COMPARISON OF MICROPHYSICS IN IDEALIZED FRAMEWORKS

September/October 2006 in Toulouse

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Sensitivity of precipitation 3D fields (rain and snow+graupel `PRT0` and `PST0+PGT0` respectively), rain and snow (`PFPLSL` and `PFPLSN`) at the surface fluxes as well as of liquid (`PLT0` or `PQLI`) and solid (`PIT0` or `PQICE`) water contents in cloud and cloudiness (`PNEB`) involved in precipitation scheme (using semi-Lagrangian approach; developed by Lopez) in based on cycle 31t1 1D model (for more see [3] [1]) on a ratio of the falling speed for rain (`TFVR`) and snow (`TFVS`), on the collection processes (accretion `RACCEF`, riming `RRIMEF`, aggregation `RAGGEF`), on evaporation (`LEVAPP` key) and on timestep was tested (examined). Results of the tests were compared with values obtained as a result from AROME NWP model run (for more on AROME see [2]) and with output of ALADIN NWP model with statistical sedimentation involved instead of semi-Lagrangian approach for precipitation scheme as well. Default values for input parameters are:

for the falling speed:
`TFVR=5` (rain)
`TFVS=0.6` (snow)

for the efficency coefficient in collection processes:
`RACCEF=1` (accretion)
`RRIMEF=1` (riming)
`RAGGEF=0.2` (aggregation)

for evaporation of precipitation:
`LEVAPP=.TRUE.` (if `LEVAPP=.FALSE.` no evaporation of precipitation)

1 EXPERIMENT

It should be mentioned, that input file used for tests had been artificially prepared (by Sylvie Malardel) for study aims only and it had not represented (set out) real situation. At the very beginning of experiment the mf_phys, profilechet, writephysio and writeprofile routines were modified to have desired fields written to the output files then the tests to ascertain how ALADIN numerical weather prediction model variables depend upon the input values of parameters were run and the results were compared with AROME work output. Result — 6hour prediction is shown in figures as vertical mean of a fields but `PFPLSL` and `PFPLSN` that are the fields (values) at the surface. For AROME the distinction between snow `PST0` and graupel `PGT0` is made while in ALADIN NWP both phenomena (type of precipitation) are assumed to be one field — snow `PST0`.
Experiment consisted of three steps. In all steps of task autoconversion was done before radiation (the key `LAUTONEB=.TRUE.`)

In first step the ALADIN NWP was run with:
default values of given parameters (no label),
`TFVR=2,TFVS=2` (`"TFVS=TFVS=2"` label was put for the test),
`TFVR=5,TFVS=5` (`"TFVS=TFVS=5"` label was put for the test),
`LEVAPP=.FALSE.` (`"NO evaporation"` label was put for the test),
`RACCEF=0.5,RRIMEF=0.5,RAGGEF=0.1` (`"collection=0.5"` label was put for the test; not shown in the graphs),

RACCEF=0.2,RRIMEF=0.2,RAGGEF=0.04 ("collection=0.2" label was put for the test; not shown in the graphs),
RACCEF=0.1,RRIMEF=0.1,RAGGEF=0.02 ("collection=0.1" label was put for the test),
RACCEF=0,RRIMEF=0,RAGGEF=0, ("NO collection" label was put for the test),

In the second step of experiment the ALADIN NWP model was run with TFVR=4, TFVS=1, RACCEF=0.1, RRIMEF=0.1, RAGGEF=0.02 ("TFVR=4 TFVS=1 collection=0.1" label was put for the test in the figures),

To complete the experiment the third part of tests was prepared to compare results of computation using a semi-Lagrangian scheme and statistical sedimentation approach. (The latter needed further modifications of the code (worked on by Yves Bouteloup) that allow statistical sedimentation activation with key LSSD=.TRUE..) In the figures for this step the label "statistical" is put additionally as a assignation of model work with statistical scheme used.

There were also two values for time step length T60 (60s for AROME and ALADIN NWP models) and T900 (900s for ALADIN NWP model) used in tests (that is put in the graphs as well).

2 RESULTS

The results of the model runs in particular steps of experiment as ploted for given fields values are shown in figures.

First step: Values of examined fields were ploted in separated (for the given variable one) figures in order to satisfy the easiest (simpliest) way of comparison. As it is seen in the graphs (Fig1-11), in all runs for default input values and for "NO evaporation" test the output is (almost) the same for all fields.

PQICE (Fig.1)
◇ values for time step T900 are higher than in case of T60 in all respective tests and plots are smooth for T60 contrary to T900 cases
◇ the lowest values of PQICE (for first hours of run) for default and "collection=0.5" tests as well as for AROME work result,
◇ the higher values of collection the lower values of field

PQLI (Fig.2)
◇ values for time step T900 are lower than in case of T60 in "collection=0.2", "collection=0.1" and "NO collection" tests on the contrary others,
◇ the lowest values of the field are obtained for AROME and "TFVS=TFVS=2" and "TFVS=TFVS=5" next,
◇ the higher values of collection the lower values of field

`PITO` (Fig.3)
◇ for T60 similar to `PQICE` plots, as for T900 values (with the exception of `"NO collection"` output) are lower in comparison with `PQICE` (quod vide Fig.1)

`PLTO` (Fig.4)
◇ for T60 findings are similar to `PQLI` ones, as for T900 calculated values (with the exception of `"NO collection"` output) are lower in comparison with `PQLI` (cp Fig.2)

`PSTO` (Fig.5)
◇ values for time step T900 are higher than in case of T60 in all respective tests
◇ the lowest values of `PQICE` (for first hours of run) for default and `"TFVS=TFVS=5"` and `"TFVS=TFVS=2"` tests and for AROME work result next,
◇ for `"collection=0.5"`, `"collection=0.2"`, `"collection=0.1"` plots are similar (especialy in case of T60), for `"NO collection"` values of `PSTO` are higher

`PRTO` (Fig.6)
◇ the higher values of collection the higher values of field but the form of plots similar
◇ in comparison with above maximum of `PRTO` are shifted in case of the same fall speeds for snow and rain, the AROME output (with the lowest (in general) values) is similar to `"TFVS=TFVS=5"` results

`PFPLSN` (Fig.7, Fig.8)
◇ findings not easy to interpret

`PFPLSN` (Fig.9, Fig.10)
◇ findings not easy to interpret

`PNEB` (Fig.11)
◇ almost the same values for time step T900 in all tests,
◇ the lowest values of `PNEB` (for first hours of run) for `"TFVS=TFVS=2"` test,
◇ the higher values of collection the lower values of field
◇ AROME output is near the values computed during the lowest collection test run

Comparison of Aladin NWP model output for default input values of parameters, `"TFVR=4 TFVS=1 collection=0.1"` test and AROME computation represents the second part of the task. As previously the result of this step are shown in the figures for examined fields separately. Results obtained in test `"TFVR=4 TFVS=1 collection=0.1"` fall between those of 'default' ALADIN and AROME models output data for `PSTO` (Fig.16) as well as the part of plot of `PRTO` (Fig. 17) or `PNEB` (Fig. 22). Mostly, the `"TFVR=4 TFVS=1 collection=0.1"` set of (tuning) parameters input increases the values of fields (see Fig. 12–15 and Fig. 18–21) and there was no improvement in comparison with default parameters seen.

Finally, comparison of work of ALADIN model with use of semi-Lagrangian scheme and output of ALADIN model with statistical scheme involved instead represented the area of our interests. And again results of tests for default values as well as for `"TFVR=4 TFVS=1 collection=0.1"` (the later not presented in the graphs) are shown in figures (Fig. 23–33). One can see the high (but at surface fluxes `PFPLSN` and `PFPLSL` values) correspondence beetween both approachs. The only (small) discrepancy can be seen especially for tests run with longer time step.

The results of the investigation show the sensivity of examined 1D model output (with respect to microphysical scheme and consequently prognostic fields — cloud condensate and precipitation as well as cloudiness and snow and rain at surface) for input values of precipitation fall speeds values and collection. As for evaporation no significant influence on output was observed during the experiment. Large disagreement was indicated for surface fields `PFPLSN` and `PFPLSL` in all parts of the task. Next, the instability for shorter — the T60 time step arose in some tests that suggests to examine a time step with a length from the interval (60, 900). In the end of experiment it was shown, that statistical sedimentation can stand in for (more expensive) semi-Lagrangian scheme in cloud and precipitation scheme.
(In view of above) All above encouraged to examinate the influence of falling speed definition involved in microphisics of ALADIN NWP model with statistical sedimentation scheme on variables. Thus the falling speed as the function of the rain and snow concentration was taken (again after Yves Bouteloup) into account in deliberations. Very first results appeared promising in case of fluxes `PFPLSN` (Fig. 40 Fig. 41) and `PFPLSL` (Fig. 42 Fig. 43) as well as `PRTO` (Fig. 39) in particular. For `PRTO` graphs showing variability with altitude and time to indicate the speed definition on output more clearly were ploted additionally (see Fig. 45–48).
However farther investigation on scheme improvement on account of time step and

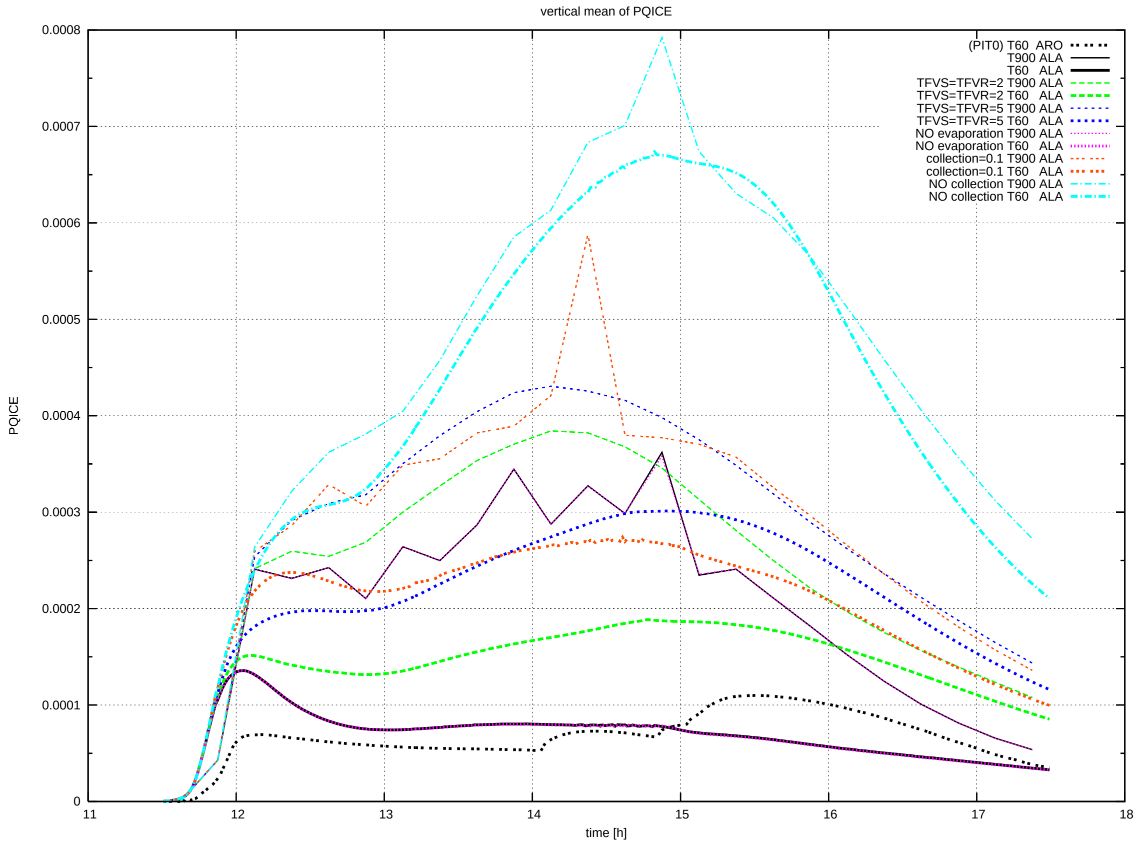

Fig. 1 The influence of input values of parameters on `PQICE` variable as the output of ALADIN NWP model in comparison with AROME NWP output (black dashed line)

