New tuning of 3MT

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Motivation

- Correction of several bugs (mainly in downdraft; fall 2010);
- Various small improvements (2010-2011);
- Discovery of some weaknesses (numerics, formulations – 2010, 2012)
- Increase of resolution, both in vertical and horizontal (2010)
- Introduction of cloud water sedimentation (2012)

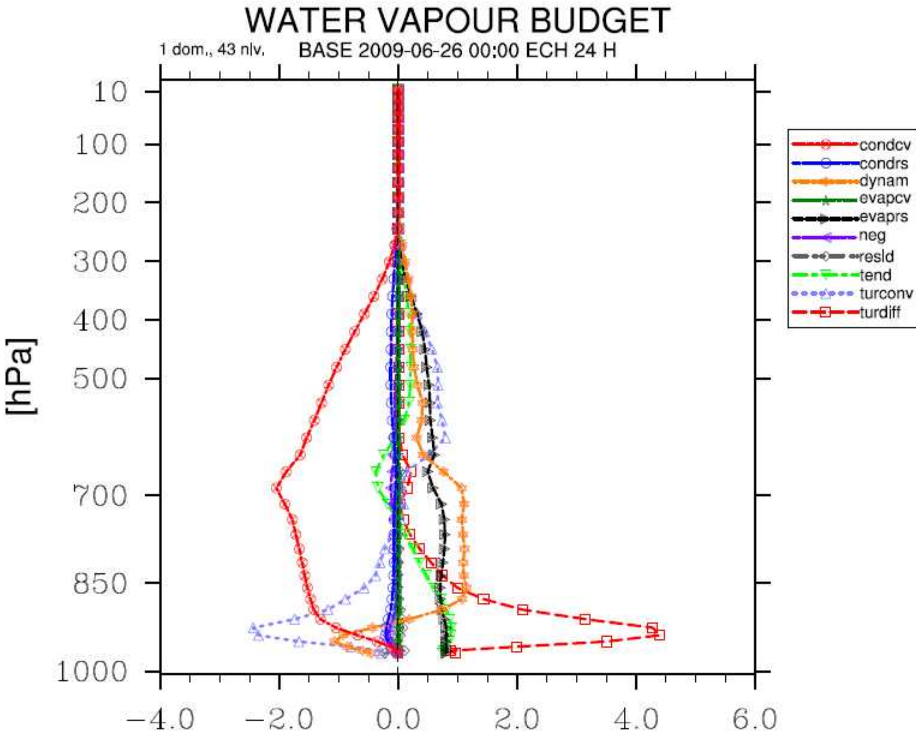
Corrections

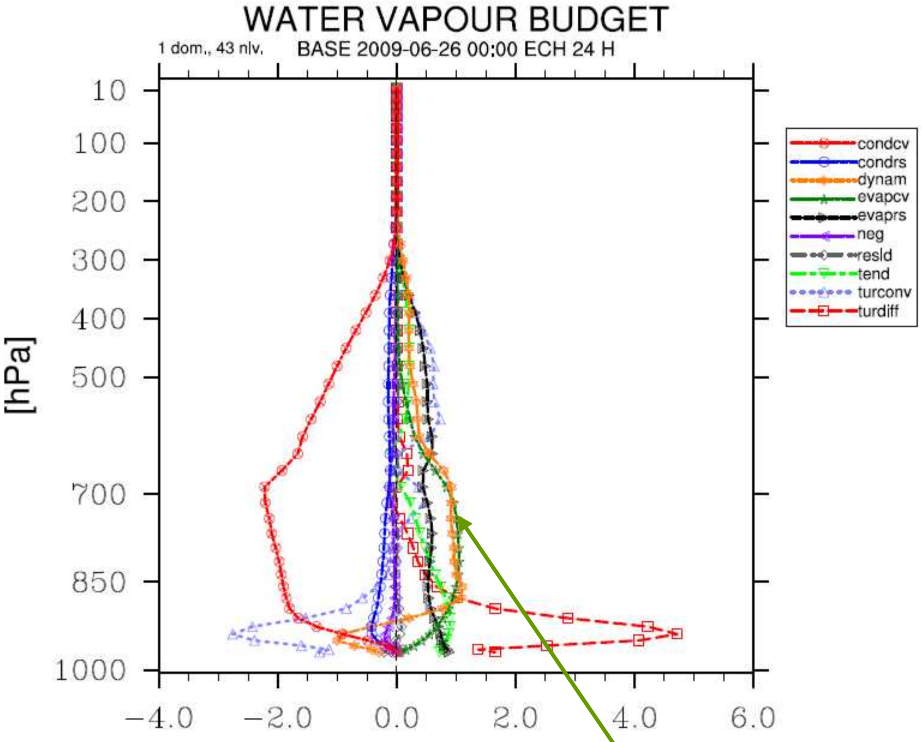
- Downdraft (ACMODO, ACUPD):
  - several small bugs corrected, without much impact on results;
  - Important bug: wrong time scaling of one term in closure - it was almost suppressing downdrafts' impact.

