Report
ARSO, Ljubljana
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Validation of new prognostic ACPLUIE scheme

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1. Introduction

A new prognostic precipitation scheme ACPLUIE_PROG was developed. The routine includes prognostic cloud and precipitation condensates and allows pseudo fluxes between water vapor and four condensed species. Furthermore, the processes of accumulation, collection and evaporation/melting are parametrized. The routine uses statistical treatment of the sedimentation process, combining three sources of precipitation: coming from the layer above, already available in the layer from previous time step and precipitation generated in the layer during the current time step.
Tuning of the scheme and study of its behavior has already started in December 2005 and January 2006, when the scheme was still unstable. In the meantime, all the basic problems of the scheme are solved. First tests to make the scheme as close as possible to the old ACPLUIE (to acquire immediate total autoconversion, avoid collection and achieve very high fall speed) were done already.
The aim of this work is further validation of the new scheme.

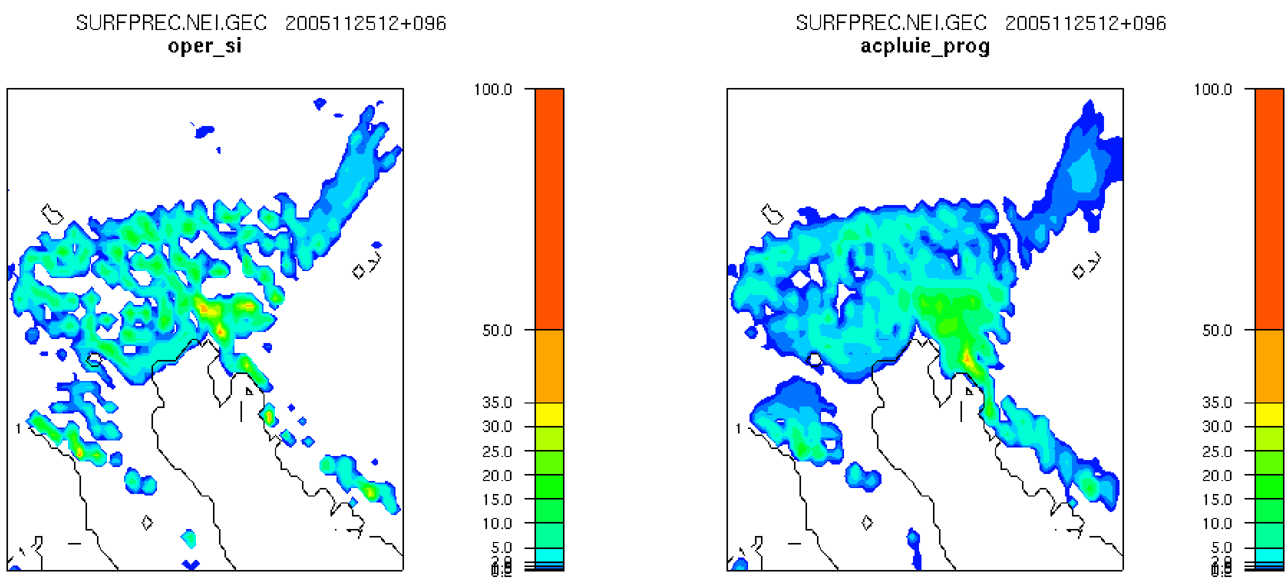
2. Plans

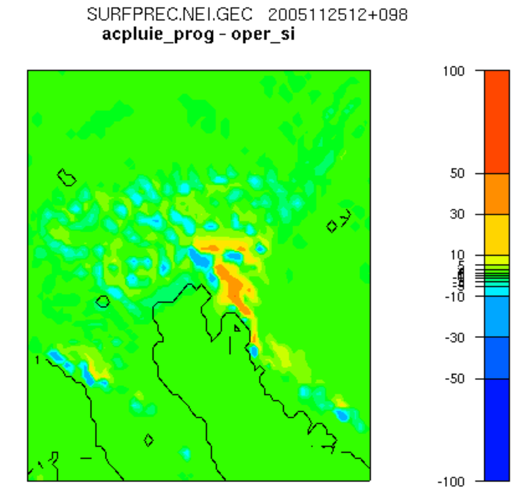
- TEST1: basic thermo-dynamics test to verify that the precipitation thermo-dynamics is rather unchanged
- TEST2: sensitivity tests to determine the efficiency of autoconversion from cloud water to snow in a mixed rain/snow event
- TEST3: sensitivity tests to determine the formation of cirrus clouds in an event with high cloudiness
- TEST4: comparing prognostic ql and qi produced by the micro-physics scheme to the ones produced by cloudiness scheme ACNEBN

3. Testing

TEST1: basic thermo-dynamics test to determine the effects of new scheme in four mixed rain/snow events: 16-18 Nov, 23-24 Nov, 25-27 Nov and 1-2 Dec 2005

- fields of rain and snow plotted, comparison for oper_si (cy29t2), acpluie_prog and difference

