Forschungszentrum Karlsruhe
Technik und Umwelt

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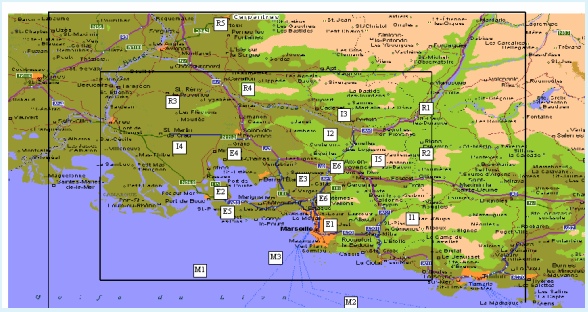
AIR POLLUTANT DISTRIBUTION AND MESO-SCALE CIRCULATION SYSTEMS DURING ESCOMPTE

1. ESCOMPTE experiment

The ESCOMPTE-experiment (http://medias.obs-mip.fr/escompte) was carried out in June and July 2001 in the urban area of Marseille and its rural surroundings to investigate periods with photosmog conditions. The overall aim is to produce an appropriate high quality 3-D data set which includes emission, meteorological, and chemical data. The data are used for the validation of mesoscale models and for chemical and meteorological process studies. The evolution of photosmog episodes with high ozone concentrations depends on both chemical transformation processes and meteorological conditions. As Marseille is situated between the Mediterranean Sea in the south and mountainous sites in the north, under weak large-scale flow the meteorological conditions are dominated by thermally driven circulation systems which strongly influence the horizontal transport of air pollutants.

2. Experimental region and IMK measurements

Within the dense network of ground based meteorological and chemical measurements with in-situ and remote sensing techniques as well as aircraft, the IMK contributed 2 radiosonde stations at Vinon (R1) and St. Remy (R3), energy balance, turbulence and SODAR measurements at R3 and aircraft flights with a Dornier 128 aircraft operating from Avignon. Flights covered the whole region at heights up to 4 km agl.



3. Specific Objectives

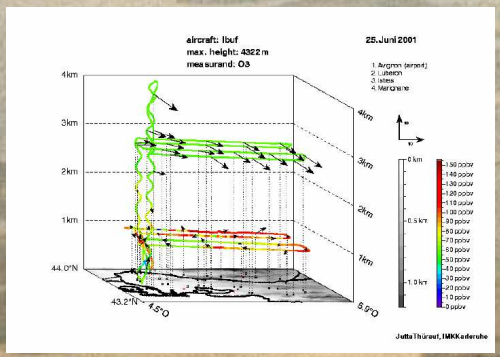
The Institute of Meteorology and Climate Research (University Karlsruhe, Research Center Karlsruhe) participated in ESCOMPTE cooperatively with the following objectives:

- Investigation of mesoscale flow patterns developing by interacting land-sea-breeze circulation, synoptic scale flow and mountain induced circulation.
- Studies of transport and vertical diffusion of trace substances, in particular of ozone, nitrogen oxides and their sources.
- Study of convection in a dry mountaineous region, influence of sub-scale soil inhomogeneity on turbulent fluxes in the convective boundary layer, and parameterisations of turbulent transport above inhomogeneous land surfaces.
- Investigation of handover processes between the boundary layer and the free atmosphere.

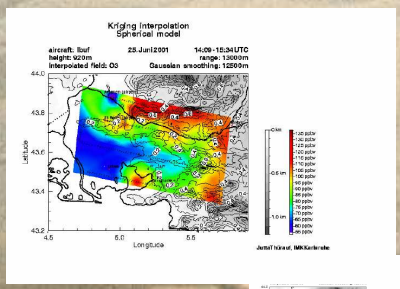
4. Wind systems and ozone distribution during IOP 2b / June 25, 2001

First results

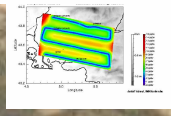
High ozone concentrations of up to 200 ppb built up on June 25 with peak values in the Durance valley in the afternoon. Aircraft data obtained at 800 - 900 m agl are consistent with ground measurements. They document that ozone concentration remained unaffected at 2800 m. Wind data from radiosondes, aircraft and Doppler Sodar reflect the development of a complex circulation system in the boundary layer with a persistent northwesterly flow above about 2km height. The flow turned to offshore winds before noon both in the Rhone valley (St. Remy) and Durance valley (Vinon), but was deeper and more vigorous due to channeling in the Durance valley. Afternoon peak were associated with the advection of the polluted air mass at Vinon.

