Operational and other ALADIN activities in Meteorological and Hydrological Service of Croatia

Martina Tudor and Stjepan Ivatek-Šahdan

1. Summary

The operational suite on the old SGI machine (Mrcina) was stopped on 6th October 2006. It is still used for research due to difficulties in porting some research tools on the new SGI Altix. Since it is not maintained it will be switched of permanently.

The new SGI machine (Viking) has been upgraded with 8 processors in July 2006 reaching total 24 CPUs, that caused some disturbance in the operational suite but now it is the only machine used for the operational 72 hour forecast.

The backup for the transfer of the LBC files is changed from RETIM to ecgate. The research on EPS, coupling of physics to dynamics, NH dynamics and SLHD in high resolution has continued. A version of Alaro0 is ported to Viking, it provides the second operational 72 hour forecast since 7th December 2006 on the same domain and resolution (8km) and on the same number of levels in the vertical as the reference (first) Aladin 72 hour forecast. Both are run twice a day, for 00 and 12 UTC starting from Arpege analyses with DFI.

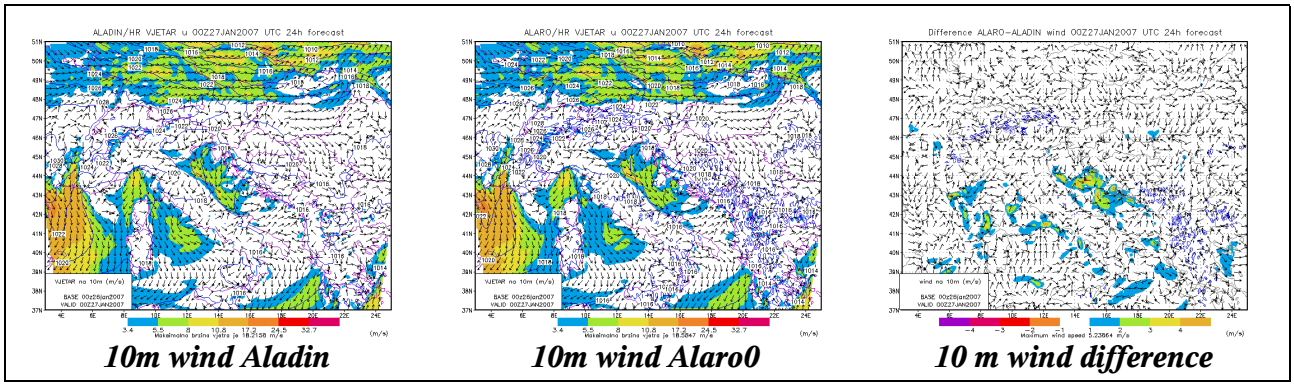
2. Operational suite

2.1 Status

ALADIN is run operationally run twice a day, for 00 and 12 UTC with two versions: the reference "CZ" package and the Alaro0 -3MT (with prognostic TKE, cloud water and ice, rain and snow, but without prognostic convective species). However, both are run with the old Geleyn radiation scheme since then the amount of low clouds increases and that is preferred by the forecasters. Coupling files are retrieved from ARPEGE (Meteo-France global model) via Internet and ecgate. Model resolution for both versions of Aladin is 8 km. Alaro is run only on the 8 km resolution Croatian domain and only reference Aladin is run on 2 km resolution for the high-resolution dynamical adaptation domains but with 2 different representations of orography, both without envelope. The execution of the suite is not controlled by the PBS Pro on the new SGI any more since the temporary licence for the 8 new processors expired on 14th November 2006 so the whole operational suite is run from cron. The research became more difficult without the scheduler so it is planned to devote one third of the machine to the long jobs only, and to run the operational suite using only 2/3 of the available CPUs.

Initialisation of ALADIN on Croatian domain is provided by Digital Filter Initialisation (DFI) for both versions of Aladin. Coupling frequency and frequency of output files is 3 hours. The forecast range is 72 hours. The operational versions of Aladin are AL29T2mxl (aem suite in Prague) and AL29T2 plus Alaro0 modset.

Visualisation of numerous meteorological fields from the new SGI is done on the archiving machine while the intranet Aladin pages containing more than numerous operational products remain LINUX PC. The many forecasted fields are plotted for both versions of Aladin, as well as their difference (Figure 1).