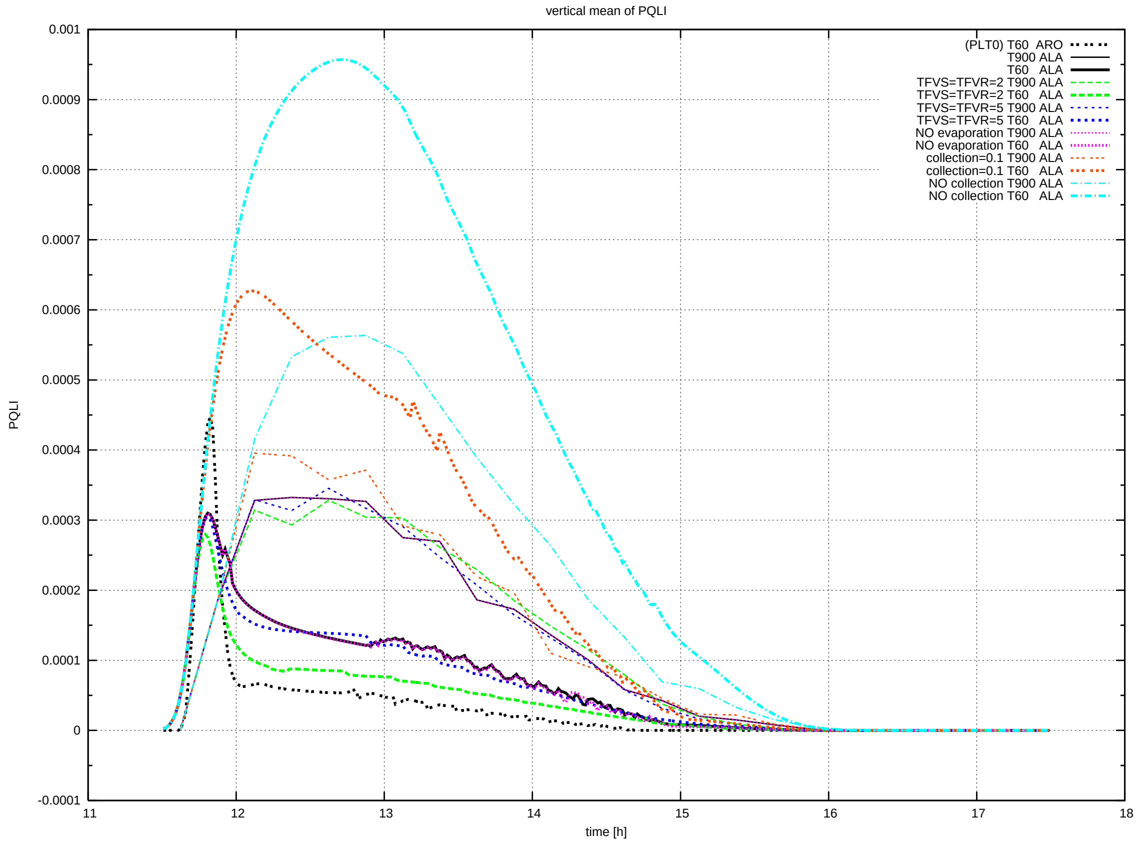

Fig. 2 As Fig. 1 but for `PQLI`

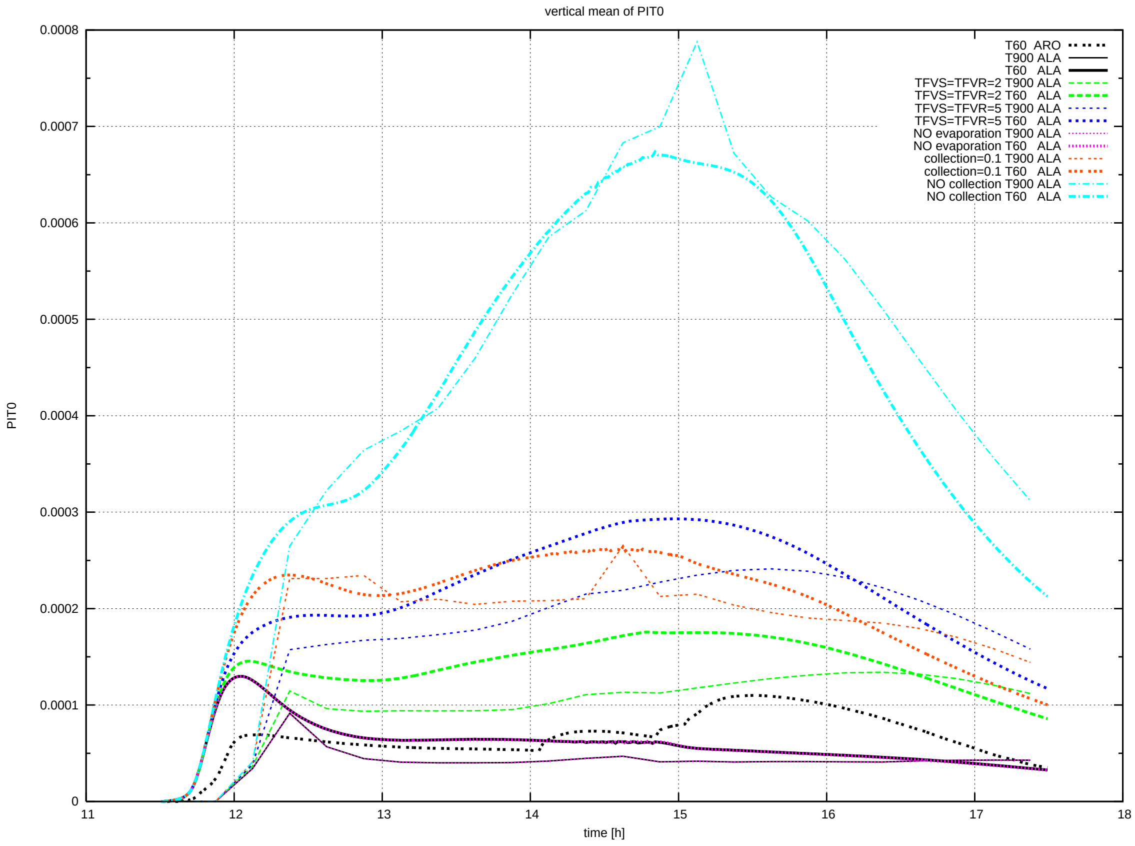

Fig. 3 As Fig. 1 but for PIT0

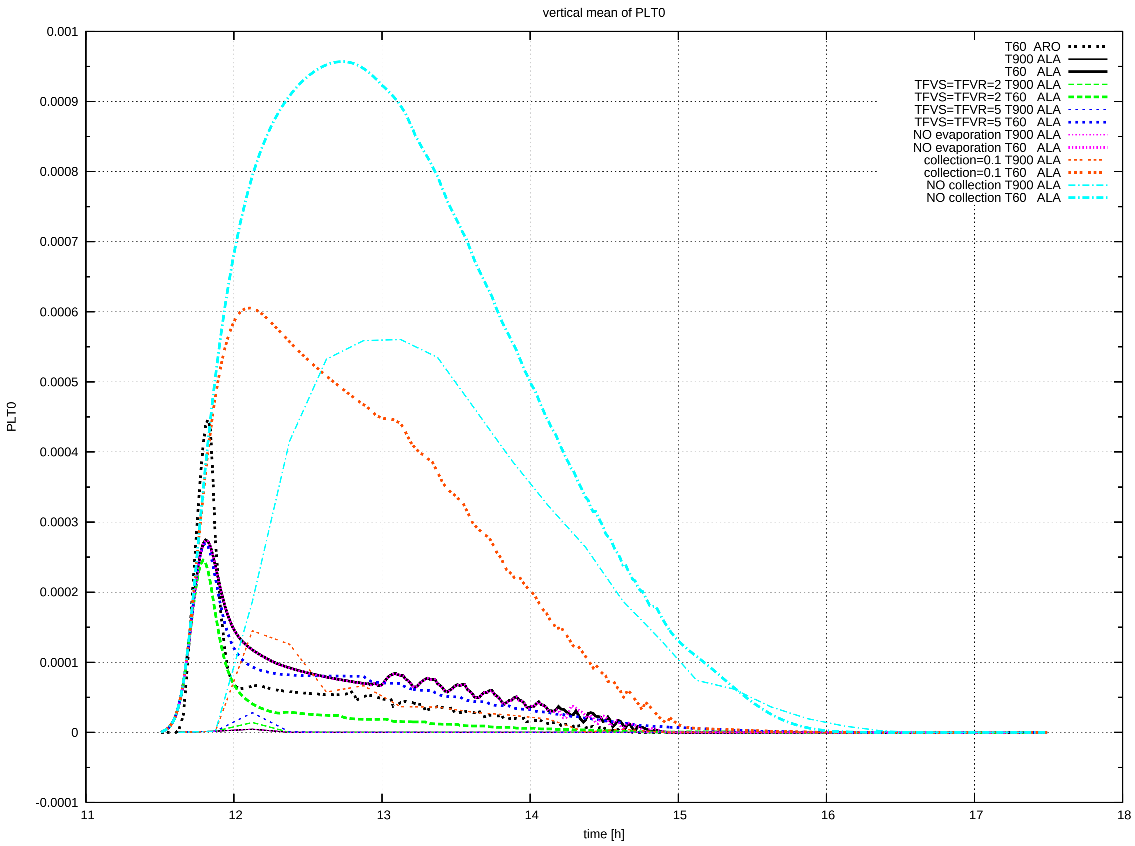

Fig. 4 As Fig. 1 but for PLT0

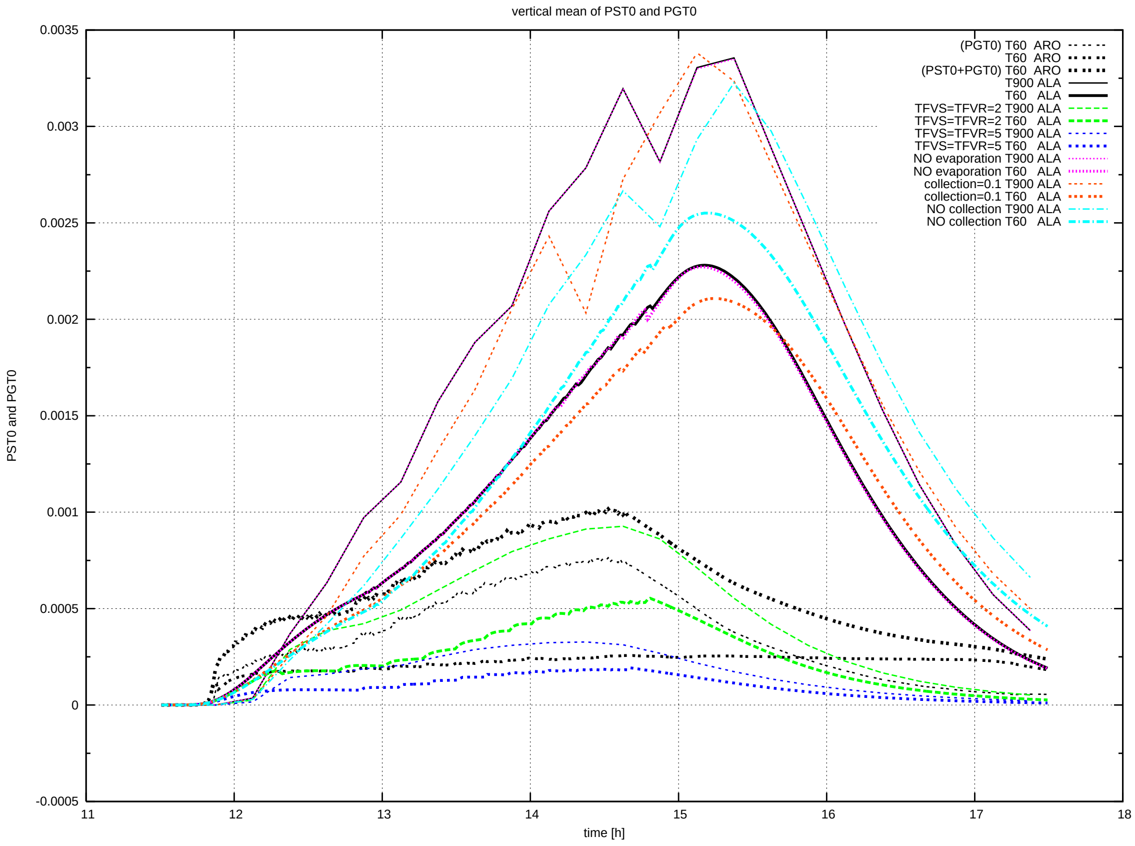

Fig. 5 As Fig. 1 but for PST0

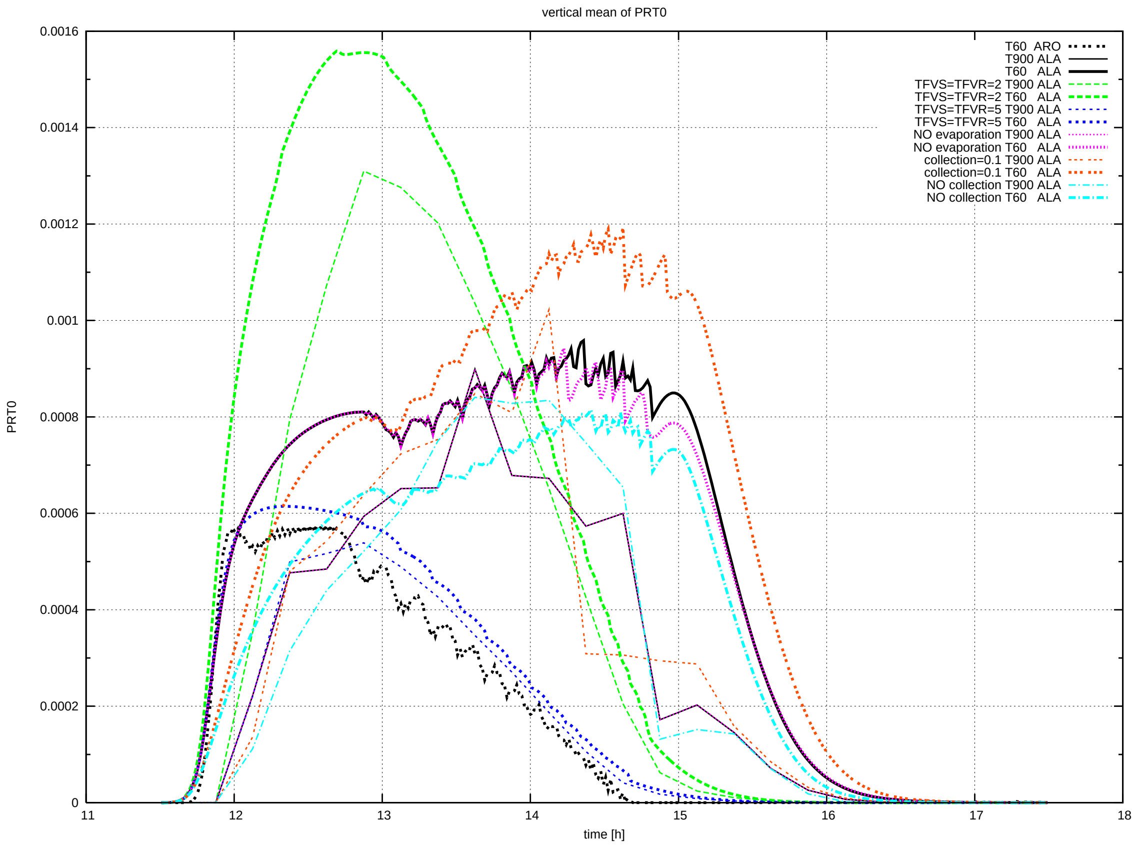

Fig. 6 As Fig. 1 but for PRT0

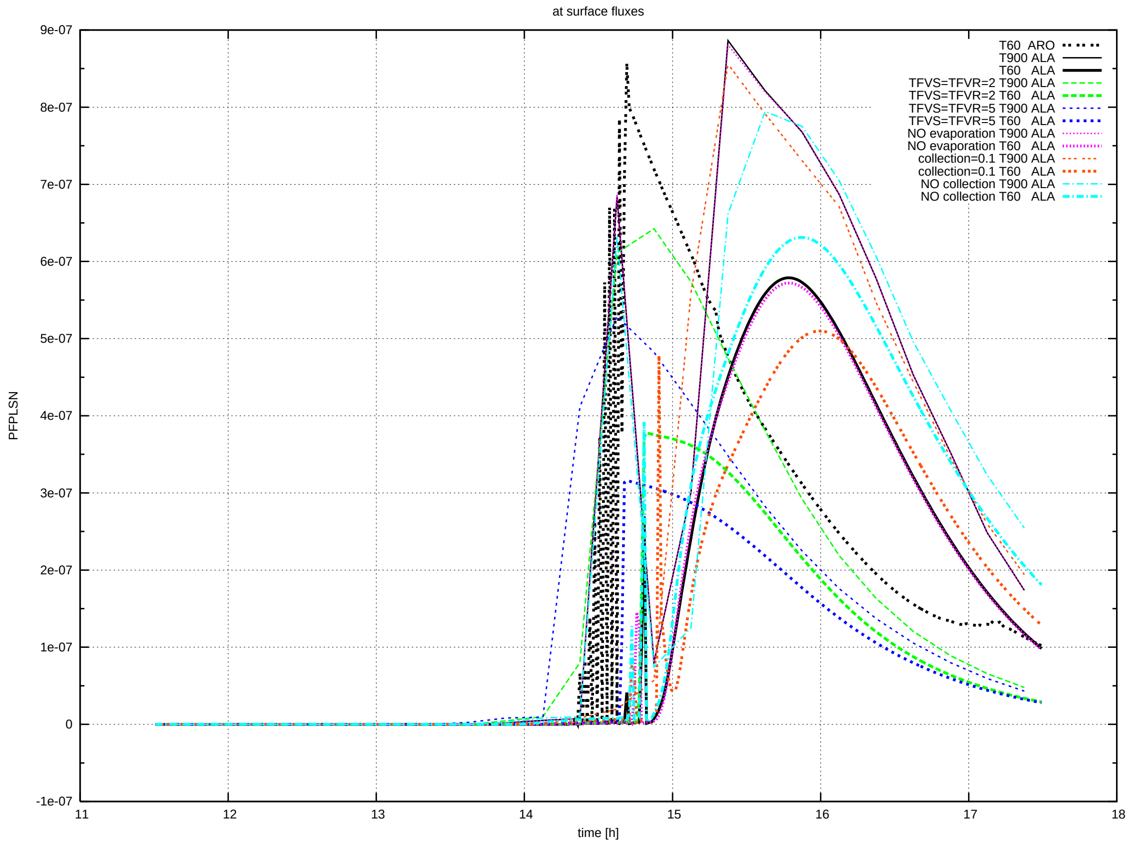

Fig. 7 As Fig. 1 but for PFPLSN

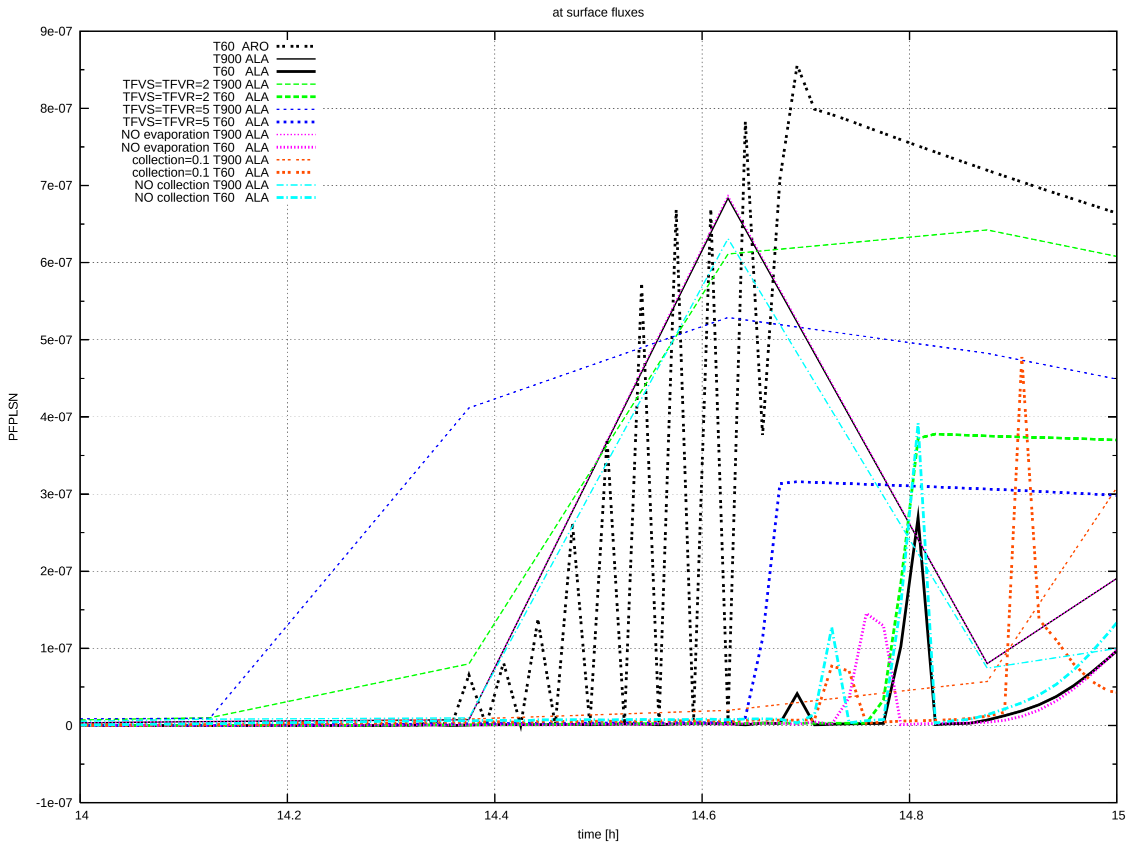

Fig. 8 As Fig. 7 but zoom

