DESCRIPTION OF THE DATA REFERENCE SYNTAX FOR ARCHIVING RESULTS OF STATISTICAL AND EMULATION-BASED DOWNSCALING

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Author(s):	Ole B. Christensen (DMI), Jesus Fernandez (CSIC), Jose Manuel Gutierrez (CSIC), Samuel Somot (CNRS-MF), Julien Boé (CNRS-CERFACS), Antoine Doury (CNRS-MF), Claas Teichmann (Hereon-GERICS), Erika Coppola (ICTP), Eren Duzenli (BSC), Ozan Mert Göktürk (NORCE), Stefan Sobolowski (NORCE)

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Contents

Abbreviations Used

CORDEX	Coordinated Regional climate Downscaling Experiment
CPM	Convection-Permitting (regional climate) Model
CV	Controlled Vocabulary
DRS	Data Reference Syntax
ESGF	Earth System Grid Federation
GCM	General Circulation Model
RCM	Regional Climate Model

1 Summary for Publication

This document provides a reference syntax to describe statistically downscaled and emulated output, building on the CORDEX-CMIP6 standard. It contains a novel and detailed description of file name and attribute syntax for files containing climatological fields obtained from emulators of high-resolution dynamical model output. Such emulators are trained within the model world of a high-resolution RCM/CPM nested into a GCM. Once the optimal emulator parameters are extracted, the fitted emulator can subsequently be used to produce local data directly from GCM output. Such approach will allow to produce high resolution decadal projection ensembles in I4C. Although RCM-emulators have been around for some years, this is the first attempt to have a reference syntax for the output they produce.

2 Contribution to the top-level objectives of Impetus4Change

2.1.1.1 Objective	2.1.1.2 Contribution from Deliverable
Overall Objective: to improve the quality, accessibility and usability of near-term climate information and services at local to regional scales – where impacts are most keenly felt and on-the ground adaptation is implemented – to strengthen and support end-user adaptation planning and action	Emulation of CPMs has been chosen as a method for obtaining local climate information from near-term global simulations. In order for such data to be useful, accessible, and inter-comparable, a DRS is a necessary prerequisite.
1) Improve understanding and flow of climate information through knowledge networks;	
2) Address persistent shortcomings to deliver seasonal to decadal predictions of improved quality;	Emulators will extract local information from global seasonal-to-decadal simulations much quicker than CPMs and will therefore enable the production of ensembles of local information from the relevant GCMs I4C has chosen emulation as a method to simultaneously provide local and reliable climate information for the coming

	decade.
3) Develop novel methods to downscale predictions to local scales;	WP3 specifically deals with emulation to address this issue. A DRS is a necessary prerequisite for the usefulness of emulator output.
4) Improve assessments of hazards and translate this into usable information for local risk assessments;	Local information from ensembles will enable quantitative risk estimation.
5) Make advances towards the goal of end-to-end seamless climate services;	The DRS defined here will allow to produce Statistical Downscaling and Emulator files similar to other climate datasets such as GCM, RCM or CPM outputs. This will facilitate their handling by users and therefore contribute to the end-to-end climate services.
6) Through transdisciplinary co-production approaches develop fit-for-purpose "Adaptation support packs" at municipal scales through our so-called urban Demonstrators;	
7) Ensure high impact and visibility through robust and targeted communication and engagement;	A standardized data file format is a necessary condition for quantitative communication of the project's results, resulting in better visibility of the produced files and hence of the entire project.
8) Commit to Open Science through development of open access tools and exploitation of data/model outputs via relevant platforms thereby ensuring improved accessibility and usability of climate knowledge.	The existence of the DRS is a prerequisite to deliver emulator output files in Open Access portals and will ease their usability by users inside and outside of the project. We will strive to make this DRS suggestion into a standard, adopted by CORDEX. Emulated data files from WP3 will be distributed openly. If CORDEX adopts the current suggestion for a DRS, the way is open to publish emulator output through ESGF.

3 Detailed Report

3.1 Introduction

For CORDEX[1], the Coordinated Regional Downscaling Experiment, regional climate model output has been distributed for many years through the Earth System Grid Federation (ESGF) network. This has been possible due to early acceptance by all data providers of a common output list and file format, including a Data Reference Syntax[2] used to identify and distinguish files. CORDEX has recently released the Archiving Specifications and DR3S[3] for the next generation of dynamically downscaled projections nested into CMIP6 Global Climate Models (GCMs). Statistical downscaling specifications are also in their second draft version[4]. Therefore, for dynamical and statistical downscaling, Impetus4Change will adopt these open standards developed by the international downscaling community.