10m wind Aladin *10m wind Alaro0* *10 m wind difference*

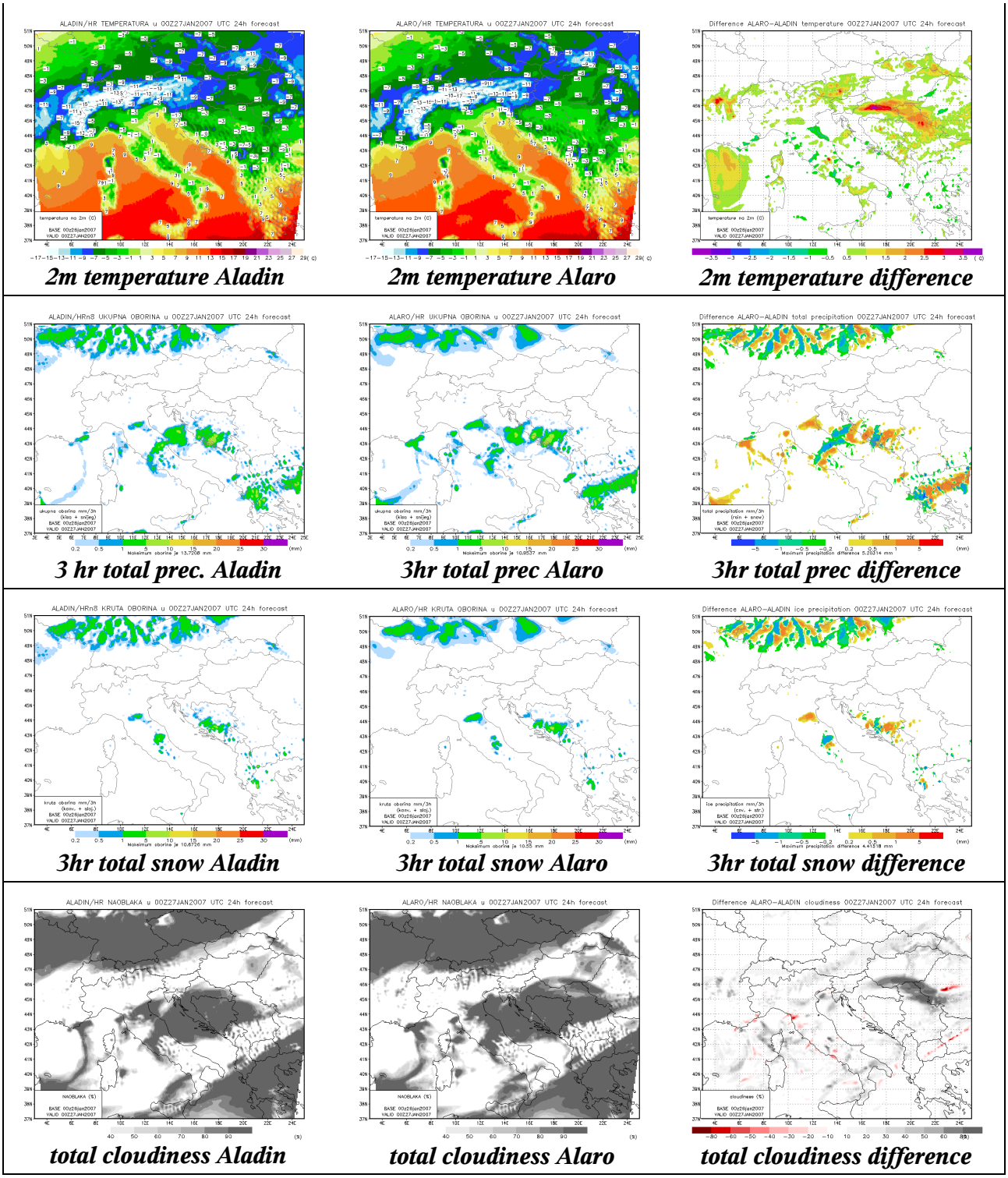


Figure 1. Comparison of forecasts with AL29T2mxl, nicknamed “Aladin” (left), AL29T2 with prognostic TKE, cloud and precipitation species, nicknamed “Alaro” (center) 8-km resolution forecasts and their difference (right).

Comparison of forecasts with data measured on SYNOP and automatic stations, done hourly for the last 5 runs for both versions of Aladin gives an EPS-like picture through 5 days (Figure 2) . Also, comparison of 24 hour precipitation with the measurements from the SYNOP stations provides an insight into effect of prognostic cloud and precipitation species (Figure 3). The products are available on the Intranet & Internet. Internet address with some of the ALADIN products, like total precipitation and 10 m wind: http://prognoza.hr/aladin_prognoza_e.html .

