Implementation of a 'Hail' Class into a Two-Moment Bulk Microphysical Scheme and its Impact on Convective Cells

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Motivation

Goal: Study the impact of aerosols on severity of storms in Europ

mportant factors:

- size of particles
- ice phase

➡ Need for

- a two-moment scheme
- an accurate representation of large ice particels in storms

nplementing a hail class

tandard graupel scheme

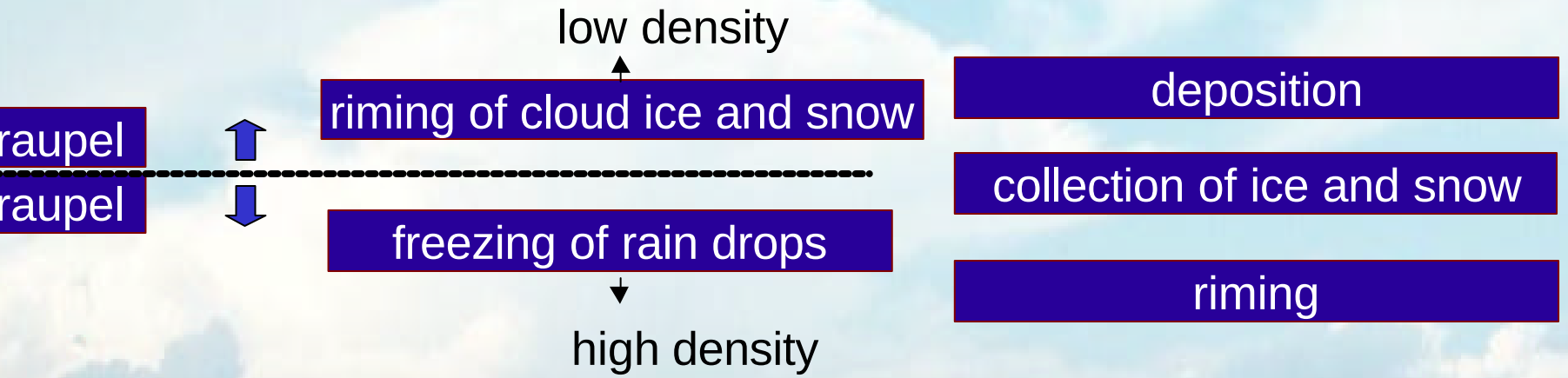
article class	Formation	Growth
raupel	low density riming of cloud ice and snow freezing of rain drops high density	deposition collection of ice and snow riming

nplementing a hail class

article class

Formation

Growth



nplementing a hail class

ew graupel scheme

article class	Formation	Growth
raupel w density	riming of cloud ice and snow	deposition collection of ice and snow riming
hail gh densitiy	freezing of rain drops	deposition collection of ice and snow riming