Previously downdraft efficiency coefficient was set to GDDEVF=0.5, for compensating too weak activity, now GDDEVF=0.12

- Small phasing bugs in ACCVUD.

Influence of downdraft correction





Before correction there is almost no convective evaporation, GDDEVF=0.5

Quite some evaporation, even with much lower value of GDDEVF (.18 in this exp.)

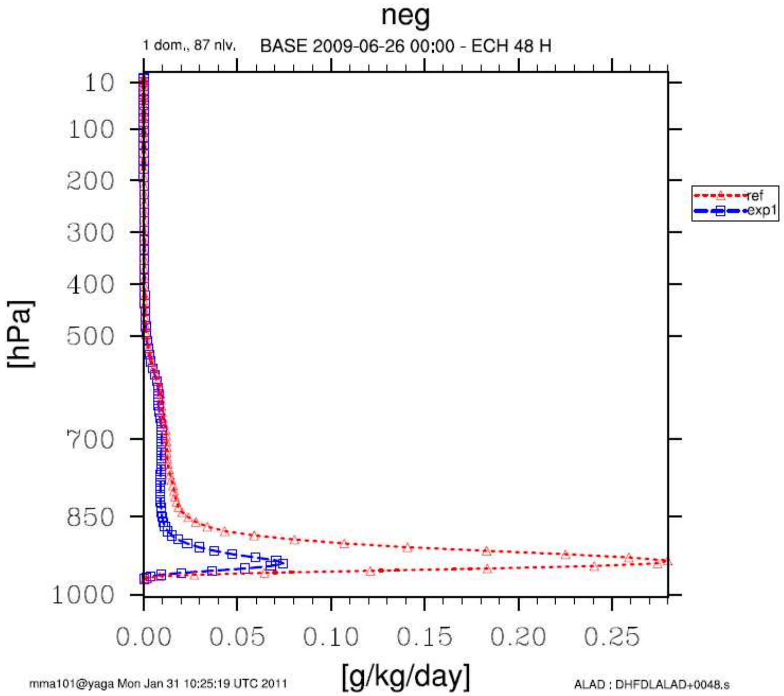
Small improvements

- Detrained part of convective cloudiness, GFL variable YUNEBH (PUNEBH in APLPAR), is now advected; => more consistency, impact is small;
- New aerosols (LRSTAER=.F. ! Standard – old – aerosols, and activation of new 4 types LAERODES, LAEROLAN, LAEROSEA, LAEROSOO) => small impact on temperature in low troposphere due to more absorption ;

Correction of algorithms (1)

- ACCVUD (updraft)
  - Too much negative cloud water detected.
  - Chosen cure:

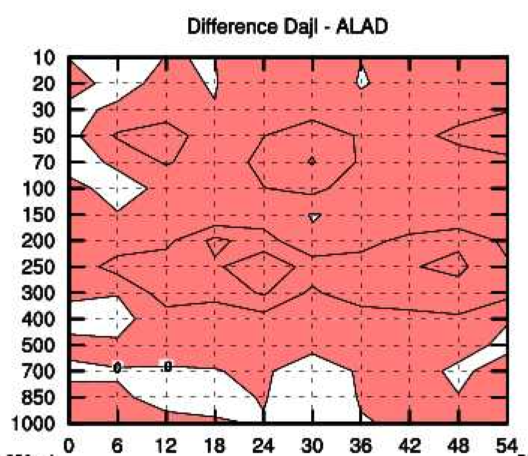
no convective cloud water (in the approximation of ascent computation) can exist below lifting condensation level; etc.