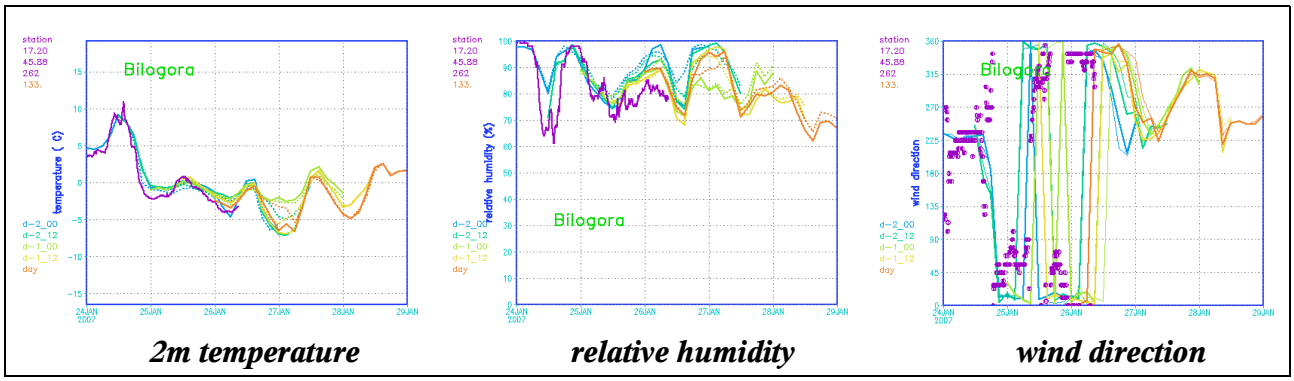


Figure 2. Comparison of forecasts with to the measurements from automatic stations for 2m temperature (left), relative humidity (center) and wind direction (right) on Bilogora station, AL29T2mxl forecasts are in full lines, Alaro is dashed (or thin line for wind direction), measured 10-minute average is purple.

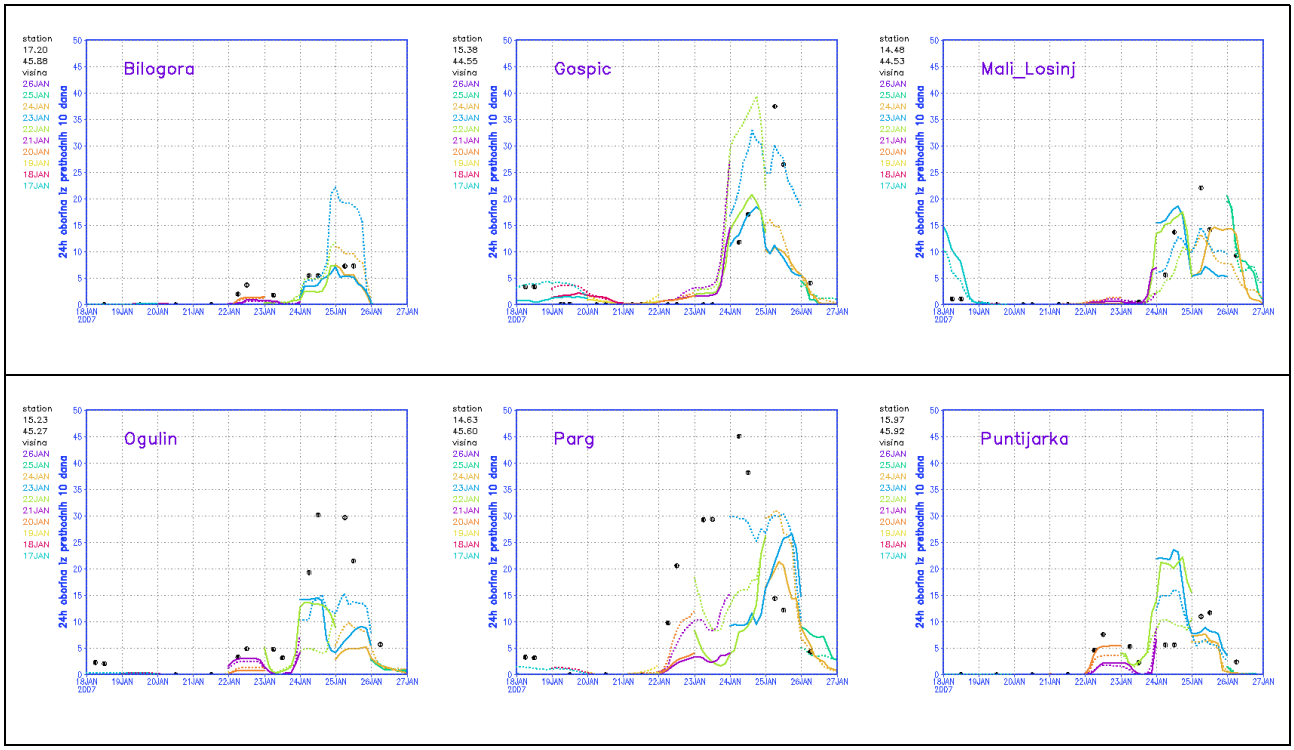
2.2 The new computer

SGI Altix LSB-3700 BX2 Server with 24x Intel Itanium2 1.6GHz/6MB, 48 GB standard system memory, 2x146 GB/10Krpm SCSI disk drive, OS SUSE Linux Enterprise Server 9 for IPF with SGI Package, Intel Fortran & C++ compilers, PBS Pro for LINUX (useless since the licence is valid only for 16 processors). gmkpack is ported, but used far less frequently than wished.

2.3 Operational model version

The first operational version of Aladin is AL29T2 including the “mxl” modifications introduced in Prague. The semi-Lagrangian horizontal diffusion is on. 72 hour forecast on 18 CPUs takes 32 minutes.

The second operational version (run after the first one) is AL29T2 including “mxl” modifications as well as Alaro0 package with prognostic TKE, cloud water, ice, rain and snow species. 72 hour forecast on 18 CPUs takes 43 minutes.



