

Simulations of the Hail Event in Villingen-Schwenningen on 28/06/2006 with LM and a 2-Moment Microphysics Scheme

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Motivation

ANTISTORM objectives:

- Study the impact of aerosols on severity of storms in Europe
- develop models that should help to improve forecasting of such storms

28/06/2006:

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28/06/2006:

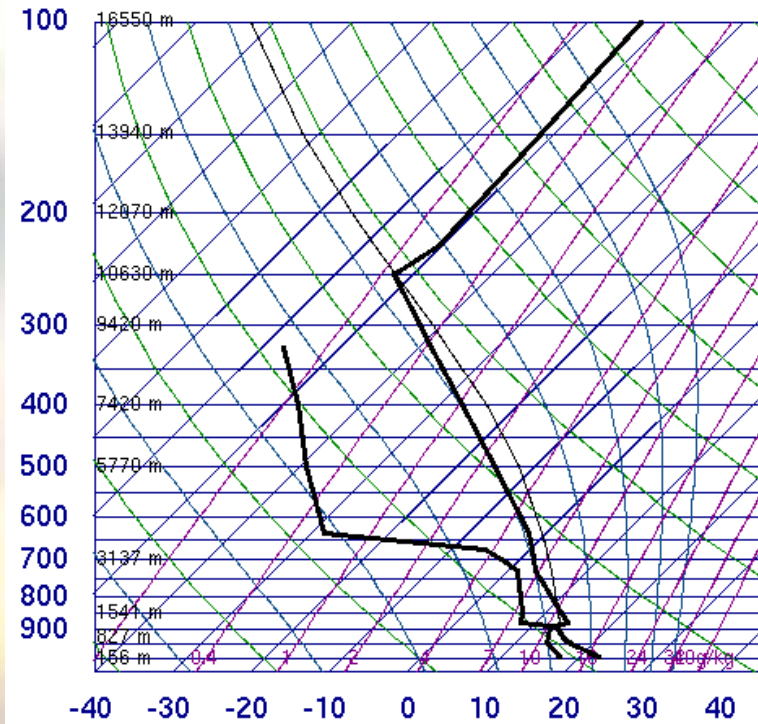
- one of the chosen case studies
- case with large hail and extreme precipitation rates
- considerable damage, >100 people got hurt, one man drowned

Observations

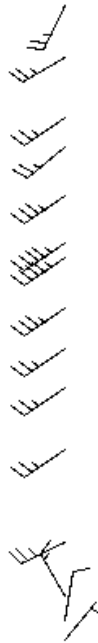


Observations

07180 LFSN Nancy-Essey



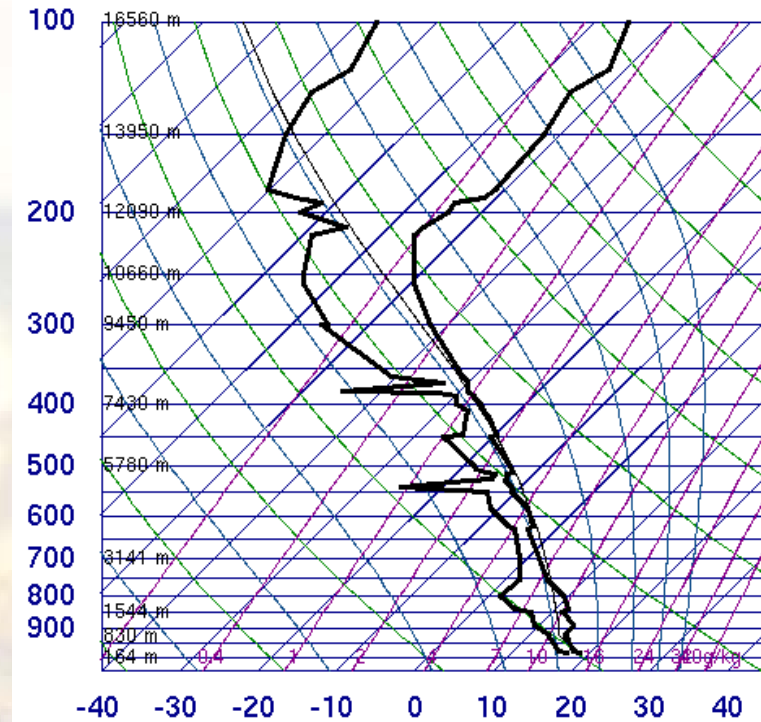
SLAT	48.68
SLOE	6.21
SELV	212.0
SHOW	0.62
LIFT	-3.20
LFTV	-3.65
SWET	149.3
KINX	30.40
CTOT	22.30
VTOT	27.30
TOTL	49.60
CAPE	761.4
CAPV	877.9
CINS	0.00
CINV	0.00
EQLV	249.7
EQTV	249.8
LFCT	914.3
LFCV	914.3
BRCH	16.48
BRCV	19.01
LCLT	287.8
LCLP	914.3
MLTH	295.2
MLMR	11.64
THCK	5614.
PWAT	27.50



12Z 28 Jun 2006

University of Wyoming

10739 Stuttgart



SLAT	48.63
SLOE	9.20
SELV	315.0
SHOW	1.75
LIFT	-0.41
LFTV	-0.55
SWET	123.0
KINX	30.80
CTOT	21.60
VTOT	25.70
TOTL	47.30
CAPE	121.9
CAPV	154.1
CINS	-66.7
CINV	-46.3
EQLV	378.5
EQTV	377.0
LFCT	765.6
LFCV	777.0
BRCH	7.21
BRCV	9.12
LCLT	287.1
LCLP	925.3
MLTH	293.6
MLMR	11.03
THCK	5616.
PWAT	30.28

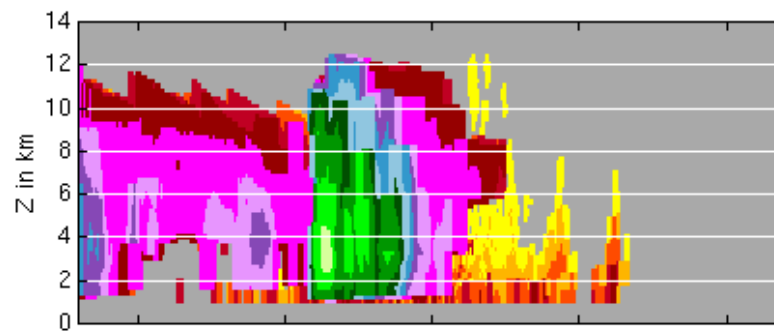


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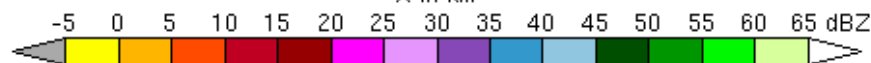
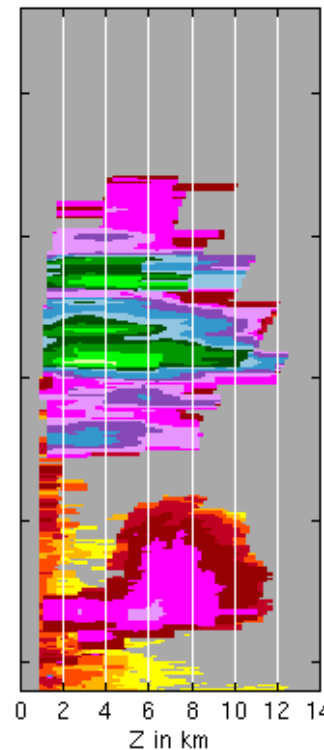
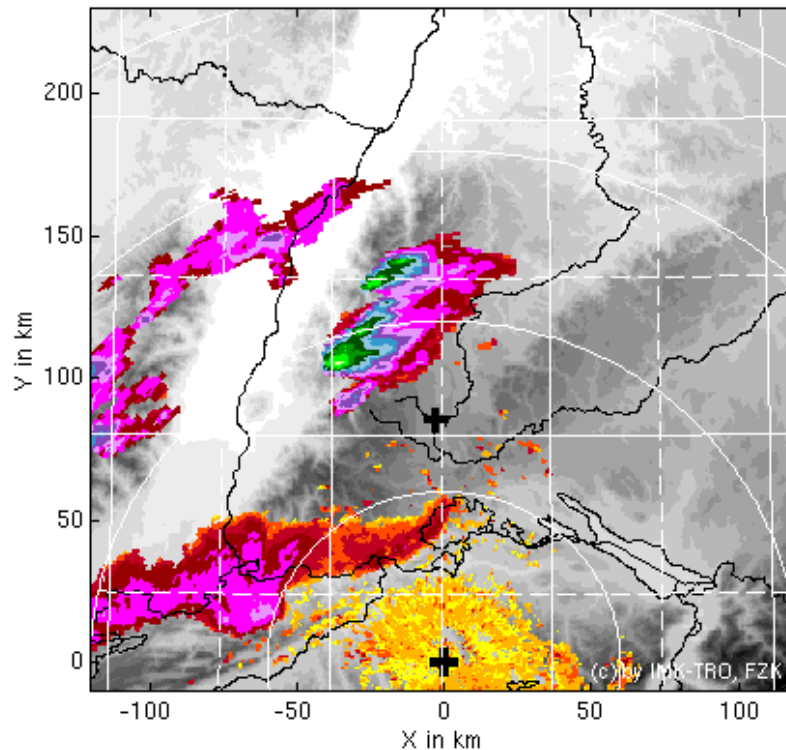
Observations

Radar (Albis)



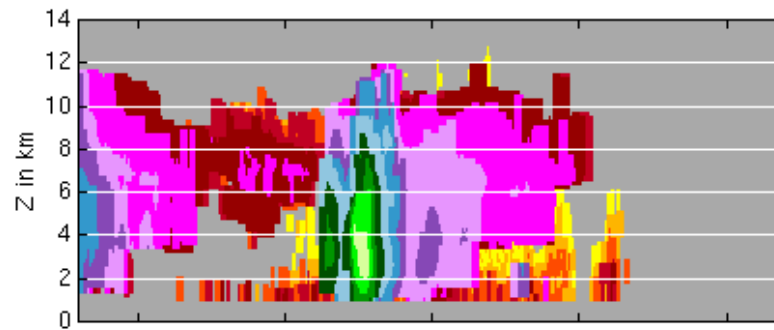
Radar Albis
MAX-CAPPI Z

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UTC



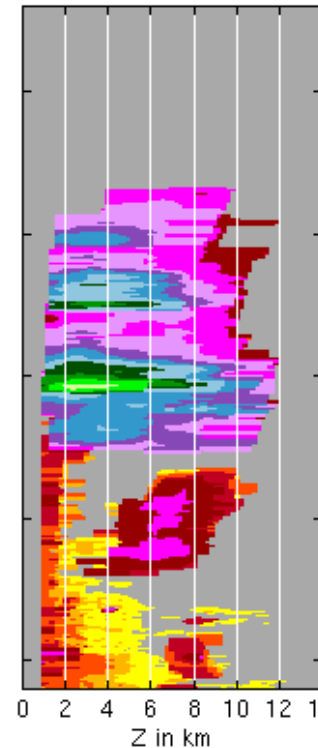
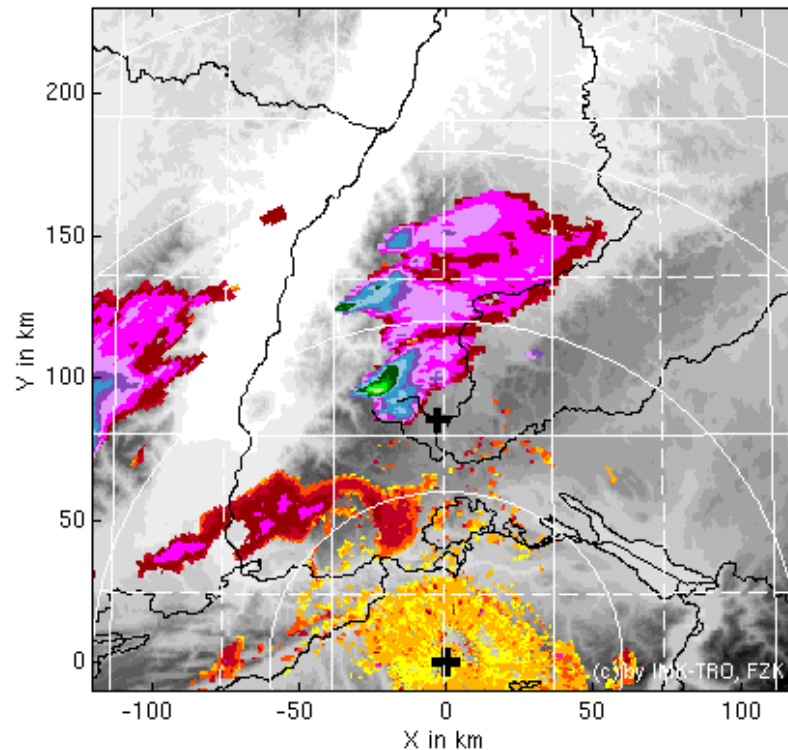
Observations

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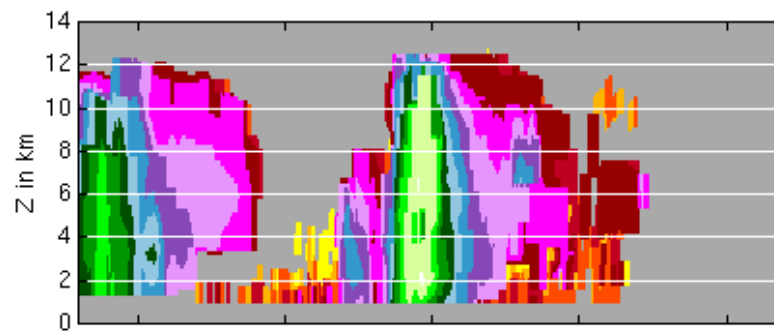
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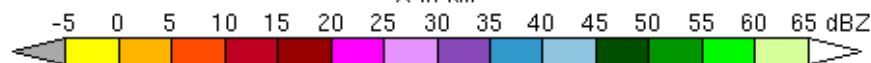
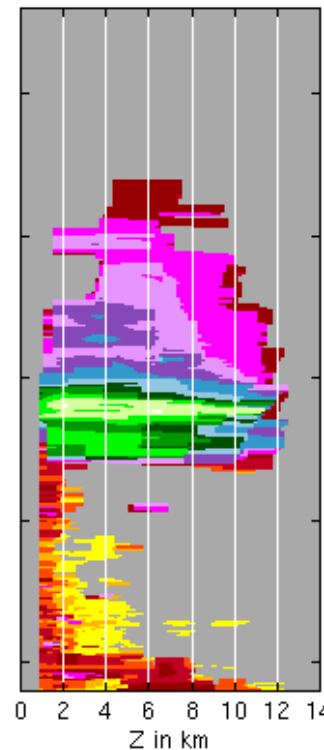
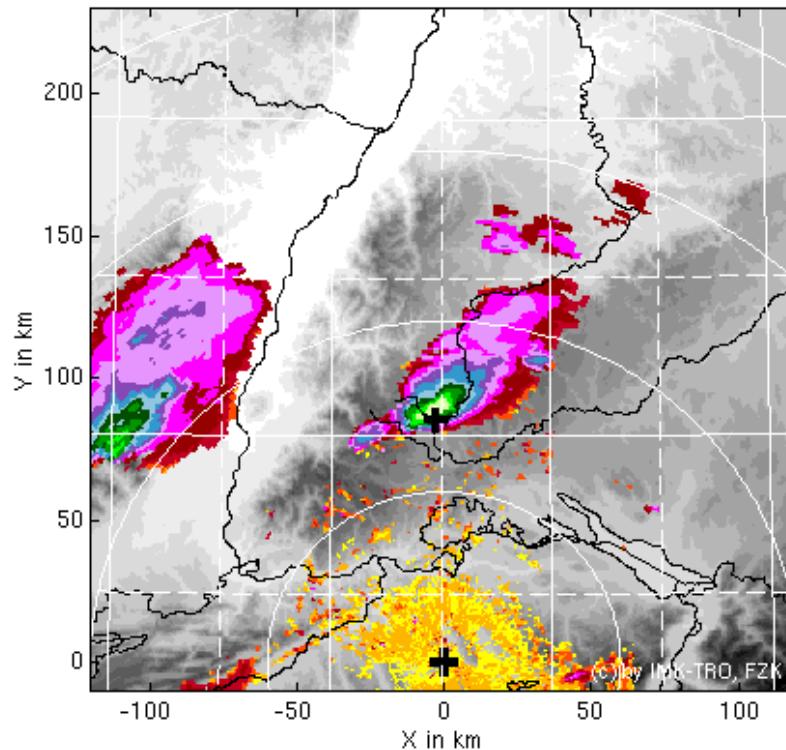
Observations

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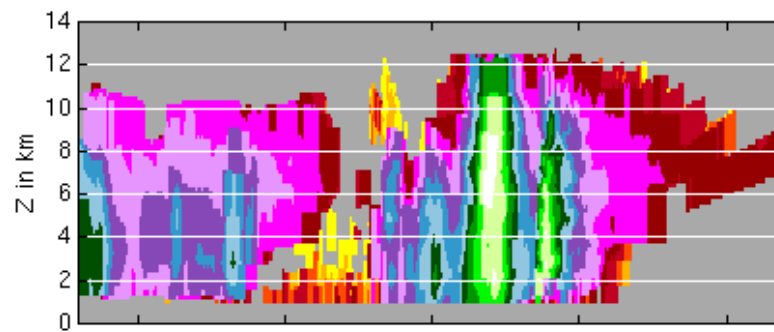
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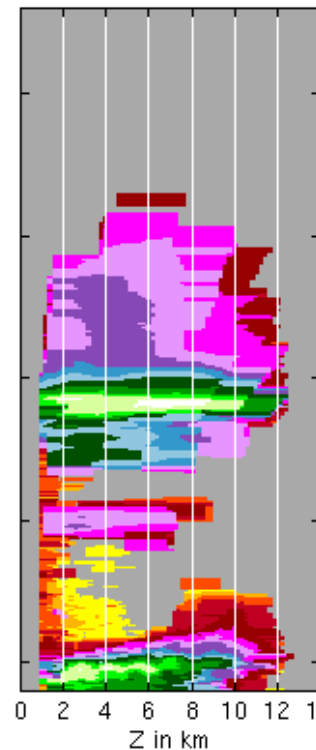
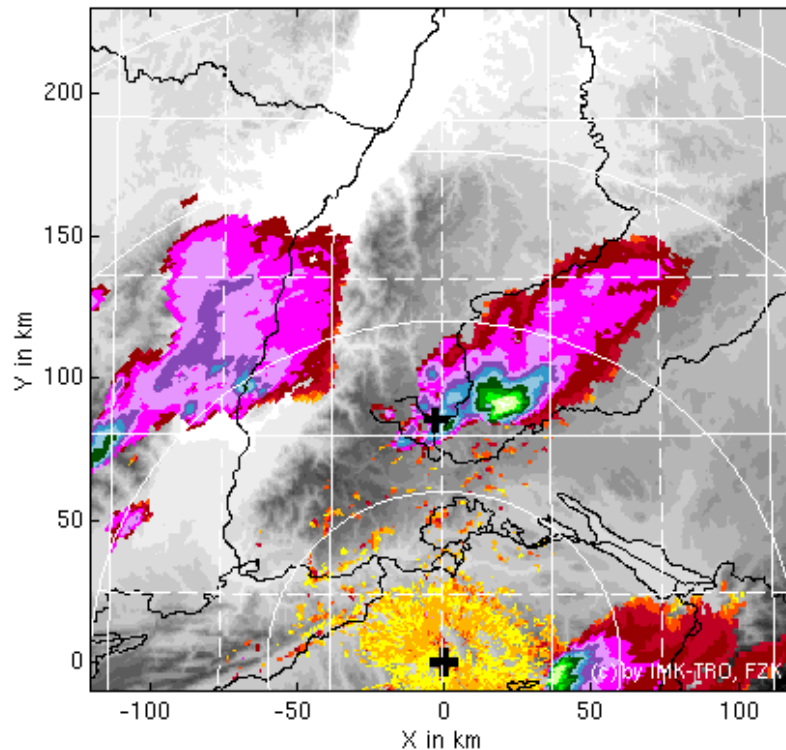
Observations

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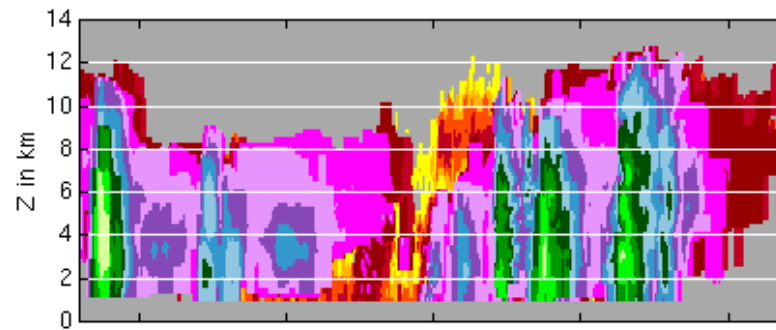
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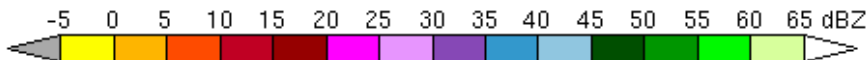
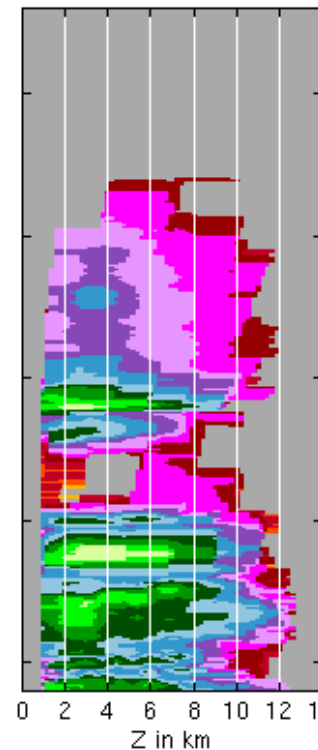
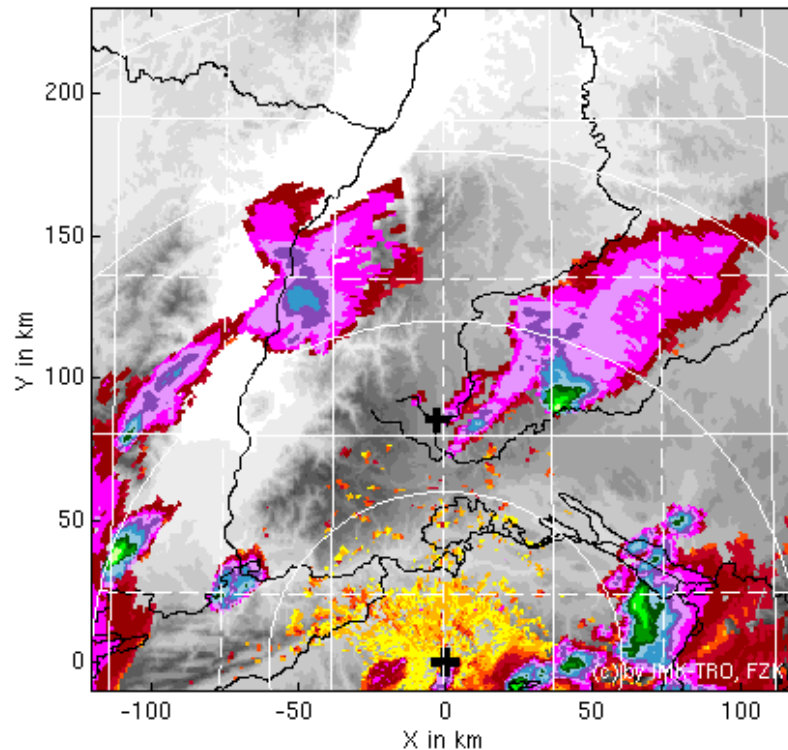
Observations

Radar (Albis)



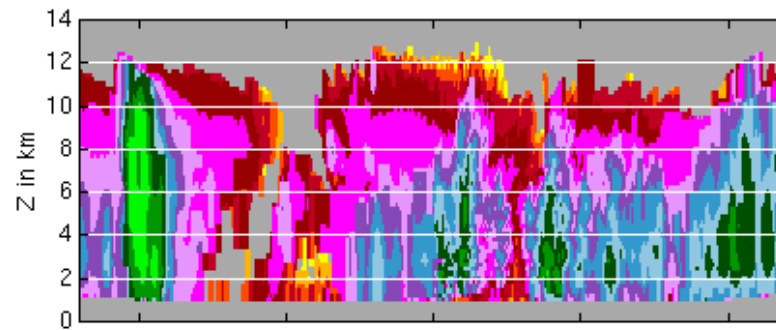
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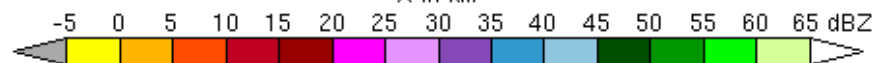
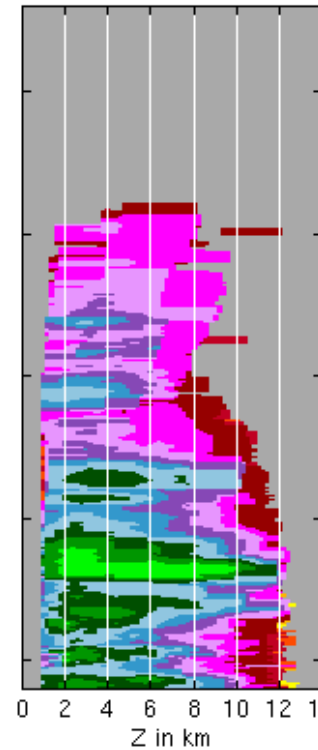
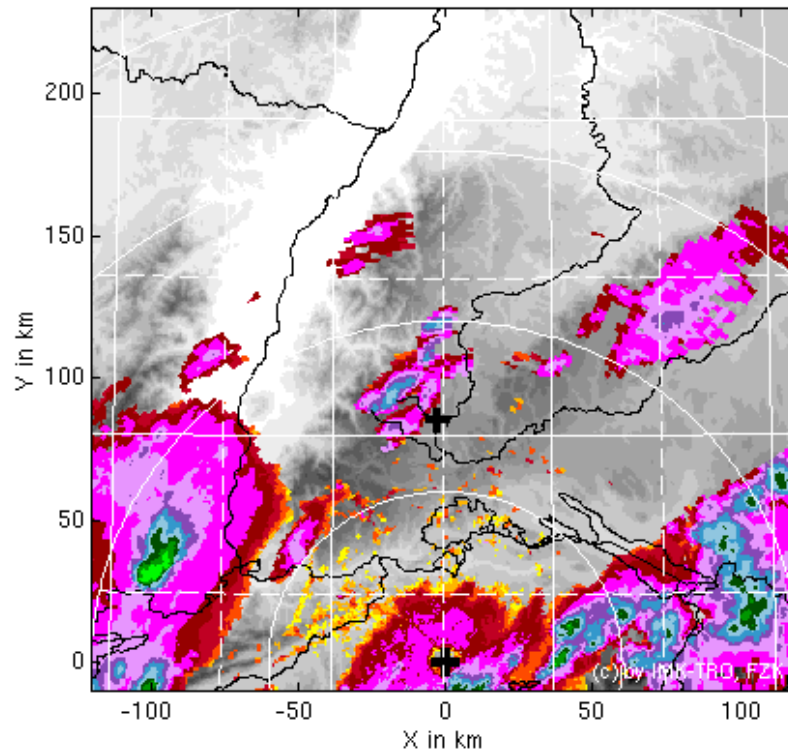
Observations

Radar (Albis)



