



## OASIS3 training session Toulouse, January 25-29 2010

*Assembled by S. Valcke, March 2010*

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### Introduction

Three months of OASIS Dedicated User Support is offered every year by CERFACS within the framework of IS-ENES Work Package 4 ("Strengthening the European Network on Earth System Modelling") to help implement new coupled models with the OASIS coupler or improve existing configurations based on OASIS. Six proposals were submitted in 2009 from AWI, IPSL, SMHI, KNMI, Lund University, and DMI to benefit from this support. After careful evaluation of the proposals, it was decided that AWI, IPSL, and SMHI would benefit from OASIS Dedicated User Support respectively for 4, 4 and 3 weeks. In addition, KNMI, DMI and U. of Lund were invited to attend a 1 week special training session on OASIS3 on January 25<sup>th</sup> to 29<sup>th</sup> at CERFACS. Two persons from LMD who were starting with OASIS and had contacted CERFACS for training were also invited to attend. The participants were:

- From KNMI: Philippe Le Sager
- From DMI: Marianne Sloth Madsen
- From U Lund: Guy Schurgers and Paul Miller
- From LMD: Cindy Lebeauvin, Marc Stéfanon

Three persons from CERFACS, Laure Coquart, Eric Maisonnave and Sophie Valcke were available full time during that week to help the participants learn about OASIS and use it in their coupled system. The training started on the first day with a general presentation of OASIS and a tutorial during which the participants were guided step-by-step through the compilation and running of a toy coupled model reproducing ping-pong exchanges between two fake models, testing different functionalities of OASIS3 (see Appendix A). The rest of the week was devoted to personal help on the specific use of OASIS3 in the participants' own coupled model on their platform accessed through remote connection.

That week was very much appreciated by the participants (see their report below) and also by CERFACS instructors. Ideas on how to improve OASIS training, tutorial, documentation and user support in general were discussed and specific aspects of OASIS that need to be carefully presented to the users (for example, the sequencing indices, the "lag" concept, the importance to test off-line the quality of their interpolations) were identified. One important conclusion of that training week is that such training should be organized more regularly for the benefit of the whole community.

## Report from Philippe Le Sager, KNMI

In one word, I became a LOT more familiar with OASIS3. I have learned a lot, from the basics of coupling to more advance features (like using `-DTREAT_OVERLAY`), and I got quite a bit of practice with coupled models. One could argue that most of the (quite technical) information I have learned is readily available in the manual. But its assimilation is way better when it is directly provided by people, and when it is used in context, i.e. with practice. The workshop was great in that respect.

### 1. The hands-on tutorial (~first day)

We ran a toy model, added a lag, parallelization of models and of OASIS3. These little exercises were simple and running smoothly (no library or environment issues on your machines!). They provide a good example to get familiar with, and not afraid of, OASIS3. This is definitively the small but important step I missed when I first look at EC-Earth few weeks before coming to the workshop.

Could it be improved? Maybe by adding some interactivity, I mean, input from the participant (doing a little bit of coding in the toy). For now, these exercises consist essentially in running the same model with different configurations. Here are some ideas for more active exercise:

1. ask participant to add a new coupled field,
2. ask participant to add a new field read from file through OASIS,
3. have a coupled model with minor bug(s) to find

#2 is my favorite, #3 is difficult to come up with, since it must teach something useful. That said, the tutorial should not be too long, not longer than what it is now.

Although not strictly part of the tutorial, I ended up checking the regridding of MY OWN GRIDS with OASIS3 in interpolator-only mode on your machine. This was also a very good practice.

### 2. Presentations by Sophie Valcke

The overview presentation was a good complement to the tutorial. It also reminded us of some regridding issues. The short presentation that discusses the `$SEQMODE` keyword is interesting, although complicated.... At one point I thought I understood, but now I just think I have a recipe: "if you have no LAG, then set `$SEQMODE` to the max number of fields you will exchange at any coupling time". The two slides should probably be included into the manual and discussed there too.

There is no need for more presentation... I thought at one point you could add a short (and I mean short, since this is a workshop) general introduction before the tutorial starts, stating some of the goals. But I doubt such formalities are really needed.

### 3. User's own code

The focus put on everybody's code the following days is definitively what needs to be done. The best exercises end up being those spend trying to solve a concrete problem: diving into the code to find a call, debugging, installing a new version of oasis,...

Obviously the more people know about their code, the more they get from this part of the workshop. Participants' codes being at a different level of development, I have only one general

suggestion here: that you recommend some preparation. It could be asking participants (1) to know where fields are put/get in their models (if there is any), and what are their LAG/SEQ, and/or (2) to come with a list of clearly identified tasks you can pick from according to their direct relevance to OASIS3, and that they would like to tackle.