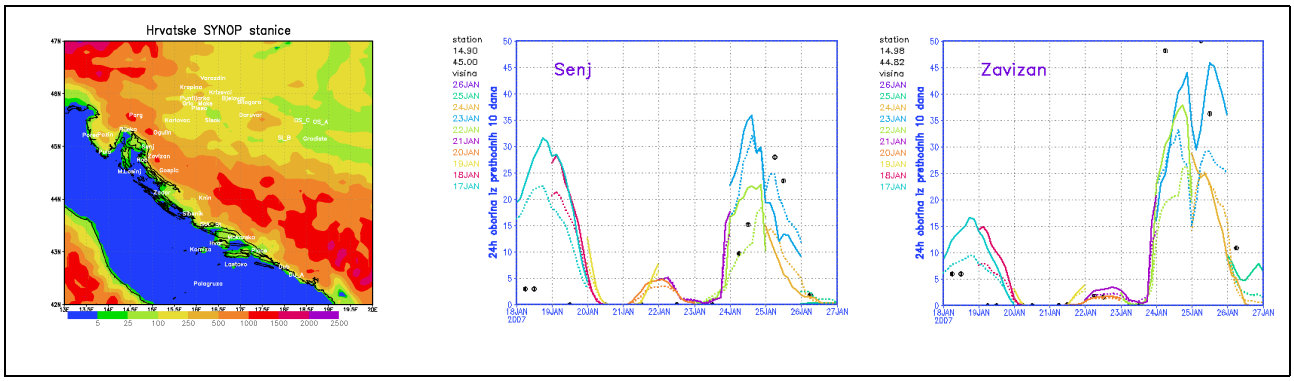


Figure 3. Comparison of 24 hour accumulated precipitation with the measurements from the SYNOP stations, AL29T2mxl forecasts are in full lines, Alaro are dashed, measured 24 hour precipitation is in black dots, the locations of different SYNOP stations in Croatia are show in the lower left panel.

Zavižan and Puntijarka are on tops of mountains, Parg is below a mountain peak and Bilogora is on a peak of a local hill. Gospić and Ogulin are inland from the Velebit mountain while Senj and Mali Lošinj are on the sea side of the Velebit mountain.

2.4 Plans

ALARO0 is now run operationally twice a day. The size of domain and forecast range are kept the same as in the reference AL29T2mxl.

Usage smaller number of larger high resolution dynamical adaptation domains, preferably only one, is considered. It should cover not only Croatia, but most of the Adriatic too, since the 10m wind field forecast is most important for the Sea.

3. Research

3.1 Alaro0

The research of the impact of different parts of the Alaro0 package continues. Main impact is observed in the precipitation, cloudiness and temperature fields.

3.2 Air-Sea interaction

In the framework of the DART project the impact of the air-sea interaction on atmospheric conditions is being studied.

3.3 LAM EPS

The research on downscaling of the ECMWF EPS members has continued and resulted in ECMWF Tech. Memo No 507.

4. Alaro0

4.1 Porting

The code was ported using gmkpack. Due to some characteristics of local compiler/computer, some code changes were necessary.

Some modifications were necessary for the code to compile on Altix. Missing or useless explicit interface blocks had to be introduced or removed. Also, number of arguments in the call to eblend did not fit the actual number of arguments in routine. The code can not be broken into a new line wherever in the code, so some constructions had to be modified.

Additionaly, due to some runtime errors, several subroutines had to be modified. The errors probably occur since the local compiler is far less forgiving than the one in Prague. Routines sucf.F90 and suxfu.F90 contain other subroutines and local ZHOOK_HANDLE has to be redefined in each of them. Also, the processor number that writes out the fullpos file in ebipos.F90 has to be initialized since the compiler does not initialize it with 0.

4.2 Runtime issues

The cputime per timestep varies during integration, following the same general pattern: the cputime per tiemstep grows during forward DFI, reaches some maximum value either during forward DFI or during the first 6 hours of forecast. Runs for from different analyses reach different maximum cputime per timestep at different forecast step, but when the same run (for the same date) is repeated the pattern is the same, even with different number of processors. This was noticed on Croatian SGI already some months ago, and some time was spent searching for a reason for it, but it was left as it was since the cost of it is 5-10% and thecomputer is stil empty. In the following exaples, the historical output files are written every hour, while fullpos files are written every 3 hours.