Radar Albis
MAX-CAPPI Z

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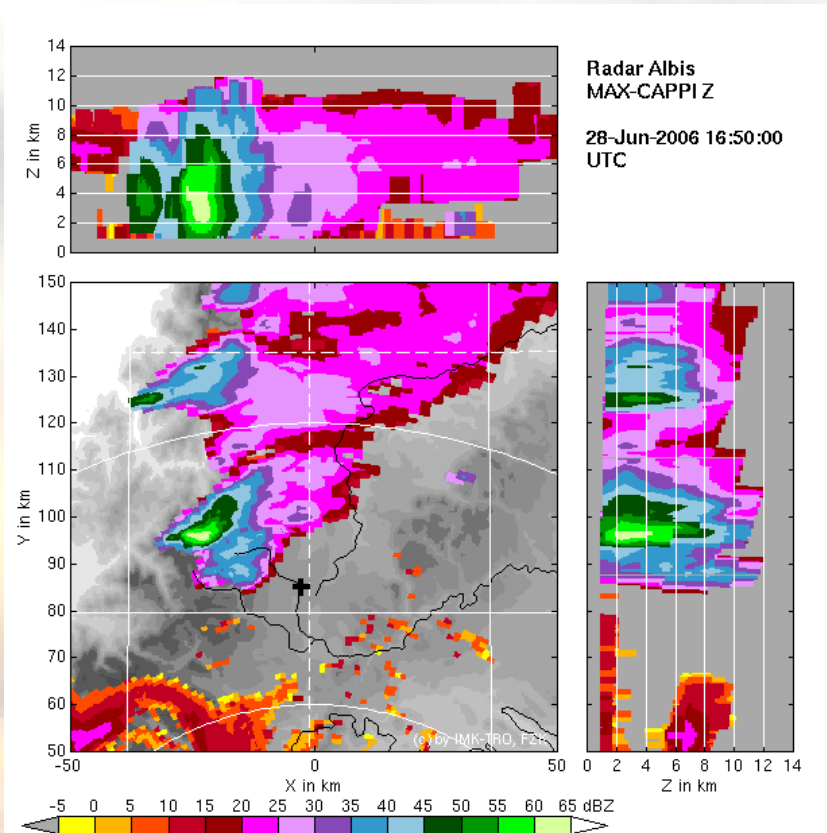


Idealised Simulations

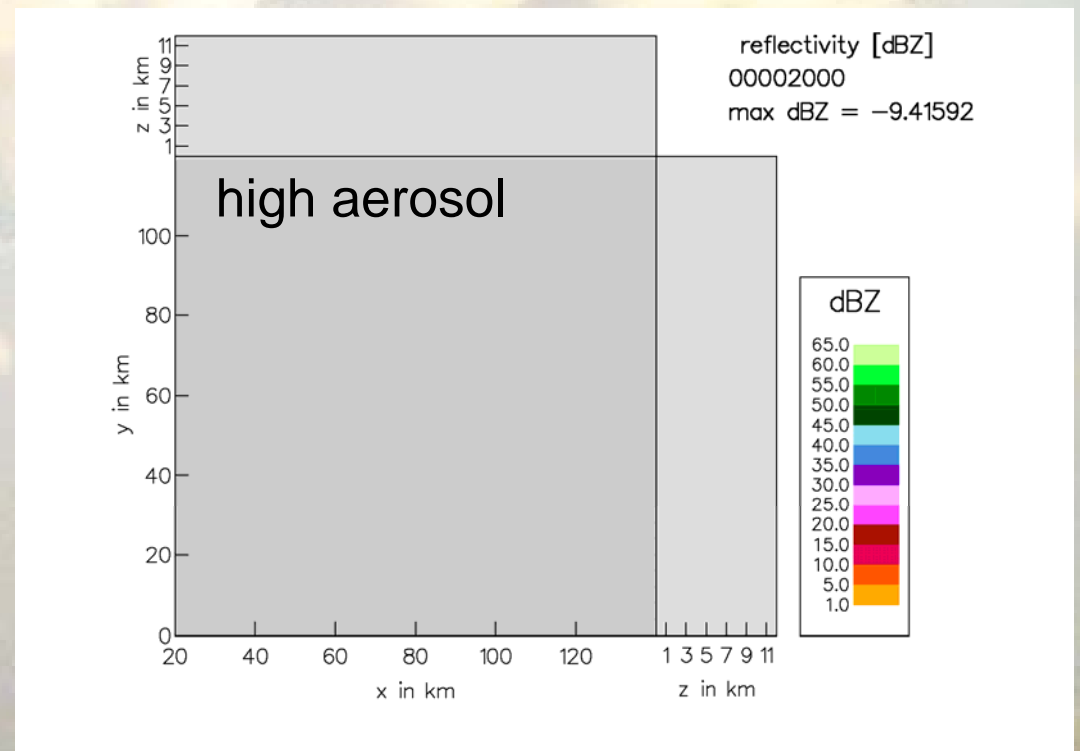
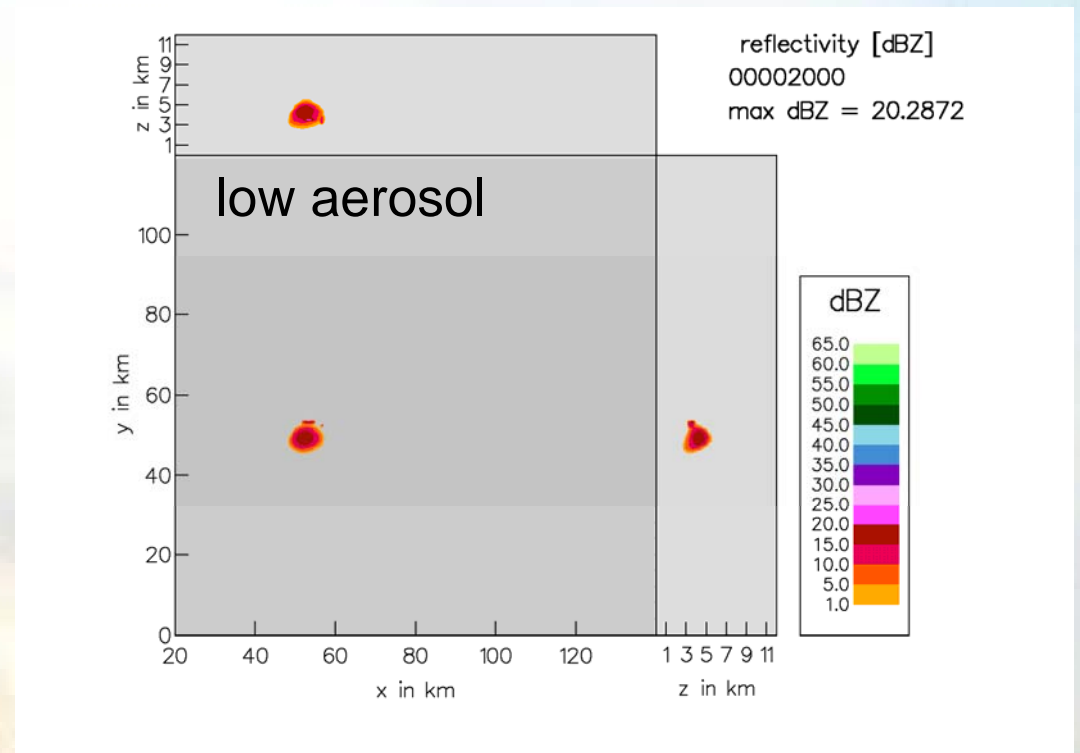
Initialisation / Setup:

- no orography
- horizontal resolution: 1 km
- Initialization with radiosounding (Nancy 12Z, modified PBL)
- no energy fluxes at the ground
- convection triggered by warm air bubble
- 2-moment scheme by Seifert & Beheng for cloud microphysics

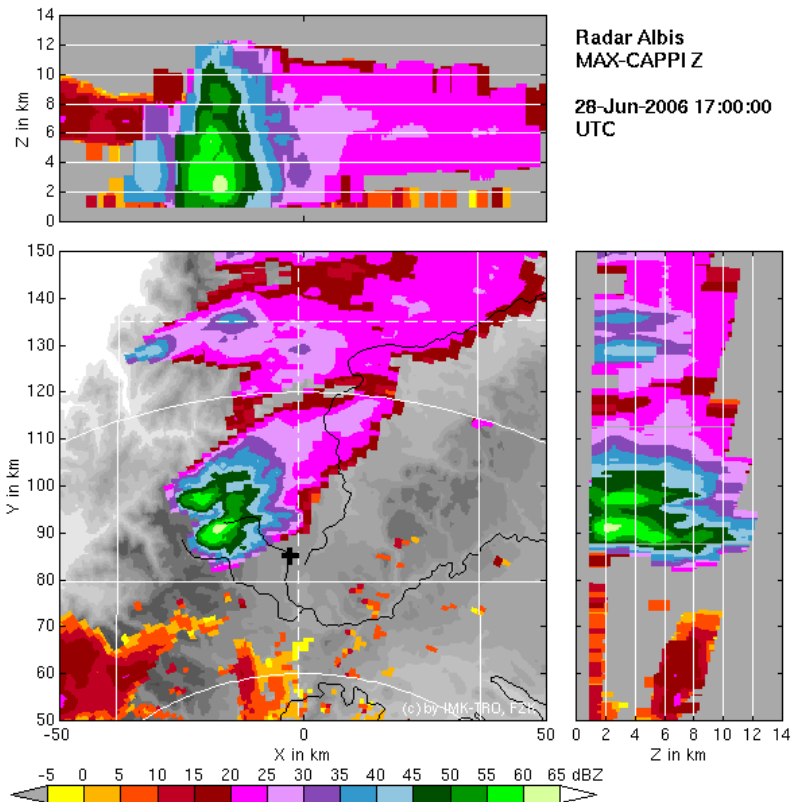
Idealised Simulations



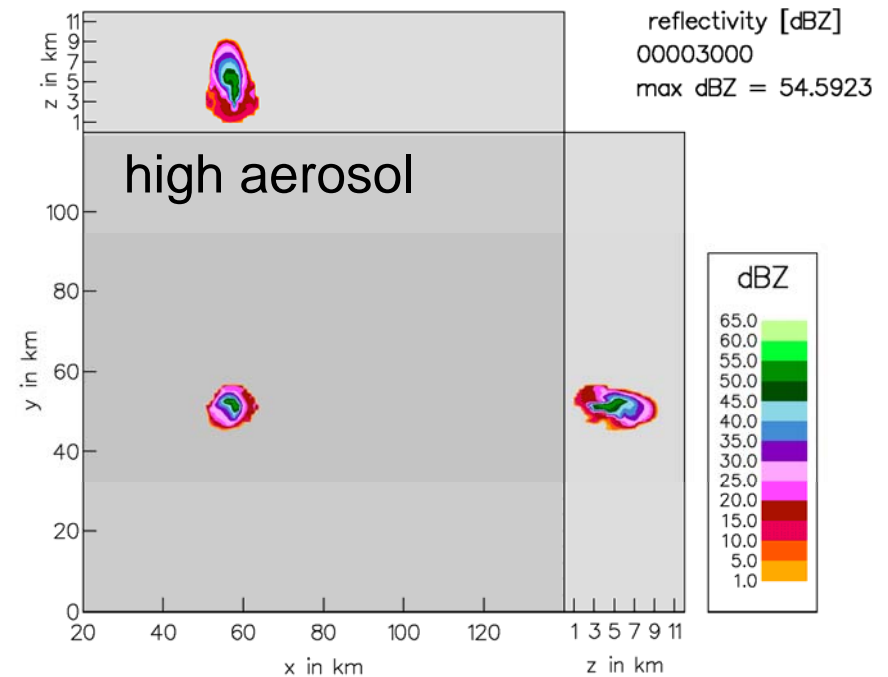
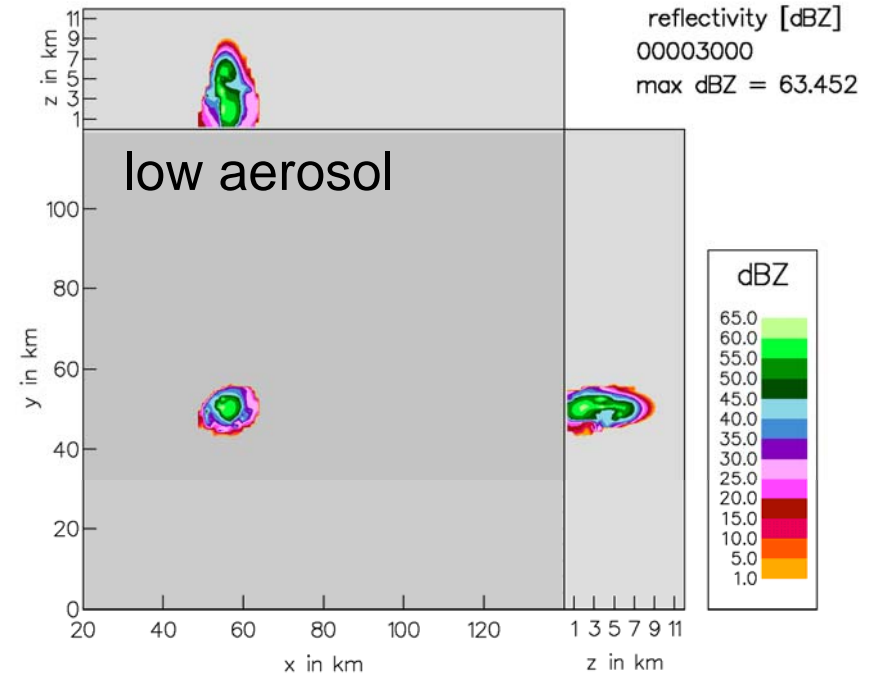
time after warm bubble: 10 min



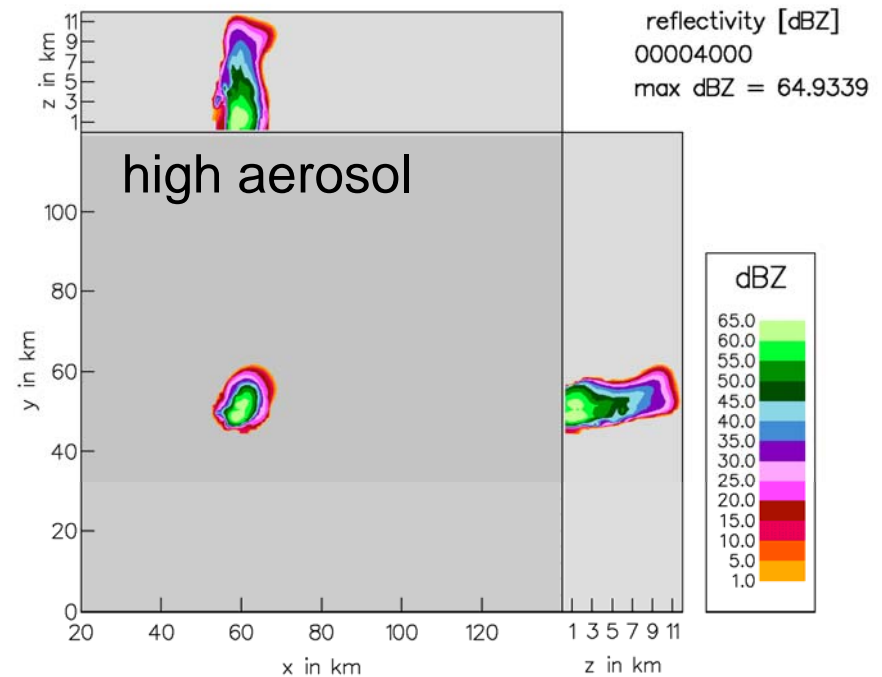
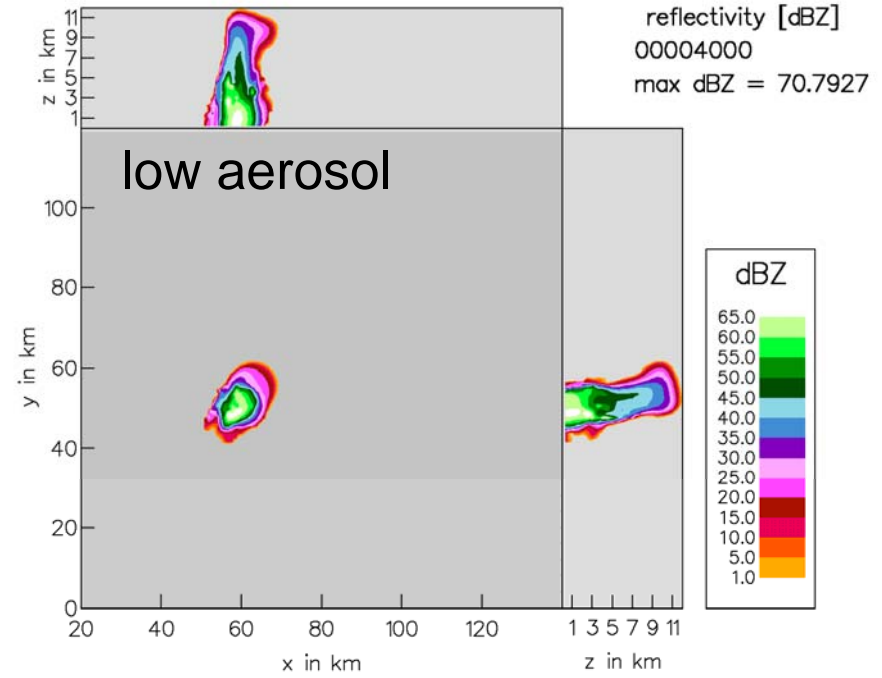
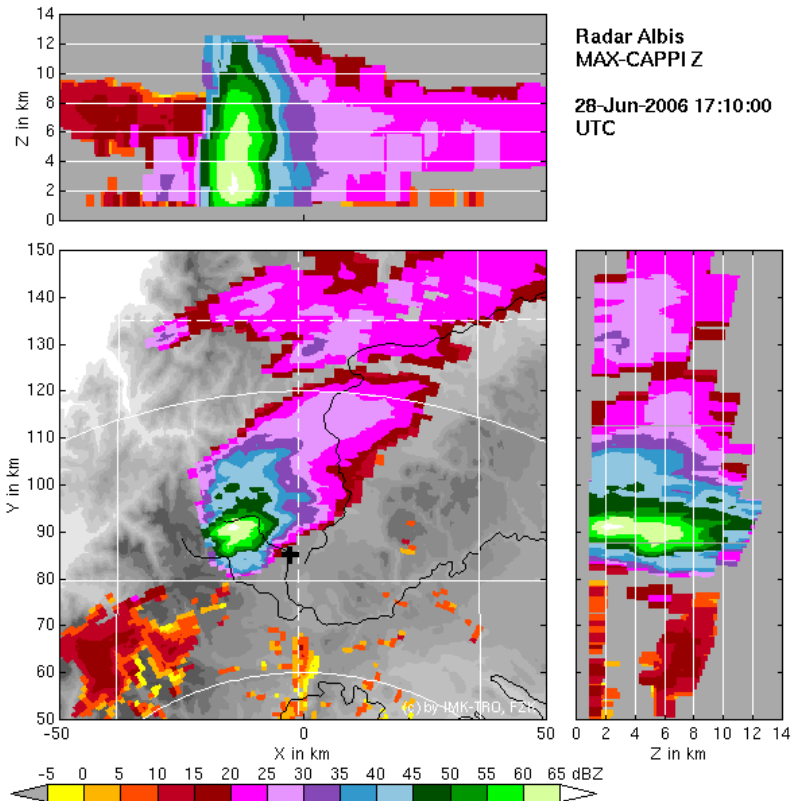
Idealised Simulations



time after warm bubble: 20 min

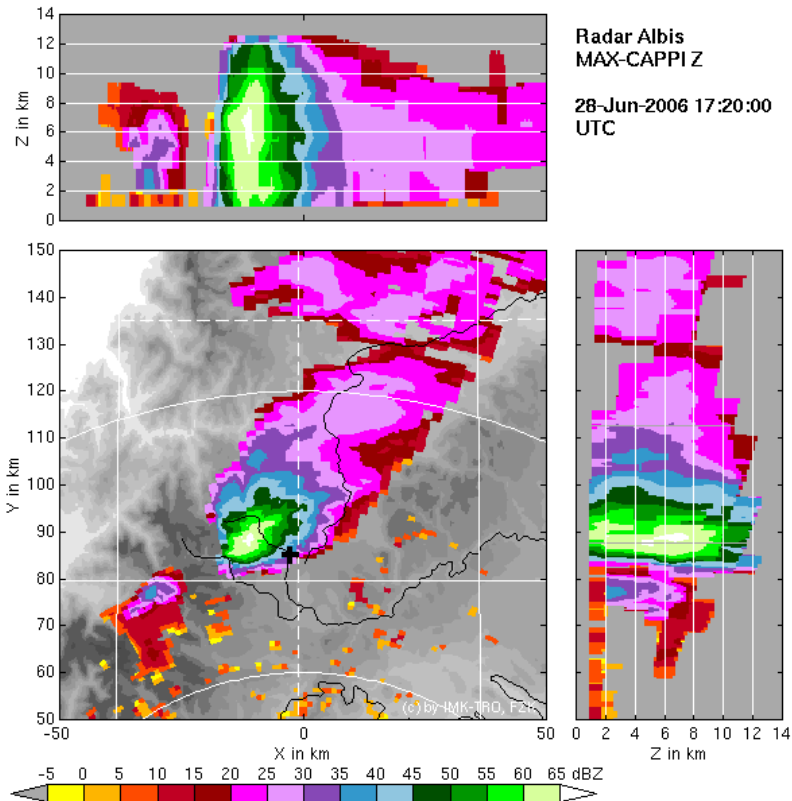


Idealised Simulations

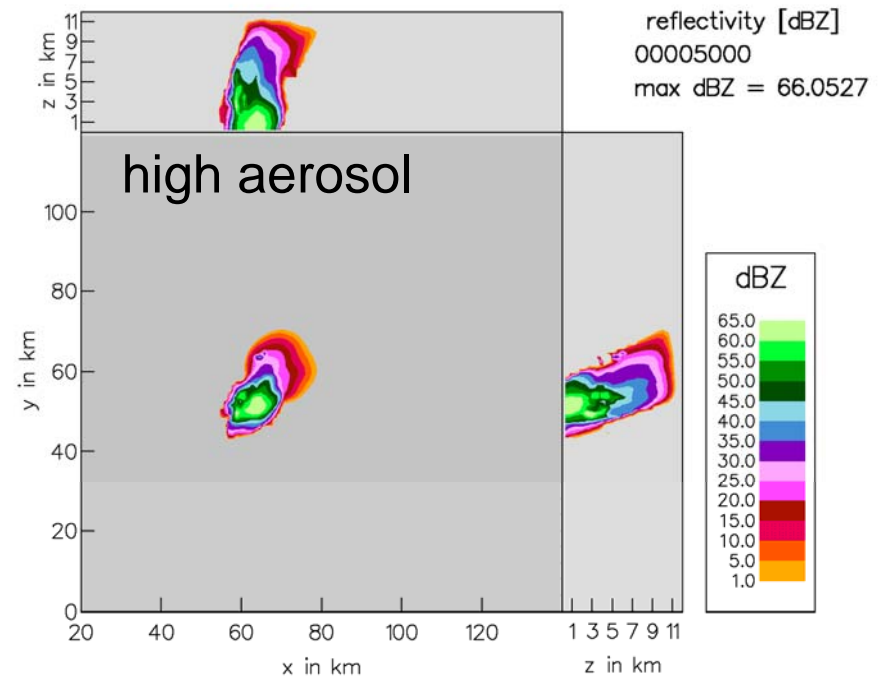
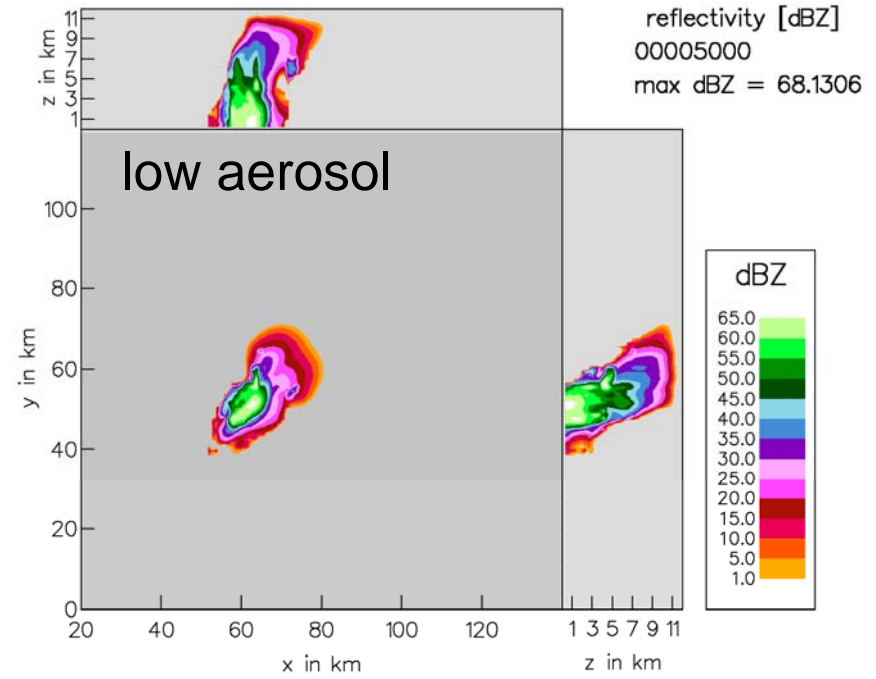


time after warm bubble: 30 min

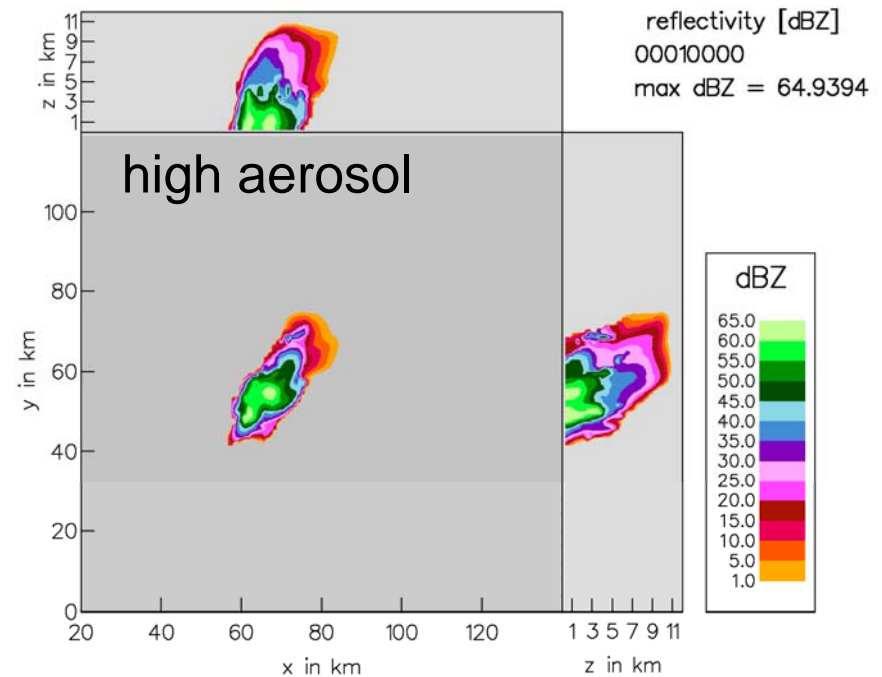
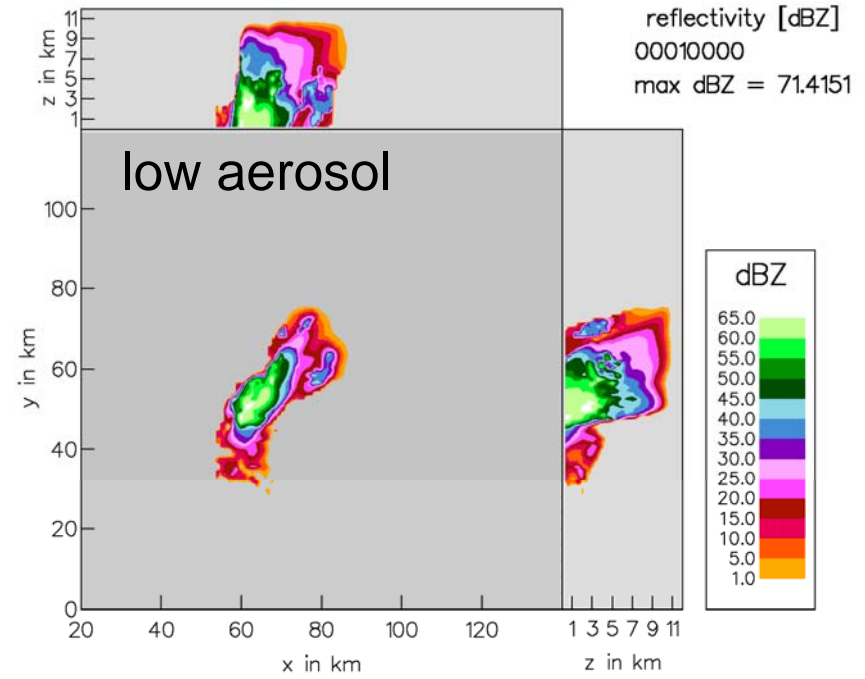
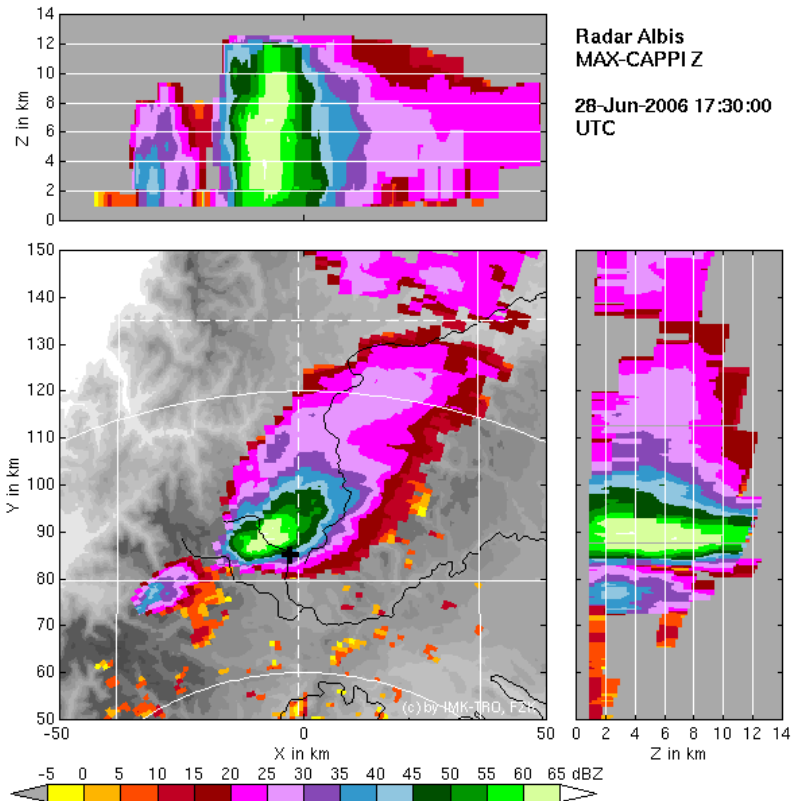
Idealised Simulations