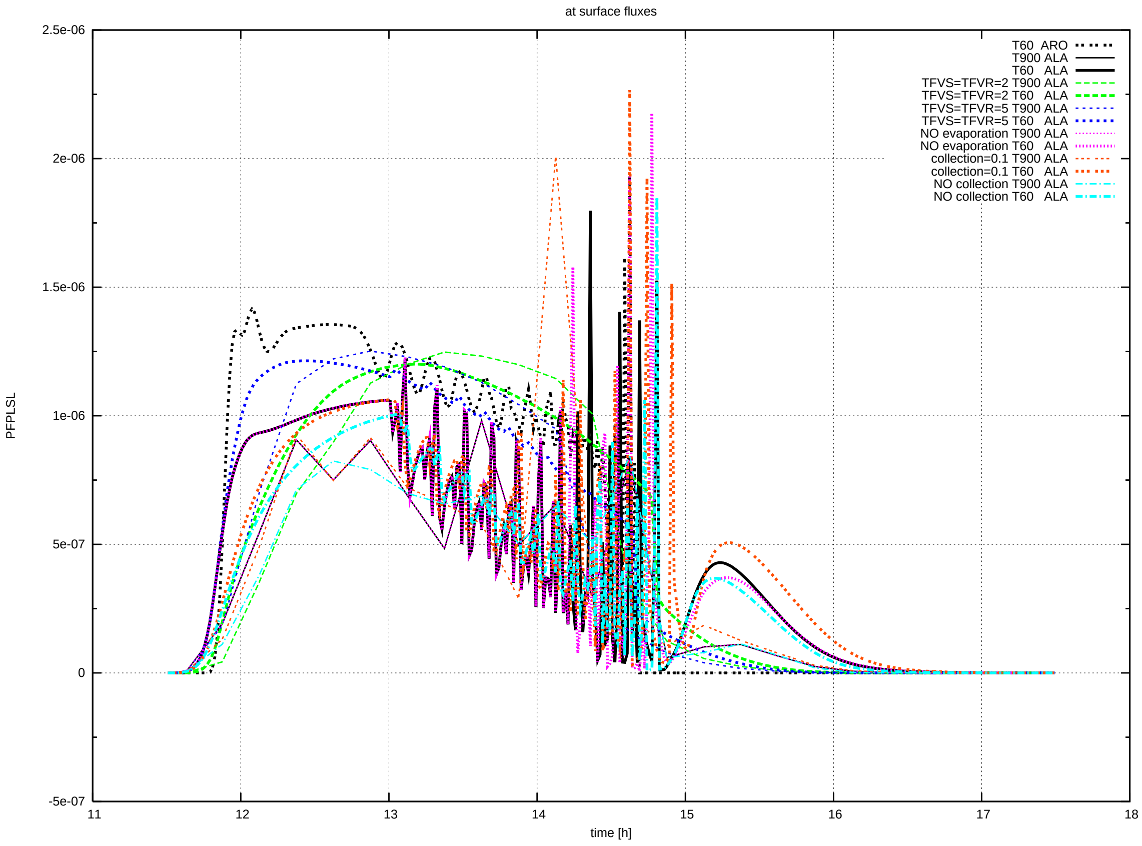

Fig. 9 As Fig. 1 but for PFPLSL

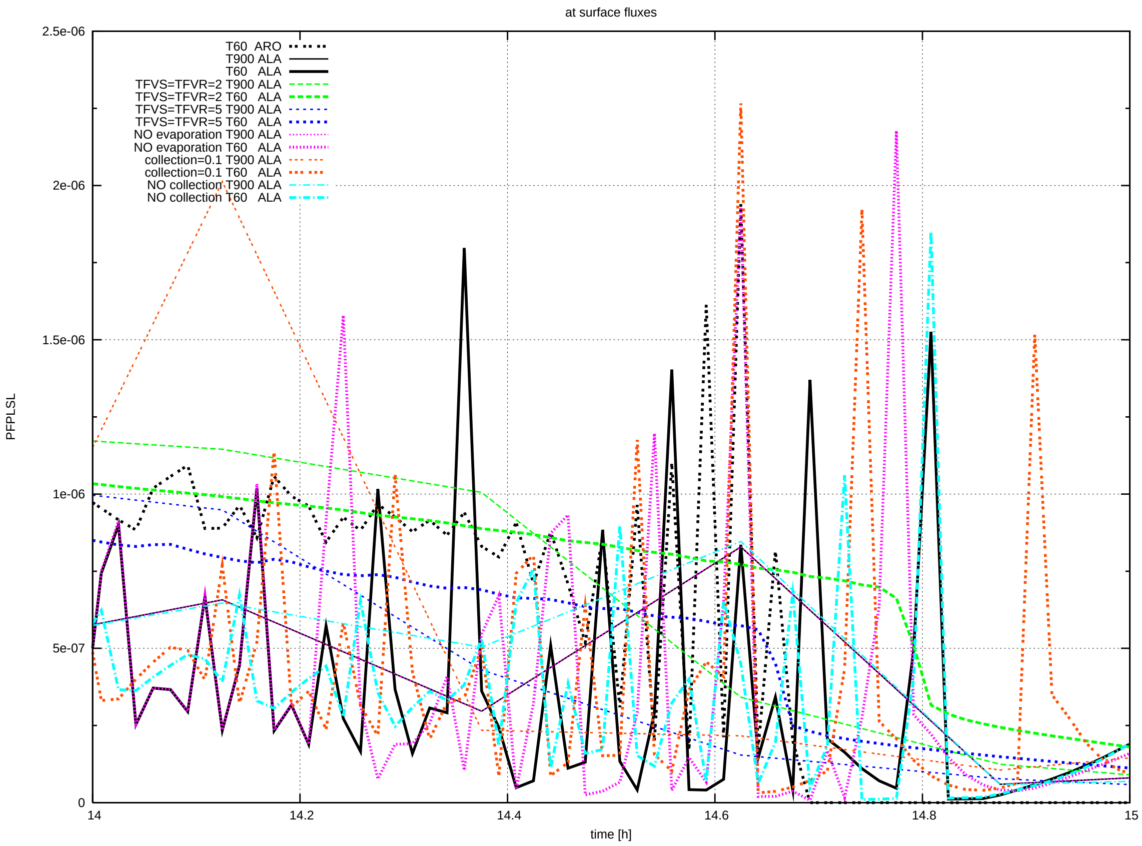

Fig. 10 As Fig. 9 but zoom

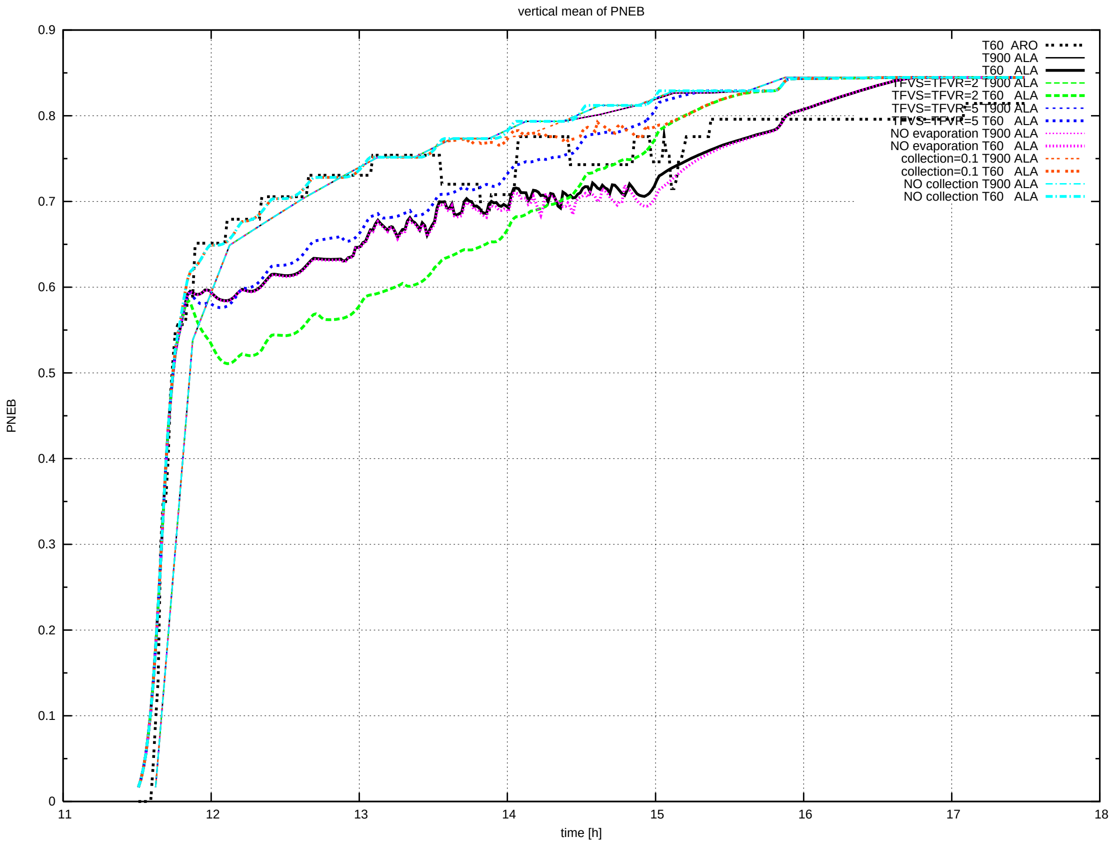

Fig. 11 As Fig. 1 but for `PNEB`

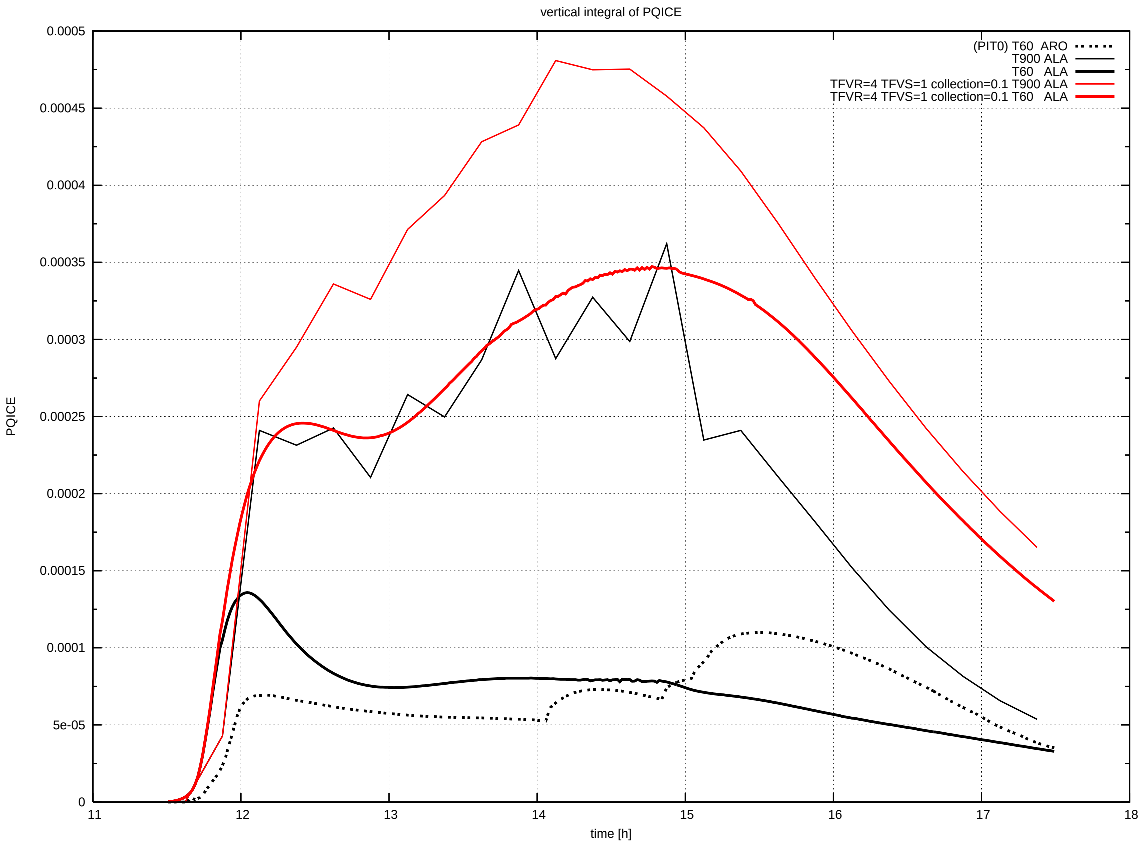

Fig. 12 Comparison of Aladin NWP model output for default input values of parameters (black solid line), `"TFVR=4 TFVS=1 collection=0.1"` test (red line) and AROME computation (black dashed line) in case of `PQICE` field

