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Atmospheric Chemistry and Physics Discussions

Interactive comment on "An investigation of ozone and planetary boundary layer dynamics over the complex topography of Grenoble combining measurements and modeling" *by* O. Couach et al.

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Anonymous Referee #2 Received and published: 15 April 2003

GENERAL COMMENTS

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Interactive Discussion
Discussion Paper

The paper describes measurements and modelling of ozone and planetary boundary layer height during a three-day period in July 1999. Three-dimensional fields of ozone were obtained from 2 ground level stations (one equipped with a vertical sounder) and from 4 flights with an aeroplane. The temporal evolution of the mixed layer height was deduced from the signals of a LIDAR. The measurements of ozone, planetary boundary layer height and various meteorological parameters are compared with the output of a numerical model. The paper includes a fair amount of detailed descriptions on certain parameters while many important aspects are only discussed superficially.

AUTHORS REPLY TO GENERAL COMMENTS

The complete description of the all measurements involved in this campaign was largely done in the paper "Couach, O., Balin, I., Jim`enez, R., Perego, S., Kirchner, F., Ristori, P., Simeonov, V., Quaglia, P., Vestri, V., Clappier, A., Calpini, B., and Van den Bergh, H.: Study of a photochemical episode over the Grenoble area using a mesoscale model and intensive measurements, Pollution Atmosphérique, 174, 2002a", as well as in the final report campaign of GRENOPHOT, which can be find on: http://lpas.epfl.ch/lidar/publications/repports/RapGrenophot99.pdf

SPECIFIC COMMENTS

To me the comparison between model output and measurements does not look very convincing. The temperature data depicted in Fig. 4, for example, show an offset of 5-10 Kelvin which makes any later statements of calculated planetary boundary layer height very uncertain. I also find the reported wind speeds of only 1-2 m/s between 1800 and 2900 meters hard to believe (but that's just a feeling and I may be in error here). Although there exist a connection between the aerosol backscatter signal obtained from the LIDAR and the planetary boundary layer height in the real world I think the discussion and stated numbers (in meters) of the planetary boundary layer height is a gross over interpretation of this sparse amount of data available. The temperature profiles depicted in Fig. 8 does not give much guidance and it's very difficult to esti-

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mate planetary boundary layer height from these profiles. From Fig. 9 it is clear that atmospheric ozone is destroyed near the ground during night. It is a very interesting approach to break down the process into the mechanisms shown in Fig 10. The method to end up with the presented results is, however, very rough and many other possibilities exist. To resolve this interesting question much more data and a combination of laboratory work and atmospheric modelling is needed.

AUTHORS REPLY TO SPECIFIC COMMENTS

We did not notice 5-10 K of difference but more likely 3-5 K between the model outputs and the airborne measurements, which is more than acceptable taking in account the precision of the aircraft measurements as well as the error of localizing (space and time) the aircraft measurements. In addition the ground wind and temperature measurements were founded in very good agreement with the simulations (see paper "Couach, O., et al.: Study of a photochemical episode over the Grenoble area using a mesoscale model and intensive measurements, Pollution Atmosphérique, 174, 2002a". In fact for estimating the PBL height only the temperature variations (slope changes) are considered and we can see that the variations of the temperature are very well reproduced by model. Concerning the low wind speed between 1800-2900 m, this is a specific stratification layer in the Grenoble region due to the specific topography consisting on mountains in the range of 2000 - 3000 m ASL. This low speed values were recorded only in the case of high-pressure conditions while we clearly saw stronger winds in the same altitude ranges from south (10-15 m/s) when the synoptic regime is changing.

Estimating the PBL height based on the aerosols backscatter is a well-demonstrated method (e.g. Boers, R., S.H. Melfi, and S.P. Palm, Cold-Air Outbreak During GALE: Lidar Observations and Modeling of Boundary Layer Dynamics, Mon. Wea. Rev., 119, 1132-1150, 1991).. We already did this for Milan in 1998 with the same LIDAR system and the comparison with radiosonde and aircraft measurements shown perfect agreement. In the case of Grenoble, the PBL height estimation based on Lidar is also

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validated when compared with the aircraft estimation based on PM10 and water vapor (see fig. 7c), as well as the model outputs (see fig. 8). Nevertheless it's remains as subject to discussions the complexity and the low height in the nighttime or in the cases with a not well-defined PBL top even in daytime.

We consider that based on few representative measurements combined with simulations, one may estimated many key parameters and mechanisms governing a typical summer air pollution episode characterizing the Grenoble region. At our Knowledge this is the first 3D approach depicting the air pollution patterns in a complex topography.

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