Moist Physics Response to the Modifications of the Initial Profile

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Motivation of the work

Radar data assimilation

reflectivity ⇨ *condensed water*

clouds and precipitation above a given level

\+ ***cloud top*** *(from satellite)*

The aim:

to get some knowledge about the physics response to the foreseen profile changes whithin radar data assimilation

Method

- **Use of 1D model**

  analysis of model results after 1 step integration

  - *variation of precipitation amount* -

- **Statistical approach**

  different profiles samples, extracted from the 3D ALADIN model

- **Modification setup**

  Modification of specific humidity, temperature and humidity convergence

  For layers of different depth

  * at the top of the cloud
  * for the low troposphere

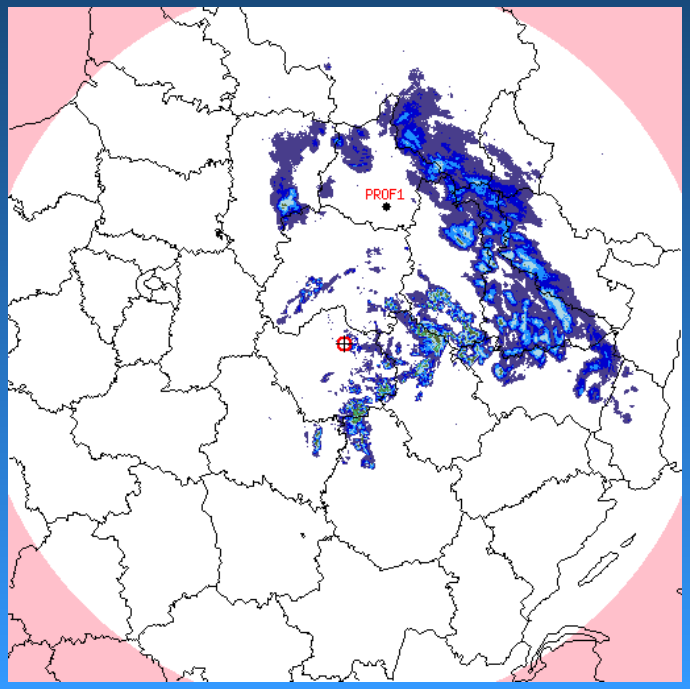
Tacking into account the characteristics of condensation schemes in ARPEGE/ALADIN model

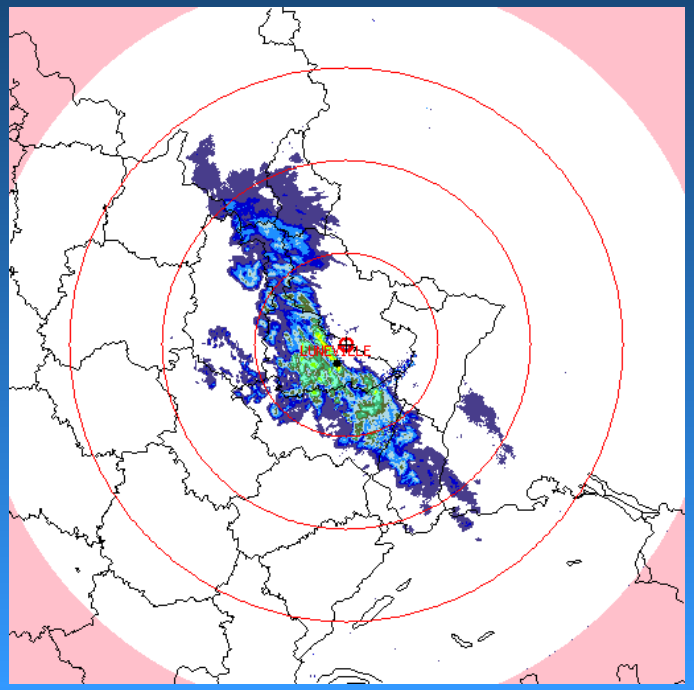
- no prognostic equation for condensed water