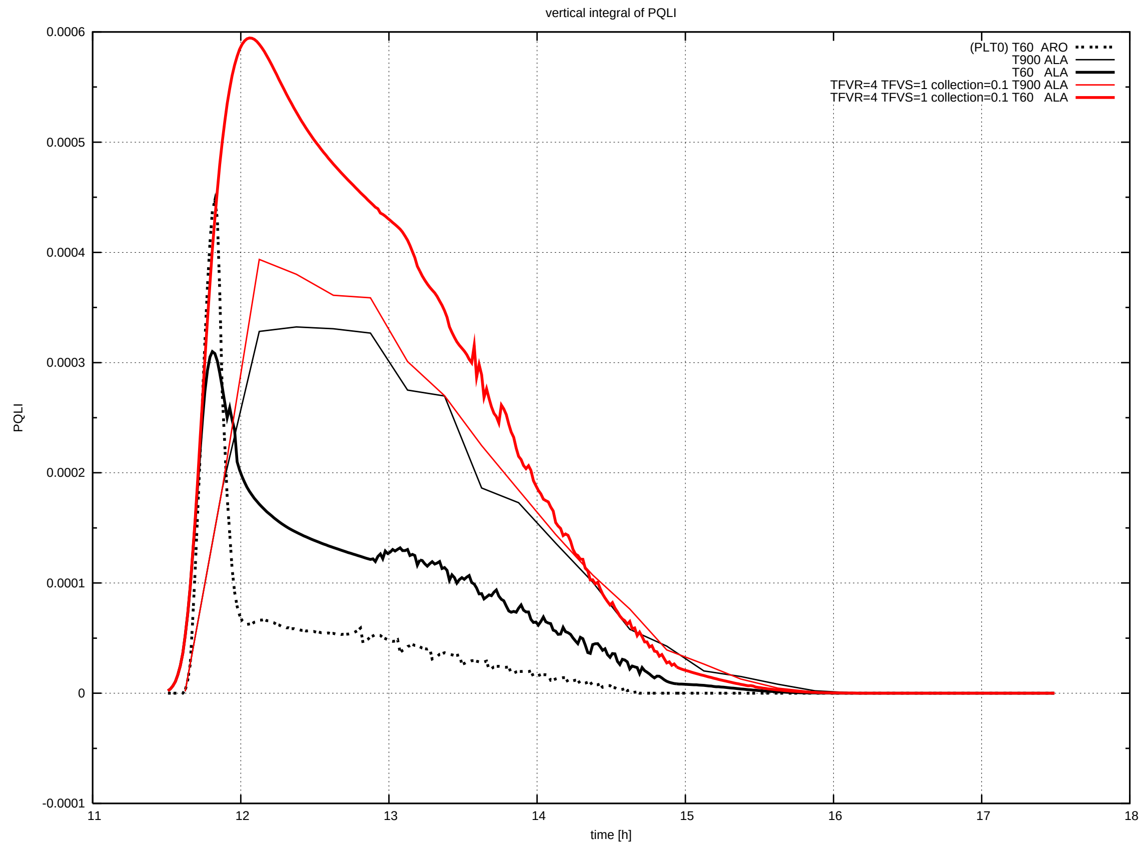

Fig. 13 As Fig. 12 but for `PQLI`

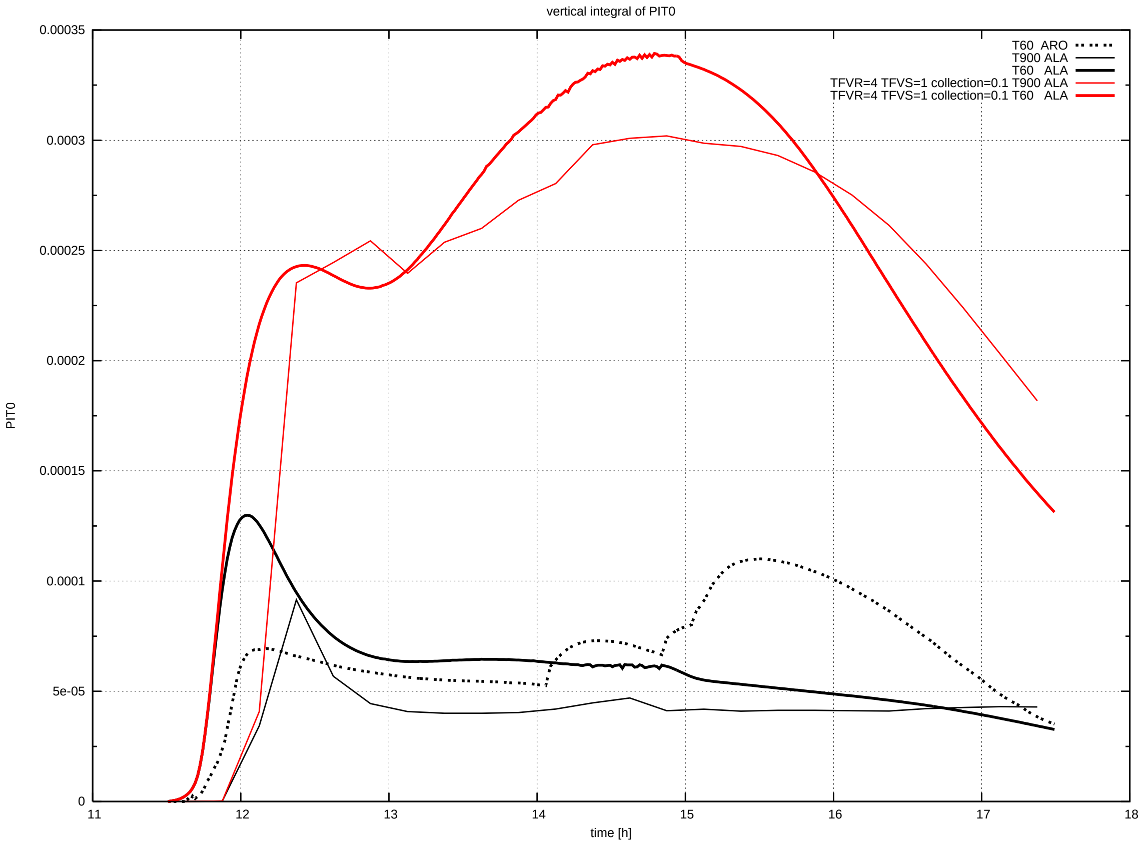

Fig. 14 As Fig. 12 but for `PIT0`

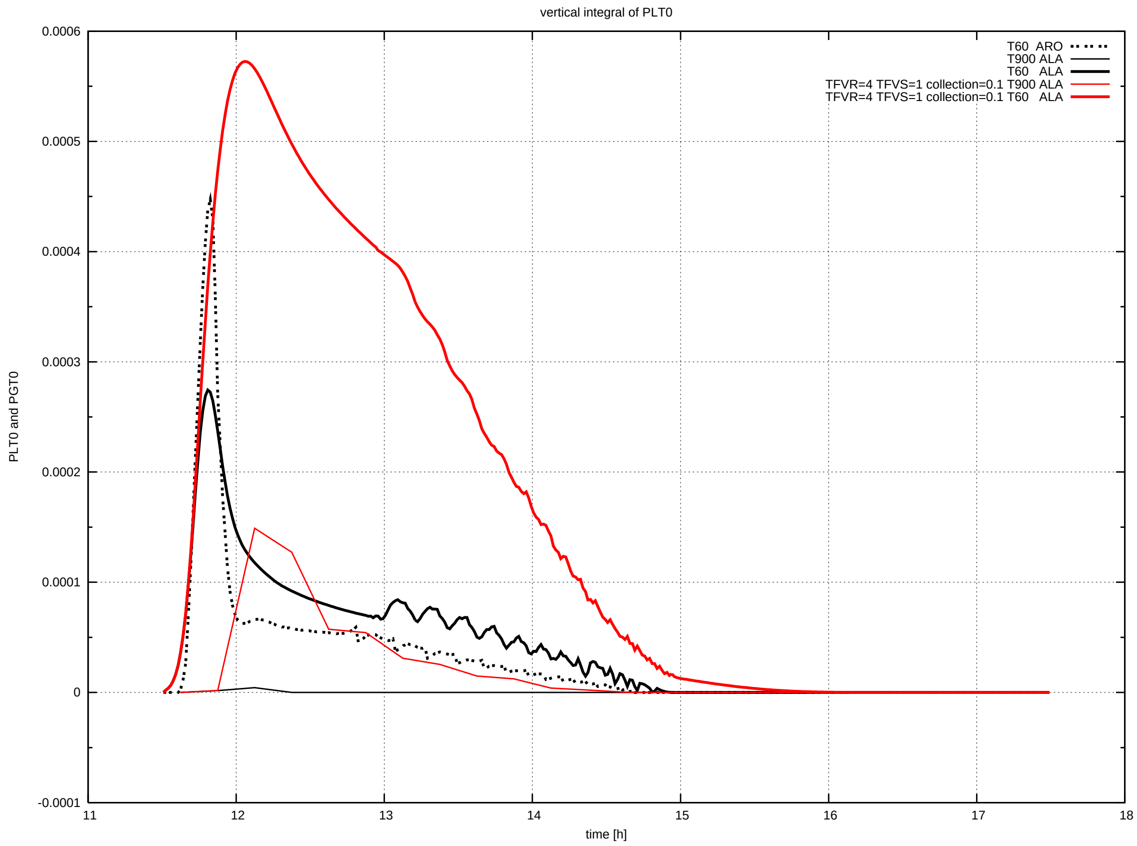

Fig. 15 As Fig. 12 but for `PLT0`

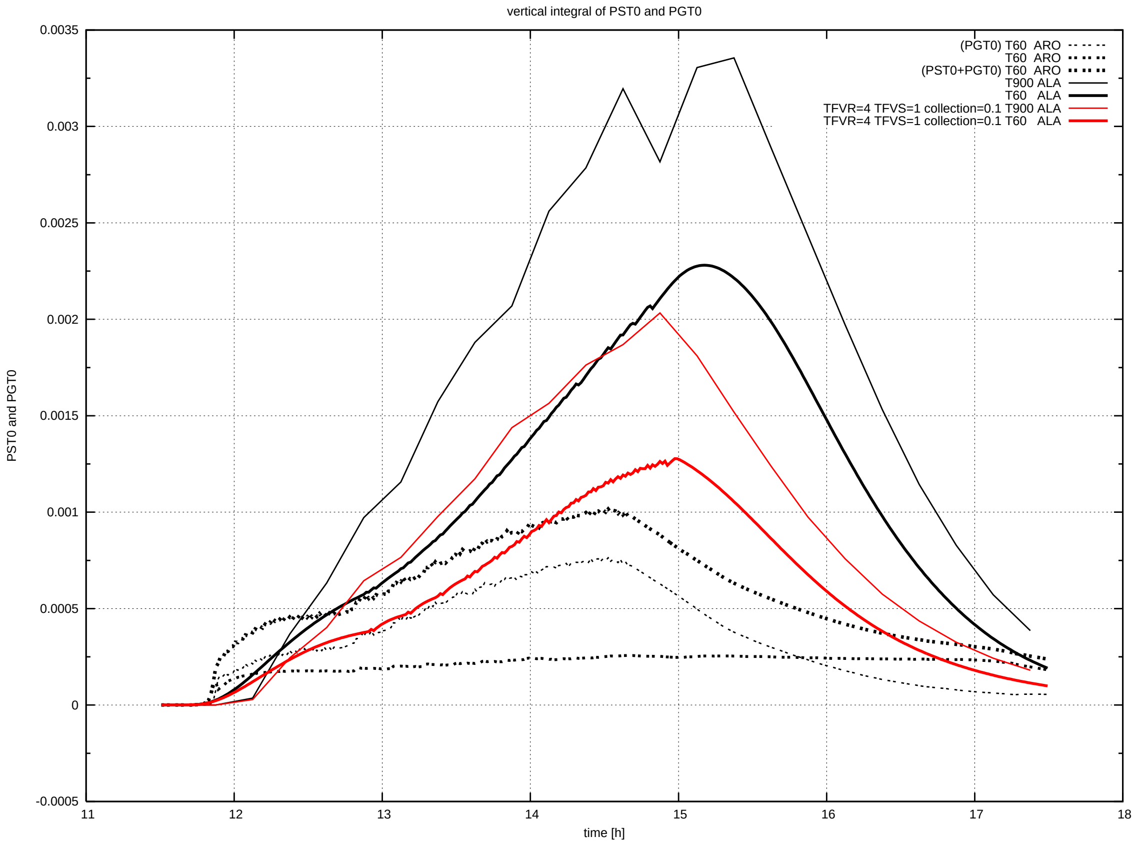

Fig. 16 As Fig. 12 but for PST0

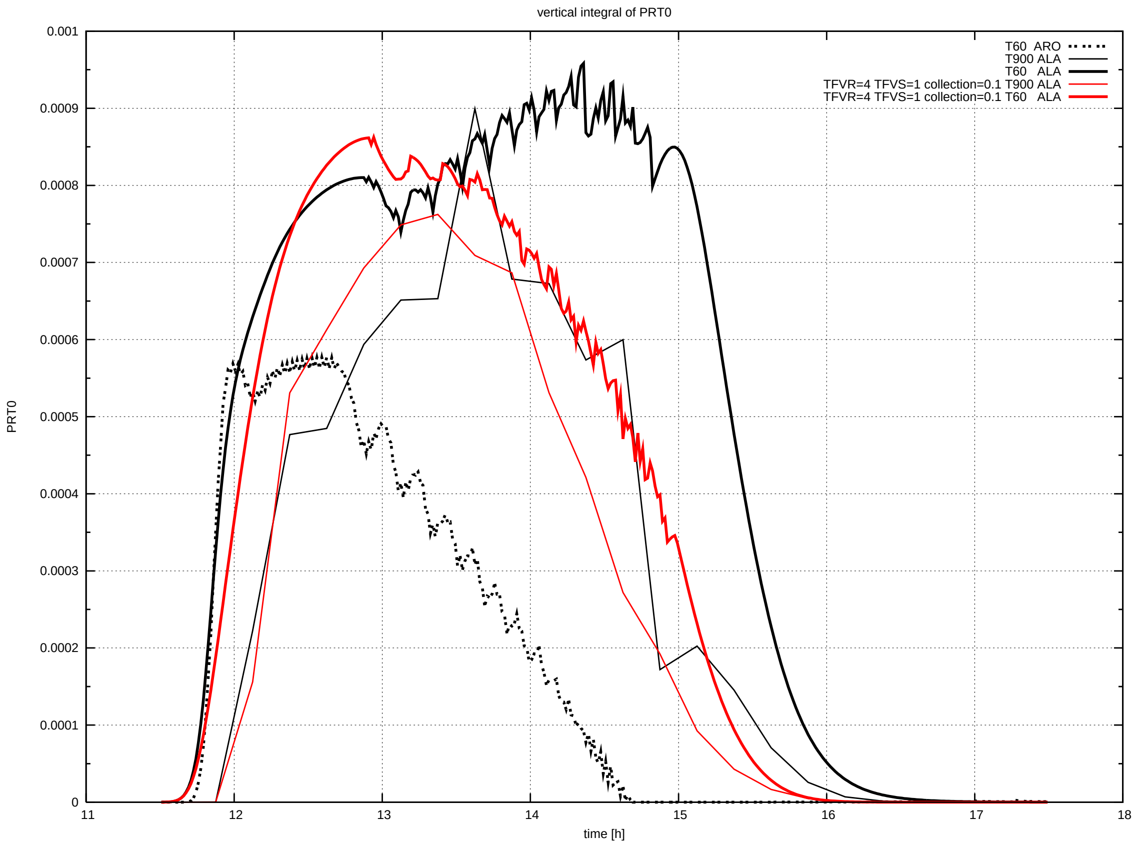

Fig. 17 As Fig. 12 but for PRT0

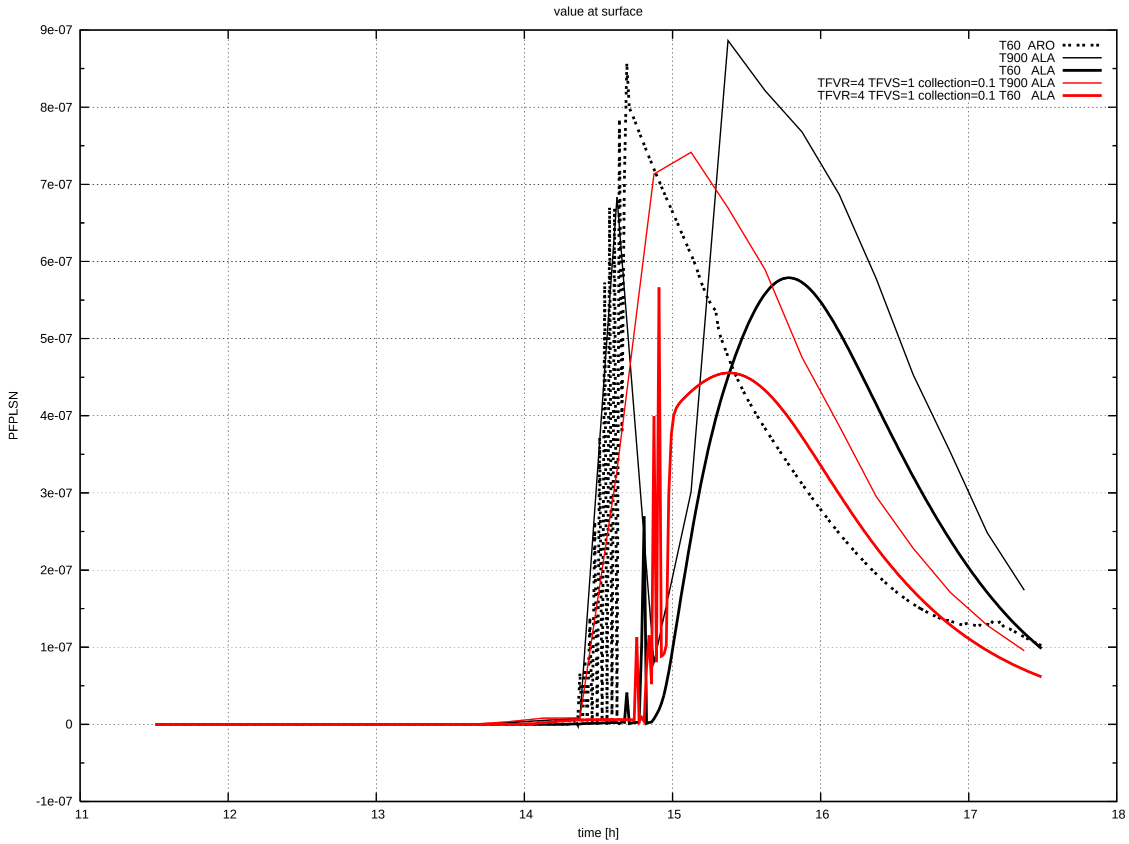

Fig. 18 As Fig. 12 but for `PFPLSN`

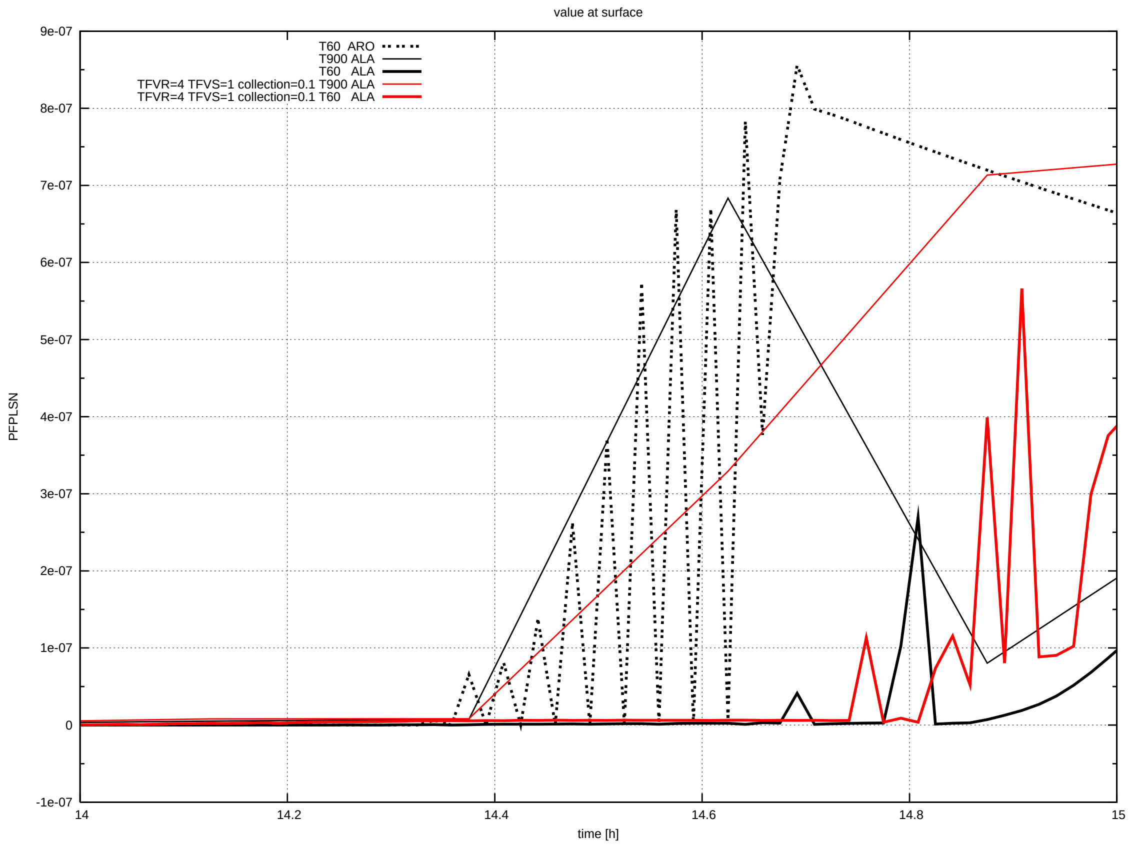

Fig. 19 As Fig. 18 but zoom

