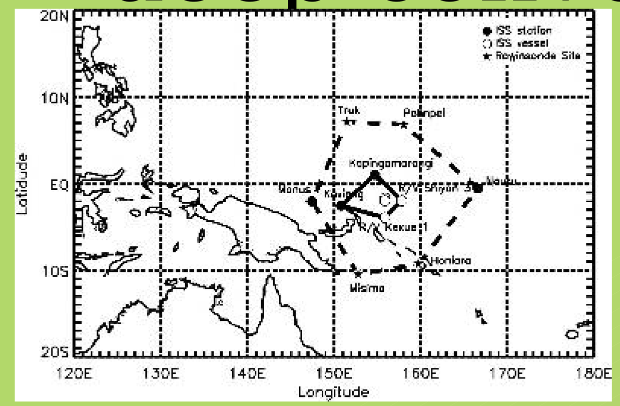
Relative importance of small scale downwards ozone transport from the TTL associated with deep convection on the tropospheric ozone budget in the TOGA-COARE/CEPEX region.



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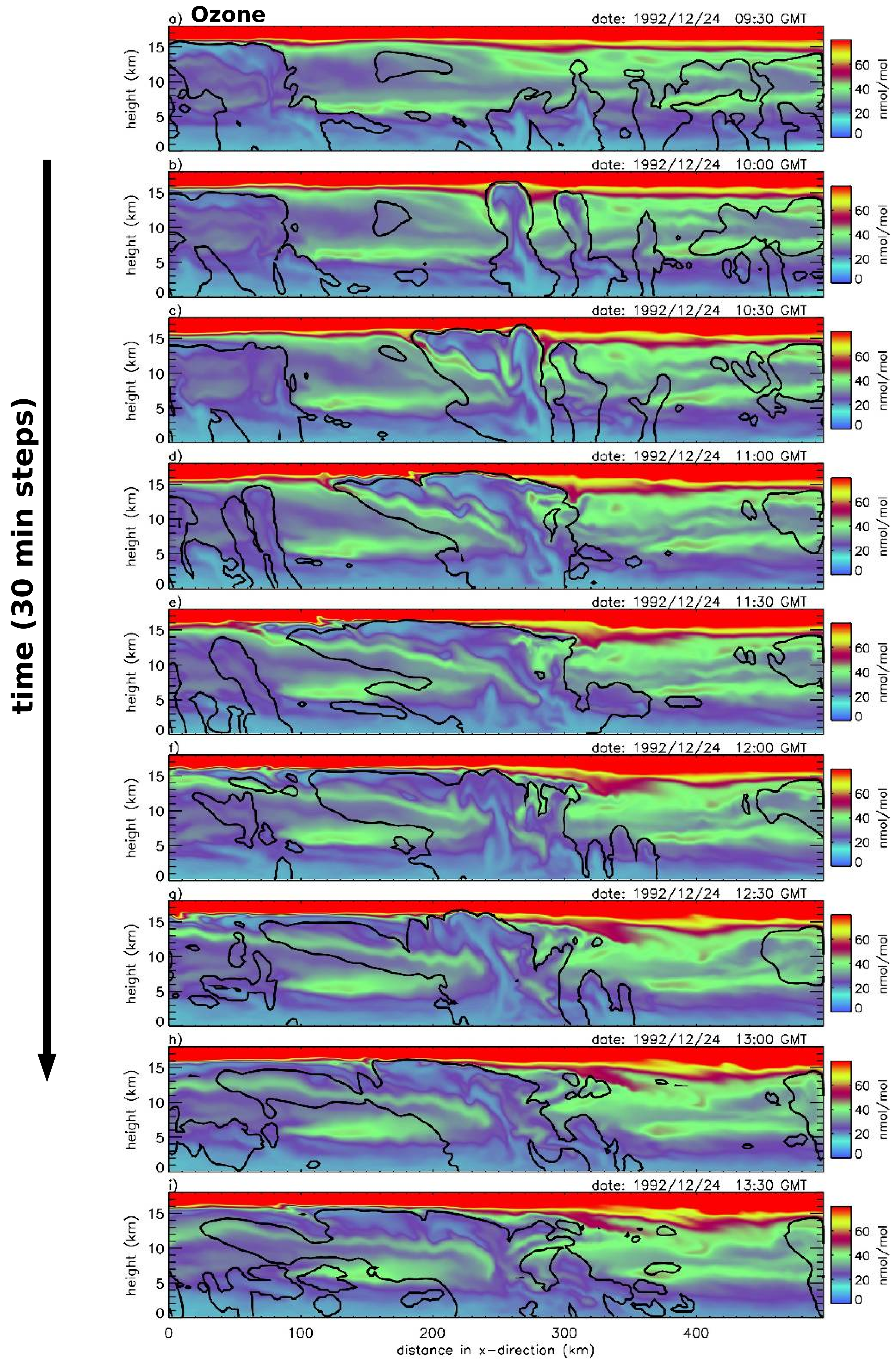


