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RADAR BASED CLIMATOLOGICAL STUDIES OF THE INFLUENCE OF OROGRAPHY ON THUNDERSTORM ACTIVITY IN CENTRAL EUROPE

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1. INTRODUCTION

The knowledge of the influence of orography on initiation and development of thunderstorms is important for both, the design of convection schemes of numerical weather prediction models and the routine of operational weather forecasting. Nowcasting thunderstorms within an orographically structured region requires besides anticipation of the synoptical and mesoscale environment the assessment of possible orographical forcing on time and location of thunderstorms. The orography of Central Europe is bounded to the south by the high reaching mountains of the Alps. The northern parts are characterized by lowlands and in between exist widespread hilly regions. With the installation of operational remote sensing systems like meteorological satellites, radar and lightning networks dense information is given on the geographical and temporal occurrence of thunderstorms. The DLR Oberpfaffenhofen (Finke, Hauf) has built up a climatology for southern Germany in recent years on basis of a lightning network. Radar data also has the capacity to describe the geographical distribution of thunderstorms. The data used for the description given here are operational data of radar network of the German meteorological service. Some of the results have been derived in the framework of the European Nowcasting project COST78 "Improvement of Nowcasting Techniques", which was active 1994-1999.

2. RADAR DATA BASIS

The Deutscher Wetterdienst (DWD) operates a radar network of 16 radar stations monitoring Central Europe and measuring reflectivity with 11 radar stations also producing Doppler radial winds. 5 radar stations have provided reflectivity data since the eighties, comprising Munich, Frankfurt/M., Essen, Hamburg and Berlin. The data of Berlin and Hamburg are representing the northern lowlands, the data of Essen are covering the hilly regions of the middle parts, the data of Frankfurt/M. are scanning middle and southern regions of Germany and the data of Munich are monitoring the southern hilly region and northern flanks of the Alps. The radar data used for the investigation of thunderstorms are covering the years from 1992 to 1997, completed by data of Hanover. Two indicators have been chosen for defining thunderstorm activity: Radar reflectivity above a threshold value of 28 dBZ in the ppi field and the existence of actual warning markers. The warning markers are based on reflectivity thresholds in the vertical profile, used for the Swiss hail experiments in the 1970's. The warning markers are defined doublefolded : "Strong shower" markers are given, when the reflectivity exceeds 40 dBZ in a height of 6 km and 10 dBZ in a height of 8 km. "Hail" markers give positions where additionally to the strong shower criterium the reflectivity is higher than 46 dBZ above freezing level. Broad synoptical experience has proved close correlation between occurrence and density of warning markers and the degree of actual thunderstorms.

In the evaluation focus was given on following aspects : Detection of regions where thunderstorm activity is first originating (places of initiation), investigation of prefered paths of thunderstorms, distribution of thunderstorm activity in relation to the time of year and day, time of mean daily maximum of thunderstorm activity. Main interest was directed to conceptual mechanisms of thunderstorm development within the northern slopes of the Alps and the hilly regions in Germany.

3. RESULTS OF INVESTIGATION

Summer thunderstorm activity in Central Europe generally develops in south-westerly flow in unstable subtropical air ahead and within convergence lines and cold-fronts. Early source regions of strong convection therefore tend to be the western/southwestern hilly regions.

