

HOW TO DEBUG ORCHIDEE

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LABORATOIRE DES SCIENCES DU CLIMAT & DE L'ENVIRONNEMENT

Formation orchidee - 25/11/2016



Content

Objectives

What does it mean debug ?

From modipsl to debug

- Locate error message from LibIGCM and Orchidee

Debug

- Compile
- TotalView
- Scripts for Curie/ADA
- Simple example

Hints

Conclusion

Questions



Objectives

Understand how/where find the error message

Be able to start a debugging session with totalview

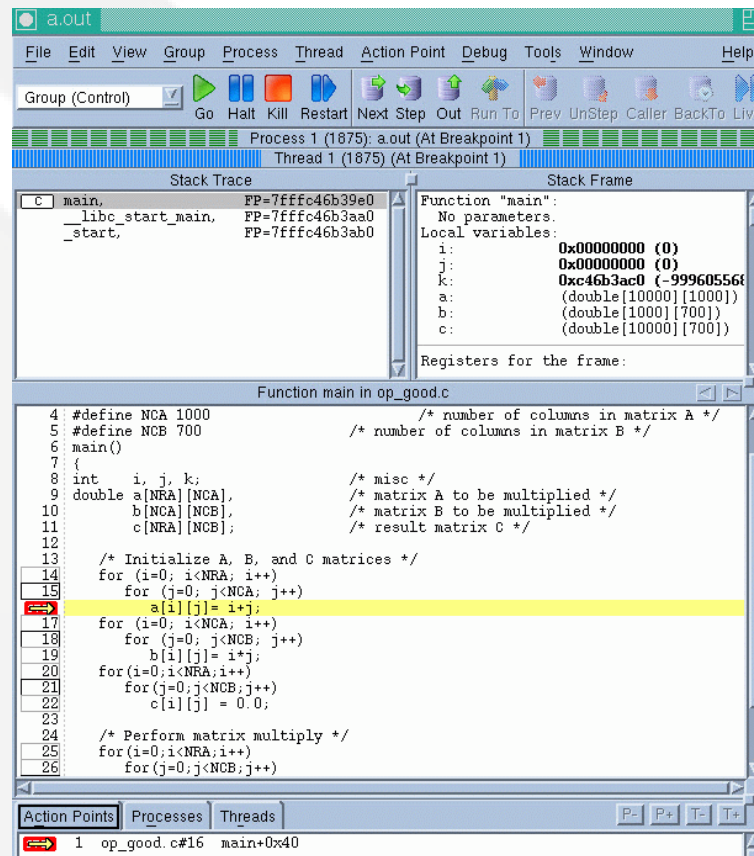
- Parallel Standalone Orchidee

First steps with Totalview



Debug: what does it mean

Debugging is the process of finding and resolving of defects that prevent correct operation of computer software or a system (wikipedia)



The screenshot shows a debugger window titled 'a.out'. The main window displays the source code of a C program named 'op_good.c'. The code defines two matrices, A and B, and initializes matrix C to zero. The program is currently stopped at a breakpoint on line 15, which is the first iteration of the inner loop for matrix A: `a[i][j] = 1;`. The debugger interface includes a menu bar (File, Edit, View, Group, Process, Thread, Action Point, Debug, Tools, Window, Help), a toolbar with various debugging actions (Go, Halt, Kill, Restart, Next Step, Out, Run To, Prev, UnStep, Caller, BackTo, Live), and a status bar at the bottom showing '1 op_good.c#16 main+0x40'. The 'Stack Trace' and 'Stack Frame' panels are visible at the top, showing the current function 'main' and its local variables: `i: 0x00000000 (0)`, `j: 0x00000000 (0)`, `k: 0xc46b3ac0 (-99960556)`, `a: (double[10000][1000])`, `b: (double[1000][700])`, and `c: (double[10000][700])`. The 'Function main in op_good.c' panel shows the source code with line numbers 4 through 26.



