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# Data Reference Syntax (DRS) for bias-adjusted CMIP6 simulations

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# Data Reference Syntax (DRS) for bias-adjusted CMIP6 simulations

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This document specifies the Data Reference Syntax (DRS) elements for managing bias-adjusted CMIP6 simulation data. The document includes file naming conventions and metadata as NetCDF attributes. The DRS elements are allowed to either assume values defined by Controlled Vocabularies (CV), or free text, or free text with build rules.

## 1. Bias-adjustment DRS sub-elements

It is proposed that the DRS for bias-adjusted CMIP6 simulation data should be as close as possible to the [CMIP6 archiving specifications](#). If needed, the bias-adjusted CMIP6 DRS could also include Bias-correction information to the CMIP6 DRS following some the guidelines of [CORDEX Adjust](#) archives design.

Three bias-correction DRS sub-elements are introduced:

- ***bc\_name*** is an identifier for the applied bias-correction method that includes a dash-separated combination of acronyms for the institute and the bias-correction method (e.g. SMHI-DBS43, LSCE-IPSL-CDFt, UCAN-EQM etc.).
- ***obs\_name*** is an acronym for the observation/reanalysis datasets used as reference data for bias adjustment. Presently, there is no unique CV for regional observational datasets, and acronyms for observations have to be defined in consultation with institutions responsible for the observational products.
- ***ref\_period*** is the reference or calibration period in YYYY-YYYY format (e.g. 1971-2000 or 1981-2010).

These 3 sub-elements are attached using dashes ("-") to the CMIP6 DRS creating a new element *called* ***bias\_adjustment***. The new ***bias\_adjustment*** element is a bit long but provides all necessary information about the bias adjustment methodology.

One grid label DRS element is modified:

- *grid\_label* is the information of the regrided data used for bias-adjustment.

*Example:*

A CMIP6 simulation is bias-adjusted by TCDF CDFt method using ERA5 Land as a reference observational dataset for the 1981-2010 period, the *bias\_adjustment* becomes TCDF-CDFT23-ERA5Land-1981-2010

(*i.e.*, *bc\_name-obs\_name-ref\_period*). Note that dashes in sub-elements can be dropped for consistency and easy automatic parsing.

## 2. File names, variable names, and NetCDF attributes

The names of the files in the C3S-CMIP6-Adjust project are made up of the CMIP6 DRS elements, CMIP6 DRS and CORDEX-Adjust DRS with the changes described above. The elements are separated by underscores (“\_”) and must appear in the following order:

```
VariableName_Frequency_GCModelName_CMIP6ExperimentName_CMIP6EnsembleMember_GridLabel_BiasAdjustment[_StartTime-EndTime].nc
```

In order to avoid any confusion and clearly distinguish original and bias-adjusted CMIP6 simulation data, it has been decided to follow an approach used in CMIP5 ([CMOR Table Amon: 2-D bias-corrected fields on atmospheric grid](#)) for the adjustment of decadal experiment results by appending ‘Adjust’ to the variable name DRS elements in file names and in NetCDF files, for instance *pr* variable becomes *prAdjust* (used also in [ISI-MIP](#)).

The long variable names (*long\_name* NetCDF attribute) have to be also modified by pre-pending “Bias-Adjusted”, for instance *Near-Surface Air Temperature* becomes *Bias-Adjusted Near-Surface Air Temperature*.

One issue which has to be taken into account is a situation when the reference/calibration period includes years from both historical and scenario experiments. In this case a different bias-adjusted historical simulation is created for each scenario experiment instead of the same input one for all scenarios. It is proposed to use only the scenario acronyms (*ssp126*, *ssp246* and *ssp585*) in file names for the entire bias correction period even for the historical experiment (until 2014 in the CMIP6 ).

Example:

*input files containing original uncorrected model results:*

```
tas_day_IPSL-CM6A-LR_ssp585_r1i1p1f1_gr_20150101-21001231.nc
```

### *bias-adjusted file (new/modified information in blue)*

tasAdjust\_day\_IPSL-CM6A-LR\_ssp585\_r1i1p1f1\_gr010\_TCDF-CDFT23-ERA5L  
and-1981-2010\_20160101-20251231.nc

gr010 is the metadata for the regridding method.

## 3. Time periods for each data file

Bias-corrected daily CMIP6 data sets have to include the same years (time records) as requested for the input CMIP6 files (see 5.4 “Time periods for each data file” in [CORDEX archiving specifications](#)).