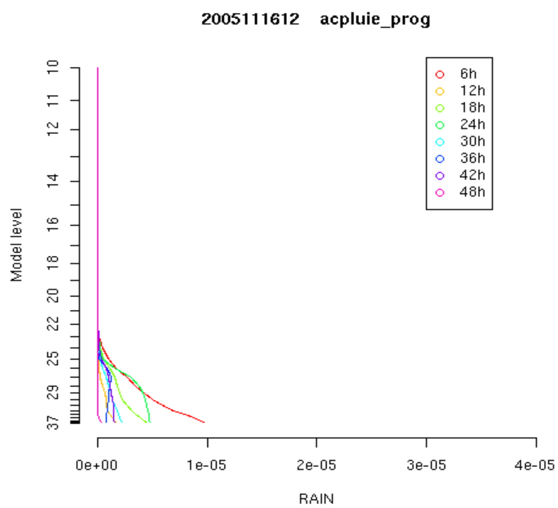


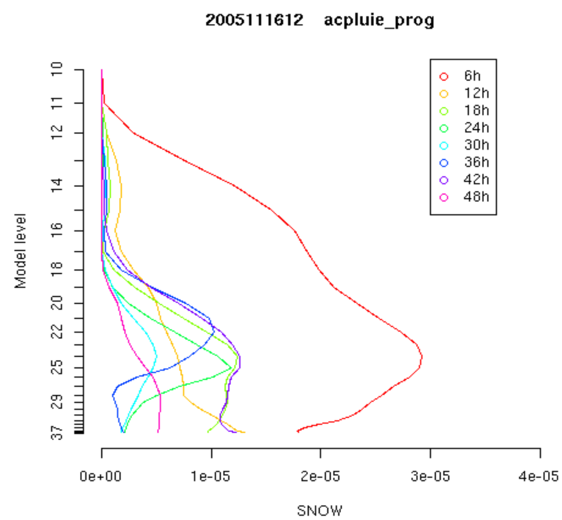


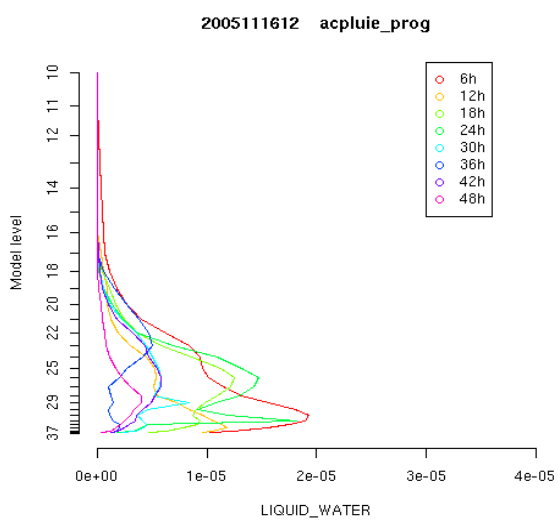
- generally smoother precipitation field
- reduced extremes, especially pronounced for warm sector and orographically induced precipitation (1-2 Dec)

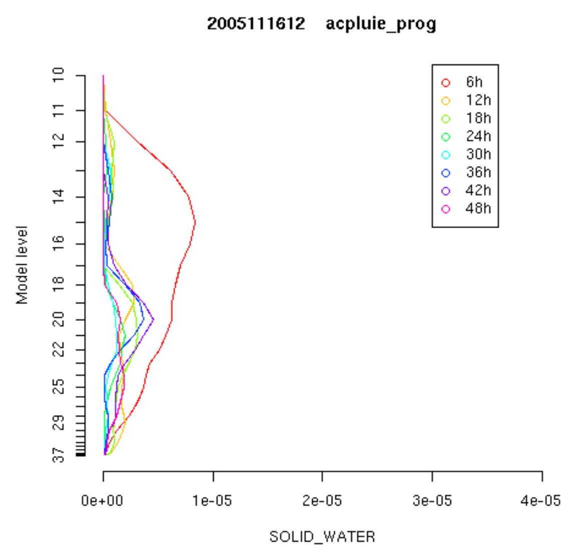
- results showed in
SURFPREC.EAU.GEC_2005111612.html
SURFPREC.EAU.GEC_2005112300.html
SURFPREC.EAU.GEC_2005112512.html
SURFPREC.EAU.GEC_2005120100.html
SURFPREC.NEI.GEC_2005111612.html
SURFPREC.NEI.GEC_2005112300.html
SURFPREC.NEI.GEC_2005112512.html
SURFPREC.NEI.GEC_2005120100.html

- vertical profiles of horizontally averaged cloud and precipitation condensates LIQUID_WATER, SOLID_WATER, RAIN and SNOW for 48 hours integration in four mixed rain/snow cases, one autumn (with snow only on the highest Alpine peaks) and one summer case with no snow







