

## IPSLCM6 configurations

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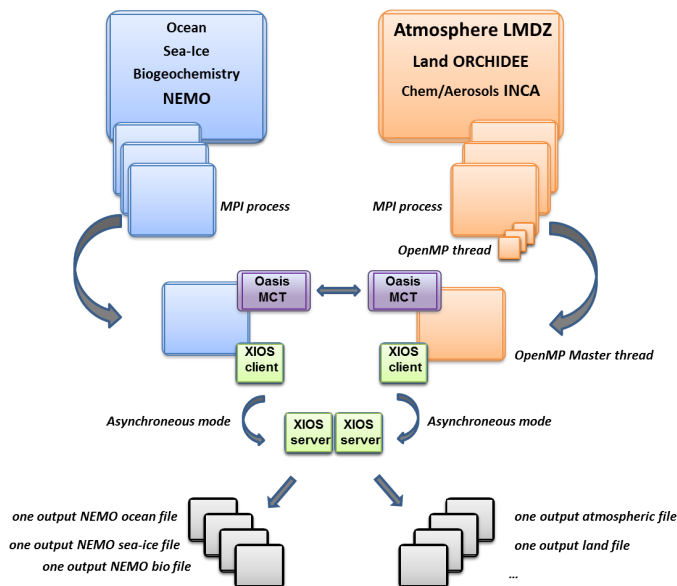
Person in charge: Arnaud Caubel

## 1. IPSLCM6 model

IPSLCM6 is **the IPSL coupled climate model** under development for the CMIP6 simulations including atmosphere, land, ocean, sea ice and carbon cycle. This model includes :

- model components :
  - **LMDZ** as atmospheric model ;
  - **NEMO** as ocean model including sea ice (LIM2/LIM3) and marine biogeochemistry (PISCES) ;
  - **ORCHIDEE** as land model ;
- tools :
  - **OASIS3-MCT** as parallel coupler ;
  - **XIOS** as I/O library ;
  - **libIGCM** as running environment (scripts) to run the model and to perform post processing ;

This model runs on **Curie-TGCC** and **Ada-IDRIS**.



## 2. Resolutions and configurations

IPSLCM6 model will be available at different resolutions/configurations :

- **IPSLCM6A-VLR\_rc0** : LMDZ(Old Physics) 96x95x39-ORCHIDEE(Choisnel) - NEMO-LIM2-PISCES ORCA2
- **IPSLCM6-LR** (under development, not available) : LMDZ 144x144x79-ORCHIDEE - NEMO-LIM3-PISCES ORCA1xL75

### 2.1. IPSLCM6A-VLR\_rc0

The resolution of LMDZ is 96x95 (3,75° in longitude and 1,875° in latitude) with 39 vertical levels. The ocean configuration is ORCA2 : global ocean with a tripolar grid with one South pole, one North pole above Siberia and one North pole above northern America. The resolution is 2°. In the tropical region, the latitudinal resolution decreases to 1/2°. There are 31 vertical levels.

**IPSLCM6-VLR\_rc0** is composed of following components and tools :

```
#-H- IPSLCM6_rc0  IPSLCM6_rc0 coupled configuration
#-H- IPSLCM6_rc0  Working configuration started 17/04/2013
#-H- IPSLCM6_rc0  with 5 NEMO sub-domains
#-H- IPSLCM6_rc0  NEMOGCM trunk revision 4859
```

```

#-H- IPSLCM6_rc0 XIOS branch xios-1.0 revision 592
#-H- IPSLCM6_rc0 IOIPSL/src svn tags/v2_2_2
#-H- IPSLCM6_rc0 LMDZ5 LMDZ6_rc0 branch revision 2283
#-H- IPSLCM6_rc0 ORCHIDEE version trunk rev 2247
#-H- IPSLCM6_rc0 OASIS3-MCT 2.0_branch rev 1129
#-H- IPSLCM6_rc0 IPSLCM6 v6_rc0 svn
#-H- IPSLCM6_rc0 libIGCM trunk 1174
#-M- IPSLCM6_rc0 arnaud.caubel@lsce.ipsl.fr
#-C- IPSLCM6_rc0 IOIPSL/tags/v2_2_2/src HEAD 8 IOIPSL/src modeles
#-C- IPSLCM6_rc0 trunk/ORCHIDEE 2247 14 ORCHIDEE modeles
#-C- IPSLCM6_rc0 branches/OASIS3-MCT_2.0_branch/oasis3-mct 1129 15 oasis3-mct .
#-C- IPSLCM6_rc0 LMDZ5/branches/LMDZ6_rc0 2283 11 LMDZ modeles
#-C- IPSLCM6_rc0 CONFIG/UNIFORM/v6_rc0/IPSLCM6 HEAD 8 IPSLCM6 config
#-C- IPSLCM6_rc0 trunk/libIGCM 1174 10 libIGCM .
#-C- IPSLCM6_rc0 trunk/NEMOGCM 4859 7 . modeles
#-C- IPSLCM6_rc0 XIOS/branchs/xios-1.0 592 12 XIOS modeles