From modipsl to debug

You need to find error message

Check outputs from config/ORCHIDEE_OL/YOUR_EXP

LibIGCM is in charge to manage the simulation. 3 steps :

- Before: copy files, consistent paths and folders , ... Debug folder is not yet created.
- Running: check for Debug folder. Some Orchidee outputs are placed there. It is a copy of the real simulation.
- After: copy files to ARCHIVE (?), next simulation, merged outputs, ...



libIGCM outputs

Folder Config/ORCHIDEE_OL/your_exp/
Check :

- Script_Output_job_name.XXXXX: libIGCM output. Mostly first step.
- Debug folder (Does it exists?):
 - No: There is an issue at the first step (missing file/folder, ...)
 - Yes: merged orchidee simulation output files.

your_exp config folder file list:

COMP
Job_SECHSTOM.3273
PARAM
POST
Debug/
Script_Output_SECHSTO
M.3273.000001
Script_Output_SECHSTO
M.3273.000002
config.card
config.card.org
config.card.xios_server
config.card~
run.card
run.card.bak
run.card.init

```
IGCM_sys_IdxWork : /ccc/scratch/cont003/dsm/p529jom/IGCM_OUT/OL2/PROD/secto/SECHSTOM.3273/Out
IGCM_sys_IdxPost : rebuild_fromWorkDir
Submitted Batch Session 619859

2016-09-27 14:23:49 --Debug1--> IGCM_config_Periodend

2016-09-27 14:23:49 --Debug1--> Check components binary : size and creation date
2016-09-27 14:23:49 .....Debug1--> SIF
2016-09-27 14:23:49 .....Debug1--> SDB
2016-09-27 14:23:49 .....Debug1--> OOL
2016-09-27 14:23:49 --Debug1--> orchidee.ol has changed in /ccc/work/cont003/dsm/p529jom/modips1/bin !
2016-09-27 14:23:49 --Debug1--> Save latest orchidee.ol in /ccc/work/cont003/dsm/p529jom/modips1/config/ARCHIVE/IGCM_OUT/OL2/PROD/secto/SECHSTOM.3273/Exe !
IGCM_sys_Put_Out : orchidee.ol /ccc/work/cont003/dsm/p529jom/modips1/config/ARCHIVE/IGCM_OUT/OL2/PROD/secto/SECHSTOM.3273/Exe/SECHSTOM.3273_19020101_19021231_orchidee.ol.nv
IGCM_sys_IdxArchive : /ccc/scratch/cont003/dsm/p529jom/modips1/config/ARCHIVE/IGCM_OUT/OL2/PROD/secto/SECHSTOM.3273/Exe
IGCM_sys_PutBuffer_Out : out_execution /ccc/scratch/cont003/dsm/p529jom/IGCM_OUT/OL2/PROD/secto/SECHSTOM.3273/Out/SECHSTOM.3273_19020101_19021231_out_execution
IGCM_sys_IdxDir : /ccc/scratch/cont003/dsm/p529jom/IGCM_OUT/OL2/PROD/secto/SECHSTOM.3273/Out
IGCM_sys_Cmd : 444 /ccc/scratch/cont003/dsm/p529jom/IGCM_OUT/OL2/PROD/secto/SECHSTOM.3273/Out/SECHSTOM.3273_19020101_19021231_out_execution
```



Orchidee Outputs I

Config/your_exp/Debug/
Related to Orchidee

- Outputs moved by libIGCM

Potentially find error message:

out_orchidee_XXXX (file
written by each core)

