Atmos. Chem. Phys., 8, 3231-3246, 2008
www.atmos-chem-phys.net/8/3231/2008/

Transport pathways of CO in the African upper troposphere during the monsoon season: a study based upon the assimilation of spaceborne observations

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Abstract. The transport pathways of carbon monoxide (CO) in the African Upper Troposphere (UT) during the West African Monsoon (WAM) is investigated through the assimilation of CO observations by the Aura Microwave Limb Sounder (MLS) in the MOCAGE Chemistry Transport Model (CTM). The assimilation setup, based on a 3-D First Guess at Assimilation Time (3-D-FGAT) variational method is described. Comparisons between the assimilated CO fields and in situ airborne observations from the MOZAIC program between Europe and both Southern Africa and Southeast Asia show an overall good agreement around the lowermost pressure level sampled by MLS (~215 hPa). The 4-D assimilated fields averaged over the month of July 2006 have been used to determine the main dynamical processes responsible for the transport of CO in the African UT. The studied period corresponds to the second AMMA (African Monsoon Multidisciplinary Analyses) aircraft campaign. At 220 hPa, the CO distribution is characterized by a latitudinal maximum around 5° N mostly driven by convective uplift of air masses impacted by biomass burning from Southern Africa, uplifted within the WAM region and vented predominantly southward by the upper branch of the winter hemisphere Hadley cell. Above 150 hPa, the African CO distribution is characterized by a broad maximum over northern Africa. This maximum is mostly controlled by the large scale UT circulation driven by the Asian Summer Monsoon (ASM) and characterized by the Asian Monsoon Anticyclone (AMA) centered at 30° N and the Tropical Easterly Jet (TEJ) on the southern flank of the anticyclone. Asian pollution uplifted to the UT over large region of Southeast Asia is trapped within the AMA and transported by the anticyclonic circulation over Northeast Africa. South of the AMA, the TEJ is responsible for the tranport of CO-enriched air masses from India and Southeast Asia over Africa. Using the high time resolution provided by the 4-D assimilated fields, we give evidence that the variability of the African CO distribution above 150 hPa and north of the WAM region is mainly driven by the synoptic dynamical variability of both the AMA and the TEJ.

Final Revised Paper (PDF, 661 KB) | Discussion Paper (ACPD)

Citation: Barret, B., Ricaud, P., Mari, C., Attié, J.-L., Bousserez, N., Josse, B., Le Flochmoën, E., Livesey, N. J., Massart, S., Peuch, V.-H., Piacentini, A., Sauvage, B., Thouret, V., and Cammas, J.-P.: Transport pathways of CO in the African upper troposphere during the monsoon season: a study based upon the assimilation of spaceborne observations, Atmos. Chem. Phys., 8, 3231-3246, 2008. Bibtex EndNote Reference Manager