```

### 2.1.1. How to use it

Here are the commands you need to know if you want to retrieve and compile the IPSLCM6 model and if you want to setup and run a piControl experiment (only piControl experiment is available):

```

mkdir MONREPERTOIRE ; cd MONREPERTOIRE
svn_ano # svn co http://forge.ipsl.jussieu.fr/igcmg/svn/modipsl/trunk modipsl
cd modipsl/util
./model IPSLCM6_rc0
cd ../config/IPSLCM6
gmake # by default ORCA2xLMD9695-L39
cp EXPERIMENTS/IPSLCM5/EXP00/config.card .
vi config.card # modify JobName (at least) : MYJOBNAME, restarts
../util/ins_job # Check and complete job's header
cd MYJOBNAME
vi Job_MYJOBNAME # modify PeriodNb, adjust the time, headers ...
llsubmit Job_MYJOBNAME # IDRIS
ccc_msub Job_MYJOBNAME # TGCC

```

#### 2.1.1.1. Specific command on TGCC Bull Curie thin nodes

The basic configuration (default configuration) uses **160 computing cores** or 10 nodes: 1 process for XIOS, 31 processes for NEMO, and 32 MPI processes and 4 OpenMP thread for LMDZ. You have to modify header of the Job script as follow :

```

#MSUB -n 160 # number of cores used by the Job (equal to the total number of process/threads : for example 32x4 + 31 + 1 = 160)
#MSUB -x # Sprecify the node is not shared
#MSUB -E '--cpu_bind=none'

```

#### 2.1.1.2. Specific command on IDRIS IBM Ada

The basic configuration uses **56 computing cores** or 2 nodes: 1 for XIOS, 7 for NEMO, and 24 MPI and 2 OpenMP for LMDZ. You have to modify headers of the Job script as follows :

```

# Nombre de processus MPI demandes (ici 24 + 7 + 1 = 32)
# @ total_tasks = 32
# Nombre de coeurs réellement utilisés (ici 24 x 2 + 7 + 1 = 56)
# @ environment = "BATCH_NUM_PROC_TOT=56"
# Nombre de taches OpenMP/pthreads par processus MPI
# @ parallel_threads = 2

```

and config.card as follows :

```

#=====
#D-- Executable -
[Executable]
#D- For each component, Real name of executable, Name of executable for oasis
ATM= (gcm.e, lmdz.x, 24MPI, 2OMP)
SRF= ( " " , " " )
SBG= ( " " , " " )
OCE= (opa, opa.xx , 7MPI)
ICE= ( " " , " " )
MBG= ( " " , " " )
CPL= ( " " , " " )
IOS= (xios_server.exe, xios.x, 1MPI)

```

### 2.1.2. Restart files

IPSLCM6 configuration could restart from any IPSLCM5A, IPSLCM5\_v5 and IPSLCM6 restart files. Default configuration starts from IPSLCM5A piControl2pm01 simulation (2349-12-31).

### 2.1.3. Lengths, frequencies

#### 2.1.3.1. Period length

Default period length is 1Y, i.e in config.card :

```
PeriodLength=1Y
```

Note that clean\_month.job will remove last period files, i.e last simulated year files.

