VERTIKATOR

AFO 2000

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

Subproject 3: Vertical Transport by Deep Convection

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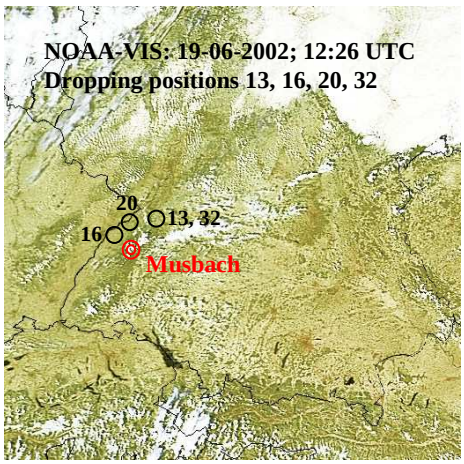
Objectives

The subproject aims at the experimental investigation of vertical transport of momentum, energy, water and trace gases by deep convection over complex terrain. These processes are widely unknown, model parametrizations are therefore poor and in consequence local forecasts of clouds and precipitation using model output and/or online nowcasting techniques based on observations are not very reliable.

Experimental Setup

In June 2002 the threedimensional structure of the atmosphere under conditions of unstable stratification and its daily cycle was investigated over the Black Forest, using 5 aircraft, vertical sounding systems, satellite data and meteorological surface stations. Seven days with different atmospheric stratification and convection development ranging from shallow convection to severe thunderstorms were investigated. Case studies and process analyses provide understanding of convection as triggered by orography, resulting in better nowcasting and forecasting results.



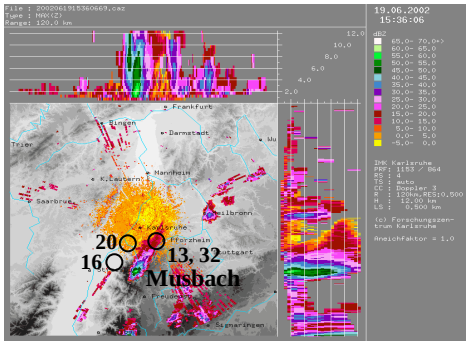


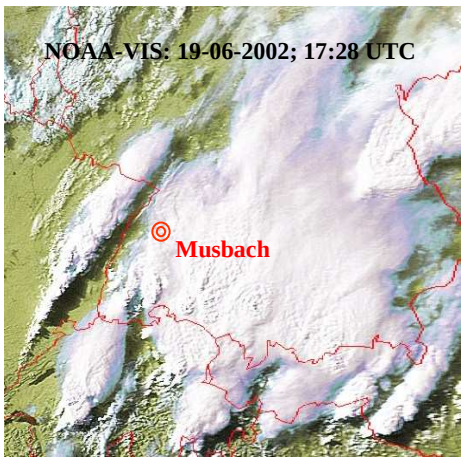
Fig. 1: Radar echo (13:36 UTC) of a convective cell near Musbach, originating above mountain slopes.

Case Study: June 19, 2002

As shown in subproject 1, the vertical stratification of the atmosphere in the investigation area is governed by high CAPE over the mountains as well as over flatlands. The satellite images, however, show beginning convection at noon only over the Vosges Mountains and the Black Forest but not in the plaines (left). Severe thunderstorm cells exist in the evening, originating in the Alps, the prealpine regions and the southern Black Forest (right). Single cells develop in the northern Black Forest, one at 13:36 UTC near Musbach (Fig. 1 and subproject 2).

The humidity in the lower troposphere up to 1500 m, accompanied by a northeasterly flow, is extremly high over the whole area (14 g/kg). Above this level, humidity decreases slightly up to 4000 m and the wind turns to southwest. In the northern part the humid layer is shallower (<1500 m) than in the southern part (>1500 m), (Fig. 2). Advection of dryer air from northeast controls instability, most severe convective development thus takes place in the southern part of the Black Forest.

Dropsondes released at Pforzheim (13, 32) and in the Rhine Valley near Rastatt (20) and Achern (16) indicate the difference in the height of the humid layer between 1600 m and 2500 m from north to south (Fig 3) according to the height of the PBL inversion (Fig 4). At Pforzheim a remarkable stretching of the inversion layer is detected within 27 min. between drop 13 and 32. This indicates rapidly growing destabilisation over the mountain ranges. The time series measured by DO 128 (Fig. 5) show that sondes 13 and 32 are dropped within clouds over Pforzheim.



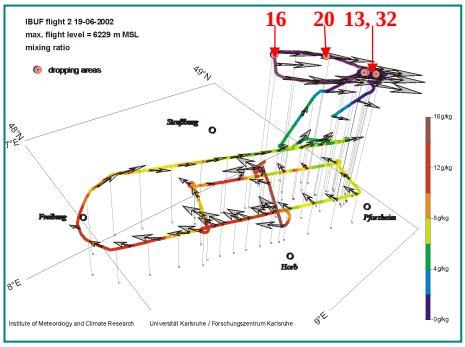


Fig. 2: Wind and humidity in the afternoon above the Black Forest measured by DO 128.

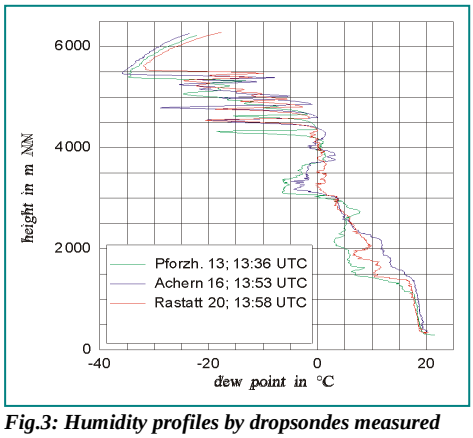


Fig.3: Humidity profiles by dropsondes measured at the the beginning of deep convection over the Rhine Valley and the northern Black Forest.

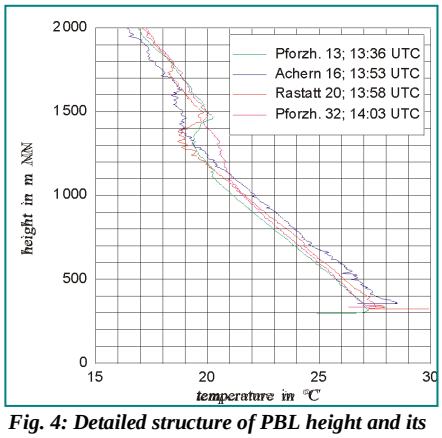


Fig. 4: Detailed structure of PBL height and its development at the north and westerly edge of area covered by convection in the later hours.

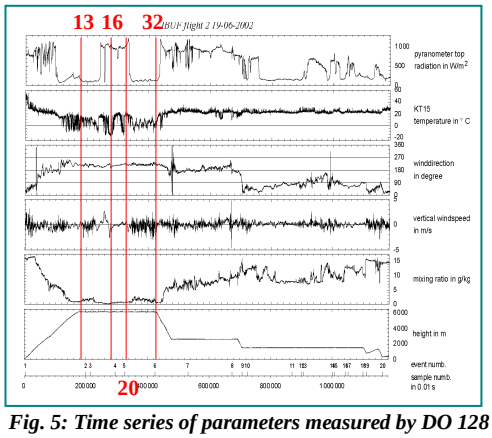


Fig. 5: Time series of parameters measured by DO 128 during flight pattern as Fig. 2. Positions of dropping are indicated by sonde numbers.