INFLUENCE OF THE WIND PROFILE ON THE LOCATION OF HOTSPOTS OF CONVECTION IN MOUNTAINOUS TERRAIN

Martin Hagen[1], Joël Van Baelen [2], Evelyne Richard [3]

[1] Deutsches Zentrum für Luft- und Raumfahrt (DLR), Oberpfaffenhofen, Germany
E-mail: *martin.hagen@dlr.de*
[2] Université de Clermont-Ferrand, France
[3] Observatoire Midi-Pyrénées, Toulouse, France

Abstract: Radar observation of the initiation and life cycle of small convective cells during the COPS field campaign in south-western Germany and eastern France show a dependence on the prevailing wind profile. Several hotspots for convective initiation were identified. Orographic features favour convergent flow. On the days when weak winds were prevailing cells developed over the crest line, whereas on days when strong westerly wind were observed the initiation of convection took place in the lee of the mountains within convergent flow.

Keywords: *convection, mountainous area, radar observations*

1 INTRODUCTION

COPS (Convective and Orographically-induced Precipitation Study, Wulfmeyer et al., 2008) was an international field campaign that took place in the Upper Rhine Valley, the Black Forest and the Vosges Mountains during summer 2007. The aim of COPS was to study the orographic influence on the initiation and life cycle of convection, mainly by investigating the humidity structure. Observations with advanced instruments should help to improve the forecast skill of mesoscale numerical models, especially precipitation forecasts. Among the large number of observed convective systems we will concentrate on the observations of isolated small convective rain showers which developed in the Vosges Mountains on two consecutive days. While on one day the cells were initiated at the crest line of the mountain range, on the second day the cells developed on the lee side of the Vosges Mountains in the Rhine Valley.

2 THE COPS FIELD CAMPAIGN

For the COPS field campaign the polarimetric C-band Doppler radar POLDIRAD was deployed for 3 month in the foothills of the Vosges Mountains about 20 north-west of Strasbourg (Fig. 1) and about 100 m above the floor of the Rhine Valley. Volume scans were performed up to 120 km range every 10 minutes. A large set of instruments were set up at the super sites Aachern, Hornisgrinde, Deckenpfronn, and Bischenberg/ Meistratzheim. Additionally the ARM mobile facility was installed in the Murg Valley. At the French super site Bischenberg a high resolution (temporal 30 sec., radial 60 m) scanning X-band radar was installed. The maximum range was 20 km.

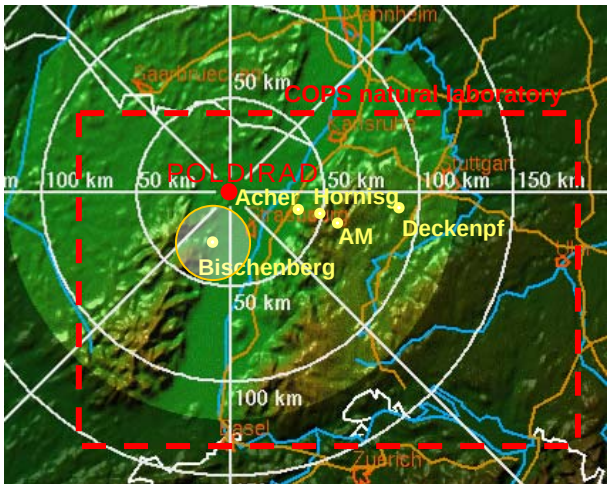

Fig. 1 The COPS region in South-Western Germany and North-Eastern France. Range rings are from POLDIRAD, yellow dots show locations of super sites. The highlighted circle around Bischenberg indicates the 20 km range of the X-band radar.

In addition to the observations several meso-scale numerical models were used to provide forecasts for the field campaign and to perform studies with different microphysics schemes. For the present study we used the simulations with the French MesoNH model.

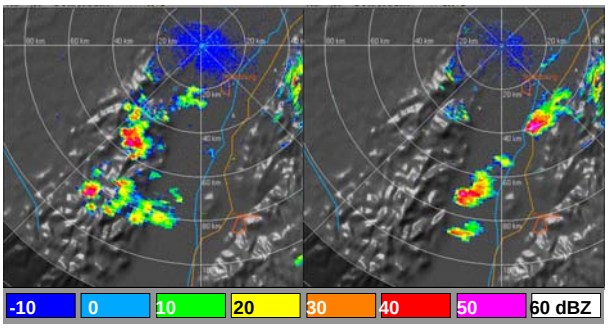

Fig. 2 PPI of reflectivity on 12 Aug. 2007 1440 UTC (left) and 13 Aug. 2007 1120 UTC (right).