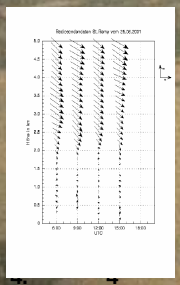


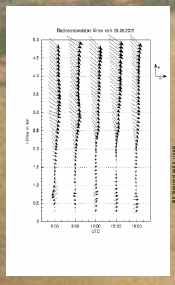
Threedimensional view of horizontal winds and ozone from the Dornier flight on June 25, afternoon



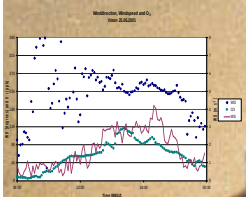
Kriging-interpolated distribution of ozone from the afternoon flight on June 25 (top), statistical error of the interpolation (right)



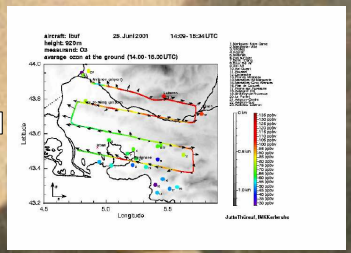




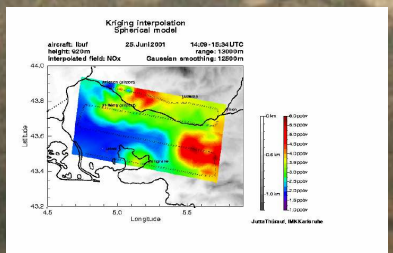
Vertical profiles of horizontal winds from radio-soundings on June 25, at St. Remy and Vinon



Wind speed and direction and ozone concentration on June 25 at Vinon

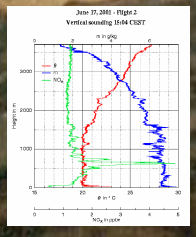


Horizontal wind and ozone from Dornier flight and at AIRMARAIX ground stations



As above, for nitrogen oxide

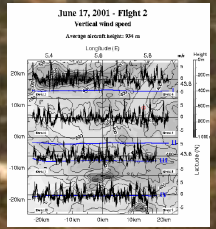
Due to high insolation and dry surface conditions intense convection develops over the mountain regions of the Escompte region in summer. Convection then plays an important role for the vertical transport and dilution of pollution, which is studied by airborne turbulence measurements.Results arte shown for the non-IOP day June 17, 2001.



Vertical profiles of potential temperature, mixing ratio, and nitrous oxide from Dornier data near Avignon. Cumulus clouds ranged from 1500 m to 3000 m.

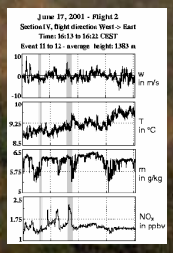
5. Vertical transport by convection

Very strong up- and downdrafts of up to 8 m/s were passed during flights (blue lines) over Mt. St. Victoire, Luberon, and Durance valley. No distinct differences of convection are found in relation to orography.



Series of vertical velocity along the four flight tracks (blue lines) at a height of 950 m agl.

The updrafts are clearly associated with positive deviations of Nox due to high concetrations at lower layers. Dry air from the uppermost PBL (low m-values) is mixed downward by downdrafts.



A 8 km long section at 1380 m with fast measurements of vertical velocity, temperature, mixing ratio and nitrous oxide.