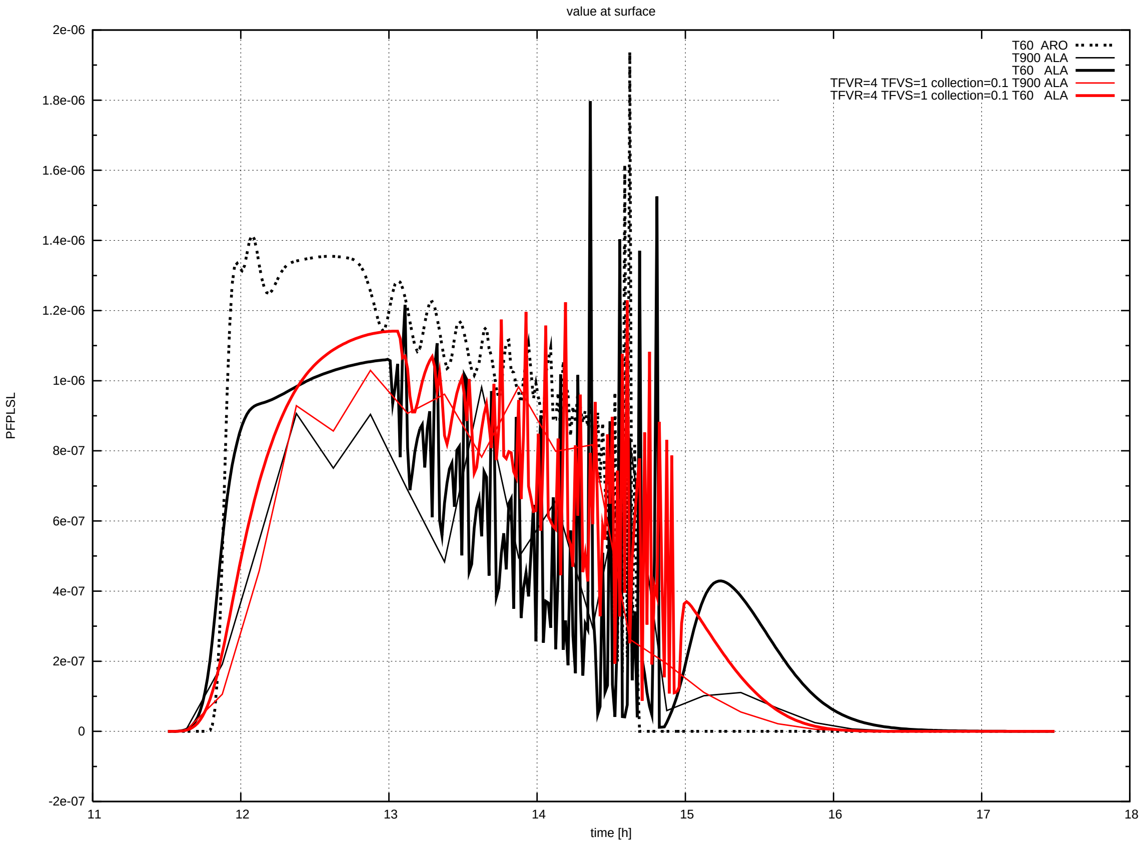

Fig. 20 As Fig. 12 but for PFPLSL

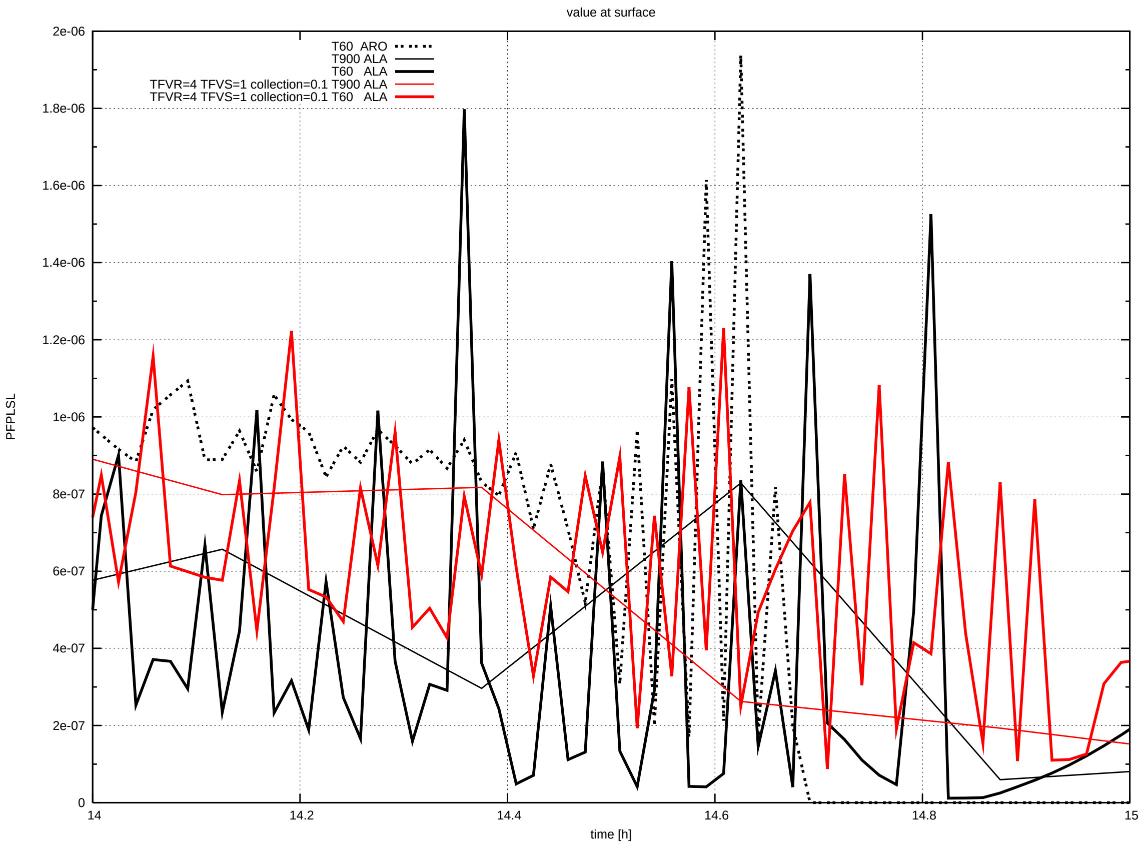

Fig. 21 As Fig. 20 but zoom

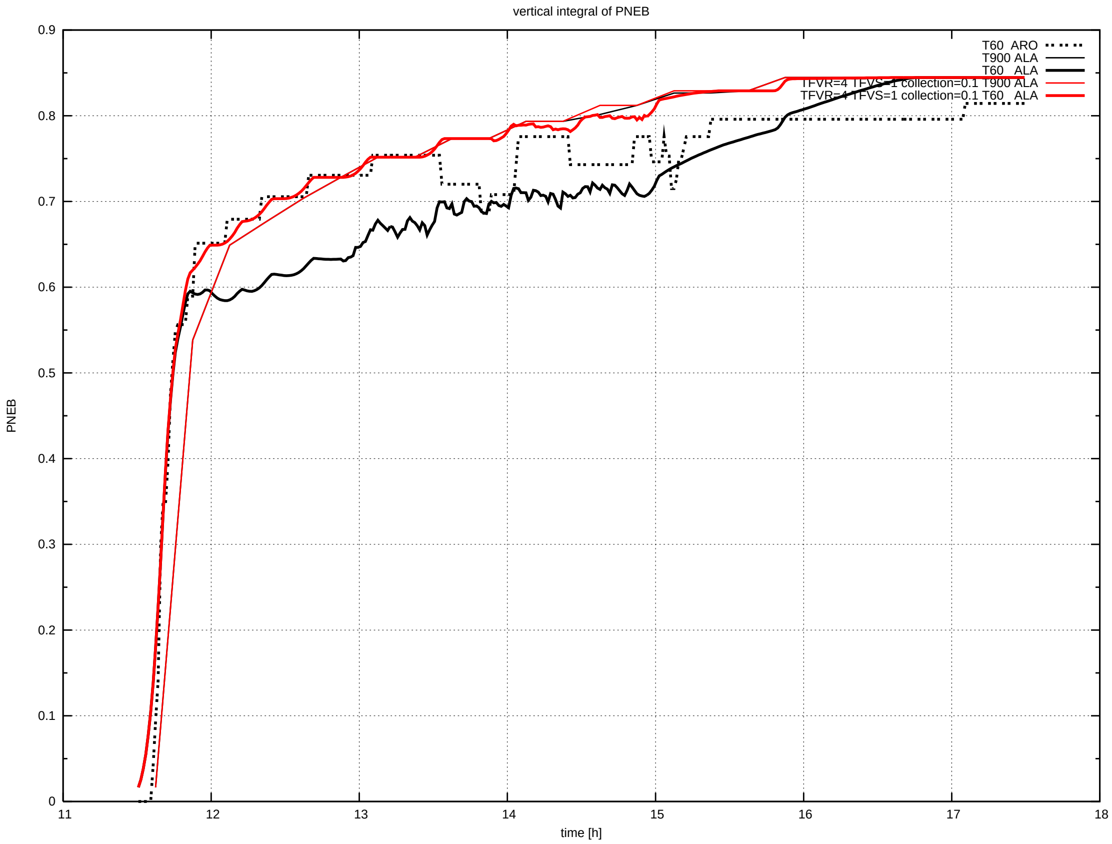

Fig. 22 As Fig. 12 but for `PNEB`

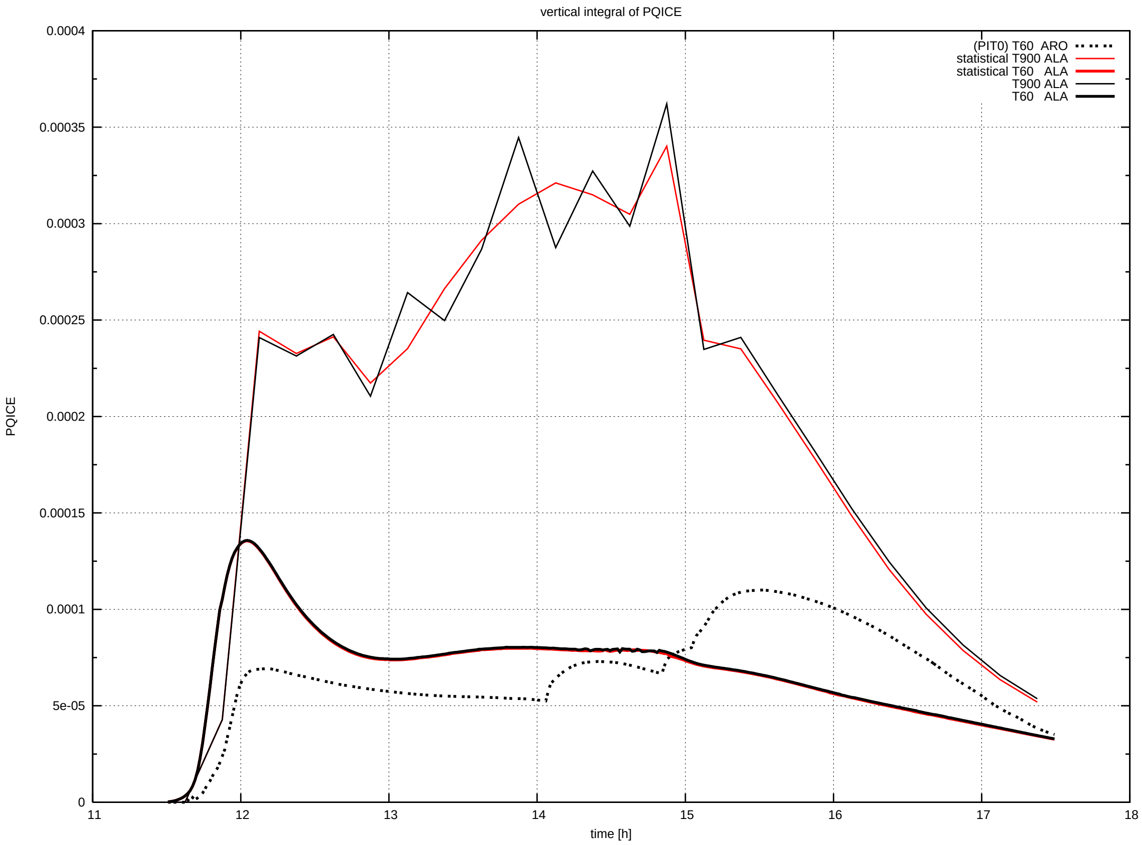

Fig. 23 The influence of precipitation scheme involved in ALADIN NWP model (statistical sedimentation in red solid line, semi-Lagrangian approach in black solid line) on `PQICE` variable for default values of input parameters in comparison with AROME NWP output (black dashed line)