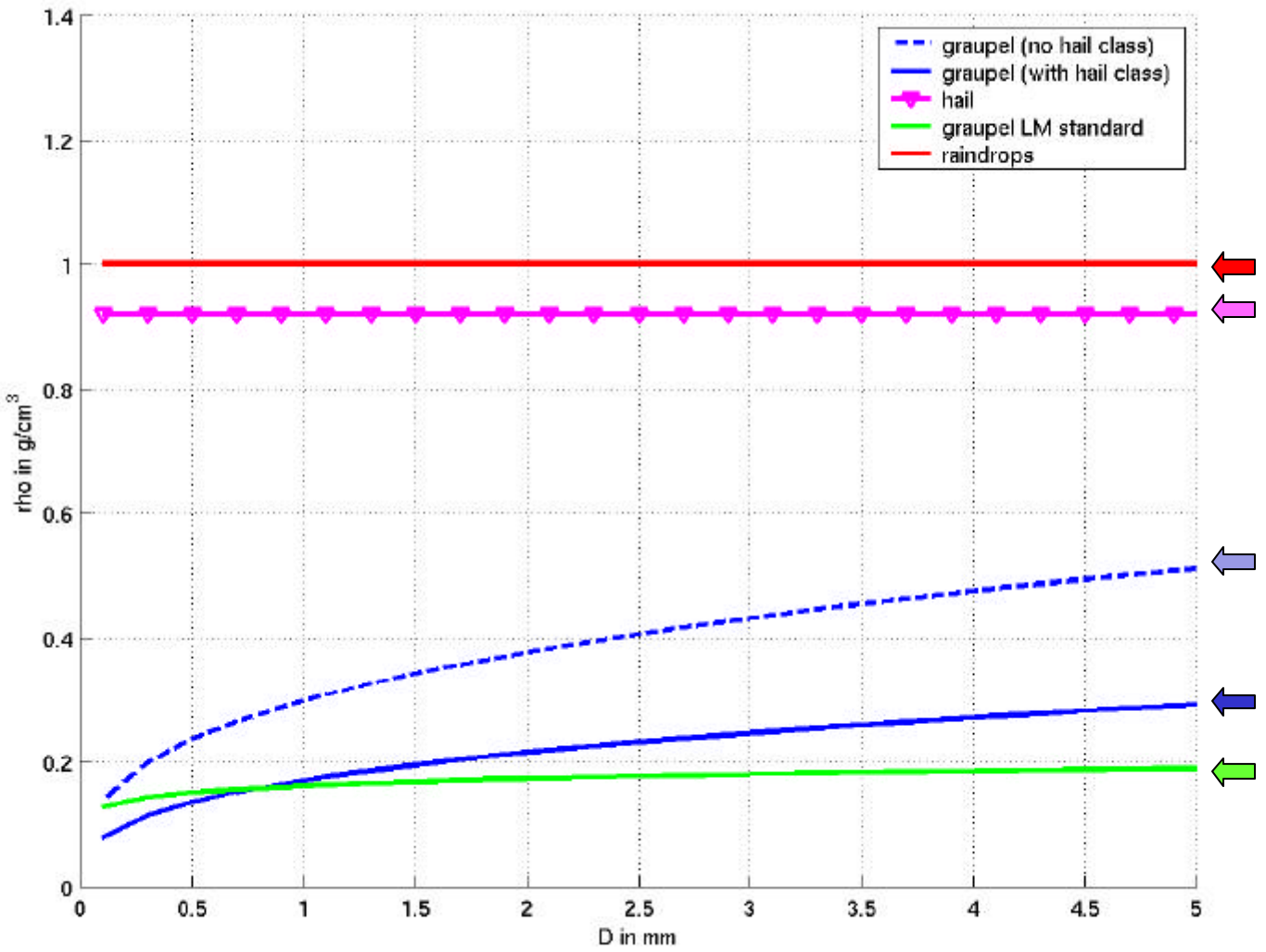
mplementing a hail class

lease note that in the following

hail = graupel formed from frozen raindrops

haracteristics of the old and new particles

Density



haracteristics of the old and new particles

Size-distribution

ze-distribution function: $f(x) = A\, x^{?} \exp(-?x^{\mu})$

Total number density $N = M^0(f(x))$

Total mass density $L = M^1(f(x))$

ne-moment scheme:

only **L** prognostic ⇨ **?, μ** and **A** fixed, **?**= **?**(**L**)

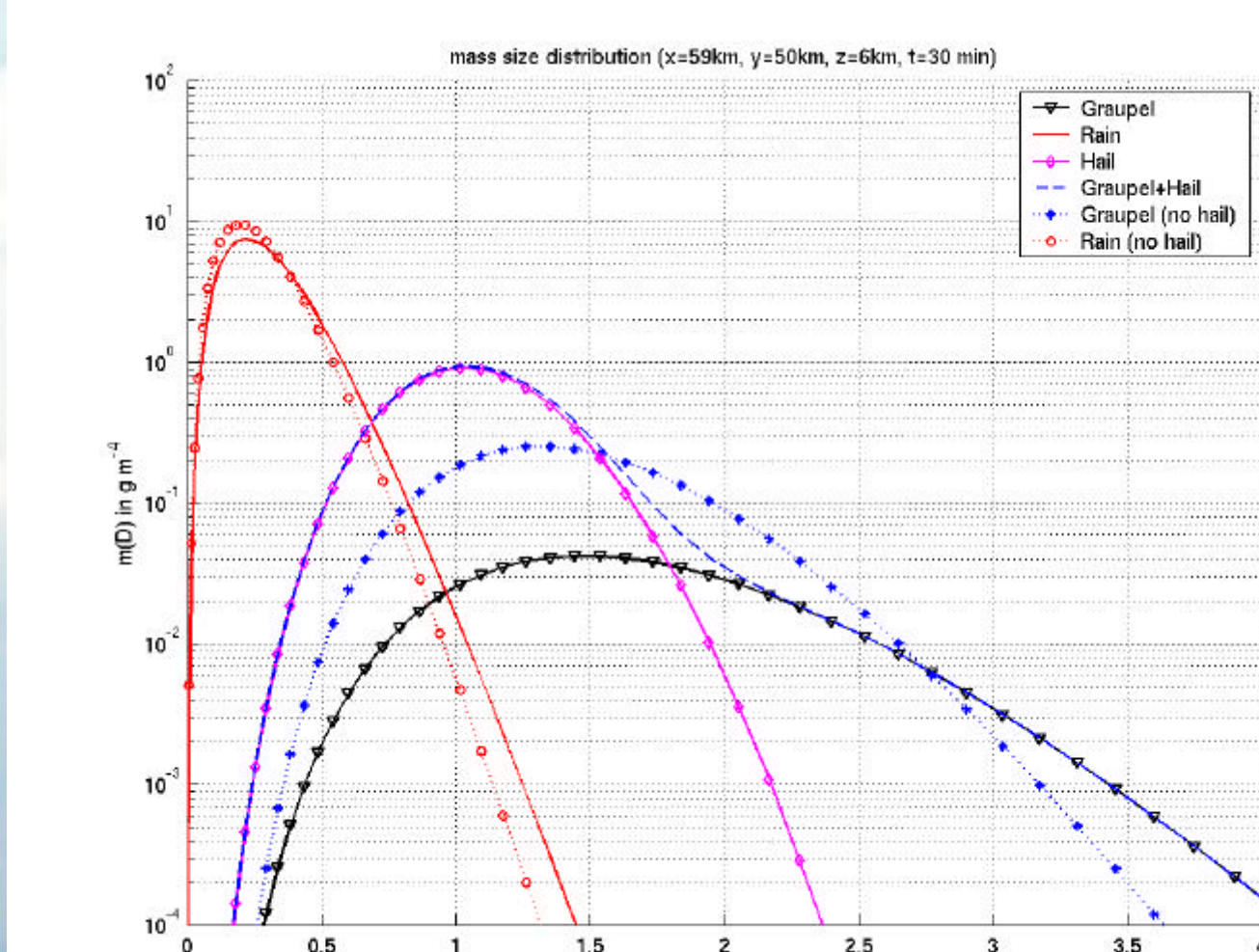
wo-moment scheme:

