IPSLCM6_VLR (IPSLCM6_rc0) configuration

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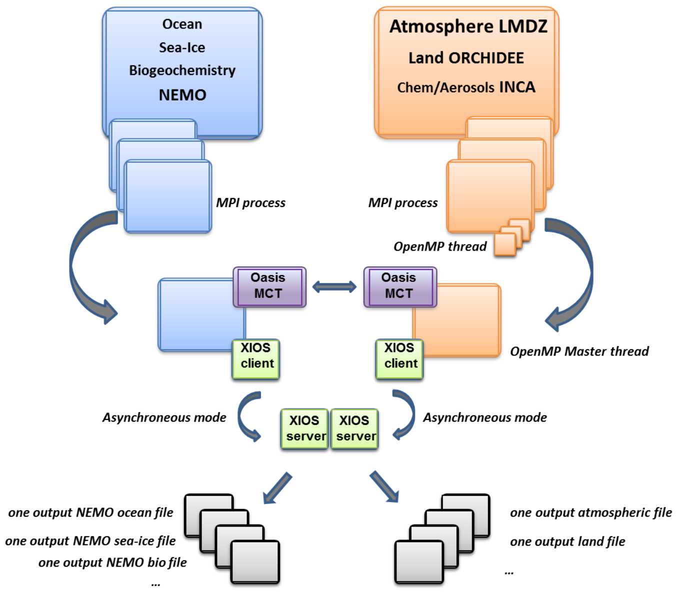
1. IPSLCM6 model

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. You can find here informations on the VLR configuration.

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 604
#-H- IPSLCM6_rc0  IOIPSL/src svn tags/v2_2_2
#-H- IPSLCM6_rc0  LMDZ5 LMDZ6_rc0 branch revision 2296
#-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 tag libIGCM_v2.6
#-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                    2296        11  LMDZ           modeles
#-C- IPSLCM6_rc0  CONFIG/UNIFORM/v6_rc0/IPSLCM6               HEAD         8  IPSLCM6        config
#-C- IPSLCM6_rc0  tags/libIGCM_v2.6                           HEAD        10  libIGCM        .
#-C- IPSLCM6_rc0  trunk/NEMOGCM                               4859         7  .              modeles
#-C- IPSLCM6_rc0  XIOS/branchs/xios-1.0                        604        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 YOUR_DIRECTORY ; cd YOUR_DIRECTORY
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 =
#MSUB -x # Specify 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)
```

On Ada, it is needed to use adjust option for LMDZ(beware of OpenMP case, more information here).

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. Output level

By default, only **monthly outputs** and **low output levels** are activated.

2.1.4. Lengths, frequencies

2.1.4.1. Period length

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

```
PeriodLength=1Y
```

Note that clean_PeriodLength.job will remove last period files, i.e last simulated year files.

2.1.4.2. Pack Frequency

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