time after warm bubble: 40 min

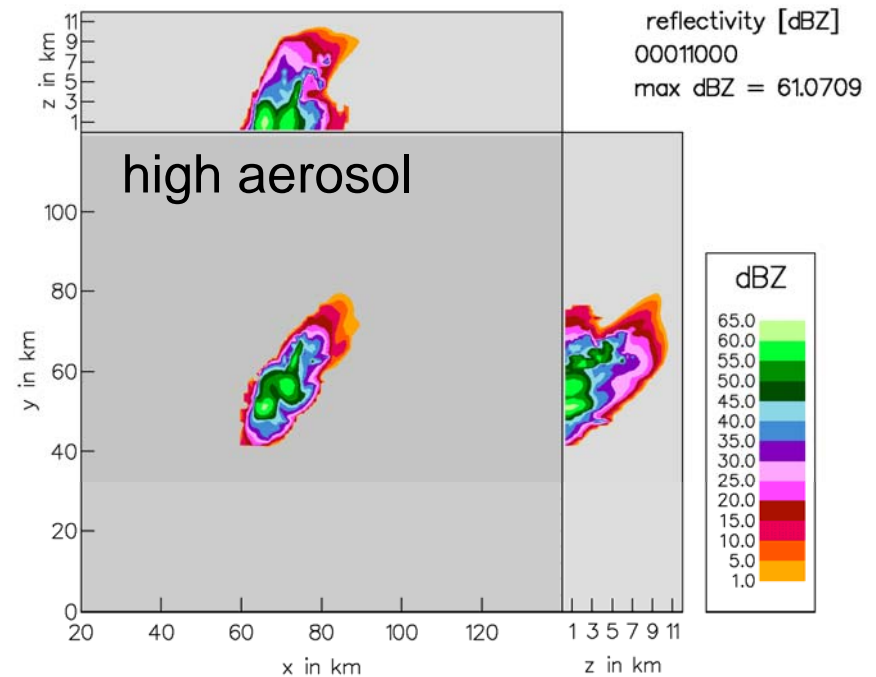
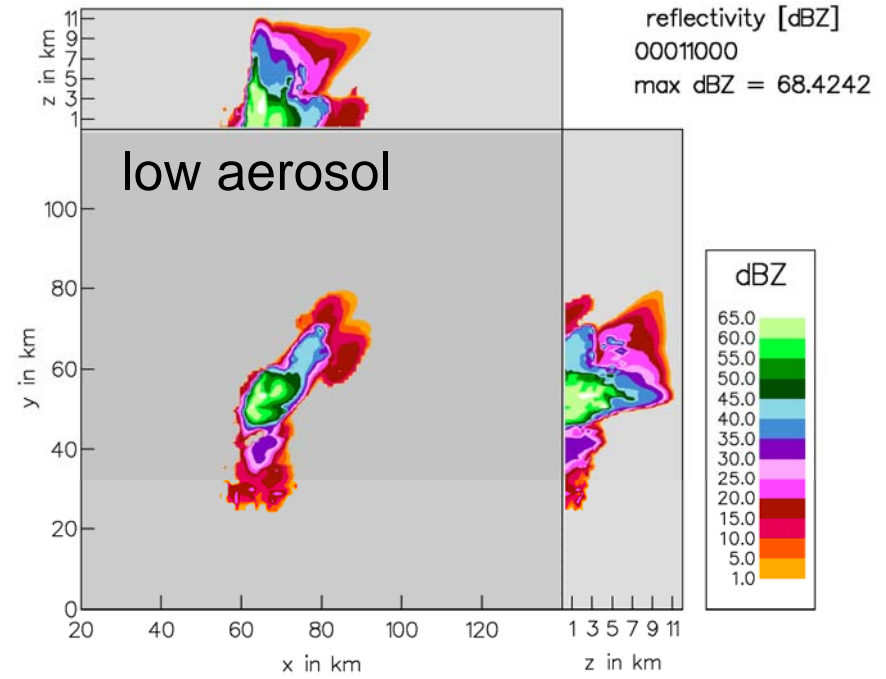
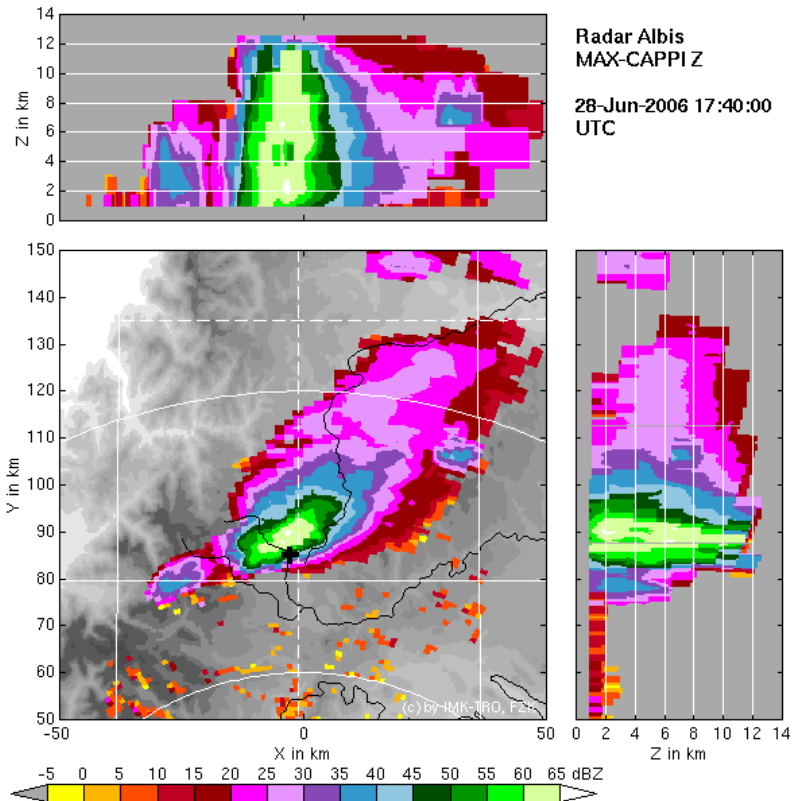


Idealised Simulations



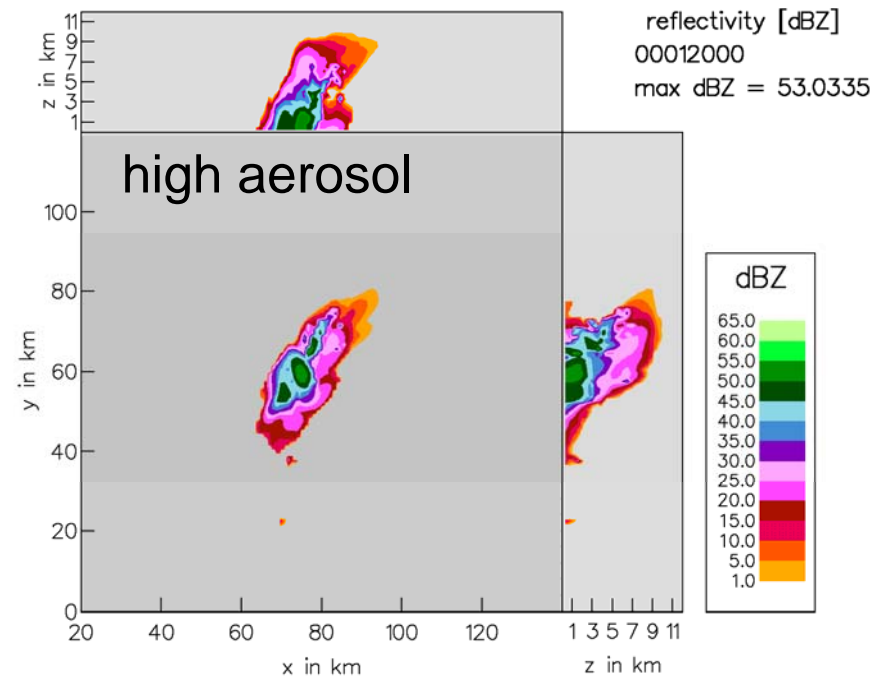
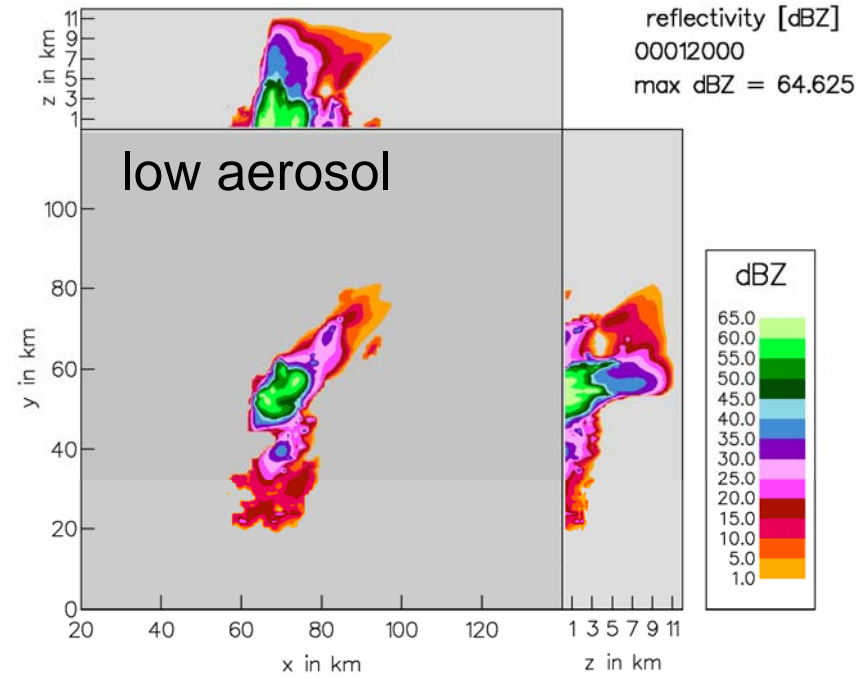
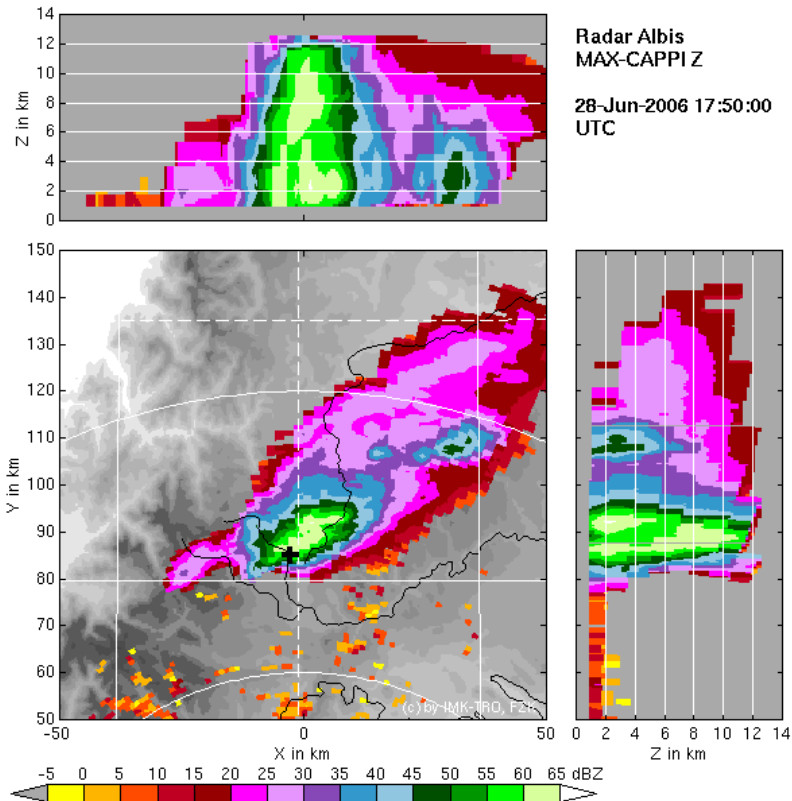
time after warm bubble: 50 min

Idealised Simulations



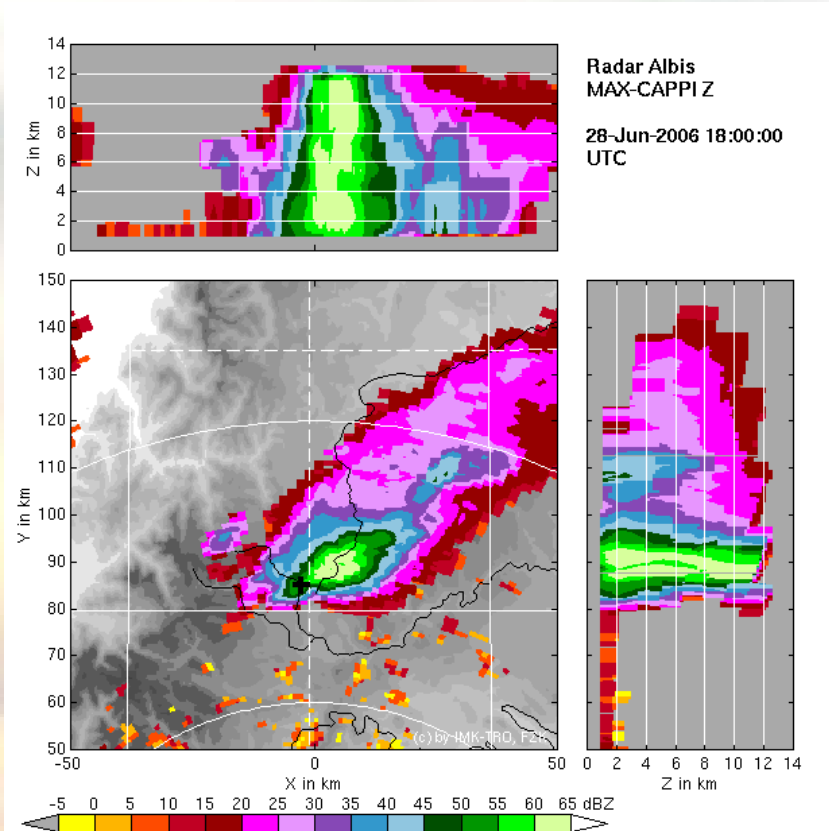
time after warm bubble: 60 min

Idealised Simulations

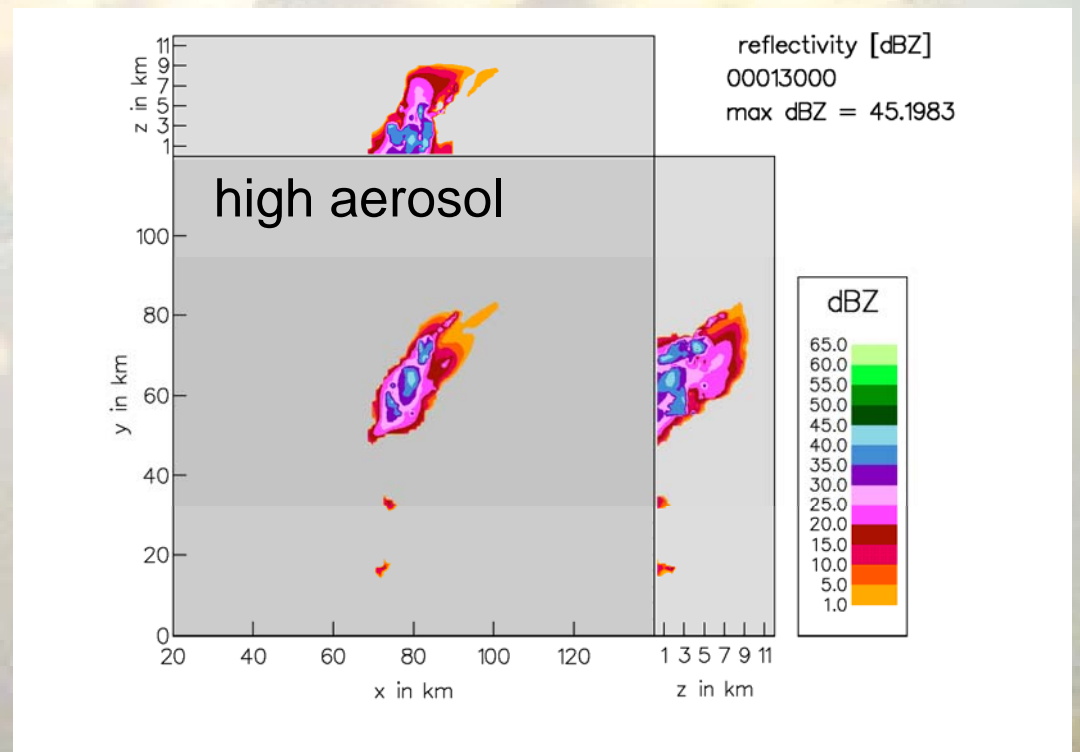
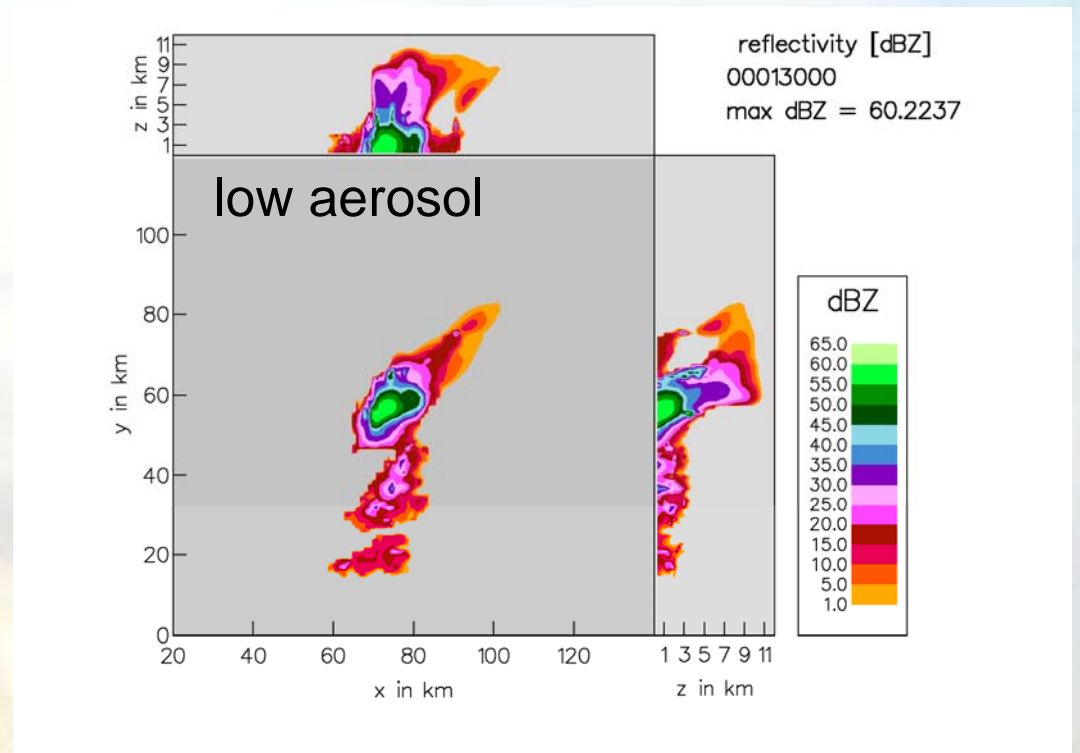


time after warm bubble: 70 min

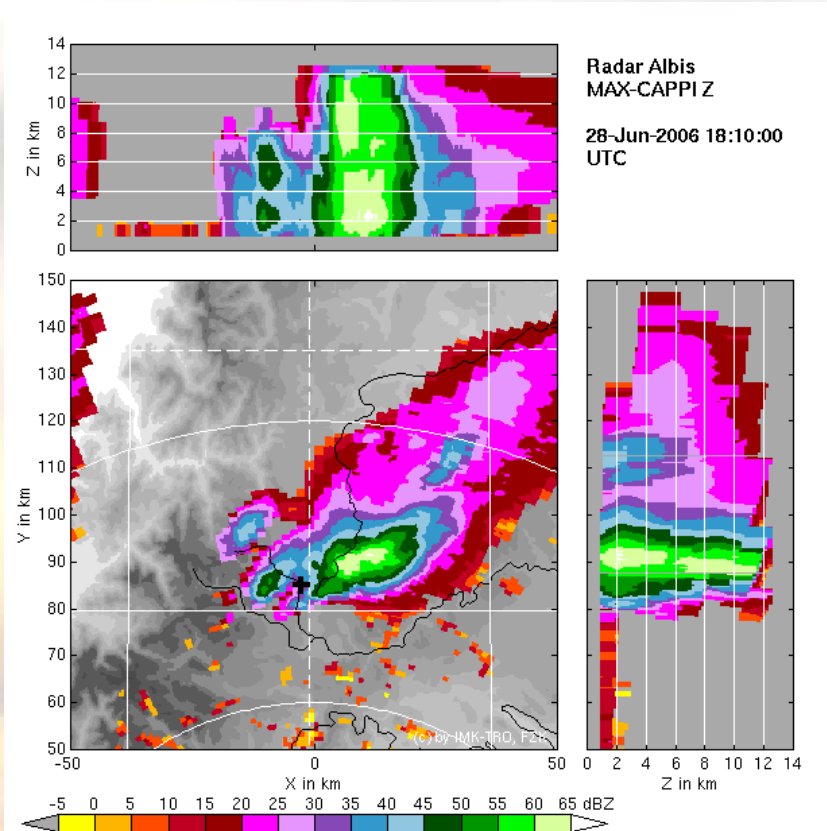
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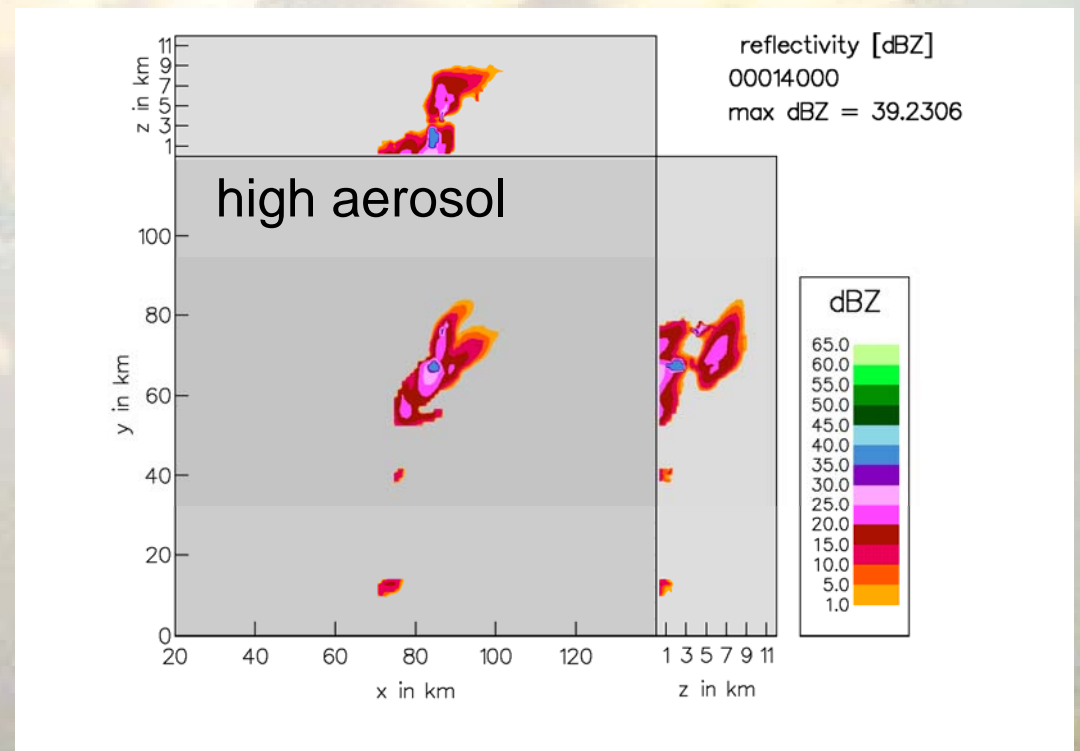
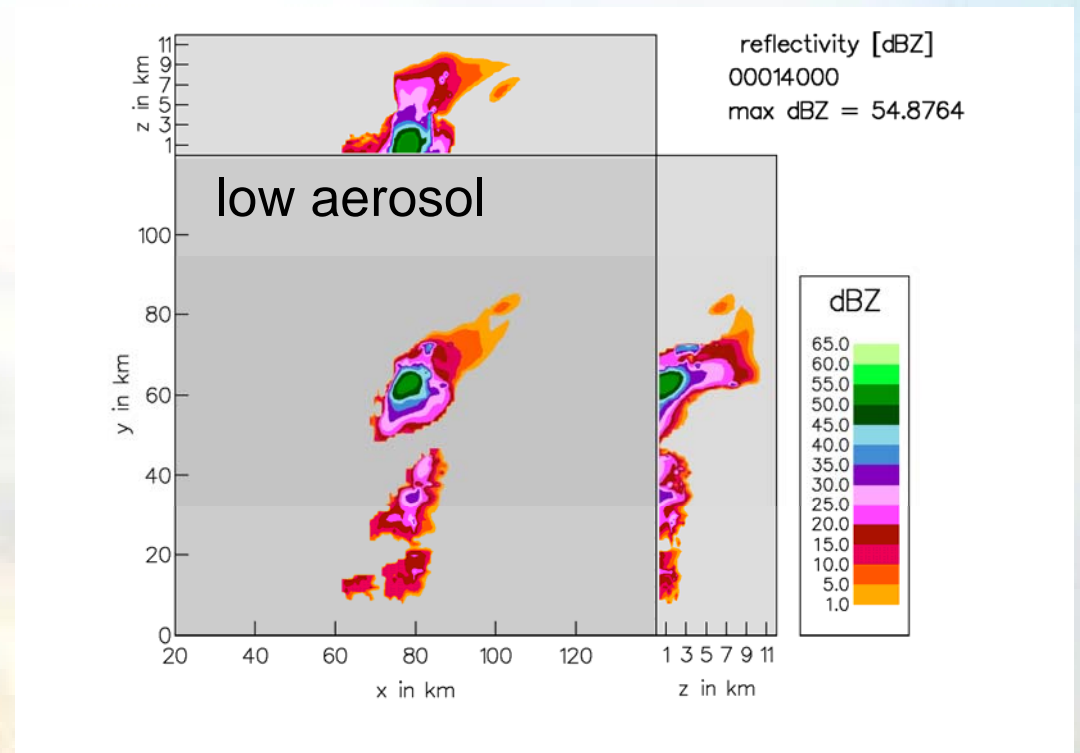
time after warm bubble: 80 min