L and **N** prognostic ⇨ **?** and **μ** fixed, **A=A(L,N)** and **?**= **?**(**L,N**)

haracteristics of the old and new particles

Size-distribution

ass-size distributions for a specific case,
cation and time



ase studies

fferent Weisman-Klemp profiles

	Precip. mass after 2 (in 1000 t)	
	no Hail class	Hail cla
se 1: low CAPE, low wind shear, continental aerosol	8	4
se 2: moderate CAPE, low wind shear, continental aerosol	74	28
maritime aerosol	790	135
se 3: high CAPE, strong wind shear, continental aerosol	760	222

rizontal resolution: 1 km
odel domain: 180 km x 100 km
vertical levels
M version 3.16.x

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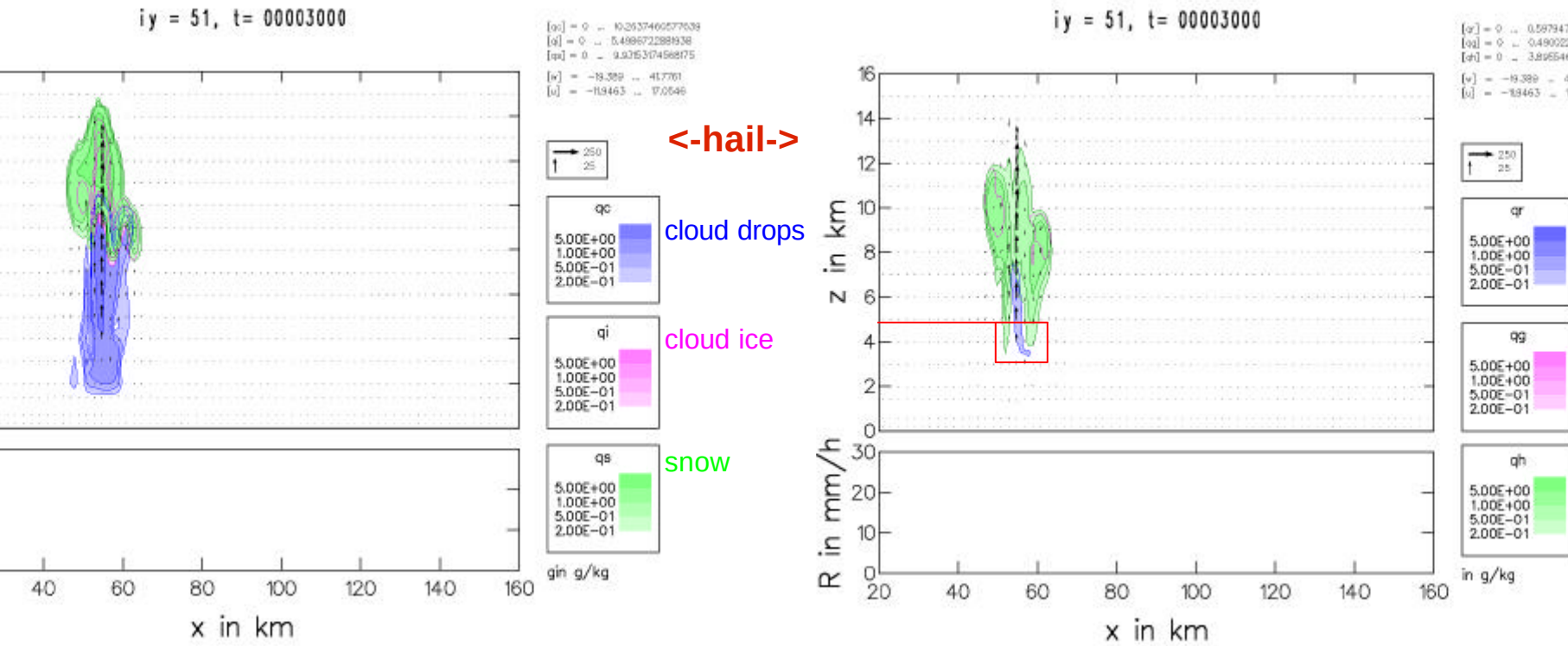
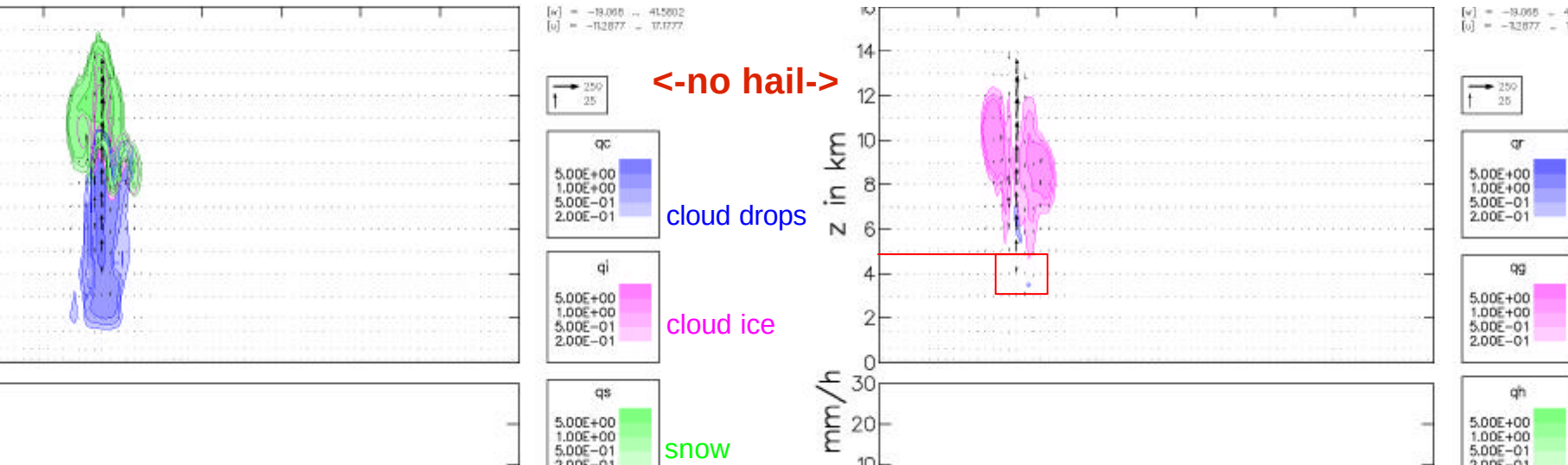
Results (case 2, continental)





