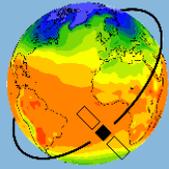


# Evaluation of Native Earth System Model Output with ESMValTool



## ESMValTool

Earth System Model Evaluation Tool



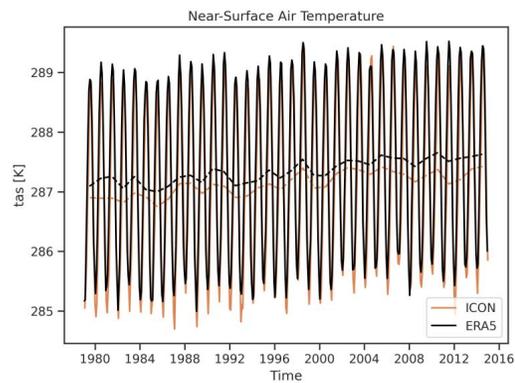
- Community-developed open-source diagnostic and performance metrics tool for **routine evaluation of Earth system models (ESMs)**.
- Designed to process model output that follows **CMOR (Climate Model Output Rewriter) standards** about variable names, experiment names, dimensions, etc.

Hinders application of ESMValTool to **native model output**

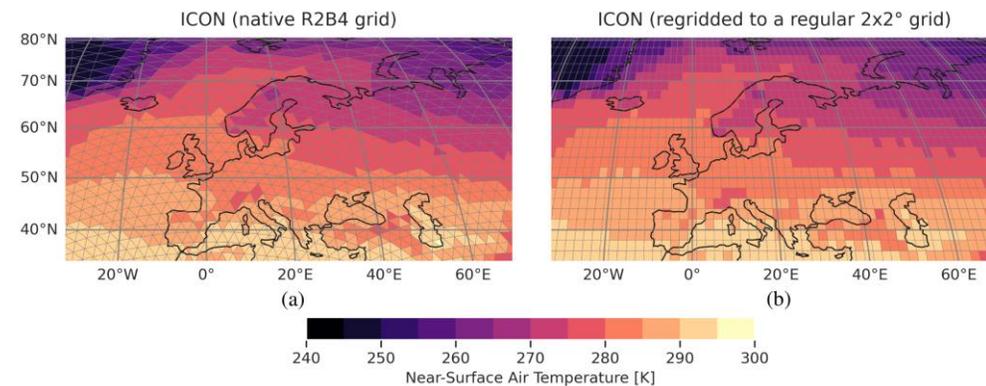
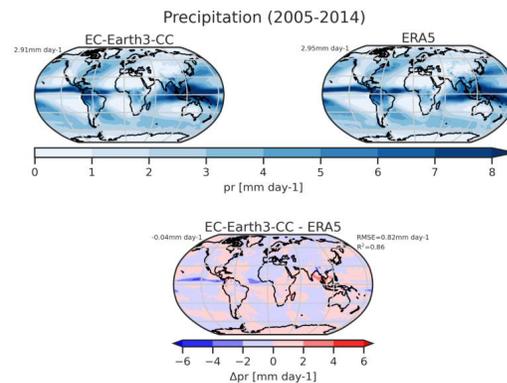
**Native model output** = operational output produced by running a climate model (usually does not follow the CMOR standards)

New since ESMValTool v2.6.0: **CMOR-like reformatting of native model output during runtime**

- Allows application of the rich collection of diagnostics provided by ESMValTool to native model output.
- Currently supported models: CESM2, EC-Earth3, EMAC, ICON, and IPSL-CM6; can be easily extended.



General-purpose diagnostics



Regridding of data on unstructured grids



Sharing is encouraged



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# ESMValTool

- Fast and easy routine evaluation of ESMs including provenance records for all results (traceability and reproducibility).
- Well-established analysis based on peer-reviewed literature.
- Multitude of generalized preprocessor functions (e.g., regridding, statistics, multi-model analysis, etc.).
- Extensive documentation (user guide, peer-reviewed papers, tutorial).