out_execution/orchid_XXX

- Stdout/stderr outputs
messages

```
lmd998@ada338: SECHSTON.3797.USDA.57853_ioipsl_05 Imprv| $ ls
lib_bg.nc out_orchidee_0017 out_orchidee_0048 sechiba_history_0010.nc sechiba_history_0041.nc stomate_history_0005.nc stomate_history_0036.nc
carfepente2d_15min.nc out_orchidee_0018 out_orchidee_0049 sechiba_history_0011.nc sechiba_history_0042.nc stomate_history_0006.nc stomate_history_0037.nc
context_orchidee.xml out_orchidee_0019 out_orchidee_0050 sechiba_history_0012.nc sechiba_history_0043.nc stomate_history_0007.nc stomate_history_0038.nc
driver_rest_out.nc out_orchidee_0020 out_orchidee_0051 sechiba_history_0013.nc sechiba_history_0044.nc stomate_history_0008.nc stomate_history_0039.nc
field_def_orchidee.xml out_orchidee_0021 out_orchidee_0052 sechiba_history_0014.nc sechiba_history_0045.nc stomate_history_0009.nc stomate_history_0040.nc
file_def_orchidee.xml out_orchidee_0022 out_orchidee_0053 sechiba_history_0015.nc sechiba_history_0046.nc stomate_history_0010.nc stomate_history_0041.nc
floodplains.nc out_orchidee_0023 out_orchidee_0054 sechiba_history_0016.nc sechiba_history_0047.nc stomate_history_0011.nc stomate_history_0042.nc
forcing_file.nc out_orchidee_0024 out_orchidee_0055 sechiba_history_0017.nc sechiba_history_0048.nc stomate_history_0012.nc stomate_history_0043.nc
ioodef.xml out_orchidee_0025 out_orchidee_0056 sechiba_history_0018.nc sechiba_history_0049.nc stomate_history_0013.nc stomate_history_0044.nc
launch-ada-intel-server.sh out_orchidee_0026 out_orchidee_0057 sechiba_history_0019.nc sechiba_history_0050.nc stomate_history_0014.nc stomate_history_0045.nc
launch-ada-intel.sh out_orchidee_0027 out_orchidee_0058 sechiba_history_0020.nc sechiba_history_0051.nc stomate_history_0015.nc stomate_history_0046.nc
launch-ada-intel-tracer.sh out_orchidee_0028 out_orchidee_0059 sechiba_history_0021.nc sechiba_history_0052.nc stomate_history_0016.nc stomate_history_0047.nc
orchidee.39977 out_orchidee_0029 out_orchidee_0060 sechiba_history_0022.nc sechiba_history_0053.nc stomate_history_0017.nc stomate_history_0048.nc
orchidee.ol out_orchidee_0030 out_orchidee_0061 sechiba_history_0023.nc sechiba_history_0054.nc stomate_history_0018.nc stomate_history_0049.nc
out_orchidee_0000 out_orchidee_0031 out_orchidee_0062 sechiba_history_0024.nc sechiba_history_0055.nc stomate_history_0019.nc stomate_history_0050.nc
out_orchidee_0001 out_orchidee_0032 out_orchidee_0063 sechiba_history_0025.nc sechiba_history_0056.nc stomate_history_0020.nc stomate_history_0051.nc
out_orchidee_0002 out_orchidee_0033 PFTmap.nc sechiba_history_0026.nc sechiba_history_0057.nc stomate_history_0021.nc stomate_history_0052.nc
out_orchidee_0003 out_orchidee_0034 reftemp.nc sechiba_history_0027.nc sechiba_history_0058.nc stomate_history_0022.nc stomate_history_0053.nc
out_orchidee_0004 out_orchidee_0035 routing.nc sechiba_history_0028.nc sechiba_history_0059.nc stomate_history_0023.nc stomate_history_0054.nc
out_orchidee_0005 out_orchidee_0036 run_def sechiba_history_0029.nc sechiba_history_0060.nc stomate_history_0024.nc stomate_history_0055.nc
out_orchidee_0006 out_orchidee_0037 run_file sechiba_history_0030.nc sechiba_history_0061.nc stomate_history_0025.nc stomate_history_0056.nc
out_orchidee_0007 out_orchidee_0038 sechiba_history_0000.nc sechiba_history_0062.nc stomate_history_0026.nc stomate_history_0057.nc
out_orchidee_0008 out_orchidee_0039 sechiba_history_0001.nc sechiba_history_0063.nc stomate_history_0027.nc stomate_history_0058.nc
out_orchidee_0009 out_orchidee_0040 sechiba_history_0002.nc sechiba_rest_out.nc stomate_history_0028.nc stomate_history_0059.nc
out_orchidee_0010 out_orchidee_0041 sechiba_history_0003.nc sechiba_history_0034.nc soils_param.nc stomate_history_0029.nc stomate_history_0060.nc
out_orchidee_0011 out_orchidee_0042 sechiba_history_0004.nc sechiba_history_0035.nc soils_param_usdatop.nc stomate_history_0030.nc stomate_history_0061.nc
out_orchidee_0012 out_orchidee_0043 sechiba_history_0005.nc sechiba_history_0036.nc stomate_history_0000.nc stomate_history_0031.nc stomate_history_0062.nc
out_orchidee_0013 out_orchidee_0044 sechiba_history_0006.nc sechiba_history_0037.nc stomate_history_0001.nc stomate_history_0032.nc stomate_history_0063.nc
out_orchidee_0014 out_orchidee_0045 sechiba_history_0007.nc sechiba_history_0038.nc stomate_history_0002.nc stomate_history_0033.nc stomate_rest_out.nc
out_orchidee_0015 out_orchidee_0046 sechiba_history_0008.nc sechiba_history_0039.nc stomate_history_0003.nc stomate_history_0034.nc xios_server.exe
out_orchidee_0016 out_orchidee_0047 sechiba_history_0009.nc sechiba_history_0040.nc stomate_history_0004.nc stomate_history_0035.nc xios.x
```



