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Modelling study of the impact of deep convection on the utls air composition - Part I: Analysis of ozone precursors

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Abstract. The aim of this work is to study the local impact on the upper troposphere/lower stratosphere air composition of an extreme deep convective system. For this purpose, we performed a simulation of a convective cluster composed of many individual deep convective cells that occurred near Bauru (Brazil). The simulation is performed using the 3-D mesoscale model RAMS coupled on-line with a chemistry model. The comparisons with meteorological measurements show that the model produces meteorological fields generally consistent with the observations. The present paper (part I) is devoted to the analysis of the ozone precursors (CO, NO_x and non-methane volatile organic compounds) and HO_x in the UTLS. The simulation results show that the distribution of CO with altitude is closely related to the upward convective motions and consecutive outflow at the top of the convective cells leading to a bulge of CO between 7 km altitude and the tropopause (around 17 km altitude). The model results for CO are consistent with satellite-borne measurements at 700 hPa. The simulation also indicates enhanced amounts of NO_x up to 2 ppbv in the 7–17 km altitude layer mainly produced by the lightning associated with the intense convective activity. For insoluble non-methane volatile organic compounds, the convective activity tends to significantly increase their amount in the 7–17 km layer by dynamical effects. During daytime in the presence of lightning NO_x, this bulge is largely reduced in the upper part of the layer for reactive species (e.g. isoprene, ethene) because of their reactions with OH that is increased on average during daytime. Lightning NO_x also impacts on the oxydizing capacity of the upper troposphere by reducing on average HO_x, HO_2, H_2O_2 and organic hydroperoxides. During the simulation time, the impact of convection on the air composition of the lower stratosphere is negligible for all ozone precursors although several of the simulated convective cells nearly reach the tropopause. There is no significant transport from the upper

troposphere to the lower stratosphere, the isentropic barrier not being crossed by convection.

The impact of the increase of ozone precursors and HO_x in the upper troposphere on the ozone budget in the LS is discussed in part II of this series of papers.

Final Revised Paper (PDF, 904 KB) Discussion Paper (ACPD)

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