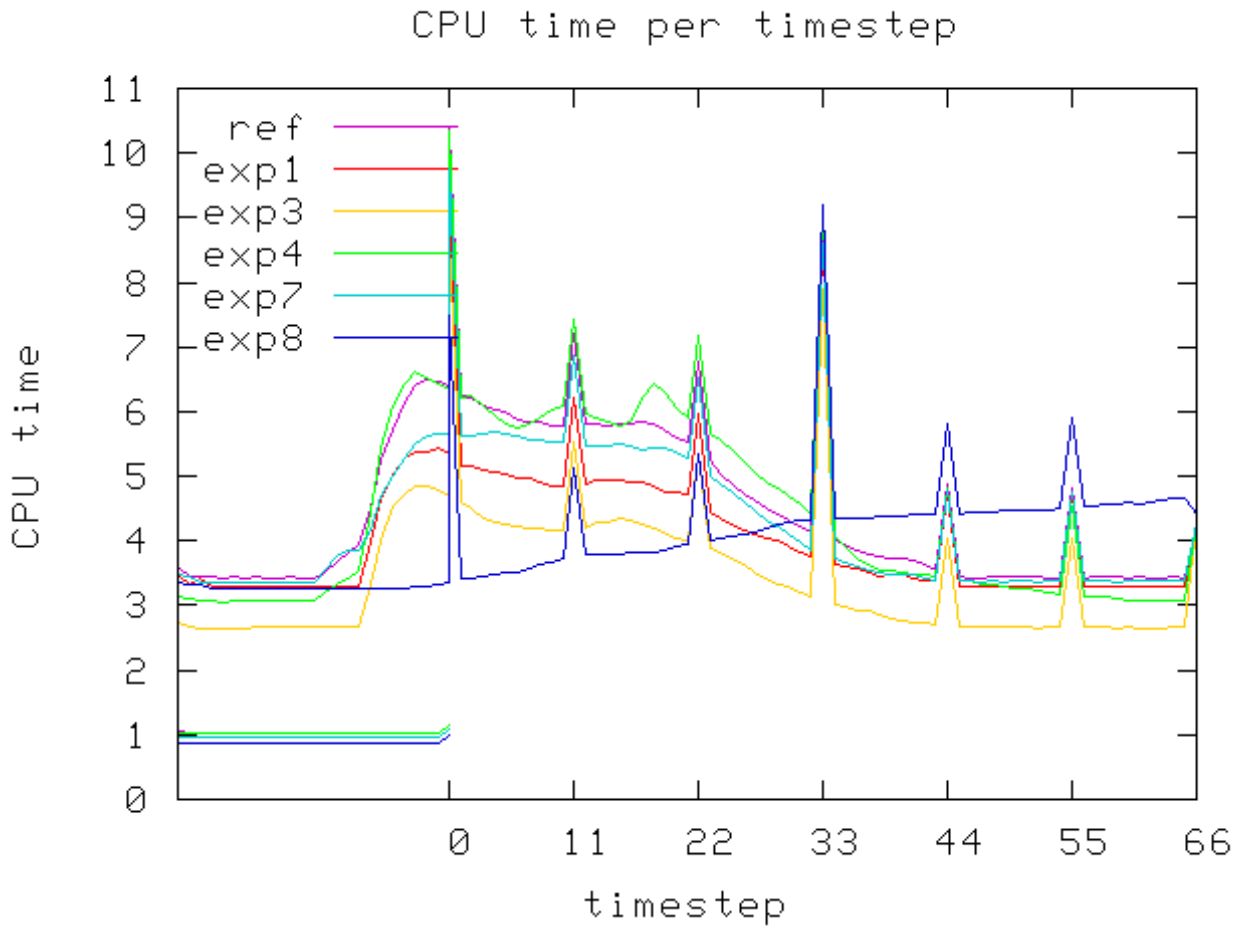


Figure 4. Cputime per timestep for several experiments from the Table during the first 6 hours, 11 timesteps per hour.

Experiments:

	LCLSATUR	LRAYPL	LRAY	LCVRA	LADV	LSLHD	LSLONDEM
ref	T	T	T	T	T	T	T
exp1	F	T	T	T	T	T	T
exp2	F	F	T	T	T	T	T
exp3	F	F	F	T	T	T	T

	LCLSATUR	LRAYPL	LRAY	LCVRA	LADV	LSLHD	LSLONDEM
exp4	T	T	T	F	T	T	T
exp7	T	T	T	T	T	F	T
exp8	T	T	T	T	F	F	T
exp9	T	T	T	T	F	F	F

LADV=.F. means that YX_NL%LADV=.F. for GFL species X=L,I,R and S that only the condensed species were not advected, Qv and TKE were advected. LSLHD=.F. means that YX_NL%LSLHD=.F. for GFL species X=L,I,R,S and TKE.

Figure 4. shows CPU time per timestep for several experiments from the Table during the first 6 hours, 11 timesteps per hour. When advection of new GFL variables is switched off the increase of CPU per timestep during forward DFI is avoided, but the cputime per timestep grows slowly and as we can see from Figure 5 it continues to do so until 72 hours.

Switching LSLONDEM and LIMP_NOOLAP to FALSE (exp9) and comparing it to exp8 when it was on (Figure 6) shows only that LSLONDEM amd LIMP_NOOLAP TRUE reduce the cputime per timestep, but is not the cause of the problem. LSLONDEM and LIMP_NOOLAP did not improve anything, except when true, the code is faster.