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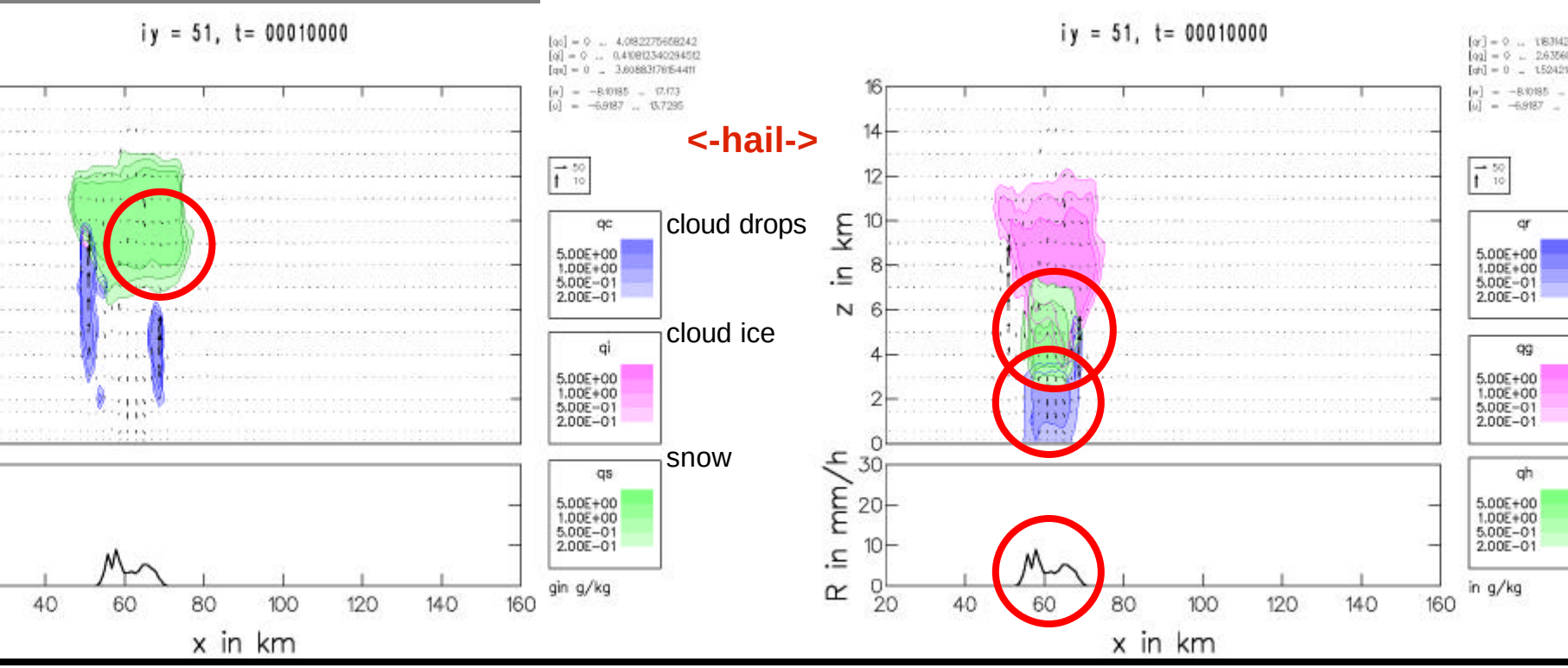