For the EC-EARTH/TM5 model, I came with a list of things to look at (looking into OASIS3 pseudo-parallel, problem with different coupling periods with atmosphere for ocean and chemistry models, issue with SCRIPP CONSERV regridding). We spend some time into the code for each of them, making substantial progress and the workshop a success.

### Report from Marianne Sloth Madsen from DMI

At DMI we are going to couple the PISM ice sheet model to EC-Earth as part of the COMBINE project. I attended the CERFACS training course to get familiar with OASIS which is already used in the EC-Earth model for coupling the atmosphere and ocean.

Overall, the course was very useful and well organized.

We started by going through a tutorial which described compilation issues and introduced a toy coupled model. Playing with the toy model was very useful to get the basic knowledge about the main coupling issues and it was a very good starting point for the individual work. During the first day we also had an introductory talk about development and main issues of OASIS.

During the rest of the week, we could work on our own projects with great assistance from the CERFACS team (Sophie Valcke, Laure Coquart and Eric Maissonave). This was very useful and it was good that we actually had the time to dig into the problems which appeared. I considered the EC-Earth OASIS set-up and I got a much better understanding of the namelist settings. For instance, we were introduced to a specific "interpolator-only" environment into which OASIS can be used off-line to test the transformation between grids for different settings and visualize the results. This was very informative and the tools will be very useful for testing the coupled EC-Earth-PISM system when we reach that far.

With the help of the CERFACS team we also found that the EC-Earth model does not handle the ORCA1 grid properly in the present set-up and that the normalization options might not be chosen in the most appropriate way. These issues have been reported to the EC-Earth consortium.

During the last days I spent some time considering a c++/OASIS interface which has been developed by Uwe Fladrich (SMHI) and is already used by Guy Schurgers who also participated in the course. I need this interface since the PISM ice sheet model is written in c++ and it was very nice to be able to interact on this issue.

It was a nice week and I learned a lot of useful methods.

### Report from Paul Miller and Guy Schurgers from Dept. of Earth and Ecosystem Science, Lund University

1. Our objectives

For several ongoing projects, most notably a project dealing with the coupling of the dynamic vegetation model LPJ-GUESS to the EC-earth framework, model coupling has become a prerequisite and has gained attention within our institute. Within EC-earth, a coupling will be established between the vegetation model and the land surface scheme in the atmosphere model (IFS/HTESSSEL) on the one hand, and between the vegetation model and the atmospheric chemistry component (TM5) on the other hand. Initial work for this coupling (in particular with respect to the land surface scheme) had been implemented by Guy with help from Uwe Fladrich (SMHI). For both Guy and Paul, one of the main objectives was to learn more about OASIS3, as well as to evaluate the work that had already been done to see whether we were using the coupler in a proper and efficient way.

## 2. Progress

During the week, we spent some time on the exercises provided by CERFACS. In particular the example from the pseudo-parallel approach offered a nice test case that might be applicable to our model setup once the number of fields that are transferred increases. Besides that, we compiled OASIS3 and our test models on our department's Linux cluster - till now we were using SMHI's computing system in Linköping - and tried to set up a test there. We were not quite successful, but technical assistance from our administrator is expected to solve this.

On Thursday, we started drafting a testing setup with LPJ-GUESS and two toy models, mimicking the setup that we expect to have with LPJ-GUESS coupled to both IFS/HTESSSEL and TM5. This setup had some problems with the order of the transfer of fields, which appears a critical issue when working with more models. This needs to be sorted out, but after our training week we are confident to have the skills to get this to work.

Overall, we now have much greater familiarity with compiling OASIS, its general functionality, the fields in the namcouple driver file, and the documentation. We are still coming to terms with the concepts of lag and sequence, but expect these to become clearer with time, trial and error, and frequent reference to the manual!

## 3. Suggestions

For us, the week has been very useful: We learned a lot from the training and we managed to work on our own setups with help from the OASIS3 developers. CERFACS has been very generous in hosting us and providing this training, and CERFACS' hospitality is much appreciated. The group dinner on Wednesday evening was very pleasant, as were the daily lunches in the on-site restaurant.

We would recommend this or a similar training to anyone who is starting or working with OASIS, and we hope that similar opportunities will be available for future collaborators on these topics within our institute or in other institutes. In addition, it is convenient to know that the OASIS3 team will be available for us should we have questions in the future. We feel that we have established a good working relationship with the CERFACS team this week, and hope that this will benefit us all in the months and years to come.

CERFACS' computer systems were well prepared for the different examples, though it seemed to take considerable time to get the same or similar setups compiled on other systems or with different compilers – something to be aware of for people starting the training.

If it doesn't already exist, we would recommend the establishment of an OASIS User Group, perhaps with an online presence, where users could exchange tips, ask for help from other users or the developers, and generally update others on what has and is being done with OASIS. We particularly valued the interaction with other users during the training, and are sure that others would too, even if it's online.

