The VERTIKATOR Field Campaign in the Loisach Valley

U. Corsmeier[2], H. Giehl[1], S. Kreipl[1], O. Reitebuch[3], T. Trickl[1]

[1]Forschungszentrum Karlsruhe, IMK-IFU, Kreuzeckbahnstr.19, D-82467 Garmisch-Partenkirchen

[2]Forschungszentrum Karlsruhe, IMK, Hermann-von-Helmholtz-Platz 1, D-76344 Eggenstein-Leopoldshafen

[3]DLR, Institut für Physik der Atmosphäre, Postfach 1116, D-822230 Weßling

Motivation

- Understanding of the local vertical aerosol distributions in view of EARLINET
- Understanding of the efficient vertical transport above Alpine valleys
- Experimental input for improving the description of convection above complex terrain in meteorological models (e.g., in view of better precipitation forecasts)

Previous Knowledge

Lidar measurements in the Loisach valley and the Swiss Mesolcina valley have shown that the orographic wind system in and above Alpine valleys may transport boundary-layer (PBL) air to heights 1 to 1.5 km above neighbouring summit and ridge heights under conditions of moderate humidity (Carnuth et al., 2002, Carnuth and Trickl, 2000, Kreipl et al., 2001; see Figs. 1-4). In the morning, an up-valley flow forms ("valley wind") advecting air pollution from outside the valley which is exported from the PBL in the upper parts of the valley. A return flow may form above the PBL. In the deep Mesolcina valley (300 m to 3000 m a.s.l.) this return flow was partly channeled and, thus, rather independent of the synoptic wind direction. The export efficiency from the PBL was roughly 80 %. The measurements at IFU, in the shallower Loisach valley, the influence of the synoptic wind is more pronounced. Bimodal aerosol and ozone distributions in the afternoon (Figs. 4, 5) have been only observed for synoptic wind directions between east and south, with wind speeds less than 5 m/s. Although the interpretation of the upper part of the distribution by the formation of a return flow is obvious wind measurements had been missing.

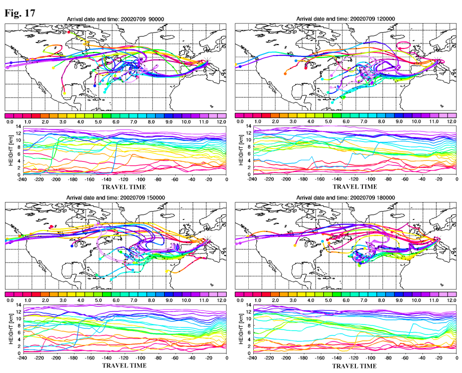
VERTIKATOR Campaign

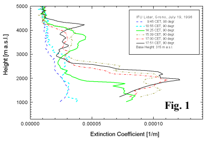
Between July 5 and 22, 2002, a field campaign devoted to "Alpine pumping" was carried out in a large area between the Loisach, Isar and Inn valleys as a part of the German VERTIKATOR project. Three research aeroplanes and the EARLINET aerosol lidars of IFU and MIM were operate. The IFU lidar measurements and concentrated on the Loisach valley (two aerosol lidars, at IFU and in the Murnauer Moos, see Fig. 6). Wind data were obtained from measurements onboard the FZK DO 128 aircraft and wind lidar measurements onboard the DLR Falcon. The IFU ultralight aircraft was flown in the Isar valley.

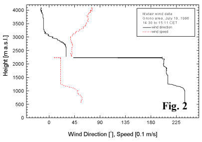
Here, preliminary results for July 8 and 9 are presented, first selected because of the pronounced differences in temporal evolution of the vertical distribution.

Fig. 6: Map of the Bavarian Apls around the Loisach valley; the circles mark the positions of the two IFU lidars (IFU and Murnauer Moos (Fig. 7), i.e. next to the high Wetterstein mountains and about 6 km outside the mopuntians, respectively). Both aerosol lidars were scanned in elevation, along the directions indicated by the blue arrows. In this way, day-by-day differences in the aerosol flow in and above the PBL may be mapped and compared with the orographic and synoptic wind conditions.

Fig. 7: The mobile three-wavelength lidar of IFU in the Murnauer Moos; in the background the Wetterstein mountains and Zugspitze are seen above the Loisach valley.







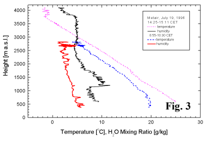
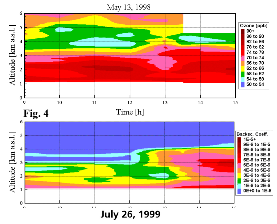


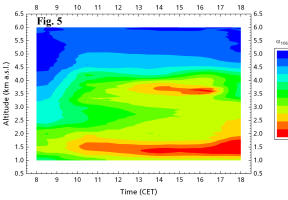
Fig. 1: Aerorol lidar measurements in Grono (Mesolcina valley) on July 19, 1996, showing efficient vertical transport up to 4500 m a.s.l. starting in the late morning.