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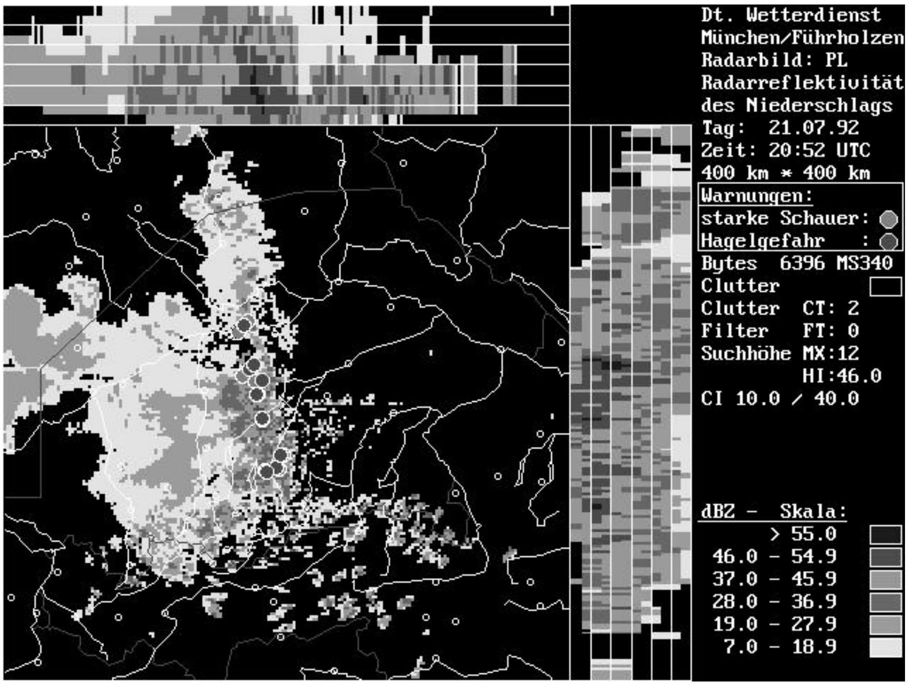
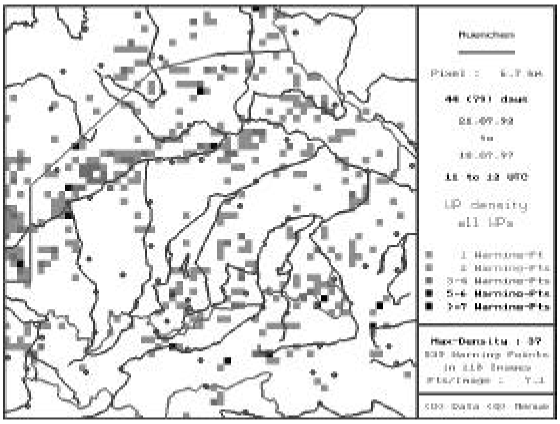
Radar Domain	Cases 1 N	Max. 1 UTC	Diff. 1 to mean h.mm	Cases 2 N	Max. 2 UTC	Diff. 2 to mean h.mm	Mean 1+2 UTC	Mean Diff. 1 + 2 h.mm
10147 Hamburg	19	15.53	+ 0.35	19	17.25	+ 0.53	16.39	+ 0.44
10338 Hannover	10	14.27	- 0.51	10	16.31	- 0 .01	15.29	- 0.26
10384 Berlin	10	15.18	0.00	10	15.27	- 1.05	15.23	- 0.32
10410 Essen	18	13.36	- 1.42	18	13.25	- 3.07	13.31	- 2.24
10637 Frankfurt/M.	22	15.02	- 0.16	22	17.01	+ 0.29	16.02	+ 0.07
10870/871 Munich	18	17.31	+ 2.13	18	19.22	+ 2.50	18.27	+ 2.32
Mean		15.18			16.32		15.55	

Evaluation interval : 1992 – 1997
Cases 1 : Amount of dBZ values attributed to warning marker (strong showers/hail)
Cases 2 : Size of area >= 28 dBZ



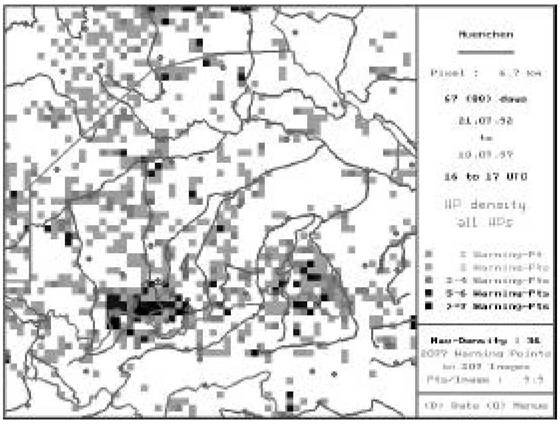
Local radar image of Munich displaying the severe weather situation of 21 July 1992 with reflectivity And warning markers