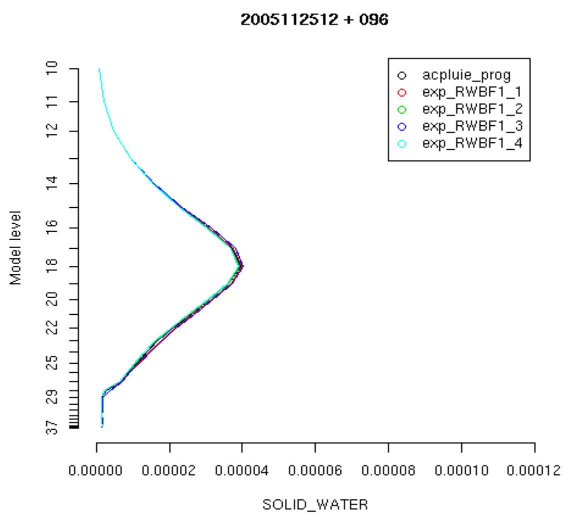


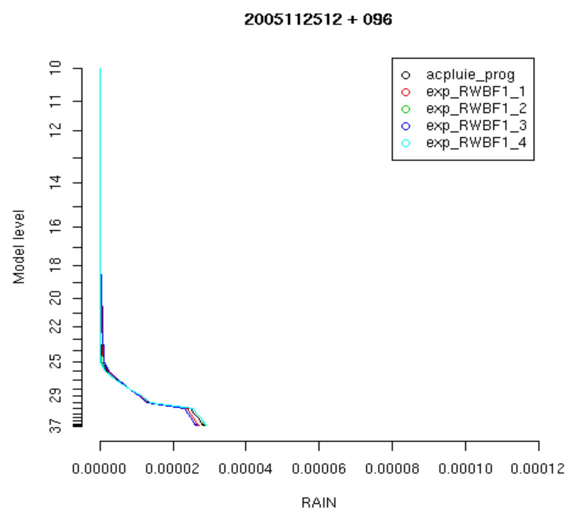
- vertical distribution of water and precipitation species, large amounts of snow somewhat suspicious, but not necessarily unrealistic, cause it should fall 4 times slower than rain
- further investigation, to check what happens with all that snow, the autumn case (2006091612) shows that most of the snow melts, and summer case (2006072300) confirms that all of it is gone out
- results in PROFILES.html

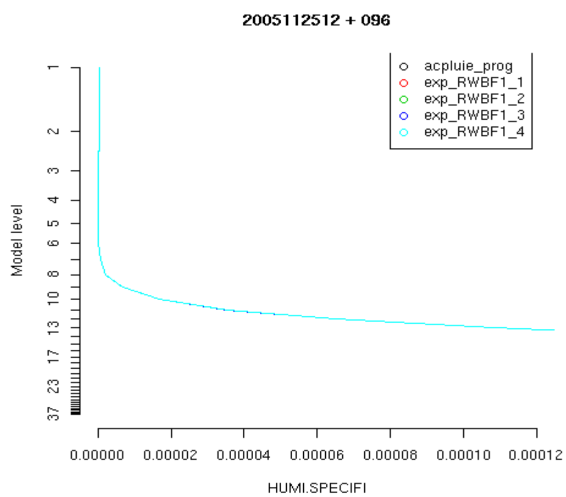
TEST2: RWBF1, sensitivity tests to determine the efficiency of autoconversion from cloud water to snow in a rain/snow event 25-27 Nov 2005

- RWBF1, e.g. F^a_{WBF}, the first constant in Wegener-Bergeron-Findeisen (WBF) process determining the efficiency of autoconversion from cloud water to snow with current default 300., set in NAMCLOUD0

- exp_RWBF1_1: RWBF1=30. (10 times smaller)
- exp_RWBF1_2: RWBF1=3000. (10 times bigger)
- exp_RWBF1_3: RWBF1=3. (100 times smaller)
- exp_RWBF1_4: RWBF1=30000. (100 times bigger)



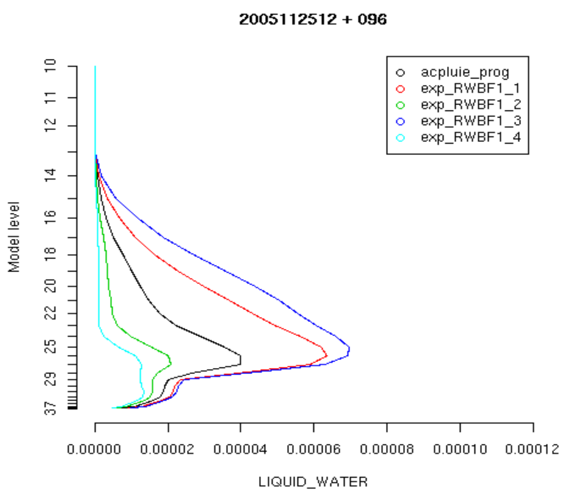


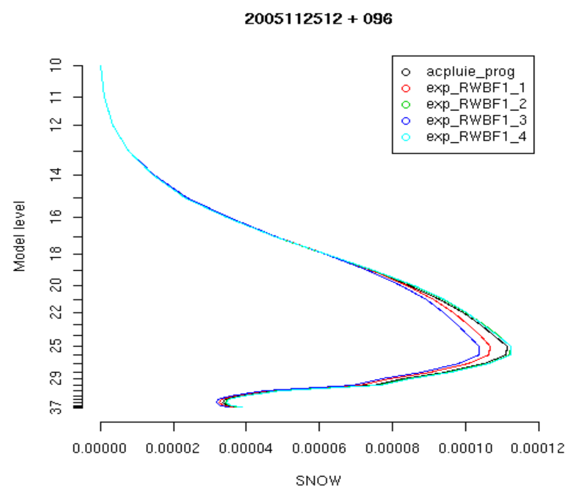


- there is no impact of the autoconversion coefficient on specific humidity, rain and solid water