In the Impetus4Change[5] project, some data sets are produced through emulation of high-resolution data, i.e., high resolution data approximated through a statistical treatment of GCM low-resolution model fields and RCM or CPM high resolution model fields. This requires a training period, where the relevant low-resolution and high-resolution fields are used as input to the statistical tool. In addition, a validation period is needed where existing dynamically downscaled high-resolution data are compared to statistically emulated high-resolution data to evaluate the approach. Then the statistical emulator can be applied to GCM inputs or periods of time for which no high-resolution dynamical downscaled data are available. In the context of the Impetus4Change project, due to the low cost of the statistical emulator approach, this will enable the creation of large ensembles of high-resolution datasets for the next decades. Ensembles of that size do not exist today and are not feasible with RCMs or CPMs due to computational constraints, or with GCMs due to their too low spatial resolution. On the other hand, unlike statistical downscaling, which requires observed high resolution variables, the emulator approach is not restricted to a limited number of output variables. The most important variables for application in Impetus4Change can be simulated.

[1] http://www.cordex.org/
[2] http://is-enes-data.github.io/cordex_archive_specifications.pdf
[3] https://doi.org/10.5281/zenodo.10961068
[4] https://eur04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fcordex.org%2F2024%2F04%2F25%2Fthe-second-version-draft-of-the-cordex-experiment-design-and-archiving-specifications-for-statistical-downscaling-of-cmip6-now-open-for-comments&data=05%7C02%7Cmesi%40norceresearch.no%7Cc0669ad16f5549f6477308dc654759b0%7C70a6eba4967145d2b83e432e06502242%7C0%7C0%7C638496604323643933%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C0%7C%7C%7C&sdata=KAN2oT3Y%2BCsMXhkMfVME3%2FmApxBHusgKbj9DR50TeUw%3D&reserved=0
[5] https://impetus4change.eu/

The various emulators developed in the project, their training strategy, evaluation and results will be described in Deliverable 3.3 later in the project. It is out of scope of the current Deliverable 3.4.

This document specifies a suggested DRS for exchanging emulator data within I4C and, ultimately, for publishing emulated simulation data through the Earth System Grid Federation (ESGF). 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.

This document will help to easily exchange and make use of data within the project and with potential project-external partners. In addition, it will facilitate the legacy of the project having common standards for the Impetus4Change ensemble ensemble and, later, potentially being adopted by international initiatives such as CORDEX or COPERNICUS..

3.2 DRS sub-elements

The DRS for emulated simulation data follows the general CORDEX approach as described in the recently completed CORDEX-CMIP6 archiving specifications[2] w.r.t. the number of CORDEX DRS elements in file names. We propose to build the emulator `source_id by` merging the CORDEX model acronyms for the CPM model(s) being emulated with an acronym for the emulation method. Similarly, we propose to let the existing `version_realization` refer to the emulation, addressing the possibility for newer versions and possible error corrections of the emulation model itself. This approach allows publishing of the emulated CORDEX simulation data on ESGF using the ESGF configuration for CORDEX-CMIP6 with a minimum of changes. The version of the regional model targeted will be stored in the global attribute `target_version_realization`.

Most DRS elements are copied directly from the CORDEX-CMIP6 specifications:

`variable_id`

`domain_id`

`driving_source_id`

`driving_experiment_id`

`driving_variant_label`

`institution_id`

`version_realization`

`frequency`

`StartTime and EndTime`

`mip_era`

project_id

Several emulation-related DRS elements are modified. Note that the separators underscore and dash ("_" and "-") cannot be part of any of the new sub-elements.

activity_id should be set to "emulation".

source_id (CV) is augmented with an identifier for the applied emulation algorithm; the RCM being emulated is isolated in the new element `target_source_id`, and the institution having performed the RCM simulation in `target_institution_id`. In order for a file to be instantly recognizable as the result of an emulation, we propose the literal string "emul" as part of this identifier, which furthermore includes a combination of acronyms for the target source (`target_source_id`) and the emulation method (`emulator_id`) separated by dashes "-" (e.g. ALADIN64E1-emul-UNET11, HCLIM43-ALADIN-emul-ANOVA11 etc.). These sub-elements are connected using dashes (-) to build a valid CORDEX-CMIP6 DRS element `source_id` (the model identifier).

