

CORDEX SAT's response to comments on the First Order Draft of the CORDEX experiment design for dynamical downscaling of CMIP6

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The First Order Draft (**FOD**) of the CORDEX experiment design (protocol hereafter) for dynamical downscaling of CMIP6 was shared with the CORDEX community in June 2020. We are very grateful to all who have read the protocol in detail and provided comments. The Second Order Draft (**SOD**) of the new CORDEX protocol is ready and we share it with the CORDEX community for comments. In order to keep the process of developing the CORDEX protocol transparent and open for the community, here, the CORDEX Science Advisory Team (SAT) provides response to the comments on the **FOD** and how they have been addressed in the **SOD**.

A general note

All together we received more than 100 comments on the **FOD** and the first priority has been given to topics with a number of similar comments. We've also tried to take into account (as much as possible) individual comments that appear only once or for a specific CORDEX domain/RCM. If you feel that your comments on the **FOD** have not been properly addressed, please comment on the **SOD** or contact the International Project Office for CORDEX (IPOC). Empirical-Statistical downscaling (ESD) is addressed in a separate document, which will be also shared with the CORDEX community.

Why downscale CMIP6 data?

There are comments asking a question "Why" (e.g. why downscale CMIP6 data, what is the added value of new CMIP6-driven simulations, etc.). We need to note that the CORDEX experiment design is a technical document providing details and recommendations on what to downscale and, when possible, on how. The protocol does not aim to provide a scientific background for downscaling and its added value or to explain why to downscale CMIP6. For more details on these aspects of CORDEX we refer to "WCRP COordinated Regional Downscaling EXperiment (CORDEX): a diagnostic model intercomparison project (MIP) for CMIP6" ([Gutowski et al. 2016](#)) and to [the CORDEX White paper](#) which is in preparation. The protocol also does not aim to propose any analysis.

CORDEX domains

A number of comments pointed out that some CORDEX domains are too large and generating long multi-decadal simulations at high resolution under multiple scenarios can be a heavy task. In general, the protocol recommends that the regional CORDEX communities should decide on what resolution they need and can afford with a preference for high resolutions where possible. If a large domain is a common problem for a regional RCM community, there is a possibility to update the current CORDEX domains or even to establish a new domain. Details about doing this are available in the **SOD**. We need to note that a request on updating a CORDEX domain has to come from the POCs of a CORDEX domain after a common agreement by that domain's community, not from individual RCM groups.

Resolution/Grid spacing

A number of comments pointed out that the selection of the horizontal resolution is not clear enough. The **FOD** stated that it is up to the regional CORDEX communities to decide on what resolution they need and can afford with a preference for high resolutions where possible. Two primary resolutions (**25 and 12.5km**) are recommended. Additional clarifications have been added to **the SOD**. This includes a recommendation to use one common grid spacing per domain avoiding a wide range of resolution for the same domain. There is also a possibility to use a resolution between **25 and 12.5km** if both **25 and 12.5km** do not fit and there is a common agreement on an intermediate resolution within a domain.

Model complexity

Multiple comments suggested that it would be good to provide recommendations on a minimum configuration for RCMs. A new section **Model complexity** has been added to address these comments.

Evaluation experiment

In the **FOD**, the ERA-Interim reanalysis was defined as the primary driving reanalysis for the evaluation experiment and then the ERA-Interim driven simulations could be complemented by ERA5-driven ones. Many who provided comments suggested that it is better to use the latest ECMWF ERA5 reanalysis to drive the evaluation experiment. We completely agree that ERA5 represents the latest advances in reanalyses and outperforms ERA-Interim which is already an outdated product. Our main concern in spring 2020 was that model levels of ERA5 were not publicly available through the Copernicus Climate Data Store (CDS) in contrast to pressure levels. Additionally, there were many reports on problems with downloading large volumes of data from the CDS. The ERA5 model levels are now publicly available from the CDS, although in a slow mode (on ECMWF MARS tapes, not on CDS fast disks as pressure

levels). **The ERA5 reanalysis is now the primary reanalysis to drive the evaluation experiment.** The evaluation experiment has to cover the entire 1979-2019 period or a longer period (e.g. 1979-2020) depending on availability of the ERA5 forcing.