- results in RWBF1_HUMI.html
- RWBF1_RAIN.html
- RWBF1_SOLID_WATER.html

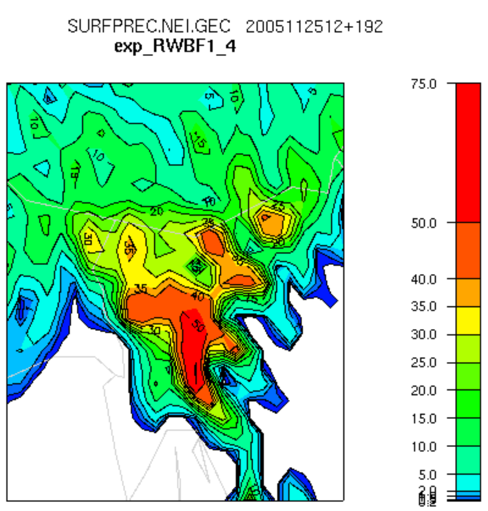
- for RWBF1=3000. and RWBF1=30000. there is a significant loss of QL (above 25. model level), resulting with only small increase in QS (with negligible difference between the two)
- for RWBF1=30. and RWBF1=3. there is a significant increase of QL (20-25. model level), resulting with only small decrease in QS (with small difference between the two)

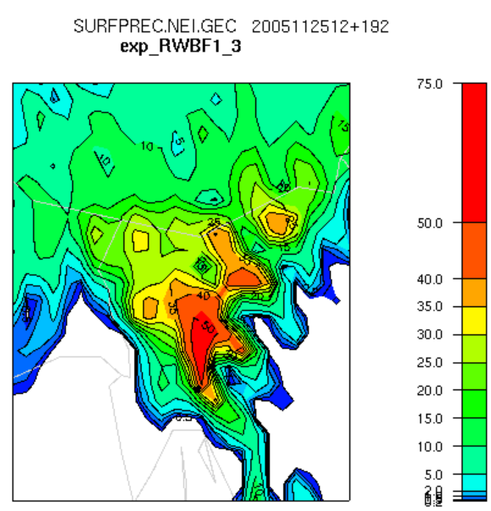




- results in RWBF1_LIQUID_WATER.html
- RWBF1_SNOW.html
- and combined for every second time step to show the process evolution in RWBF1_test.html

- snow fields on a smaller part of domain for 100 times larger and 100 times smaller RWBF1
- the impact is quite week, but the experiment with stronger autoconversion is more realistic, validated against Slovenian (height of the new snow) data



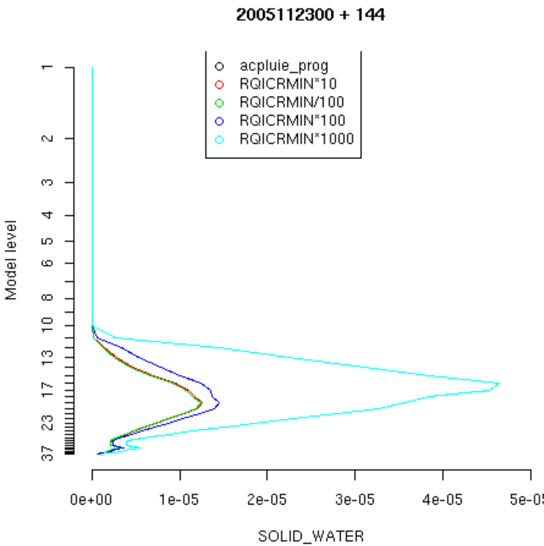


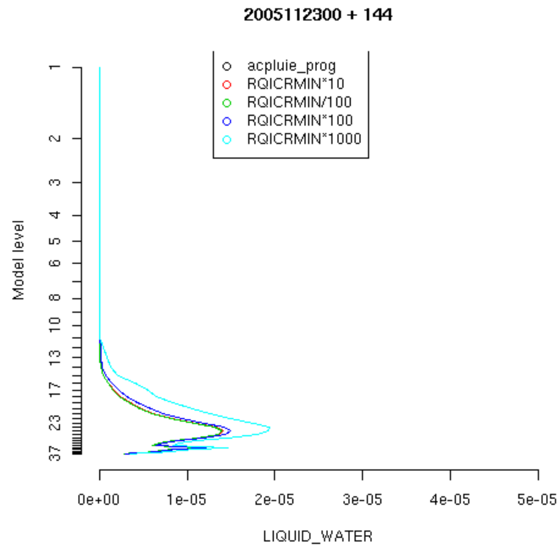
- results in SURFPREC.NEI.GEC_RWBF1tests_2005111612.html
- SURFPREC.NEI.GEC_RWBF1tests_2005112512.html

