

# PMIP4 and the CMIP6 DRS



All the *attributes* have to be defined properly when creating data for the CMIP6 database, but you will find below details about some attributes that are especially relevant for PMIP4

## Some key concepts...



- **attribute**: a *global attribute* (e.g. in a NetCDF file) used to describe the data
- **CV**: sometimes the value of a given **attribute** has to be taken from a predefined set of values, known as a *Controlled Vocabulary (CV)*
  - [CMIP6 allowed CV values](#)
- **DRS** = *Data Reference Syntax*: the *DRS* is used to identify experiments, simulations, ensembles of experiments, atomic datasets and is used, for example, in [file names](#), [directory structures](#), the *further\_info\_url*, and in *facets* of some search tools
- **facet** = a category or attribute you can put a search constraint on, when doing a *faceted search*

Example: the *experiment\_id* **attribute** is used in the **DRS**, and its value has to be chosen from a **CV** (*[piControl, past1000, lgm, ...]*).

On the [IPSL CMIP5 search node](#), you can put a search constraint on the *Experiment* **facet** by clicking on *Experiment* and then selecting *lgm* and clicking on *Search*

## CMIP6 official specifications

The following CMIP6 document is still *in prep* (as of July 14th 2016)



*This document specifies all the global attributes that are defined for CMIP6. It also indicates how a subset of those relate to the Data Reference Syntax (DRS) and are used in file names and directory structures. Controlled vocabularies are defined for some global attributes (e.g., *source\_type* and*



*grid\_resolution).*

- **CMIP6** document: [CMIP6 Global Attributes, DRS, Filenames, Directory Structure, and CV's \(version 1.0\)](#)
  - Note: [CMIP6 allowed CV values](#)
- Legacy **CMIP5** documents:
  - [CMIP5 Data Reference Syntax \(DRS\) and Controlled Vocabularies \(Version 1.3.1 - 13 June 2012\)](#)
  - [CMIP5 Model Output Requirements: File Contents and Format, Data Structure and Metadata \(7 January 2010\)](#)

## Project identification attributes

- `activity_id` = activity labels
- `mip_era` = activity's associated CMIP cycle
- Note: *The project\_id used in CMIP5 is being replaced in CMIP6 with two global attributes: 1) an activity\_id, and 2) a mip\_era (a label indicating the cycle of CMIP that this activity falls under which will be set to "CMIP6" for the 6th CMIP cycle). In a few cases it may be appropriate to include multiple activities in the activity\_id (with multiple activities allowed, separated by single spaces). An example of this is "LUMIP AerChemMIP" for one of the land-use change experiments.*

Project	activity_id	mip_era	Note
CMIP6	CMIP	CMIP6	
PMIP4-CMIP6	CMIP "CMIP PMIP"??	CMIP6	Should we use <i>CMIP</i> or " <i>CMIP PMIP</i> " for <a href="#">PMIP4 experiments that are part of CMIP6?</a> This is confusing
PMIP4	PMIP	PMIP4?? CMIP6??	Use this for non-CMIP6 experiments, or groups that are not part of CMIP6 Should we use <i>PMIP4</i> because it is the 4th phase of PMIP, or <i>CMIP6</i> because we will be using CMIP6 format specifications?

## Experiment names

You can find all the referenced experiment names on [es-doc search](#) site: select Project=CMIP6-DRAFT and Type=Experiment

- `experiment_id` = root experiment identifier
- `experiment` = short expt. description
- `sub_experiment_id`=none ⇒ *needed for CMIP6 hindcast and forecast experiments to indicate "start year". For other experiments, this should be set to none*
- `sub_experiment`=none ⇒ *needed for CMIP6 hindcast and forecast experiments. For other experiments, this should be set to none*

## DECK and historical experiments



### Fix Me!

How do we specify that an *historical* experiment is the true continuation of a *past1000* experiment?



We probably need to use `parent_experiment_id=past1000` in the files' metadata, as well as `parent_activity_id`, `parent_mip_era=CMIP6`, `parent_source_id`, `branch_time_in_parent` and other related `parent_*` variables. We can probably also agree on a specific `variant_label` that will appear in the file names.