Deep convection is triggered in most cases from noon. The thunderstorm development may remain at first within the source regions. But in the early afternoon thunderstorms spread out downstream from the hilly regions. The thunderstorm paths are clearly influenced by the direction of the main mountain crests. The temporal peak of activity measured by the warning markers is reached in the central parts of Germany on the average during middle afternoon at about 13 - 15 UTC (15h - 17h local time). By influence of coastal wind convergences the temporal culmination of thunderstorm activity in the most northern low-lands of Germany is somewhat later between about 15 and 16 UTC (17h and 18h local time). The precipitation activity connected with thunderstorms measured by the area of reflectivity >= 28 dBZ, is delayed to the warning marker's peak by about 1/2h.



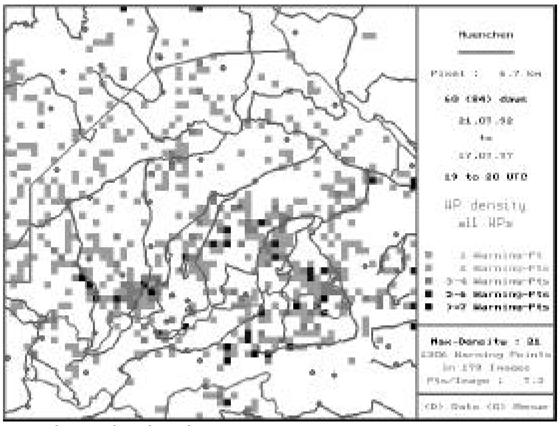
Warning point density 11 – 12 UTC

The northern slopes of the Alps and the directly adjacing regions build up a third very specific regime: Start of strong convection is often even after the noon and reaches peak only in early or middle evening. The main reason for that proves to be apparently the general downslope upper winds in the northern Alps during the thunderstorm situations and the shadowing of the steep northern flanks of the Alps in the early hours of the day. In the domain of the radar station of Munich the temporal peak of warning marker activity is only between 17 und 18 UTC (19 - 20h local time), that means about 3-4 hours later than in the central parts of Germany. After that time thunderstorms at the flanks of the Alps are mostly dying out, with some activity still remaining in the neighbouring table-lands.



Warning point density 16 – 17 UTZ

On the whole the areas near and direct at the northern slopes of the Alps act as culmination regions of thunderstorm frequency in Central Europe and very often the northern flank of the Alps are direct paths of thunderstorm clusters.



Warning point density 19 – 20 UTC

4. CONCLUSIONS

The inferred radar results confirm the output of the investigation of thunderstorm activi ty by DLR Oberpfaffenhofen on basis of lightning data. DLR also revealed a specific maximum of thunderstorm activity near the northern Alps with a accumulation of thunderstorms in the late evening. Synoptic reasoning indicates that much of thunderstorm features north of the Alps is apparently influenced by the thermally driven circulation at the Alpine slopes and the late advection of thunderstorm systems from source-regions to the southwest (Switzerland, France).

5. REFERENCES

COST78, 2001: Improvement of nowcasting techniques, final report, EUR 19544

Jaeneke,M., 2000 : Internationales Training-Seminar Satelliten-Meteorologie, Deutscher Wetterdienst, Bildungs- und Tagungszentrum (BTZ)

Jaeneke,M., 2000 : Grundlagen, Daten, Hilfsmittel und Praxis von Kürzest-fristvorhersage und Nowcasting sommerlicher Gewitterlagen, Deutscher Wetterdienst, Bildungs- und Tagungszentrum (BTZ)

Finke U.,T.Hauf, 1996 : The Characteristics of Lightning Occurence in Southern Germany, Contr.Atmos.Phys.,69,361-374

U.Finke, T.Hauf 1999 : Blitzstatistik für Süddeutschland, CD-ROM, Bayerisches Staatsministerium for Landesentwicklung und Umweltfragen