Atmos. Chem. Phys. Discuss., 11, C2386–C2388, 2011
www.atmos-chem-phys-discuss.net/11/C2386/2011/

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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Received and published: 28 April 2011

Thank you very much for appreciating the work. We hope more research in the future will help us understand further details of greenhouse gases cycling in this region.

We agree with the reviewer that there are uncertainties in emission inventories of the supporting tracers (CH4, N2O, SF6). One would still be in doubt whether the transport or surface flux (likely to be the both) is the cause of model-observation mismatches, but since we used four tracers with distinct surface fluxes and photochemical loss properties, such a confusion is pretty much eliminated, if not entirely. For example, the low N2O values clearly identify the samples that are influenced by the stratospheric air (the model tends to underestimate the decreases in CH4, SF6 and CO2 for these samples). Separating those enables us to look for surface flux errors. The SF6 emis-

sions are relatively simple to estimate and probably have the lowest uncertainty among these 4 species, and you can see the model almost always tracks down the latitudinal variations for the tropospheric samples within the observational error bars. Only on August 13, the observed CH4, N2O and SF6 increases over the South Asia are underestimated beyond measurement uncertainties by the ACTM on both ways, although the latitudinal profile shape of CH4 is well reproduced. Considering all these aspects, we believe ACTM transport is fairly accurate to ingest upper tropospheric data in surface flux inversion. More comparisons of CO2 vertical profiles are given in Niwa et al. (ACPD, 2011).

Nevertheless, we have no hesitation to accept that there is still much room for improvements in modeling of minor constituents in the earth's atmosphere, from the perspectives of uncertainties in surface fluxes and model transport. Simplest of all is that we used quite course horizontal resolution (T42 or $\sim$2.8 x 2.8 degrees latitude x longitude) to be able to represent the monsoon dynamics and heterogeneity in surface fluxes accurately.

At the bottom of Page 5386: Following your recommendation we plan to introduce these sentences here. "During the JJA season most land regions of the northern hemisphere act as a strong sink, except the South Asian region for the TDI64 inversion (Fig. 2a). This is contradictory to an expected intense carbon uptake under the influence of the South Asian monsoon rainfall. This scenario however changes when CARIBIC CO2 observations are used in the inversion (Fig. 2c). For the SON season, both inversions produced similar CO2 fluxes, suggesting the information content in the CARIBIC data are in agreement with that in GLOBALVIEW-CO2."

Figure3b for Arabia: The fluxes for Arabia region are shown in Fig. 3 because the CARIBIC flight tracks passes over this region, and thus could be influenced towards a positive or negative flux when the South Asia becomes a strong sink due to the use of CARIBIC data. The results for the neighbouring regions are shown to emphasis the stability of the inversion system. We will add this sentence in the revised ACP version

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"Note that the changes in South Asian flux do not disturb the fluxes from the neighbouring regions of Northwest Asia and Arabia (Fig. 3a-b), even though the CARIBIC flight tracks pass over these regions."

Page 5382: Chemical tracer transport is driven by advection, convection and diffusion in the troposphere (Patra et al. (ACP, 2009) have shown relative contribution of these processes for SF6). However, the NCEP reanalysis (and other traditional reanalysis products) do not provide every information needed to model all these processes for tracer transport, and also the time step of 6-hourly interval is not sufficient for representing planetary boundary layer (PBL) processes and deep cumulus convection in the CTMs. On the contrary AGCM simulated meteorology is not accurate enough to model tracer transport for synoptic scale winds variations and often has temperature bias in the lower stratosphere. Thus we found AGCM nudged to a reanalysis winds and temperature provides us best results for longlived species simulation in the troposphere at hourly to annual timescales.

Page 5390: Thank you for pointing out this mistake. Will be corrected in the revised version.

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