- elimination of over-saturation in 1 step

Troyes

64 profiles
mainly stratiform



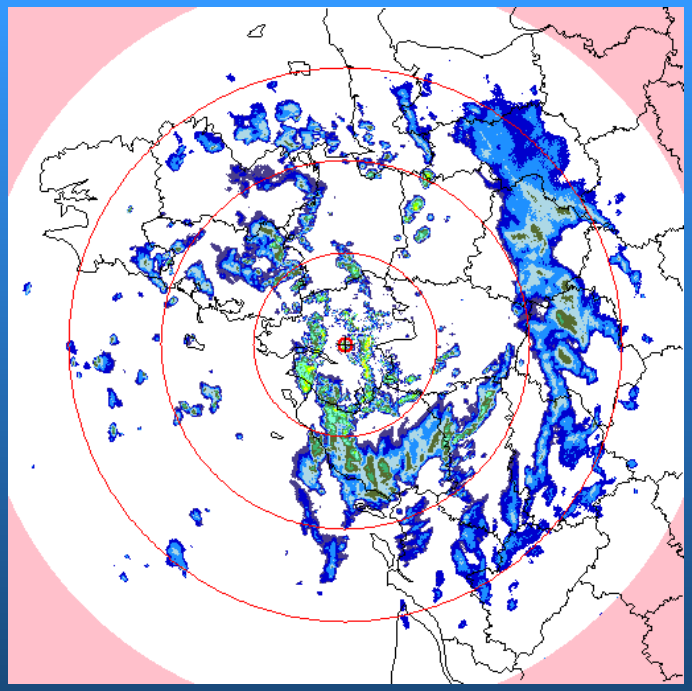


Nancy

186 profiles
stratiform & convective

Nantes

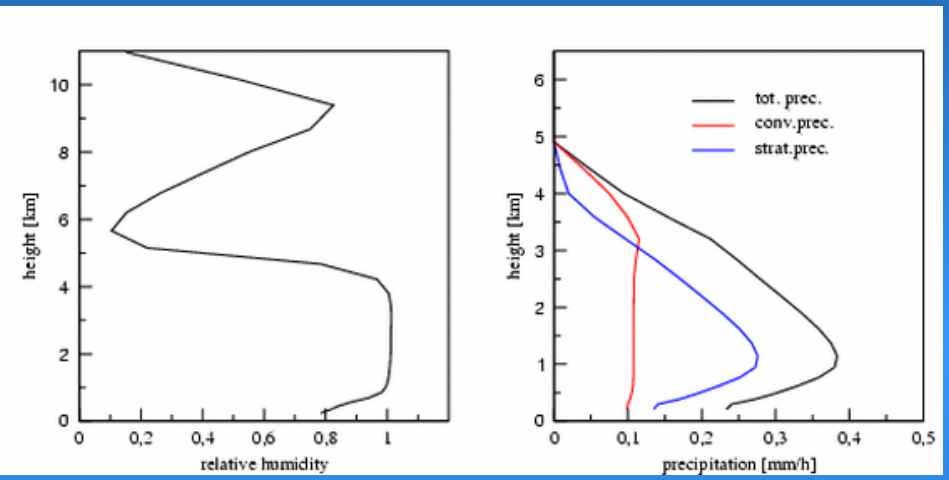
190 profiles
mainly convective



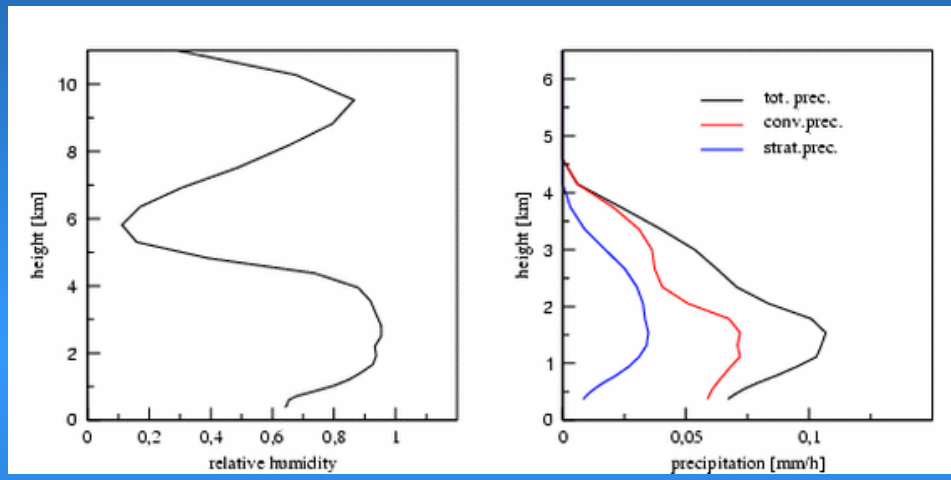
Mean Profile

Average over the 1D profiles after 1 step integration

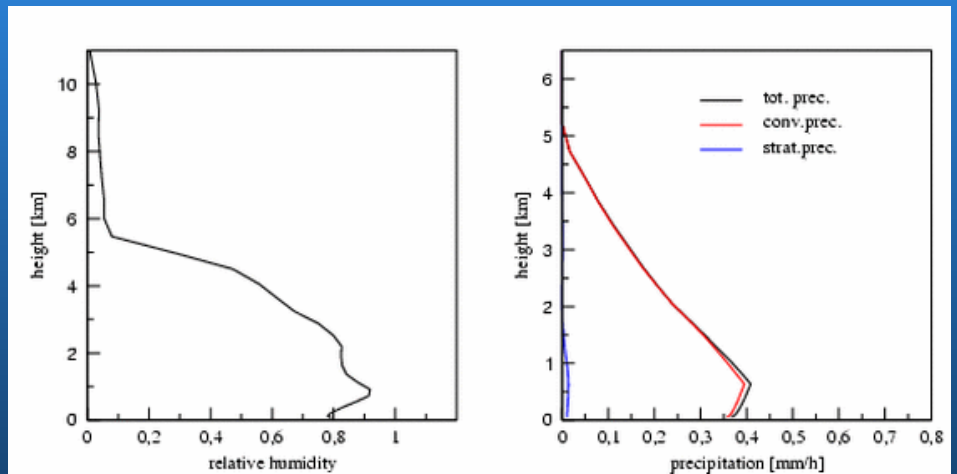
Troyes *(stratiform)*



Nancy *(stratiform & convective)*



Nantes *(convective)*



Modification Qv – series 1

each Qv profile was modified by adding a constant value

between -0.5 and +0.5 g/kg

- for different layer depths of 1000, 2000, 3000,4000,5000 m
- for different position of the modified layer between 500 and 7500 m

Constraint:
- minimum value of Qv = 1.E-15

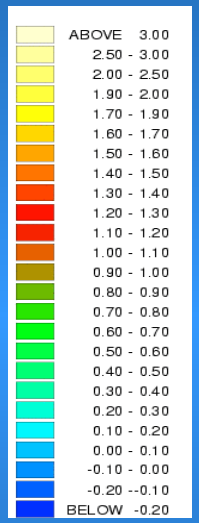
for each profile 1 step integration

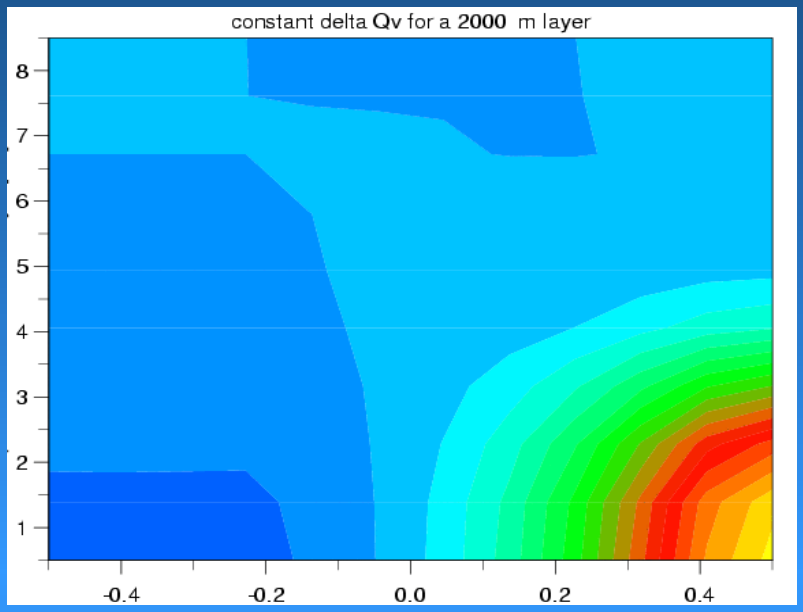
- starting from the corespondent modified profile
- output compared with the reference run