## 4. Global attributes

A number of global attributes have to be copied from input CMIP6 files and some of them have to be modified. Also, a number of new global NetCDF attributes have to be added to bias-adjusted CMIP6 data sets. See attached table [CMIP6-Adjust DRS attributes](#).

product as change for bias-adjusted-output  
project\_id as change for CMIP6-Adjust

institution of the CMIP6 dataset as save in input\_institution  
institute\_id of the CMIP6 dataset as save in input\_institution\_id  
tracking\_id of the CMIP6 dataset as save in input\_tracking\_id  
grid\_label of the CMIP6 dataset as save in input\_grid\_label  
grid of the CMIP6 dataset as save in input\_grid  
nominal\_resolution of the CMIP6 dataset as save in  
input\_nominal\_resolution

new global NetCDF attributes to bias-adjusted CMIP5 data set :

- bc\_method
- bc\_method\_id
- Bc\_observation
- bc\_observation\_id
- bc\_period
- bc\_info

Optional : metadata for the regridding:

- grid\_resolution
- grid\_interpolation\_method
- grid\_info

## 5. DRS directory structure

The data have to be managed with the following directory structure:

```
<activity_id>/
  <product>/
    <institute_id>/
      <model_id>/
        <experiment_id>/
          <member_id>/
            <table_id>/
              <bias_adjustment>/
                <variable_id>/
                  <grid_label>/
                    <version>/
```

Note that the upper 2 levels `<activity_id>/<product>` are fixed to `CMIP6-Adjust/bias-adjusted-output`.

## 6. Examples of bias-adjusted CMIP6 netcdf files

New information in blue

IPSL-CM6A-LR simulation interpolated at 0.10° and bias-adjusted by TCDF using CDFt v2.3 and the ERA5-Land daily gridded observational dataset, 1981-2010 period as reference.

[tasAdjust\\_day\\_IPSL-CM6A-LR\\_ssp585\\_r1i1p1f1\\_gr010\\_TCDF-CDFT23-ERA5Land-1981-2010\\_20260101-20351231](#) {

dimensions:

```
time = UNLIMITED ; // (3652 currently)
lat = 1801 ;
lon = 3600 ;
bnds = 2 ;
```

variables:

```
double time(time) ;
    time:bounds = "time_bnds" ;
    time:units = "days since 2015-01-01 00:00:00" ;
    time:calendar = "standard" ;
    time:axis = "T" ;
    time:long_name = "time" ;
    time:standard_name = "time" ;
double time_bnds(time, bnds) ;
double lat(lat) ;
    lat:bounds = "lat_bnds" ;
    lat:units = "degrees_north" ;
```

```

    lat:axis = "Y" ;
    lat:long_name = "latitude" ;
    lat:standard_name = "latitude" ;
double lat_bnds(lat, bnds) ;
double lon(lon) ;
    lon:bounds = "lon_bnds" ;
    lon:units = "degrees_east" ;
    lon:axis = "X" ;
    lon:long_name = "longitude" ;
    lon:standard_name = "longitude" ;
double lon_bnds(lon, bnds) ;
double height ;
    height:units = "m" ;
    height:axis = "Z" ;
    height:positive = "up" ;
    height:long_name = "height" ;
    height:standard_name = "height" ;
float tasAdjust(time, lat, lon) ;
    tasAdjust:standard_name = "air_temperature" ;
    tasAdjust:long_name = "Bias-Adjusted Near-Surface Air Temperature" ;
    tasAdjust:comment = "Bias-Adjusted near-surface (usually, 2 meter) air
temperature" ;
    tasAdjust:units = "K" ;
    tasAdjust:original_name = "tasAdjust" ;
    tasAdjust:cell_methods = "time: mean" ;
    tasAdjust:cell_measures = "area: areacella" ;
    tasAdjust:coordinates = "height" ;
    tasAdjust:missing_value = 1.e+20f ;
    tasAdjust:_FillValue = 1.e+20f ;

// global attributes:
    :branch_method = "standard" ;
    :branch_time_in_child = "0" ;
    :data_specs_version = "01.00.28" ;
    :external_variables = "areacella" ;
    :further_info_url =
"https://furtherinfo.es-doc.org/CMIP6.IPSL.IPSL-CM6A-LR.ssp585.none.r1i1p1f1" ;
    :license = "CMIP6 model data produced by IPSL is licensed under a Creative
Commons Attribution" ;
    :mip_era = "CMIP6" ;
    :parent_activity_id = "CMIP" ;
    :parent_mip_era = "CMIP6" ;
    :parent_source_id = "IPSL-CM6A-LR" ;
    :source_id = "IPSL-CM6A-LR" ;
    :parent_time_units = "days since 1850-01-01 00:00:00" ;
    :source_type = "AOGCM BGC" ;