This DRS element cannot contain the necessary information about the possibly complex emulation method; it will work as an index with links to further information provided in the `method registration and documentation` (see below). If more than one RCM has been used as target training for the emulation, the literal string "multi" should be used in place of the target_source_id part of `source_id`; in this case, the global attribute `source` should contain the relevant list of RCMs used for training.

A final, dash-separated subelement of the `source_id` is the `training_id`, which reflects specific training details described in the `training` global attribute. This element must be used also to distinguish among different "multi-emul" emulators, trained on different sets of target RCMs.

The existing DRS element `version_realization` is a shorthand for the version of the emulation in a format like v1-r1, where *v* is incremented if an error has been found in a prior dataset, which has subsequently been replaced, and *r* is a realization of the emulation. The training RCM related version index is kept in `target_version_realization`.

3.3 Time periods for each data file

Emulated daily CORDEX data sets have to include the same years (time records) as requested for the input CORDEX files (see 5.4 "Time periods for each data file" in CORDEX-CMIP6 archiving specifications[3]).

3.4 File names

The names of the emulated files are constructed like CORDEX-CMIP6 DRS elements for RCM simulations with modifications of several elements as mentioned. The elements are separated by underscores ('_') and must appear in the following order:

file_name=<variable_id>_<domain_id>_<driving_source_id>_<driving_experiment_id>_<driving_variant_label>_<institution_id>_<source_id>_<version_realization>_<frequency>[_<StartTime>-<EndTime>].nc

3.4.1 Examples

pr_ALP-3_CNRM-CM6_ssp370_r1i1p1f2_CNRM-MF_AROME41t1-emul-CNRM-UNET11-T11_v1-r1_1hr_201601010130-201612312230.nc

Here, CNRM-UNET11-T11 is the emulator model, with a particular training T11. This syntax allows for example University of Bergen to use this emulator to emulate the ICTP RegCM4 run over the ALP-3 domain, with a resulting file name

pr_ALP-3_CNRM-CM6_ssp370_r1i1p1f2_UBERGEN_RegCM4-emul-CNRM-UNET11-T11_v1-r1-e1_1hr_200601010130-200612312230.nc

This is how it would be using the same input as above, but with the ICTP emulator:

pr_ALP-3_CNRM-CM6_ssp370_r1i1p1f2_ICTP_RegCM4-emul-GNN4CD-T3_v1-r1_1hr_201601010130-201612312230.nc

Another example following the suggested syntax:

tas_NWE-3_CNRM-CM5_rcp85_r1i1p1_CECI_AROME41t1-emul-CONSTANA-T1_v1-r1_day_20410101-20601231.nc

3.5 Directory structure

The data have to be transferred to the ESGF data nodes with the following directory structure:

<activity_id>/<product>/<domain_id>/<institution_id>/<driving_source_id>/<driving_experiment_id>/<driving_variant_label>/
<source_id>/<version_realization>/<frequency>/<variable_id>/

Note that the upper two levels `<activity_id>/<product>` are always the same and that `<institution_id>` refers to the institution that is responsible for creating the data.

3.6 Netcdf global attributes

A number of global attributes have to be copied from input CORDEX files and some of them have to be modified. Also, a number of new global NetCDF attributes have to be added to emulated CORDEX data sets.

3.6.1 CORDEX global attributes which have to be copied without changes

conventions

domain

domain_id

driving_source_id

driving_variant_label

driving_experiment

driving_experiment_id

driving_institution_id

mip_era

variable_id

3.6.2 CORDEX global attributes which have to be modified

product Should be "emulator-output".

source The source information pertaining to the emulator.

source_id See above.

source_type Should be "RCM-emulator".

project_id I4C (Will change if this DRS is accepted by the CORDEX community).

comment (optional): additional information, free text.

contact Contact information (name, e-mail) of institution that is responsible for the emulated data sets.

frequency Frequency of emulated output.

history (optional): A time-stamped trail for modifications to the original data, as suggested by the CF conventions.

institution Full name of institution that is responsible for the emulated data sets.

institution_id A short acronym for the institution responsible for the emulated data sets.

creation_date To be modified accordingly.

license License information for the emulator data in the file.

version_realization As described above for the corresponding DRS element.

version_realization_info (optional): Description of the version_realization. This attribute is not mandatory, but it is recommended if version_realization is not v1-r1.

tracking_id A new tracking ID has to be generated.