#### 2.1.3.2. Output frequency

By default, only **monthly outputs** are activated.

#### 2.1.3.3. Pack Frequency

Default pack frequency is 10Y, i.e in config.card :

```
PackFrequency=10Y
```

Note that since clean\_year.job works on the latest pack period, clean\_year.job will remove files from latest 10Y pack period. clean\_year.job can also be used several time in a row to delete several 10Y pack periods.

#### 2.1.3.4. Rebuild frequency

Since we run with XIOS (server mode) as output library, **the rebuild step is not needed anymore.**

### 2.1.4. Computing centres

#### 2.1.4.1. TGCC Bull Curie thin nodes

Default configuration on **160 cores** allows you to run **38 simulated years per day**. Because of load-balancing (difference between ocean computing time and atmosphere computing time), not all configurations (in terms of number of process/threads) are efficient. If you want to run a configuration with less cores, ask Arnaud Caubel what would be the optimum configuration. The configuration is regularly used and evaluated on this machine:

■ <http://webservices.ipsl.jussieu.fr/trusting/>

#### 2.1.4.2. IDRIS IBM Ada

Configuration on **56 cores** allows you to run **16 simulated years per day**. This configuration is regularly used and evaluated on this machine:

■ <http://webservices.ipsl.jussieu.fr/trusting/>

### 2.1.5. Evaluation

Person in charge: Jérôme Servonnat

2.1.5.1. Results comparison between TGCC Curie and IDRIS Ada supercomputers

Simulations with default configuration have been performed both on Curie and Ada :

- CTLCM6G on Curie : <http://dods.extra.cea.fr/work/p86caub/IPSLCM6/PROD/piControl/CTLCM6G/MONITORING>
- CM6VLR1 on Ada : <http://dodsp.idris.fr/rcses061/IPSLCM6/PROD/piControl/CM6VLR1/MONITORING>

Inter-monitoring comparison : [http://dods.extra.cea.fr/work/p86caub/INTERMONITORING/intermonit\\_comp\\_ada\\_curie\\_rc0](http://dods.extra.cea.fr/work/p86caub/INTERMONITORING/intermonit_comp_ada_curie_rc0)

2.1.5.2. Results comparison between IPSL5 and IPSL6 simulations

Here are simulations performed to validate IPSL6-VLR\_rc0 configuration :

**CTLCM6G (default configuration IPSL6-VLR\_rc0)** : IPSL6-VLR\_rc0 model (CM6 water routing scheme, pmagic=-0.01, start from 2349-12-31 piControl2pm01)

- Output and Analyse files : /ccc/store/cont003/dsm/p86caub/IGCM\_OUT/IPSLCM6/PROD/piControl/CTLCM6G
- CTLCM6F : IPSL6-VLR\_rc0 model(CM5 water routing scheme, start from 2499-12-31 piControl2)
- Output and Analyse files : /ccc/store/cont003/dsm/p86caub/IGCM\_OUT/IPSLCM6/PROD/piControl/CTLCM6F
- CTLCM6H : IPSL6-VLR\_rc0 model (CM6 water routing scheme, pmagic=-0.01, without NEMO TKE IPSL5 parameters, start from 3199-12-31 CTLCM6G)
- Output and Analyse files : /ccc/store/cont003/dsm/p86caub/IGCM\_OUT/IPSLCM6/PROD/piControl/CTLCM6H

These simulations have been compared with IPSL5 simulations results :

- piControl2 : IPSL5A reference simulation
- CTLCM5V5v5 : IPSL5\_v5 configuration(aerosols v5)
- piControl2pm01 : IPSL5A reference simulation with pmagic=-0,01.

