Atmos. Chem. Phys. Discuss., 7, S2935–S2938, 2007
www.atmos-chem-phys-discuss.net/7/S2935/2007/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Perturbation of the European free troposphere aerosol by North American forest fire plumes during the ICARTT-ITOP Experiment in summer 2004" *by* A. Petzold et al.

A. Petzold et al.

Received and published: 7 July 2007

Response to Reviewer #2

The comments and remarks of reviewer #2 touch several aspects which will be discussed separately.

(1) The use of ECHAM results was limited to what a global model can contribute to such a study. The ECHAM emission inventory uses average values, so it cannot be used for a direct comparison of observations of single flights with model results. We discussed during the preparation of the manuscript whether it might be useful to run ECHAM for

year 2004 conditions in order to compare the results with observations. However, what could we learn from such an intercomparison of monthly averaged meteorological field data with single plume events probed during a particular flight? Even in case of good agreement we cannot evaluate the statistical robustness of such a result.

What ECHAM can deliver instead, is a vertical distribution of black carbon mass concentration. We decided to run the model for Year 2000 conditions as a reference case with reduced fire activity. Arguments are given in section 2.4, which show that year 2000 indeed is a good reference year with reduced boreal fire activities. There is no other possibility to get such a "background" vertical profile for BC mass for intercomparison with our observations. Without the ECHAM data the effect of the fire plumes on the black carbon mass level in the free troposphere would not be accessible.

The investigation of the effect of injection height on particle size distributions requires more detailed models which include aerosol dynamics and processing. For ECHAM/MADE this is not really the case since MADE in its implemented version is not capable of treating aerosol size distribution modifications (see section 2.4). Moreover, MADE is focusing on aerosol mass instead of microphysics.

(2) Data analysis strategy:

The reviewer raises a few questions concerning the availability of data and the underlying data analysis strategy. As is explained in the appendix, the analysis of PSAP data requires flight sequences at constant pressure since pressure changes affect the instrument response. Hence, absorption coefficient data are available only for those flight sequences where a constant level track crossed a forest fire plume. Unfortunately, this restriction limits the availability of a full data set consisting of size distributions and absorption coefficient data to a few plume encounters which are summarised in Table 5. The reviewer requests absorption coefficient information for the size distribution from 30 July. At this day, the smoke plume was only crossed during decent of the aircraft. Hence, the limitation of the number of full data sets is not a question of performed

ACPD
7, S2935–S2938, 2007

EGU

measurements but a matter of whether or not the smoke plume was probed during a constant level flight sequence.

PCASP data are available for all flight sequences. Although the PCASP is not affected by pressure changes, we decided to present only those flight sequences where all data are at hand. Furthermore, constant level sequences show better statistics in the size distribution since the duration of the plume encounter is longer than during a vertical decent across the plume. The size distribution parameterisations compiled in Table 6 refer to representative cases which characterise the probed plumes.

Concerning the question of a fixed relationship between BC and CO we used this parameter for an estimate of the export efficiency of BC. This approach follows the strategy presented by Park et al. (2005). Additionally, information of the ratio of BC to CO for fresh fire emissions is available from the Andreae and Merlet (2001) paper. The relationship between CO and BC has to be interpreted in this sense, because CO is an inert fire tracer which is also used in FLEXPART while carbonaceous particles may undergo various transformation and removal processes. Hence, the relationship is not established by any chemical processes but can be used for an estimate of the fraction of BC entering the long-range transport region of smoke plumes. Shifting from CO to BC is not just a transformation of variables but offers some insight into the fraction of BC transported over long distances.

The ambiguity of the conversion of absorption to black carbon mass is reflected in the use of apparent BC, following Andreae and Gelencser (2006). However, if we want to draw conclusions from our smoke plume observations to the export of black carbon mass from fire regions in North America to Europe, we have to convert the measured absorption to black carbon mass. The proposed conversion offers one approach with an estimated uncertainty of the order of 20%. Sticking to absorption coefficient data would not permit a determination of the export efficiency.

The responses to the reviewer's comments including the suggestion of rewriting sec-

ACPD

7, S2935–S2938, 2007

tion 3.2 on The European Free Troposphere for Periods of Normal Fire Activity will be considered in the revision of the manuscript before submission to ACP. A better separation of new results from existing knowledge will be organised in the manuscript revision. The discussion of fire aerosol properties as a function of plume age for tropical forest fires is to our opinion beyond the scope of this paper. Interested readers may refer to the paper by Dentener et al. (2006) where those size distributions are discussed. We will include a link to this discussion in the revised manuscript.

References

Andreae, M.O., and Merlet, P.: Emission of trace gases and aerosols from biomass burning, Global Biogeochem. Cyc., 15, 955 - 966, 2001.

Andreae, M.O. and Gelencser, A.: Black carbon or brown carbon? Atmos. Chem. Phys., 6, 3131-3148, 2006.

Dentener, F., Kinne, S., Bond, T., Boucher, O., Cofala, J., Generoso, S., Ginoux, P., Gong, S., Hoelzmann, J.J., Ito, A., Marelli, L., Penner, J.E., Putaud, J.-P., Textor, C., Schulz, M., van de Werf, G.R., and Wilson, J.: Emissions of primary aerosol and precursor gases for the years 2000 and 1750, prescribed data sets for AeroCom, Atmos. Chem. Phys., 6, 2703-2763, 2006.

Park, R.J., Jacob, D.J., Palmer, P.I., Clarke, A.D., Weber, R.J., Zondlo, M.A., Eisele, F.L., Bandy, A.R., Thornton, D.C., Sachse, G.W., and Bond, T.C.: Export efficiency of black carbon aerosol in continental outflow: Global implications, J. Geophys. Res., 110, D11205, doi:10.1029/2004JD005432, 2005.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 4925, 2007.