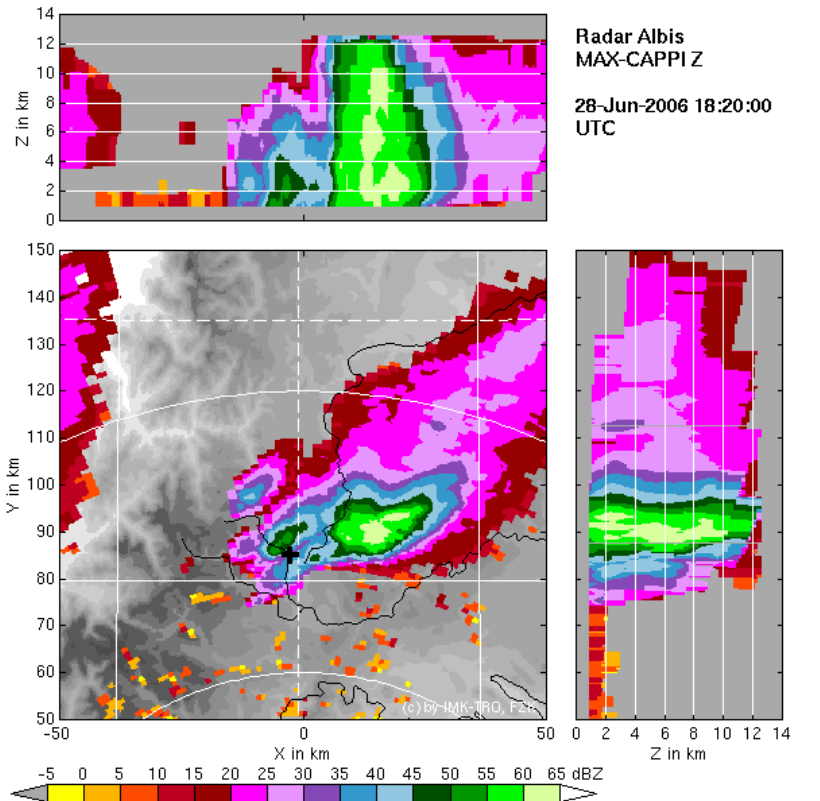
Idealised Simulations



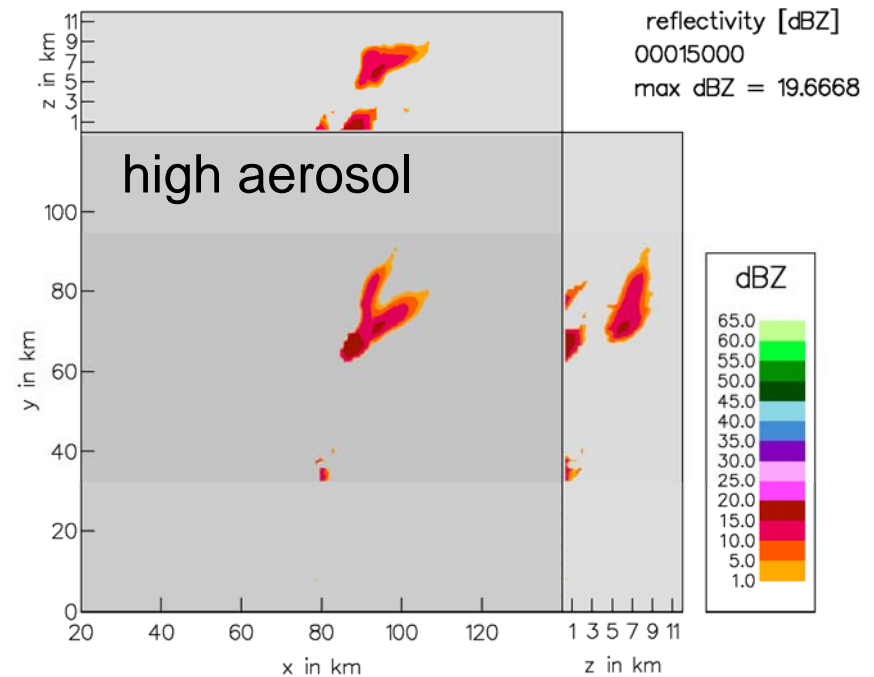
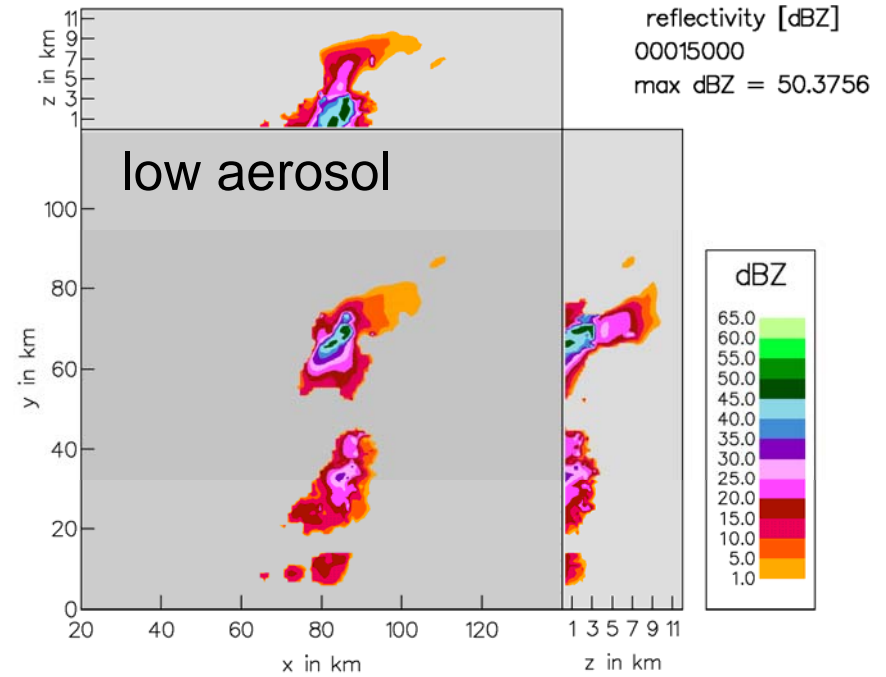
time after warm bubble: 90 min



Idealised Simulations

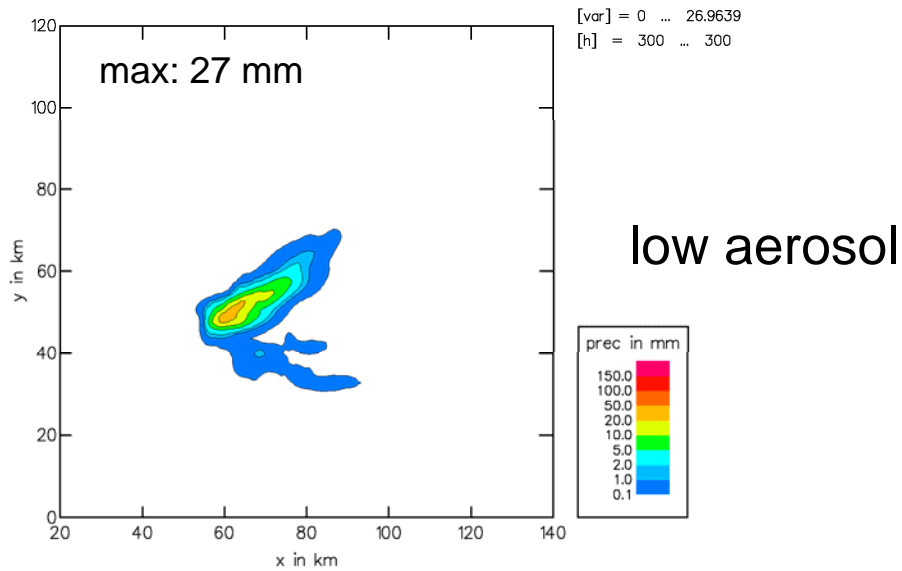


time after warm bubble: 90 min

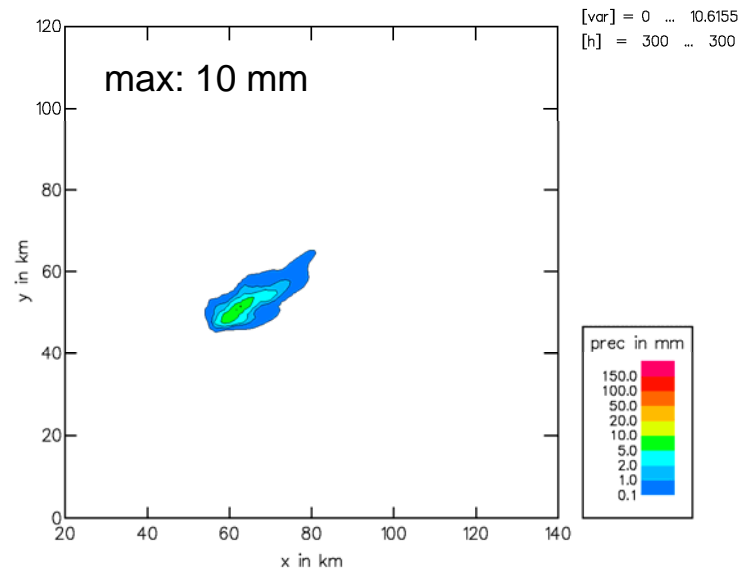


Idealised Simulations

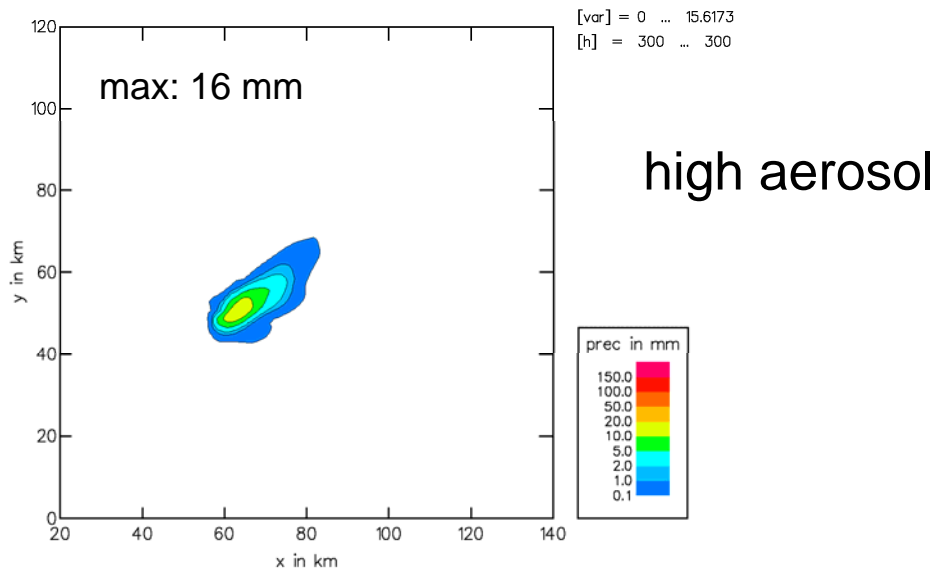
total acc. precip



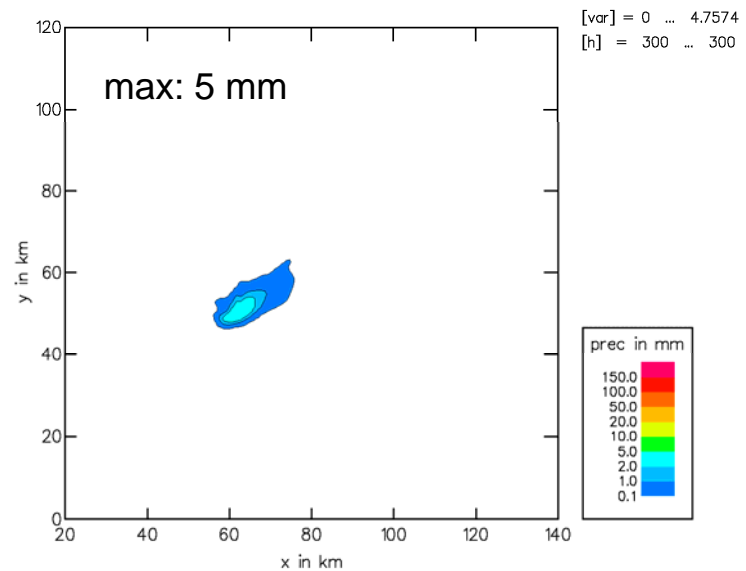
acc. precip by graupel and hail



surface precipitation amount [mm], t= 00023000
total volume: 9.987e+05 m³



surface precipitation amount by graupel and hail [mm], t= 00023000
total volume: 1.729e+05 m³



“Real” Simulations

Initialisation / Setup:

- horizontal resolution: 1 km
- initialization by LMK analysis (2.8 km, 12 UTC)
- boundary conditions: LMK forecasts (every hour)
- model domain: 291 x 291 grid points

“Real” Simulations

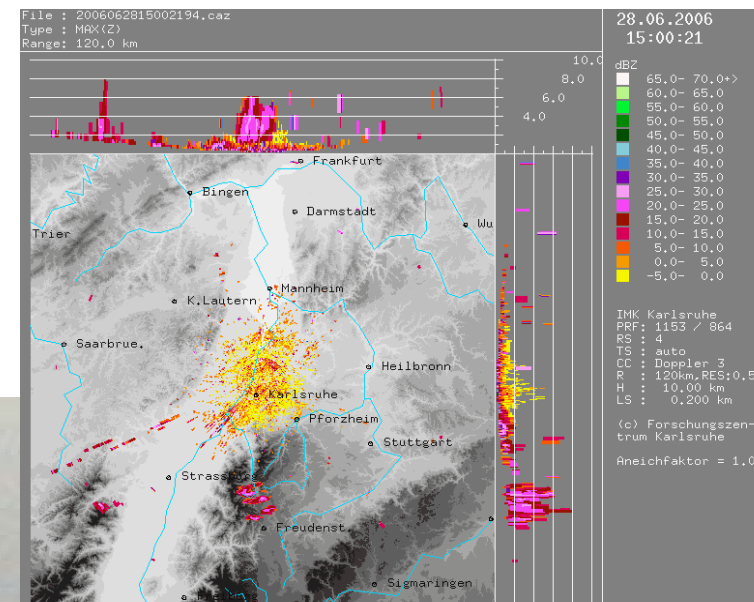
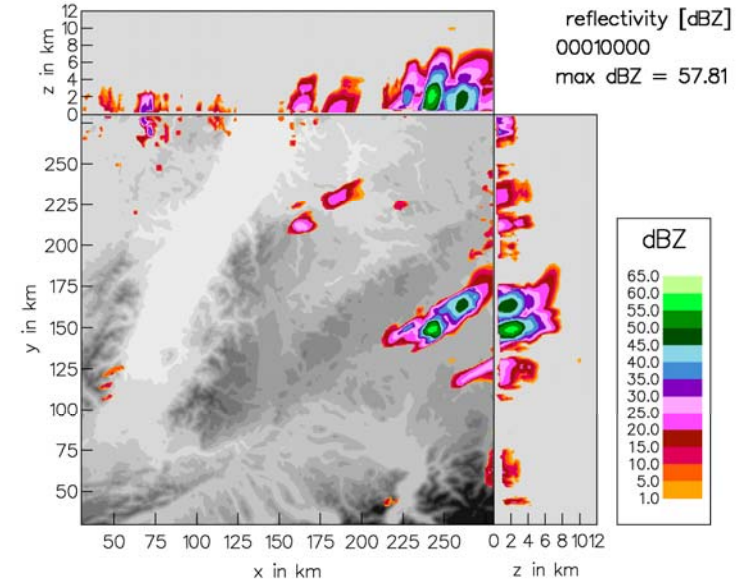
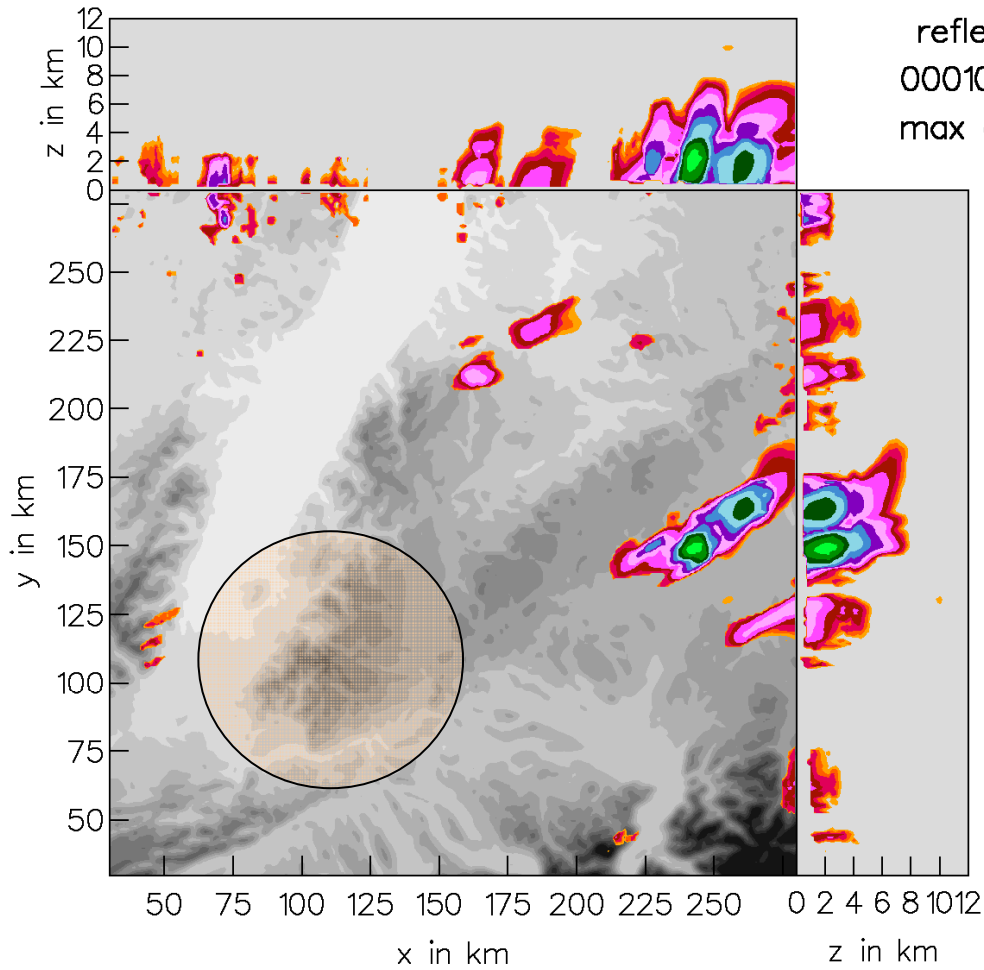
Results:

- + Convective cells develop in the Black Forest / Swabian Alb but
- about 3 h later than the observed hailstorm
- acc. precipitation too low
- no right-mover (i.e. no rotating cell)

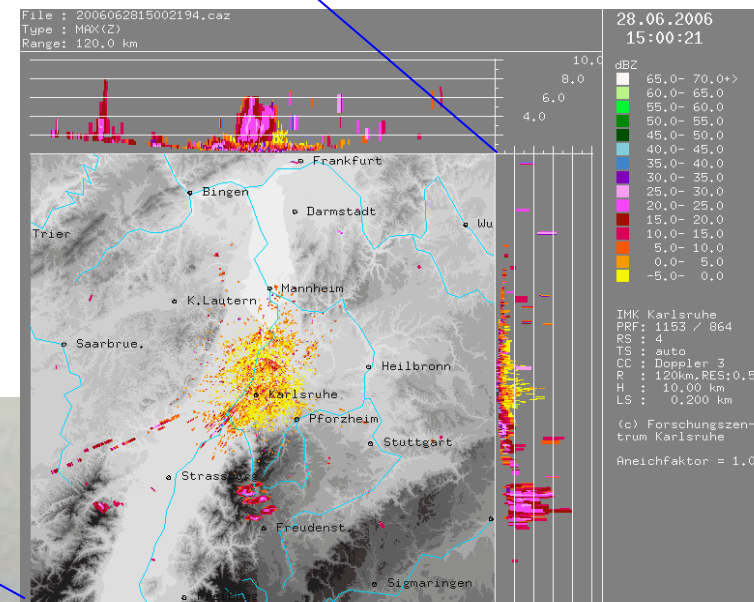
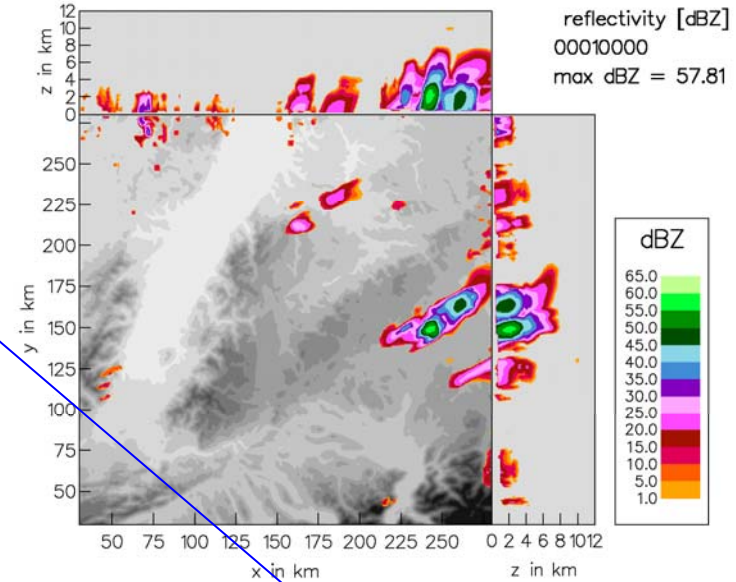
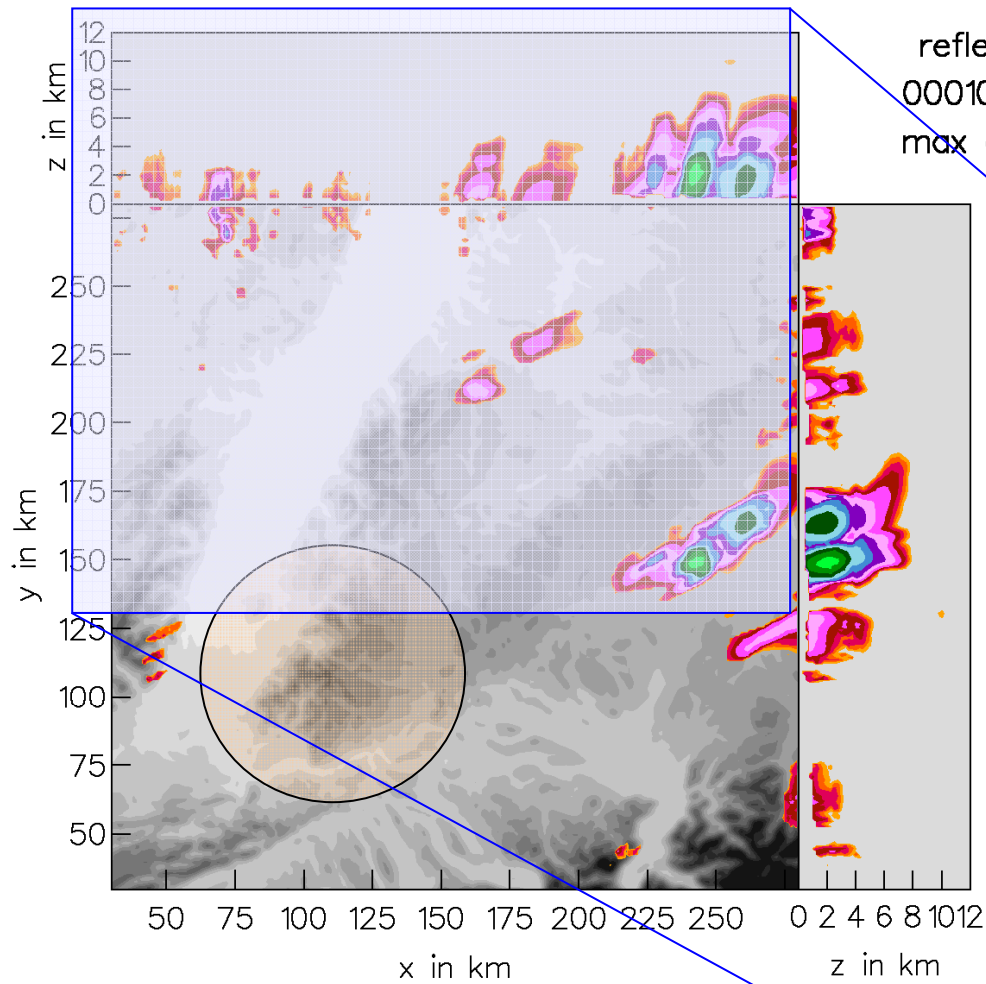
“Remedy”:

artificial heating and moistening of the lowest model layer in a given area and for a given time

