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## Cloud system resolving model study of the roles of deep convection for photo-chemistry in the TOGA COARE/CEPEX region

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**Abstract.** A cloud system resolving model including photo-chemistry (CSRMC) has been developed based on a prototype version of the Weather Research and Forecasting (WRF) model and is used to study influences of deep convection on chemistry in the TOGA COARE/CEPEX region. Lateral boundary conditions for trace gases are prescribed from global chemistry-transport simulations, and the vertical advection of trace gases by large scale dynamics, which is not reproduced in a limited area cloud system resolving model, is taken into account. The influences of deep convective transport and of lightning on  $\text{NO}_x$ ,  $\text{O}_3$ , and  $\text{HO}_x$  ( $=\text{HO}_2+\text{OH}$ ), in the vicinity of the deep convective systems are investigated in a 7-day 3-D  $248\times 248\text{ km}^2$  horizontal domain simulation and several 2-D sensitivity runs with a 500 km horizontal domain. Mid-tropospheric entrainment is more important on average for the upward transport of  $\text{O}_3$  in the 3-D run than in the 2-D runs, but at the same time undiluted  $\text{O}_3$ -poor air from the marine boundary layer reaches the upper troposphere more frequently in the 3-D run than in the 2-D runs, indicating the presence of undiluted convective cores. In all runs, in situ lightning is found to have only minor impacts on the local  $\text{O}_3$  budget. Near zero  $\text{O}_3$  volume mixing ratios due to the reaction with lightning-produced NO are only simulated in a 2-D sensitivity run with an extremely high number of NO molecules per flash, which is outside the range of current estimates. The fraction of  $\text{NO}_x$  chemically lost within the domain varies between 20 and 24% in the 2-D runs, but is negligible in the 3-D run, in agreement with a lower average  $\text{NO}_x$  concentration in the 3-D run despite a greater number of flashes. Stratosphere to troposphere transport of  $\text{O}_3$  is simulated to occur episodically in thin filaments in the 2-D runs, but on average net upward transport of  $\text{O}_3$  from below  $\sim 16\text{ km}$  is simulated in association with mean large scale ascent in the region. Ozone profiles in the TOGA COARE/CEPEX region are suggested to be strongly influenced by the intra-seasonal (Madden-Julian) oscillation.

[Final Revised Paper](#) (PDF, 8740 KB) [Supplement](#) (10389 KB) [Discussion Paper](#) (ACPD)

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