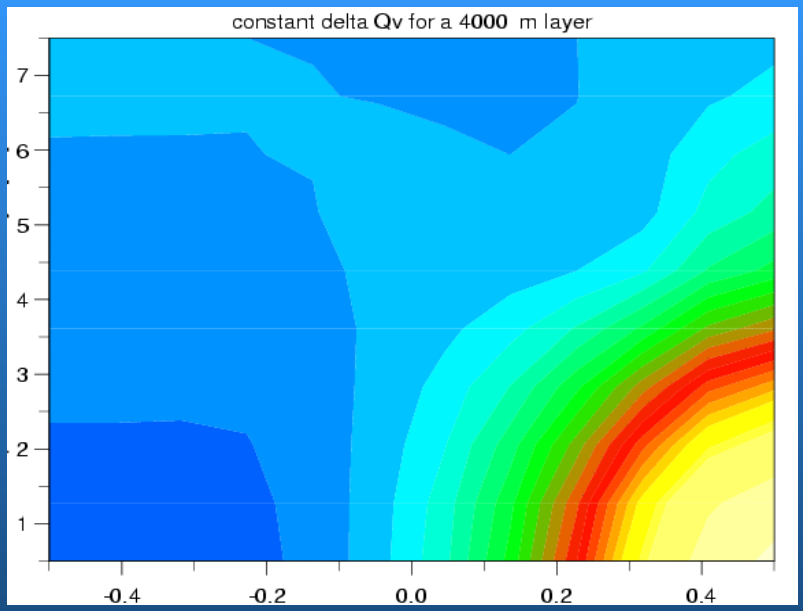
Modif.1 Qv

- stratiform sample-

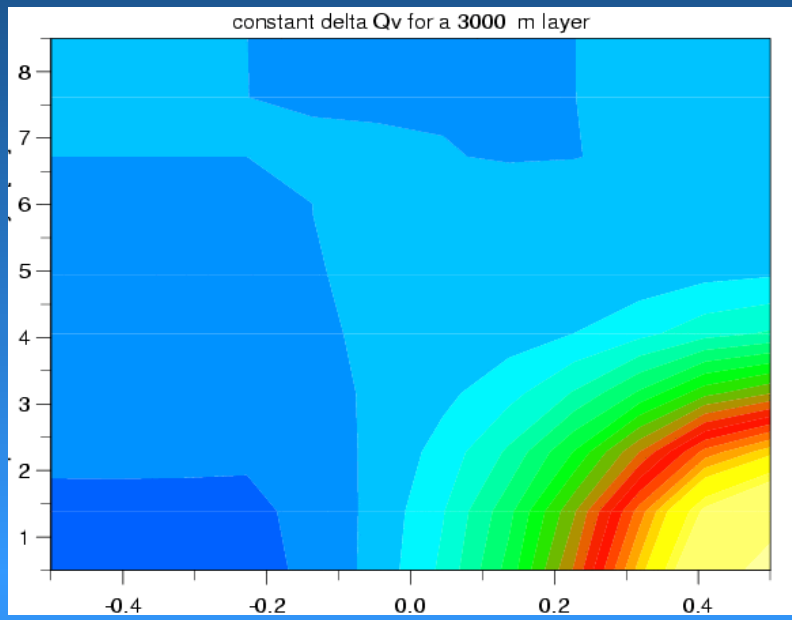
Variation of the surface precipitation [mm/hour] : mod - ref

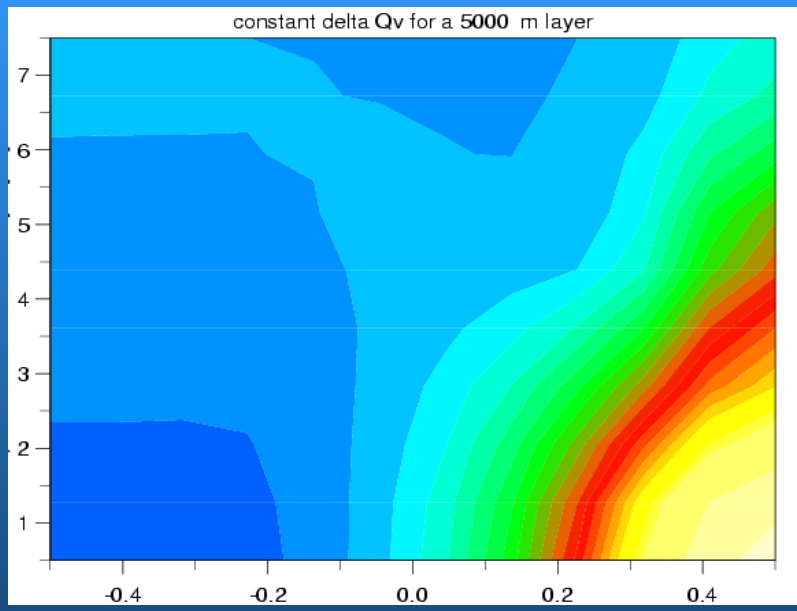






position of modified layer [km]





Delta Qv [g/kg]

Delta Qv [g/kg]

Modification Qv– series 2

each Qv profile was modified by setting the specific humidity to:

Qsat*Coef (1.02)

- for different layer depths of 1000, 2000, 3000,4000,5000, 6000 m
- the modified layer is applied at the cloud top

Definition of the cloud:
- if there is stratiform precipitation:
cloud bottom: the maximum precipitation level
cloud top: the level where the precipitation = 0 (upward)
- if there is not stratiform precipitation:
cloud bottom = cloud top = level of maximum relative humidity

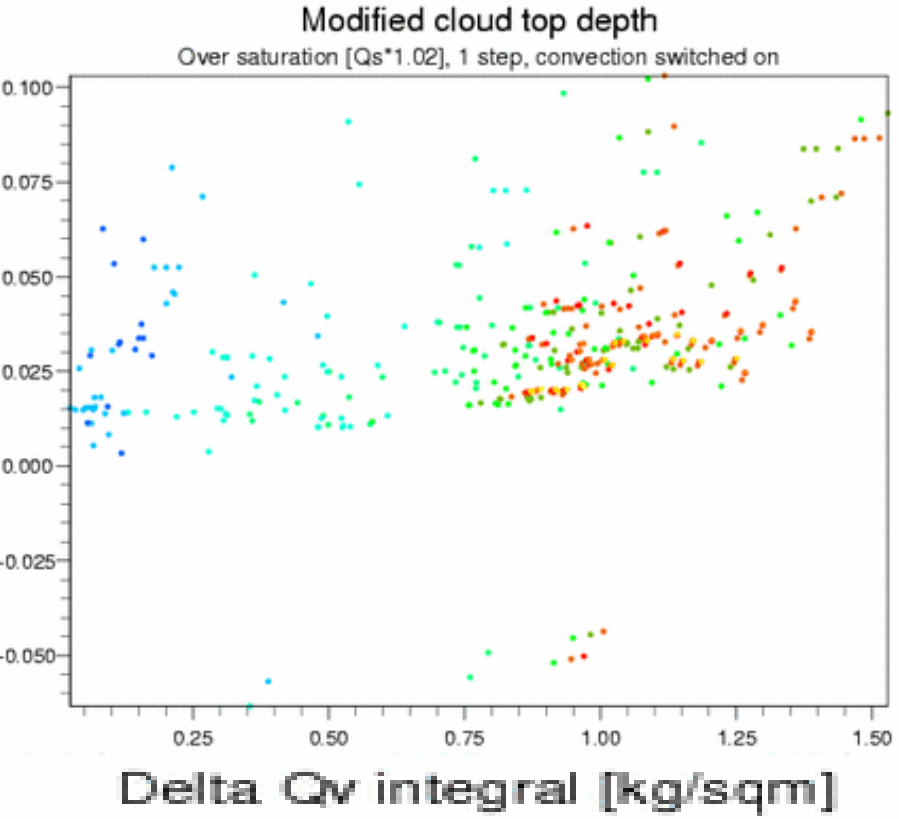
for each profile 1 step integration
- starting from the corespondent modified profile
- output compared with the reference run