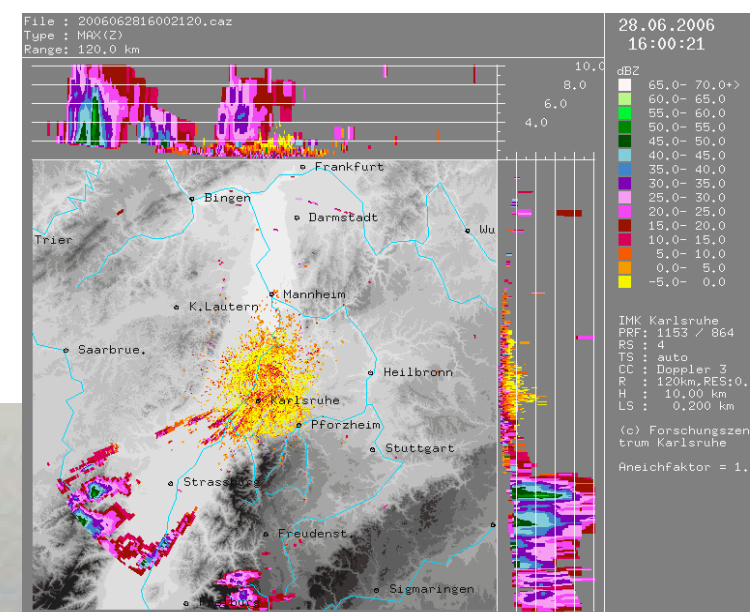
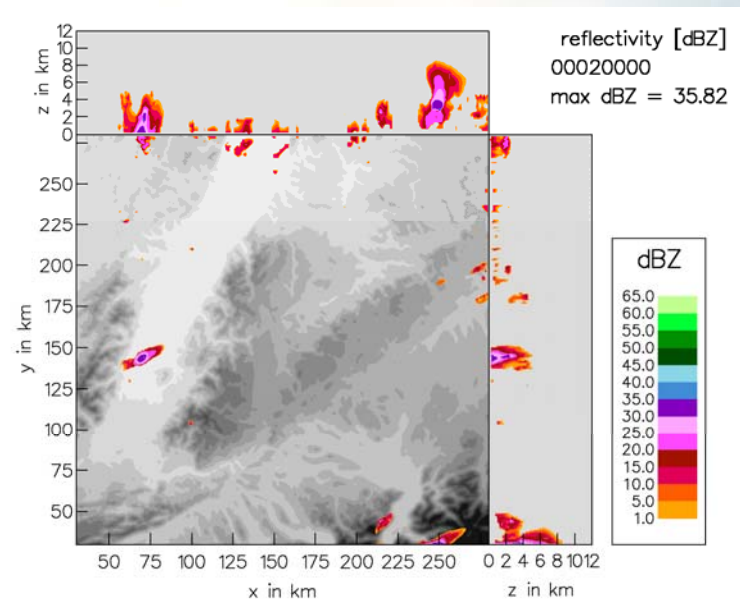
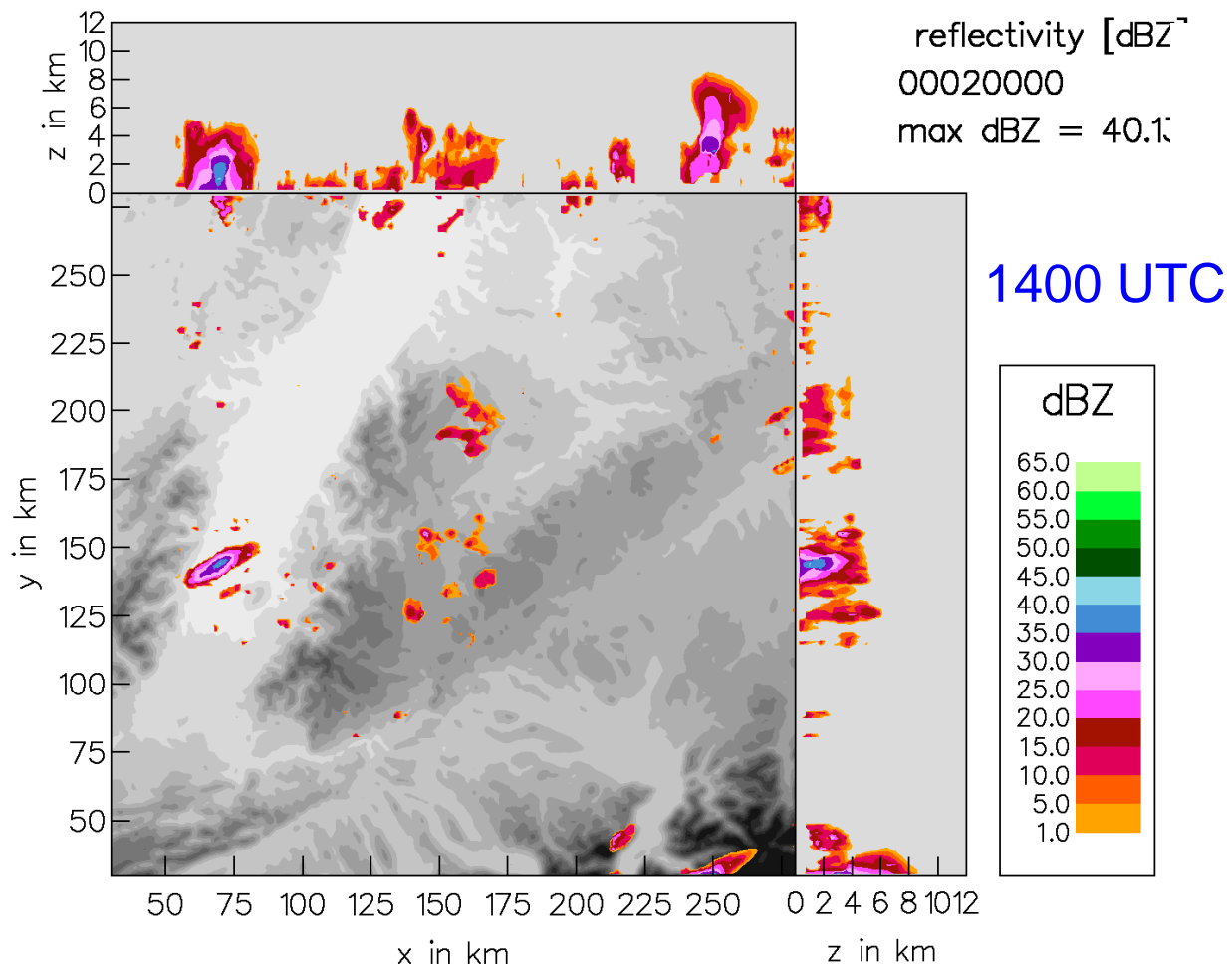
“Real” Simulations



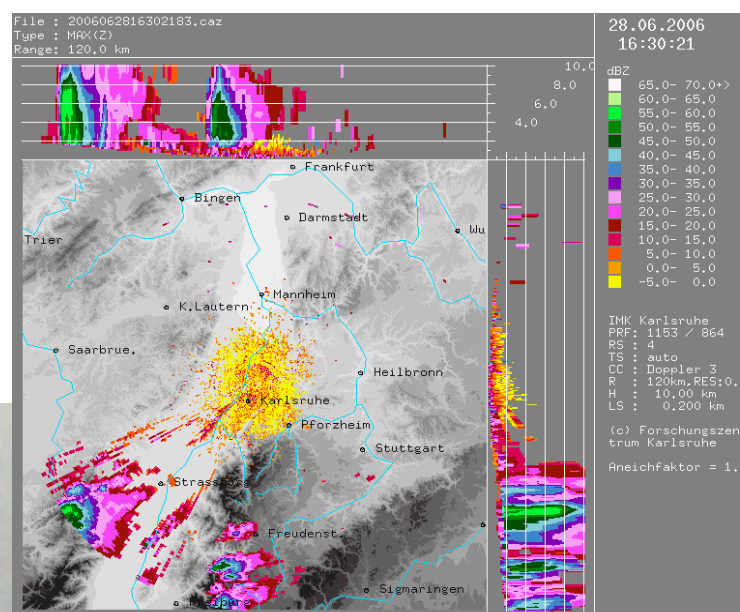
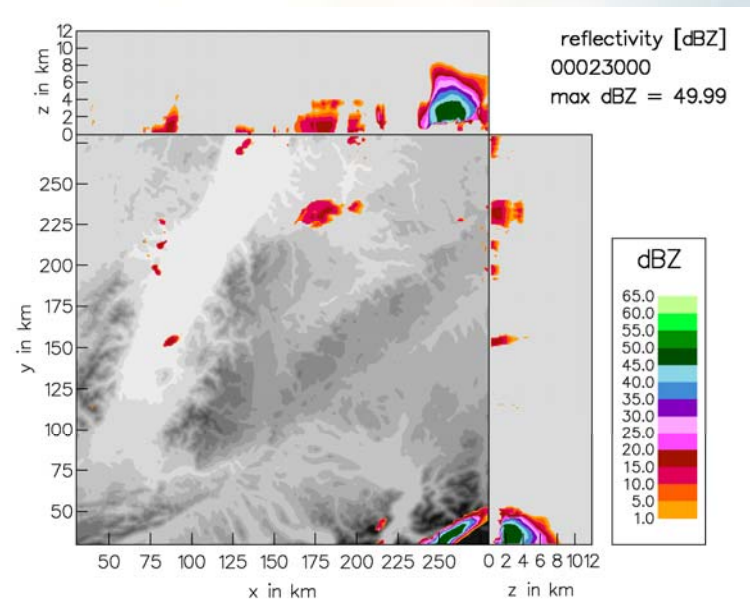
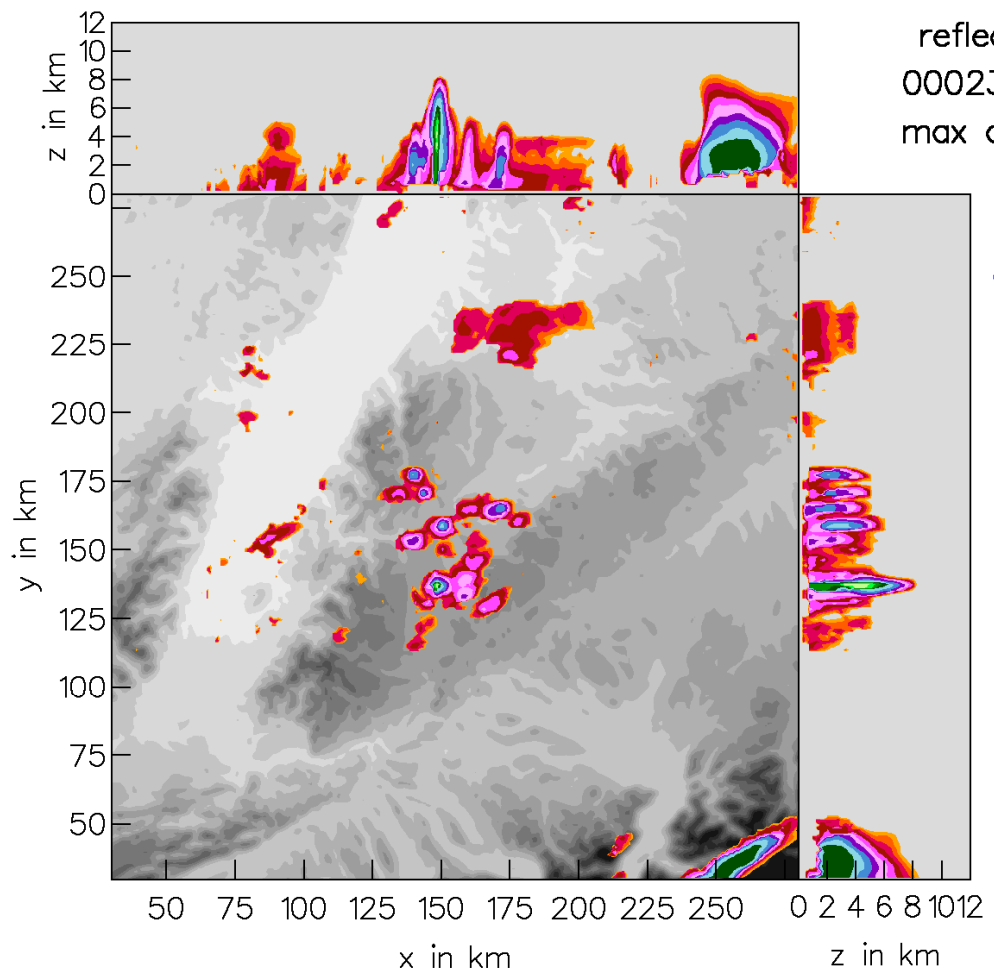
“Real” Simulations



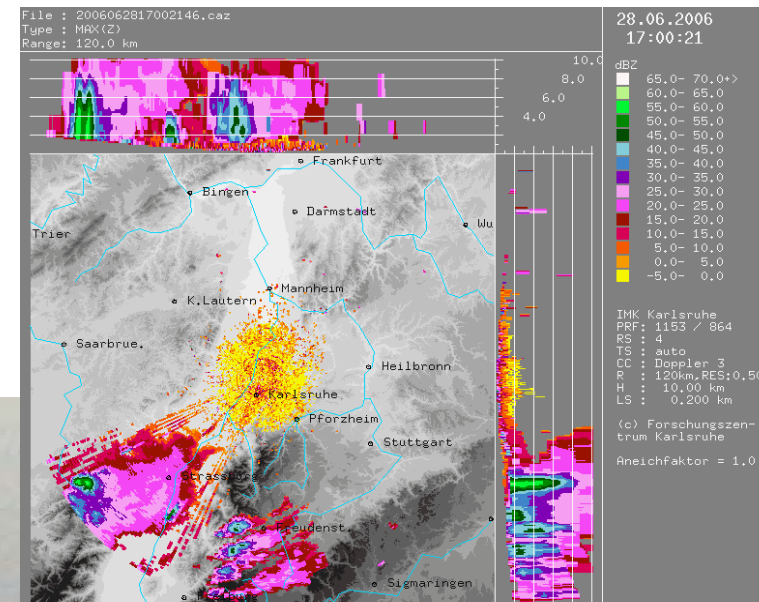
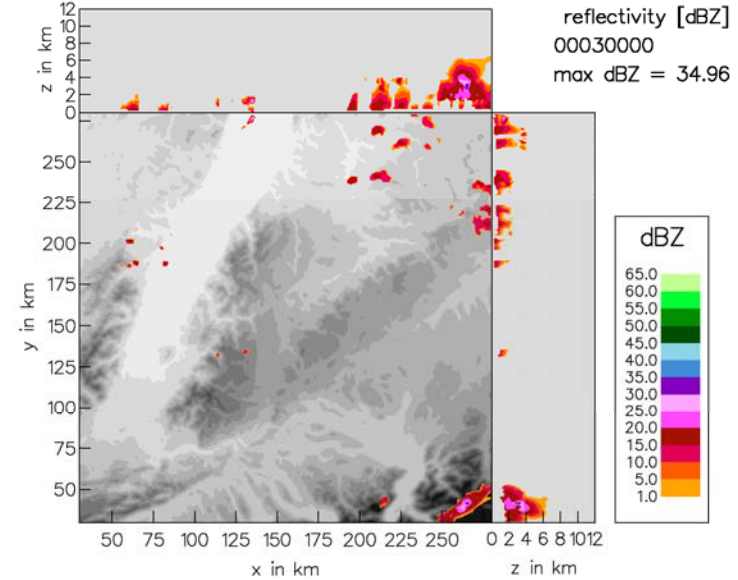
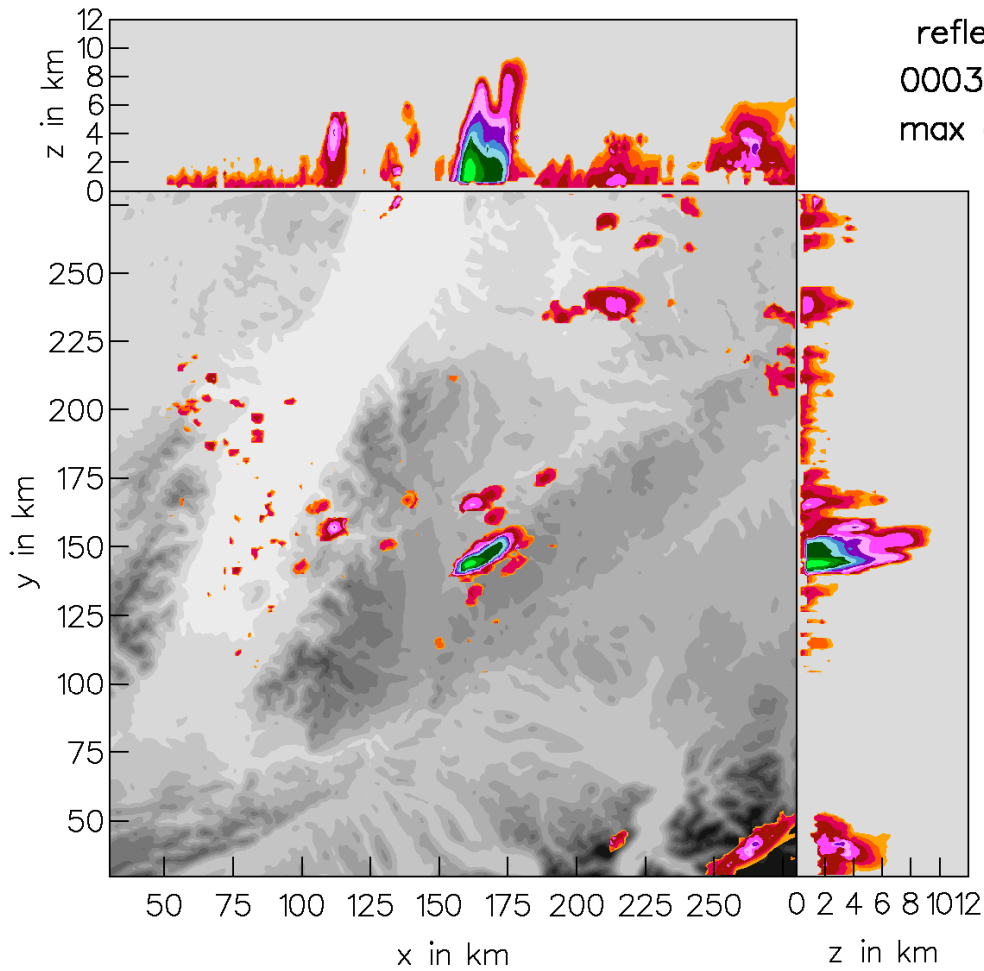
“Real” Simulations



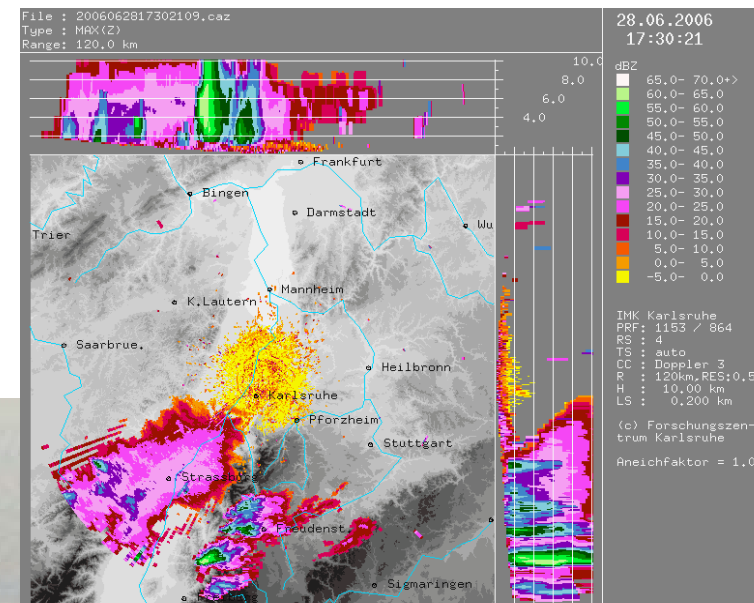
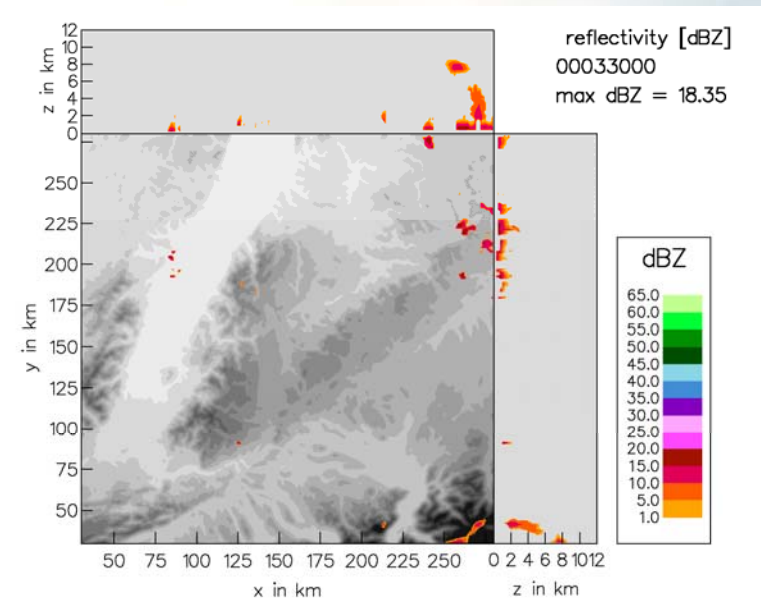
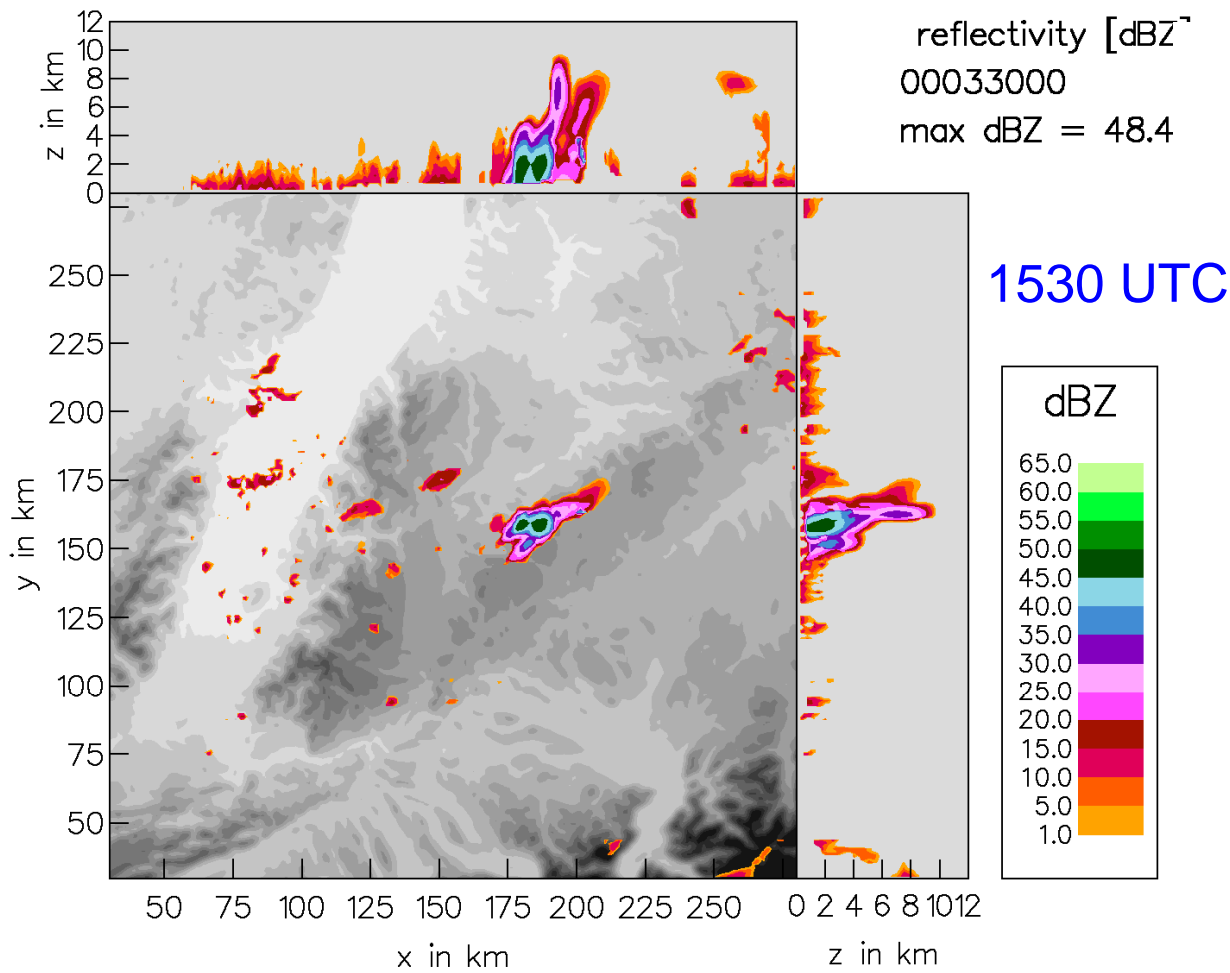
“Real” Simulations



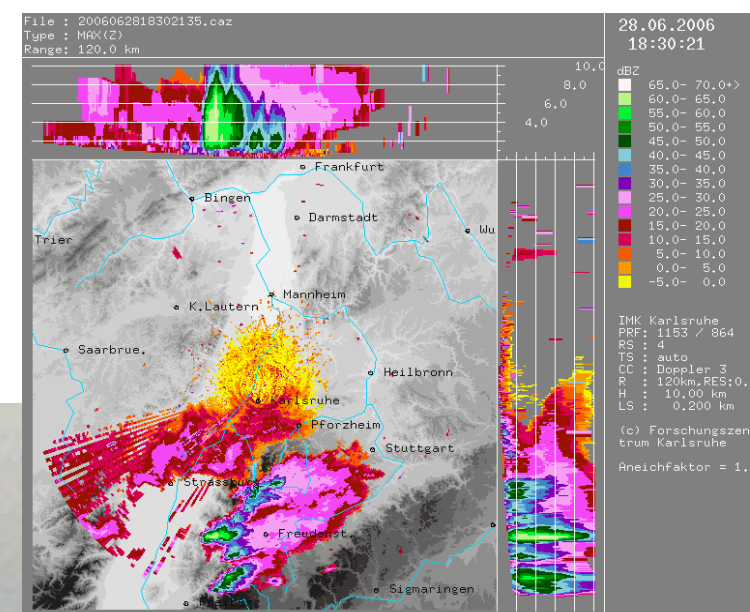
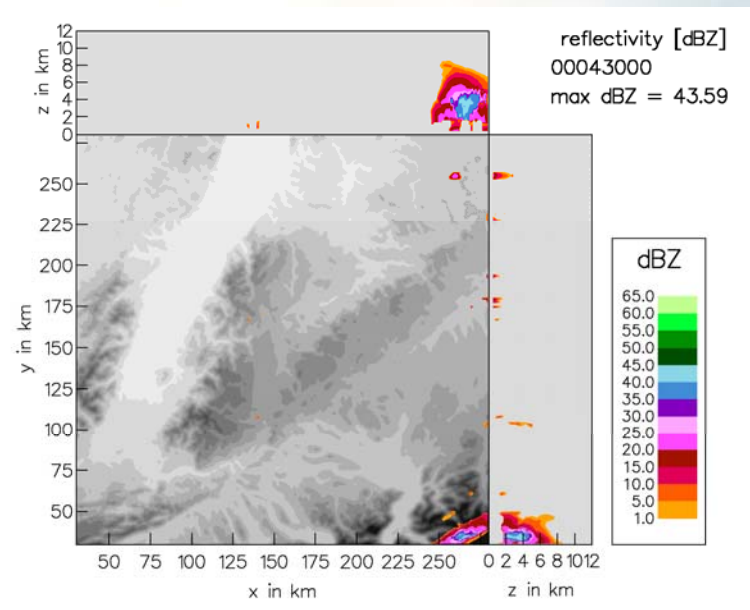
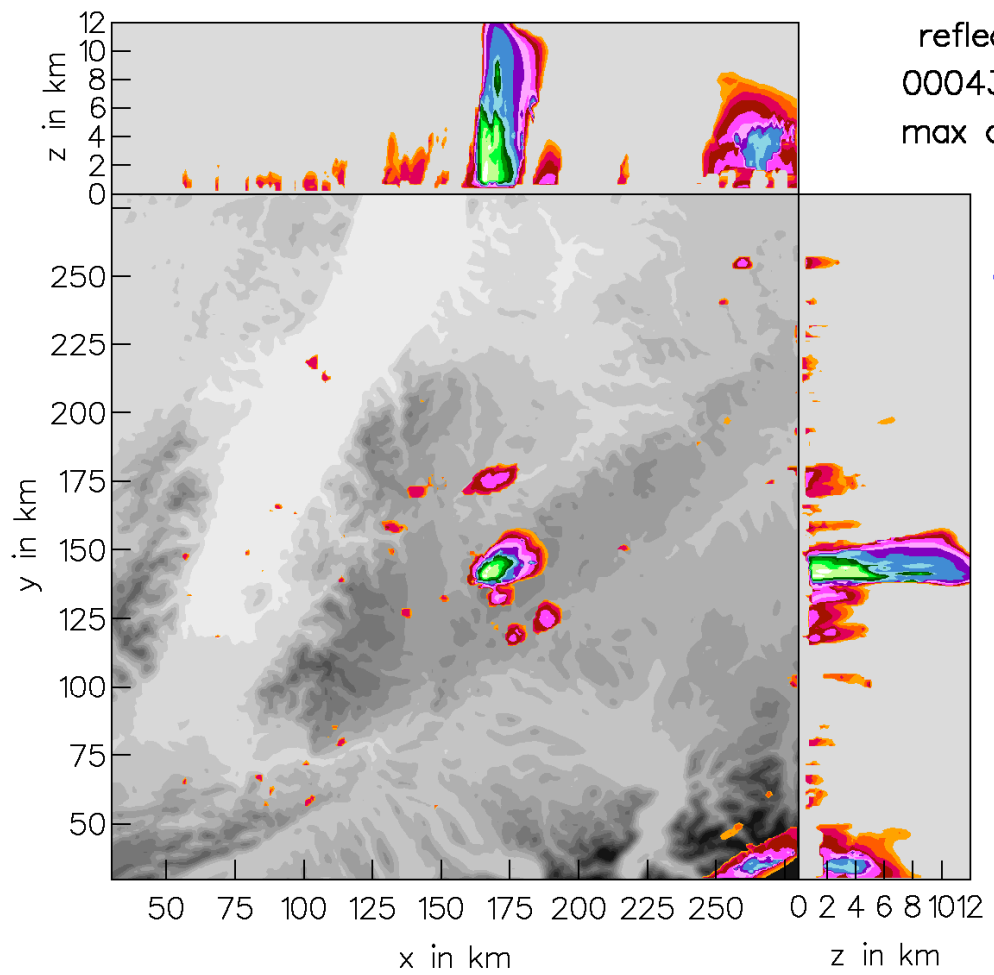
“Real” Simulations