TEST3: checking the sensitivity to the RQICRMIN in one event with high cloudiness 23 – 25 Nov 2005

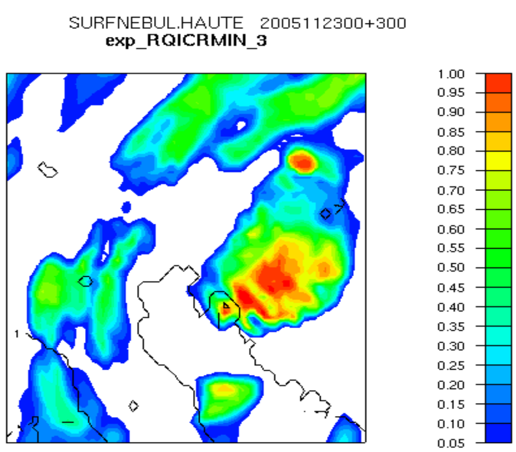
- RQICRMIN, minimum critical ice content for autoconversion of stratiform ice, which is set to an arbitrary value of 8.E-07 and assumed to be to low, set in NAMPHY0
- exp_RQICRMIN_1: RQICRMIN=8.E-08 (10 times smaller)
- exp_RQICRMIN_2: RQICRMIN=8.E-06 (10 times bigger)
- exp_RQICRMIN_3: RQICRMIN=8.E-09 (100 times smaller)
- exp_RQICRMIN_4: RQICRMIN=8.E-05 (100 times bigger)
- exp_RQICRMIN_5: RQICRMIN=8.E-04 (1000 times bigger)

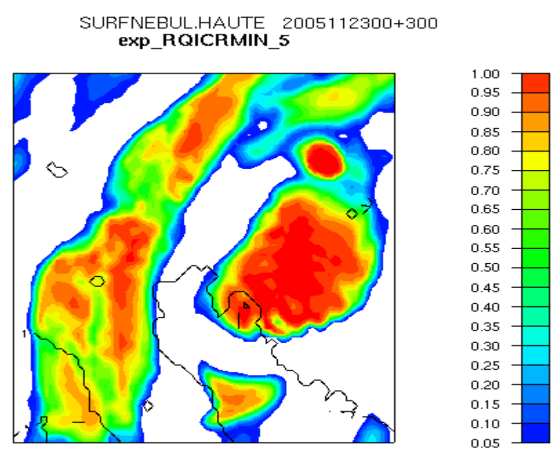
- vertical profiles of horizontally averaged QL and QI with special attention to the higher levels



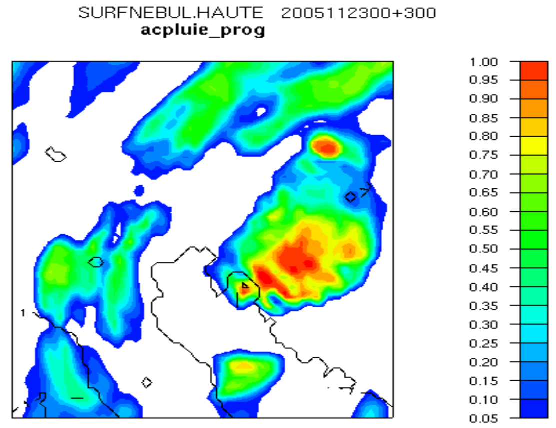


- showing no impact whatsoever to the changes up to 2 orders of magnitude, negligible impact of RQICRMIN*100
- strong impact only for RQICRMIN*1000 to the amounts of QL in middle and QI in higher troposphere
- results in RQICRMIN_LIQUID_WATER.html
- RQICRMIN_SOLID_WATER.html