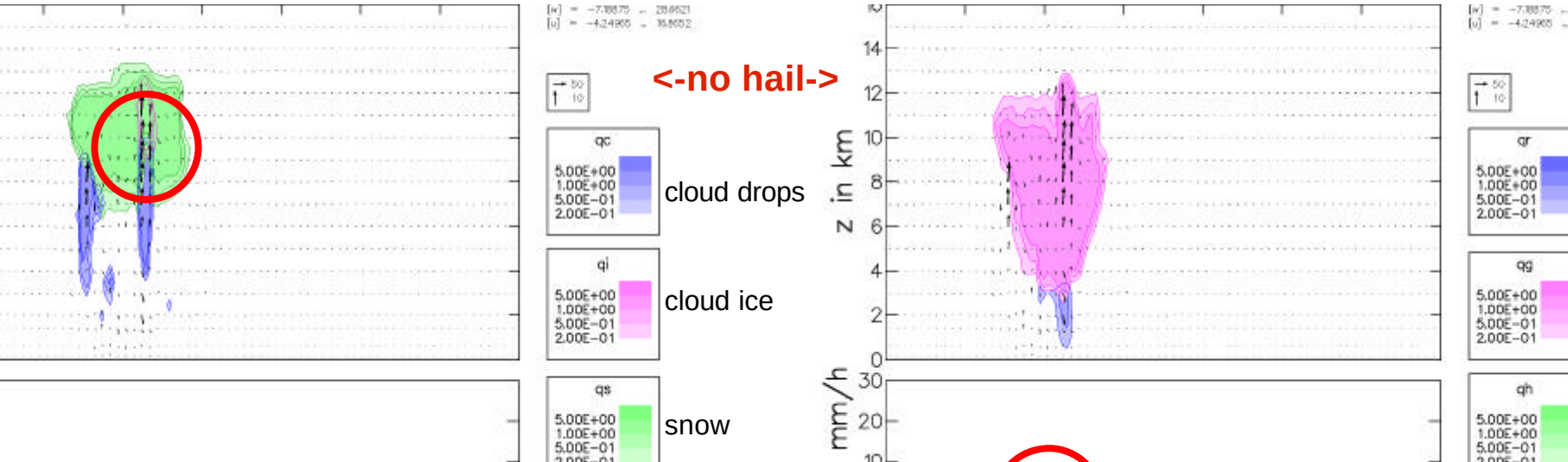
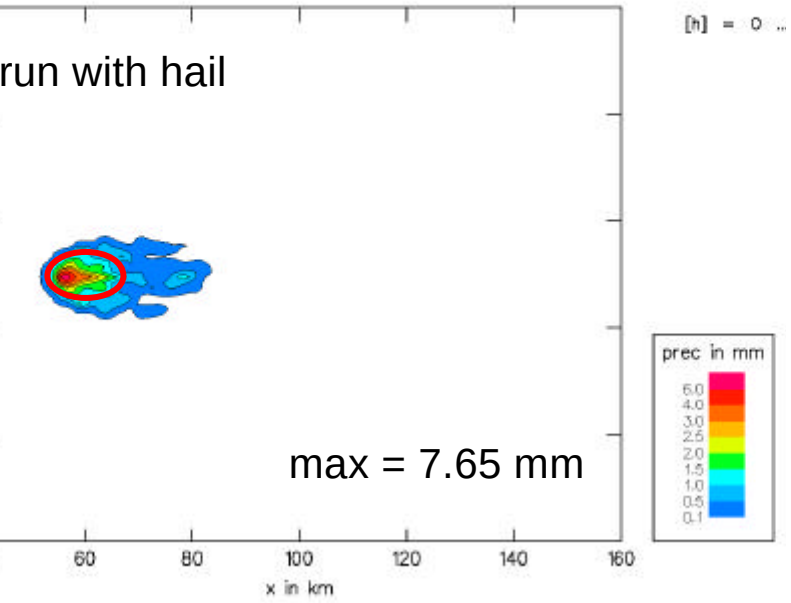
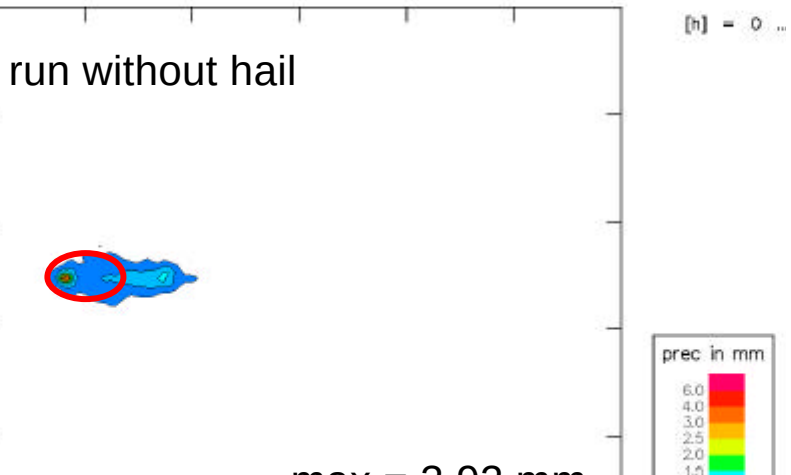