Orchidee Outputs II

Debug folder is not available in config/ORCHIDEE_OL/YOUR_EXP

- Check Scratch directory
- No scratch directory?
 - Enable RUN DIR PATH in Job_XXX file:
RUN_DIR_PATH=/to/some/path/RUNDIRPATH

Once the simulation fails, go to the folder

Copy this folder and work from here

Run in interactive mode

- e.g: in curie: `ccc_mprun/orchidee`

Simplify your issues:

- You avoid an extra layer (libIGCM)
- Run as many times as you need

```
cd /ccc/work/cont003/dsm/p529jorn/autolauncher/experiments/mict_test_32_05deg_4196
cat
ccc_mprun -f pp.conf
terminate called after throwing an instance of 'xios::CNetCdfException'
what(): Error when calling function nc_enddef(ncId)
letCDF: HDF error
Unable to end define mode of this file, given its id: 65536

fortrtl: error (76): Abort trap signal
image      PC          Routine      Line      Source
529jorn_xios_ser 0000000008199C9 Unknown      Unknown  Unknown
529jorn_xios_ser 00000000081829E Unknown      Unknown  Unknown
529jorn_xios_ser 0000000008ACD922 Unknown      Unknown  Unknown
529jorn_xios_ser 0000000008AE503 Unknown      Unknown  Unknown
529jorn_xios_ser 0000000008B2362 Unknown      Unknown  Unknown
ibpthread.so.0 00002B842615D7E0 Unknown      Unknown  Unknown
libc.so.6       00002B842615D5E5 Unknown      Unknown  Unknown
libc.so.6       00002B842615EDC5 Unknown      Unknown  Unknown
libstdc++.so.6 00002B8424827A70 Unknown      Unknown  Unknown
libstdc++.so.6 00002B8424825806 Unknown      Unknown  Unknown
libstdc++.so.6 00002B8424825C03 Unknown      Unknown  Unknown
libstdc++.so.6 00002B8424825D22 Unknown      Unknown  Unknown
529jorn_xios_ser 000000000803506 Unknown      Unknown  Unknown
529jorn_xios_ser 0000000007327F5 Unknown      Unknown  Unknown
529jorn_xios_ser 00000000073138F Unknown      Unknown  Unknown
529jorn_xios_ser 000000000710BF0 Unknown      Unknown  Unknown
529jorn_xios_ser 000000000718779 Unknown      Unknown  Unknown
529jorn_xios_ser 0000000006C5148 Unknown      Unknown  Unknown
529jorn_xios_ser 0000000006940F4C Unknown      Unknown  Unknown
529jorn_xios_ser 0000000006CA5E3 Unknown      Unknown  Unknown
529jorn_xios_ser 0000000005719C1 Unknown      Unknown  Unknown
529jorn_xios_ser 000000000AD9848 Unknown      Unknown  Unknown
libc.so.6       00002B8426149D1D Unknown      Unknown  Unknown
529jorn_xios_ser 0000000005718B9 Unknown      Unknown  Unknown
ccc/work/cont003/dsm/p529jorn/autolauncher/experiments/mict_test_32_05deg_4196/pp.conf
mpirun: error: curie4334: task 0: Aborted
mpirun: First task exited 600s ago
```



Compilation : debug mode

It requires debug mode.

In addition :

- Compilation becomes more sensitive. It could detect some issues.
- During execution other problems might show up. Division by 0, ...
Otherwise they stay hidden until you analyze the outputs (weird pixels, ...).
- Make sure your simulation runs in debug (e.g 1Y). Then move to production mode.