3.6.3 New global attributes to be added

emulator Description of the emulation method.

emulator_id Acronym of the emulation method (the same as the emulation part of the source_id DRS sub-element).

training Full description of the training, including the list of RCM input data and periods used for emulator training.

training_id Acronym for the training data and training strategy.

target_source_id The source_id of the RCM used as target for training the emulator. This is part of the augmented source_id.

target_institution The institution global attribute has to be copied from input CORDEX files to corresponding emulated files by creating this new global attribute. In the case of several RCM simulations used for emulation training, this attribute should contain a list of the responsible institutions.

target_institution_id The institute_id global attribute has to be copied from input CORDEX files to corresponding emulated files by creating this new global attribute.

training_tracking_id The tracking_id global attribute has to be copied from input CORDEX files to corresponding emulated files by creating this new global attribute.

3.7 License

Licensing recommendations follow the CORDEX-CMIP6 recommendations: All modeling groups choose a license for their simulations depending on institutional and/or funding agency policies. This information is necessary to register an emulation method in the CORDEX RCM emulation CV. It is strongly recommended to use the Creative Commons Attribution 4.0 International (CC BY 4.0) license, as currently in CMIP6. Note, that any kind of "non-commercial" license will significantly limit the use of the data in downstream climate mitigation and adaptation applications.

The global attribute license has the only option "link will be provided " leading to a table with information about the license for all CORDEX-CMIP6 RCMs.

3.8 Registration

To register your institution or emulation_method, partners must open an issue using these forms:

New institution_id

New source_id (i.e. model)

These forms will automatically create a pull request in the I4C fork of the CORDEX-CMIP6 CV github repository, where further details can be discussed. Models must not be distinguished by the institution_id. Do not register a new source_id if the

same model or method configuration is already registered by other institutions. Just request to add your `institution_id` to the list of the corresponding `source_id`.

3.9 Examples of attributes of Impetus4Change emulator output netcdf files

`tas_ALP-12_NorESM1-M_rcp85_r1i1p1_UCAN_ALADIN63-emul-DeepESD1-tPU1MPI_v1-r2_day_20410101-20501231.nc` (Download sample file)

```
// global attributes:
:Conventions = "CF-1.10" ;
:activity_id = "emulation" ;
:contact = "meteo@unican.es" ;
:domain_id = "ALP-12" ;
:domain = "EUR-11 CORDEX domain cropped to the greater Alpine
region" ;
:driving_experiment = "Future projection (2006-2300) forced by
RCP8.5" ;
:driving_experiment_id = "rcp85" ;
:driving_institution_id = "NCC" ;
:driving_source_id = "NorESM1-M" ;
:driving_variant_label = "r1i1p1" ;
:emulator = "DeepESD1 is a Convolutional Neural Network (CNN)
composed of three convolutional layers (of 50, 25 and 10 filter
maps, respectively) followed by a single dense layer. Each
convolution is followed by a set of Rectified Linear Units (ReLU).
DeepESD1 minimizes the mean squared error between the ground truth
and predicted temperature fields." ;
:emulator_id = "DeepESD1" ;
:frequency = "day" ;
:further_info_url = "" ;
:institution = "Instituto de Fisica de Cantabria (IFCA), CSIC-
Universidad de Cantabria. Santander, Spain" ;
:institution_id = "UCAN" ;
:mip_era = "CMIP5" ;
:native_resolution = "0.11 degree" ;
:product = "emulator-output" ;
:project_id = "I4C" ;
:realm = "" ;
:source = "DeepESD1 emulator trained on " ;
:source_id = "ALADIN63-emul-DeepESD1-tPU1MPI" ;
:source_type = "RCM-emulator" ;
:version_realization = "v1-r2" ;
:target_institution_id = "CNRM" ;
:target_source_id = "ALADIN63" ;
:target_version_realization = "v1" ;
:tracking_id = "" ;
:training = "This DeepESD1 instance has been trained as PP using
predictors from the CNRM ALADIN63 RCM (EURO-CORDEX) nested into
CMIP5 MPI-ESM-LR (r1i1p1) for the periods 1996-2005 (CMIP
historical, v20120315) and 2090-2099 (ScenarioMIP RCP8.5,
v20111014). Predictors were upscaled by conservative remapping to a
1.5 degree grid covering the area 0.25/18.25 E and 38.25/51.75 N.
```

