## Atmospheric Chemistry and Physics

An Interactive Open Access Journal of the European Geosciences Union

| Copernicus.org | EGU.eu |

| EGU Journals | Contact

### Home

### Online Library ACP

- Recent Final Revised Papers
- Volumes and Issues
- Special Issues
- Library Search
- Title and Author Search

Online Library ACPD

Alerts & RSS Feeds

General Information

Submission

Review

Production

Subscription

### Comment on a Paper



indexed



PORTICO

■ Volumes and Issues
■ Contents of Issue 12

Atmos. Chem. Phys., 5, 3219-3231, 2005 www.atmos-chem-phys.net/5/3219/2005/
© Author(s) 2005. This work is licensed under a Creative Commons License.

# Transport and chemical transformations influenced by shallow cumulus over land

J. Vilà-Guerau de Arellano<sup>1</sup>, S.-W. Kim<sup>2</sup>, M. C. Barth<sup>2</sup>, and E. G. Patton<sup>2</sup>

<sup>1</sup>Meteorology and Air Quality Section, Wageningen University, The Netherlands

<sup>2</sup>Mesoscale and Microscale Meteorology Division, National Center for Atmospheric Research, USA

Abstract. The distribution and evolution of reactive species in a boundary layer characterized by the presence of shallow cumulus over land is studied by means of two large-eddy simulation models: the NCAR and WUR codes. The study focuses on two physical processes that can influence the chemistry: the enhancement of the vertical transport by the buoyant convection associated with cloud formation and the perturbation of the photolysis rates below, in and above the clouds. It is shown that the dilution of the reactant mixing ratio caused by the deepening of the atmospheric boundary layer is an important process and that it can decrease reactant mixing ratios by 10 to 50 percent compared to very similar conditions but with no cloud formation. Additionally, clouds transport chemical species to higher elevations in the boundary layer compared to the case with no clouds which influences the reactant mixing ratios of the nocturnal residual layers following the collapse of the daytime boundary layer. Estimates of the rate of reactant transport based on the calculation of the integrated flux divergence range from to -0.2 ppb hr<sup>-1</sup> to -1 ppb hr<sup>-1</sup> 1, indicating a net loss of sub-cloud layer air transported into the cloud layer. A comparison of this flux to a parameterized mass flux shows good agreement in mid-cloud, but at cloud base the parameterization underestimates the mass flux. Scattering of radiation by cloud drops perturbs photolysis rates. It is found that these perturbed photolysis rates substantially (10-40%) affect mixing ratios locally (spatially and temporally), but have little effect on mixing ratios averaged over space and time. We find that the ultraviolet radiance perturbation becomes more important for chemical transformations that react with a similar order time scale as the turbulent transport in clouds. Finally, the detailed intercomparison of the LES results shows very good agreement between the two codes when considering the evolution of the reactant mean, flux and (co-)variance vertical profiles.

■ Final Revised Paper (PDF, 705 KB) ■ Discussion Paper (ACPD)

Citation: Vilà-Guerau de Arellano, J., Kim, S.-W., Barth, M. C., and Patton, E. G.: Transport and chemical transformations influenced by shallow cumulus over land, Atmos. Chem. Phys., 5, 3219-3231, 2005. Bibtex EndNote Reference Manager



### Search ACP

Library Search

Author Search

### News

- Sister Journals AMT & GMD
- Financial Support for Authors
- Journal Impact Factor
- Public Relations & Background Information

### Recent Papers

01 | ACP, 19 Feb 2009: Relating observations of contrail persistence to numerical weather analysis output

02 | ACP, 19 Feb 2009: Increasing ozone in marine boundary layer inflow at the west coasts of North America and Europe

03 | ACP, 19 Feb 2009: Influence of non-ideality on condensation to aerosol