Reminder: **DECK** = *Diagnostic, Evaluation and Characterization of Klima*. More information on the CMIP6 experiments is available in [Eyring et al 2017](#)

experiment_id	experiment
amip	Atmospheric Model Intercomparison Project
piControl	Pre-Industrial Control
abrupt-4xCO2	abrupt quadrupling of CO2
1pctCO2	1 percent per year increase in CO2
historical	all-forcing simulation of the recent past

## PMIP4-CMIP6 experiments

You can find specific details about the experiments by visiting the [PMIP4 experimental design](#) section, or by directly clicking on one of the experiments below

experiment_id	experiment
past1000	<a href="#">past 1000 years</a>
mid-Holocene	<a href="#">mid-Holocene</a>
lgm	<a href="#">last glacial maximum</a>
lig127k	<a href="#">last interglacial</a>
midPliocene-eoi400	<a href="#">mid-Pliocene</a>

## PMIP4 only experiments

### Guidelines for creating new PMIP4 experiment\_id values

- Allowed characters: CMIP6 experiment\_id values are similar to [CMIP5](#) (...so the permitted characters will be: a-z, A-Z, 0-9, and "-"), but a compound structure is allowed (segments separated by hyphens; e.g., "abrupt-4xCO2"); in a few cases multiple sub-experiments will be defined belonging to this root and constituting an ensemble.

- Being wise when creating/proposing a new name
  - Global attributes that label experiments are needed to construct file names and directories and can generally be used as search facets. Together, they should have the following characteristics:
    - \* Uniquely label each experiment within CMIP6 and distinguish experiments with specified conditions that differ in any way
    - \* Easily be interpreted and remembered
    - \* Facilitate representations of groups of experiments that are closely related (e.g., same forecast conditions but different start dates, or experiment with an “offline” model driven by output from various models)
- Planning for groups of related simulations
  - Often several simulations will be performed that satisfy the conditions specified for each experiment. For example simulations of the historical period can branch from various points in a control run, and each of these will satisfy the conditions defining the experiment. Together such simulations constitute a “conforming ensemble” with member all satisfying the same “root” experiment specifications. There are also occasional cases where the experiment designers (MIP leaders) define a family of related simulations and choose to label these with a common “root” experiment name. An example of this is the set of decadal prediction hindcasts that are all run similarly but started from different start dates (with each simulation identified by a different sub-experiment label). Such “defined ensembles” of experiments will be labeled with a “root” experiment name, and a “sub-experiment\_id” will be used to distinguish among members in the ensemble.
  - Ensemble of simulations usually share a common `experiment_id` and have different *ripf* [variant labels](#).







## Proposed PMIP4 `experiment_id` values



The following suggested PMIP4 `experiment_id` values should be considered as a *work in progress*, till they are validated!

You can find specific details about the experiments by visiting the [PMIP4 experimental design](#) section, or by directly clicking on one of the experiments below

experiment_id	experiment	Status
LDv1-LGMspin	<a href="#">Last Glacial Maximum spinup</a>	Work

experiment_id	experiment	Status
LDv1-transpin	<a href="#">Transient orbit and trace gases spinup (26-21 ka)</a>	Work
LDv1	<a href="#">Transient deglaciation (21-0 ka)</a>	Work
 <b>Fix Me!</b>	Early Holocene (9.5 ka? 8.5 ka?)	Work
lig116k ?	Transition from the LIG to the glacial (2 experiments)	Work
 <b>Fix Me!</b>	MIS11 (2 experiments)	Work
 <b>Fix Me!</b>	Transient Holocene (6 ka to 0)	Work
 <b>Fix Me!</b>	Transient LIG (130 ka to 125 ka)	Work
 <b>Fix Me!</b>	<a href="#">DeepMIP</a>	Work
 <b>Fix Me!</b>	More experiments to come...	