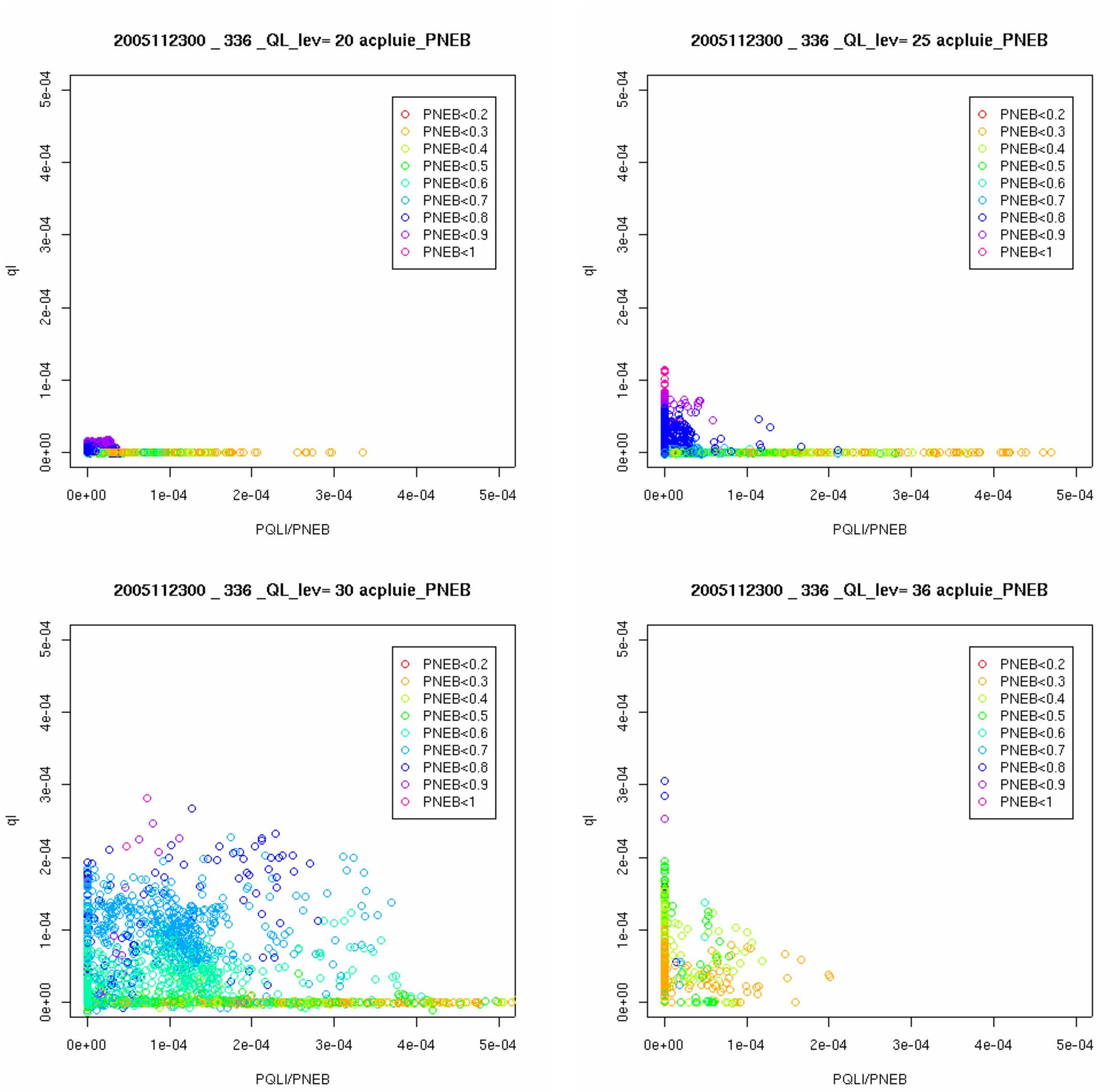




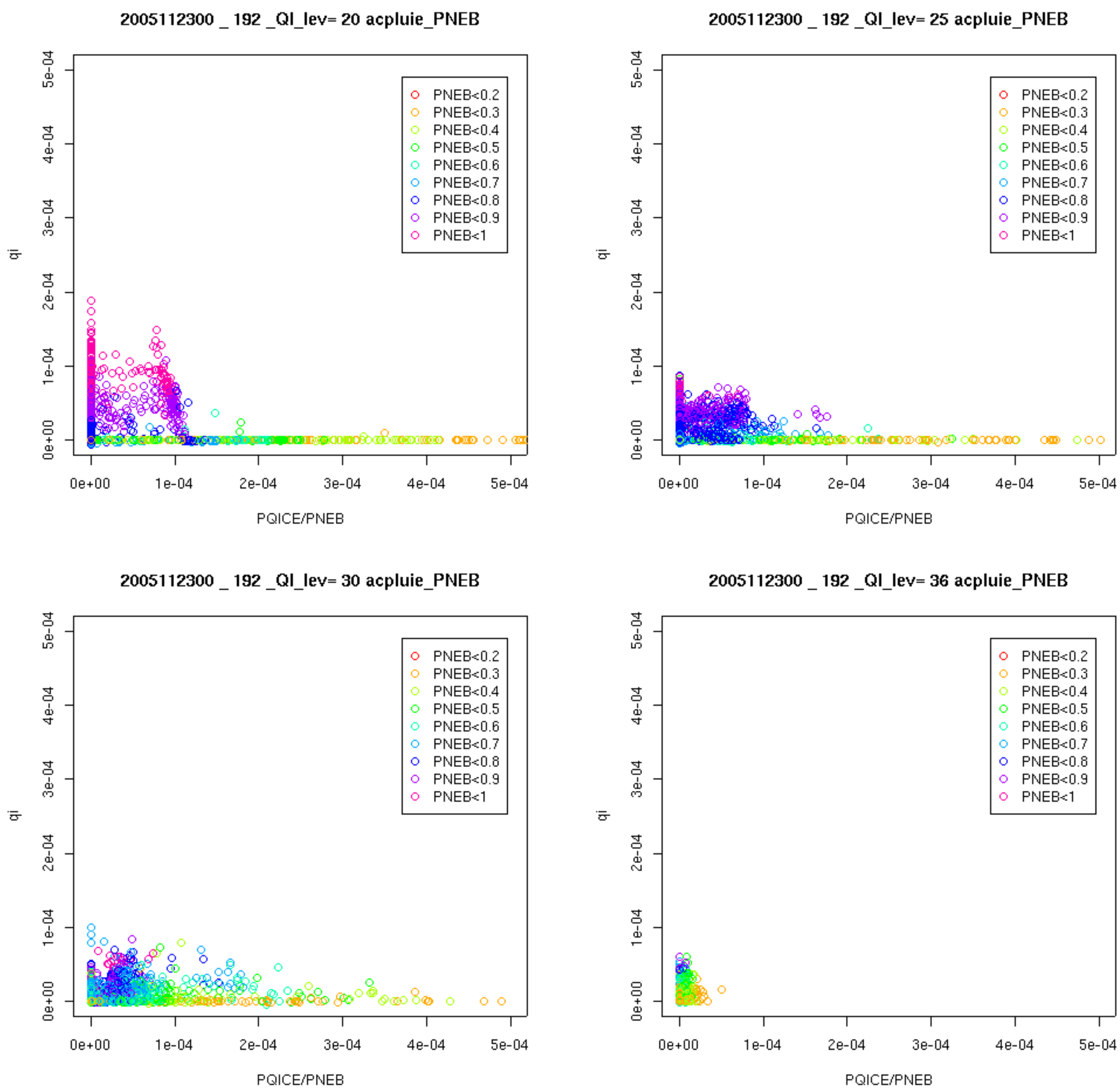
- plots of high could cover for different experiments and their differences
- significant increase leads to irrealistic values of high cloudiness
- images in SURFNEBUL.HAUTE_2005112300.html