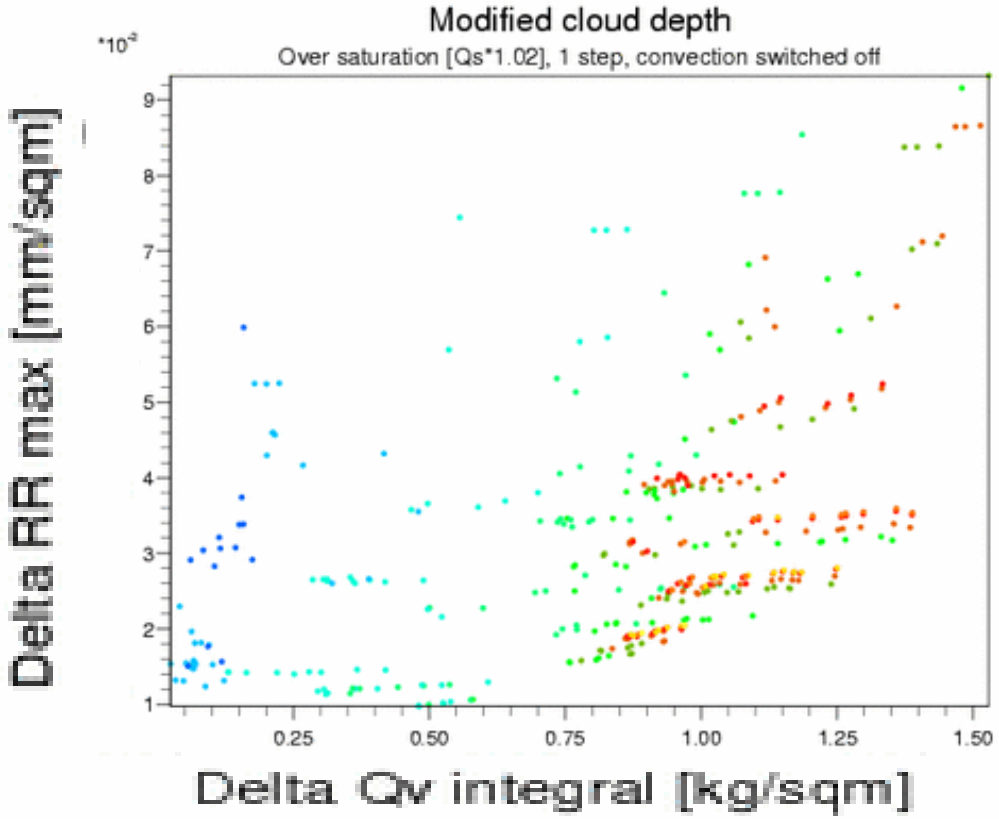
Modif.2 Qv

- stratiform sample-

Variation of the maximum precipitation: mod - ref

*Qv=1.02*Qsat*





Delta RR max [mm/sqm]