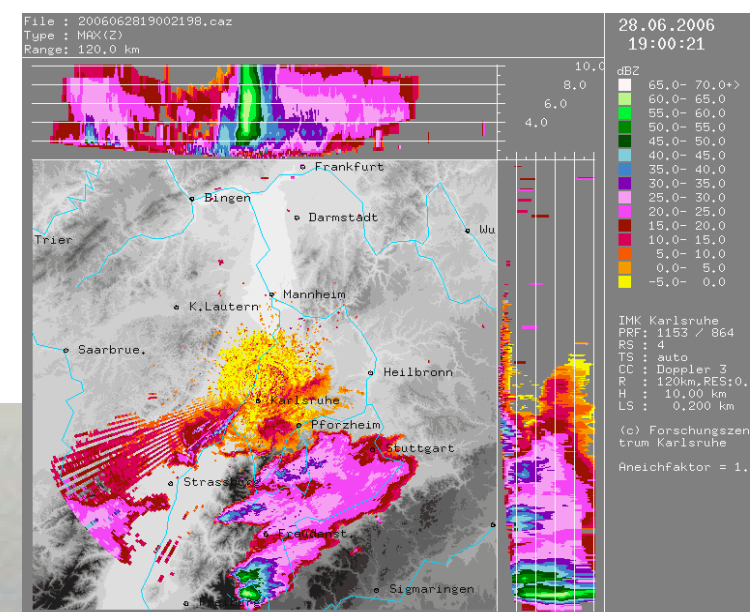
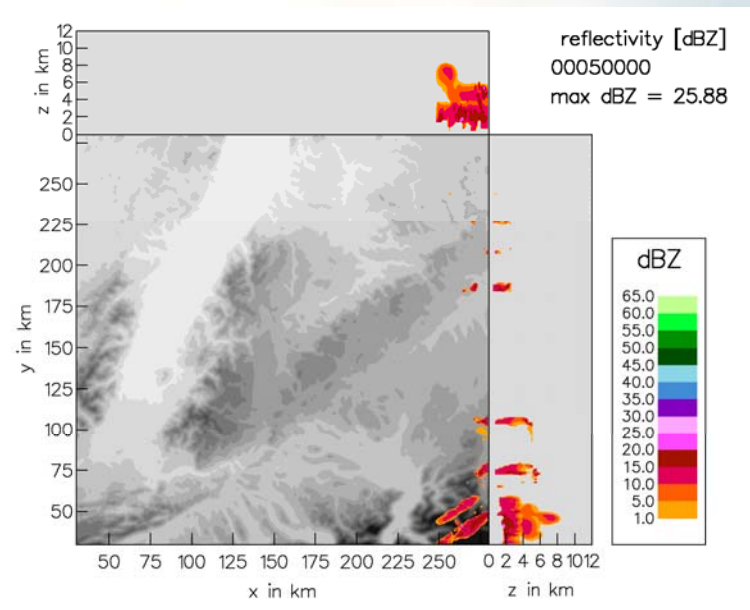
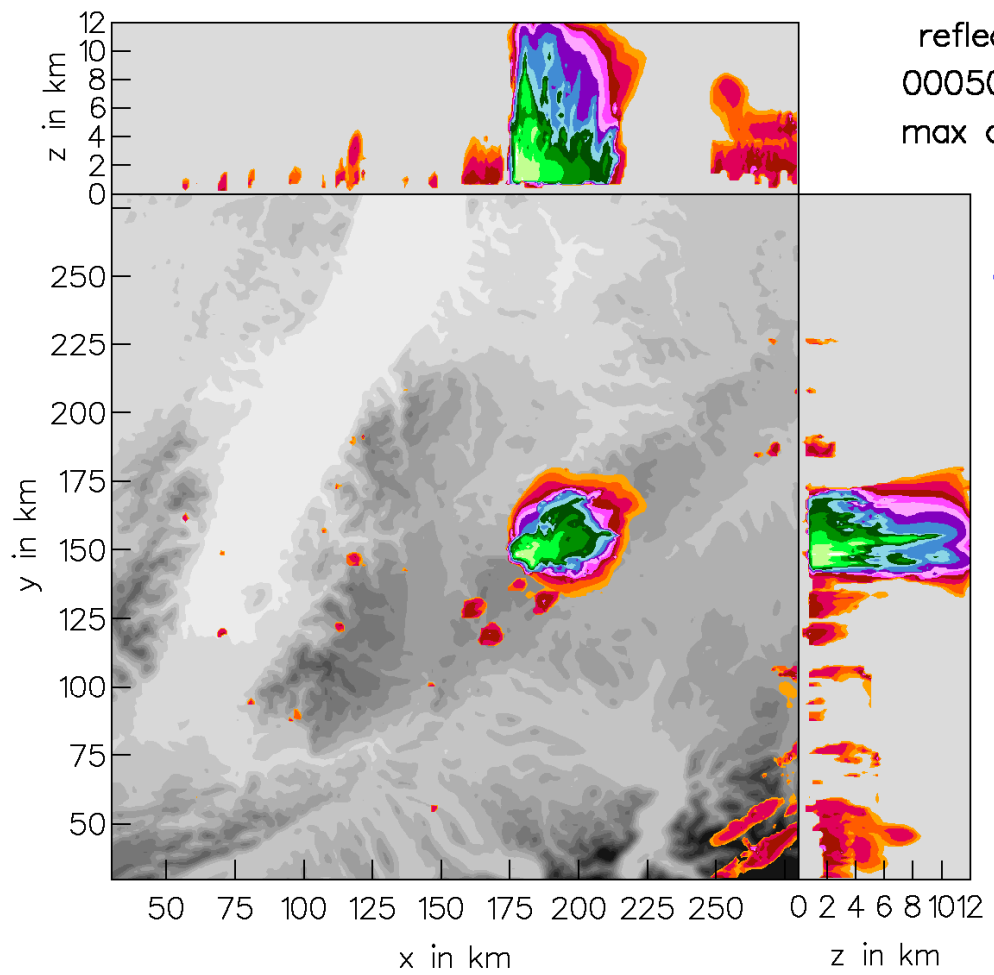
“Real” Simulations



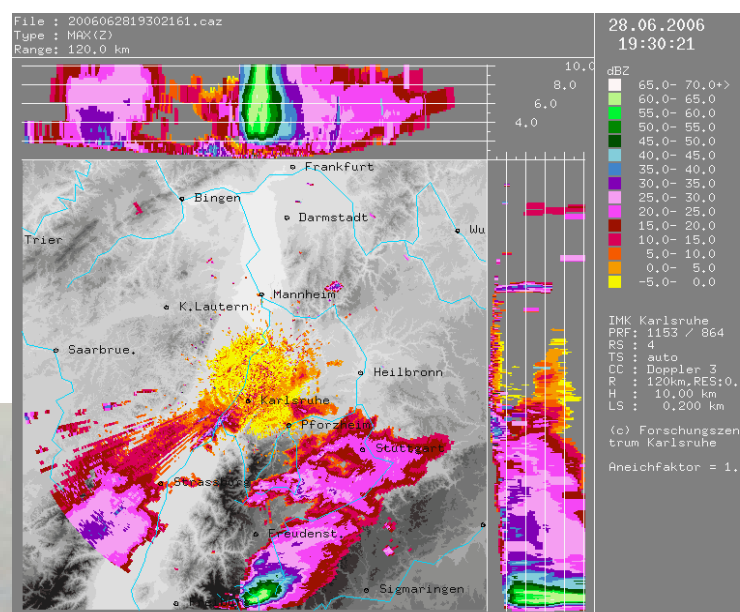
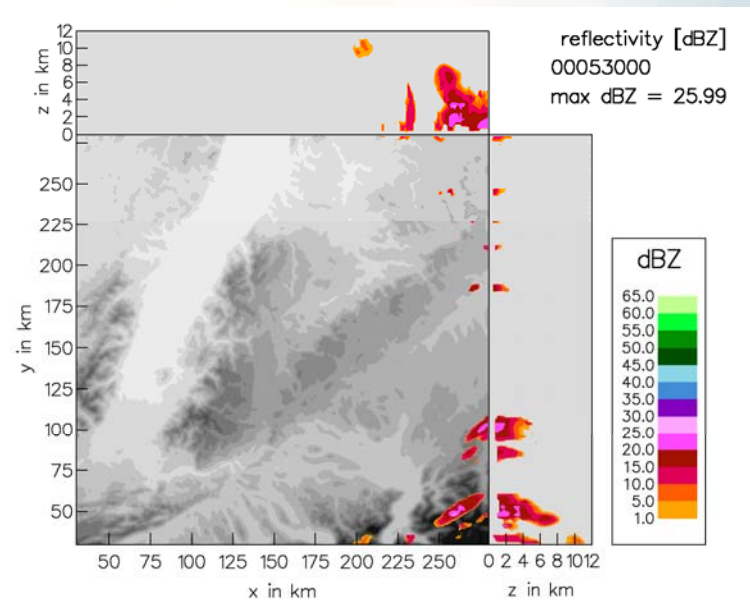
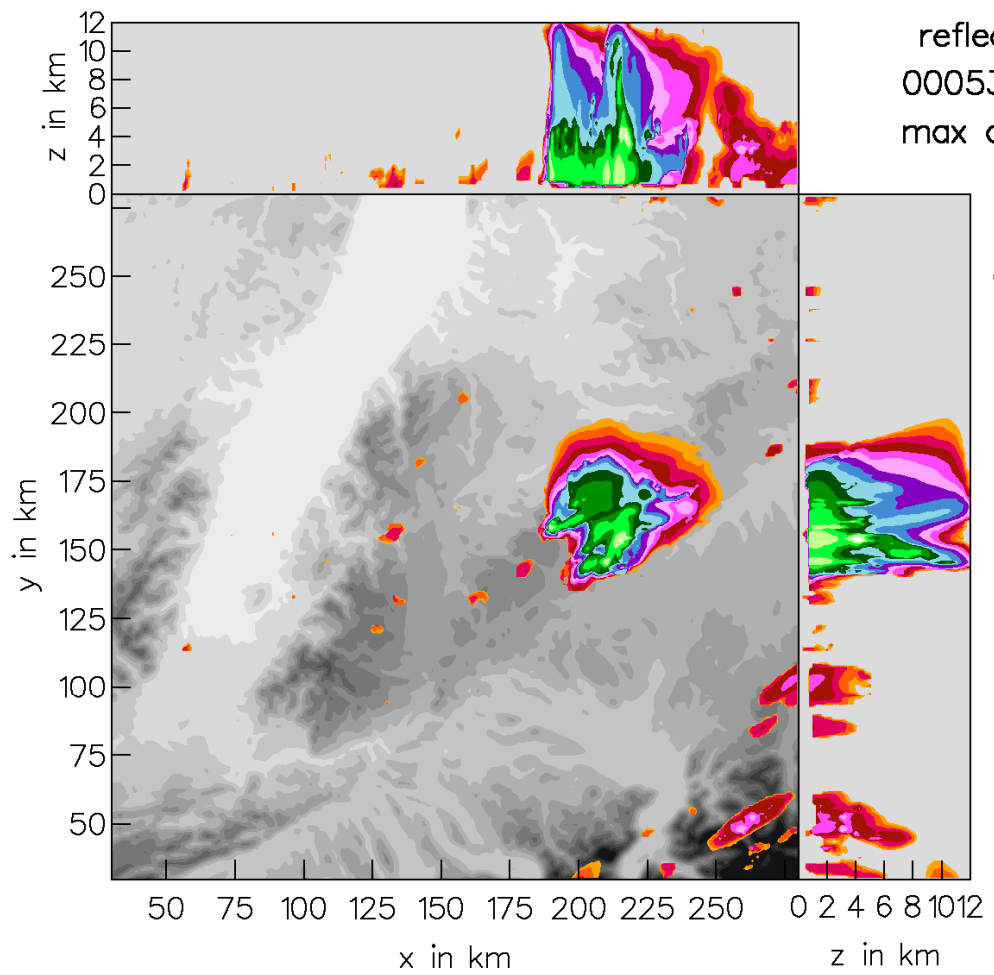
“Real” Simulations



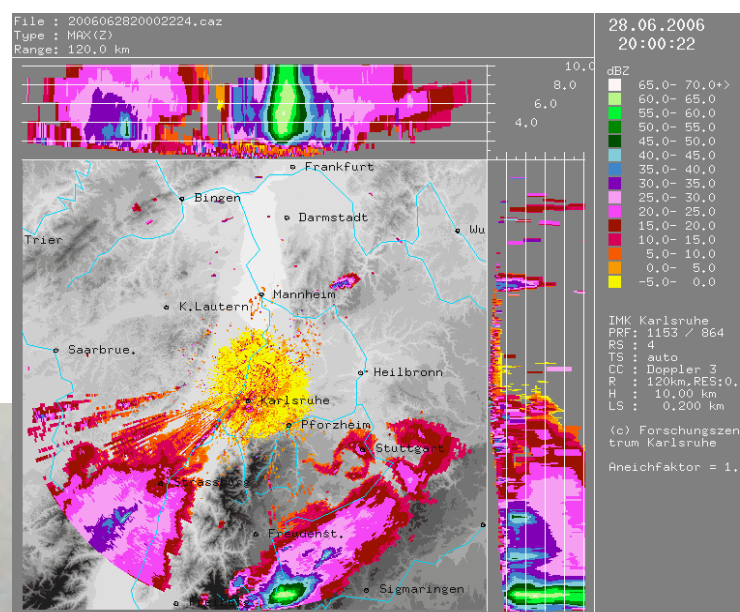
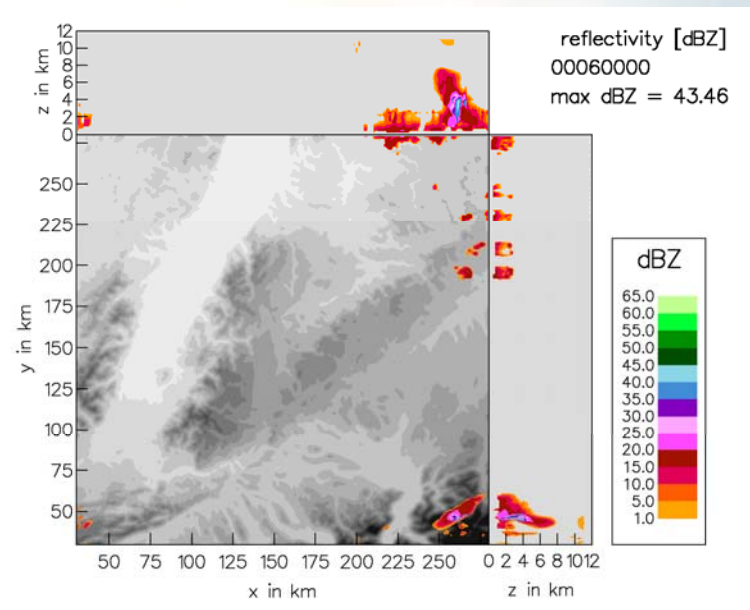
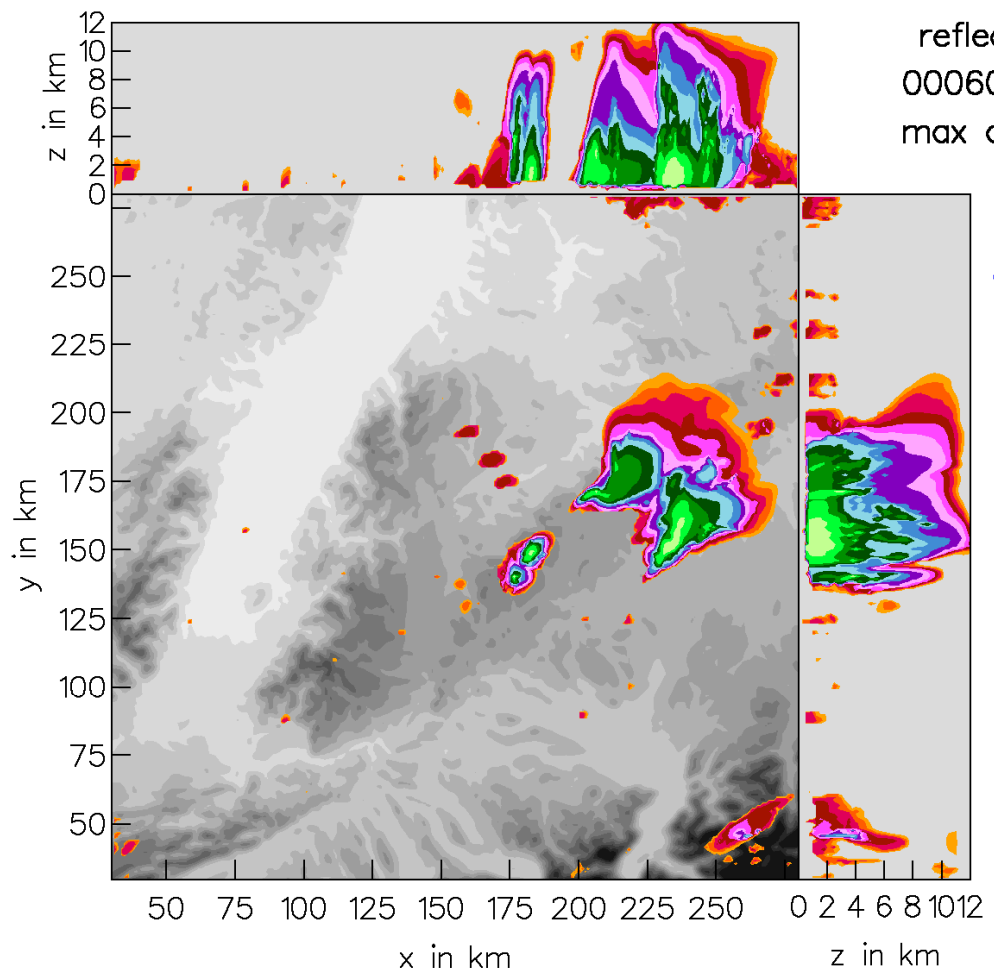
“Real” Simulations



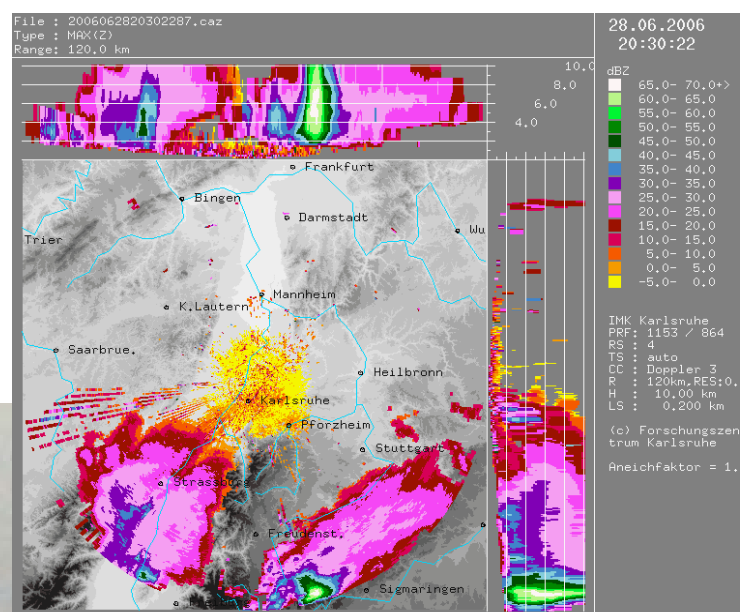
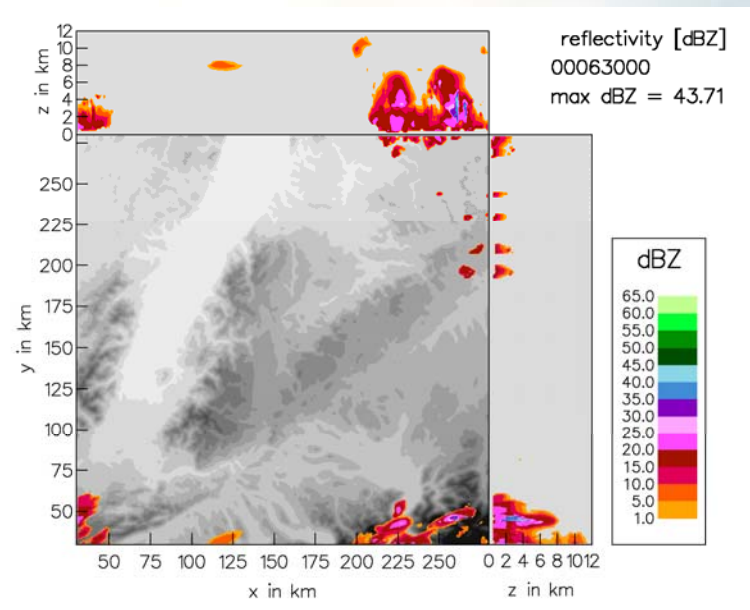
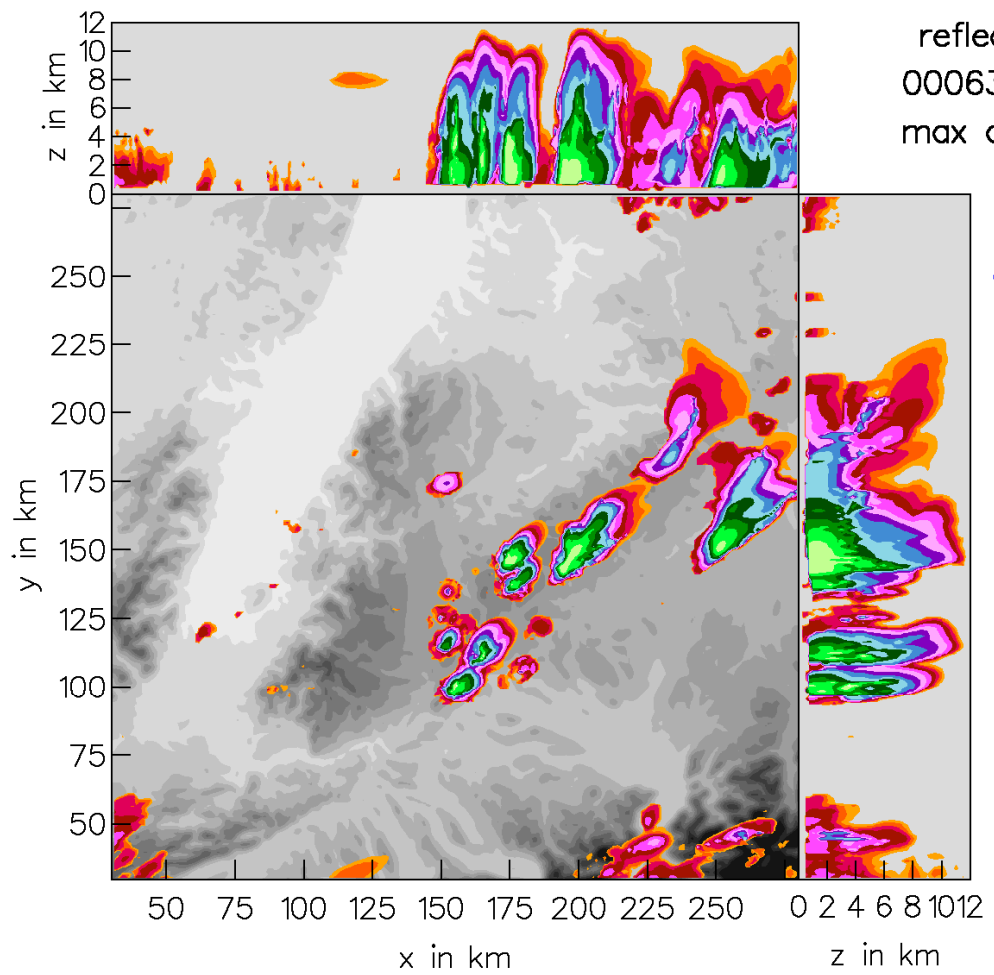
“Real” Simulations



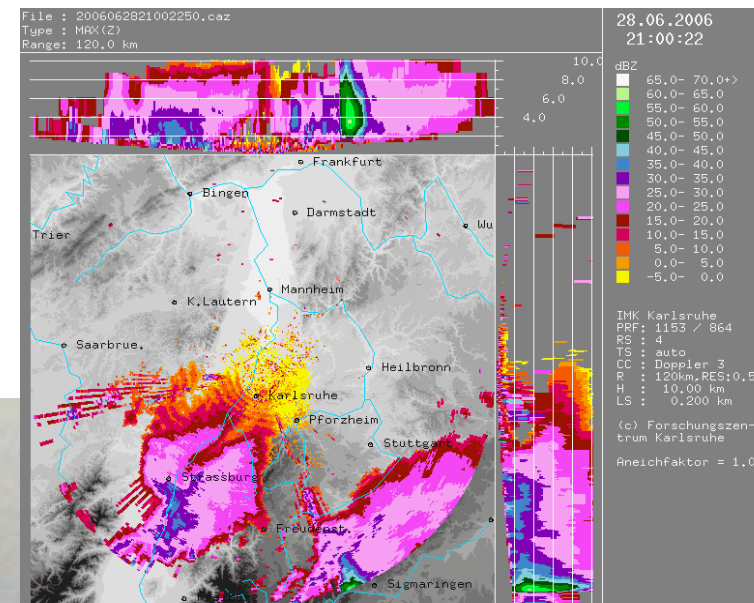
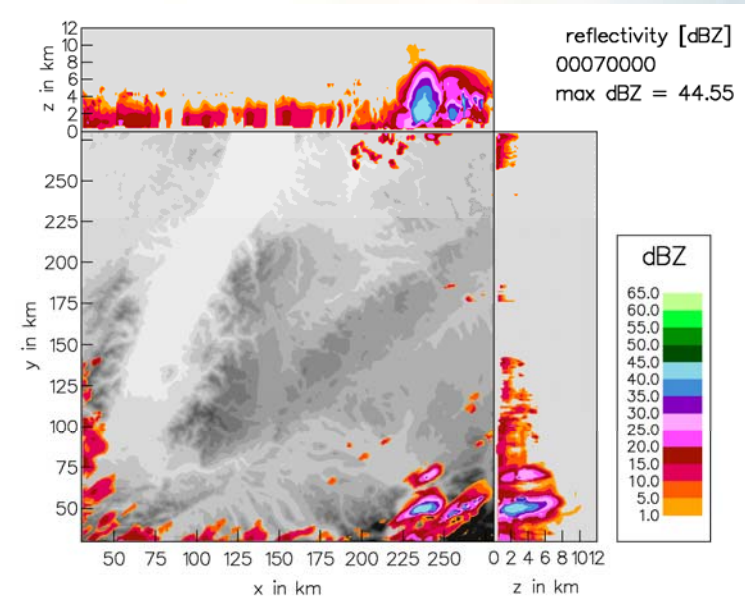
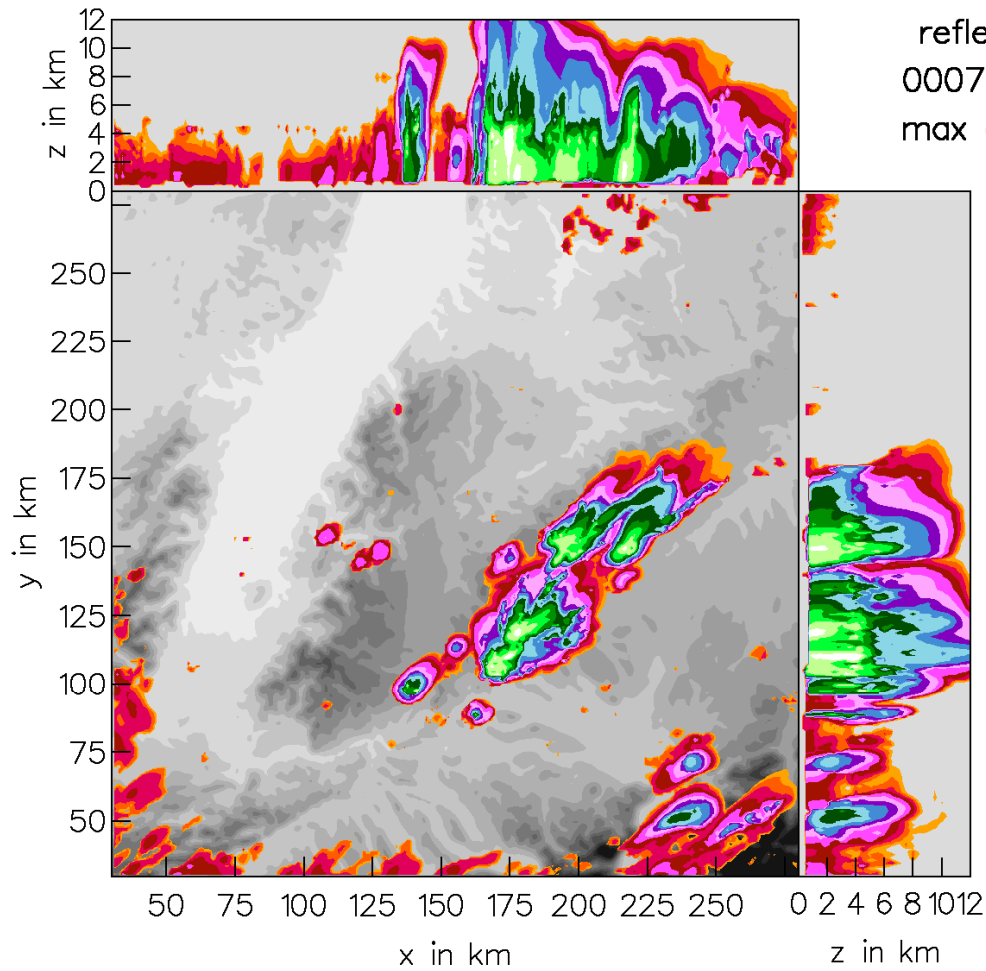
“Real” Simulations