The NPROMA value used here is 80, when increased to 800 the performance was much slower but more stable (since processors did not talk to each other so much). Since on NEC NPROMA is much bigger and the NPROC much smaller, the problem might be negligible even if it existed, so this is some platform dependent thing. Actually, a colleaguedeveloped a theory that the processors in SGI Altix are actually women :)

Setting LSTATS, LSYNCSTATS, LDETAILED_STATS, LSTATSCPU, LSTATS_MEM, LSTATS_ALLOC, LBARRIER_STATS to true and gives a huge printout that since it does not give any reason to spend more CPU in any time-step than in the first one after DFI for example.

The routines that used most CPU (slcomm1) were compiled with different optimizations and it did not help (it was assumed that compiler optimizes something in a wrong way).

The next desperate attempt was introduction of some printouts to slcomm1 to see if the starting and finishing points of the loop behave in some strange manner since it would explain the behaviour, but they do not. Perhaps it would help to somehow diagnose the amount of points of SL halo being transferred.

Figures 4, 5 and 6 show results on 14 processors. Figure 7 shows cputime per timestep as in reference (exp11) and exp8 (exp10) but on 8 processors.

Alaro0 modset is perhaps proven innocent for the CPU increase. The CPU increase does not happen with "usual" Aladin, so maybe it is the existence of additional species that activated this, but it is not a specific Alaro problem, we should find it with any other microphysics/physics package. Ii is believed that this is a specific SGI problem, if not even specific for our machine since nobody maintains it at the moment.

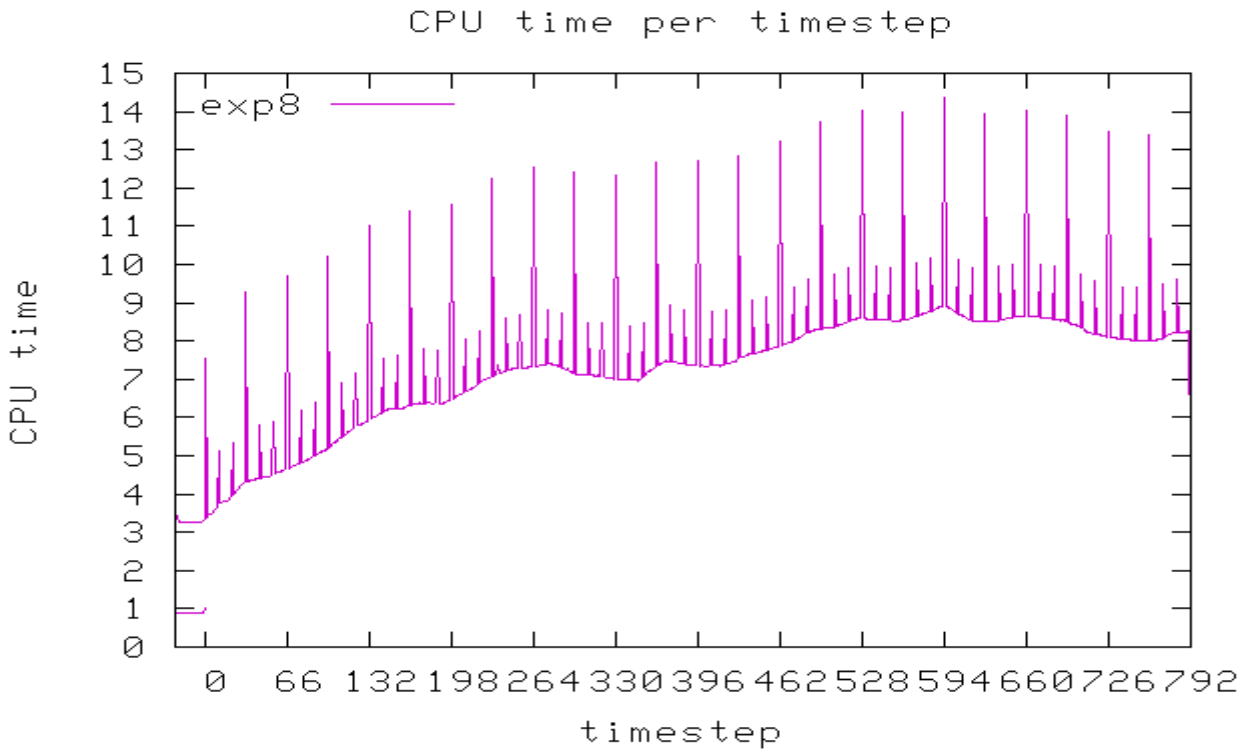


Figure 5. Cputime per timestep for exp8 during 72 hours, 11 timesteps per hour.