## Scientific Documentation

*Righi et al., GMD, 2020*

**Technical overview**

*Eyring et al., GMD, 2020*

**Large-scale diagnostics**

*Lauer et al., GMD, 2020*

**Diagnostics for emergent constraints and future projections**

*Weigel et al., GMD, 2021*

**Diagnostics for extreme events, regional and impact evaluation**

*Schlund et al., GMD, 2023*

**Evaluation of native ESM output**



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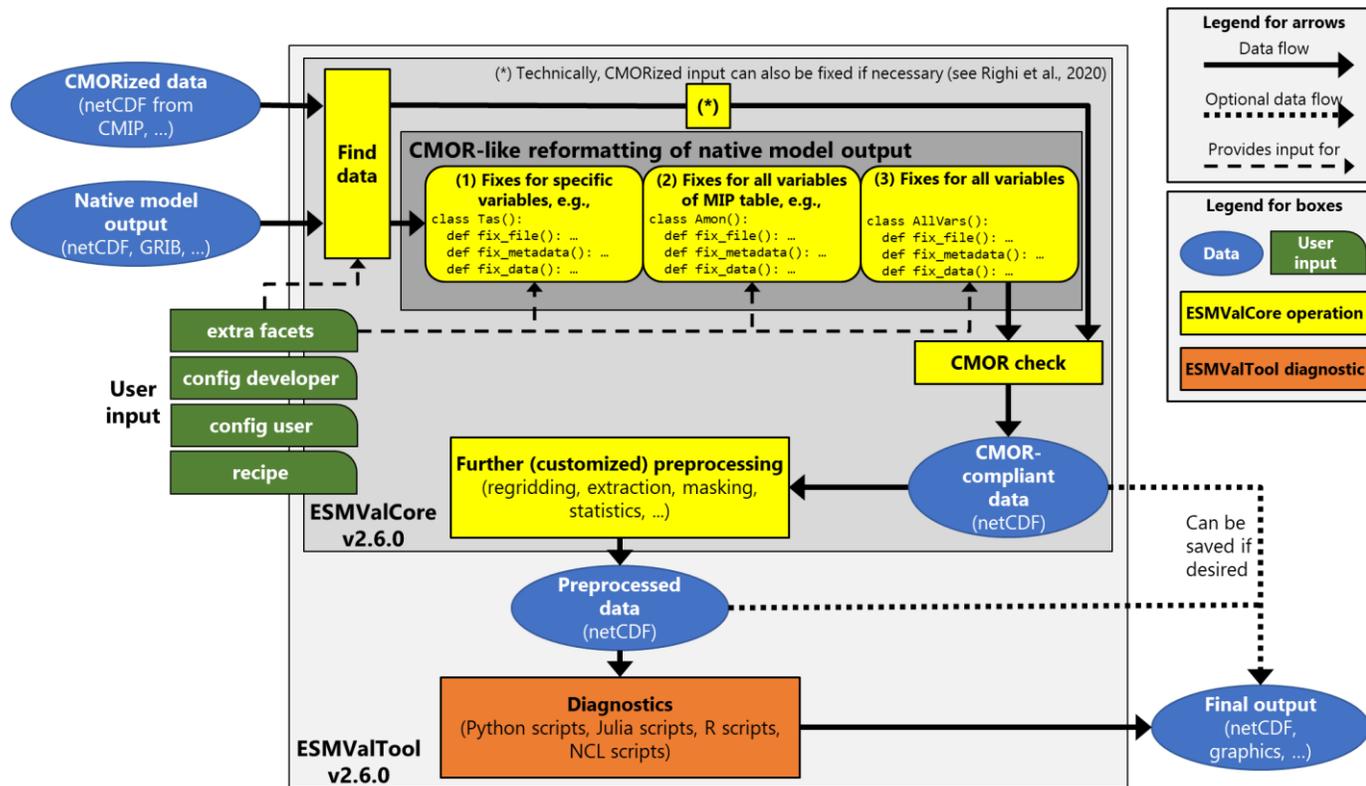


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# CMOR-like Reformatting of Native Model Output



## Then

- Originally, all input data for ESMValTool needed to be **CMORized** (CMOR = Climate Model Output Rewriter), i.e., follow the CMOR standards and conventions.
- CMORization is an expensive postprocessing step** that is usually only performed for model output provided for large model intercomparison projects (e.g., CMIP – Coupled Model Intercomparison Project).
- This hindered application of ESMValTool to native model output (operational output produced by running a climate model) is usually not CMORized.

## Now: CMOR-like reformatting of native model output during runtime

- Allows application of the rich collection of diagnostics provided by ESMValTool to native model output.
- Currently supported models: CESM2, EC-Earth3, EMAC, ICON, and IPSL-CM6; can be easily extended.