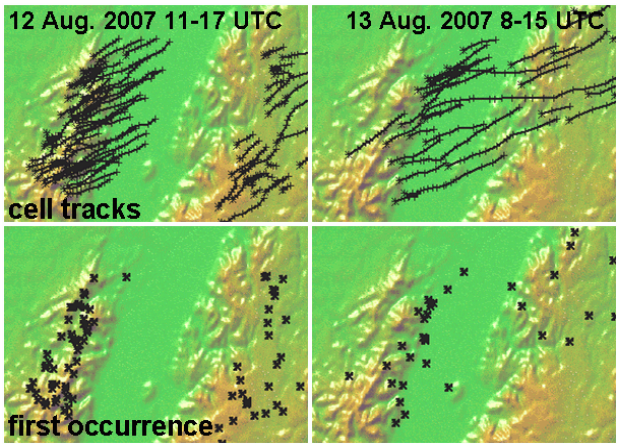

Fig. 3 Tracks of cells (top row) and location of first occurrence (bottom row) for 12 August and 13 August 2007.

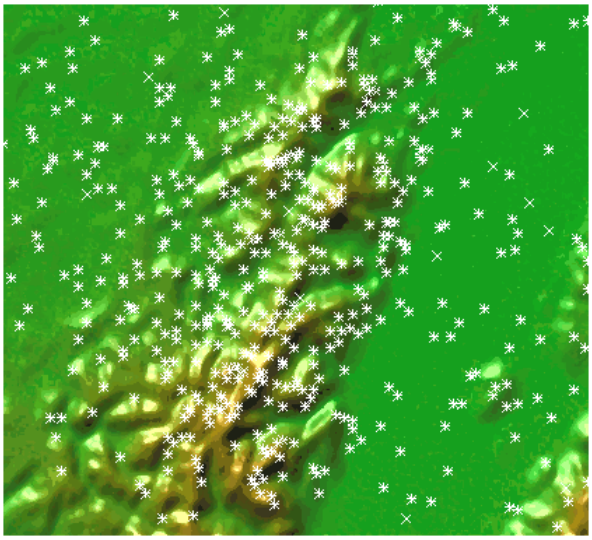

Fig. 4 Location of first occurrence of convective cells observed by POLDIRAD over the Vosges Mountains on 15 days during COPS.

3 OBSERVATIONS OF ISOLATED CELLS

In addition to stratification and the moisture field, topographic features have a strong influence on the initiation and development of convection. Mountains provide elevated heat surfaces which can destabilize the stratification in the boundary layer. Also, mountains can initiate flow convergence along the crest line providing a source for convection initiation. On a larger scale mountains can distort the flow generating convergence in relation the orography. During COPS on several days only small isolated shower or thunderstorm cells developed in the COPS region. A distinct situation was observed on August 12 and 13, 2007. On both days isolated cells developed in relation to the Vosges Mountains. Fig. 2 shows two sample PPI images of reflectivity for the two days. On 12 August cells developed over the Vosges and travelled afterwards with the mean south-westerly flow into the Rhine Valley while decaying there. On 13 August the cells developed in the lee of the Vosges, travelling across the Rhine Valley and some of them where enhanced again at the windward slopes of the Black Forest. Fig. 3 shows the cell tracks and location of first radar echo for the two days. In total 80 and 38 cells were tracked on 12 and 13 August, respectively. 51 (22) of them have been initiated in relation to the Vosges Mountains. On both days the life time was in the order of 0.5 to 2 hours, with some cells being active for even a longer time. This was mainly for 13 August.

Simulations with the mesoscale model MesoNH have been able to reproduce the diverse life cycle of the cells. The quite realistic simulations are also of great value to access atmospheric parameters which have not been observed in 3 dimensions, like the moisture structure and the wind field. While on 12 Aug. weak south-westerly winds are prevailing, strong westerly winds are simulated and observed on 13 Aug. The simulated cells correspond to the observed ones, not exactly in time and location, but with similar life time and cell initiation.

Fig. 4 shows the convective initiation over the Vosges Mountains on 15 days in 2007 (June 4+5, 8-12, July 17, Aug. 3, 6, 12, 13, 17, 23, 24). Wind direction and profile were varying and radar observations were available only every 10 minutes. Despite the large variability of the initiation points common features can be identified: (i) initiation tends to be located along mountain ridges; (ii) initiation is concentrated along mountain peaks; (iii) initiation occurs along the edge of ridges towards the Rhine Valley (right side); (iv) there is a gap region between the crest line and the edge towards the Rhine Valley.

4 CONCLUSIONS

Observations with radar during the COPS field campaign in Central Europe of isolated shower cells show a strong dependence on the orography and the prevailing wind field. The simulations with MesoNH were able to reproduce the observations in a quite realistic manner, even reproducing “hot spots” of cell initiation in relation to orography. The X-band radar at Bischenberg allowed for observations with high temporal resolution at one of the north-eastern hot spots. Convergences along ridges favours the initiation of convection.

REFERENCES

Wulfmeyer, V., et al., 2008: The Convective and Orographically-induced Precipitation Study. *Bull. Amer. Meteor. Soc.*, **89**, 1477-1486.