```
PackFrequency=10Y
```

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

2.1.4.3. Rebuild frequency

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

2.1.5. Computing centres

2.1.5.1. 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/

2.1.5.2. 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/

2.1.6. Evaluation

Person in charge: Jérôme Servonnat

2.1.6.1. 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://esgf.extra.cea.fr/thredds/fileServer/work/p86caub/IPSLCM6/PROD/piControl/CTLCM6G/MONITORING/index.html
- CM6VLR1 on Ada : https://prodn.idris.fr/thredds/fileServer/ipsl_public/rces061/IPSLCM6/PROD/piControl/CM6VLR1/MONITORING/index.html

Inter-monitoring comparison : http://esgf.extra.cea.fr/thredds/fileServer/work/p86caub/INTERMONITORING/intermonit_comp_ada_curie_rc0/index.html

2.1.6.2. Results comparison between IPSLCM5 and IPSLCM6 simulations

Here are simulations performed to validate IPSLCM6-VLR_rc0 configuration :

CTLCM6G (default configuration IPSLCM6-VLR_rc0) : IPSLCM6-VLR_rc0 model (CM6 water routing scheme, pmagic=-0.01, start from 2349-12-31 piControl2pm01)
  - Output and Analyse files : $CCCSTOREDIR/../../dsm/p86caub/IGCM_OUT/IPSLCM6/PROD/piControl/CTLCM6G
- CTLCM6F : IPSLCM6-VLR_rc0 model(CM5 water routing scheme, start from 2499-12-31 piControl2)
  - Output and Analyse files : $CCCSTOREDIR/../../dsm/p86caub/IGCM_OUT/IPSLCM6/PROD/piControl/CTLCM6F
- CTLCM6H : IPSLCM6-VLR_rc0 model (CM6 water routing scheme, pmagic=-0.01, without NEMO TKE IPSLCM5 parameters, start from 3199-12-31 CTLCM6G)
  - Output and Analyse files : $CCCSTOREDIR/../../dsm/p86caub/IGCM_OUT/IPSLCM6/PROD/piControl/CTLCM6H

Warning : CTLCM6G, CTLCM6F, CTCCM6H have problems on atmospheric variable on level pressure (problem fixed in reference IPSLCM6-VLR_rc0 version).

These simulations have been compared with IPSLCM5 simulations results :

- piControl2 : IPSLCM5A reference simulation
- CTLCM5V5v5 : IPSLCM5_v5 configuration(aerosols v5)
- piControl2pm01 : IPSLCM5A reference simulation with pmagic=-0.01.

Following validation aspects are available :

- Inter-monitoring comparison : http://esgf.extra.cea.fr/thredds/fileServer/work/p86caub/INTERMONITORING/intermonit_valid_CM6A_VLR_rc0/index.html
- Metric table

			rms_xyt_ann_GLB															Mean
		variable	pr		prw	psl		rlut	rlutcs	rsut	rsutcs	tas		uas		vas		
		referenceType	alternate1	default	default	alternate1	default	default	default	default	default	alternate1	default	alternate1	default	alternate1	default	
		referenceName	TRMM	GPCP	RSS	ERA40	ERAINT	CERES	CERES	CERES	CERES	ERA40	ERAINT	ERA40	ERAINT	ERA40	ERAINT	
simulationModel	simulationName	simulationPeriod																
IPSLCM5A	CTLCM5V5v5	2510_2519	-0.958	-0.854	+0.443	-4.114	-4.256	+0.081	+0.692	-1.008	-0.930	-3.155	-3.186	-5.575	-5.508	+0.189	+0.425	-1.847
		2520_2529	-0.958	-0.854	+0.279	+1.184	+1.215	-1.084	-0.154	-0.880	-0.705	-3.470	-3.493	+1.251	+0.972	-0.284	-0.284	-0.484
	piControl2pm01	2000_2009	-0.359	+0.569	+3.723	-3.907	-4.159	+5.148	+10.684	-2.161	+3.870	-18.927	-20.037	-2.730	-3.348	+0.900	+1.134	-1.973
		2010_2019	+0.239	+1.992	+3.149	+0.467	+0.536	+4.135	+9.608	-2.161	+1.920	-17.666	-18.505	+1.251	+1.512	-0.047	+0.189	-0.892
		2020_2029	-0.060	+1.044	+3.395	-2.233	-2.498	+3.932	+9.762	-2.332	+1.995	-17.981	-18.811	-1.593	-2.268	+0.663	+0.662	-1.755
IPSLCM6	CTLCM6F	2530_2539	+0.838	+3.416	-0.049	-4.405	-4.359	-0.375	-2.152	-1.520	-5.205	-0.631	-0.429	-2.730	-2.808	+0.900	+1.134	-1.225
		2710_2719	-0.359	+1.044	-0.787	-3.606	-3.692	-0.882	-2.229	-1.093	-3.330	+1.893	+2.022	-2.730	-2.808	+0.900	+1.134	-0.968
		3200_3209	+0.239	+2.467	-0.705	+2.091	+2.115	-0.020	-0.769	-0.239	-1.905	+2.839	+2.941	+6.371	+5.832	+0.189	+0.189	+1.442