TEST4: comparing prognostic QL and QI produced by the microphysics scheme to the PQLI and PQICE (multiplied by PNEB) produced by ACNEBN in two mixed rain/snow events, 16 - 18 Nov 2005 and 23 – 25 Nov 2005



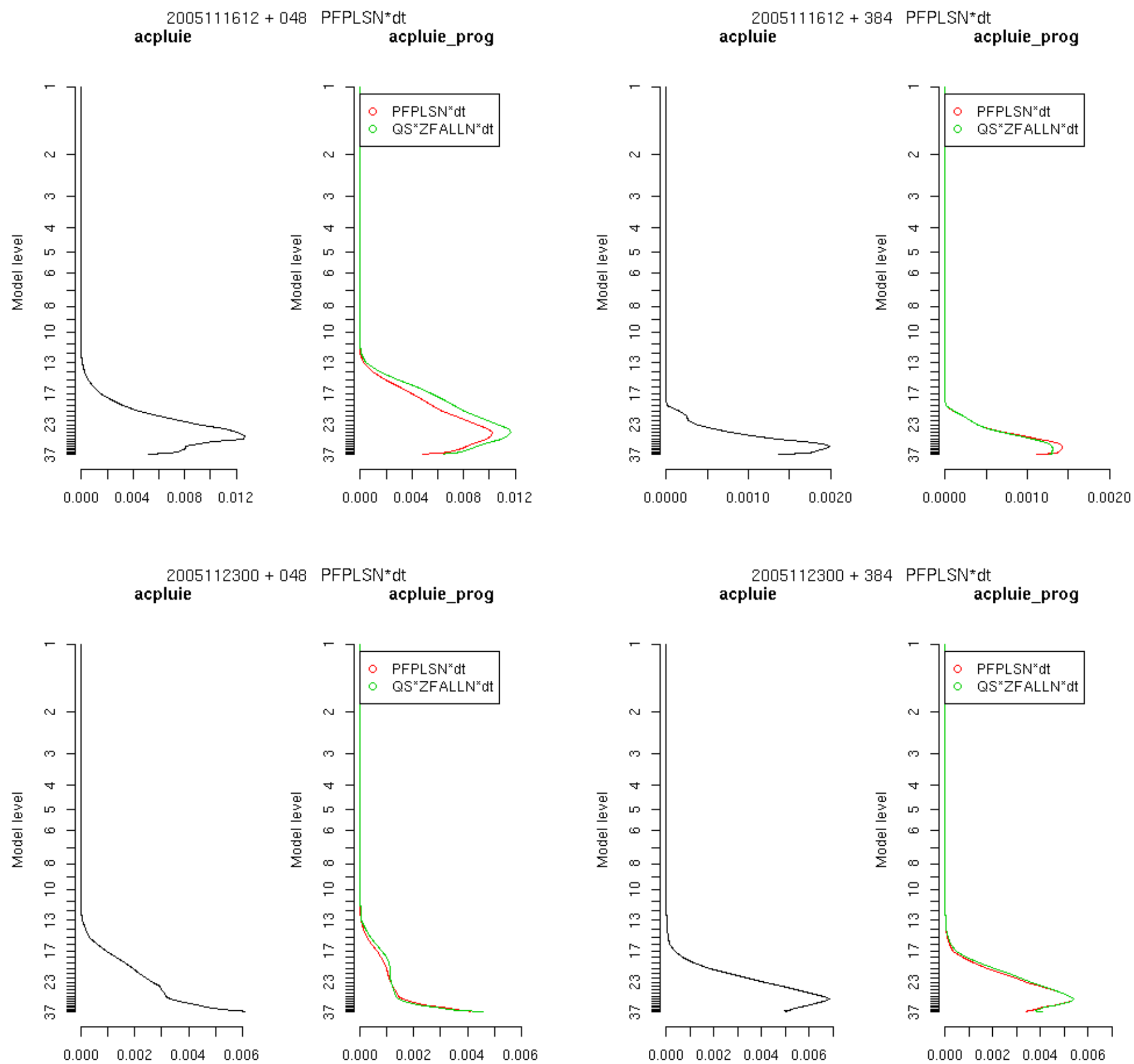
- dispersion diagrams of microphysics liquid water (QL) vs. specific humidity of liquid water for radiation divided by fractional cloudiness for radiation (PQLI/PNEB) and microphysics solid water (QS) vs. specific humidity of solid water for radiation divided by fractional cloudiness for radiation (PQICE/PNEB) in dependence to PNEB