Fig. 1: Simulated ozone volume mixing ratios (shaded) and total hydrometeor mixing ratio, q_{tot}=0.01 g kg^{-1} contour

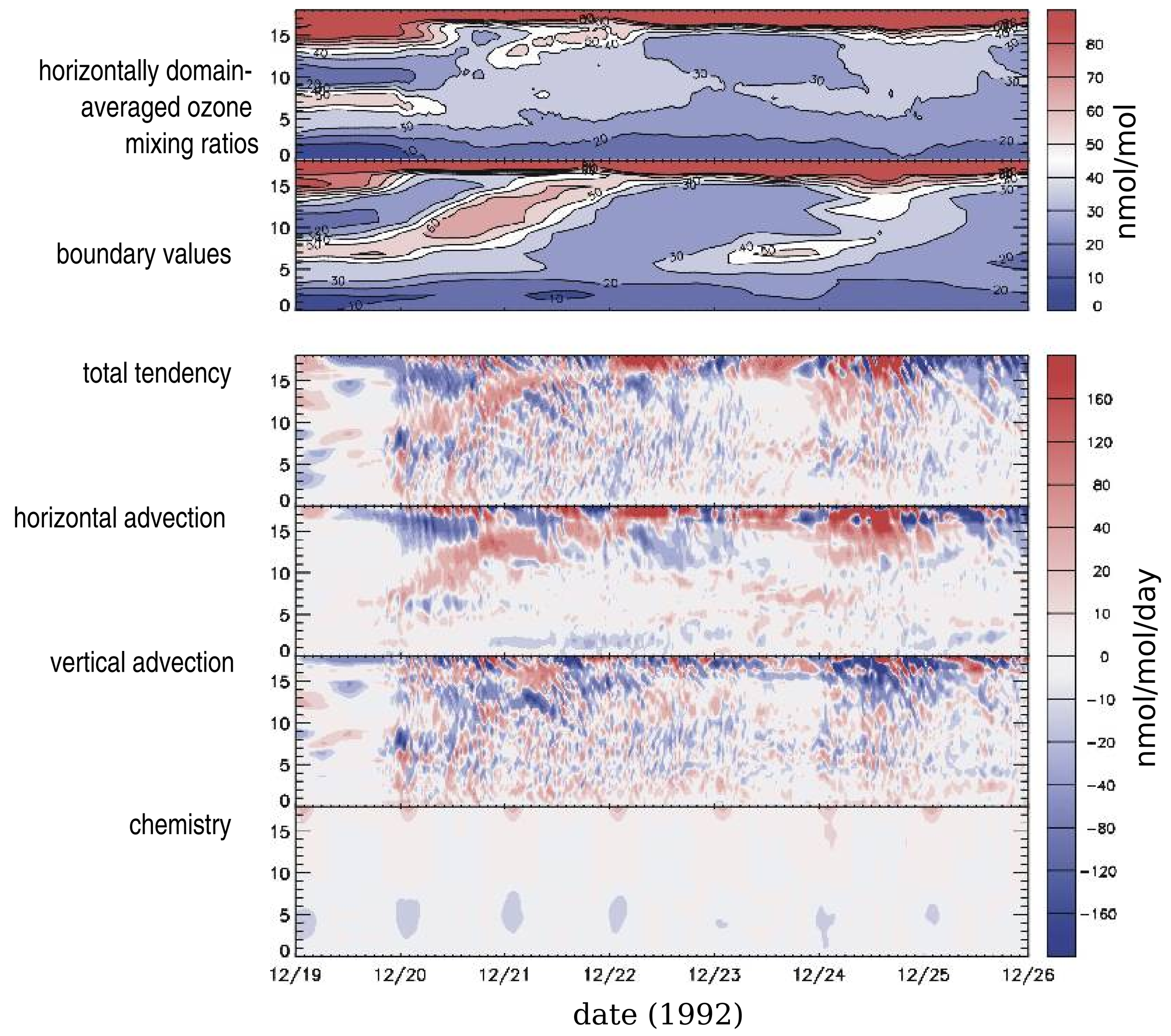
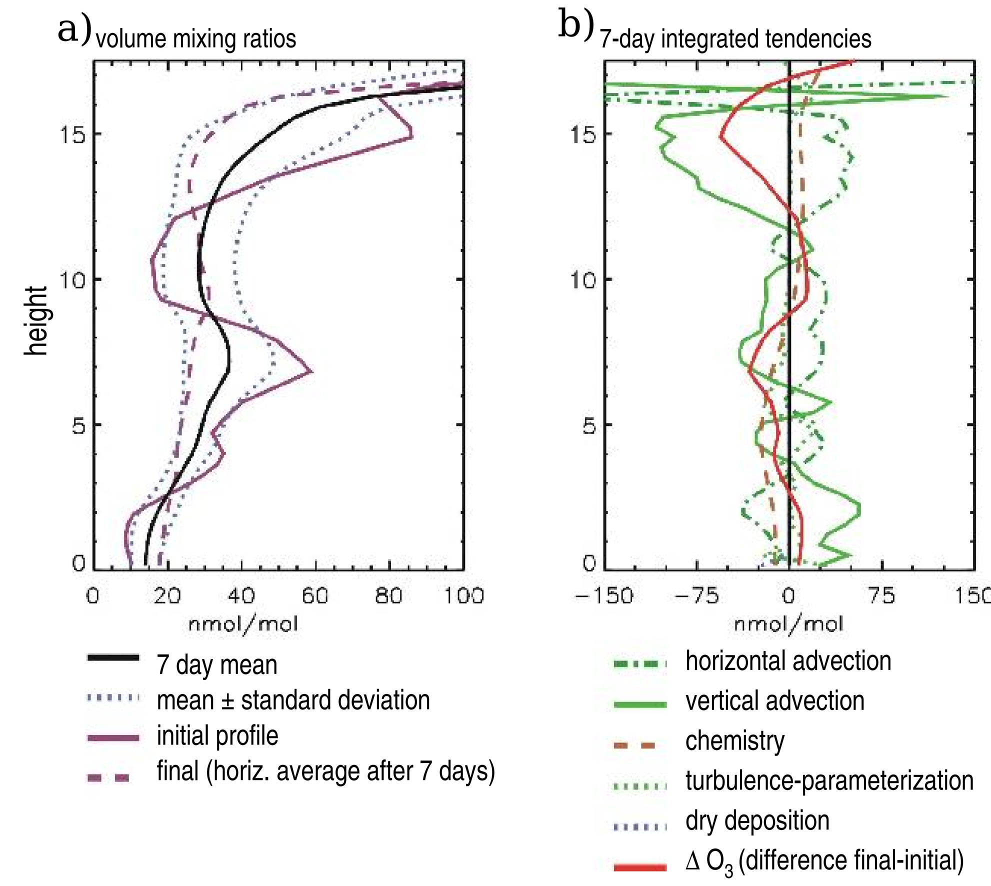