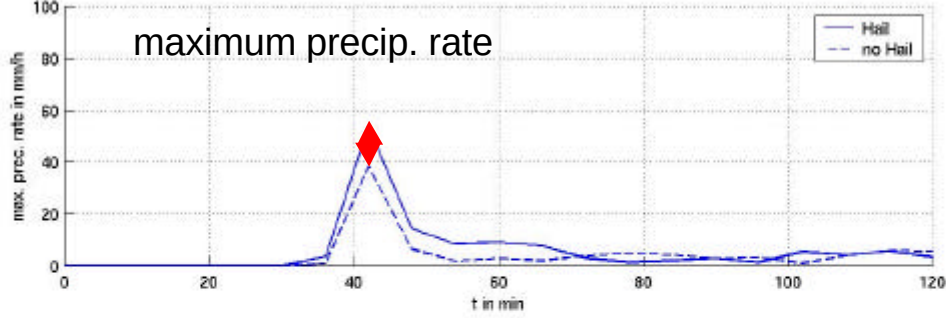


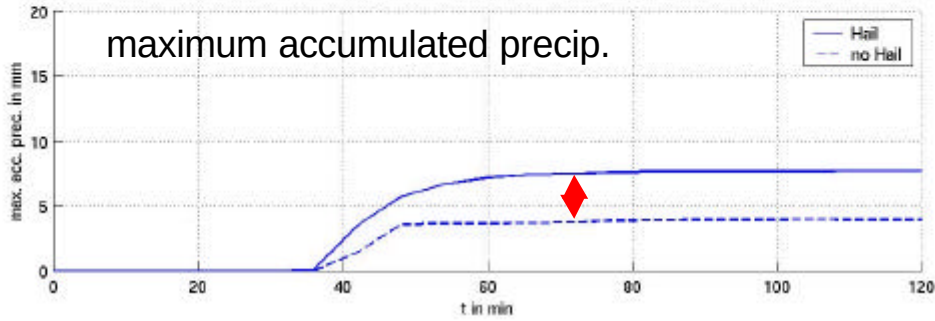
(case 2, continental)