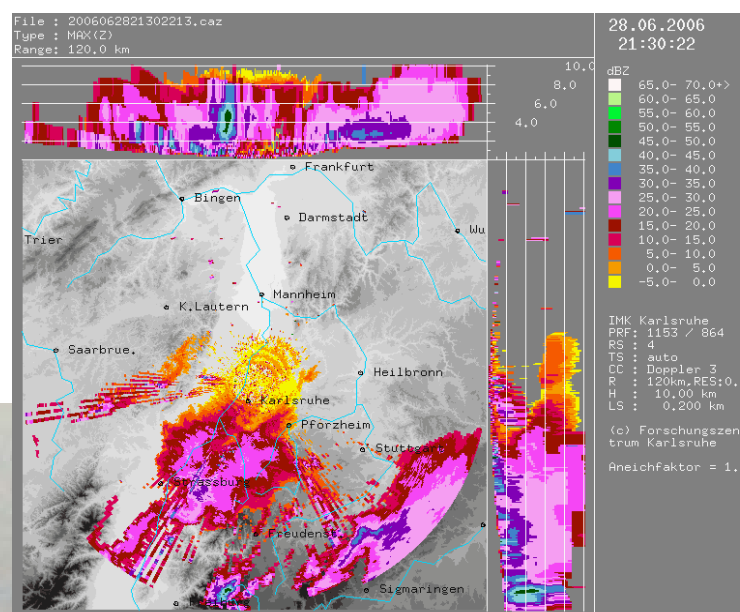
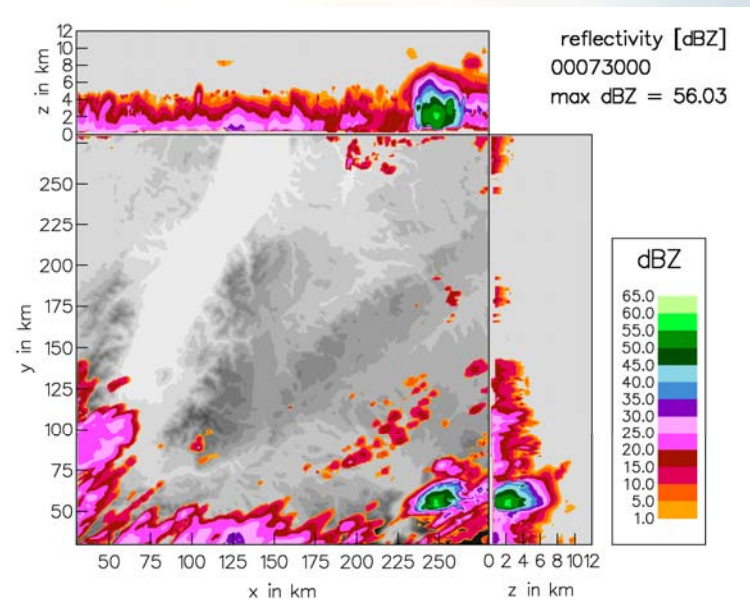
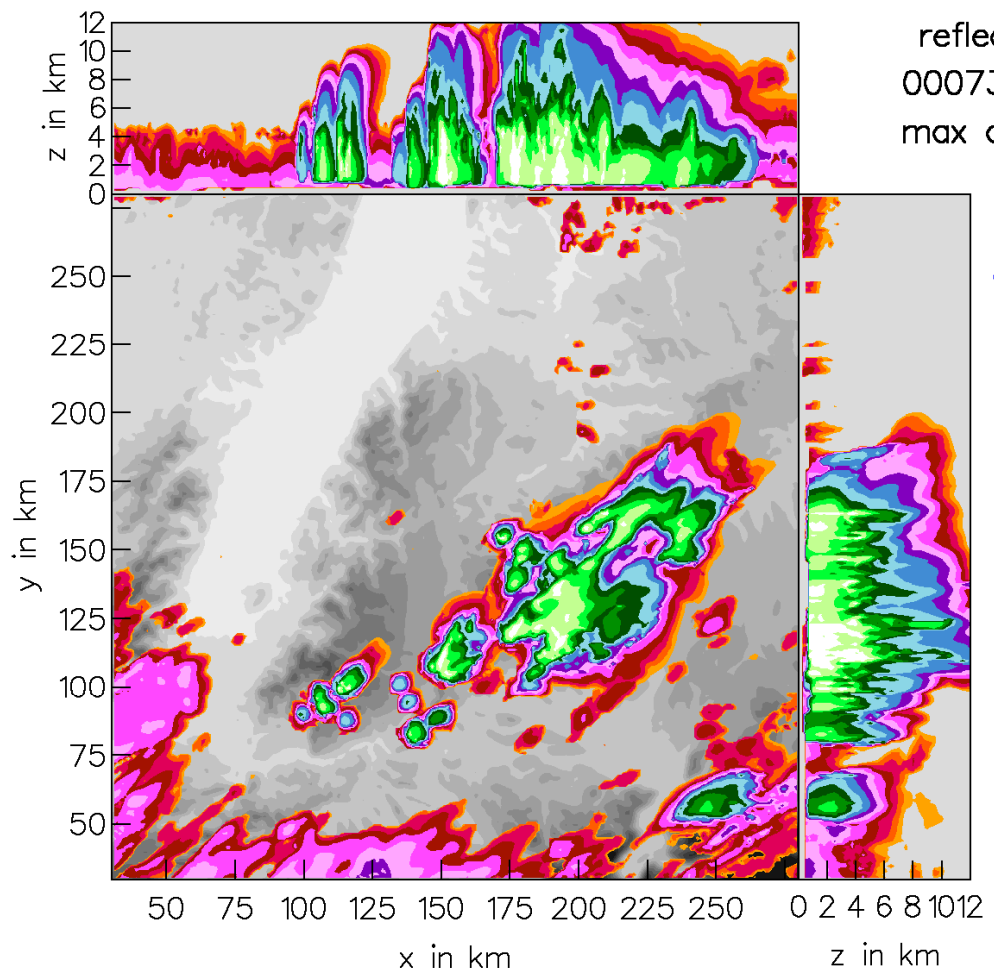
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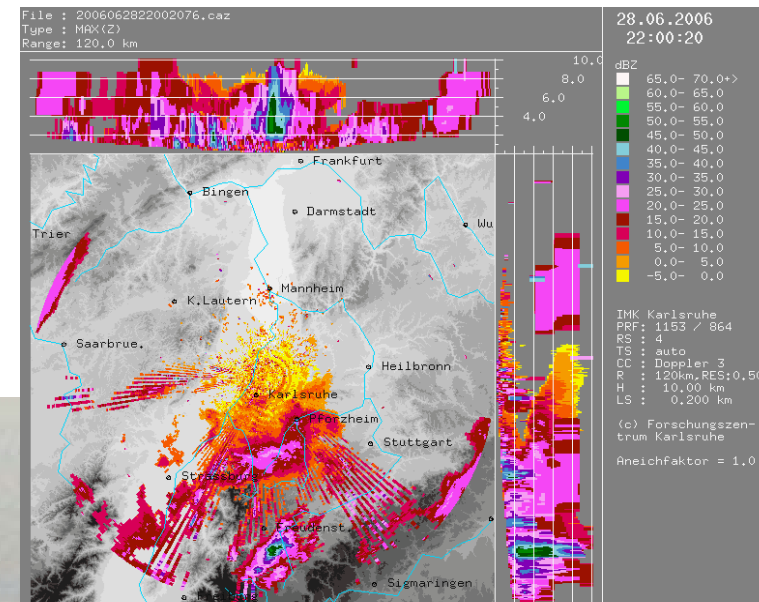
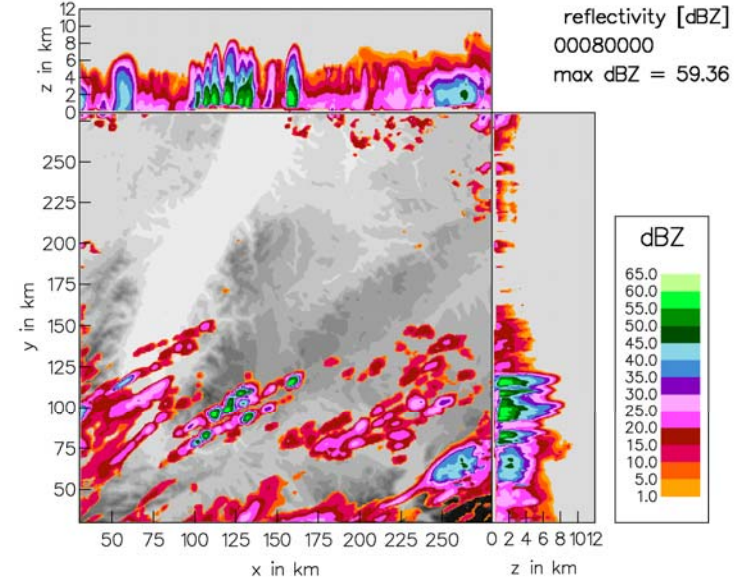
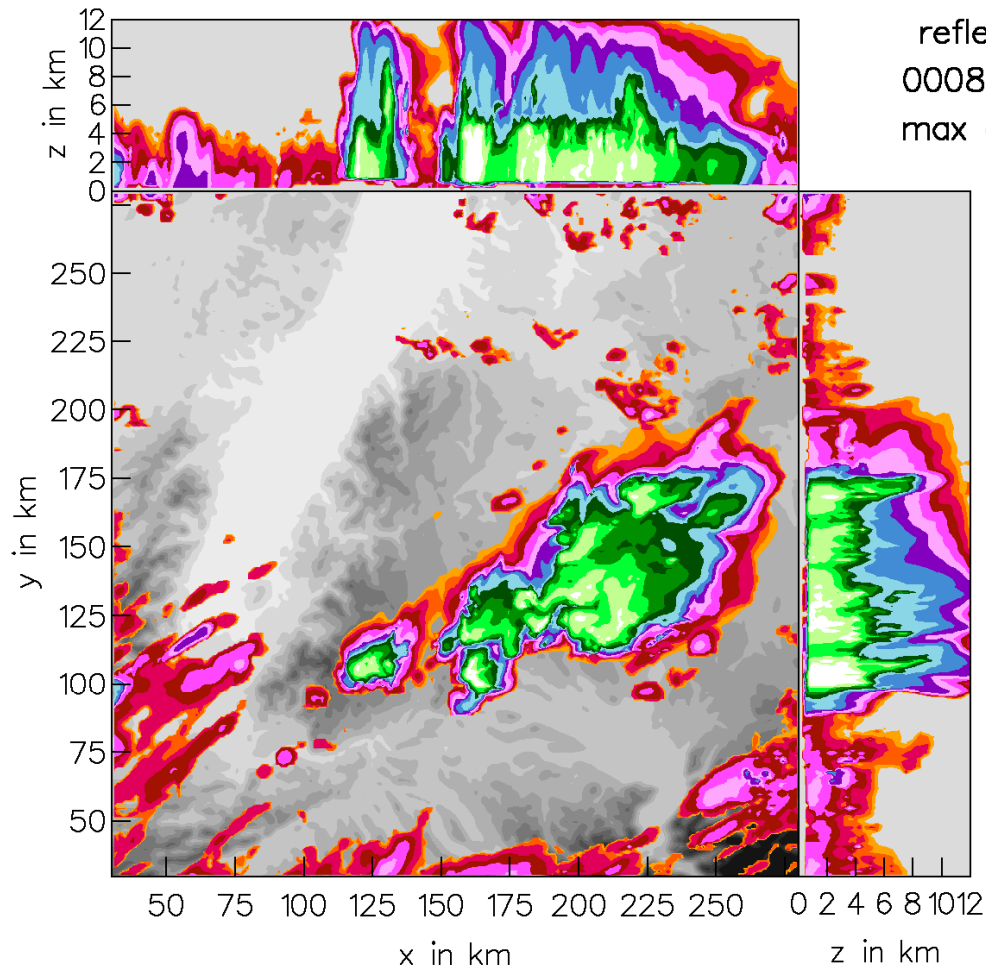
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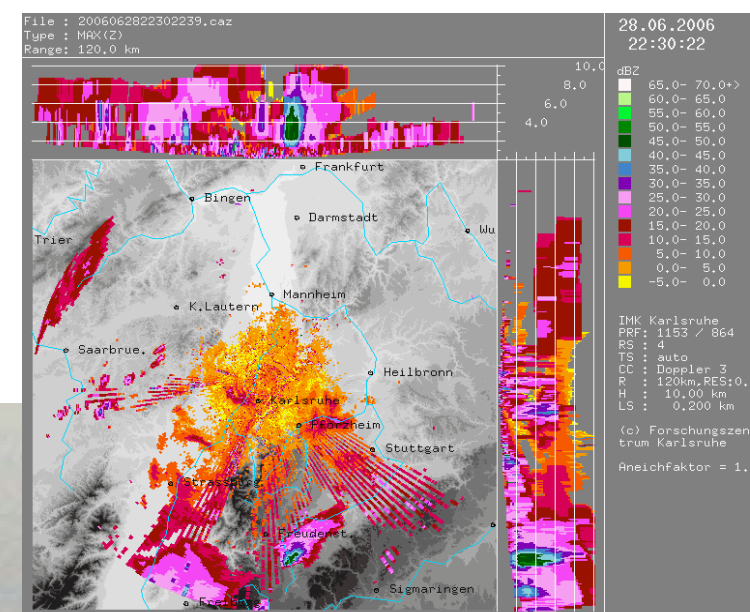
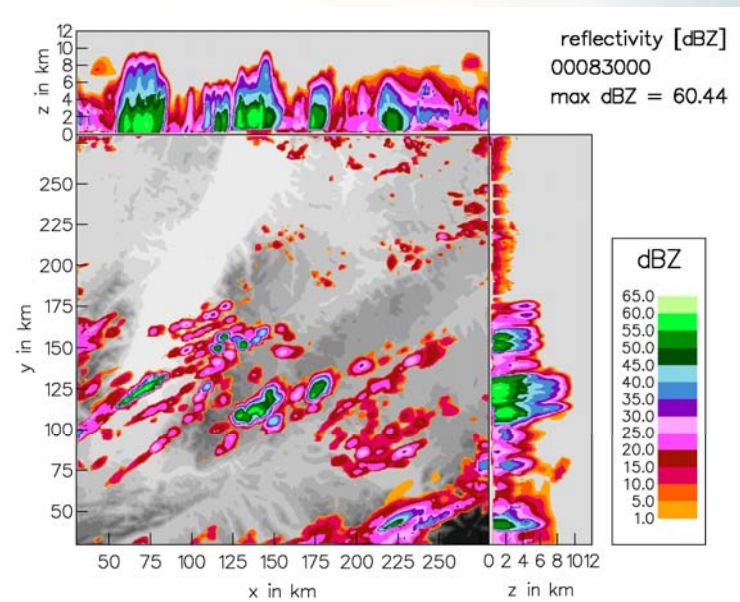
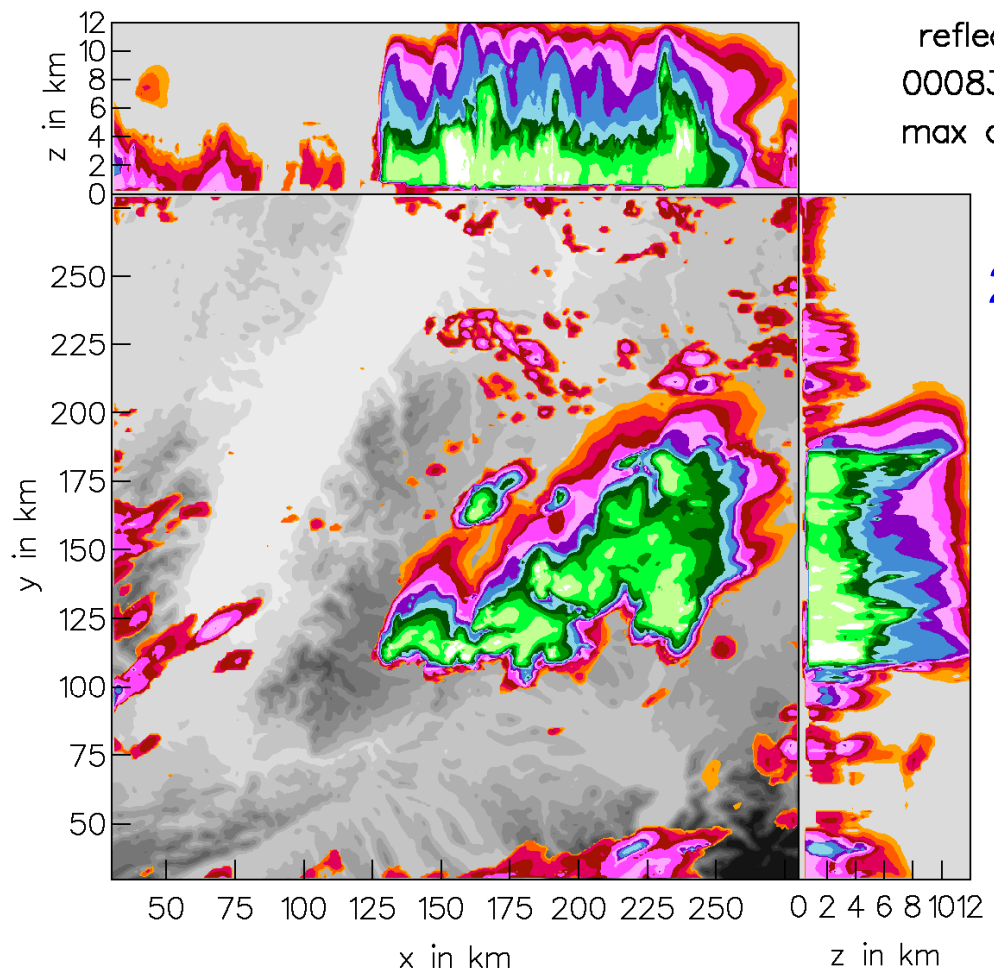
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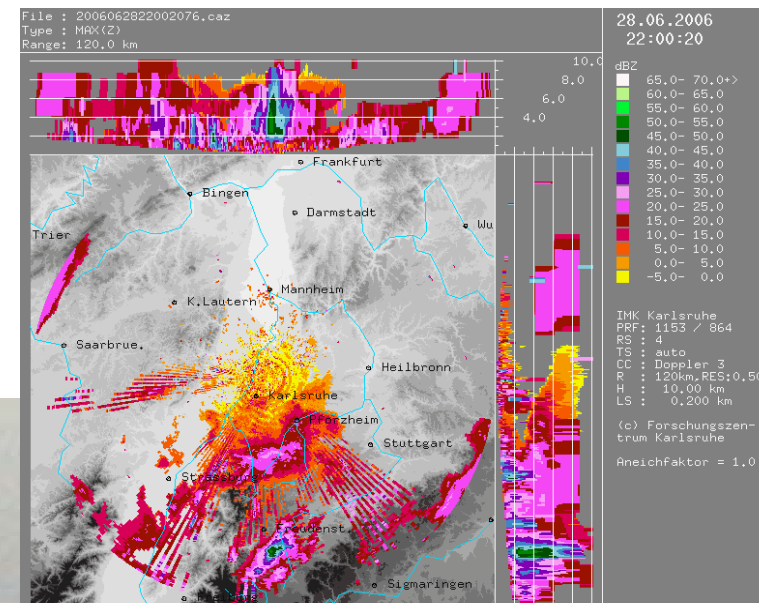
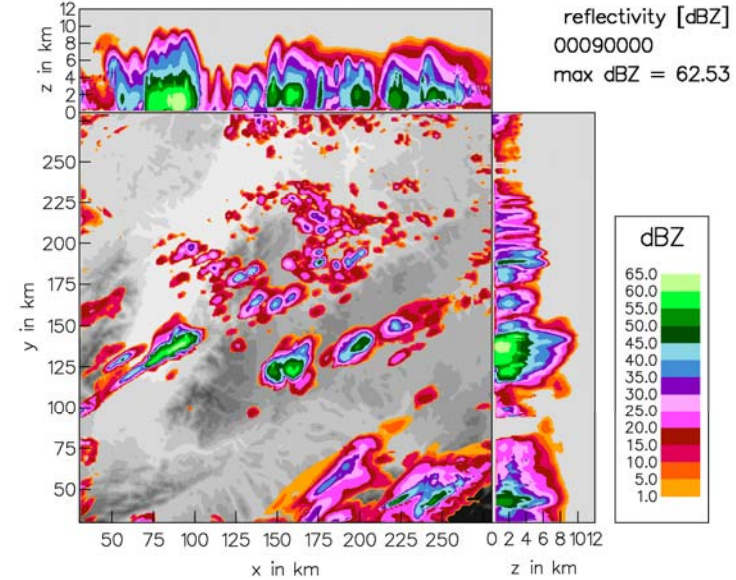
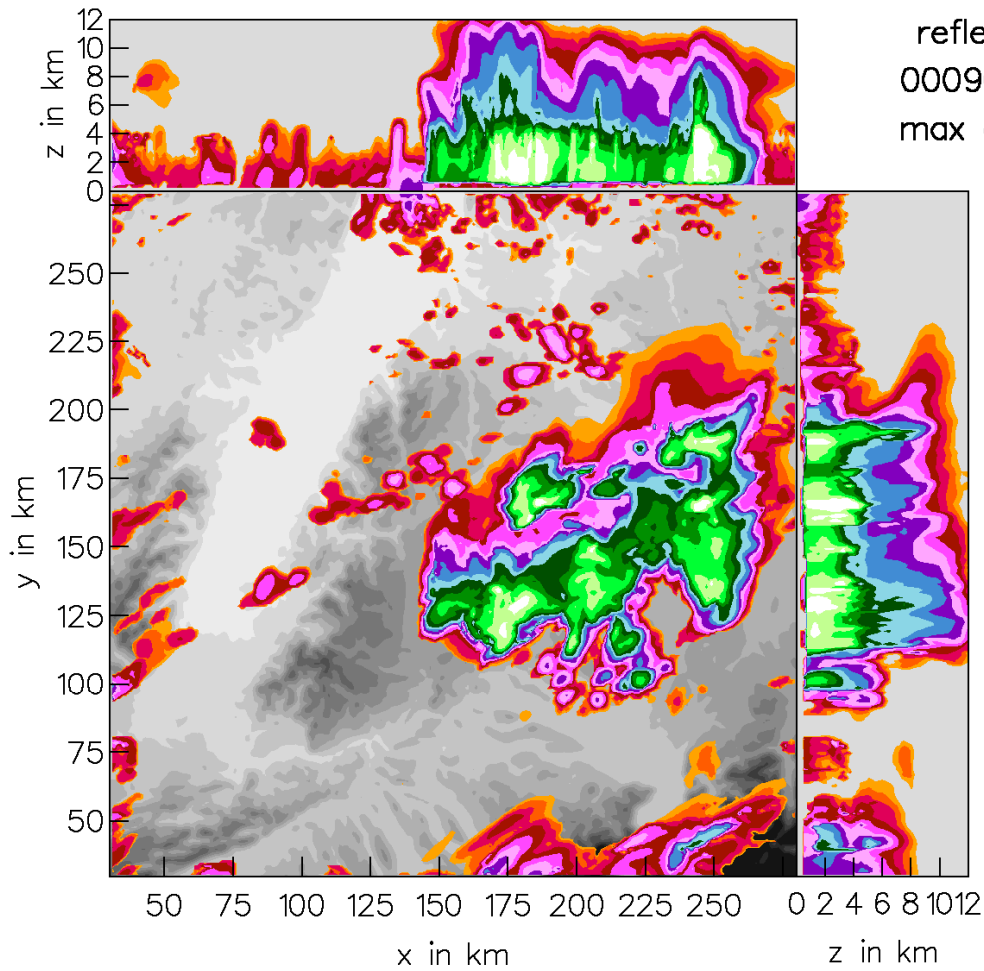
“Real” Simulations



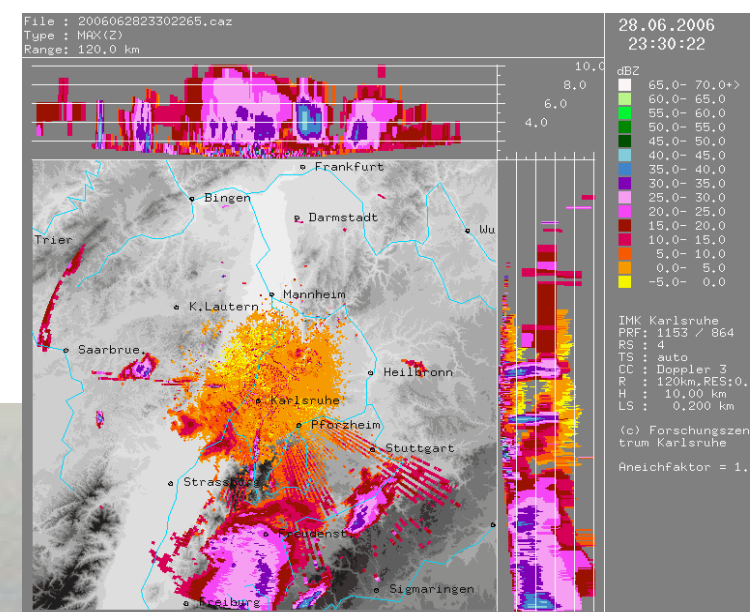
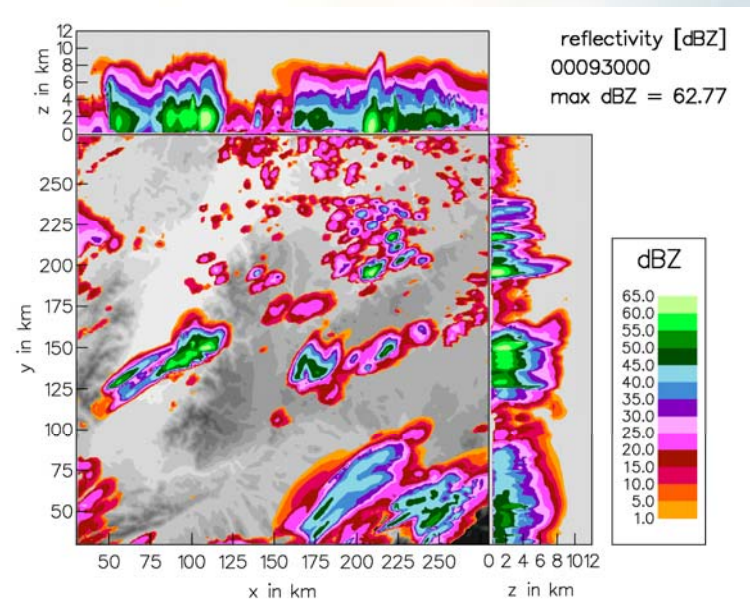
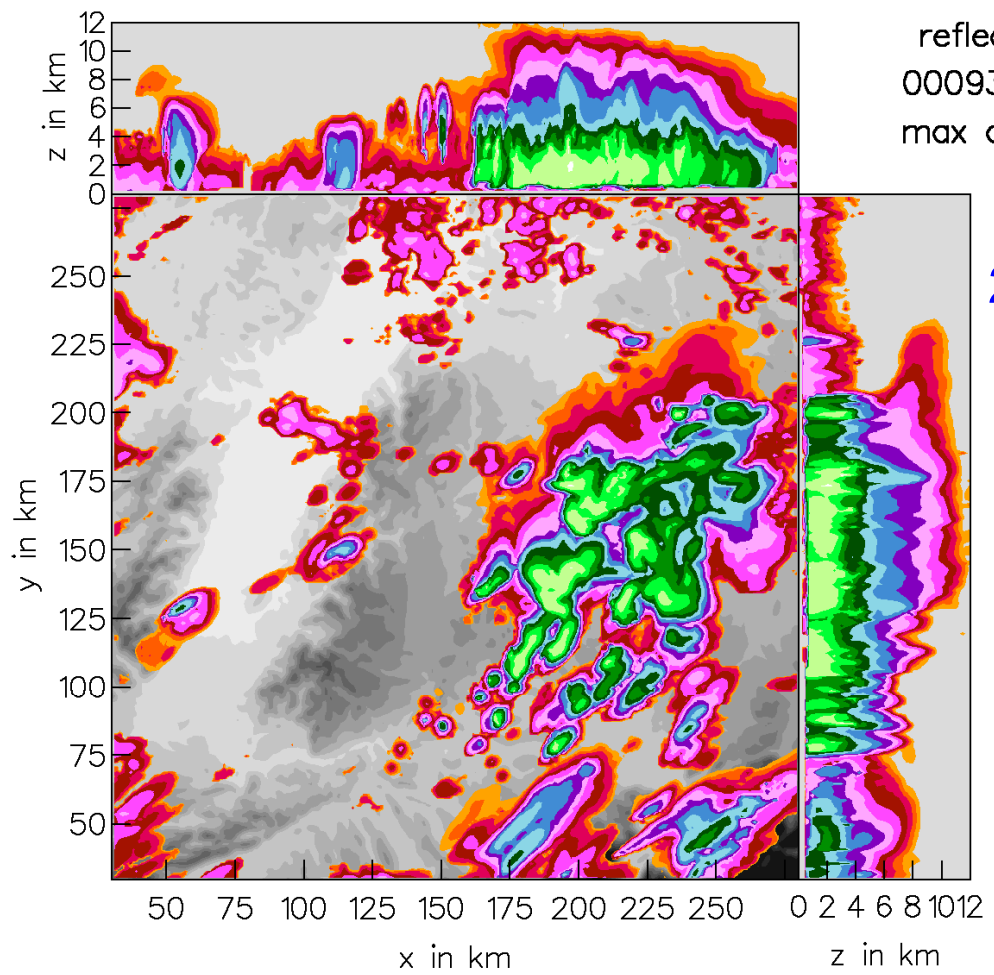
“Real” Simulations



