

A numerical study of the precipitation over the Cévennes' foothills under medium convective conditions

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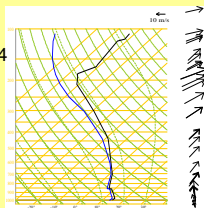
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Objective: analysis of the observational case
27/28 October 2004
Chapon et al. (2005)
 by means of numerical modeling with detailed microphysics

- with special emphasis on
- ◆ the role of the ice phase and
 - ◆ the role of atm. aerosol particles

Model setup and initialization

Nîmes sounding, 23h, 27 October 2004
 Set up : Model domain: 128x128x64 points with $\Delta x = \Delta y = 1$ km, $\Delta z = 250$ m time step $\Delta t = 4$ s



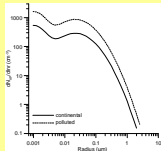
Model : DESCAM 3D

- Dynamics : Clark and Hall (1991)
 Microphysics : Detailed SCAvenging Model (Flossmann et al. 1985; Leroy et al., 2006)
- 3 number density distribution functions (aerosol particles, drops, ice crystals)
 - 2 mass density distribution functions of aerosol in drops and crystals

Microphysical processes : AP activation, heterogeneous and homogeneous nucleation, growth of droplets and ice crystals, coalescence, riming.

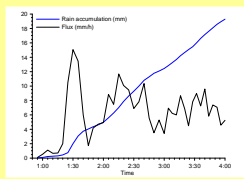
aerosol particle spectra:

- reference case: 1400 particles per cm^3
 polluted case: 4200 particles per cm^3



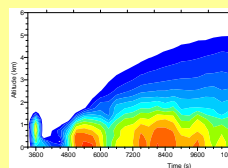
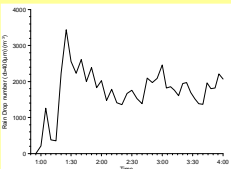
Model Results

- After 4 h of integration a precipitating cloud field forms with:
- a max. of 20 mm of rain
 - mean rain drop diameter of 1 mm
 - radar reflectivities up to 38 dBZ



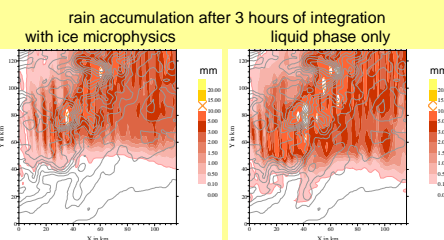
rain accumulation and rain flux
 start time of simulation: 0:00

the total number of rain drops compares very well with the observations of Chapon et al. (2005)

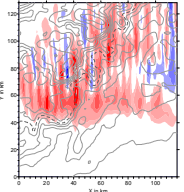


radar reflectivity compares with the observations after midnight (see above)

Influence of the ice phase



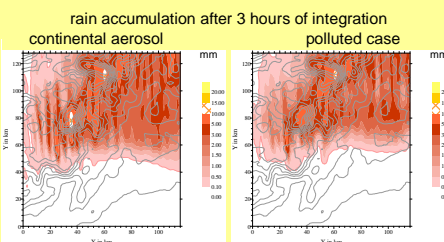
difference of rain in mm



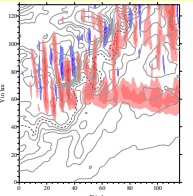
- the omission of the ice phase enhances rain formation
- the onset of rain takes places significantly earlier when ice phase processes are ignored
- the vertical extension of the cloud field is much higher when ice crystals are considered

- A few number of ice crystals in the upper cloud layers can persist as $RH > 100\%$, however, no drops are present as $RH < 100\%$. The ice crystals contribute to the rain formation by the so-called feeder/seeder mechanism.

Influence of the aerosol number

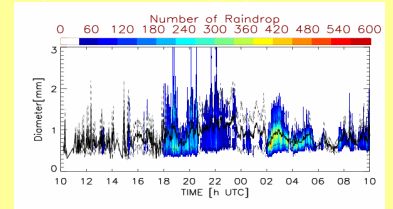


difference of rain in mm

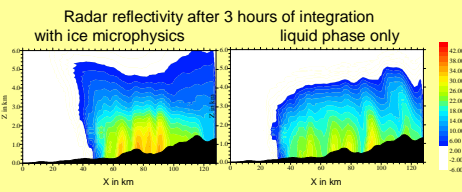
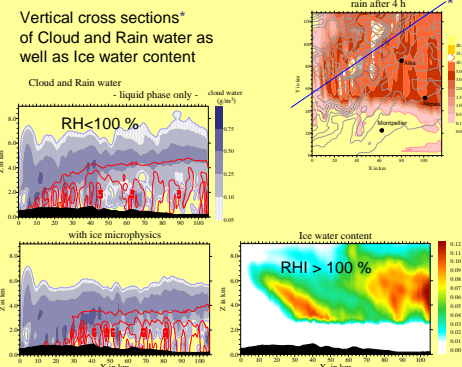


- the change of the number of aerosol particles modifies the intensity and the location of rain
- rain intensity slightly decreases in the polluted case and
- the rain on-set is delayed

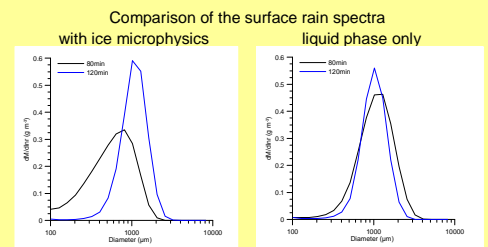
II) surface rain drop spectra at Alès



Influence of the ice phase

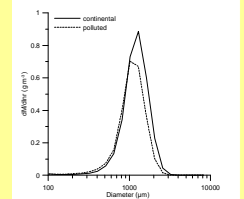


Rain drop spectra



- differences in number and size of the rain spectra only occur in the initial phase of the precipitating cloud field
- after 2 h of integration the surface spectra are quite similar in number and size

- Comparison of the rain spectra under continental and polluted number concentrations:
- the rain drop number concentration and drop sizes decrease in a polluted atmosphere



Preliminary Conclusions:

The microphysical model is able to reproduce reasonably well the cloud field and its precipitation for a medium convective situation over the Cévennes' foothills. Ice crystals are present in the levels above 3km. They are responsible for the weak reflectivities observed in the mid-tropospheric levels. The rain drop spectra show no changes due to the ice microphysics, however, the CCN number influences rain intensity and spectrum.

References :

Chapon, B., M. Gosset et G. Delrieu, 2005 : Lien entre la structure 3D des nuages et la granulométrie des pluies au sol. Cas du 27-28 Octobre 2004 à Alès. Poster présenté aux 5^{èmes} journées de l'OHM-CV. Grenoble.
 Clark, T. L. and W. D. Hall, 1991 : Multi-domain simulations of the time dependent Navier-Stokes equations : benchmark error analysis of some nesting procedure. *J. Comp. Phys.*, **92**, 456-481.
 Flossmann, A. I., W. D. Hall, and H. R. Pruppacher, 1985 : A theoretical study of the wet removal of atmospheric pollutants. Part I : The redistribution of aerosol particles captured through nucleations and impaction scavenging by growing cloud drops. *J. Atmos. Sci.*, **42**, 582-606.
 Leroy, D., W. Wobrock and A. I. Flossmann, 2006 : On the influence of the treatment of aerosol particles in different bin microphysical models : a comparison between two different schemes. *Submitted to Atm. Res.*