How to compile Orchidee in Debug mode

- cd config/ORCHIDEE_OL
- Modify Makefile
- Replace all prod → debug
- gmake clean && gmake (recompile from zero)
 - Only use gmake for the following code changes

Copy file to simulation folder

- cp bin/orchidee_ol to/your/isolated/folder/



Debug : totalview

Parallel debugger

- Supports OpenMP (Couple)/MPI (Couple, offline)
- MemoryScape: memory debugging
- GUI

Available

- ADA
- Curie



ar: creating /ccc/work/cont003/dsm/p529jorn/modipl/modeles/ORCHIDEE/...
ar: creating /ccc/work/cont003/dsm/p529jorn/modipl/modeles/ORCHIDEE/...
ifort: command line warning #10212: -fno-

Array data Uninitialized Values

Field	Value
(1)	6.42285339593621e-323 <denormalized>
(2)	3.45845952088873e-323 <denormalized>
(3)	3.45845952088873e-323 <denormalized>
(4)	3.45845952088873e-323 <denormalized>
(5)	3.45845952088873e-323 <denormalized>
(6)	1
(7)	1

Array data

Field	Value
(1)	.false. (0)
(2)	.false. (0)
(3)	.false. (0)
(4)	.false. (0)
(5)	.false. (0)
(6)	.true. (-1)
(7)	.true. (-1)

Array data

Field	Value
(1)	0.644711847541582
(2)	0.796727828742632
(3)	0.738472015034421
(4)	0.787642347910486
(5)	0.841371425671515
(6)	0.920750803288028
(7)	0.930705211333916

vpd: 0.346288170746466

Proc 6

File Edit View Group Process Thread Action Point Debug Tools Window Help

Group (Control) Go Halt Kill Restart Next Step Out Run To Record GoBack Prev UnStep Caller Back To Live Save

Rank 6: sruncorchidee_ol.6 (Error) [M]

Thread 1 (47424198918816): orchidee_ol (Error) <Floating Point Exception>

Stack Trace

Address	Module	Symbol
(F80)	DIFFUCO	diffuco_trans_co2, FP=7ffcb6eb6390
(F80)	DIFFUCO	diffuco_main, FP=7ffcb6eb2b0
(F80)	sechiba_main	, FP=7ffcb6ec1fd0
(F80)	intersurf_main_2d	, FP=7ffcb6ec6b80
(F80)	driver	, FP=7ffcb6ed44f0
(F80)	main	, FP=7ffcb6ed4500
(F80)	libc	__start_main, FP=7ffcb6ed4640
(F80)	libc	__start, FP=7ffcb6ed4650

Stack Frame

Address	Module	Symbol
(F80)	monrep	, (REAL*8(7,13))
(F80)	assim_param	, (REAL*8(7,13,1))
(F80)	ca	, (REAL*8(7))
(F80)	veget	, (REAL*8(7,13))
(F80)	veget_max	, (REAL*8(7,13))
(F80)	lai	, (REAL*8(7,13))
(F80)	qsintveg	, (REAL*8(7,13))
(F80)	qsintmax	, (REAL*8(7,13))
(F80)	vbeta3	, (REAL*8(7,13))
(F80)	vbeta3pot	, (REAL*8(7,13))
(F80)	rveget	, (REAL*8(7,13))
(F80)	rstruct	, (REAL*8(7,13))

Current Subroutine Stack

Function DIFFUCO_diffuco_trans_co2 in diffuco_f90

```

2480
2481
2482
2483
2484
2485
2486
2487
2488
2489
2490
2491
2492
2493
2494
2495
2496
2497
2498
2499
2500
2501
2502
2503
2504
2505
2506
2507
2508
2509
2510
2511
2512
2513
2514
2515

```

! eq. 4 of Yin et al (2009)
 $J_{max}(:) = vj2(:)$
 $JJ(:) = (\alpha_{LL}(jv) * Iabs(:) + J_{max}(:) - \sqrt{(\alpha_{LL}(jv) * Iabs(:) + J_{max}(:))^2 + 4 * \theta * (\alpha_{LL}(jv) * Iabs(:) + J_{max}(:))}) / (2 * \theta(jv))$

IF (is_c4(jv)) THEN
 ! addtogroup Photosynthesis
 ! 2.4.2 Assimilation for C4 plants (Collatz et al., 1992)\n
 ! \latexonly
 ! \input{diffuco_trans_co2_2.4.2.tex}
 ! \endlatexonly
 ! 0
 !
 IF (nic .GT. 0) THEN
 DO inic=1,nic

 ! Analytical resolution of the Assimilation based Yin et al. (2009)
 icinic=index_calc(inic)