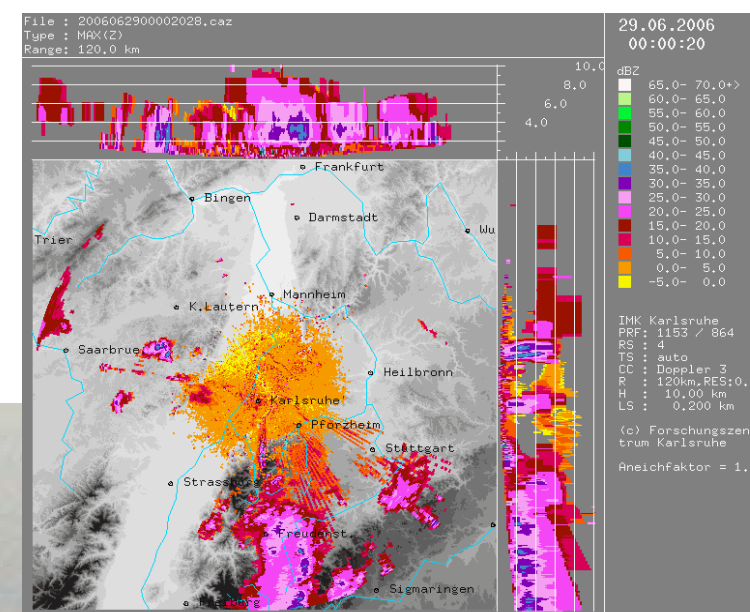
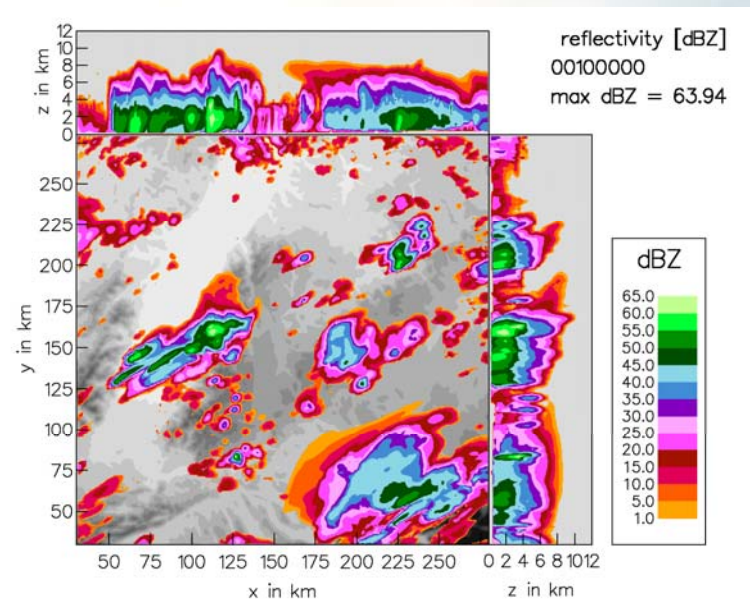
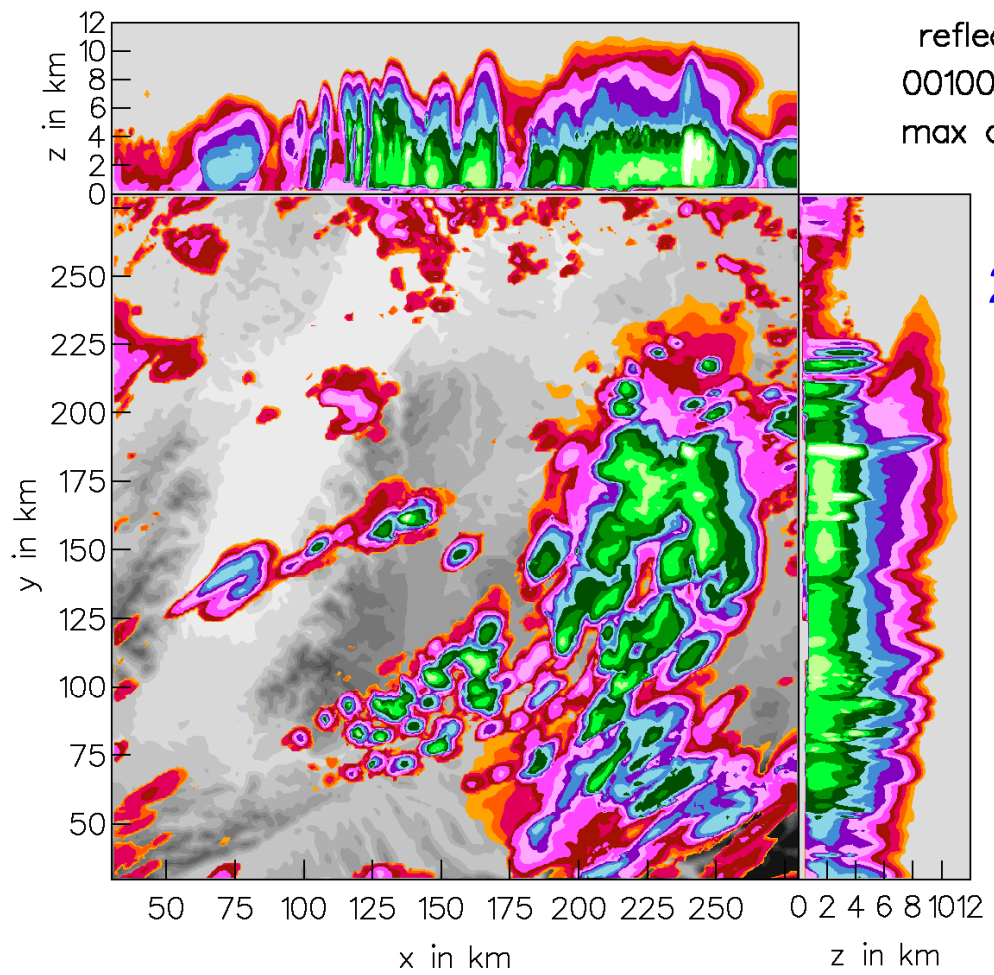
“Real” Simulations



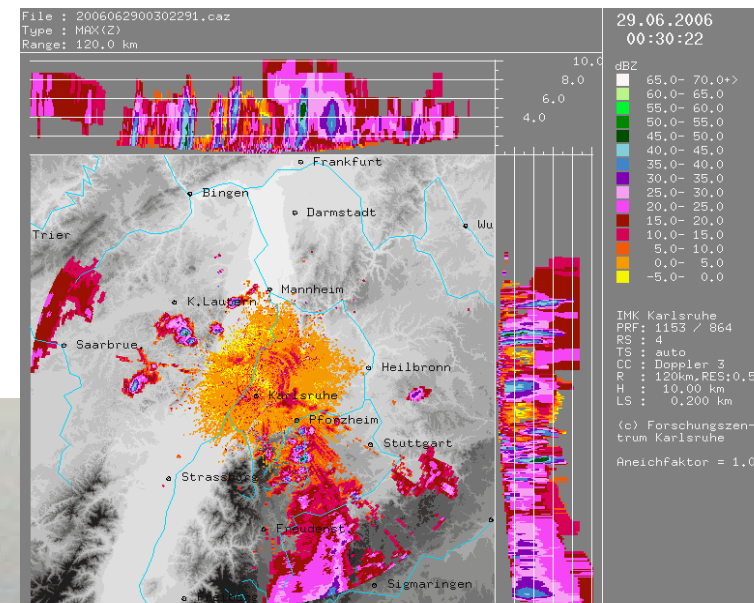
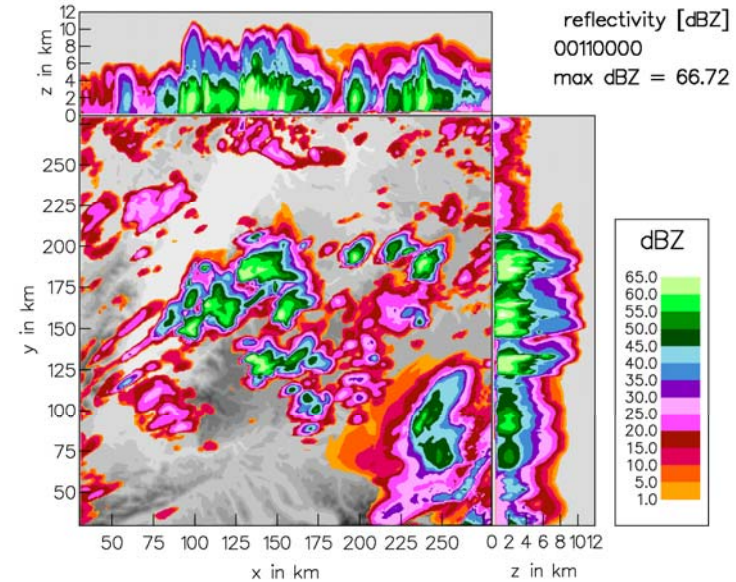
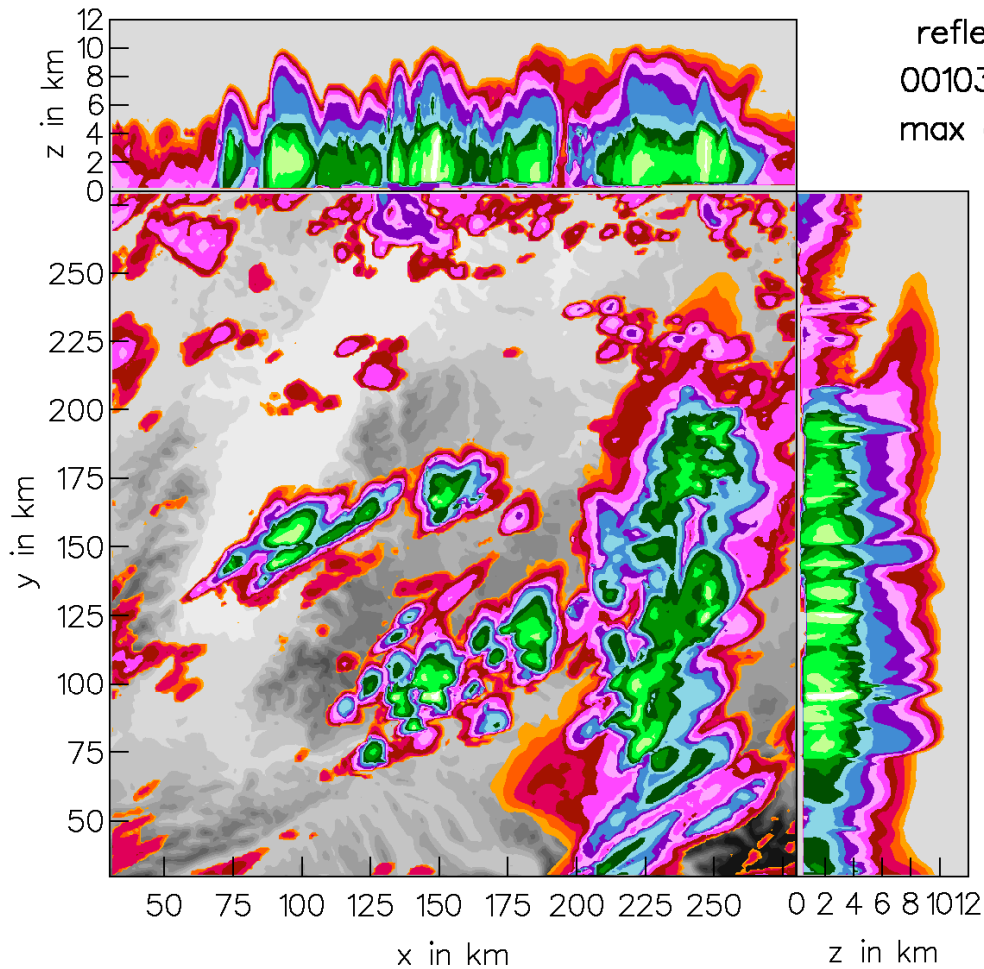
“Real” Simulations



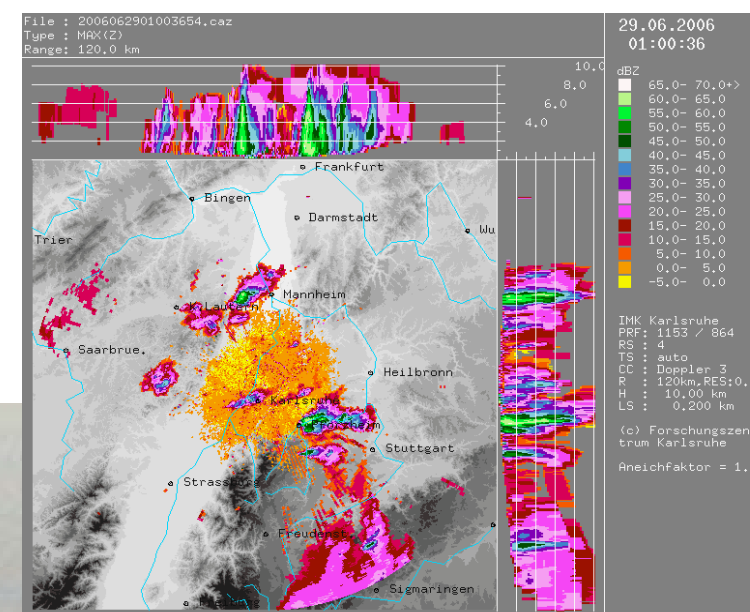
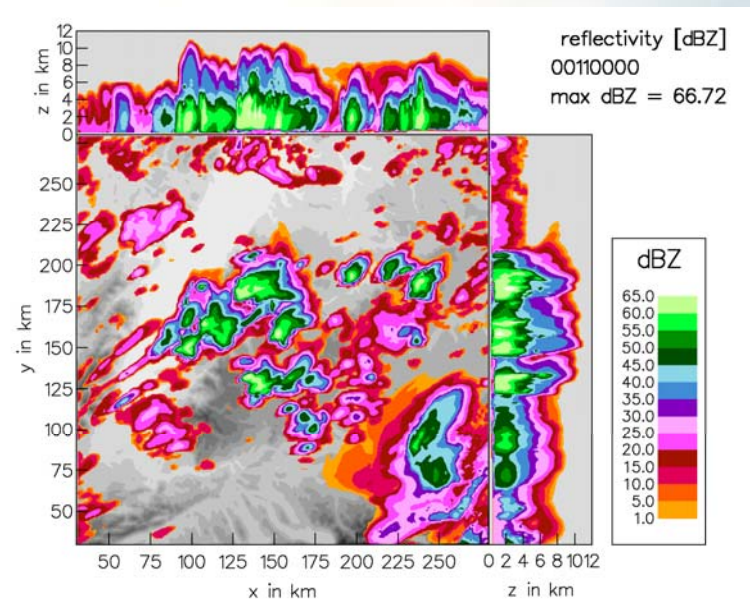
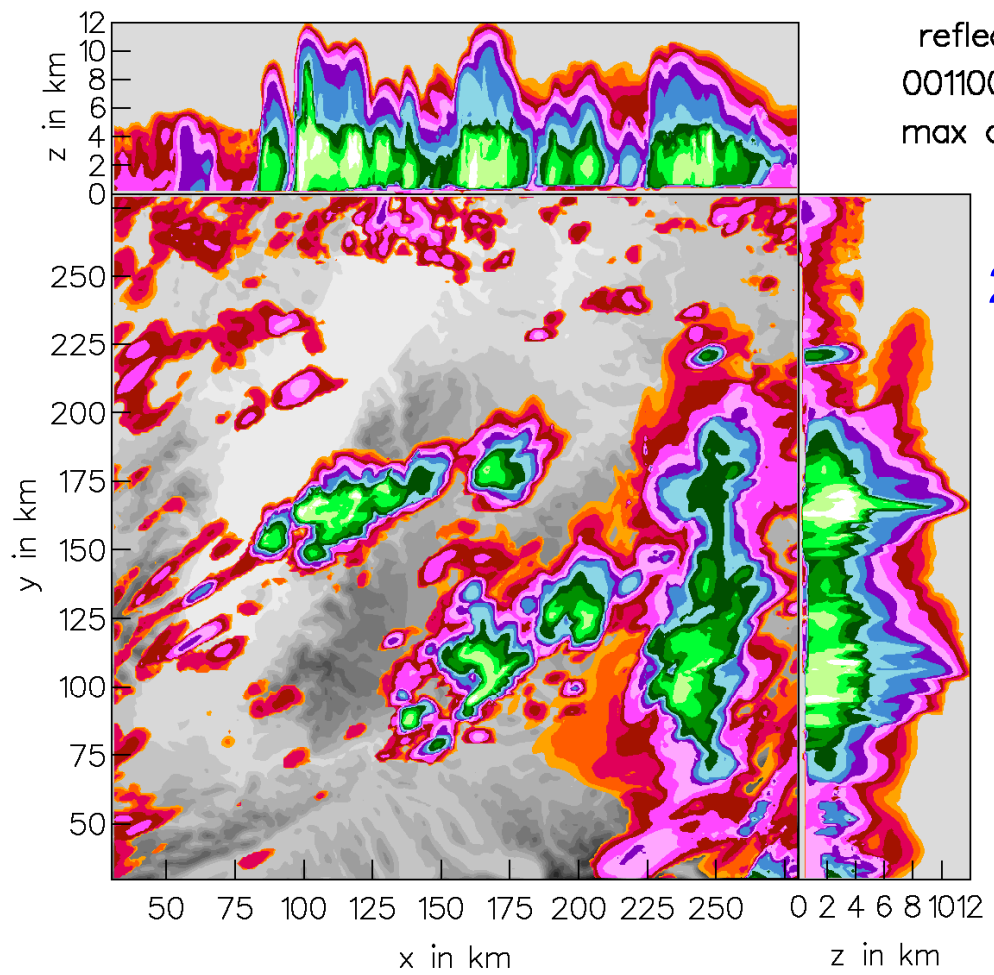
“Real” Simulations



“Real” Simulations

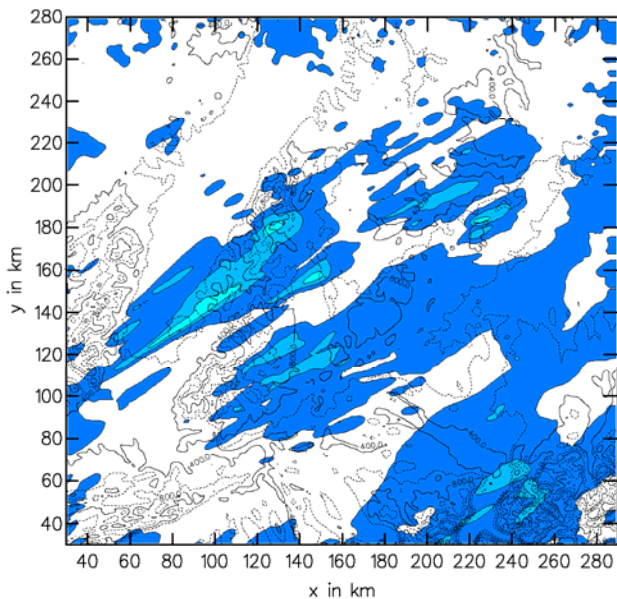


“Real” Simulations



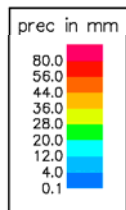
“Real” Simulations

surface precipitation amount [mm], t= 00110000
total volume: 4.15e+07 m³

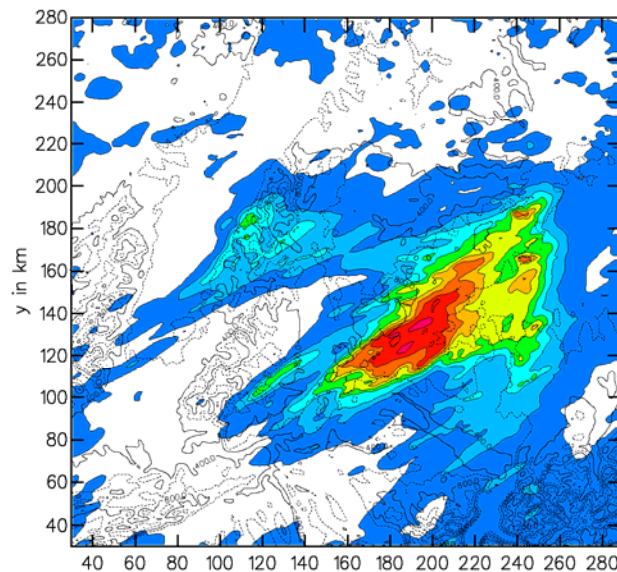


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[h] = 90.361 ... 2905.55

acc. precip
12-22 UTC
high aerosol

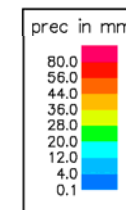


surface precipitation amount [mm], t= 00120000
total volume: 2.755e+08 m³

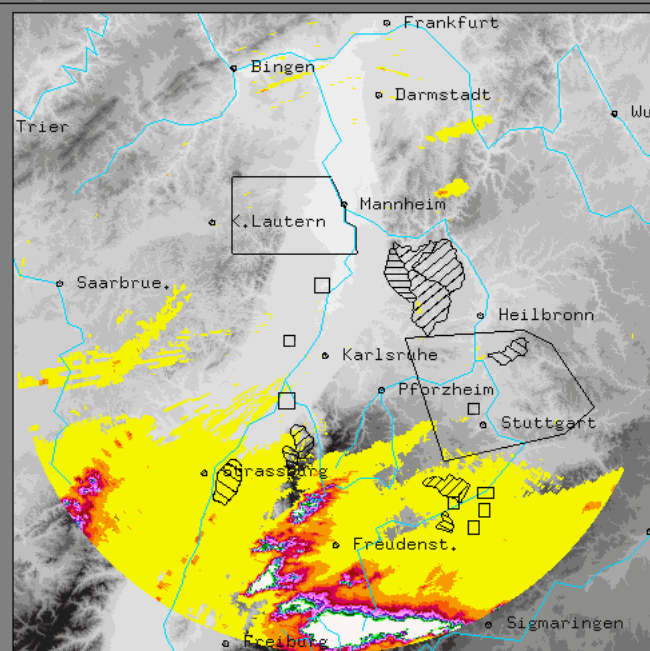


[var] = 8.65809e-07 ... 96.3397
[h] = 90.361 ... 2905.55

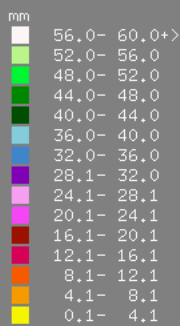
acc. precip
12-22 UTC
high aerosol
heating



File : 2006062900002042.pac
Type : PAC
Range : 120.0 km



29.06.2006
00:00:20

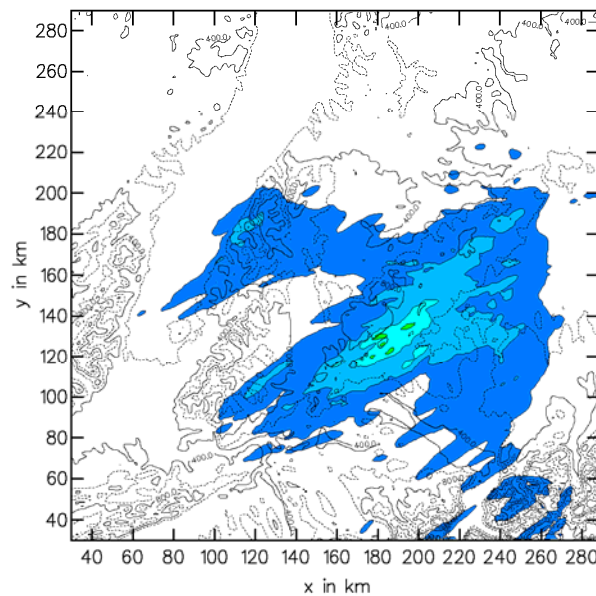


IMK Karlsruhe
PCNT:73
DD/HH:MM: 0/12:2
START/STOP TIME:
28.06.2006/12:00
29.06.2006/00:00

(c) Forschungszentrum
Karlsruhe
Anzeichfaktor = 1.0

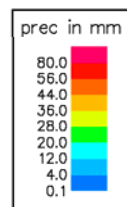
acc. precip
10-22 UTC

surface precipitation amount [mm], t= 00120000
total volume: 4.398e+07 m³



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[h] = 90.361 ... 2905.55

acc. precip
by graupel&hail
12-22 UTC
high aerosol
heating



Summary and Conclusions

Idealised Simulations:

- ✓ LM (COSMO) with 2-moment microphysics is able to produce a convective storm that resembles the observed one quite well
- ✓ the model produces large hailstones ($D > 4\text{cm}$)
- ✓ aerosol concentration has a strong impact on accum. precip.
- ✓ impact especially strong on precipitation by frozen hydrometeors

Summary and Conclusions

Real Simulations:

- ✓ LM (COSMO) produces convection in the Black forest, but about 3 hours late
- ✓ heating and moistening of the boundary layer leads to earlier convection, and enhanced precipitation downstream
- ✓ with artificial heating/moistening a hailstorm occurs at about the right location and the right time (cell splitting)
- ✓ with heating/moistening max. acc. precipitation is more realistic
- ✓ the influence of aerosol loading is about the same as in the idealised simulations

Summary and Conclusions

Conclusions:

- LM with a 2-moment microphysics scheme (Seifert & Beheng, 2006) is an appropriate tool to study the influence of aerosols on a severe storm
- aerosol loading can have a strong impact on the severity of a hailstorm

Questions?