```

```

:sub_experiment = "none" ;
:sub_experiment_id = "none" ;
:variable_id = "tas" ;
:variant_label = "r1i1p1f1" ;
:realm = "atmos" ;
:grid = "interpolated grid at 0.10 (1801x3600 latxlon)" ;
:grid_label = "gr010" ;
:grid_resolution = "0.10°" ;
:grid_interpolation_method = "remapbil" ;
:grid_info = "ERA5-Land" ;
:bc_method = "Cumulative Distribution Function Transform (CDFt) method -
Vrac, M., T. Noël, and R. Vautard (2016), Bias correction of precipitation through Singularity
Stochastic Removal: Because occurrences matter, J. Geophys. Res. Atmos., 121,
5237–5258, doi:10.1002/2015JD024511." ;
:bc_method_id = "TCDF-CDFT23" ;
:bc_observation = "Muñoz Sabater, J., (2019): ERA5-Land hourly data from
1981 to present. Copernicus Climate Change Service (C3S) Climate Data Store (CDS).
10.24381/cds.e2161bac" ;
:bc_observation_id = "ERA5-land" ;
:bc_period = "1981-2010" ;
:bc_info = "TCDF-CDFT23-ERA5-land-1981-2010" ;
:input_tracking_id =
"hdl:21.14100/4fbbc635-6702-4b9d-be25-7bd2e7a9d433" ;
:input_institution = "Institut Pierre Simon Laplace, Paris 75252, France" ;
:input_grid_label = "gr" ;
:activity_id = "ScenarioMIP" ;
:input_grid = "LMDZ grid" ;
:institution = "TCDF (The Climate Data Factory)" ;
:experiment_id = "ssp585" ;
:source = "IPSL-CM6A-LR (2017): atmos: LMDZ (NPv6, N96; 144 x 143
longitude/latitude; 79 levels; top level 40000 m) land: ORCHIDEE (v2.0,
Water/Carbon/Energy mode) ocean: NEMO-OPA (eORCA1.3, tripolar primarily 1deg; 362 x
332 longitude/latitude; 75 levels; top grid cell 0-2 m) ocnBgchem: NEMO-PISCES sealce:
NEMO-LIM3" ;
:model_id = "IPSL-CM6A-LR" ;
:parent_experiment_id = "historical" ;
:references = "P.-A. Michelangeli, M. Vrac, H. Loukos. 'Probabilistic
downscaling approaches: Application to wind cumulative distribution functions'. Geophysical
Research Letters, 36, L11708, doi:10.1029/2009GL038401, 2009" ;
:product = "bias-adjusted-output" ;
:frequency = "day" ;
:creation_date = "2021-02-28T18:32:19Z" ;
:history = "2021-02-28T18:32:19Z CMOR rewrote data to comply with CF
standards and CMIP6-Adjust requirements." ;
:project_id = "CMIP6-Adjust" ;
:table_id = "Table day (Jan 2020) cdd7e9b9044b6539bf6483098893d2a3" ;

```



:title = "IPSL-CM6A-LR model output prepared for CMIP6-Adjust SSP585" ;  
:parent\_experiment = "historical" ;  
:modeling\_realm = "atmos" ;  
:cmor\_version = "2.9.3" ;  
:tracking\_id = "35c037f6-347a-4ef1-9f01-1e994d47888d" ;  
:input\_institution\_id = "IPSL" ;  
:institution\_id = "TCDF" ;  
:forcing\_index = "1" ;  
:parent\_variant\_label = "r1i1p1f1" ;  
:branch\_time\_in\_parent = 60265. ;  
:initialization\_index = 1 ;  
:physics\_index = 1 ;  
:realization\_index = 1 ;  
:experiment = "update of RCP8.5 based on SSP5" ;  
:Conventions = "CF-1.7 CMIP-6.2" ;  
:nominal\_resolution = "11 km" ;

:variant\_info = "Each member starts from the corresponding member of its parent experiment. Information provided by this attribute may in some cases be flawed. Users can find more comprehensive and up-to-date documentation via the further\_info\_url global attribute." ;

:contact = "[support@theclimatedatafactory.com](mailto:support@theclimatedatafactory.com) Data manager : Thomas NOEL (TCDF)" ;

:comment = "The data was processed on the IPSL mesocenter ESPRI facility that is supported by CNRS, SU, and Ecole Polytechnique partly funded by IS-ENES3 project." ;