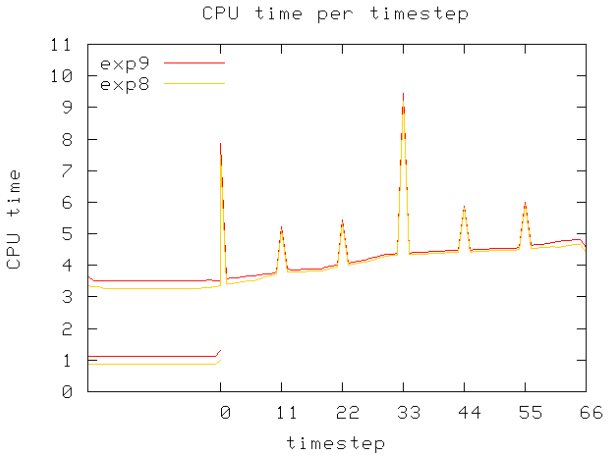


Figure 6. Cputime per timestep for LSLONDEM=T (exp8) and LSLONDEM=F (exp9) during the first 6 hours, 11 timesteps per hour.

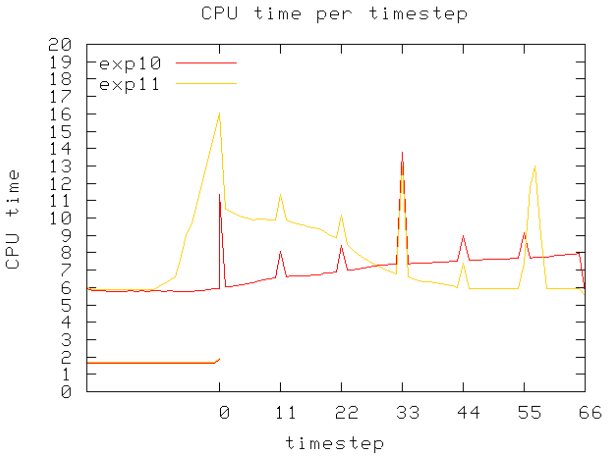


Figure 7. Cputime per timestep for exp10 (as exp8 but on 8 proc) and exp11 (as ref but on 8 proc).

```
Profiling information for program='./ALARO', proc#1:
        No. of instrumented routines called : 583
        Instrumentation started : 20070206 114448
        Instrumentation   ended : 20070206 115131
        Instrumentation overhead: 0.12%
        Memory usage : 6597069767099 MBytes (heap), 0 MBytes (rss), 0 MBytes (stack), 0 (paging)
        Total CPU-time is 400.13 sec on proc#1 (14 procs, 1 threads)
        Thread#1:      400.13 sec (100.00%)

    #  % Time         Cumul         Self        Total     # of calls        Self       Total    Routine@<tid>
                                                                                                 (Size; Size/sec;
AvgSize/call)
        (self)        (sec)        (sec)        (sec)                   ms/call     ms/call

    1    16.19       64.769       64.769       64.771            117      553.58      553.59    SLCOMM1@1
    2    14.19      121.545       56.776       66.548           4140       13.71       16.07    ACRANEB@1
    3     8.79      156.711       35.166       35.171           4140        8.49        8.50    ACCOEFK@1
    4     4.88      176.225       19.514       19.514           4140        4.71        4.71    APLMPHYS@1
    5     4.56      194.483       18.259       30.837           4140        4.41        7.45    ACCVIMP@1
    6     3.75      209.481       14.998       15.001            151       99.32       99.34    TRGOTL@1
    7     3.57      223.771       14.290       14.290            159       89.87       89.87    TRLTOG@1
    8     3.20      236.573       12.802       12.805           4140        3.09        3.09    ACDIFUS@1
    9     3.12      249.068       12.495       12.499           4140        3.02        3.02    ACCVIMPD@1
   10     2.20      257.888        8.819        9.764           4140        2.13        2.36    AC_CLOUD_MODEL@1
   11     2.13      266.394        8.506        8.506            117       72.70       72.70    SLCOMM2A@1
   12     1.73      273.327        6.934      205.927           4140        1.67       49.74    APLPAR@1
   13     1.59      279.697        6.370        6.376           4140        1.54        1.54    ACTQSAT@1
   14     1.53      285.817        6.120       11.752           4140        1.48        2.84    ACNEBN@1
   15     1.41      291.441        5.624        5.629           4140        1.36        1.36    ACNEBXRS@1
   16     1.38      296.944        5.503       19.938            159       34.61      125.40
EFTINV_CTL_MOD:EFTINV_CTL@1
   17     1.24      301.921        4.977        4.981           5265        0.95        0.95    ELARCHE@1
   18     1.22      306.809        4.888        4.917          26325        0.19        0.19    LAITRI@1
   19     1.11      311.258        4.449       23.966           4140        1.07        5.79    ACPLUIE_PROG@1
   20     1.07      315.558        4.300        5.235              7      614.26      747.91    WRSPECA@1
   21     1.05      319.761        4.203        4.206            159       26.43       26.45    TRMTOL@1
   22     1.05      323.952        4.191      234.596            117       35.82     2005.09    CPG@1
```