## Handling groups of simulations

### CMIP5 ensemble member

aka  $r < N > i < M > p < L >$  or *rip*

The definitions below have been superseded by CMIP6 specifications, but it is still useful to remember them. They have been copied from:



- a) [CMIP5 Data Reference Syntax \(DRS\) and Controlled Vocabularies \(Version 1.3.1 - 13 June 2012\)](#)
- b) [CMIP5 Model Output Requirements: File Contents and Format, Data Structure and Metadata \(7 January 2010\)](#)

- b)  $\Rightarrow$  realization = an integer ( $\geq 1$ ) distinguishing among members of an ensemble of simulations (e.g., 1, 2, 3, etc.). If only a single simulation was performed, then it is recommended that realization=1.  
For fields appearing in table "fx" in the CMIP5 Requested Output, set realization=0 (violating the general rule that it should be a positive definite integer).  
Note that if two different simulations were started from the same initial conditions, the same realization number should be used for both simulations. For example if a historical run with "natural forcing" only and another historical run that includes anthropogenic forcing were initiated from the same point in a control run, both should be assigned the same realization. Also, each so-called RCP (future scenario) simulation should normally be assigned the same realization integer as the historical run from which it was initiated. This will allow users to easily splice together the appropriate historical and future runs. A similar convention should be

followed, when appropriate, with other simulations (e.g., the decadal simulations).

Note that the realization can be used in constructing the “ensemble member” called for by the DRS document; it is the value of **N** in  $r<N>i<M>p<L>$ .

[Note that for the “Transpose AMIP” project, the “realization” number is used to distinguish among the 16 members of each of 4 suites of runs (i.e., the 4 “seasons”) generated from different observed conditions, spaced 30 hours apart. So, for example, the 16-member ensemble of runs initialized at 00Z on 15 Oct 2008, 06Z 16 Oct 2008, 12Z 17 Oct 2008, and so on, would be assigned “r1”, “r2”, “r3”, etc.]

- b)  $\Rightarrow$  `initialization_method` = an integer ( $\geq 1$ ) referring to the initialization method used or different observational datasets used to initialize.

If only a single method and dataset was used to initialize the model, then this argument should normally be given the value 1.

For fields appearing in table “fx” in the CMIP5 Requested Output, set `initialization_method=0` (violating the general rule that it should be a positive definite integer).

See the DRS document for guidance on assigning `initialization_method`. Note that the `initialization_method` is used in constructing the “ensemble member” called for in the DRS document; it is the value of **M** in  $r<N>i<M>p<L>$ .

- b)  $\Rightarrow$  `physics_version` = an integer ( $\geq 1$ ) referring to the physics version used by the model. If there is only one physics version of the model, then this argument should be normally given the value 1.

Note that model versions that are substantially different should be given a different “model\_id”; assigning a different “physics\_version” should be reserved for closely-related model versions (e.g., as in a “perturbed physics” ensemble) or for the same model, but with different forcing or feedbacks active. In CMIP5, one would distinguish, for example, among runs forced by different combinations of “forcing” agents (as called for under the “historicalMisc” experiment – experiment 7.3) by assigning different values to `physics_version`.

For fields appearing in table “fx” in the CMIP5 Requested Output, set `physics_version=0` (violating the general rule that it should be a positive definite integer). Note that the `physics_version` is used in constructing the “ensemble member” called for by the DRS document; it is the value of **L** in  $r<N>i<M>p<L>$ .

- a)  $\Rightarrow$  Ensemble member ( $r<N>i<M>p<L>$ ) =

This triad of integers (N, M, L), formatted as shown above (e.g., “r3i1p21”) distinguishes among closely related simulations by a single model. All three are required even if only a single simulation is performed.

The so-called “realization” number (a positive integer value of “N”) is used to distinguish among members of an ensemble typically generated by initializing a set of runs with different, but equally realistic, initial conditions. CMIP5 historical runs initialized from different times of a control run, for example, would be identified by “r1”, “r2”, “r3”, etc.). The data supplier must assign a realization number to each atomic dataset. It is generally recommended that the numbers be assigned sequentially starting with 1 (but other recommendations,

specified below, may override this recommendation). In CMIP5, time-independent variables (i.e., those with frequency="fx") are not expected to differ across ensemble members, so for these N should be invariably assigned the value zero ("r0"). For TAMIP ("the Transpose AMIP activity), the "realization" number is used to distinguish among the 16 members of each of 4 ensembles (one for each of 4 "seasons") generated from different observed conditions, spaced 30 hours apart. So, for example, the 16-member ensemble of runs initialized at 00Z on 15 Oct 2008, 06Z 16 Oct 2008, 12Z 17 Oct 2008, and so-on, would be assigned "r1", "r2", "r3", etc.