Fig 2 (left): simulated horizontally averaged ozone volume mixing ratios, boundary values, 30 min integrated total ozone tendency, and contributions from various processes.

Fig 3 (right): (a) Time and domain-averaged ozone volume mixing ratios ± standard deviation, initial, and final ozone profiles. **(b)** Ozone budget (time integrated and domain-averaged tendencies divided by the average air density).



Model Description and Setup

- A cloud system resolving model including photochemistry based on the Weather Research and Forecasting (WRF) model (Skamarock et al., 2001) and on photochemistry from the global Model of Atmospheric Transport and Chemistry – Max Planck Institute for Chemistry Version (MATCH-MPIC, Lawrence et al., 1999, von Kuhlmann et al., 2003) has been used to examine influences of tropical deep convective clouds on the transport and chemistry of ozone and related gases for a seven day TOGA COARE episode in December 1992.

- Lateral boundary conditions for trace gases have been derived from simulations using MATCH-MPIC and large scale ascent has been taken into account for the calculation of the vertical trace gas transport (Salzmann et al., 2004, Salzmann, 2005).

- Results from 2-D calculations for a 500km long domain are shown. The resolution is 2km in the horizontal (E-W) and 350m in the vertical direction.

Results/Conclusions

- Small scale downwards transport of ozone from the TTL is simulated to take place in filaments which occur in association with rear inflow in deep convective cloud systems and extend far into the troposphere (Fig. 1).

- Upward transport of ozone poor air from the marine boundary layer is, however, found to dominate the ozone budget (Fig. 3) in the upper troposphere (which is also the case if the large scale ascent is not considered in the simulations, not shown). This contrasts a result from an earlier cloud resolving model study (Wang and Prinn, 2000) for the same region. Wang and Prinn studied a single storm and prescribed a relatively "flat" ozone profile (i.e. a profile with a small vertical gradient in the troposphere) as the initial condition.

- The horizontal transport of ozone into the model domain plays a role for the ozone budget even on relatively short timescales (Fig. 2).

- The influence of the large scale ascent on tracers has been considered in the simulations, while for air mass periodic boundary conditions have been used, not permitting net air mass convergence (divergence) in the lower (upper) troposphere. An advantage of properly nested cloud resolving models vs. the setup used here would be that one would not have to "artificially" include a large scale tracer advection term (as discussed in Salzmann et al., 2004). However, to the author's knowledge nested models have not yet been successfully used to simulate the conditions during TOGA COARE. The large scale nature of the circulations associated with the deep convection could perhaps best be taken into account combining multiple nesting and nudging of large scale data.

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