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Modification of ozone mixing ratios inside and outside the Berlin-plume

Starting position:

The local and temporal change of the ozone mixing ratio is determined by the processes advection, chemical transformation, turbulent diffusion and deposition:

$$\frac{\partial O_3}{\partial t} + \mathbf{v} \cdot \nabla O_3 = Q_{O_3} - D_{O_3}$$

Project aims:

- Quantifying of the turbulent ozone transport in the atmospheric boundary layer and determination of the exchange between the boundary layer and the free atmosphere under different ozone advection and varying ozone production.
- Determination of the turbulent diffusion coefficient for ozone in the lower troposphere as a function of stability of the atmospheric stratification.

Measuring concept:

Registration of the mixing ratio of CO, NO, NO₂, O₃ and of VOCs in windward, lee and over Berlin. For this purpose a research aircraft (DO 128) with quality controlled trace gas analytic instruments for O₃ (at 10 Hz measuring frequency) for NO and NO₂ (at 1 Hz measuring frequency) was used. At the same time

- the meteorological basic condition,
- the turbulence and
- the top of the mixing layer was detected.

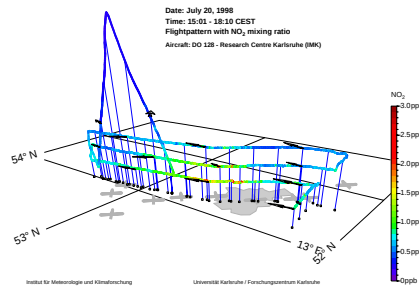


Fig. 1: Horizontal profiles of the NO₂-mixing ratios in the afternoon of July 20th. The wind direction is given by arrows.

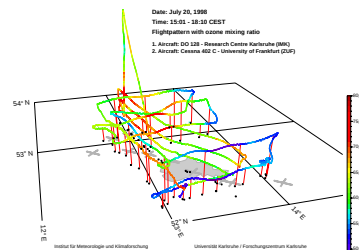


Fig. 2: Profiles of O₃-mixing ratios in the afternoon of July 20th.

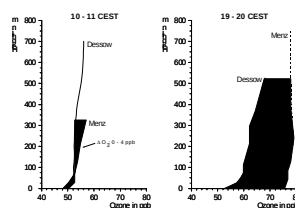


Fig. 3: O₃-vertical profiles at the stations 70 km on the lee (Dessow and Menz) in the morning and the evening of July 20th.

Case studies:

Meteorological and air chemical episodes were surveyed in Greater Berlin during the BERLIOZ-research campaign in July/August 1998, which showed big changes in the ozone mixing ratio in the lee of the city:

- Photo smog weather conditions with the formation of a characteristic ozone plume in the lee of the city, e.g. on July 20th.
- Photo smog weather conditions with greater ozone advection without a characteristic leeward ozone plume, e.g. on July 21st, 1998.
- Weather conditions with advection of cold, unpolluted air with formation of an ozone minimum in the lee of the city, e.g. on August 5th, 1998.

The diagrams show the opposite NO₂- and O₃-development over Berlin on July 20th, 1998 in the lee of the city (photo smog condition with ozone plume).

Results:

In a 1500 m strong mixing layer over Berlin and in the leeward suburbs the NO₂-values were recorded in the afternoon of July 20th (Fig. 1). At the same time the O₃-values on the windward side and over the city were at approx. 55 ppb, while far in the lee in a distance of 40 to 70 km from the city in the north west they increased by approx. 15 ppb up to 70 ppb (Fig. 2). This O₃-difference between the windward and the leeward side developed in the same dimension in the course of the day at the leeward stations Dessow (outside of the plume) and Menz (within the plume) in the whole mixing layer up to 750 m MSL (Fig. 3).