- for small cloud cover (PNEB~0.1-0.3), microphysics sheme does not produce (liquid or solid) water content; for significant cloud cover and overcast (PNEB>0.8) water content produced by microphysics is sometimes significantly larger than one produced by ACNEB
- in mid-levels, for non-negligible cloud cover, QL and QI from the two schemes are comparable!
- results in PNEBtests_2005111612_???.html and PNEBtests_2005112300_???.html, where ??? stands for integration steps (every 6 hours, up to 48 hours, e.g.: 48, 96, 144, 192, 240, 288, 336, 384)

TEST5: comparing stratiform precipitation flux of acpluie and acpluie_prog, together with domain average profiles of QS*ZFALLN in two mixed rain/snow events, 16 - 18 Nov 2005 and 23 – 25 Nov 2005

- this test demanded some changes in the code to prepare the new non-standard outputs (new binary referenced in the APPENDIX)
- vertical profiles of domain averaged precipitation fluxes PFPLSL and PFPLSN for acpluie compared to acpluie_prog with the product of snow and falling speed of snow for certain time step



- examples given for two cases for T+6 and 48 hours of integration
- distribution and order of magnitude of two fluxes are comparable, new ones generally a bit smaller
- in acpluie_prog, stratiform precipitation flux profile is very close to the product of snow and its falling speed, with similar vertical distribution and almost identical magnitude, showing the tunings are good
- results given in PFPLSNtests_2005112300.html and PFPLSNtests_2005111612.html

CONCLUSIONS

The basic thermodynamic tests show that the new scheme is more realistic than the old one, precipitation field much smoother with lower extremes. Vertical profiles show (what seemed to be) too big amounts of snow throughout the integration. Further study showed that snow melts properly and it can be assumed that too much snow can be the result of the fact that it is falling four times slower than rain.

Sensitivity tests for the Wegener-Bergeron-Findeisen autoconversion show that stronger WBF process produces negligibly more snow. On the other hand, damping of the autoconversion results with a significant increase of liquid water in mid-troposphere but still only small decrease in production of snow which probably saturates for those high values of liquid water.

The tests for autoconversion of stratiform ice showed that the scheme is not sensitive to changes of one order of magnitude; hence it is already in a range of saturated values. Any significant increase would result with unwanted big amounts of cloud ice and increased cloudiness.

Plots for comparison of the prognostic cloud condensates produced by the micro-physics to ones produced by cloudiness scheme show that the two values are of the same order of magnitude.

Furthermore, stratiform precipitation fluxes in two schemes have similar vertical distribution and almost identical magnitudes.

All of this could lead to the conclusion that the scheme is well tuned.

Because of the lack of time, some of the tests which were planned could not be executed.

APPENDIX: List of used files

- all the work was done on tuba, in home directory of Dunja Drvar
- new binaries are linked in:
  /home/dunja/alaro_test/>

LAM-cy29t2_export.03.IA32_intel90.score... reference, operational suite

LAM-cy29t2_alaro_prg.IA32_intel90-g.score... acpluie_prog

LAM-cy29t2_alaro_PNEB.IA32_intel90-g.score... acpluie_prog with new outputs (carefully, things are mixed up!!):

PNEB -> PUNEBH (SXXXPSHI_CONV_CLOUD)
PQLI -> PDDAL (SXXXDD_MESH_FRAC)
PQICE -> PDDOM (SXXXDD_OMEGA)
PFPLSL -> PUDAL (SXXXUD_MESH_FRAC)
PFPLSN -> PUDOM (SXXXUD_OMEGA)
ZFALLN -> PENTCH (SXXXUD_ENTRAINME)

LAM-PFPLSLN... reference, operational suite with new outputs (beware, things are even more mixed up here!!):

PFPLSL -> (SXXXRAIN)
PFPLSN -> (SXXXSNOW)

- new scripts and namelists, with names related to particular experiments:
  /home/dunja/alaro_test/rundir001/script/001_.sh**
  /home/dunja/alaro_test/rundir001/namelist/fort.4.*
- new history files in subdirectories of particular cases, with names related to particular experiments:
  /mnt/scratch/dunja/YYYYMMDDRR>
- ploting done with R, scripts with names mostly related to the particular experiments, kept in:
  /home/dunja/Rprimeri>
- all the plots and related htmls are kept in tmpdunja directory, which can be browsed on the local intranet
  /var/www/html/tmpdunja -> /mnt/scratch/dunja/public_html>