8.3 INFLUENCE OF EMBEDDED CONVECTION ON MICROPHYSICS OF PRECIPITATION

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1 INTRODUCTION

The connection between embedded convection and riming is generally acknowledged. However, experimental observations of the riming degree of ice crystals together with convective parameters are scarce and several questions cannot be answered satisfactorily:

Which dynamic or thermodynamic reasons are causing embedded convection? What are the correlations to the microphysics of riming? The answers to these questions are of fundamental interest to understand the formation of precipitation and thus also of interest for e.g. high resolution weather modelling.

The degree of riming – the amount of accreted supercooled cloud water on ice crystals – can be expressed on a scale of six classes starting from unrimed (class 0) over lightly rimed (1), moderately rimed (2), densely rimed (3), heavily rimed (4) up to graupel which is class 5 (Mosimann et al., 1994).

Several groups have observed riming with help of vertically pointing X-band radars. Riming results in a higher Doppler velocity and can cause a bimodality in the Doppler spectra below the region where riming takes place (Zawadzki et al., 2001).

Embedded convective cells in stratiform (Houze, 1997) precipitation could be a reason for riming. Classifications of convection resp. turbulence intensity have e.g. been made by Mosimann (1995) for vertical X-band radars via the variability of the mean Doppler velocity and by Wüest et al. (2000) for horizontal C-band radars by analyzing the spectral width of the Doppler spectra.

To answer some of the above mentioned open questions, a field experiment is in progress in the pre-Alpine region of Switzerland.

2 SETUP AND INSTRUMENTATION

Two mountains – the Mount Rigi and Mount Üetli – were chosen as measuring sites, which have a steep rising front pointing towards the lowlands and the main weather direction. The setup, as seen in Figure 1, is identical at both mountains and is split up in two locations – one at the bottom and one close to the top. The steepness of the mountains allows to measure variables on different height levels at similar horizontal position.

At the base of the mountain a just recently completed and modernized mobile vertically pointing X-band Doppler radar with 1 s temporal and 50 m spatial resolution is situated below the melting layer. It is measuring the full Doppler spectrum of the precipitation particles with 0.125 m/s resolution. For measuring the raindrop size distribution a Joss-Waldvogel-Disdrometer is used. In addition standard meteorological parameters are monitored and radio soundings can be performed.

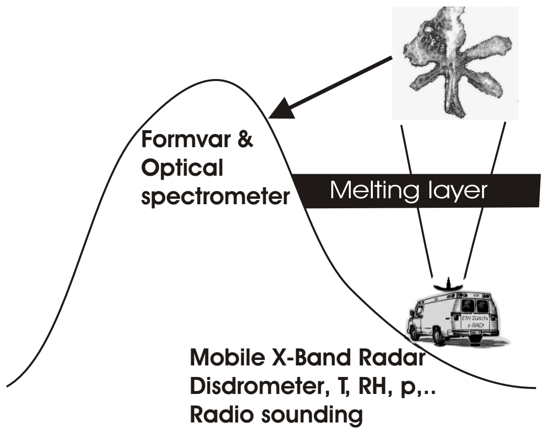

Fig. 1: *Schematic drawing of the setup with two locations, one at the bottom and the second close to the top of the respective mountains.*

On the top of the mountain, above the radar and above the melting layer, ice precipitation is observed with an optical spectrometer, measuring the size distribution of the ice particles and their fall velocities which are influenced by the degree of riming. In addition, ice crystals are replicated with the Formvar method to determine their size, type and riming degree (for more details see Schefold et al. (2002) presented at this conference as talk number 8.4).

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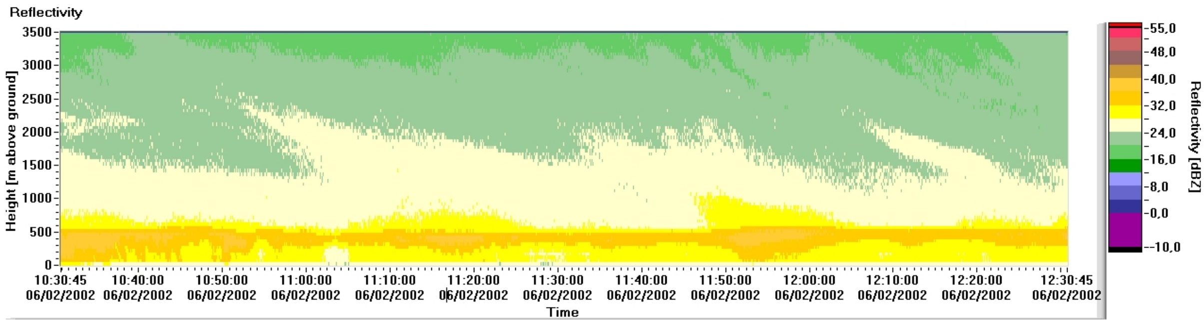

Fig. 2: Stratiform precipitation.