Following validation aspects are available :

- Inter-monitoring comparison : [http://dods.extra.cea.fr/work/p86caub/INTERMONITORING/intermonit\\_valid\\_CM6A\\_VLR\\_rc0](http://dods.extra.cea.fr/work/p86caub/INTERMONITORING/intermonit_valid_CM6A_VLR_rc0)
- Metric table

variable	rms_1y1_ann_GLB															Mean				
	pr	prv	pat	flut	flutes	frut	frutes	tas	uss	vsr	vsr	vsr	vsr	vsr	vsr					
referenceType	default	default	default	default	default	default	default	default	default	default	default	default	default	default	default					
referenceName	TRMM	GPCP	RSS	ERA40	ERAINT	CERES	CERES	CERES	ERA40	ERAINT	ERA40	ERAINT	ERA40	ERAINT						
simulationModel	simulationName	simulationPeriod																		
IPSLCM5A	CTLCM5V5v5	2010_2010	-0.918	-0.854	+0.843	-4.114	-4.236	+0.581	+0.499	-1.108	-0.930	-3.355	-3.184	-5.370	-5.038	+0.188	+0.433	-1.842		
		2020_2020	-0.918	-0.854	+0.279	+1.184	+1.215	-1.084	-0.124	-0.880	-0.705	-3.470	-3.893	+1.261	+0.972	-0.264	-0.284	-0.484		
	piControl2pm01	2000_2000	-0.239	+0.169	+2.723	-3.907	-4.239	+5.148	+20.884	-2.341	+3.870	-18.827	-20.070	-2.750	-3.248	+0.960	+1.134	-1.972		
		2010_2010	-0.239	+0.169	+2.149	+0.467	+0.536	+4.135	+9.628	-2.341	+1.820	-27.666	-28.700	+1.261	+1.512	-0.247	+0.189	-0.892		
	IPSLCM6	CTLCM6G	2020_2020	-0.060	+1.044	+2.295	-2.233	-2.498	+3.932	+9.762	-2.232	+1.995	-27.981	-28.913	-1.983	-2.208	+0.463	+0.462	-1.750	
			2030_2030	-0.038	+0.816	-0.949	-4.903	-4.339	-0.379	-2.132	-1.920	-0.205	-6.431	-6.424	-2.750	-2.808	+0.960	+1.134	-1.220	
		CTLCM6F	2710_2710	-0.239	+1.044	-0.787	-3.604	-3.492	-0.882	-2.229	-1.993	-3.205	+1.893	+0.202	-2.750	-2.808	+0.960	+1.134	-0.968	
			3200_3200	-0.239	+1.044	-0.787	-3.604	-3.492	-0.882	-2.229	-1.993	-3.205	+1.893	+0.202	-2.750	-2.808	+0.960	+1.134	-0.968	
		CTLCM6H	3210_3210	-0.239	+1.044	-0.787	-3.604	-3.492	-0.882	-2.229	-1.993	-3.205	+1.893	+0.202	-2.750	-2.808	+0.960	+1.134	-0.968	
			3220_3220	+1.735	+0.332	-0.131	+0.742	+0.419	+1.551	-0.384	-0.410	-0.805	+1.202	+1.408	+3.207	+3.132	+0.428	+0.425	+1.094	
IPSLCM5A		piControl2	2020_2020	+2.035	+0.736	+2.333	+1.073	+1.148	+7.125	+10.377	-2.232	-0.404	-10.404	-10.278	+0.462	+0.292	+1.127	+1.134	+0.273	
			2710_2710	-0.038	+0.816	+1.673	+3.653	+3.656	+3.428	+4.226	-2.887	-3.760	-12.618	-13.297	+0.215	+0.531	+0.189	+0.189	+0.594	
		CTLCM6G	2720_2720	+1.137	+0.839	+2.165	+0.727	+0.411	+4.996	+7.994	-2.473	-3.105	-13.880	-14.522	+0.223	+0.752	+0.428	+0.425	-0.058	
			3200_3200	+2.932	+0.159	+2.047	-1.087	-1.270	+0.547	+0.278	-2.923	+0.485	-10.773	-10.667	+2.908	+2.052	+1.611	+1.607	+0.209	
	CTLCM6H	3200_3200	+2.234	+1.211	+2.411	+1.893	+1.278	+4.844	+6.486	-3.229	+1.895	-10.088	-10.973	+0.223	+0.752	+0.463	+0.462	+0.292		
		3210_3210	+2.234	+1.211	+1.673	-1.824	-1.813	+0.148	+0.817	-0.820	+0.890	-10.142	-10.463	+1.820	+0.972	+1.127	+1.134	+0.428		
	IPSLCM5A	piControl2	3220_3220	+1.735	+0.262	+2.328	+0.223	+0.107	+4.468	+10.743	-2.332	+0.890	-14.184	-14.748	+10.490	+10.490	+0.189	+0.189	+0.271	
			2700_2700	-0.068	+0.095	+0.033	-0.798	-0.854	+0.588	+1.220	+0.145	+1.201	-0.431	-0.428	-1.583	-1.704	-0.467	-0.467	-0.225	
			2710_2710	+1.137	+0.569	-0.049	+0.148	+0.269	-0.274	-0.844	+0.067	-0.200	+0.431	+0.495	+0.114	+0.432	-0.467	-0.467	-0.199	
			2720_2720	+0.239	+1.992	+0.361	+4.441	+4.456	+0.385	+0.000	+0.000	-0.280	-1.892	-2.007	+0.802	+0.832	-0.251	-0.252	+1.071	
2730_2730			-1.057	-2.077	-0.049	-0.440	-0.440	-0.426	+0.538	-0.485	-0.485	+0.210	+0.495	+0.463	+0.432	+0.189	+0.189	+0.138		
2740_2740			+0.539	-0.285	-0.295	-3.355	-3.411	-0.274	-0.922	-0.196	+1.295	+1.077	+1.718	+0.006	-4.968	+0.428	+0.423	-0.949		