Models used for forecasts that depend on the initial conditions might be initialized from observations using different methods or different observational datasets. These should be distinguished by assigning different positive integer values of "M" in the "initialization method indicator" ( $i < M >$ ). For CMIP5 this indicator might in some cases be needed to distinguish among runs in the decadal-prediction suite of experiments (1.1-1.6). The data supplier must assign an initialization method number to each atomic dataset. It is recommended that the numbers be assigned sequentially starting with 1. In CMIP5, time-independent variables (i.e., those with frequency="fx") are not expected to differ across ensemble members, so for these M should invariably be assigned the value zero ("i0"). A key (i.e., a table) should be made available that associates each value of M with a particular initialization method and/or observational dataset.

If there are many closely related model versions, which, as a group, are generally referred to as a perturbed physics ensemble (e.g., QUMP or climateprediction.net ensembles), then these should be distinguishable by a "perturbed physics" number,  $p < L >$ , where the positive integer value of L is uniquely associated with a particular set of model parameters (e.g., r3ilp78 is a third realization of the seventy-eighth version of the perturbed physics model). If there are different "forcing" combinations prescribed in experiment 7.3 in CMIP5 (the "historicalMisc" runs), then

each of these different runs are also assigned different values of  $L$  (in " $p < L >$ "). Note that the data supplier must assign a physics version number to each atomic dataset. It is recommended that the numbers be assigned sequentially starting with 1. In CMIP5, time-independent variables (i.e., those with frequency="fx") are not expected to differ across ensemble members, so for these  $L$  should always be assigned the value zero (" $p0$ "). A key (i.e., a table) should be made available that associates each value of  $L$  with a particular set of model parameter values and/or, in the case of the "historicalMisc" experiment, a particular suite of "forcing" agents.

Note that for a single model and experiment  $N$ ,  $M$ , and  $L$  should be interpretable independently; for all members of the ensemble, the correspondence between the values of  $N$ ,  $M$ , and  $L$  and the simulation characteristics they represent should be consistent. For example the two different ensemble members,  $r3i1p7$  and  $r3i1p8$ , should both be initialized from exactly the same initial conditions using the same method (because the " $r$ " and " $i$ " values are identical) although the subsequent evolution of the simulations will presumably differ since they were produced by two different "perturbed physics" versions of the same model. Note that there may be cases where "gaps" could occur in the list of ensemble members. If, for example, two different initialization procedures were used, but the second procedure was tested with only a subset of the initial condition cases of the first procedure (say, every other case). Then the list of ensemble members would look like:  $r1i1p1$ ,  $r2i1p1$   $r3i1p1$ ,  $r4i1p1$ ,  $r5i1p1$ ,  $r6i1p1$ , ...,  $r1i2p1$ ,  $r3i2p1$ ,  $r5i2p1$ , ...

A recommendation for CMIP5 is that each so-called RCP (future scenario) simulation should when possible be assigned the same realization integer as the historical run from which it was initiated. This will allow users to easily splice together the appropriate historical and future runs. Thus, for example, suppose a 3-member ensemble of historical runs of a model exists, and a single  $rcp45$  simulation was produced, initialized from the third member of the historical ensemble. The  $rcp45$  simulation would be designated " $r3$ " (rather than " $r1$ "), even though it is the only existing ensemble member, in order to indicate that it was



spawned from member 3 of the historical ensemble. A similar convention should be followed, when appropriate, with other simulations (e.g., the decadal simulations).

