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Chemical composition in mesoscale convective systems during AMMA and its impact on the NOx and O3 budget

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Deep convection is responsible for a rapid redistribution of trace gases between the boundary layer (BL) and the upper troposphere (UT). Large convective systems as mesoscale convective systems (MCS) very effectively contribute to this redistribution and change the oxidizing capacity in the UT over a wide area. Especially ozone (O3) plays an essential role in determining the oxidizing capacity of the atmosphere and contributes largely to the global greenhouse effect. The production of ozone is driven by the oxidation of carbon monoxide (CO) and volatile organic compounds (VOC) in presence of nitrogen oxide (NO) and sunlight. During the African Monsoon Multidisciplinary Analysis (AMMA) Special Observation Period carried out in West Africa in July and August 2006, the DLR research aircraft Falcon probed several MCS originating over different vegetation types both north and south of the ITCZ. The outflow of the MCS was penetrated close to the convective core but also further away ($\sim$500 km). In the fresh outflow, mean NOx (=NO+NO2) mixing ratios between 0.3-0.4 nmol mol-1 were observed. A rapid entrainment of ambient air in the UT was observed and both CO and O3 mixing ratios soon reached ambient conditions. However, in the aged outflow NOx mixing ratios were still clearly enhanced above the background. The potential for ozone production in the UT was very different depending on the chemical composition in the BL and two different cases are presented. Mainly pollution from the BL (transported upward) but also some production by lightning contributed to enhance the NOx mixing ratios in the fresh outflow. The nitrogen mass flux in the MCS outflow was determined and combined with measurements from a smaller lightning location network (LINET) and with global lightning observations from LIS. A global contribution of $\sim$1-2 Tg(N) a-1 was estimated to be produced by lightning if we assume that MCS over West Africa are typical global thunderstorms. Compared to results from previous field campaigns carried out by our group in Germany (EULINOX), Brazil (TROCCINOX), and Australia (SCOUT-O3) with similar objectives, MCS over West Africa are not as productive concerning lightning-NOx as thunderstorms in midlatitudes and subtropical regions, or as the intense Hector thunderstorm in Darwin. Different thermodynamical and dynamical parameters were investigated which may explain these differences and recommendations for the parameterisation of lightning-produced NOx in models will be given.