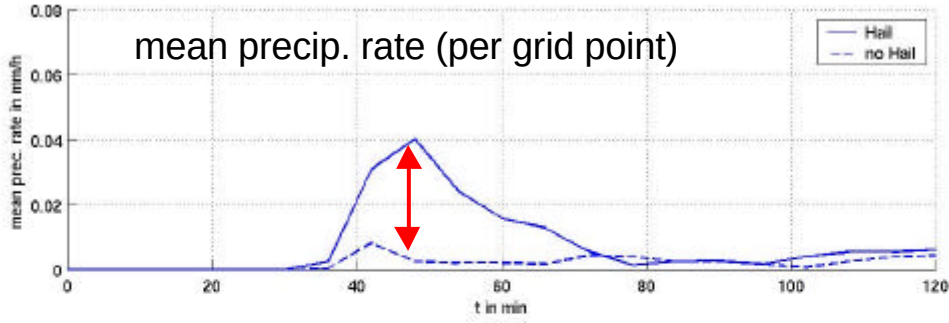
mulated precipitation after 2 h

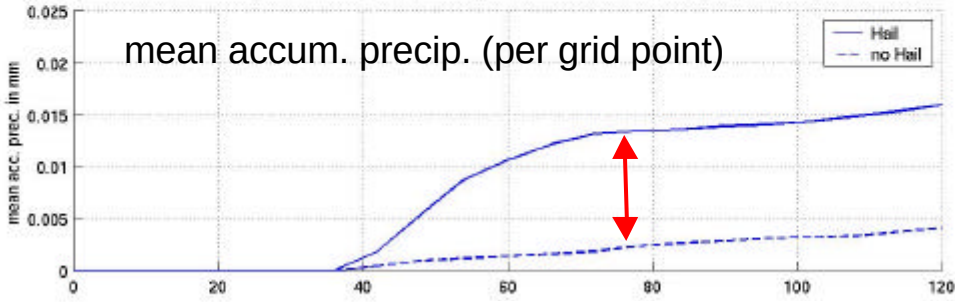








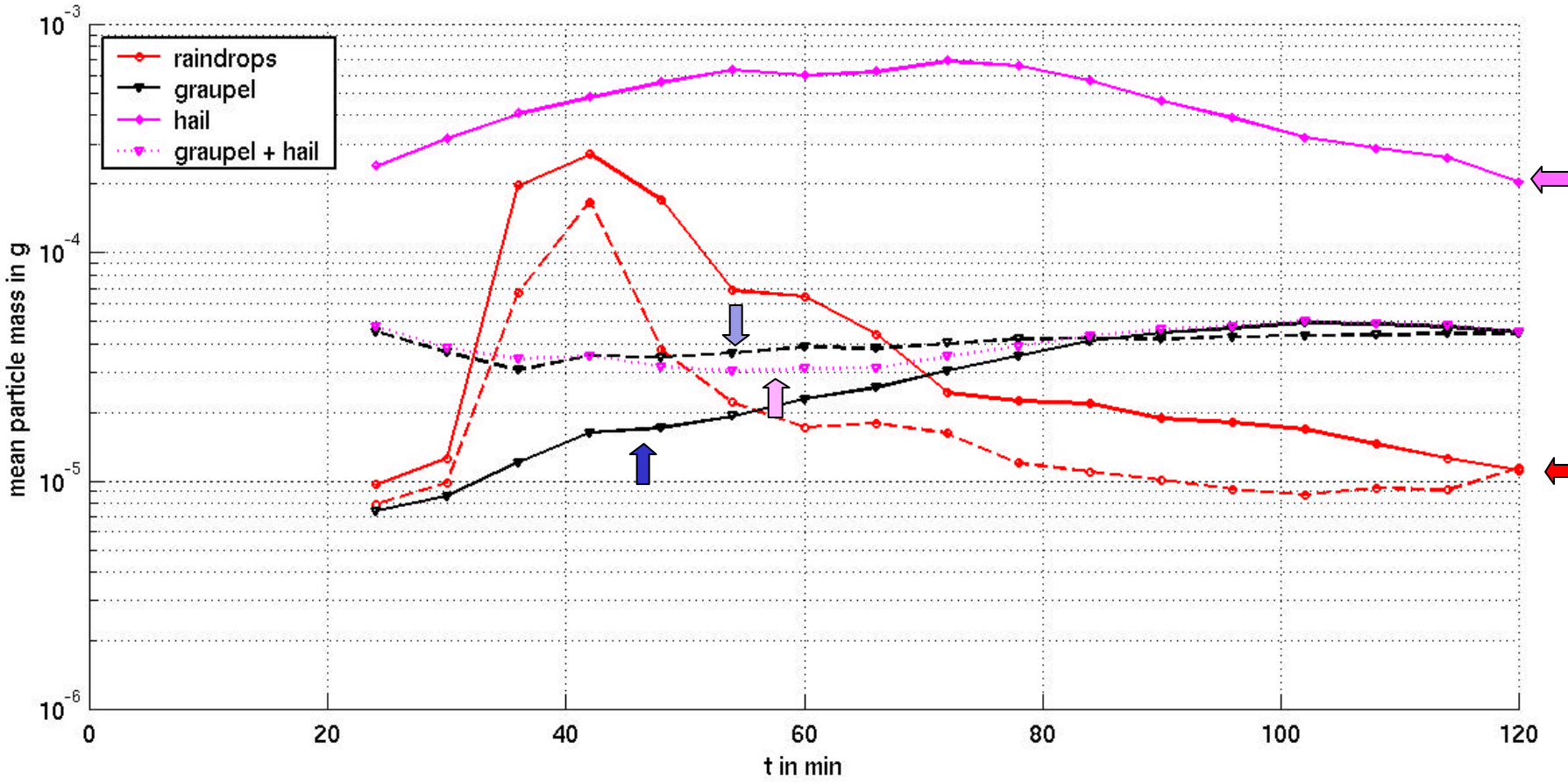




Results (case 2, continental)