## CMIP6 variant\_label

aka  $r<k>i<l>p<m>f<n>$  or *ripf*

- `realization_index` = realization number (integer >0)
- `initialization_index` = index for variant of initialization method (integer >0)
- `physics_index` = index for model physics variant (integer >0)
- `forcing_index` = index for variant of forcing (integer >0)
  - Note: the information stored in the *forcing* attribute in CMIP5 may in CMIP6 appear in the `variant_info` attribute
- `variant_label` = a label constructed from 4 indices stored as global attributes

◦  $r<k>i<l>p<m>f<n>$

where

`k` = `realization_index`

`l` = `initialization_index`

`m` = `physics_index`

`n` = `forcing_index`

- `variant_info` = brief description of what is unique about this *ripf* variant
  - Example: “*forcing: black carbon aerosol only*”, “*realization 1*”, “*realization 1; initialized using anomaly approach (method 2)*”

## PMIP4 and variant\_label notes

Reminder: each option in  $r<k>i<l>p<m>f<n>$  has to be a strictly positive integer

### realization\_index $r<k>$

The long PMIP4 simulations are going to require both a lot of processing power and a lot of storage. It is quite likely that there will be **only one realization**, for a given set of  $i<l>p<m>f<n>$  and that the variant label will always start with `r1`

### forcing\_index $f<n>$

Depending on available resources, the PMIP4 groups may choose to perform several simulations for the same experiment, using different combinations of forcings. **The forcings used will have to be carefully described** in the documentation (and in the metadata inside each NetCDF file) and be *encoded* in the integer value of the `forcing_index`.

There are several ways to proceed. The easiest way is to let each group choose its own way of

numbering the forcings combinations (and document it!), but **all groups should try to use a common scheme** for and associate the same combination of forcings with the same integer

### Sequential numbering scheme

The contact people for each experiment determine which forcings combinations are most likely to be used and associate them with a predefined number. If necessary, a group can later ask for a new forcing combination to be registered

Forcings	fforcing_index
Recommended default, or most likely combination, or mandatory simulation	f1
forcing1='on', forcing2='off', etc	f2
Some other combination	fN

### Hierarchical numbering scheme

The following scheme will create bigger integers, but the values will be more meaningful

If there are 10 or less options for each type of forcing, we can assign a power of 10 to each type, multiply it with the forcing option and add everything

Tentative example for the [lgm](#) experiment:

Power	Forcing	Options
2	Ice sheet	1= <i>ICE-6G-C</i> 2= <i>GLAC-1D</i>
1	Aerosols	1= <i>Hopcroft et al</i> 2= <i>Albani et al</i>
0	Vegetation	1= <i>interactive vegetation</i> 2= <i>interactive carbon cycle</i> 3= <i>prescribed</i>

Example: *GLAC-1D* + *Hopcroft et al* + *interactive vegetation* =  $2 * 100 + 1 * 10 + 1 \Rightarrow f211$

## variant\_label constraints for PMIP4 experiments

### historical

historical simulations that are the continuation of a [past1000](#) simulation should use 1000 for the `initialization_method`  $\Rightarrow i1000$

### past1000



**mid-Holocene**



There are at least [2 sensitivity experiments](#)

**lgm**



**lig127k**



There are at least [3 sensitivity experiments](#)

**midPliocene-eoi400**



**LD-LGMspin**



**LD-transpin**



**LD**



## Other PMIP4 specific experiments

There may be other experiments listed in [Proposed PMIP4 experiment\\_id values](#) and [PMIP4 experiments](#)



## PMIP4-CMIP6 directory structure and file names

The *DRS* defines (among other things) how the different attributes will be combined to generate unambiguous directories and file names, in the ESGF distributed database

```
Directory structure = <mip_era>/
                    <activity_id>/
                    <institution_id>/
                    <source_id>/
                    <experiment_id>/
                    <member_id>/          <== variant_label
                    <table_id>/
                    <variable_id>/
                    <grid_label>/
                    <version>/
```

```
file name = <variable_id>_<table_id>_<experiment_id>
>_<source_id>_<member_id>_<grid_label>[_<time_range>].nc
```

For PMIP4, we have `sub_experiment_id == none` (because we don't use forecast and hindcast), and therefore `member_id == variant_label`

