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# Evaluation of Native Earth System Model Output with ESMValTool

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Projections from Earth system models (ESMs) are essential to allow for targeted mitigation and adaptation strategies for climate change. ESMs are state-of-the-art numerical climate models used to simulate the vastly complex Earth system including physical, chemical, and biological processes in the atmosphere, ocean, and on land. Progress in climate science and an increase in available computing resources over the last decades has led to a massive increase in the complexity of ESMs and the amount of data and insight they provide. For this reason, innovative tools for a frequent and comprehensive model evaluation are required more than ever. One of these tools is the Earth System Model Evaluation Tool (ESMValTool), an open-source community diagnostic and performance metrics tool.

Originally designed to assess output from ESMs participating in the Coupled Model Intercomparison Project (CMIP), ESMValTool expects input data to be formatted according to the CMOR (Climate Model Output Rewriter) standard. While this CMORization of model output is a quasi-standard for large model intercomparison projects like CMIP, this complicates the application of ESMValTool to non-CMOR-compliant data, like native climate model output (i.e., operational output produced by running the climate model through the standard workflow of the corresponding modeling institute). Recently, ESMValCore, the framework underpinning ESMValTool, has been extended to enable reading and processing native climate model output. This is implemented via a CMOR-like reformatting of the input data during runtime. For models using unstructured grids, data can optionally be regridded to a regular latitude-longitude grid to facilitate comparisons with other data sets. The new features are described in more detail in Schlund et al., 2022 (https://doi.org/10.5194/gmd-2022-205) and in the software documentation

available at https://docs.esmvaltool.org/en/latest/input.html#datasets-in-native-format.

This extension opens up the large collection of diagnostics provided by ESMValTool for the five currently supported ESMs CESM2, EC-Earth3, EMAC, ICON, and IPSL-CM6. Applications include assessing the models' performance against observations, reanalyses, or other simulations; the evaluation of new model setups against predecessor versions; the CMORization of native model data for contributions to model intercomparison projects; and monitoring of running climate model simulations. Support for other climate models can be easily added. ESMValTool is an open-source community-developed tool and contributions from other groups are very welcome.