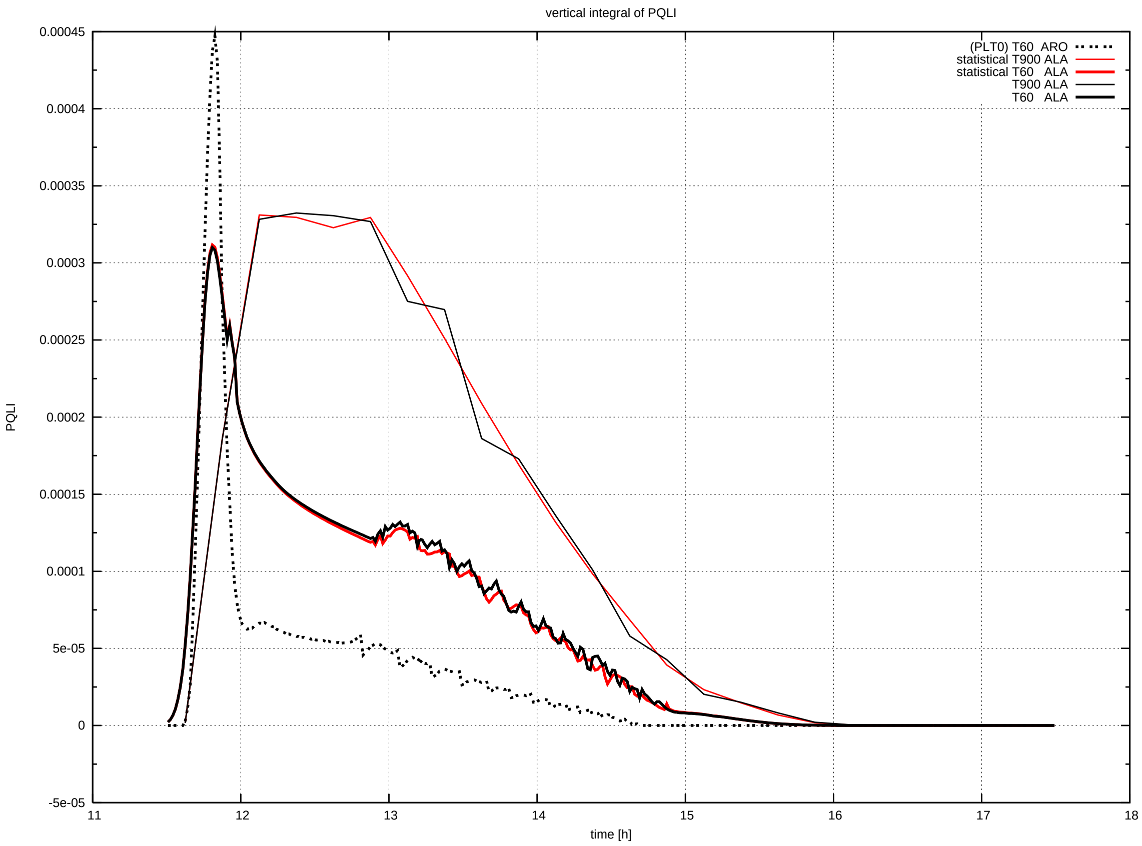

Fig. 24 As Fig. 23 but for `PQLI`

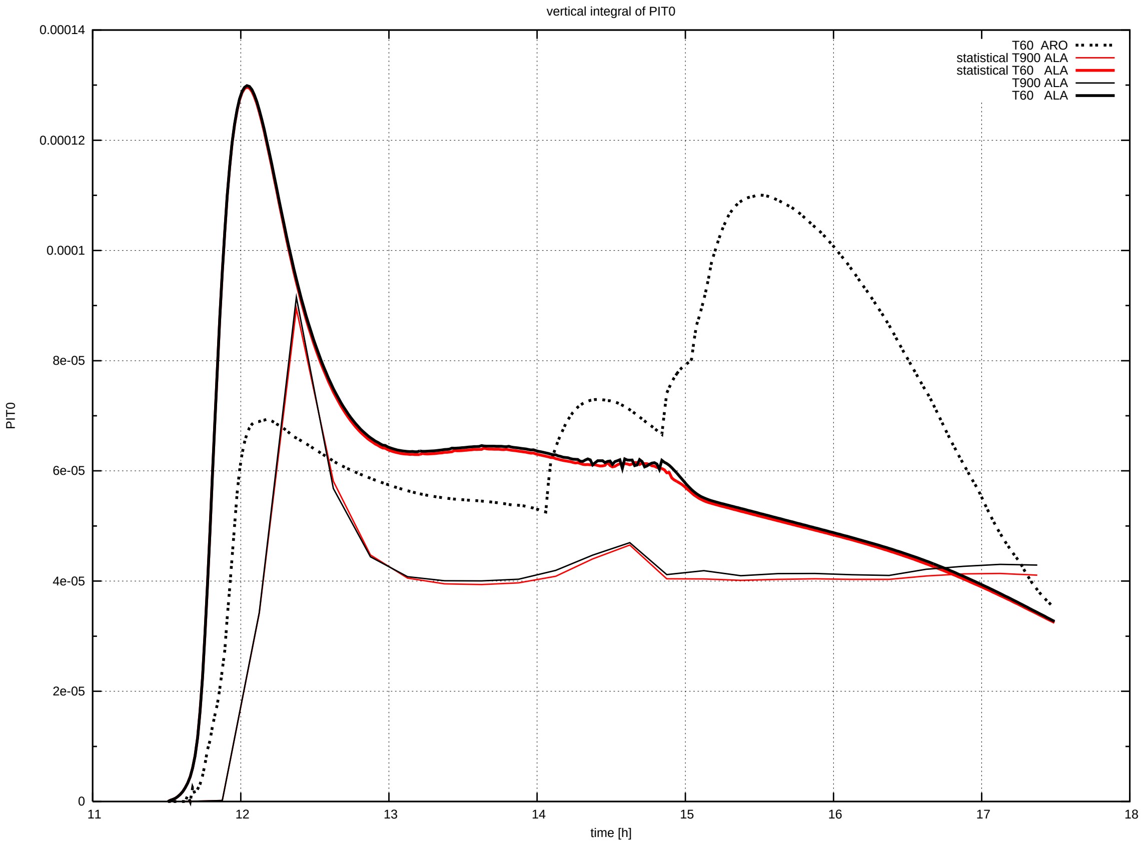

Fig. 25 As Fig. 23 but for PIT0

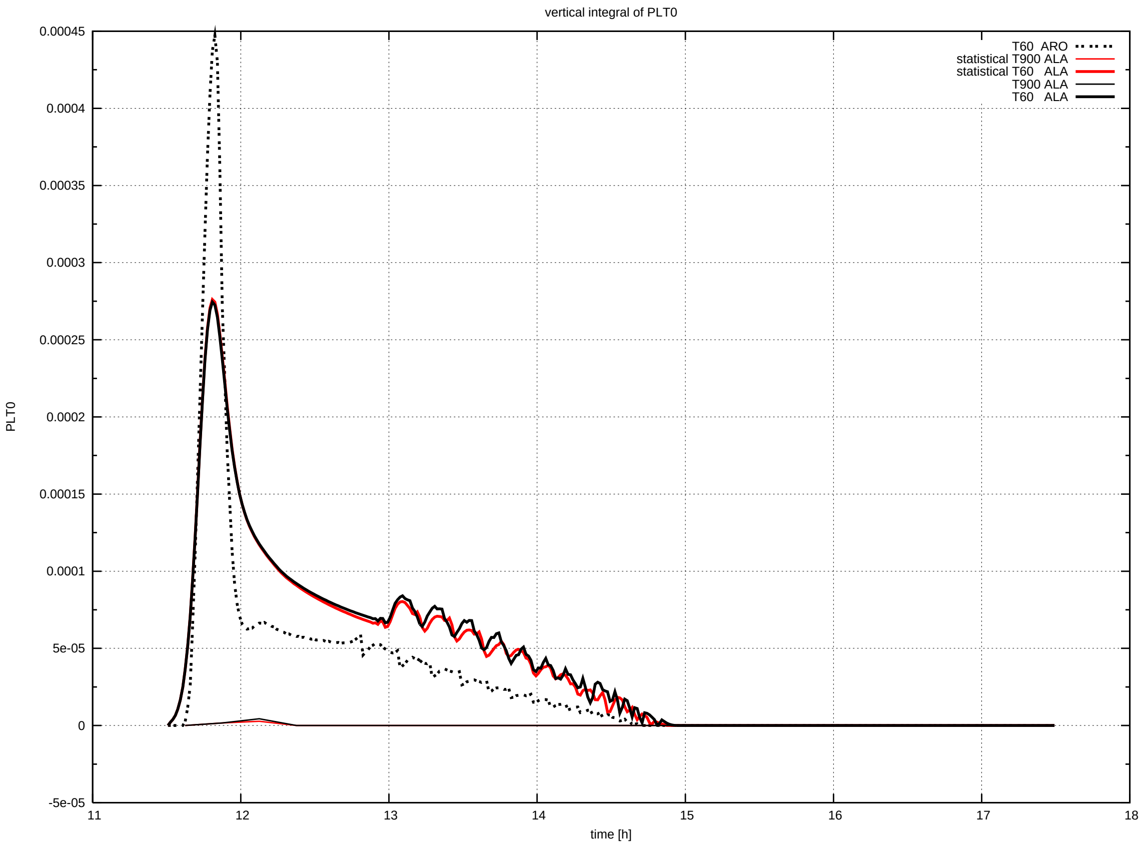

Fig. 26 As Fig. 23 but for PLT0

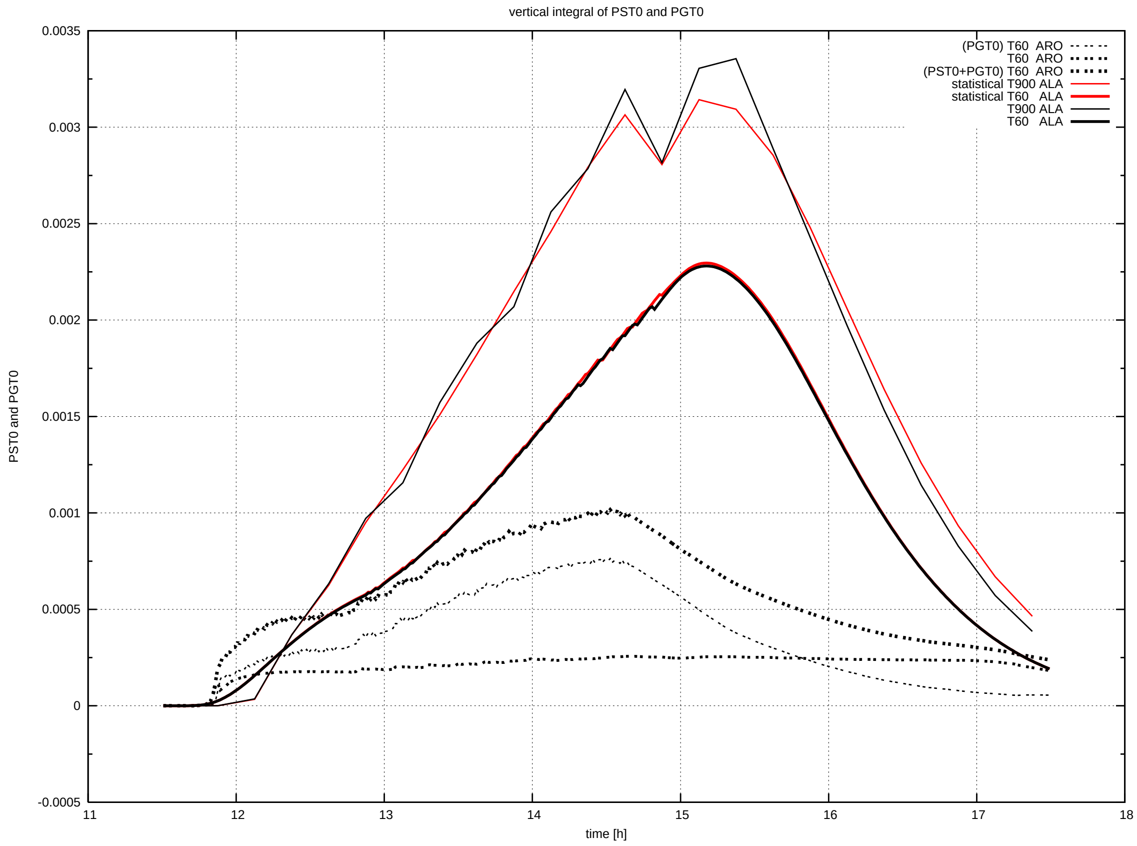

Fig. 27 As Fig. 23 but for PST0

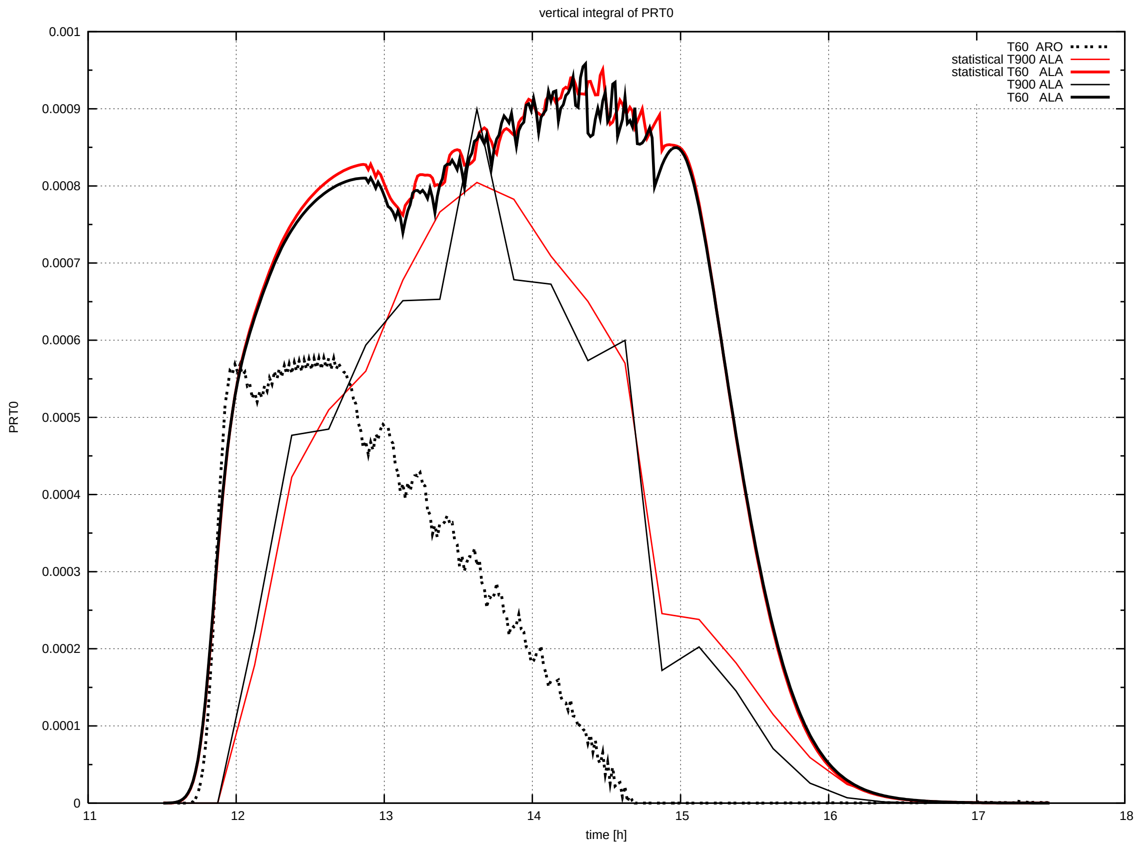

Fig. 28 As Fig. 23 but for PRT0

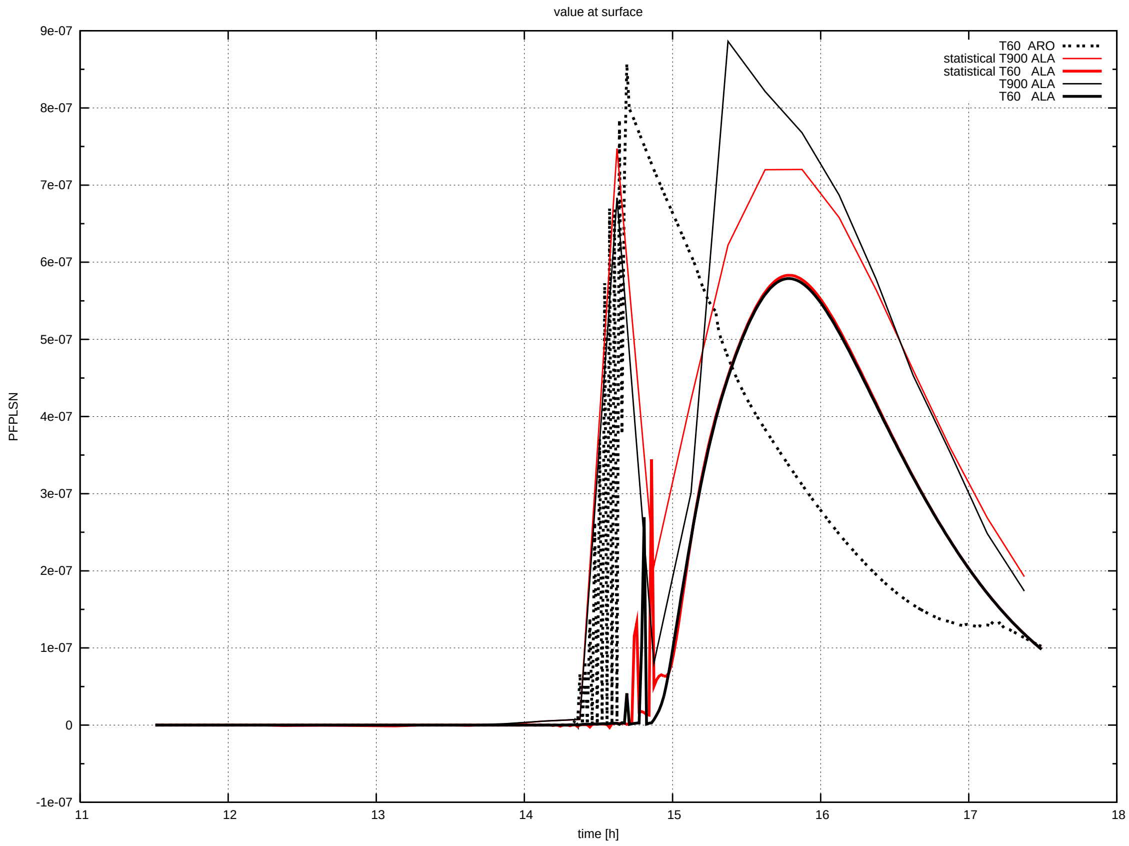

Fig. 29 As Fig. 23 but for PFPLSN

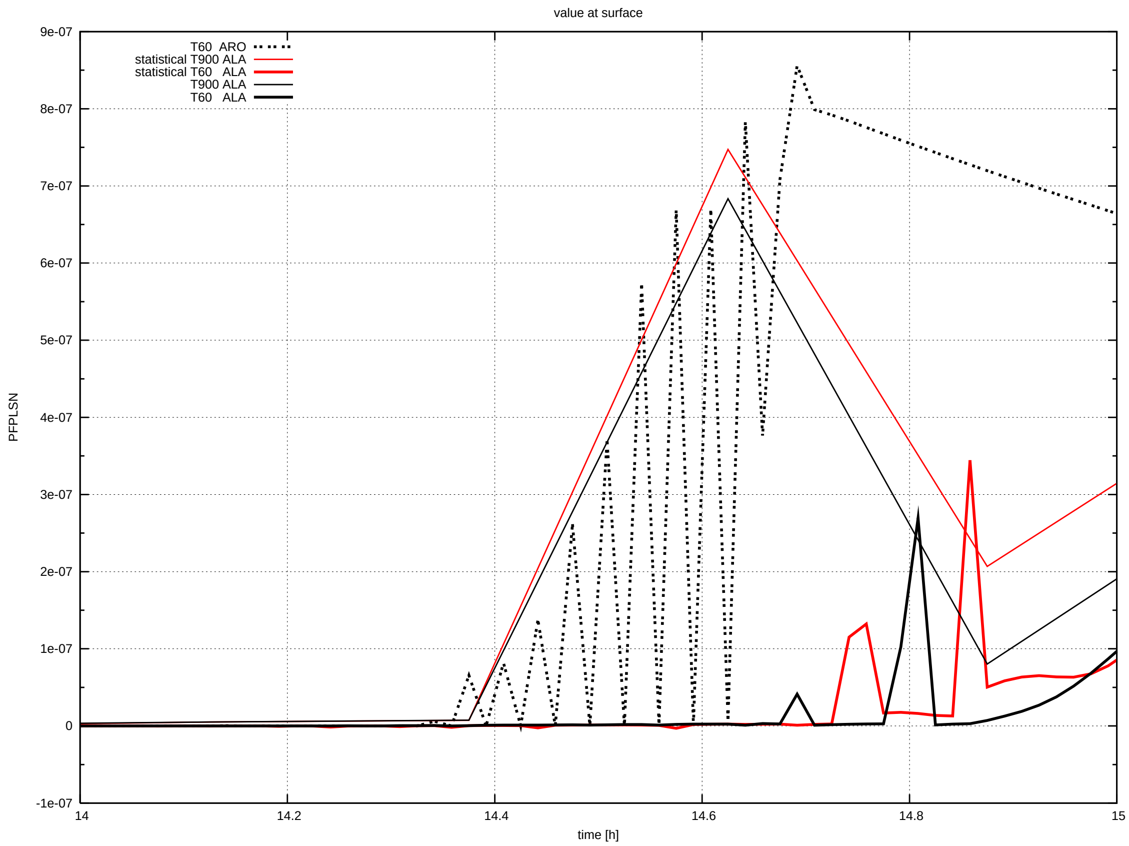

Fig. 30 As Fig. 29 but zoom

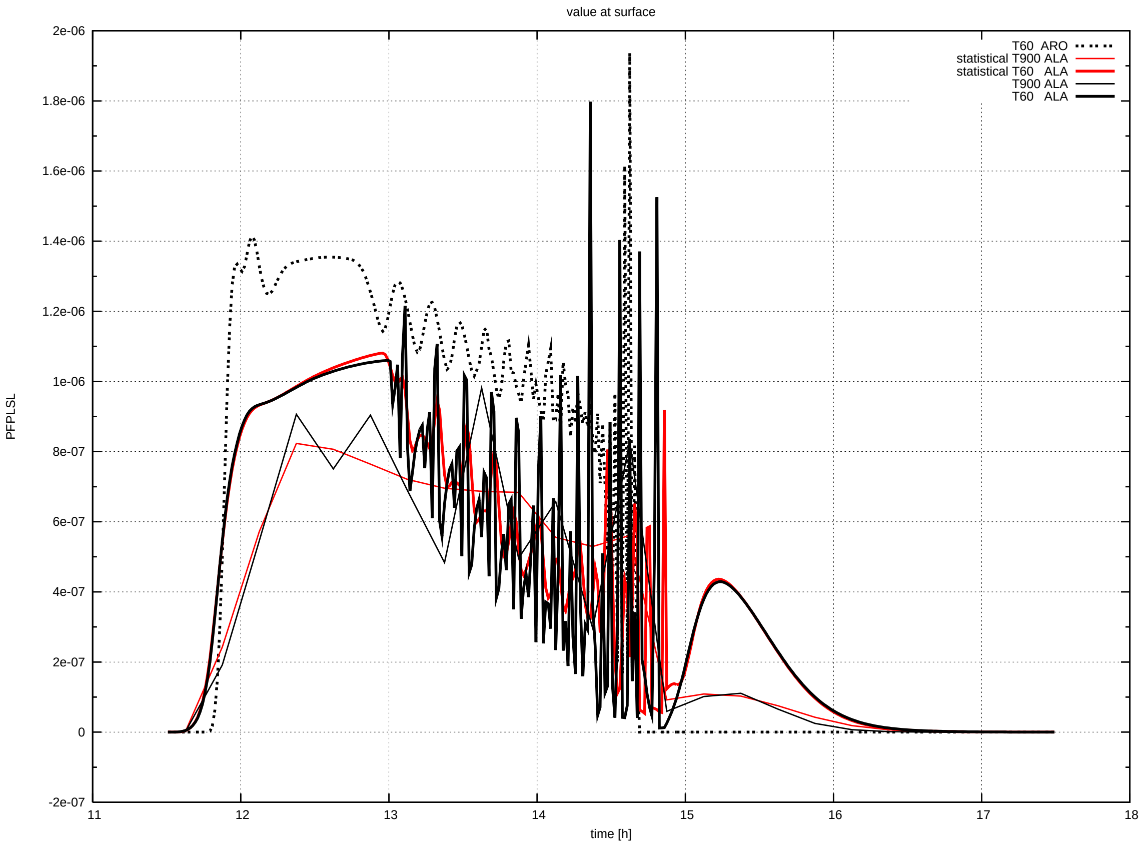

Fig. 31 As Fig. 23 but for PFPLSL

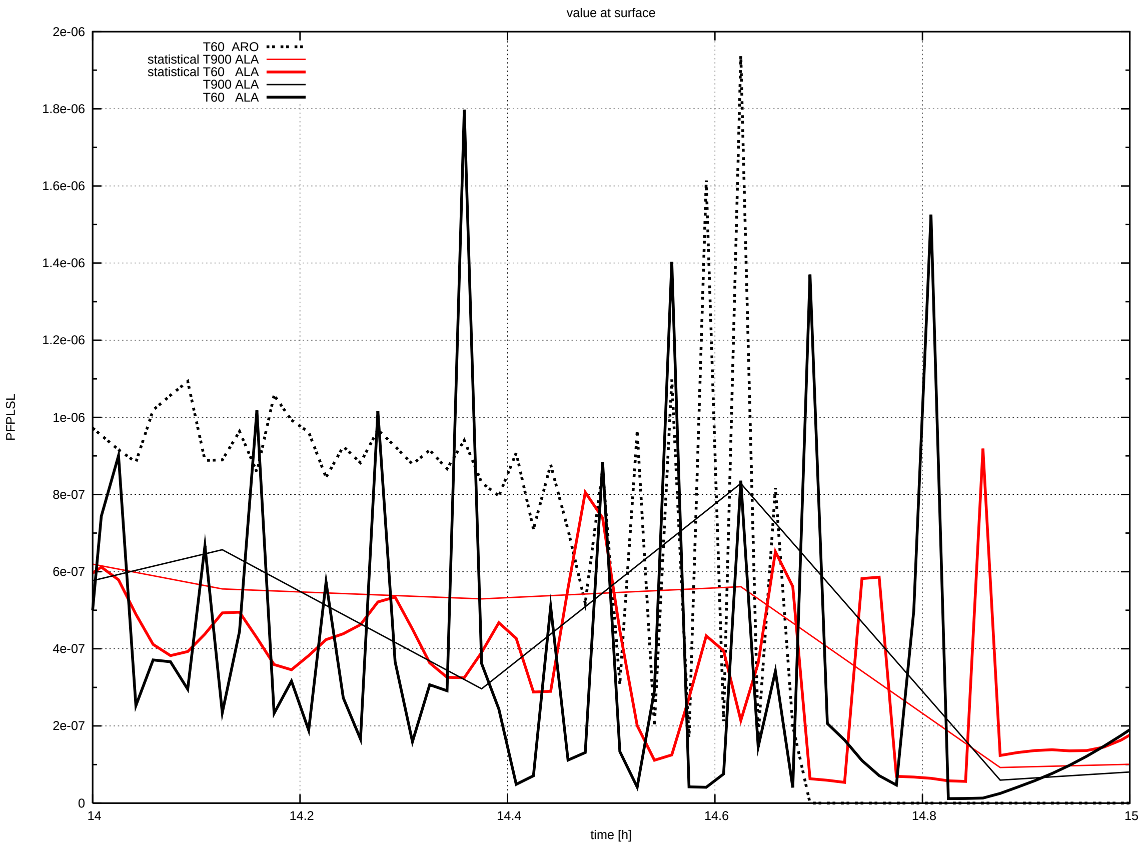

Fig. 32 As Fig. 31 but zoom

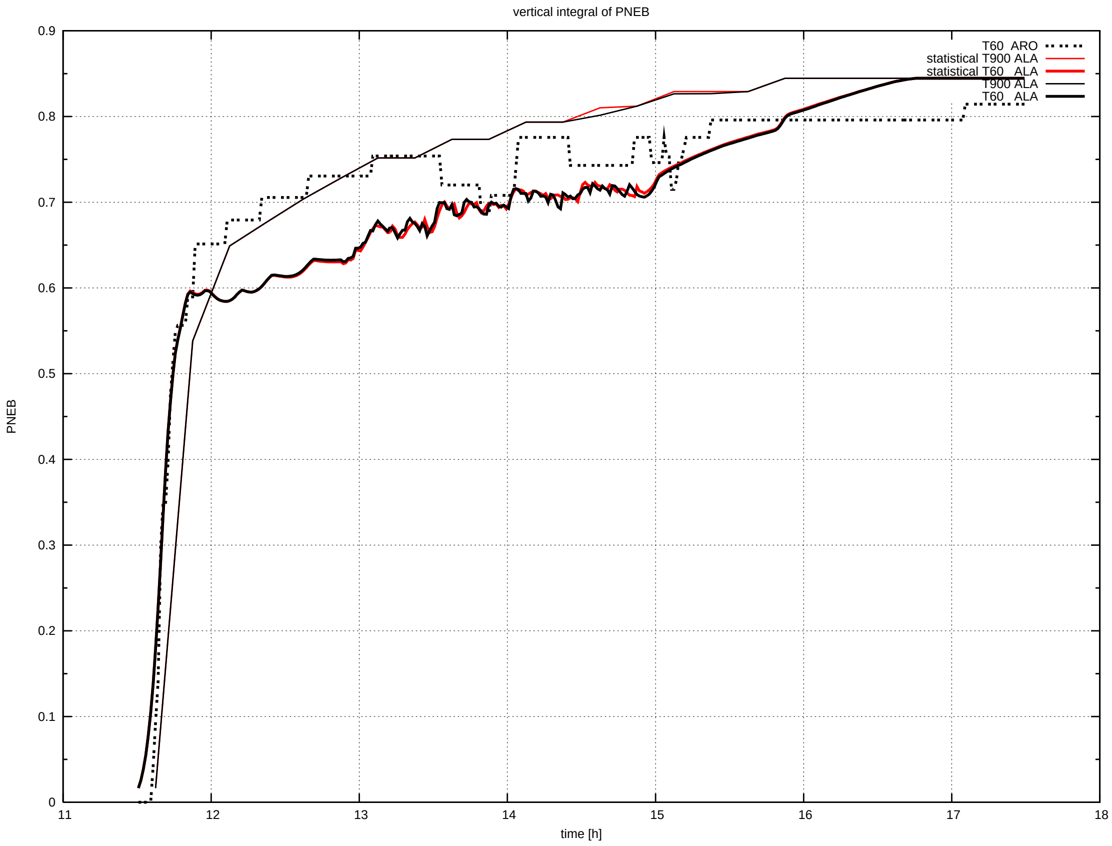

Fig. 33 As Fig. 23 but for `PNEB`

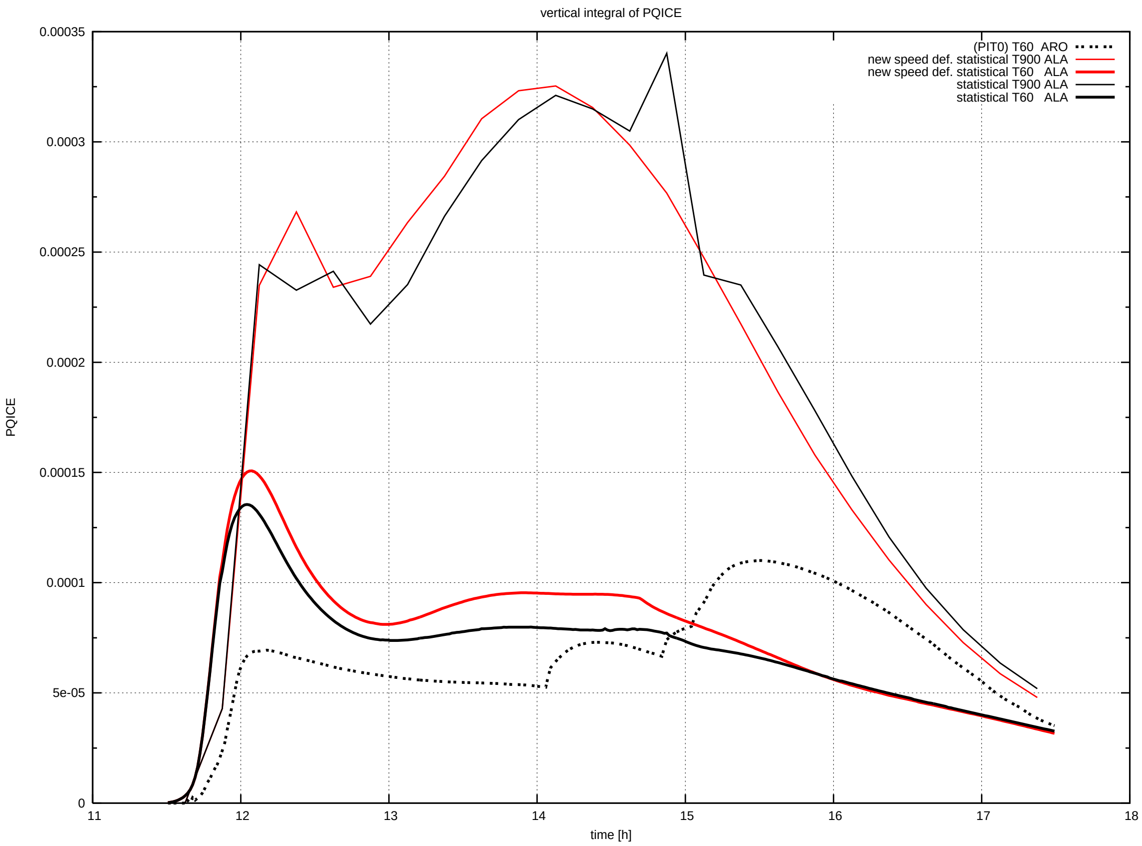

Fig. 34 The influence of falling speed on `PQICE` variable for default values of input parameters and for statistical sedimentation approach in precipitation scheme. The AROME NWP output (black dashed line) is also shown