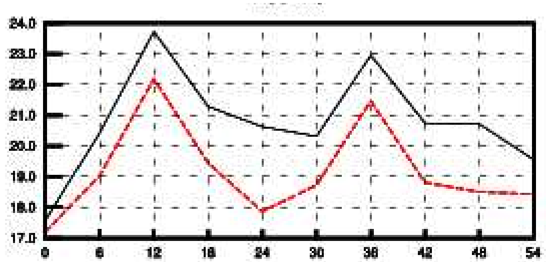


Red – original formulation,
Blue – corrected one

Correction of algorithms (2)

- APLMPHYS (microphysics)
  - Correction of 4-delta eta noise problem (see the presentation on microphysics);
  - Correction of pseudo-graupel falling speed (new);
  - Introduction of cloud water sedimentation (new) => improved bias of humidity at high atmosphere.





250 hPa

Red – test with cloud water sedimentation

Change of resolution (1)

- Vertical from 43 to 87 levels:
  - Cloudiness for radiation (Xu-Randall, LQXRTGH): due to finer vertical mesh, it is easier to reach the threshold for getting clouds, even if the water vapor content is the same:

QXRTGH moves from 3.5 (43 levels) to 1.6 (87 levels)

  - Attention put also to the thermodynamic adjustment (condensation and cloudiness at grid-scale, used for prognostic microphysics).

Change of resolution (2)

- Horizontal from 9km to 4.7 km:
  - In the first configuration, model was too warm at the surface; it was especially seen for the warm night minima;
  - There was not enough rain; especially in the late afternoon and first half of the night
  - First trial to cure this (operational in 2011):
    - Less entrainment (to enhance subgrid-scale convection work – GCVALFA pushed to 5.E-05)
    - More downdraft evaporation – GDDEVF put around 0.2)

=> Some improvement in scores but very bad for precipitation (spread, not enough strong maxima, too low amounts)

Change of resolution (3)