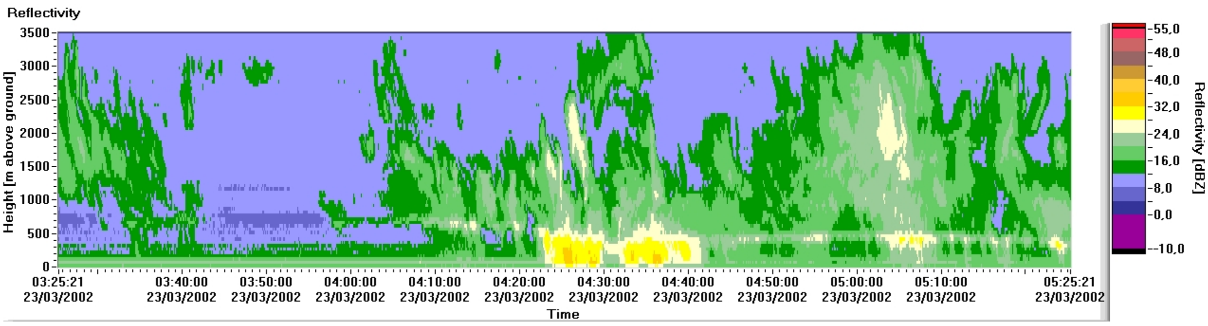

Fig. 3: Stratiform precipitation with embedded convective cells.

The horizontal wind field around the experimental site is monitored with two C-band Doppler radars, working in dual-Doppler mode – the method is presented at this conference in poster number P1.10 (Wüest et al., 2002; Wüest, 2001).

3 MEASUREMENTS

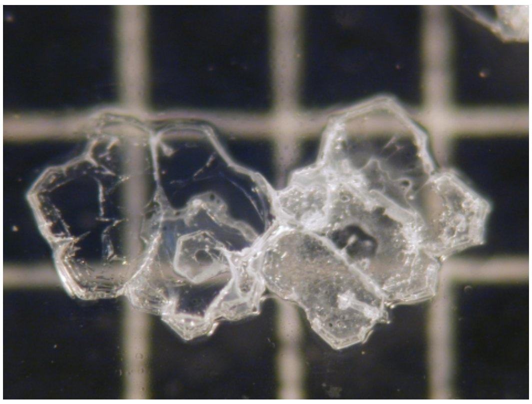

Fig. 4: Formvar replica of an unrimed (class 0) snow crystal. The grid size is 1 mm.

Several case studies have been taking place in winter season 2001/2002. There are indications for a connection between the degree of riming and embedded convective cells which can be found in the reflectivity and Doppler data of the X-band radar.

Figure 2 gives an example of a HTI (height-time-indicator) of the reflectivity for a stratiform case. A strong and long-lasting bright band is visible. During the two hours of the period shown here the degree of riming at the top station (about 1000 m above the radar) was unrimed (0) up to lightly rimed (1). Figure 4 shows a Formvar replica of an example for an unrimed (class 0) snow crystal. The probe was taken at 11:24 on 6 February 2002 – in the middle of the very stratiform phase shown in Figure 2.

In another case where snow with a degree of riming of 3 (Figure 5) was predominant a bright band existed, but it was very weak and had interruptions. Here a cellular structure, probably caused by embedded convective cells, is visible in the reflectivity HTI (Figure 3).

4 OUTLOOK

Experiments and analysis are still in progress. Further plans are e.g. to identify with help of the dual Doppler wind fields special synoptic and orographic situations, which are the reason for the generation of embedded convective cells in stratiform winter precipitation and thus creating prerequisites for riming to occur. Furthermore, the newly achieved high temporal resolution of the radar may be useful to improve existing or define new methods for the quantification of the intensity of embedded convective cells.

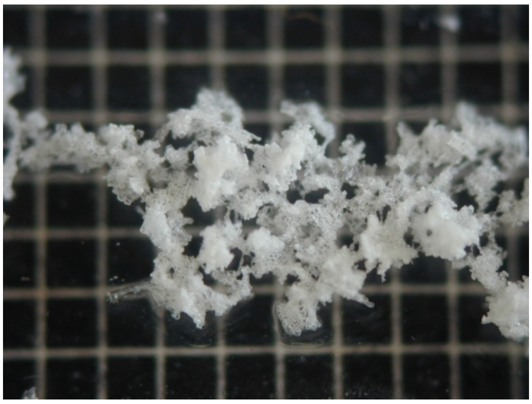

Fig. 5: Formvar replica of a densely rimed (class 3) crystal. The grid size is 1 mm.

5 ACKNOWLEDGEMENTS

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