Figs. 2 and 3: Wind and humidity measuremnrts by two Metair research aeroplanes on July 19, 1996, confirming the presence of a return flow above the PBL which gradually turns to the direction of the synoptic wind above the summits (3000 m).

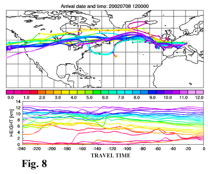
Fig. 4: Ozone and aerosol measurements on May 13, 1998, with the IFU ozone lidar showing a similar behaviour for the Loisach valley (bimodal distributions, see also Carnuth et al., 2002).

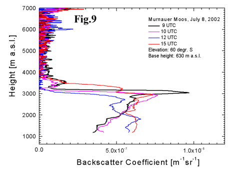
Fig. 5: Aerosol extinction coefficients above IFU on July 26, 1999; after 9:30 CET the valley wind advected polluted air from outside the mountains. About 2 h later a pronounced layer formed between 3.5 and 4 km.

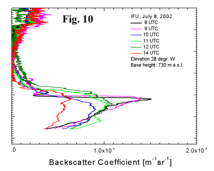


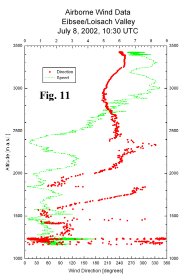


July 8, 2002









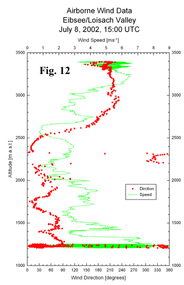
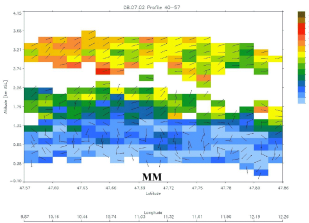
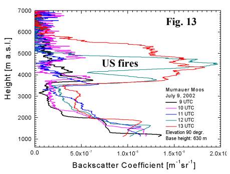


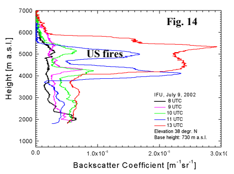
Fig. 13: Murnauer Moos (MM) 10:50 UCT

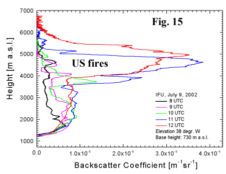


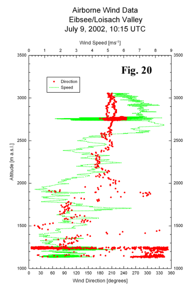
Figs. 8, 17: FLEXTRA backward trajectories; **Figs. 9,10, 14-16, 18, 19:** IFU lidar measurements; **Figs. 11,12, 20:** DO 128 vertical wind profiles above Eibsee; **Figs 13, 21:** DLR wind lidar measurements on flight legs W-E outside the Alps; the passage to the north of the Murnauer Moos is marked by MM.

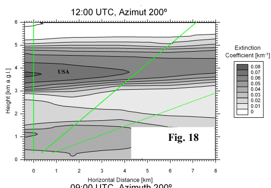
July 9, 2002

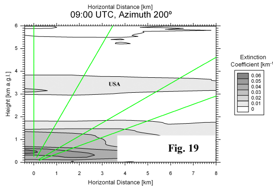








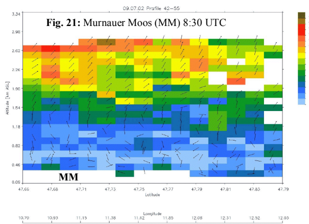




Conclusions:

The measurements have hardened the existing knowledge about the wind system in the Loisach valley. Since the valley wind was normal on both days the differences between July 8 and 9 are tentatively ascribed to differences in synoptic conditions (W and SW, respectively). The wind data do not suffice to understand all the details presently available. The results are also influenced by the presence of U.S. fire plume above 3600 m. The analysis will go on and also the other days will be examined. However, it is anticipated that further measurements are needed, including more detailed flights in the Loisach valley alone.

Fig. 21: Murnauer Moos (MM) 8:30 UTC



References:

W. Carnuth, U. Kempfer, T. Trickl, Tellus 50B (2002) 163-185

W. Carnuth, T. Trickl, Atmos. Environ. 34 (2000) 1425-1434

S. Kreipl, R. Mücke, H. Jäger, T. Trickl, A. Stohl, ILRC 2000, Vichy

Funding

European Union: VOTALP, EARLINET

German BMBF: AFS Lidar Network, VERTIKATOR