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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Carbon balance of South Asia constrained by passenger aircraft CO_2 measurements" *by* P. K. Patra et al.

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Thank you very much for appreciating the work. We too hope more research in the future will help us understand further details of greenhouse gases cycling in this region. However, we would like to mention here that 3 other transport models systematically underestimate the CO2 concentrations over Delhi with respect to a remote island Minamitorishima in the western Pacific Ocean (Niwa et al., ACPD, 2011), while using TDI22 fluxes, during June-August months.

As far as our information goes, presently CO2 measurements are conducted at about four sites in India through collaborative efforts between institutes in India and Australia/France/Japan. We look forward to seeing the results out of those measurement programmes in the near future, and will be used for such inverse modeling studies by

us as soon as the data are available outside the measurement groups.

Page 5384, line 26: The extrapolation method of CARIBIC data to the earlier months is displayed in Supplementary Figure 1. Basically the ACTM simulations are used for Jan-Mar months, when CARIBIC observations were not available, and as shown in the supplementary figure as well as by the validation effort using CONTRAIL data (Fig. 4 & 5), this seems to be a reasonable approach. There was no alternative method available at our disposal to extrapolate less then one year of data.

Page 5386, line 6: This addition will be done in the revised ACP version.

Figure 1: We are not showing the optimal fit to the data by inverse modeling. We use the forward simulation results of the inversion fluxes in Fig. 1 (also Supplementary Fig. 1). The a posteriori data match within the error bars of the observations, but those statistics do not represent the quality of inversion fluxes. Please note that when the inversion fluxes are used in forward simulation and again compared to the same set of data, the results do not show exactly the same match as the a posteriori data. The reason is that the forward run of the inversion fluxes accounts for the remote as well as local fluxes, while the a posteriori fit is mostly related to the local region.

To help the readers, we modify the Fig. 1 caption to 'Comparison between ACTM simulated concentrations and CARIBIC observations. . .'

Page 5386, line 20: Yes, that exactly is the problem if CO2 only is used for validating model transport and infer surface fluxes. Thus we needed to employ 4 different species with distinct surface fluxes and photochemical destruction properties to assess the transport model error, and then attribute the CO2 model-data mismatches to the surface fluxes with greater confidence. This is particularly true when the data from the upper troposphere are to be used in estimating surface fluxes by inversion.

More discussion is given in the 2nd paragraph of our reply to reviewer#2.

Page 5386, line 25 Page 5387, line 2: Will be modified to 'Asian' in the revised ACP

version.

Page 5387, line 8: The annual budget would not have been given here, if the validation of TDI64/CARIBIC inversion fluxes using CONTRAIL CO2 observations looked unacceptable. We feel the 0.37 PgC/yr uptake is valid for the year 2007 and 2008 within the stated uncertainty of 0.2 PgC/yr. Thus the years are always mentioned when the annual uptakes are presented in abstract, main text and the conclusions.

Page 5389, line 10: It is difficult to argue very much at this point whether or not our results are true at decadal or longer time scales. We only hope that future studies using surface observations, mentioned earlier, will be able to tell us more about the regional carbon budget of the South Asia region. We modify this sentence to be more specific for our analysis years 'Thus, the total summer time uptake in South Asia is much less variable than the monthly mean fluxes in interannual time scales and is relatively well conserved between 2007 and 2008.'

Page 5389, line 18: Following your suggestion, 'impossible' will be changed to 'unlikely'

Page 5389, line 27: This sentence is modified as '. . .by CARIBIC, yet some uncertainties in forward model transport and site representation error in coarse model horizontal resolution remained'. ('remained' added)

Table 1: Since Table 1 is presented after Fig. 6, which showed the location of the airport and full name, we thought a footnote here is not required.

Figure 3: Line colour 'cyan' will be chosen

Figure 5: Line colour 'blue' will be chosen for TDI22

Figure 6: This panel nicely summarises the CONTRAIL flight tracks and data density and the locations of CO2 seasonal cycle comparison. A separate plot will disturb that integrity. Unless absolutely necessary, we would like to keep this Figure as it is.

Figure 7: This is a good suggestion, and such an analysis should constitute a detailed

network design paper in our opinion. We are afraid full justice cannot be done to this issue here. However, we show some of the response functions as used in our inversion as a Figure file with this reply. This will be included in the supplementary document as Supplementary Figure 3 in the revised ACP version, with following figure caption.

Supplementary Figure 3: Timeseries of response functions for 1.0 PgC/yr emission from the South Asia region of TDI64 are plotted. The responses sampled at (1) CRI, India surface site, (2) 4 selected/representative CARIBIC locations and (3) Hawaii at 7500 m (haa7500), which is located within the latitude range of South Asia region. Note that the response at haa7500 is generally greater for the first month of simulation during Feb, May and Nov. Because the vertical transport is not efficient, compared to the horizontal advection, during these months the South Asian flux signal first sampled further away, and later over the South Asia after the air is zonally well mixed. During the monsoon months of August, however, the South Asian signal is captured at the CARIBIC flight level due to vertical transport of flux signal by the deep cumulus convection.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 5379, 2011.

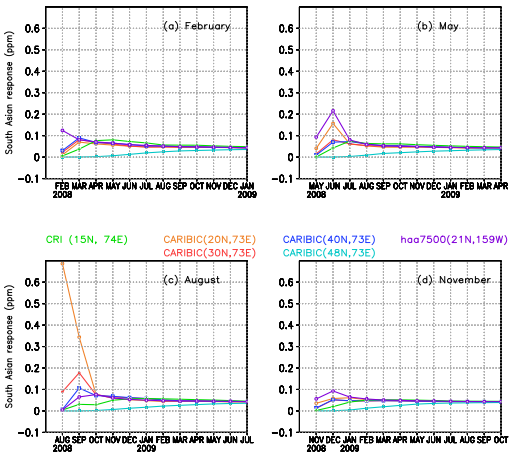
(a) February
(b) May
(c) August
(d) November
South Asian response (ppm)
CRI (15N, 74E)
CARIBIC(20N,73E)
CARIBIC(30N,73E)
CARIBIC(40N,73E)
CARIBIC(48N,73E)
haa7500(21N,159W)

Fig. 1.