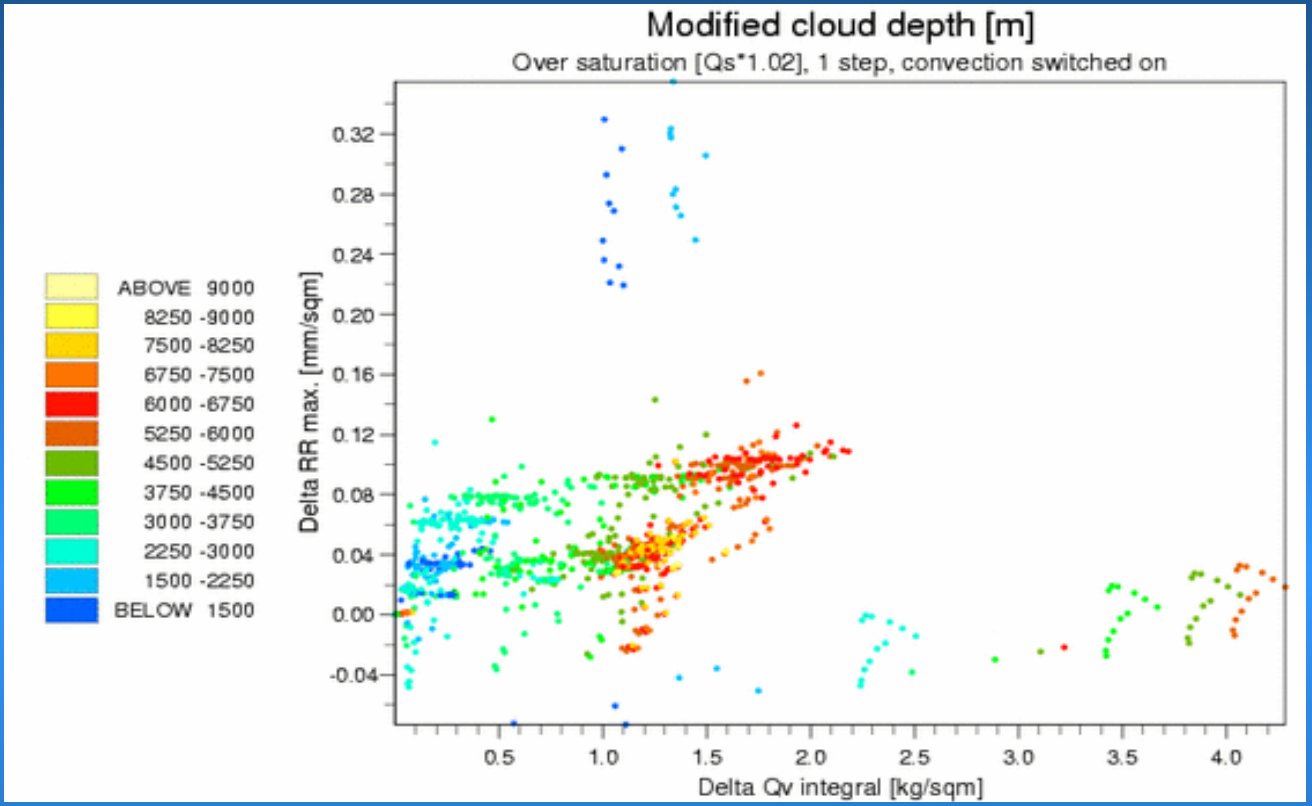
Convection scheme switched on

Convection scheme switched off

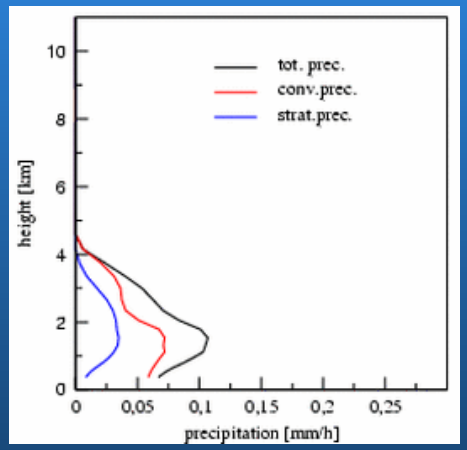
Modif.2 Qv

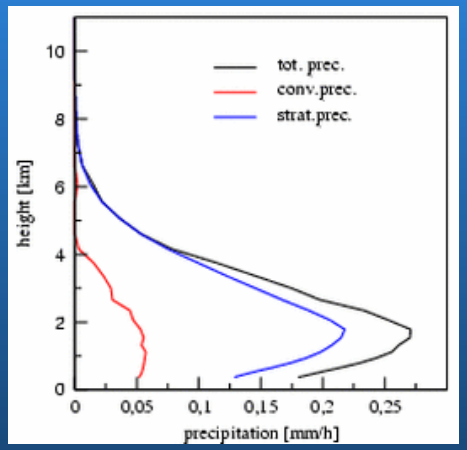
- *stratiform & convective sample*-

Variation of the maximum precipitation



ref



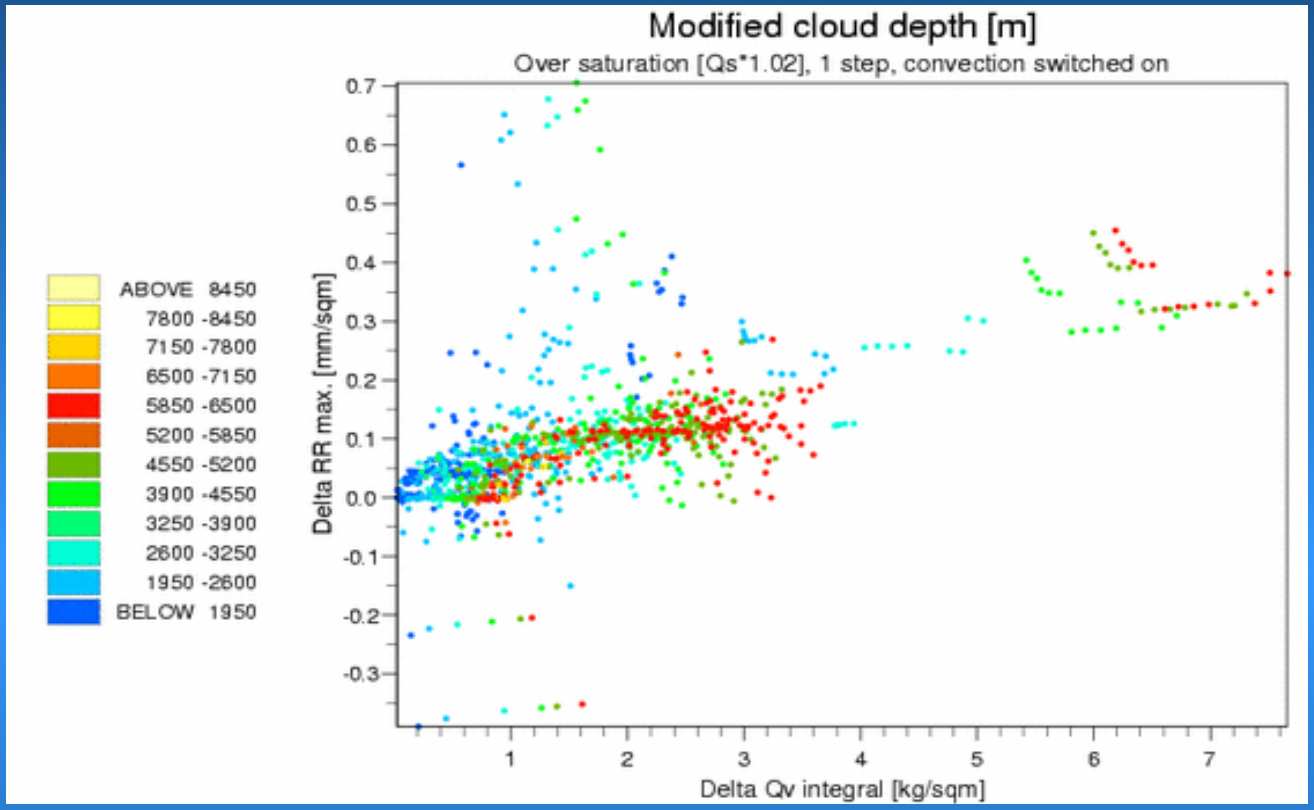


mod

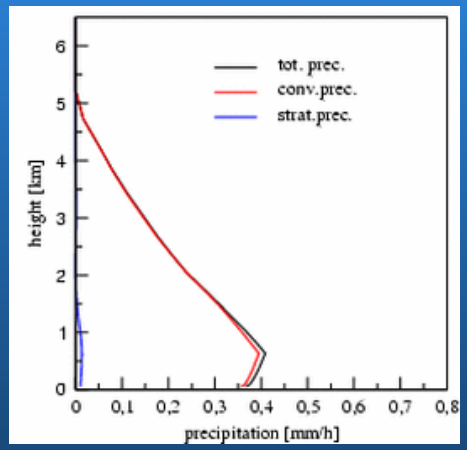
Modif.2 Qv

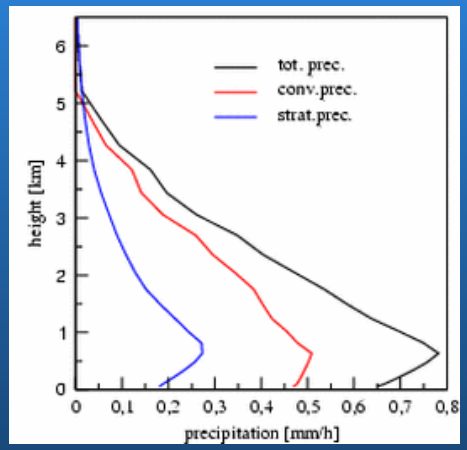
- convective sample-

Variation of the maximum precipitation: mod -ref



ref





mod

Modification of the temperature

each profile was modified by adding to the temperature a constant value: 1.5 K

- for different layer depths of 50 100, 200, ….1000 m

- the modified layer is applied at the surface

=> CAPE increase

Definition of the convective cloud:

- if there is convective precipitation:

cloud bottom: the maximum precipitation level

cloud top: the level where the precipitation = 0 (upward)

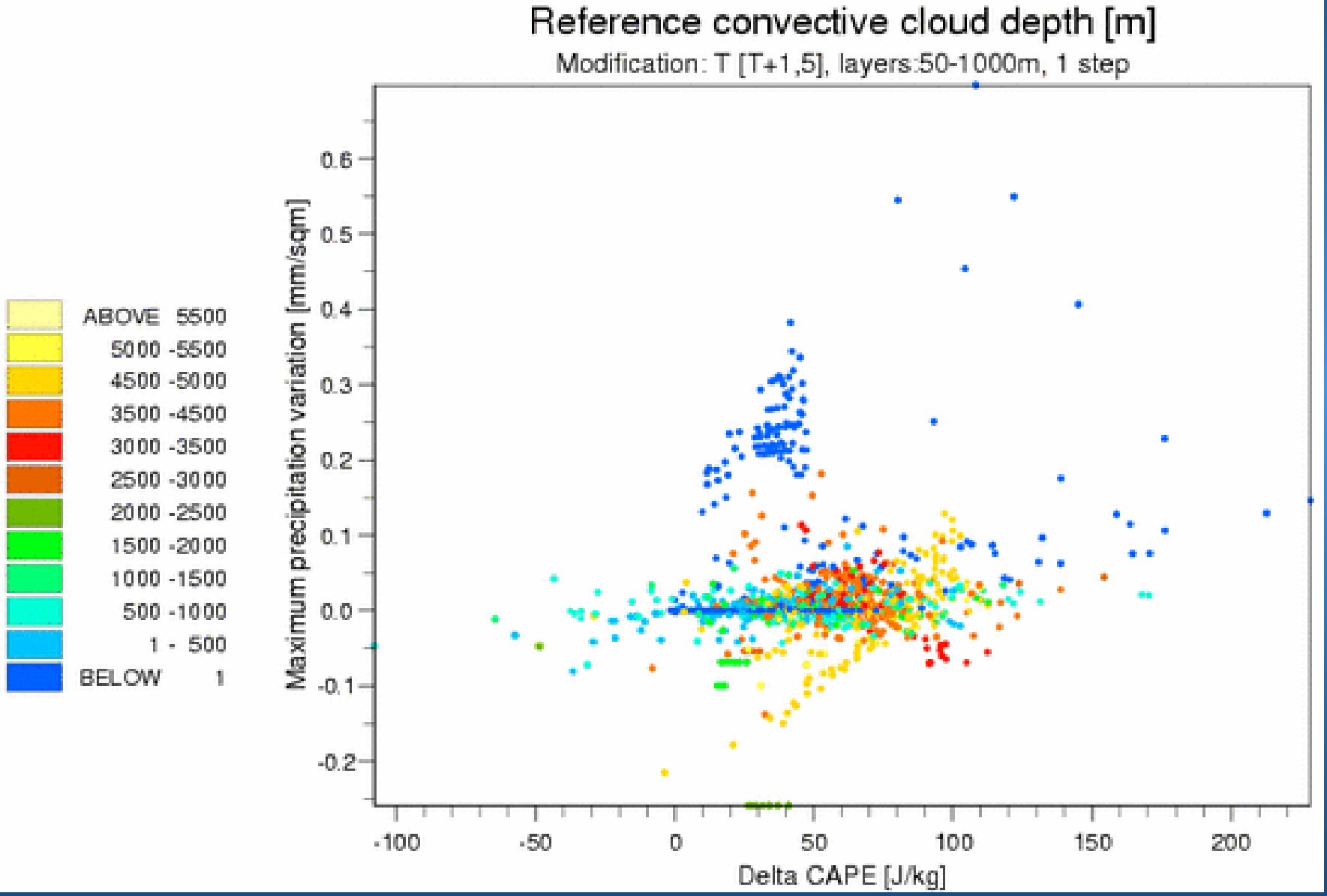
For each profile 1 step integration

- starting from the corespondent modified profile
- output compared with the reference run

