IS-ENES3 Milestone M7.3

Improved version of evaluation portal

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ABSTRACT

This report describes the work for the integration in Climate4Impact v2 of climate models comparison information computed in ESMValTool. It includes the overview of the most important requirements, the status of their implementation and the current interactive controls enabling access by the users.

Revision Table			
Version	**Date**	**Name**	**Comments**
1	01/12/2020	Alessandro Spinuso	Document Creation and preliminary discussion on the use case and extent
1	15/01/2020	Alessandro Spinuso, Janette Bessembinder	Refinement of the principal User Case and Requirements
1	4/11/2021	Alessandro Spinuso	Report on achieved results
Final Draft.	9/11/2021	Peter Kalverla, Alessandro Spinuso	Comments on requirements and implementation

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1. Introduction

The document introduces the use case and requirement leading to the production of pre-computed climate model evaluation metrics for a set of combinable parameters. The requirements are analysed and translated into recipes that will be executed by the ESMValTool[1]. The results are represented and eventually linked from the Climate4Imapct v2[2] portal's search interface (C4I v2), to facilitate users in the selection of the model data. In a second stage, users will be enabled to further configure and customise the evaluation recipes.

2. Use Case and Requirements

The use case addressed by this milestone can be defined as:

Comparison of climate model performance in support of the selection of model data for impact analysis

Description: Many impact researchers do not have the time and finances to use a large ensemble of climate model runs for their impact analysis. To get an idea of the range of impacts of climate change it also suffices to use a small number of climate model runs. In case a system is only sensitive to annual temperature, one can select a run with a high change and one with a low change of annual temperature, preferably both with a low bias. However, the information on the biases and changes in individual climate models under various RCPs is not that easily available until now. Within C3S[3] a pilot for something similar was started (DCEM), showing seasonal average biases and changes for temperature and precipitation. This is planned to be made available through the Climate4Impact portal, as information computed from the ESMValTool. Below we list the most relevant requirements.

Main Requirements and implementation status

1. Provide information about bias and change in the future (2050 and end of century). The former to judge how well models perform. The latter to be able to select models with relatively high or relatively low change. In case of the bias, it may be interesting to determine the bias against a few different references (e.g. ERA5 and E-OBS). For the selection of the models it is not that important that the time period analysed with ESMValTool exactly covers the time period that people want to use for their impact study,

[1] https://portal.enes.org/models/software-tools/esmvaltool
[2] https://dev.climate4impact.eu
[3] https://climate.copernicus.eu/

as long as it more or less cover that period and give a good view on the skill of the climate models and the level of change of the climate models. This means that some 30-year periods that are often used, should be included (At least 2036-2065 and 2071-2100 and probably also 2021-2050).
Status: The current release produces information up to 2050, against the ERA5 references. Time extent could be easily tuned in ESMValTool to include the end of the century.

2. Relevant climate variables: minimum, maximum, average temperature, precipitation, wind speed, radiation, humidity at normal measuring heights, especially. These are the most widely used climate variables in a broad range of sectors.
Status: Currently only temperature and precipitation are calculated, as proof of concept, but this can be easily extended to other variables.

3. Presentation of biases and changes. E.g. for biases in temperature use C (besides perhaps K), for precipitation mention the amount in mm per month/season or mention the % (do not use average mm/day, for many people this is not a common way to think of precipitation) (REQUIRES to contact ESMVal expert to understand the current bias information available in the tool)
Status: Accomplished

4. For the selection of climate models it is probably sufficient to have the biases and changes over the subcontinental regions as used in the IPCC Climate Change Atlas[4]. Providing change for smaller regions would be preferable over Global or continental areas.
Status: Currently the implementation shows Europe as one region. This can be refined later on.

Future Requirements

1. Provide info at seasonal/monthly basis, since the bias/change may be different over the year (would be good to calculate most at calendar month basis, since this is best to use for bias adjustments)
2. Besides biases and change in the averages of these relevant climate variables also biases and changes in extremes (e.g. percentiles 5, 95, or standard deviations). More extreme could also be interesting, but this may be more difficult to provide. If we assume that the change in the mentioned percentiles already says something about more extreme events, this could also be useful.

[4] https://interactive-atlas.ipcc.ch/

3. Information on year-to-year variation. Is relevant for many sectors, and in the short term (about 10 years ahead) is more important than climate change. The way this information is presented is very important: people want to compare the available climate model runs (now especially CMIP6 and CORDEX), to select the models that either perform best (lowest bias) or show a relatively high or relatively low change in the future. This can be done through a visual presentation (e.g. as in the DCEM project) or by presenting the information in the form of a table. Some users have a slight preference for tables, however this can be adapted after the first release.