 ! Eq. 28 of Yin et al. (2009)
 $f_{cyc} = 1 - (4 * (1 - f_{psir}(jv)) * (1 + f_Q(jv)) + 3 * h_{protons}(jv) * f_{pseudo}(jv)) / (3 * h_{protons}(jv) - 4 * (1 - f_{psir}(jv)))$

Main code

Main Window

Array data

File Edit View Tools Window Help

Expression: vcmx Address: 0x7ffcb6eafe70

Actual Type: REAL*8(7,13)

Type: REAL*8(7,13)

Field	Value
(7,10)	34.6111111111111
(6,10)	34.6111111111111
(2,10)	34.6111111111111
(2,3)	27.9259259259259
(7,13)	0
(6,13)	0
(5,13)	0
(4,13)	0
(3,13)	0
(2,13)	0
(1,13)	0
(7,12)	0
(6,12)	0
(5,12)	0
(4,12)	0
(3,12)	0
(2,12)	0
(1,12)	0
(7,11)	0
(6,11)	0
(5,11)	0
(4,11)	0
(3,11)	0
(2,11)	0
(1,11)	0
(5,10)	0
(4,10)	0
(3,10)	0
(1,10)	0
(7,9)	0
(6,9)	0
(5,9)	0
(4,9)	0
(3,9)	0
(2,9)	0
(1,9)	0
(7,8)	0
(6,8)	0
(5,8)	0
(4,8)	0
(3,8)	0
(2,8)	0
(1,8)	0
(7,7)	0
(6,7)	0
(5,7)	0
(4,7)	0
(3,7)	0
(2,7)	0
(1,7)	0
(7,6)	0

Totalview : Curie I

Interactive

- Directly to command line

Normal Queue

Long term debugging

Test Queue

- Almost instant
- Only 30 min
- Testing

Module load totalview

Normal mode:

- `ccc_mprun -n 64 -p standard -A projectid -d tv ./orchidee_ol`

Test mode:

- `ccc_mprun -n 64 -p standard -A projectid -d tv -Q test ./orchidee_ol`



Totalview : Curie II

Interactive mode

- XIOS attached mode

- lodef.xml: set using_server to false

More info:

<http://www.prace-ri.eu/IMG/pdf/Best-Practice-Guide-Curie.pdf>

```
#!/bin/bash
#MSUB -r JOBNAME # Request name
#MSUB -n 64 # Number of tasks to use
#MSUB -T 60000 # Elapsed time limit in
seconds
#MSUB -o orchid_%l.o # Standard
output. %l is the job id
#MSUB -e orchid_%l.e # Error output.
%l is the job id
#MSUB -Q normal
#MSUB -A project_id
#MSUB -D
#MSUB -q standard

set -x

# enable core dump file in case of error
ulimit -c unlimited

ccc_mprun ./orchidee_ol
```



Totalview ADA

Interactive mode

- Up to 32 procs
- Module load totalview
- tv ./orchidee_ol

More info:

- <http://www.idris.fr/ada/ada-debogage.html>

Batch mode

```
#@ job_name = orchidee
#@ output = $(job_name).$(
  jobid)
#@ error = $(output)
#@ job_type = parallel
#@ total_tasks = 128
#@ wall_clock_limit = 2:00:00
#@ environment = $DISPLAY
#@ queue
```

```
module load totalview
```

```
xterm -sb -e 'module load tv;
tv ./orchidee_ol'
```



Example

Parallel debugger



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Formation orchidee - 25/11/2016



Hints

Simplify the simulation by :

- Move from global to regional domain (1 gridcell ?).
 - Find land point coordinates
 - 1. Kjpindex/npts variable index
 - Same index in lalo variable (coordinates)
 - 2. Add to run.def:
 - LIMIT_EAST, LIMIT_WEST
 - LIMIT_NORTH, LIMIT_SOUTH
- Disable module by module until you isolate the issue

Print statements

- IF (printlev>=4) WRITE(numout,*) 'We filled MatrixA and VectorB', var1
 - 4: verbose level
 - Run.def: PRINTLEV key

Move to Attached server: easier to debug

- iodef.xml: set using_server from true to false
`<variable id="using_server" type="bool">false</variable>`

Search in the Orchidee source code:

- `grep -i "something" src*/*90`



Conclusion

Locate the error message

Isolate and simplify the issue

You should be able to start debugging with orchidee