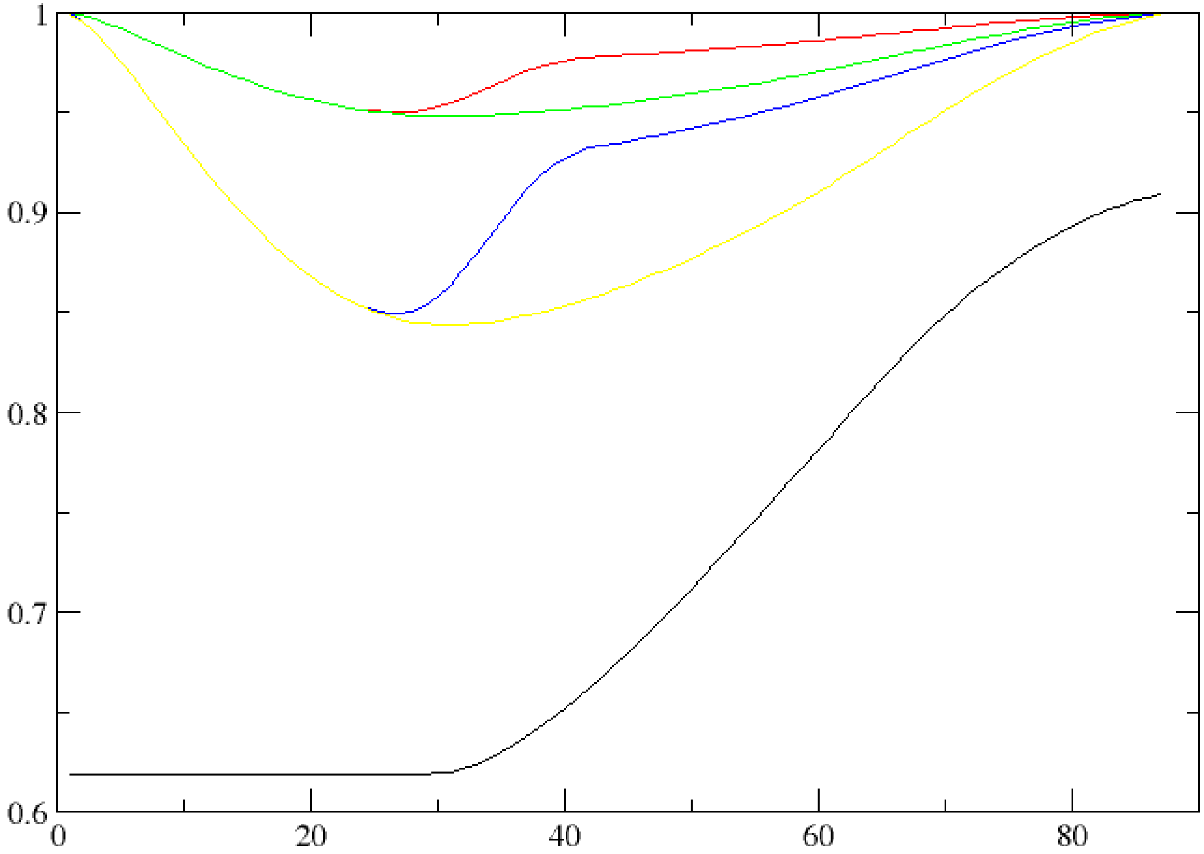
- A study was done to understand better the feedbacks, together with the exercise “3MT in ARPEGE”;
- Crucial role of mesh-size dependency of the relative critical humidity RHCRIT used in the thermodynamic adjustment was detected.
  - RHCRIT is one of key ingredients of most of the cloud schemes currently in use;
  - By the concept definition, RHCRIT is mesh dependent.

Change of resolution (4)

- In the past for radiation cloudiness, vertical profile of RHCRIT was set to fit observations (Thomas Haiden; LHUCN, HUTIL1, HUTIL2, HUCOE) – we do not need to change it;
- Horizontal mesh dependency first taken from ARPEGE; then more tuning parameters added (HUCRED and characteristic length scales for rain and snow – SCLESPR, SCLESPS).
- It was found that at 4.7km mesh size the RHCRIT approached too fast to 1

=> not enough condensation; higher values of QV play feed-back in radiation.