### Report from Cindy Lebeauvin, LMD

The training offered by CERFACS team (Sophie Valcke, Laure Coquart and Eric Maissonave) allowed us to set up the basis of the WRF/OASIS/NEMO and WRF/OASIS/ORCHIDEE coupled system planned in the framework of the MORCE-MED project.

The first day was devoted to getting more familiar with OASIS, thanks to a tutorial based on a “toy” coupled model. The general presentation that followed given by Sophie Valcke allowed us to discover different aspects of OASIS (versions, MPI option, interpolations, etc.). I think that going through a tutorial is a good approach to learn about compilation and the *namcouple* configuration file options. It could have been valuable to alternate parts of the tutorial with parts of the presentation in order to better understand what was effectively happening during the different tutorial steps.

After that, the training was really interactive. Being allowed to access our compute platforms and our model codes made us realize the complexity of setting up a real coupled system. The already existing NEMO/OASIS3 interface served as a basis for the development of the two other interfaces (WRF/OASIS and ORCHIDEE/OASIS). Trying to apply the coupling concepts learned about during the tutorial highlighted our lack of knowledge about the details of the models. In particular, the WRF model developed at NCAR XXX can easily become a black box from the user point of view. It also became clear that understanding the details of the forcing interface in stand-alone mode in the experiment I had performed separately with WRF or NEMO was helping me defining the coupling fields to be exchanged between the two models in coupled mode. That training week favored constructive contacts and fruitful discussions with the CERFACS team on physical and numerical aspects of coupling.

In conclusion, using the OASIS coupler can be considered as an essential brick in the construction of the MORCE multi-model platform. Even if we were not able to fully set-up the coupled model, we acquired strong basis for the coupling of the models 2 by 2. Furthermore, we can now anticipate what will be needed for the multi-model coupled setup (WRF/NEMO/ORCHIDEE) thanks to this training week. .

### Report from Marc Stéfanon, LMD

The tutorial we went through during the first day was really useful to learn about OASIS and understand its basic structure and functioning (e.g. the way to compile it and main options LAG et SEQ). It is possible to get through the tutorial in about half-a-day and the next step is then to have a more detailed look in the code of the toy models. Additional exercises, like having to rewrite parts of the code of one or both the toy models could be beneficial to have a practical deeper experience with OASIS model interfacing; 1,5 or 2 days could be spent on this leaving 3 days to work on our proper models.

The work done directly on our models was naturally the most interesting one, not only because we learned more about the use of OASIS in our models, but also because we first had to better understand our models. The main problem we faced is the portability and generality of the libraries needed by OASIS but this is a difficulty common to all informatics tool. We had to spend quite some time on preparing the model code for OASIS without really addressing yet the OASIS interfacing per se. To better benefit from the training week, it could have been interesting to know in advance which libraries/material are needed in order to be able to do some preparation in advance. This is of course particularly true when the coupled system has to be set up from scratch.

In general, I am very happy to have shared experiences in term of models but also to have benefited from your expertise in informatics and computing.

## Appendix A - OASIS3 tutorial

*Toulouse, January 25-29 2010*

The “toysimple” toy coupled model reproduces ping-pong exchanges between model1 and model2 with the OASIS3 coupler. The source files are found in directory prism/src/mod/oasis3/examples/toysimple.

At each coupling exchange, “model1” (see model1.F90) sends the field “FSENDOCN” to “model2” (see model2.F90), which receives it as “FRECVATM”, sends “FSENDATM” to “model1, which receives it as “FRECVOCN”; “model1” also outputs to a file the field “FOCNWRIT”, which is the same field than “FSENDOCN”. The time step of the two models is 3600 sec and the run is of 6 hours, with a coupling period of 2 hours. The “model1” runs on a logically-rectangular (182x149) grid and “model2” runs on a logically-rectangular (96x72) grid.

### A. Compiling and running «toysimple » with OASIS3 in monoprocessor mode

1. Login with login and password provided and open a terminal.
2. To compile OASIS3 and its PSMILe library:
  - Go into directory prism/src/mod/oasis3/util/make\_dir
  - Adapt the “make.inc” file which includes your platform header makefile (here “make.inc” includes “make.pgi\_cerfacs”).
  - Type “make clean -f TopMakefileOasis3; make oasis3\_psmile -f TopMakefileOasis3”
  - The executable “oasis3.MPI1.x” is available in directory prism/Linux/bin
  - The libraries that need to be linked to the models are available in directory prism/Linux/lib
3. To compile the toysimple models:
  - Go into directory prism/src/mod/oasis3/examples/toysimple
  - Type “make clean ; make”
  - The executables “toyocn” and “toyatm” are available in the current directory
  - A local link is made to the executable “oasis3.MPI1.x” in directory prism/Linux/bin
4. To run the toysimple coupled model:
  - Type “./run\_toysimple” to run the script run\_toysimple located in the directory
  - The results of the toysimple coupled model are now in subdirectory /work
  - You can visualize the results with ferret and the scripts script\_ferret\_\*\_serial\_apple.jnl. Type “ferret” and then “go xxx.jnl” where xxx.jnl is the name of the ferret script you want to run. Note that to run another ferret script, you have to restart ferret.
5. Keep your results by renaming /work into /work\_A