Temperature modification

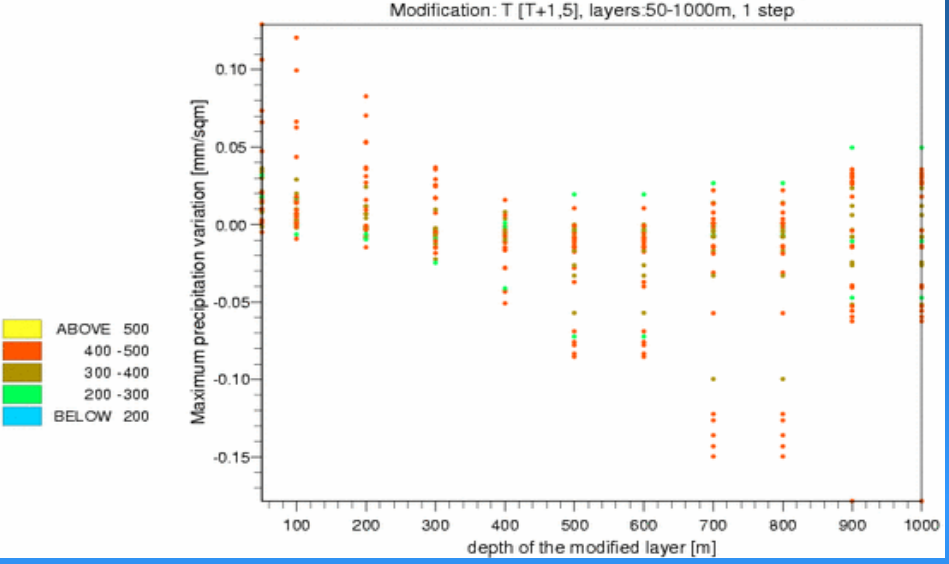
- convective sample-

Variation of the maximum precipitation

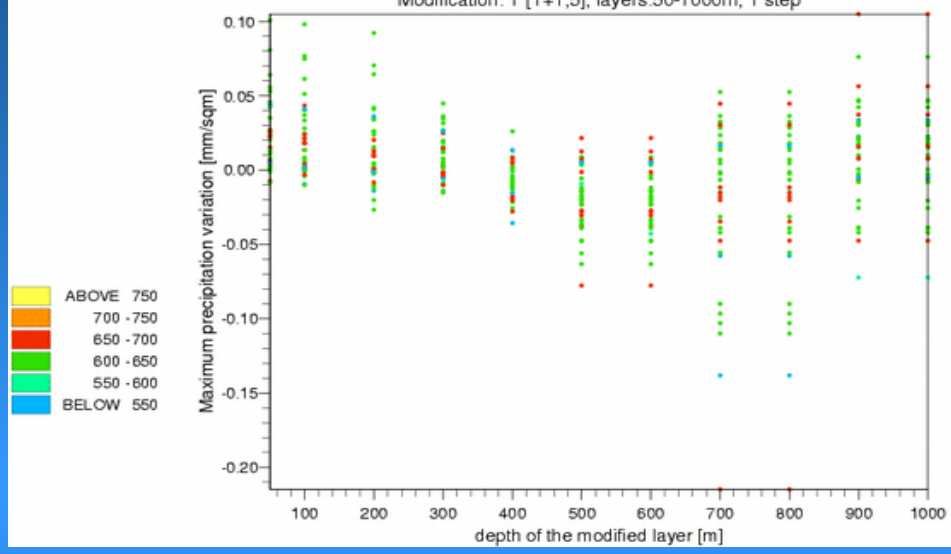


Dependency of precipitation variation on the modified layer depth

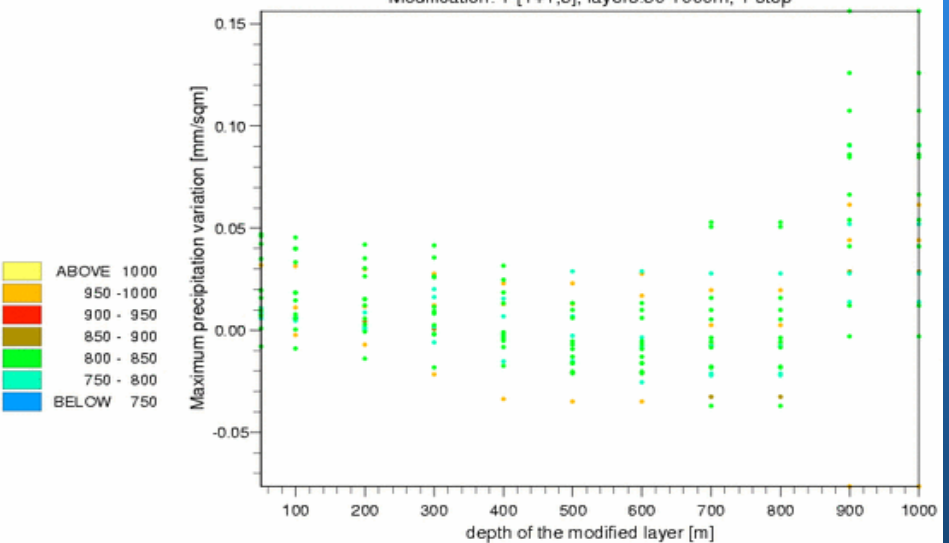
Base < 500m



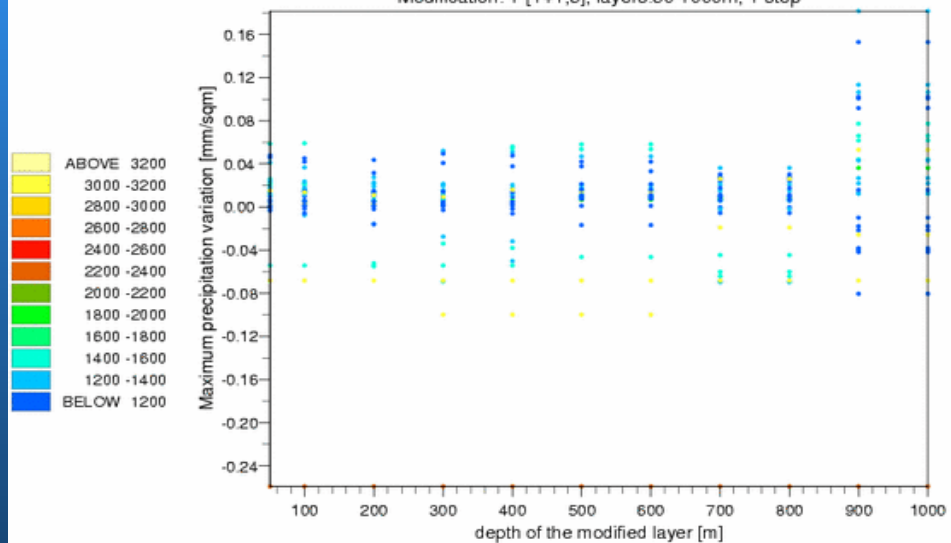
Base: 500-750 m



Base: 750 -1000m



Base > 1000m



Modification of the humidity convergence

each profile the humidity convergence was set up to 1.5 of the initial value

- for different layer depths of 200, …2000 m

- the modified layer is applied at the surface

Definition of the convective cloud:

- if there is convective precipitation:

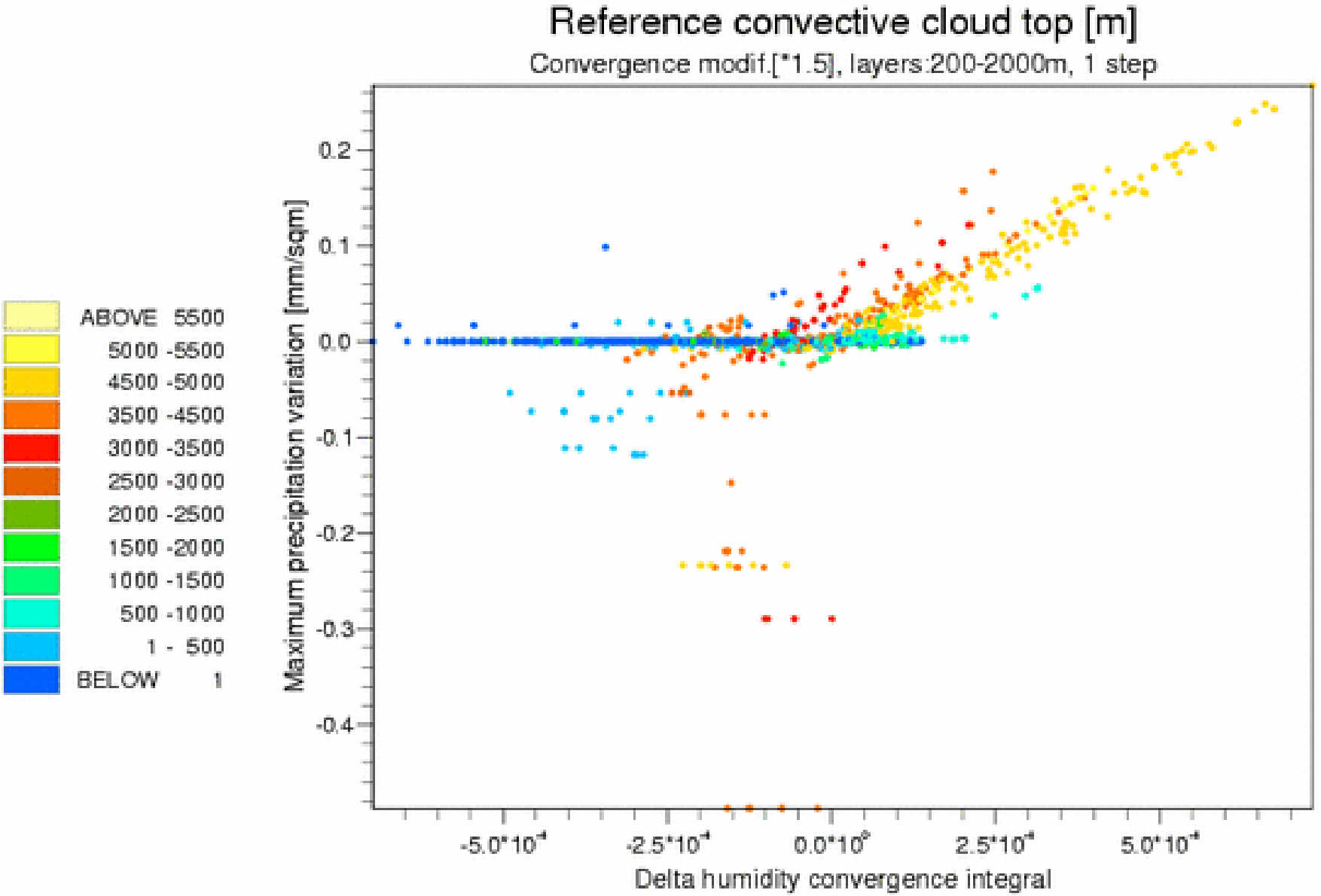
cloud bottom: the maximum precipitation level