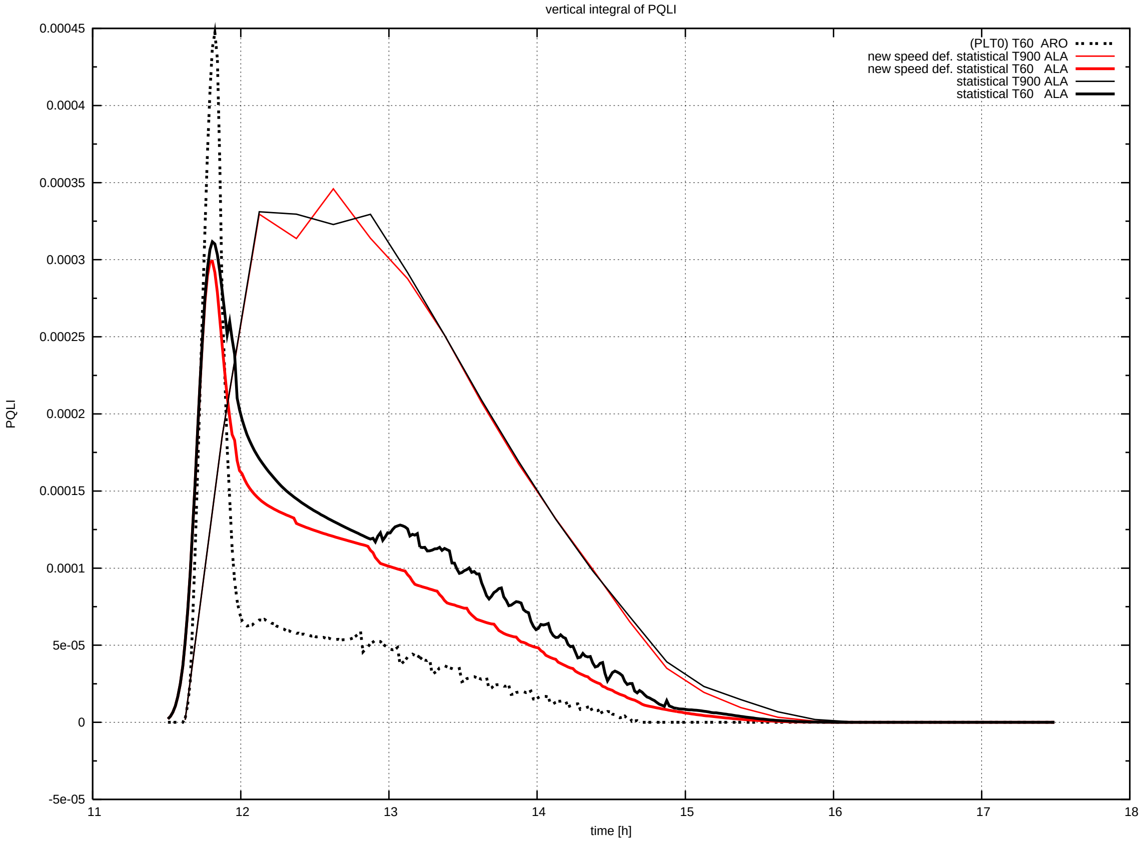

Fig. 35 As Fig. 34 but for `PQLI`

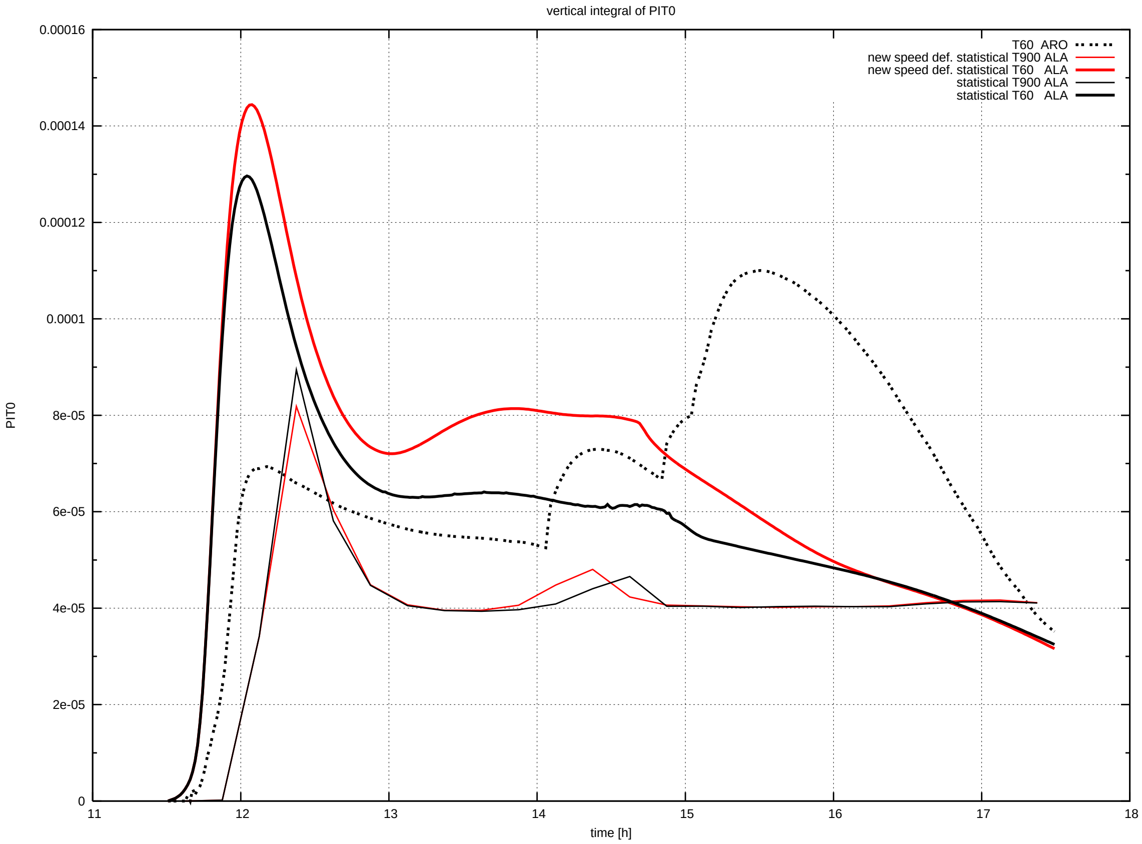

Fig. 36 As Fig. 34 but for `PIT0`

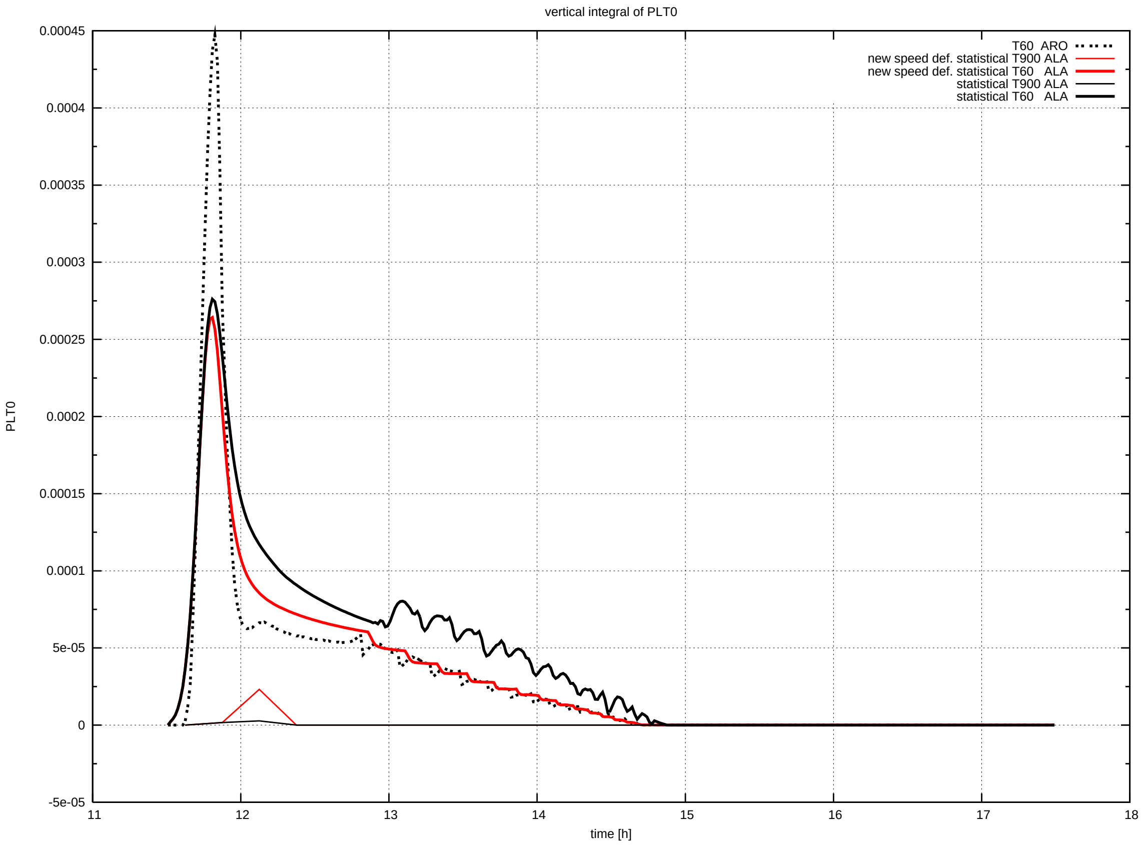

Fig. 37 As Fig. 34 but for PLT0

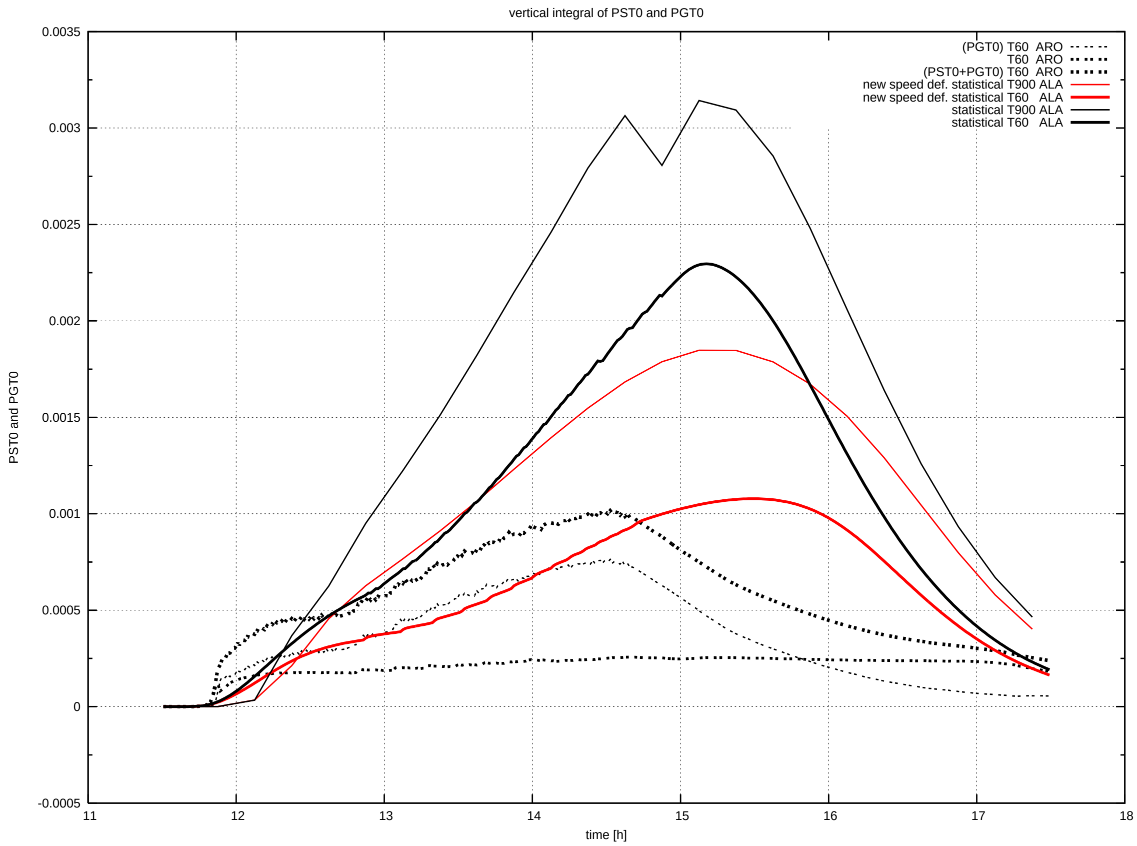

Fig. 38 As Fig. 34 but for PST0

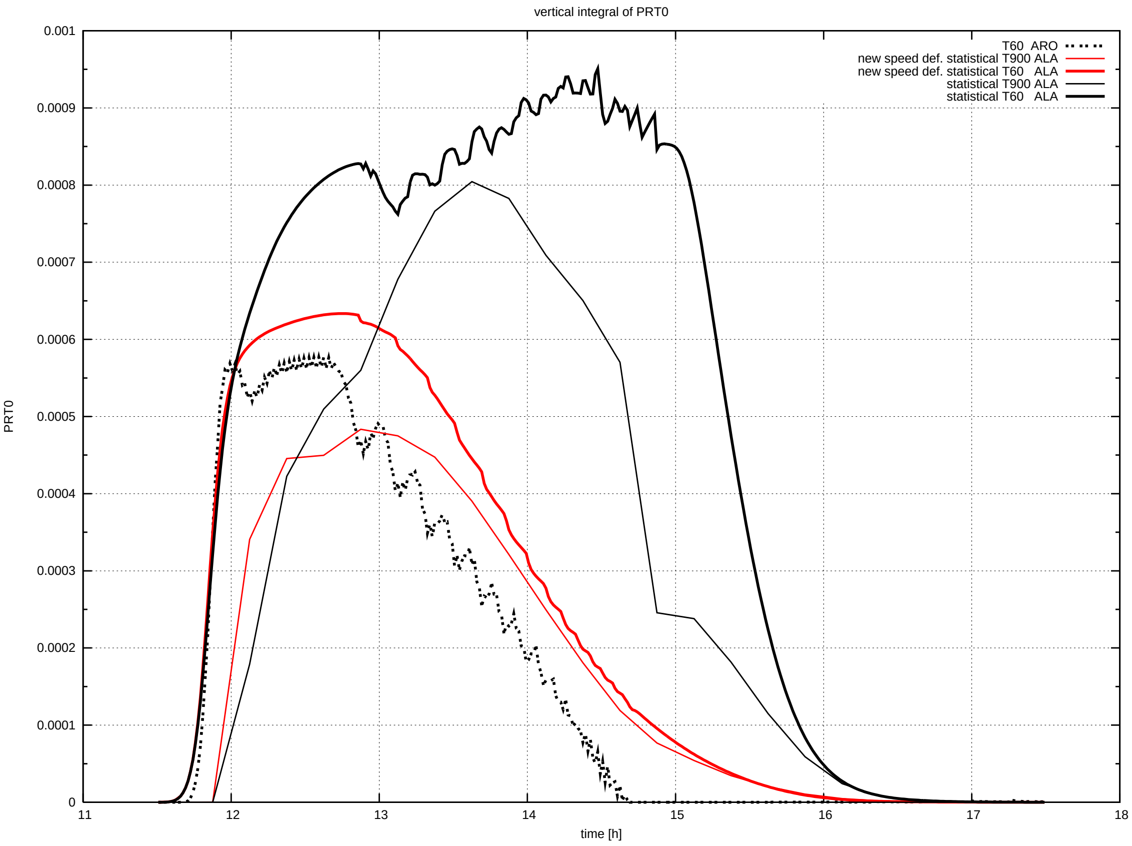

Fig. 39 As Fig. 34 but for PRT0

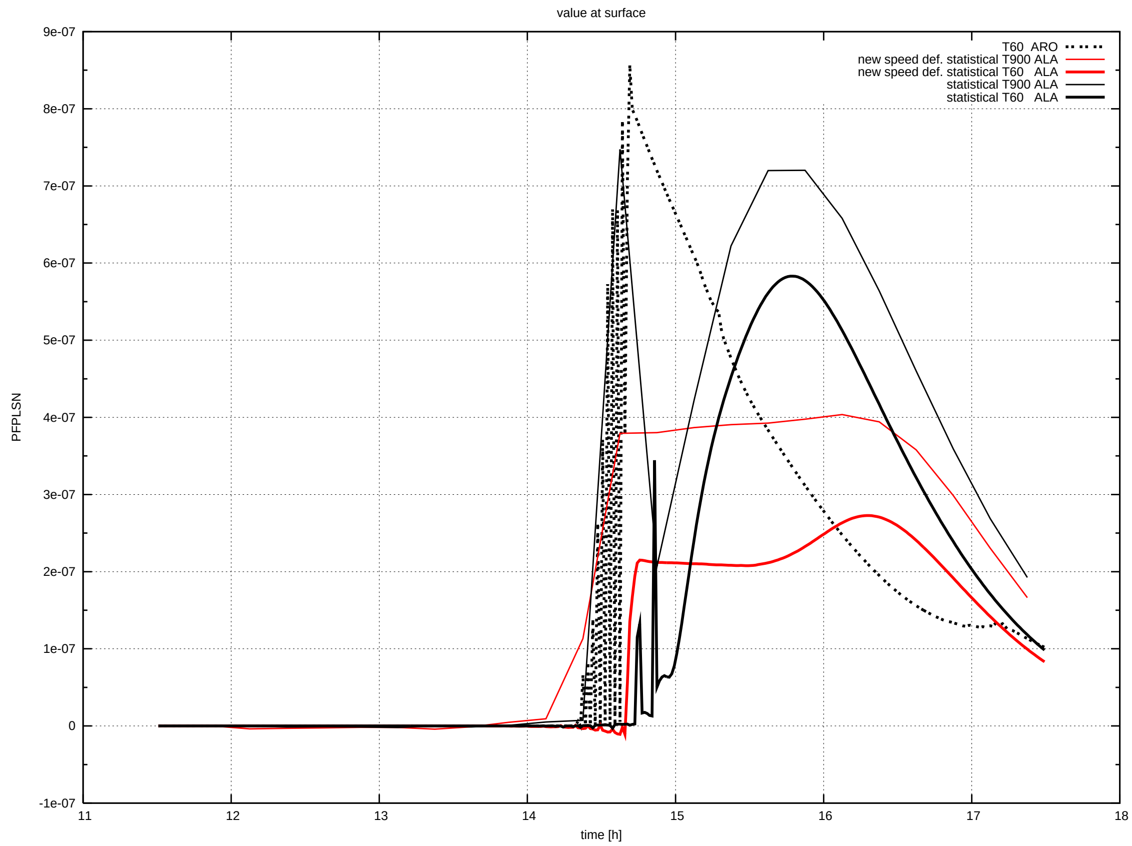

Fig. 40 As Fig. 34 but for PFPLSN

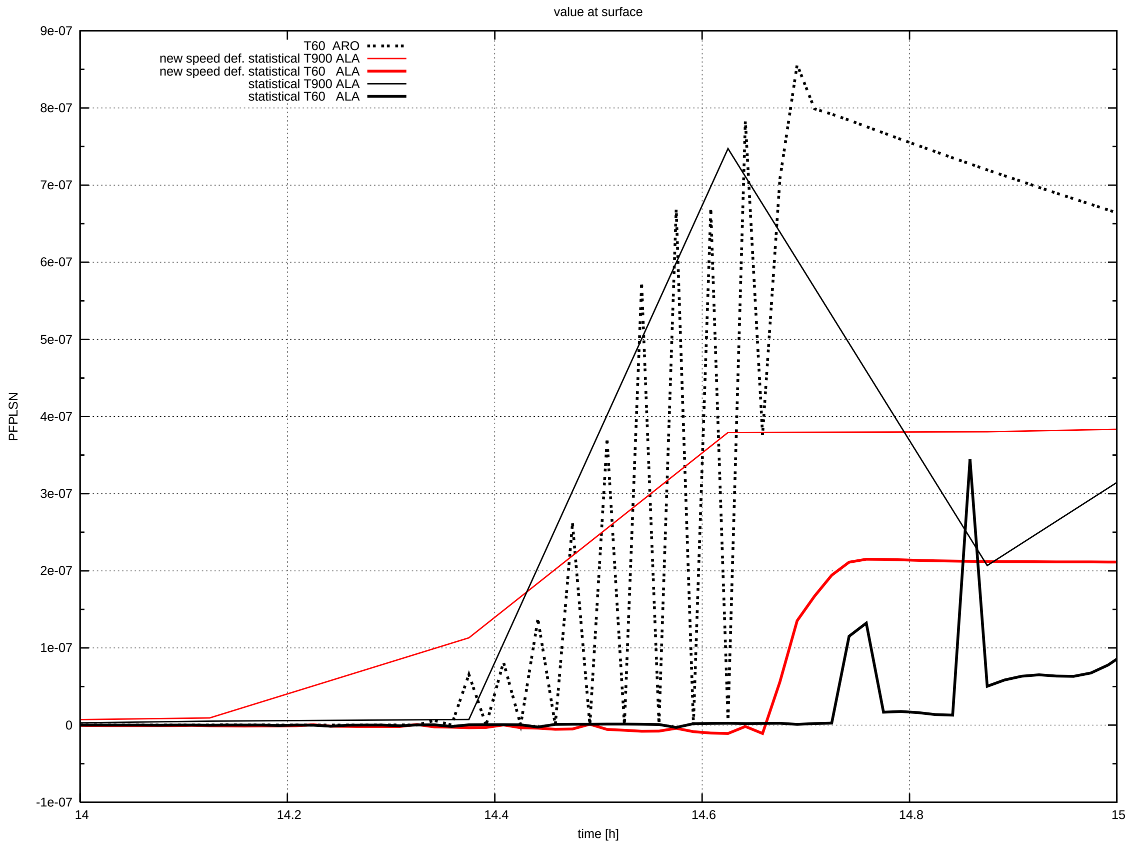

Fig. 41 As Fig. 40 but zoom

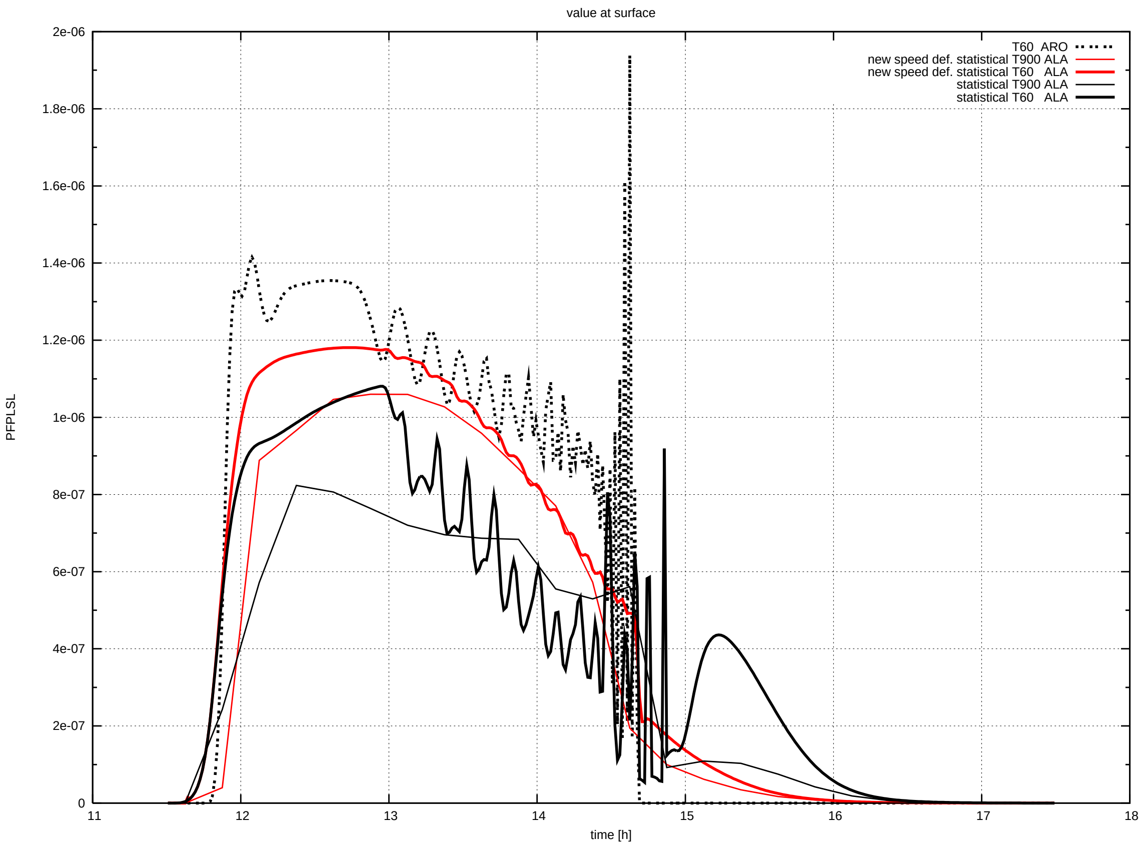

Fig. 42 As Fig. 34 but for PFPLSL

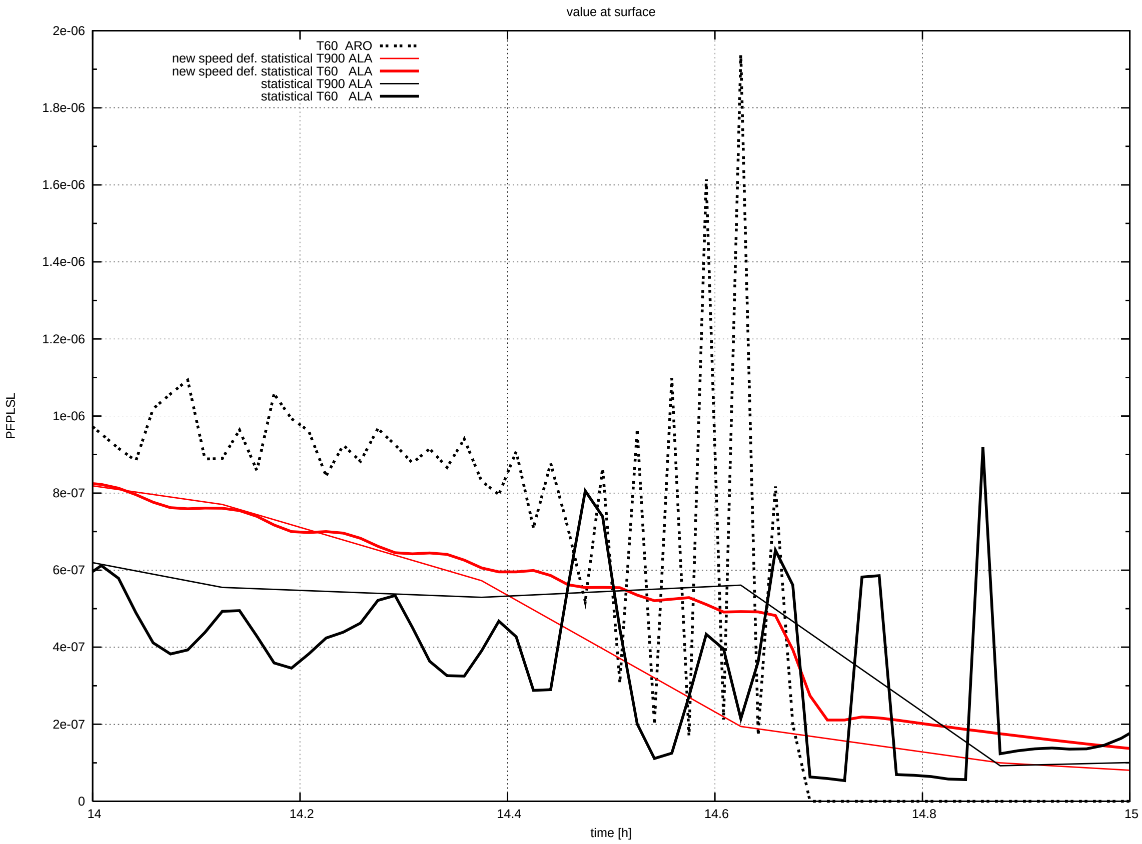

Fig. 43 As Fig. 42 but zoom

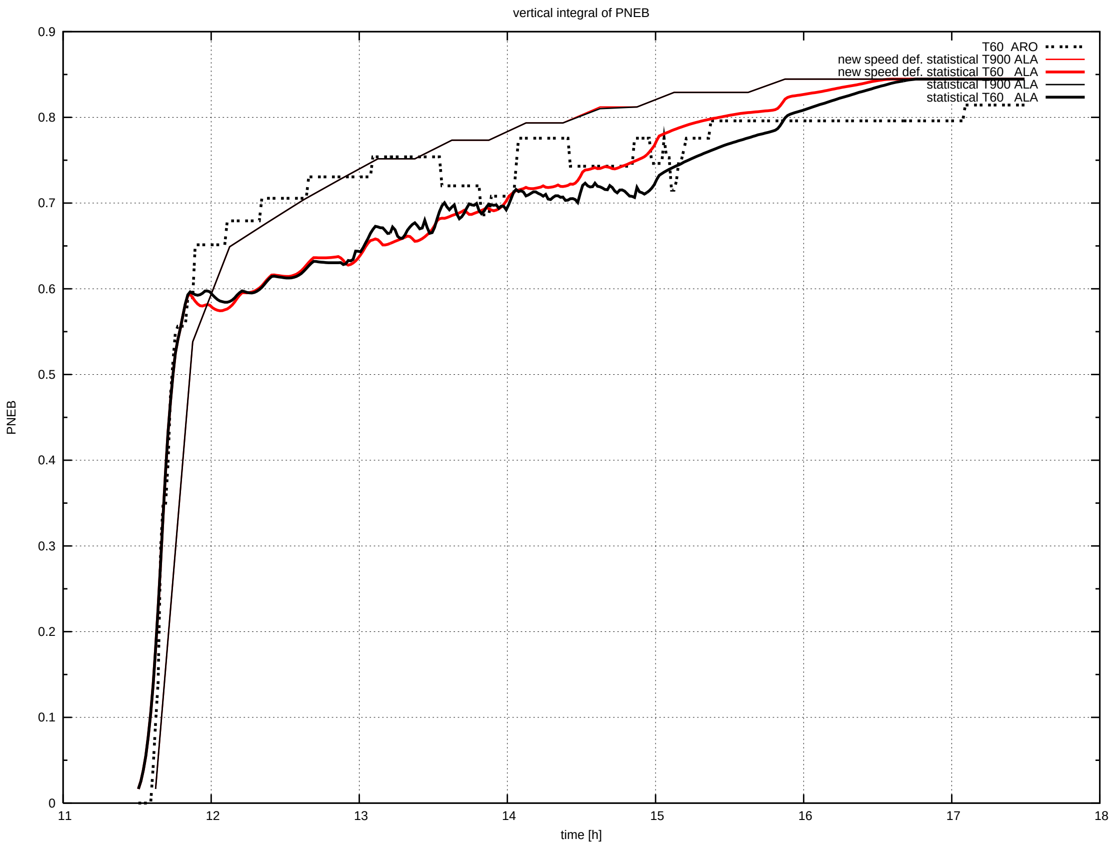

Fig. 44 As Fig. 34 but for `PNEB`

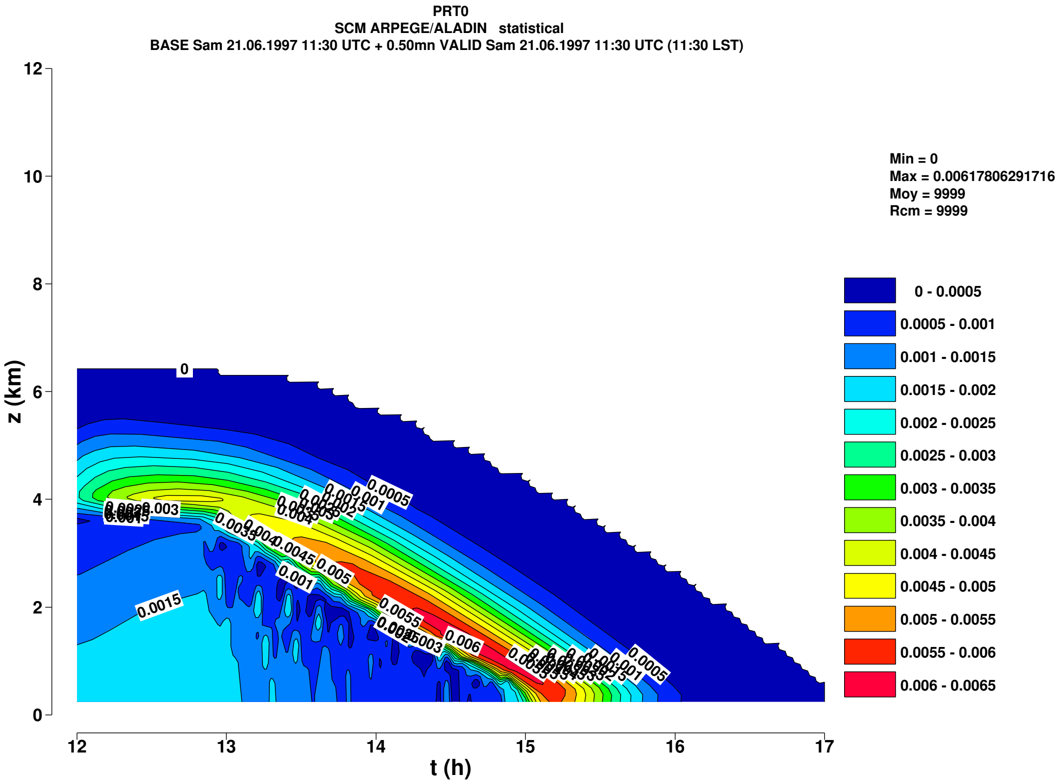

Fig. 45.a `PRT0` field variability with altitude and time for statistical scheme and default values of input parameters; time step T60.

