra counting impact the simulation?

Page 562 Has any effort been made to examine how the tides respond to the relaxation

technique in particular if the analyses are 6hourly data? (see earlier question).Tidal motions play a big part in species distributions in the region of interest especially for specific location analyses. Maybe this is beyond the scope of this paper.

Page 577 line 1 Absolute deviation shows -3 to -4 ppmv for KIMRA, Below 68km the deviation is small and less than 1ppmv but KIMRA shows a later 'knee' in the CO and falls off more rapidly from about 62km compared with the MLS, and WACCM which are definitely more consistent. The text talks mostly of the absolute deviation re MLS and doesnt discuss the larger KIMRA differences. Infact if you are going to compare MLS to WACCM then would it not be better for figure 2 to maybe show absolute deviations between these 2 datasets. The paper is after all titled as a comparison with the KIMRA data so the emphasis would seem more naturally to be with this dataset.

General comment: Since this is an examination of CO I am interested to know how well the CO_2 is modelled simultaneously as these 2 species are obviously coupled in the upper atmosphere in terms of chemistry and transport. It would be interesting to know if the CO_2 is as well modelled as the CO for this case, to see if the model is correctly getting the real chemical and transport balance of this subset of the chemical system.

Page 565 KIMRA data retrieval must be very sensitive to the temperatures used how different were the T profiles in the retrieval and the modelled T profiles?

3/ Technical issues

Page 560 line 25 'dynamics are very well' not 'is'

Page 561 line 20 typo = 'events occurred in the past' not 'is'

Page 561 line 26/27 The sentence here reads slightly awkwardly. 'This shows that the understanding of the Arctic middle atmosphere dynamics is still...' maybe use: 'This shows that a full understanding of Arctic middle atmosphere dynamics is still incomplete...'

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