Aerosol forcing

Most comments on aerosol forcing request to provide a more explicit guidance (e.g. aerosol forcing datasets, implementation of aerosol in RCMs, etc.). We agree that the recommendations on aerosol forcing in the **FOD** are too general. It has been decided to provide more explicit recommendations through a living document where all can leave comments, suggestions and questions. Based on this document the regional CORDEX communities can define the best strategy for implementing aerosol forcing in their RCMs. A static aerosol dataset (e.g. a regional model default climatology) is considered as a minimum requirement.

Land use/Land cover

Recommendation to use the Land Use Harmonized Dataset Version 2 (LUH2) for a transient land use and land cover forcing led to many comments and questions. Among them a coarse resolution of the LUH2 dataset (0.25deg), existence of other land use datasets and missing recommendations for the evaluation experiment. At the moment it is difficult to provide explicit recommendations on implementation of a transient land use forcing in RCMs (datasets, translation to RCMs etc.). It has been decided to recommend to use static land cover and land use maps that are a regional models' default as the first step and to continue working on a more detailed recommendation for the future. Later, when the recommendations based on a common agreement in the CORDEX community can be provided, simulations with the static land cover and land use can be complemented by a number of new simulations with the transient land use change. A dedicated living document will be created for comments and suggestions.

Spin-up

A number of comments questioned whether a 1-year spin-up is enough or not. In general, a spin-up depends on regions and variables (e.g. atmosphere, land or ocean) and it is impossible to provide a common recommendation for all CORDEX domains and variables. We think that the 1-year spin-up is a reasonable recommendation for atmosphere-land models while it is up to the RCM groups to use a longer spin-up (or an offline spin-up) for models that include additional climate system components. Clarifications have been added.

Spectral nudging

A common comment is that it is too much to provide two simulations (with and without spectral nudging) if a RCM group applies spectral nudging in the evaluation experiment. This requirement was actually only for the evaluation experiment, not for the historical and scenario ones. In any case, this requirement has been relaxed. If a RCM group applies spectral nudging only one evaluation simulation should be provided by default. Providing both evaluation simulations (with and without spectral nudging) is a recommendation. Another common comment is to provide more details/recommendations on spectral nudging (e.g. strength, scales, variables and levels). Such specific details can be strongly region-dependent (e.g. the midlatitudes or tropics) and it is up to RCM groups to decide on parameters of the nudging, based on their regional expertise.

Scenarios

The main focus in the CORDEX Request to CMIP6 (2016) was on the Tier 1 SSP5-8.5 and SSP1-2.6 scenarios. However, currently, there is a stronger focus on SSP3-7.0 as a high impact scenario instead of SSP5-8.5. Thus, the SSP3-7.0 and SSP1-2.6 are now two primary scenarios to be downscaled and it is recommended to complement them by downscaling the SSP2-4.5 and then SSP5-8.5 scenario.

Selection of GCMs

A number of comments suggested including references to papers on the selection of GCMs for downscaling and/or to recommend a common set of GCMs for all CORDEX domains. Currently, there is no commonly accepted methodology on how to select a subset of GCMs for downscaling but a range of different approaches or their combinations. The CORDEX experiment design does not aim to provide an overview of all existing approaches on how to select GCMs for downscaling. A preliminary work on merging different approaches for an optimal selection of GCMs for downscaling is ongoing in Euro-CORDEX and outcomes of this work will be shared with the CORDEX community. Recommending a subset of GCMs to be downscaled over all CORDEX domains is also not straightforward. A subset of GCMs selected for one CORDEX domain is not necessarily an optimal choice for other domains. This section has been refined and it is left up to the regional CORDEX communities to decide on which CMIP6 models should be downscaled over a specific domain.

Output variables

A new CORDEX variable list is under development and will be shared with the CORDEX community for discussions and comments.

Archiving and publishing specifications

A number of comments suggested providing more details on quality control and validation of CORDEX simulations. These aspects will be included in the CORDEX archive specifications that will be shared with the CORDEX community for discussions and comments.