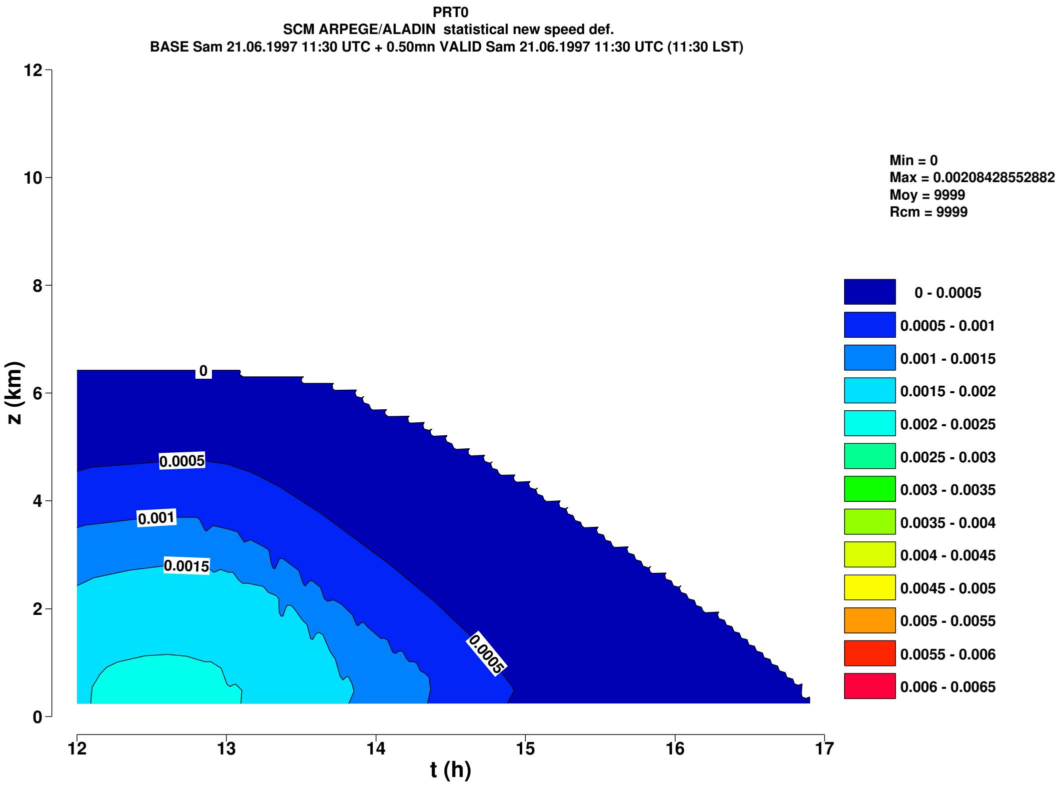

Fig. 45.b As Fig. 45.a but for new definition of falling speed introduced

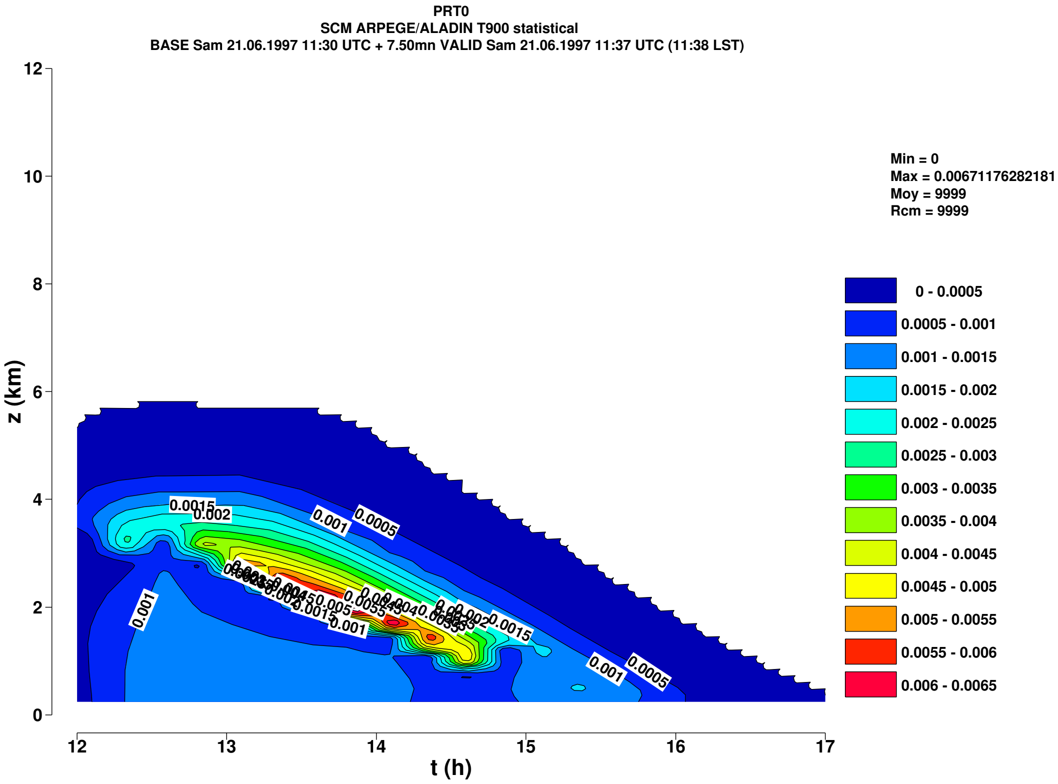

Fig. 46.a As Fig. 45.a but for T900.

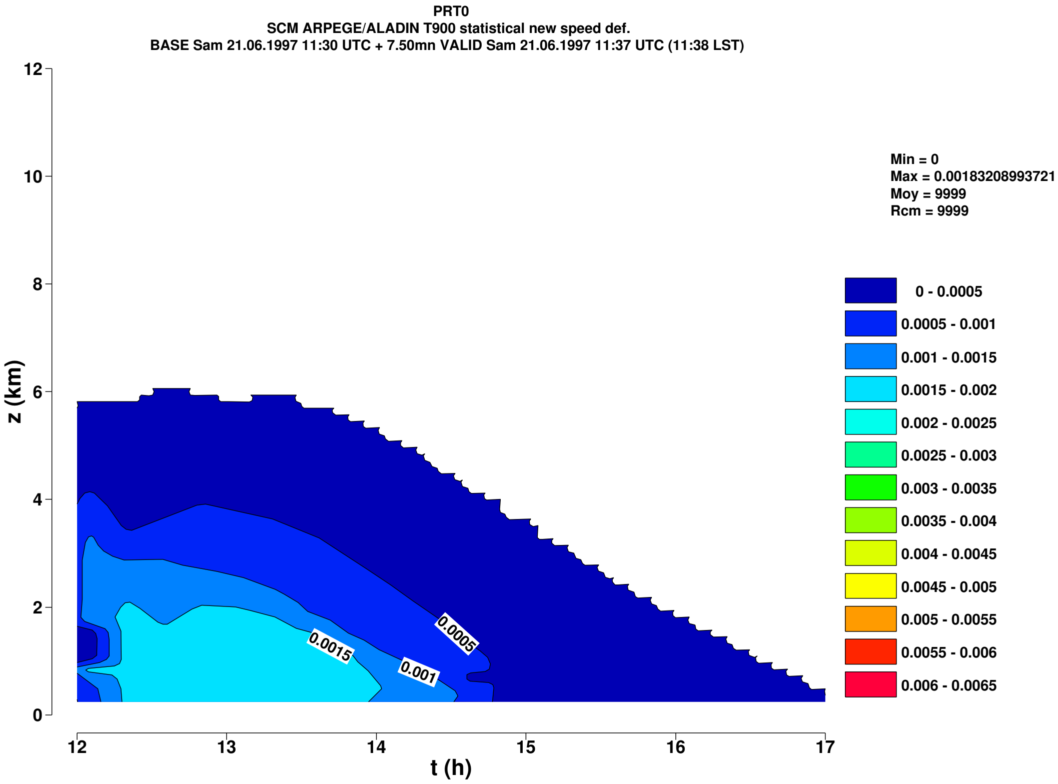

Fig. 46.b As Fig. 45.b but for T900.

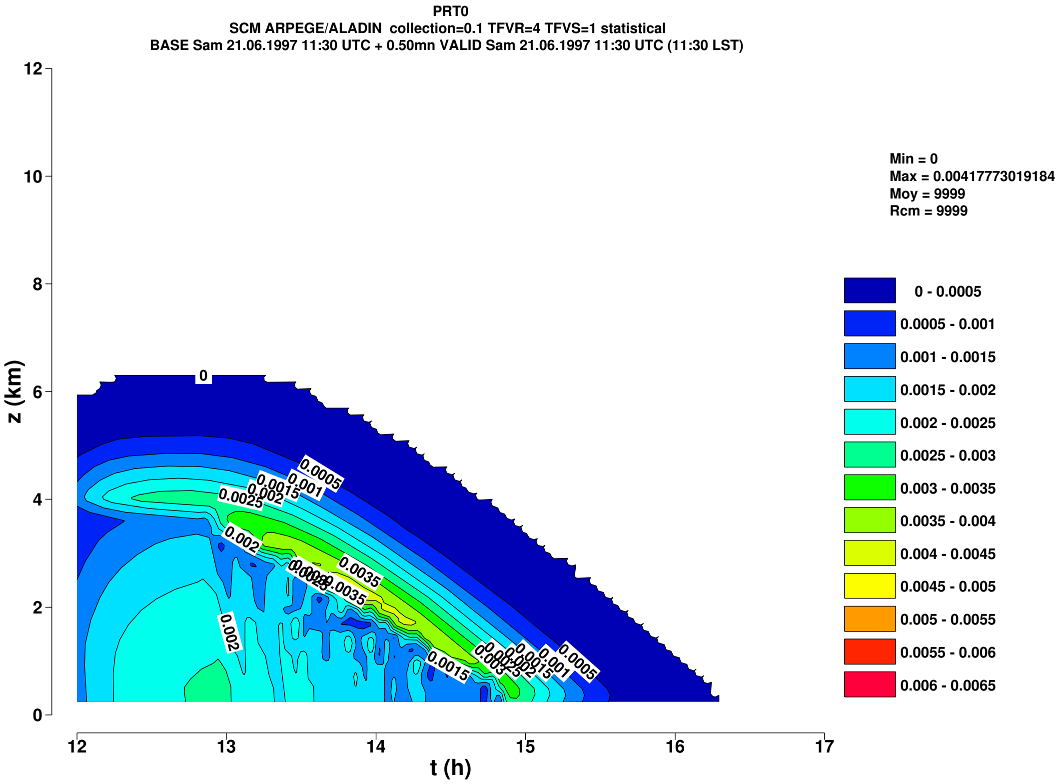

Fig. 47.a `PRT0` field variability with altitude and time for statistical scheme; values of input parameters:`TFVR=4 TFVS=1 collection=0.1`; time step T60.

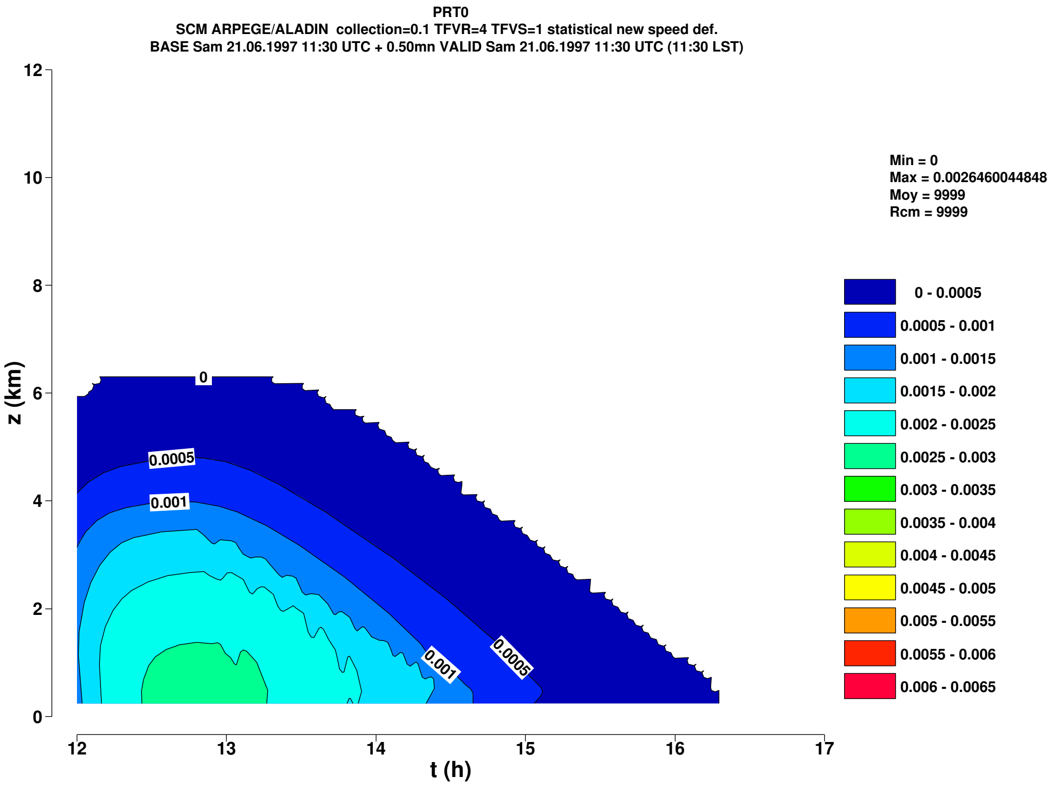

Fig. 47.b As Fig. 47.a but for new definition of falling speed introduced

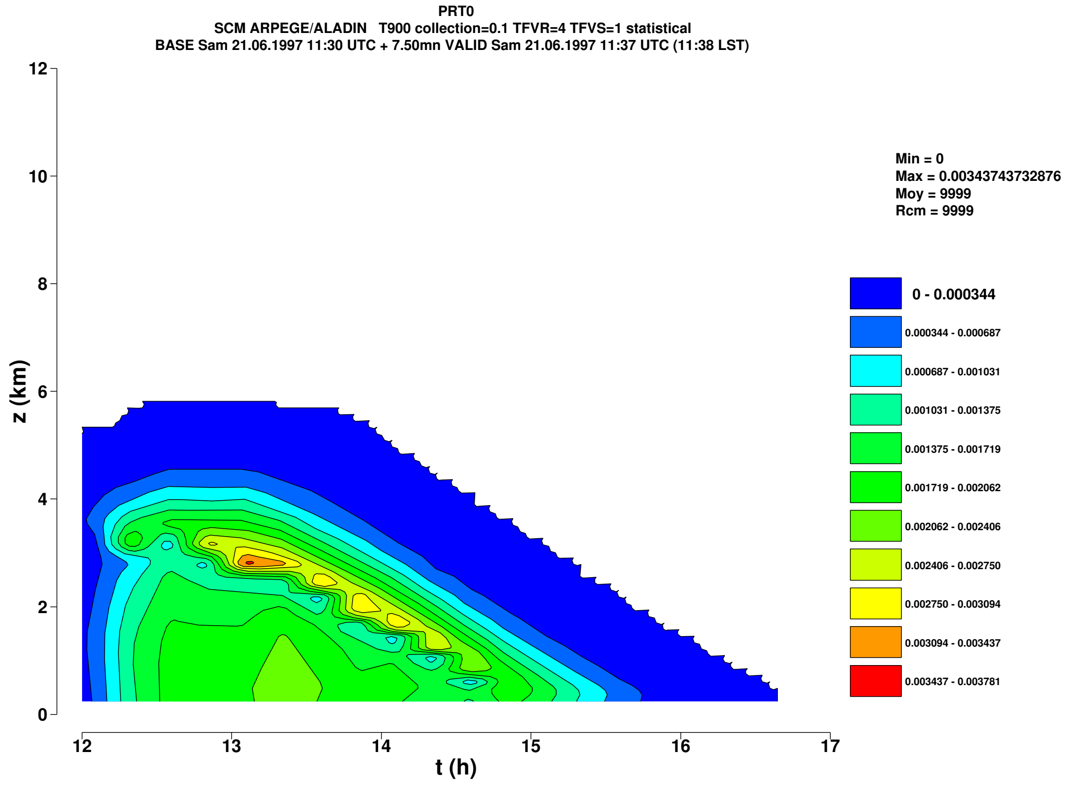

Fig. 48.a As Fig. 47.a but for T900.

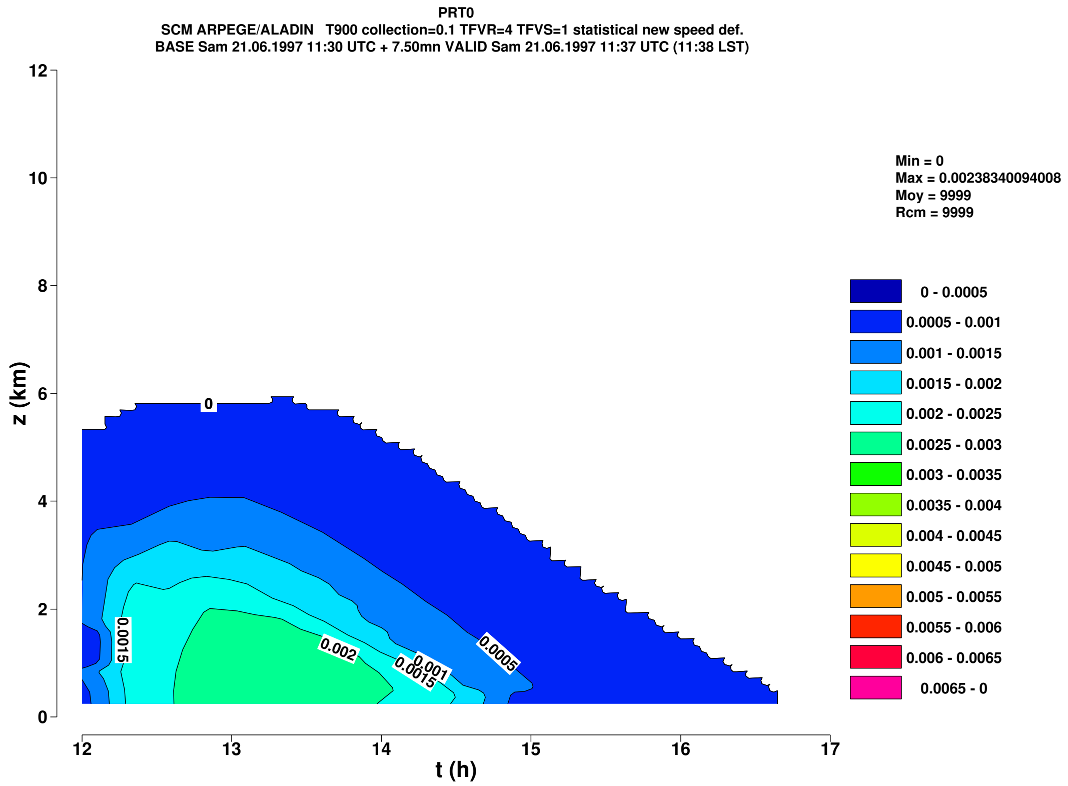

Fig. 48.b As Fig. 47.b but for T900.

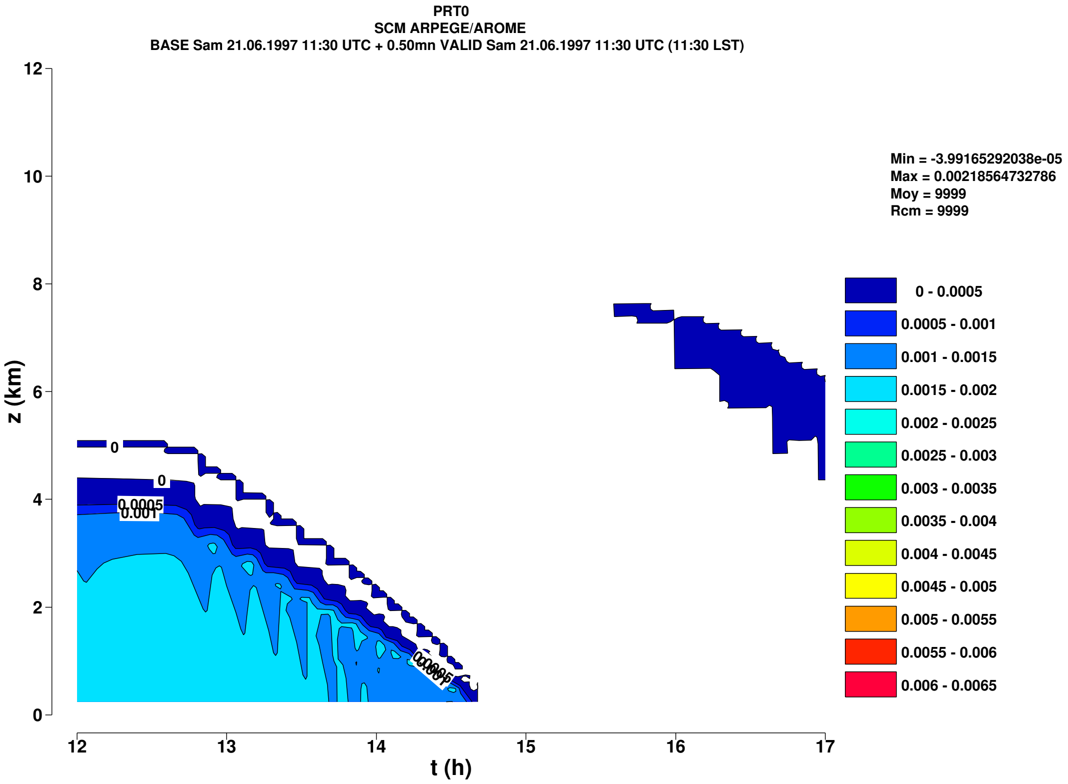

Fig. 49.a AROME NWP model output `PRT0` field variability with altitude and time.

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