Root-Mean-Square Error calculated on the seasonal cycle over the globe (land + ocean) against two different references for each variable. This metric synthesizes the bias (difference in mean), the spatio-temporal correlation and standard-deviation ratio. The results are presented in % of the mean RMSE of piControl2 => a result of -10% indicates that the RMSE is 10% lower than the average RMSE of the reference simulation (here, five seasonal cycles of piControl2) ; the blue color shows the RMSE that are lower (in better agreement with the reference dataset) than the reference simulation. Inversely, the red color indicates a degradation compared with the reference simulation. For each simulation, the RMSE are shown for several seasonal cycles to illustrate the interannual/decadal variability of the results.

The table shows that :

- CTLCM5V5v5 has similar results as piControl2 (less than 5%) ; this suggests that CM6A-VLR\_rc0 (with new water routing scheme and same p\_magic as CM5A-LR) simulates a climate that is very similar to IPSL-CM5A-LR
- Same for CTLCM6F

- CTLCM6G and CTLCM6H (IPSLCM6A-VLR\_rc0 with new water routing scheme and p\_magic = -0.01) and piControl2pm01 (p\_magic = -0.01) show a reduction of the error on the 2m-temperature (tas) of around 15%, very likely associated with the adjustment of albedo (p\_magic = -0.01)
- For those simulations, we also note a degradation of the LW up (rlut and rlutcs) between 5 and 10% (greater than the variability among the seasonal cycles of piControl2), probably linked with the p\_magic (mainly concerns the tropics, not shown); in the same time, the SW gets significantly better (around 5%)
- For CTLCM6G and CTLCM6H, we also see a slight degradation of the zonal wind at 10m (uas), of the same order as the LW ; looking at the RMSE tables for the different seasons and regions, we can see that this degradation mainly concerns the tropics (-20/20°N) and the extra-tropical southern hemisphere
- For the other variables, the results do not show significant differences between piControl2 and IPSLCM6A-VLR\_rc0 (with the new water routing scheme and p\_magic = -0.01, simulations CTLCM6G and CTLCM6H)

Conclusion:

- the evaluation metrics of the seasonal cycle of IPSLCM6A-VLR\_rc0 with the water routing scheme of CM5A and the same p\_magic are similar to the ones obtained for piControl2. This suggests that the model is the same.
- the new water routing scheme and the tuned p\_magic produce a climate that is in better agreement for IPSLCM6A-CLR\_rc0 compared with IPSLCM5A-LR for tas and the SW; we note a degradation of the LW and the zonal winds; with the new water routing scheme and p\_magic = -0.01, we can say that IPSLCM6A-VLR\_rc0 is not the same as CM5A-LR. Further assessment is needed to understand what's happening with the radiative variables.