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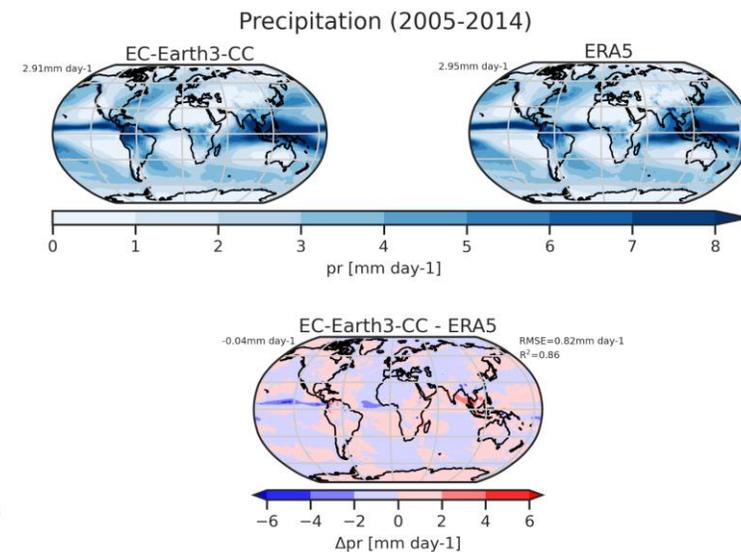
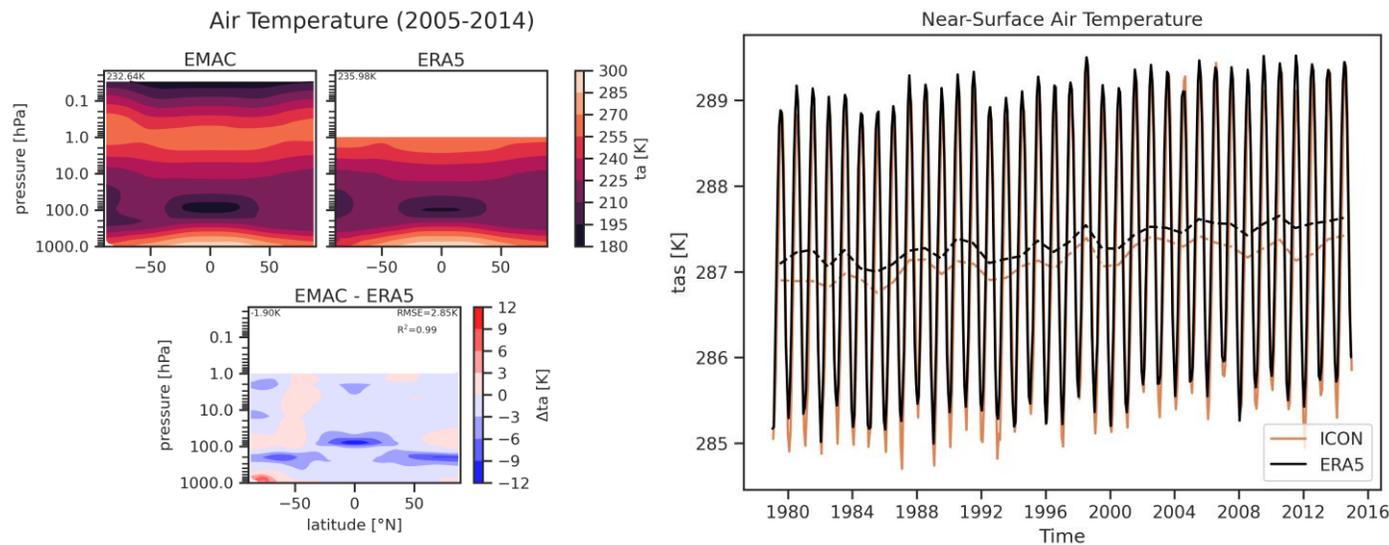
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# General-purpose Diagnostics

Plot a wide range of plot types for arbitrary data. Example applications:

- Quick overview of new simulation results.
- Comparison of models against predecessor versions.
- Assessment of performance of different simulations against observations.