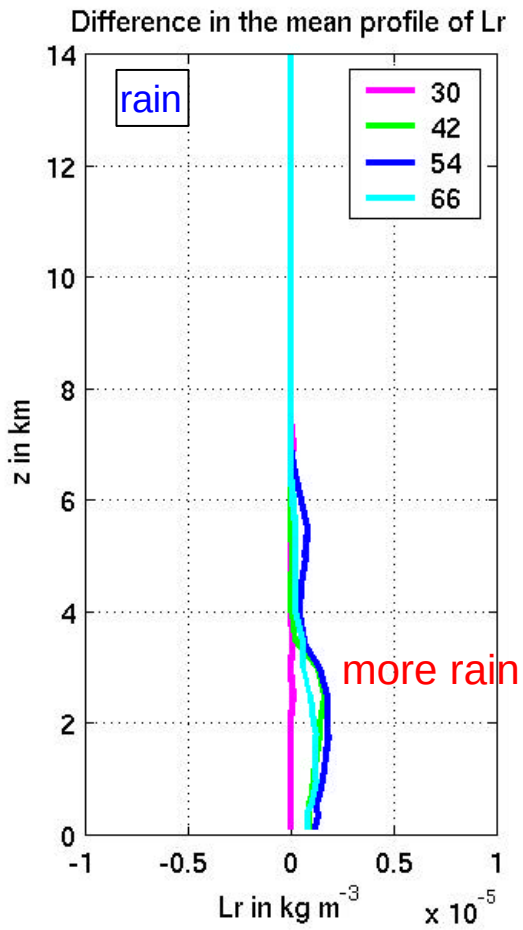
an particle mass

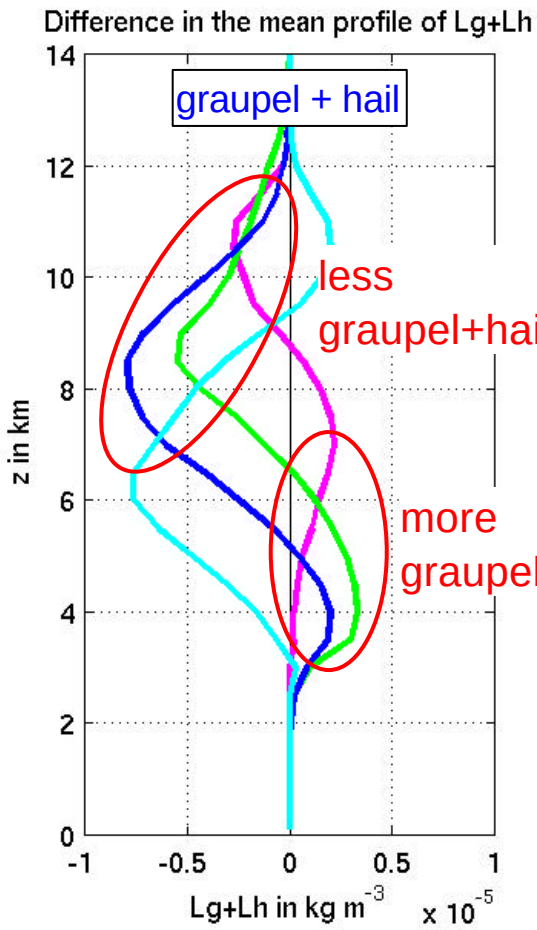
ned lines = run without “hail”

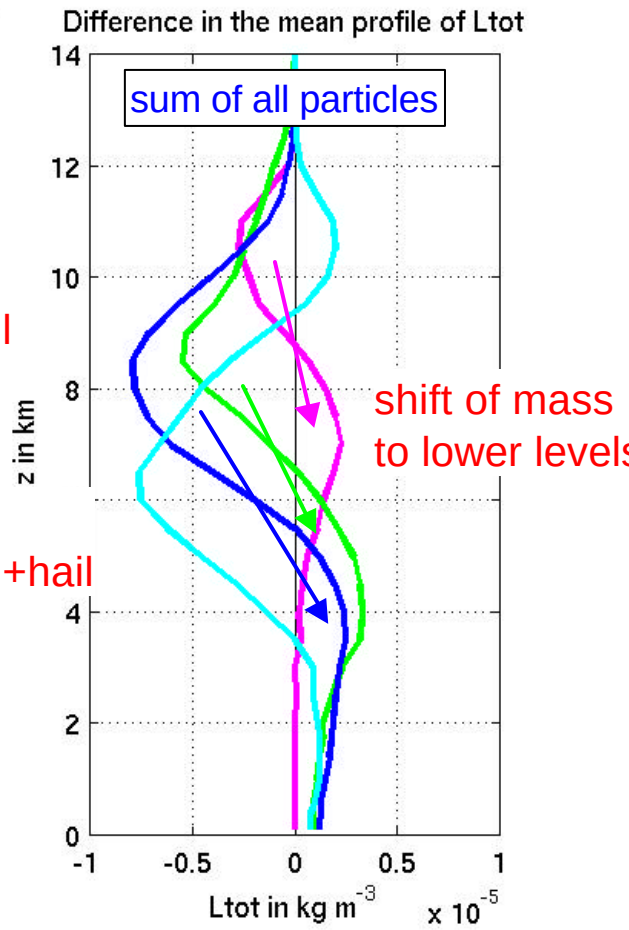


Results (case 2, continental)

profiles of **differences in mean mass density** at different times
(new scheme – old scheme)







mmary and Outlook

In the 2-moment microphysical scheme by Seifert and Beheng (2006) graupel category split up into two particle classes (graupel and 'hail')

- distinction between graupel by rimed ice particles (low density) and graupel by frozen raindrops (higher density)
- evolution of two graupel distributions which may combine to a bi-modal spectrum

Case studies showed that the additional particle class leads to

- larger raindrops
- a vertical redistribution of mass
- enhanced precipitation at ground

further studies will have to show

- in which cases these effects are strong / weak
- whether radar reflectivities obtained with the new scheme show a better argreement with observations