Used in dir?	Used in file?	Attribute name	Value for PMIP4-CMIP6
Y	N	mip_era	CMIP6 PMIP4 ?
Y	N	activity_id	CMIP PMIP Note: "CMIP PMIP" becomes CMIP ( <i>If multiple activities are listed in the global attribute, the first one is used in the directory structure</i> )
Y	N	institution_id	institution label ( <i>IPSL</i> , ...)
Y	N	version	vYYYYMMDD (e.g., v20160218), indicating a representative date for the version Note: the <i>version</i> is <b>not</b> stored in the NetCDF files and <b>not</b> used in the file names, because it is only specified when <i>publishing</i> (eg storing the data in ESGF) the NetCDF files
Y	Y	source_id	source label (e.g. the model name/version using only authorized characters)
Y	Y	experiment_id	See the <a href="#">Experiment names</a> section

Used in dir?	Used in file?	Attribute name	Value for PMIP4-CMIP6
Y	Y	member_id	PMIP4 does not use sub_experiment_id, so the value of member_id is equal to the variant_label: r<k>i<l>p<m>f<n> (see the <a href="#">CMIP6 variant label</a> section)
Y	Y	table_id	CMOR table label (Amon, ...)
Y	Y	variable_id	variable identifier (tas, pr, ...)
Y	Y	grid_label	gn: output is reported on the native grid gr: output is regridded by the modeling group to a “primary grid” of its choosing gr1, gr2, ...: output is regridded on another grid than the <i>primary grid</i> (that was already different from the <i>native grid</i> )
N	Y	time_range	the last segment of the file name indicates the time-range spanned by the data in the file, and is omitted when inappropriate. The format for this segment is <a href="#">the same as in CMIP5</a>

Examples:

- Directory = CMIP6/CMIP/NCAR/CCSM2-1/1pctCO2/r1i1p1f1/Amon/tas/gn/v20150320/  
File = tas\_Amon\_CCSM2-1\_1pctCO2\_r1i1p1f1\_gn\_202001-202912.nc
- Directory = CMIP6/DCPP/NCAR/CCSM2-1/dcppA-hindcast/s1960-r1i2p1f1/Amon/tas/gr/v20150320/  
File = tas\_Amon\_CCSM2-1\_hindcast\_s1960-r1i2p1f1\_gn\_198001-198412.nc

## CMIP6 data license and acknowledgement



PMIP data users have to add the following PMIP-specific sentence to their acknowledgement:  
**PMIP is endorsed by both WCRP/WGCM and Future Earth/PAGES**

### Data users

The data end users have to follow the Terms of Use and licensing information detailed on the [CMIP6: Proper citation and acknowledgement](#) page.

### Data providers

The Terms of Use are also detailed in the license global attribute available in each data file created by the providers

Note: you can get the [latest version of the license](#) on github.

The “license” attribute should record the following statement (with segments in square brackets optional, and with required, appropriate text entered in place of <\*> ):



“CMIP6 model data produced by <Your Centre Name> is licensed under a Creative Commons Attribution-[NonCommercial-]ShareAlike 4.0 International License (<https://creativecommons.org/licenses>). Use of the data must be acknowledged following guidelines found at <https://pcmdi.llnl.gov/home/CMIP6/CitationRequirements6-0.html>. Further information about this data, including some limitations, can be found via the further\_info\_url (recorded as a global attribute in this file)[ and at <some URL maintained by modeling group>]. The data producers and data providers make no warranty, either express or implied, including, but not limited to, warranties of merchantability and fitness for a particular purpose. All liabilities arising from the supply of the information (including any liability arising in negligence) are excluded to the fullest extent permitted by law.”

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More specifically, CMIP6 data will be distributed under the following 2 licenses (each institute has to choose one license)

Logo	Abbreviation	Full name	Details
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	CC BY-NC-SA 4.0	Attribution-NonCommercial-ShareAlike 4.0 International	<a href="https://creativecommons.org/licenses/by-nc-sa/4.0/">https://creativecommons.org/licenses/by-nc-sa/4.0/</a>

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