

## ***Interactive comment on “Seasonal evaluation of tropospheric CO<sub>2</sub> over the Asia-Pacific region observed by the CONTRAIL commercial airliner measurements” by Taku Umezawa et al.***

### **Anonymous Referee #1**

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General comments: This paper reports 10 years of CO<sub>2</sub> measurements from the upper troposphere and from vertical profiles above 16 airports across Asia, obtained from commercial airline flights by the CONTRAIL program. This data set is extensive, high quality, unique and especially valuable for the reason that it defines the CO<sub>2</sub> field above the surface in a sparsely observed part of the atmosphere.

In this study the authors investigate the upper tropospheric CO<sub>2</sub> distribution over the Asia-Pacific region. They focus on some notable features, for example zones of low summertime CO<sub>2</sub> above East Asia and boreal Asia, and interpret them in terms of surface exchange and transport processes using the NICAM-TM model.

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Specific comments: This is a good paper that makes a solid contribution to its field. My only issue with the science presented relates to the discussion of vertical profiles above Asian cities in section 3.2 (3rd paragraph). The claim is made that these profiles differ from others outside of Asia with “absence of a dramatic decrease of CO<sub>2</sub> near the ground in the summer. . . . .implying that the observed vertical profiles in the summer are not strongly influenced by uptake underneath”. My concern is that by nature of this program where the vertical profiles are above large population centres (and CO<sub>2</sub> source regions), there may be a bias towards higher CO<sub>2</sub> in the boundary layer than what was observed in vertical profile data elsewhere. The authors should address this possibility.

There is one section where some clarification and more detail is required. The 1st paragraph of section 2.1 (line 16-19 on page 3) describes standard gas measurement intervals. Where it is stated “intervals were initially 10 min. . . .20 min...” it is not clear if the 10 and 20 minute intervals etc. refer to the duration of, or the time between standard analyses. It would be helpful to specify exactly what the analysis time cycles are. For example, during the 14 minute cycle, sample air is measured for x minutes, then standard 1 for y minutes and standard 2 for z minutes. It would also be useful to record what time or fraction of these data are rejected after switching gas streams.

Technical comments: A list of technical corrections follows. Many of these address overuse of “the” or “a”. While the English used in the paper is generally very good, the readability could be easily improved by attention to these instances. Page 1, line 17 – delete “the” to leave “Pacific Rim of continental East Asia” P2, line 5 – “an increasing number” P2, line 16 – reword to “. . .less-well studied features of the CO<sub>2</sub> distribution that are associated with the Asian monsoon.” P2, line 31 – “another zone of low CO<sub>2</sub>” P3, line 27 – “flights to continental East Asia” P3, line 29 – “over continental Asia” P4, line 5 – reword to “Although measurements at other airports are less regular, data from sites where a substantial number of vertical profiles have been taken and cover much of the year, are included in this study.” P4, section 2.2, 1st paragraph – It would be

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appropriate to define here what is meant by upper troposphere. Figure 3 suggests altitudes > 8 km. It might also be worth briefly commenting on the upper boundary, presumably the tropopause, and how its height varies with latitude. P4, line 11 – “in atmospheric composition” P6, line 3 – “low CO2 values” and “of UT” P6, line 4 – “by moderately” P6, line 5 – “over boreal” P6, line 7 – “with distinctly” P6, line 22 – “by CONTRAIL observations” P6, line 23 – “500-m altitude” P6, line 24 – “due to boundary layer (BL) processes” P6, line 25 – “is beyond the scope of this study” P7, line 1 – “CONTRAIL observations provide greater” P7, line 28 – “east coast of continental” P7, line 30 – “lagging the lower troposphere (LT) minimum” P8, line 7 – “uptake by crops” P8, line 11 – “measurable” P8, line 14 – “in tropical Asia” P8, line 20,28,31 – “observations” P8, line 33 – “depletion of CO2 over boreal” P10, line 9 – Fig. 4g instead of 5g P11, line 14 – “in boreal” P11, line 20 – “in the UT is consistent” P11, line 29 – “over boreal”, also replace “inferring” with “implying” P12, line 1 – “in boreal” P12, line 2 – delete “relatively” P13, line 14 – “sweep continental” P13, line 18 – “from continental” P13, line 21 – replace “flights” with “profiles” P16, line 4 – Matsueda and Inoue (1999) appears in the reference list but is not referred to in the text Figure 6 – 1) add y-axis (latitude) labels, 2) the black lines showing geopotential height in the last column are meaningless without some numerical labelling Figure 6 caption, lines 1-2 – columns 1 – 4 show  $\Delta\text{CO}_2$ ,  $\Delta\text{FF CO}_2$  and  $\Delta\text{BB CO}_2$  Figure 6 caption, line 6 – CO2 isolines

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