Profiling for exp8 6 hour forecast.

```
Profiling information for program='./ALARO', proc#1:
        No. of instrumented routines called : 583
        Instrumentation started : 20070206 110155
        Instrumentation   ended : 20070206 110911
        Instrumentation overhead: 0.12%
        Memory usage : 6597069767111 MBytes (heap), 0 MBytes (rss), 0 MBytes (stack), 0 (paging)
        Total CPU-time is 433.28 sec on proc#1 (14 procs, 1 threads)
        Thread#1:      433.28 sec (100.00%)

    #  % Time         Cumul         Self        Total     # of calls        Self       Total    Routine@<tid>
                                                                                                 (Size; Size/sec;
AvgSize/call)
        (self)        (sec)        (sec)        (sec)                   ms/call     ms/call

    1    13.18       57.126       57.126      111.697           4140       13.80       26.98    ACRANEB@1
    2    12.39      110.817       53.691       54.567           4140       12.97       13.18    AC_CLOUD_MODEL@1
    3     9.66      152.663       41.846       41.890          47385        0.88        0.88    LAITRI@1
    4     8.35      188.831       36.168       36.172           4140        8.74        8.74    ACCOEFK@1
    5     5.20      211.358       22.527       22.529           4140        5.44        5.44    APLMPHYS@1
    6     4.26      229.800       18.441       31.037           4140        4.45        7.50    ACCVIMP@1
    7     3.30      244.104       14.304       14.305            159       89.96       89.97    TRLTOG@1
    8     3.12      257.630       13.526       13.531           4140        3.27        3.27    ACDIFUS@1
    9     2.89      270.137       12.507       12.510           4140        3.02        3.02    ACCVIMPD@1
   10     2.31      280.124        9.987        9.988            151       66.14       66.15    TRGOTL@1
   11     2.29      290.034        9.910        9.912            117       84.70       84.72    SLCOMM2A@1
   12     1.84      298.025        7.991      258.398           4140        1.93       62.42    APLPAR@1
   13     1.54      304.680        6.654        6.654            117       56.87       56.87    SLCOMM1@1
   14     1.48      311.093        6.413       12.017           4140        1.55        2.90    ACNEBN@1
   15     1.48      317.498        6.405        6.411           4140        1.55        1.55    ACTQSAT@1
   16     1.29      323.093        5.595        5.601           4140        1.35        1.35    ACNEBXRS@1
   17     1.27      328.600        5.507       19.948            159       34.63      125.46
EFTINV_CTL_MOD:EFTINV_CTL@1
   18     1.25      334.030        5.431       27.966           4140        1.31        6.76    ACPLUIE_PROG@1
   19     1.25      339.438        5.408        5.413           4140        1.31        1.31    CPTEND@1
   20     1.19      344.594        5.155      291.584            117       44.06     2492.17    CPG@1
   21     1.15      349.576        4.982        4.990           5265        0.95        0.95    ELARCHE@1
```

Profiling for exp7 6 hour forecast

```
Profiling information for program='./ALARO', proc#1:
        No. of instrumented routines called : 583
        Instrumentation started : 20070206 115552
        Instrumentation   ended : 20070206 133625
        Instrumentation overhead: 0.06%
        Memory usage : 6597069767099 MBytes (heap), 0 MBytes (rss), 0 MBytes (stack), 0 (paging)
        Total CPU-time is 6019.28 sec on proc#1 (14 procs, 1 threads)
        Thread#1:     6019.28 sec (100.00%)

    #  % Time         Cumul         Self        Total     # of calls        Self       Total    Routine@<tid>
                                                                                                 (Size; Size/sec;
AvgSize/call)
        (self)        (sec)        (sec)        (sec)                   ms/call     ms/call

    1    34.74     2090.886     2090.886     2090.905            843     2480.29     2480.31    SLCOMM1@1
    2     8.46     2600.247      509.361      603.541          36810       13.84       16.40    ACRANEB@1
    3     6.63     2999.036      398.789      398.817          36810       10.83       10.83    ACCOEFK@1
    4     5.08     3305.092      306.056      306.082          36810        8.31        8.32    CPTEND@1
    5     4.89     3599.705      294.613     2567.252          36810        8.00       69.74    APLPAR@1
    6     4.32     3859.471      259.766      259.812          36810        7.06        7.06    ACDIFUS@1
    7     4.23     4114.286      254.815      254.842          36810        6.92        6.92    APLMPHYS@1
    8     2.80     4282.718      168.432      423.291          36810        4.58       11.50    ACPLUIE_PROG@1
    9     2.70     4444.979      162.262      272.286          36810        4.41        7.40    ACCVIMP@1
   10     1.82     4554.259      109.279      109.315          36810        2.97        2.97    ACCVIMPD@1
   11     1.81     4663.147      108.889      108.897           1119       97.31       97.32    TRGOTL@1
   12     1.77     4769.767      106.619      106.639           1149       92.79       92.81    TRLTOG@1
   13     1.74     4874.324      104.558      154.062          36810        2.84        4.19    ACNEBN@1
   14     1.39     4958.031       83.707       94.125          36810        2.27        2.56    AC_CLOUD_MODEL@1
```

Profiling for exp8 72 hour forecast.

CONTENTS