:input\_nominal\_resolution = "250 km" ;

:licence = "The climate Data Factory (TCDF) adjusted/downscaled CMIP5/6 data (Data Product) are produced under a commercial license provided to You (the licensee) for a fee in consideration of you using it strictly in accordance with terms and conditions available at the following URL <https://theclimatedatafactory.com/terms-of-service/>. In particular, the Data Product license is personal to You and is not sub-licensable or capable of assignment. In general, You must: (a) Not use any Data Product unless you are familiar with the explanatory information provided in the Documentation section at the following URL <https://help.theclimatedatafactory.com>; (b) Not release the Data Product on the Internet or any other public communication network; (c) Not assert or imply that TCDF has any connection with You or your work or provide any endorsement of work you undertake; (d) Comply with any additional requirements concerning Data Products notified by us from time to time. What you are able to do with the Data Product: (a) Use it for personal work, including supporting commercial activities as long as the content of the data, in total or partially, is not made available to others; (b) Create a backup version; (d) Publish work results based on the Data Product. What you are not able to do with a Data Product: (a) Pass it along to colleagues (the license is personal); (B) Distribute it in any way to third parties. What you must do with a Data Product: Cite the source of the Data Product in any publication or presentation as expressed in the "reference" section recorded as a global attribute in this file. You acknowledge that there is 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 Data Product (including any liability arising in negligence) are excluded to the fullest extent permitted by law. This license shall automatically terminate if you violate any of these restrictions and may be terminated by TCDF at any time. Upon the termination of this license, you must destroy any downloaded materials in your possession whether in electronic or printed format." ;

}

## 7. Listing of global NetCDF Attributes

NetCDF Attribute	Status	Value	Example
experiment_id	Unchanged		ssp585
experiment	Unchanged		update of RCP8.5 based on SSP5"
model_id	Unchanged		IPSL-CM6A-LR
initialization_index	Unchanged		1
physica_index	Unchanged		1
realization_index	Unchanged		1
forcing_index	Unchanged		1
variant_label	Unchanged		r1i1p1f1
parent_experiment_id	Unchanged		historical
parent_variant_label	Unchanged		r1i1p1f1
parent_experiment	Unchanged		historical
mip_era	Unchanged		CMIP6
parent_activity_id	Unchanged		CMIP
parent_mip_era	Unchanged		CMIP6
product	Modified	Fixed	bias-adjusted-output
project_id	Modified	Fixed	CMIP6-Adjust
contact	Modified	Contact information of institution that is responsible for bias-adjusted datasets	
institution	Modified	Full name of institution that is responsible for bias-adjusted datasets	<b>TCDF (The Climate Data Factory)</b>
institute_id	Modified	Short acronym for the institution responsible for bias-adjusted data sets	TCDF
creation_date	Modified	Creation date of the dataset	
tracking_id	Modified	New UUID to generate	
grid	Modified	grid from adjust files	
nominal_resolution	Modified	nominal resolution from adjust files	interpolated grid at 0.10 (180x360 latlon)
grid_label	Modified	Acronym for the grid name (i.e., grid_label DRS element)	11 km g010
bc_method	New	Full name of the bias correction methods applied and its references	Cumulative Distribution Function Transform (CDFt) method
bc_method_id	New	Acronym of the bias correction methods (i.e., bc_name DRS sub-element)	TCDF-CDFt23
bc_observation	New	Full name of the observation data used as a reference for bias correction and its references	ERA5-land
bc_observation_id	New	Acronym for the observation data used as a reference for bias correction (i.e., obs_name DRS sub-element)	ERA5-land
bc_period	New	Reference period used for bias correction (i.e., ref_period DRS sub-element)	1981-2010
bc_info	New	Combination of bc_method_id, bc_observation_id and bc_period separated by dashes (i.e., bias_adjustment DRS element)	TCDF-CDFt23-ERA5-Land-1981-2010
input_institution	New	Full name of institution that is responsible for input CMIP6 datasets	
input_institute_id	New	Short acronym for the institution responsible for input CMIP6 datasets	
input_tracking_id	New	UUID from input CMIP6 files	
input_grid_label	New	Original Grid_label from input CMIP6 files	
input_grid	New	grid from input CMIP6 files	
input_nominal_resolution	New	nominal resolution from input CMIP6 files	250 km
grid_resolution	Optional	Grid resolution	0.10°
grid_interpolation_method	Optional	Interpolation method	remapli
grid_info	Optional	Additional information on the grid	ERA5-Land