Predictors: zg (500, 700 hPa) and hus, ta, ua, va (500, 700 and 850 hPa). The predictand fields come from CNRM ALADIN63 (EURO-CORDEX) nested into CMIP5 MPI-ESM-LR (r1i1p1)." ;
:training_id = "tPU1MPI" ;
:variable_id = "tas" ;
:license = " https://impetus4change.github.io/wp3/cprcm_license.html " ;
:reference = "Baño-Medina et al. (2024) Transferability and explainability of deep learning emulators for regional climate model projections: Perspectives for future applications. Submitted to Artificial Intelligence for the Earth Systems. https://doi.org/10.48550/arXiv.2311.03378" ;
:version_realization_info = "This is a second stochastic realization (r2) of the model training without any particular perturbation" ;
:creation_date = "2024-03-12 20:42:28" ;

tas_ALPX-12_CNRM-CM6_historical_r15i1p1f2_CNRM_ALADIN63-emul-CNRM-UNET11-tP1_v1-r1_day_19500101-20141231.nc
(The file can be found on the sigma platform for I4C at this path : /projects/NS10014K/WP3/antoine/test_ds_emul_file)

// global attributes:
:Conventions = "CF-1.10" ;
:activity_id = "emulation" ;
:contact = "contact.aladin-cordex@meteo.fr" ;
:domain_id = "ALPX-12" ;
:domain = "EUR-11 CORDEX domain cropped to a domain centered on Alps." ;
:driving_experiment = "Historical run with GCM forcing" ;
:driving_experiment_id = "historical" ;
:driving_institution_id = "CNRM-CERFACS" ;
:driving_source_id = "CNRM-CM6" ;
:driving_variant_label = "r15i1p1f" ;
:emulator = "CNRM_UNET11, introduced in Doury et al, 2022, is based fully on a convolutional neural network shaped from the UNeT base (Ronnenberg et al, 2015).The network is minimizing the mean squared error (mse) loss function." ;
:emulator_id = "CNRM-UNET11" ;
:frequency = "day" ;
:further_info_url = "" ;
:institution = "Centre National de Recherches Meteorologiques,CNRM, Toulouse, France" ;
:institution_id = "CNRM" ;
:mip_era = "CMIP6" ;
string :native_resolution = "0.11°" ;
:product = "emulator_output" ;
:project_id = "I4C" ;
:realm = "" ;
:source = "CNRM-UNET11 is trained here for the near surface temperature of CNRM-ALADIN63 RCM " ;
:source_id = "ALADIN63-emul-CNRM-UNET11" ;
:source_type = "RCM emulator" ;
:version_realization = "v1-r1" ;
:target_institution_id = "CNRM" ;
:target_source_id = "ALADIN63" ;

```
:target_version_realization = "v1" ;
:tracking_id = "" ;
:training = "Trained using PP predictors from the CNRM ALADIN63 RCM
nested into (CMIP5) CNRM-CM5 for the period 1950-2100combining the
historical and rcp85 simulations. The emulator is trained in perfect
model framework, implyingthat predictors and predictands come from
the same RCM simulation, predictors are coarsened to the GCM
resolution(150km) and a spatial smoothing is applied, following the
protocol described in Doury et al, 2022. The predictors include the
geopotential altitude, the temperature, the specific humidity and
the eastern and northern wind components at 3 pressure levels (500,
700, 850 hpa). External forcings such as the GHG concentration, and
the solar and ozone values are also inputs.The predictor list and
pre-processing is identical from the one described in Doury et al
2022,except that we remove here the uas,vas and psl variables from
predictors list." ;
:training_id = "tP1" ;
:variable_id = "tas" ;
:version_realization_info = "this is the 1st realization of the
emulator CNRM-ALADIN63-emul-CNRM-UNET11-tP1 over ALPX-12 domain." ;
:license = "" ;
string :reference = "Doury, A., Somot, S., Gadat, S. et al. Regional
climate model emulator based on deep learning: concept and first
evaluation of a novel hybrid downscaling approach. Clim Dyn 60,
1751-1779 (2023).    https://doi.org/10.1007/s00382-022-06343-9" ;
:creation_date = "14/03/2024" ;
```

3.10 Documentation and output data sharing

For future project internal and external use of the created climate information, it is essential that the process is well documented, and that the data is treated according to the FAIR principles (https://en.wikipedia.org/wiki/FAIR_data): they should be findable, accessible, interoperable and reusable. This is assured by the data management plan, which is part of the project and to which the modelling groups of WP3 contribute. It will contain, among other information, the model setup specifications (urban specific settings and meta data), the final output variable list and the domain setups.