Examples of RHCRIT profiles

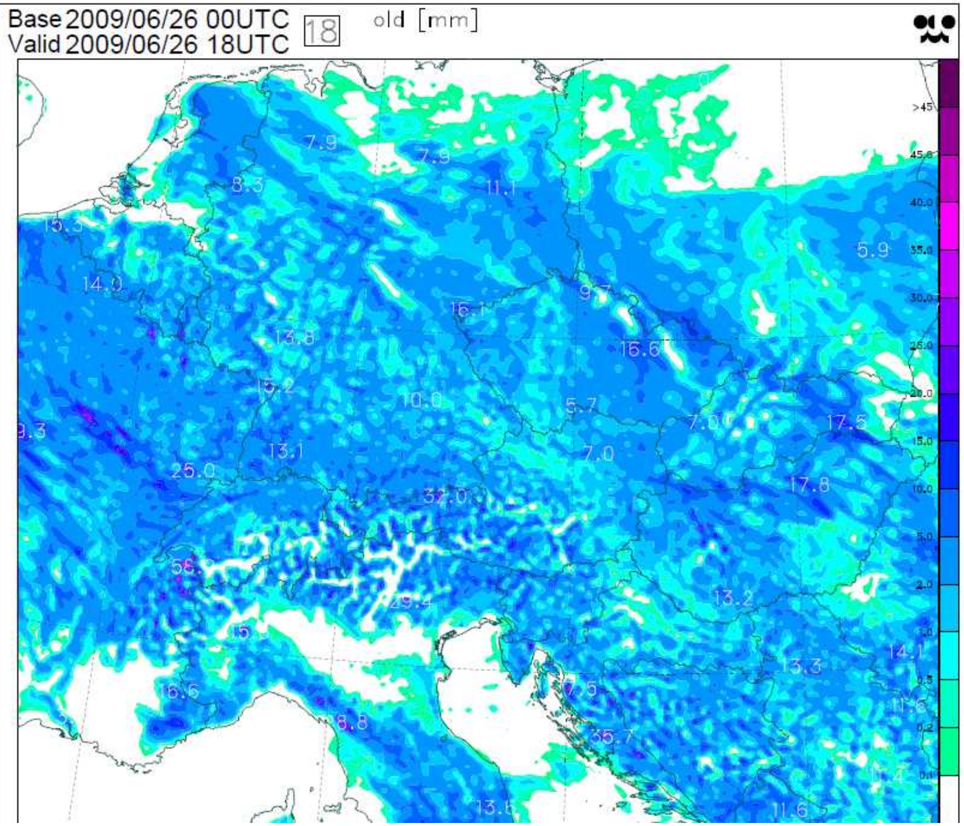


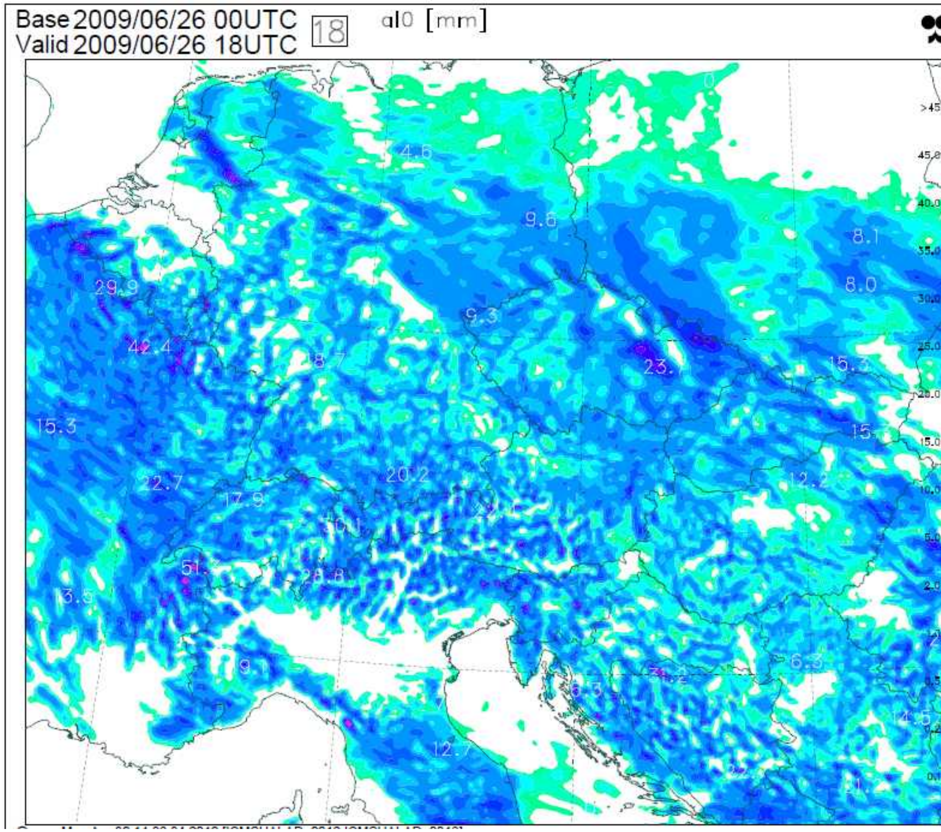
Black – Smith scheme (just for illustration, quite different distribution)
Green and red: Xu-Randall scheme with HUCRED=0.33, various ratios of snow and rain length scales;
Yellow and blue: Xu-Randall scheme with HUCRED=1. and same ratios of length scales.