cloud top: the level where the prcipitation = 0 (upward)

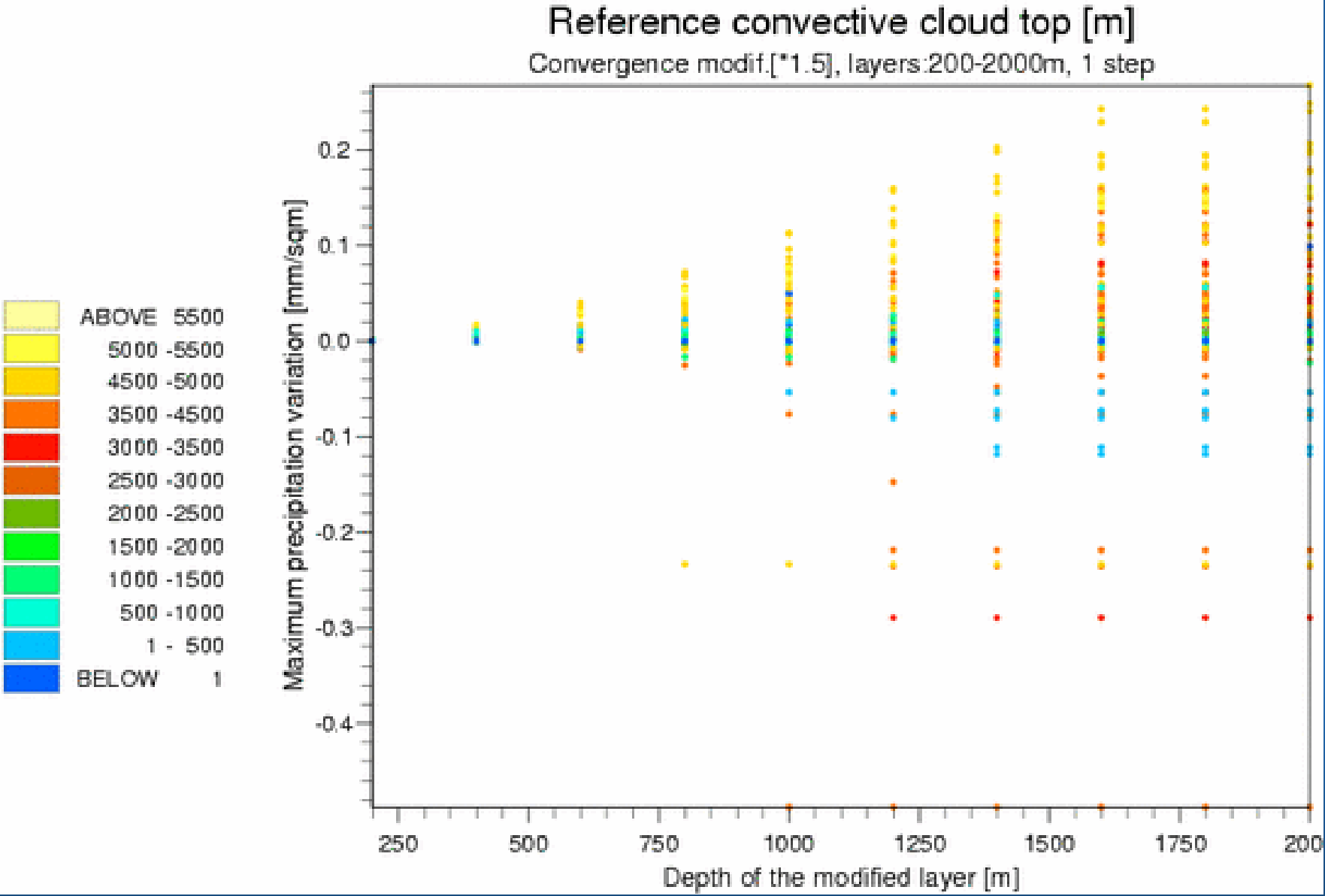
For each profile 1 step integration

- starting from the corespondent modified profile
- output compared with the reference run

Variation of the maximum precipitation on the Δ Qv conv. integral



Variation of the maximum precipitation



Conclusion

- The moist physics is sensitive to the initial profile modifications of:
  - specific humidity
  - temperature
  - humidity convergence

  …….**nothing new ….**

  The problem is the possibility of controling the response to the modification

- The control degree depends mainly on the profile type convective ⇔ stratiform

Conclusion

- **Resolved (stratiform) precipitation can be (relatively) easily modified**
  in a controlled manner, by modifying the specific humidity around the saturation value
  - The relation between:
    amount of vapour added/substracted & variation of precipitation amount depend on:
    - the profile type (mainly stratiform or convective or mixed)
    - the departure from the saturation
    - the cloud depth
- **It is more complicated to modify the model unresolved (convective) precipitation**
  (by modifying temperature and humidity convergence) in a controlled manner

  More information are necessary !!

  about
  - the humidity convergence profile
  - the level where convection is triggered