To support this deliverable, a new repository in the I4C GitHub organization has been created[6] by forking the official CORDEX-CMIP6 CV. It contains an "emulators" branch with the extended CV elements proposed in this deliverable, along with working registration templates for the institutions and emulators in I4C. This open repository guaranties public availability and discussion of these resources, and the possibility to contribute the developments back to CORDEX.

3.11 Work Carried Out

All partners contributed to the text and to the definition of the DRS; the work was led by the DMI and the specific GitHub repository by CSIC.

[6] https://github.com/impetus4change/cordex-cmip6-cv

The DRS principles and the Deliverable organization and text were discussed in several virtual meetings through a shared document stored in the I4C Sharepoint archive.

There are no deviations from the Description of Action[7].

3.12 Discussion and Next Steps

Updates and additions (if necessary) to this DRS will be made available within the project.

It is the plan to obtain approval of the suggested DRS syntax from the CORDEX Science Advisory Team and make its documentation available on the relevant CORDEX space, e.g. to accomodate emulator groups not necessarily associated with the I4C project.

3.13 Status of Knowledge

Many institutions work on emulators, which transform low-resolution global model output into local information, and the performance of such emulators is improving in time. The present DRS suggestion is to be used as a standard, enabling different emulators to be intercompared through a presentation of their output data in a standardised way.

3.14 Main Results Achieved

The suggested DRS constructed in this task will allow output from emulation model ensembles to be collected and shared into a homogeneous file structure within the project and to prepare its legacy. Hence, it is a necessary part of rendering emulated fields useful.

3.15 Progress Beyond the State of the Art

We propose for the first time an operational DRS adapted to a new family of downscaling tools called CPM emulators. This represents a clear addition to the state of the art and a key milestone for the future exploitation of such tools in research projects and climate services.

4 Impact

The deliverable will contribute to the accessibility and usability of high-resolution climate ensemble datasets for the near-term temporal scales with potentially strong positive impacts on both the research community and the climate services. Adoption of this DRS by the international CORDEX initiative in the future would reinforce these positive impacts.

7 https://norce.sharepoint.com/sites/P104887_Impetus4Change/Shared%20Documents/Forms/AllItems.aspx?id=%2Fsites%2FP104887%5FImpetus4Change%2FShared%20Documents%2FI4C%20Consortium%2FWP8%2DProject%20Management%2FGA%2FAnnex%201%20%2D%20Description%20of%20the%20action%20%28DoA%29%20%2D%20updated%20with%20Amendment%20%231%2Epdf&parent=%2F

5 Links Built

This work has linked closely to the work on new specifications for CORDEX-CMIP6 dynamical downscaling work as well as of statistical downscaling output in the international CORDEX collaboration. This Deliverable is also strongly linked with the forthcoming deliverable D3.3.

6 Communication, Dissemination and Exploitation

A DRS is basically a recipe for modelling groups about how to organise output. Also, it is a documentation, which can be used by end-users as documentation for the contents of emulator-based data files. It is the plan to obtain approval of the suggested DRS syntax from the CORDEX steering group and make its documentation available on the relevant CORDEX space, e.g. to accomodate emulator groups not necessarily associated with the I4C project.

7 References

1. http://www.cordex.org/
2. http://is-enes-data.github.io/cordex_archive_specifications.pdf
3. https://doi.org/10.5281/zenodo.10961068
4. https://impetus4change.eu/
5. https://github.com/impetus4change/cordex-cmip6-cv
6. https://norce.sharepoint.com/sites/P104887_Impetus4Change/Shared%20Documents/Forms/AllItems.aspx?id=%2Fsites%2FP104887%5FImpetus4Change%2FShared%20Documents%2FI4C%20Consortium%2FWP8%2DProject%20Management%2FGA%2FAnnex%201%20%2D%20Description%20of%20the%20action%20%28DoA%29%20%2D%20updated%20with%20Amendment%20%231%2Epdf&parent=%2F

IMPETUS4CHANGE (I4C)

IMPROVING NEAR-TERM CLIMATE PREDICTIONS FOR SOCIETAL TRANSFORMATION

Grant agreement ID: 101081555

Call: HORIZON-CL5-2022-D1-02

Type of Action: HORIZON-RIA

Start date: 1 November 2022

Duration: 48 months

Website	impetus4change.eu
Twitter	@I4C_eu
LinkedIn	Impetus4Change
Zenodo repository for I4C open access documents	Impetus4Change Community