Change of resolution (5)

- Another discovery:
  - Combination of less entrainment and more downdraft lead to a very bad precipitation structure.
- New tuning proposal, together with change in RHCRIT horizontal mesh dependency formulae:
  - HUCRED=1.
  - SCLEPSR= 34000., (dependency in power 0.6 of mesh-size)
  - SCLESPS= 8500., (dependency in power 0.6 of mesh-size)
  - GCVALFA=3.E-05,
  - GDDEVF=0.12

Influence on precipitation





old tuning of convection – bad for afternoon

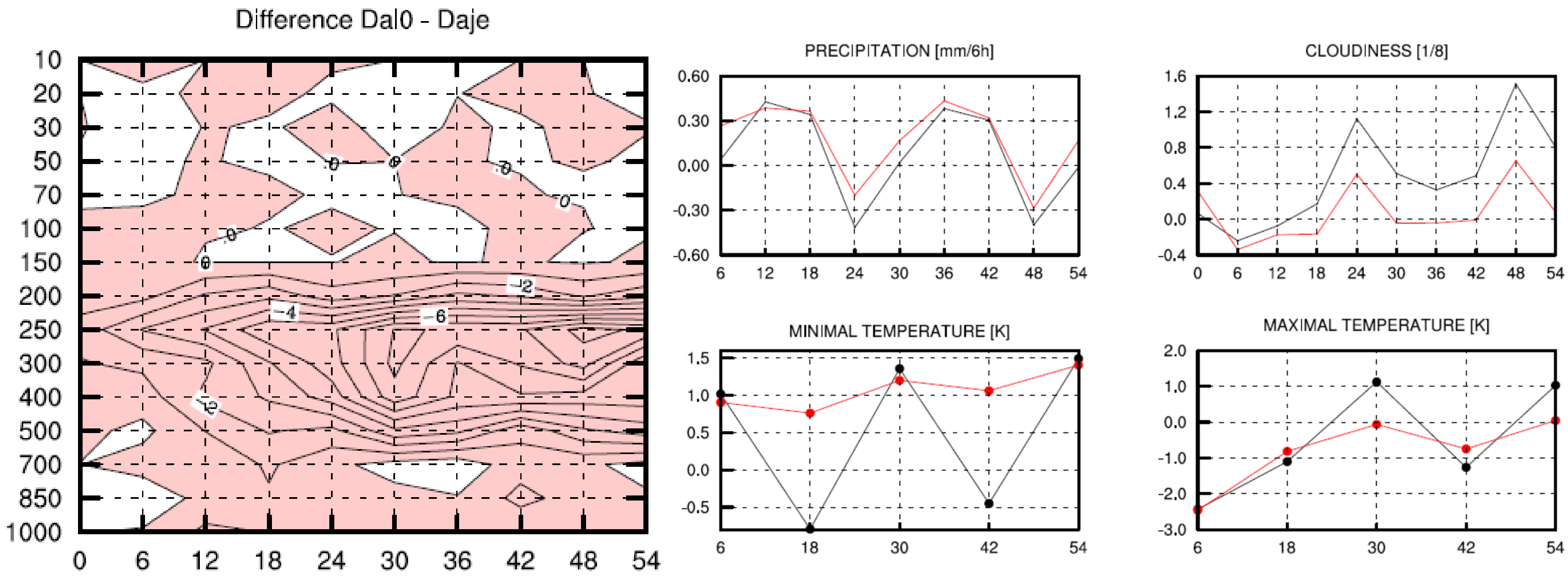
new tuning of convection – sharper structures

Miscellaneous

- Retuning of Wegener-Bergeron-Findeisen (because of mixed-phase precipitation at quite negative temperatures):

  RWBF1=1600.,
- Changed repartition of liquid and ice cloud water in ACCDEV (owing to sedimentation of cloud water, with different speeds for liquid and ice);
- Convective condensation not allowed anymore below lifting condensation level.

New and old version at 4.7km in terms of scores



RH RMSE scores => corresponds to precipitations; SURFACE => less bias in night precipitation, temperature minima, maxima and cloudiness.

Conclusion

- Better scale dependency of thermodynamic adjustment proposed (before something better is found – COST ES 0905 action);
- Return on convection tuning (similar to former 9km version);
- Changing both vertical and horizontal resolution at the same time is a risky step (!)