3. Implementation

The implementation performed by KNMI and NLeSC produced the information indicated by the requirements as pre-computed ESMValTool runs, which were configured adopting general recipes. ESMValTool[5] is a community diagnostic and performance metrics tool for routine evaluation of Earth system models in CMIP. The results computed by this system have been repurposed in graphical representation to the user of C4I v2, who interacts with the portal as follows.

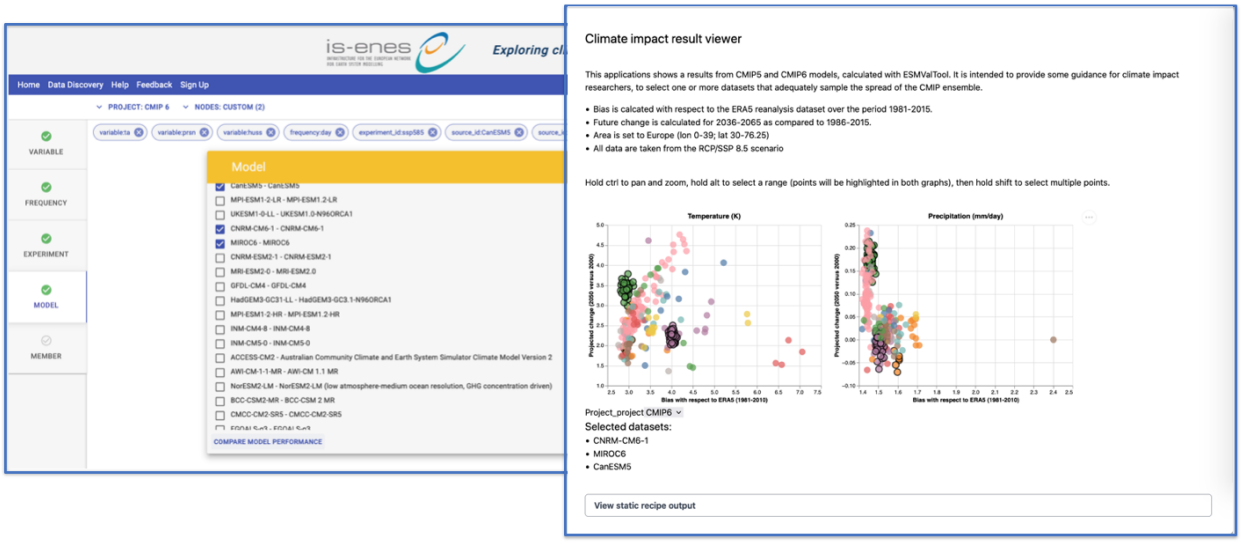

Figure 1: C4I Model Selection interface (left) and EMVal Model Comparison (right). The graph shows how a particular model foresees a change in a variable (Temperature/Precipitation) compared to the past. This, in combination with the bias, gives some confidence on performance.

1) During the interactive parametrization of the data discovery functionality, users can specify which models they are interested in on the model selection page, see Figure 1. Here they have the option to open an external site provided by the ESMValTool portal, where the different performance/comparison of multiple models can be interactively browsed. If users

[5] https://www.esmvaltool.org/

had pre-selected some models in C4I, the ESMValTool page will highlight these, to facilitate the evaluation of the initial choice.

2) On the ESMValTool pages, the evaluation/comparison data is pre-calculated by executing one or more *recipes* (this will occur once and update regularly if needed). The results are organised in two graphs related to bias and changes for Temperature and Precipitation. Users can access the same information also in tabular form, besides having access to the explanation of the particular *recipe* and the logs file produced by its execution. ESMValTool allows for easy adaptation of periods, regions, etc. However, at the moment the precomputed data will show one region, one period, etc, according to the requirements. These will be refined iteratively during the future improvements of this implementation.

Conclusions and Future work

This milestone required focused work and frequent coordination calls between KNMI and NLeSC. These saw the periodical participation of experts (Christian Page, Janette Bessembinder), to evaluate the ongoing developments and discuss progress and refinements. NLeSC took care of the formulation and execution of the recipes on DKRZ resources, and the provision of the results via the ESMValTool portal, while KNMI implemented the mechanism to communicate the model information and link the pages from C4I v2. Besides the implementation of the future requirements mentioned in Section 2, We foresee improvements especially concerning the interactive access to the graphs for bias and changes. E.g. in a graph with the changes in temperature for CORDEX runs (once these will be available in C4I v2), it could help if users could exclude those model runs that have an intermediate level of change. This would make the comparison of the remaining climate model runs easier. We will also consider adding a pre-computed RMSE (*Root Mean Square Error)* for the biases per year or per season.