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Characterization of dynamic of convection: a case study from the COPS experiment

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Motivation

The life cycle of isolated deep convection is investigated with emphasis on their dynamical evolution. The data used in this case study are from IOP8b (15/07/2007) of the COPS campaign (Convective and Orographically-induced Precipitation Study) that took place in south-western Germany and eastern France in the summer 2007. On this day, an isolated thunderstorm was initiated above the Black Forest Mountains. Due to the absence of synoptic forcing deep convection must been initiated by local processes related to the orography.

Recent studies (e.g. Barthlott et al. (2009)) show that numerical results of weather forecast models differ from each other and from measurement in a wide range. To improve forecasting the reasons for the differences have to be investigated. As a possible factor the dynamic of convection was analyzed in detail in this study.

Fig 1: MODIS picture from Aqua satellite (NASA) on 15/07/2007 at 12:15 UTC before initiation of deep convection occurs

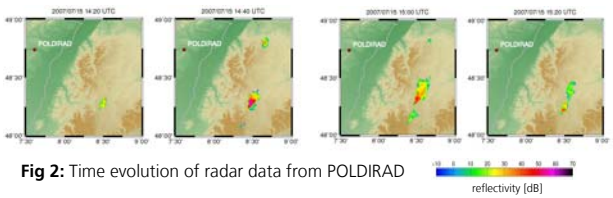

Fig 2: Time evolution of radar data from POLDIRAD

Detailed comparison between radar measurement and model output

To investigate microphysical processes different types of hydrometeors were classified by using polarimetric information of the DLR radar POLDIRAD. The type and mass density of hydrometeors are compared with the output from model calculation by using Meso-NH model.

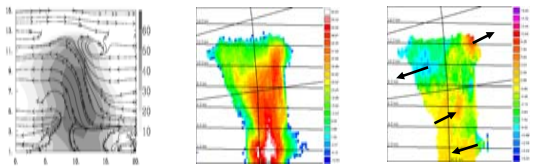

Fig 4: Comparison between a) simulated reflectivity and wind field from model data to measured radar data from POLDIRAD with b) reflectivity, c) vertical wind

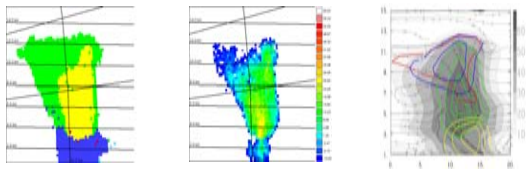

Fig 5: Derived hydrometeor information from polarimetric radar with comparison to model data

Analysis of radial wind field by comparing with VERA and model output

During initiation state a convergence line in vertical wind was seen in the radar data of DWD Feldberg radar. To investigate the influence of the convergence line to the weather forecast models the surface wind field from VERA (Vienna Enhanced Resolution Analysis) of the University of Vienna, from the MesoNH model and the COSMO model were plotted as vertical wind seen from Feldberg radar site.

The surface wind data of the VERA analysis were calculated from observed wind measurements. However the convergence is much weaker than obtained by radar probably caused by great station distances.
In contrast to the COSMO model the deep convection was forecasted by the MesoNH model. By comparing the vertical velocity showing at the figure 7 the convergence line could not be the reason for this result.

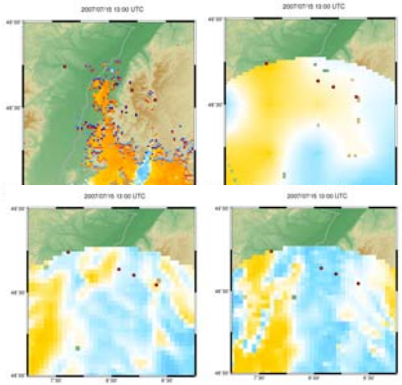

Fig 7: Vertical wind related to Feldberg site from a) radar data from Feldberg, b) VERA analysis, c) MesoNH model, and d) COSMO-DE model output

Description of life cycle of deep convection on IOP8b

On the basis of case study from 15 July the convection is described from convective initiation at 14:20 UTC to the decay around 16:30 UTC. The convective initiation is identified by significantly changing of brightness temperature of the MSG (Meteosat Second Generation satellite) rapid scan data at infrared and water vapour channel. At this time the radar reflectivity pass over 35 dBz level. Lightning only occur during 20 min.

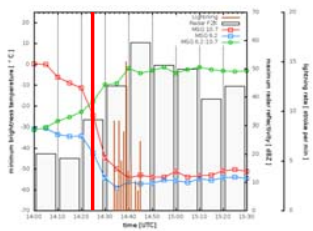

Fig 3: Time evolution of brightness temperature, radar reflectivity and lightning rate

Multiple-Doppler analysis

To investigate the wind field during mature state multiple-Doppler analysis was examine with four radars. Results show relative low wind speed at the lowest altitude level (3 km).

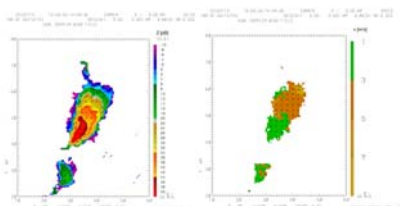

Fig 6: Reflectivity and absolute wind speed as a composite of 4 radars at 14:40 UTC

Summary and Conclusion

- The life cycle of IOP 8b (15/07/2007) from COPS campaign was evaluated in detail by using radar, satellite, and lightning data as well as VERA data.
- To improving forecasting in future direct radar measuring and derived products were compared with corresponding numerical forecasting results.
- The 3D wind field was derived from radar measuring of four radar sites.
- The convergence line which was seen by Feldberg radar seems to be the trigger for the deep convection on this case. But this convergence line could not be reconstructed neither in VERA analysis data nor in model data (MesoNH and COSMO-DE). One possible reason could be the resolution of around 2 km.

References:

Aydin, K., et al., Remote sensing of hail with a dual linear polarization radar. J. Climate Appl. Meteor., 25 (1986).
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