		3210_3219	+0.539	+2.467	-0.295	-1.425	-1.786	-0.882	-2.613	-1.221	-2.805	+0.631	+0.797	+1.251	+0.432	+0.900	+0.898	-0.208
		3220_3229	+1.735	+5.313	-0.131	+0.742	+0.619	+1.551	-0.384	-0.410	-2.805	+1.262	+1.409	+3.527	+3.132	+0.426	+0.425	+1.094
	CTLCM6G	2520_2529	+2.035	+6.736	+3.313	+1.073	+1.148	+7.125	+10.377	-2.332	-5.055	-16.404	-17.279	+5.802	+5.292	+1.137	+1.134	+0.273
		2710_2719	+0.838	+3.890	+1.673	+3.453	+3.656	+3.628	+6.226	-2.887	-3.780	-12.618	-13.297	+9.215	+8.531	+0.189	+0.189	+0.594
		2720_2729	+1.137	+4.839	+2.165	+0.727	+0.611	+4.996	+7.994	-2.673	-3.105	-13.880	-14.522	+5.233	+4.752	+0.426	+0.425	-0.058
		3200_3209	+2.932	+8.159	+2.247	-1.087	-1.270	+5.047	+8.378	-2.503	+5.445	-15.773	-16.667	+2.958	+2.052	+1.611	+1.607	+0.209
	CTLCM6H	3200_3209	+2.334	+7.211	+2.411	+1.403	+1.278	+4.946	+8.686	-3.229	+1.095	-16.088	-16.973	+5.233	+4.752	+0.663	+0.662	+0.292
		3210_3219	+2.334	+6.736	+1.673	-1.824	-1.913	+5.148	+7.917	-2.930	+1.995	-15.142	-15.441	+1.820	+0.972	+1.137	+1.134	-0.426
		3220_3229	+1.735	+6.262	+2.329	+5.023	+5.107	+6.669	+10.761	-2.332	+2.895	-14.196	-15.748	+11.490	+10.691	+0.189	+0.189	+2.071
IPSLCM5A	piControl2	2700_2709	-0.658	+0.095	+0.033	-0.795	-0.854	+0.588	+1.230	+0.145	+1.320	-0.631	-0.429	-1.593	-1.728	-0.047	-0.047	-0.225
		2710_2719	+1.137	+0.569	-0.049	+0.148	+0.269	-0.274	-0.846	+0.487	-0.030	+0.631	+0.490	+0.114	+0.432	-0.047	-0.047	+0.199
		2720_2729	+0.239	+1.992	+0.361	+4.441	+4.456	+0.385	+0.000	+0.060	-2.280	-1.893	-2.267	+5.802	+5.832	-0.521	-0.520	+1.072
		2730_2739	-1.257	-2.277	-0.049	-0.440	-0.460	-0.426	+0.538	-0.495	-0.405	+0.315	+0.490	+0.683	+0.432	+0.189	+0.189	-0.198
		2740_2749	+0.539	-0.380	-0.295	-3.355	-3.411	-0.274	-0.922	-0.196	+1.395	+1.577	+1.716	-5.006	-4.968	+0.426	+0.425	-0.849

-50.00	-45.00	-40.00	-35.00	-30.00	-25.00	-20.00	-15.00	-10.00	-5.00	+0.00	+5.00	+10.00	+15.00	+20.00	+25.00	+30.00	+35.00	+40.00	+45.00	+50.00

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. For further illustration of the differences between IPSL-CM5A-LR and CM6A-VLR_rc0 with new water routing scheme and p_magic = -0.01, please refer to the following atlases:

- IPSL-CM5A-LR: ■http://esgf.extra.cea.fr/thredds/fileServer/work/p86caub/IPSLCM5A/DEVT/piControl/CTLCM5V5v5/ATLAS/SE_2500_2539/ATM/ATM.html
- IPSL-CM6A-VLR_rc0: ■http://esgf.extra.cea.fr/thredds/fileServer/work/p86caub/IPSLCM6/PROD/piControl/CTLCM6G/ATLAS/SE_3250_3299/ATM/ATM.html

The table shows that :

- CTLCM5V5v5 has similar results as piControl2 (less than 5%) ; this suggests that CM6A-VLR_rc0 (with same 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); this is confirmed by the bias maps of CTLCM6G (■http://esgf.extra.cea.fr/thredds/fileServer/work/p86caub/IPSLCM6/PROD/piControl/CTLCM6G/ATLAS/SE_3250_3299/ATM/lw_116852/lw.pdf) compared with CTLCM5V5v5 (■http://esgf.extra.cea.fr/thredds/fileServer/work/p86caub/IPSLCM5A/DEVT/piControl/CTLCM5V5v5/ATLAS/SE_2500_2539/ATM/lw_26556/lw.pdf) ; this change mainly concerns the tropics; in the same time, the metric table shows that 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. On the bias maps (compare ■http://esgf.extra.cea.fr/thredds/fileServer/work/p86caub/IPSLCM5A/DEVT/piControl/CTLCM5V5v5/ATLAS/SE_2500_2539/ATM/vitu_44109/vitu.gif with ■http://esgf.extra.cea.fr/thredds/fileServer/work/p86caub/IPSLCM6/PROD/piControl/CTLCM6G/ATLAS/SE_3250_3299/ATM/vitu_60643/vitu.gif) we see that the zonal wind biases are the same but slightly reinforced in CTLCM6G.
- 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 of the metric table:

- 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 (stronger biases, rather than a degradation of the spatial structure) ; 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.