In this configuration, model1, model2 and OASIS3 run with one process each. This is indicated in the “namcouple” configuration file (see lines below \$CHANNEL keyword) and in the launching script “run\_toysimple” (see “nproc\_exe1” and “nproc\_exe2”), and there is no LAG.

## B. Running with a LAG for the coupling fields and with restart files with OASIS3 in monoprocessor mode

To match a sending action (prism\_put) of the source model at a particular date with a receiving action (prism\_get) of a target model at a different date, the user has to define an appropriate lag index; consequently restart files are used to read in data for the first receiving action and are produced at the end of the run for the restart of the next run.

In OASIS3 it is sufficient to indicate a lag index for the relevant coupling fields in the configuration files. The use and production of restart files are then automatically managed by the OASIS3. Of course, the restart files of the first run have to be present in the working directory at the beginning of the first run (fdocn.nc and fdatm.nc).

To reproduce a run with a lag with OASIS3:

- Go into directory prism/src/mod/oasis3/examples/toysimple/data\_oasis3. Put “LAG=+3600” on the second line of field FSENDONCN (before “SEQ=1”) and FSENDATM (before “SEQ=3”) in the namcouple configuration file. With OASIS3, the LAG is expressed in “number of seconds”.
- Rerun the toysimple coupled model with script “run\_toysimple”.
- Keep your results by renaming /work into /work\_B
- Observe the differences between the results obtained and the ones from A.

## C. Running the models in parallel with OASIS3 in monoprocessor mode

To run “model1” and “model2” in parallel, the number of processes has to be modified in the launching procedure.

OASIS3 supports different parallel decompositions for the models (see OASIS3 User Guide, section 4.3). If the models of toysimple are not parallel, the decomposition SERIAL (i.e. no partitioning) should be used; if they are run on more than one process, the APPLE or the BOX partitioning can be chosen (see routine oasis3\_decomp.F90).

To test the APPLE decomposition, recompile the toysimple models with, in Makefile: “CPPKEYDECOMP\_M1=DECOMP\_APPLE” or “CPPKEYDECOMP\_M2=DECOMP\_APPLE”. In this case, the results in subdirectory /work have to be visualized with ferret scripts script\_ferret\*\_serial\_apple.jnl. Note that in this example, OASIS3 itself still runs on 1 process; to run OASIS3 in a pseudo-parallel mode, see D.

- Recompile the models with “make clean ; make”
- Specify for example “nproc\_exe1=3”, “nproc\_exe2=3” in the script run\_toysimple
- Launch “run\_toysimple” which adapts the “namcouple” configuration file (see lines below \$CHANNEL keyword) and launches the models on 3 processes each.
- Keep your results by renaming /work into /work\_C
- Visually compare the results with the non-parallel case A.

#### D. Compiling and running toysimple with OASIS3 in IPSL parallel mode

If more than one OASIS3 process is used in a coupled model, one configuration file per OASIS3 process must be provided by the user and the files must be named `namcouple_x` where `x` is the number of the corresponding OASIS3 process; each OASIS3 executable will treat the coupling fields described in its configuration file `namcouple_x`, resulting in a pseudo-parallelisation of OASIS3 on a field-per-field basis. Note that in this case, OASIS3 must be compiled with the CPP key `use_oasis_para` and that this mode is available only with the MPI1 CLIM communication technique. To test this option with the `toysimple` coupled model:

- Go into directory `prism/src/mod/oasis3/util/make_dir`
  - Modify your platform header makefile “`make.pgi_cerfacs`” to activate the CPP key `use_oasis_para`
  - Recompile by typing “`make realclean -f TopMakefileOasis3`” and “`make oasis3_psmile -f TopMakefileOasis3`”
  - Go into directory `prism/src/mod/oasis3/examples/toysimple` ; recompile the models with “`make clean ; make`”
  - Put “`run_oasis3_ipslpara=1`” in the script `run_toysimple`
  - Run “`run_toysimple`” which then starts `model1`, `model2` and OASIS3 on two processes. Two `namcouple` files, i.e. “`namcouple_0`” and “`namcouple_1`” are copied to the working directory and respectively used by each OASIS process.
  - Keep your results by renaming `/work` into `/work_D`
- The results of the `toysimple` coupled model are now in subdirectory `/work` and can be compared with results obtained in B. or C.