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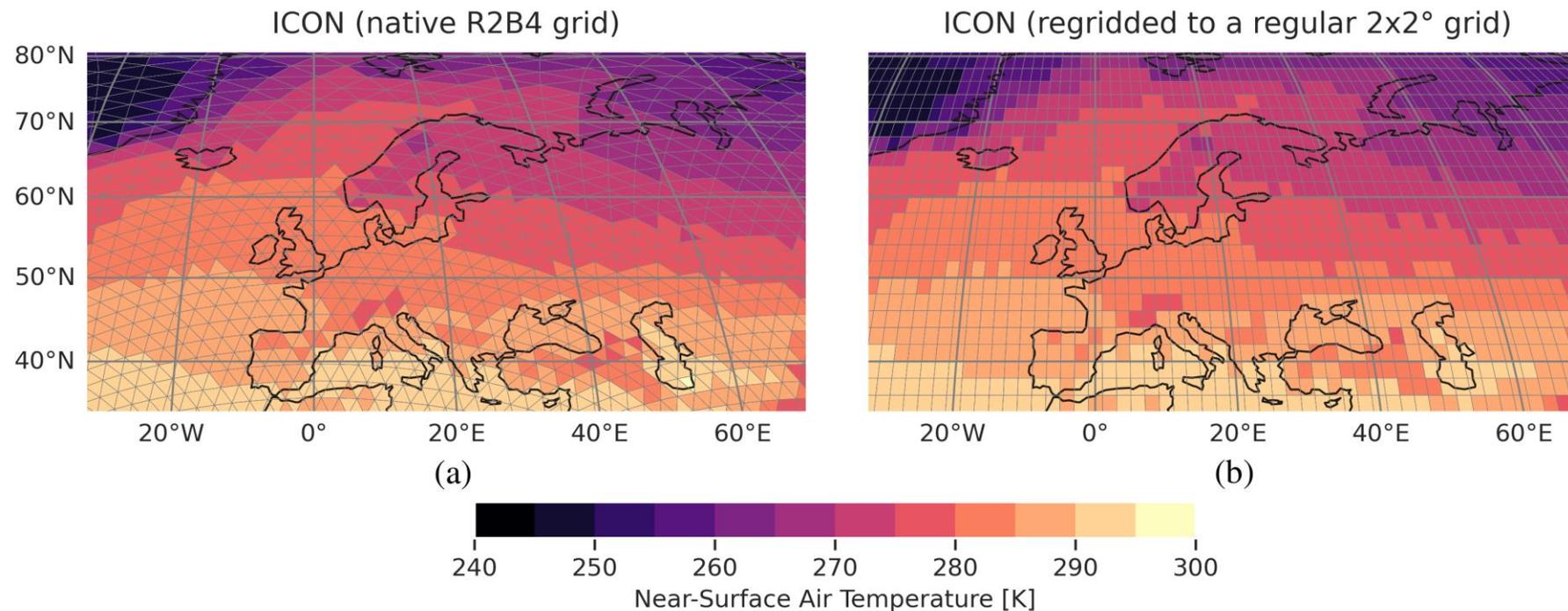
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# Regridding for Data on Unstructured Grids

- Many state-of-the-art ESMs do not use regular horizontal grids for their spatial discretization but **unstructured grids** instead (example: ICON with triangular grids).
- Regridding is crucial for comparison of these models with data on regular grids.
- Currently **supported regridding schemes**: nearest-neighbor, bilinear, area-weighted (first-order conservative).



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# Further Resources



**Publication:** Schlund, M., Hassler, B., Lauer, A., Andela, B., Jöckel, P., Kazeroni, R., Loosveldt Tomas, S., Medeiros, B., Predoi, V., Sénési, S., Servonnat, J., Stacke, T., Vegas-Regidor, J., Zimmermann, K., and Eyring, V.: Evaluation of native Earth system model output with ESMValTool v2.6.0, *Geosci. Model Dev.*, 16, 315–333, <https://doi.org/10.5194/gmd-16-315-2023>, 2023.



**Website:** <https://www.esmvaltool.org>.



**Documentation:** <https://docs.esmvaltool.org/en/latest>.



**GitHub:** <https://www.github.com/ESMValGroup/ESMValTool>.



**Tutorial:** [https://esmvalgroup.github.io/ESMValTool\\_Tutorial](https://esmvalgroup.github.io/ESMValTool_Tutorial).



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