

# ESMValTool – Introductory Tutorial

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### IS-ENES3 Project

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# Today's Tutorial

1. Introduction – presentation
2. Demo
3. Q&A
4. Hands on Exercises with the Software Carpentry online tutorial
5. Feedback

# Desired Outcomes

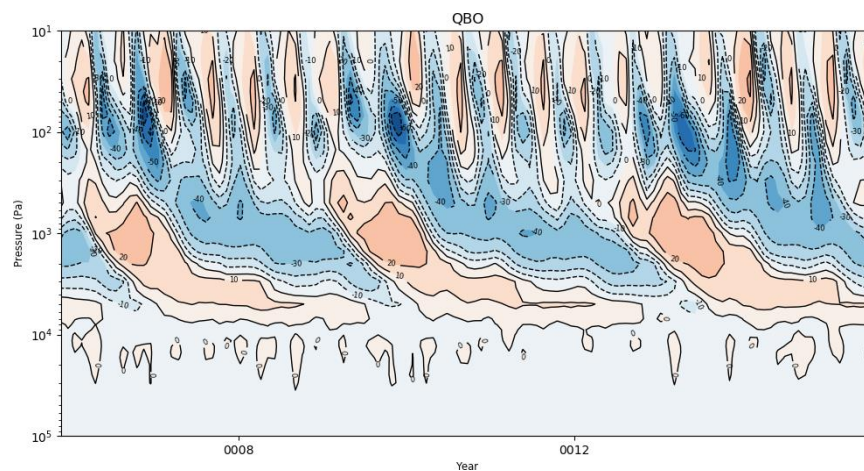
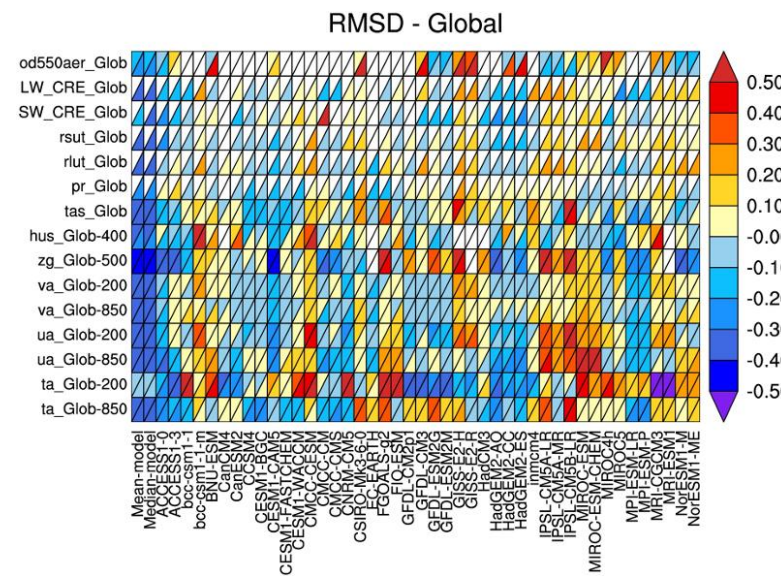
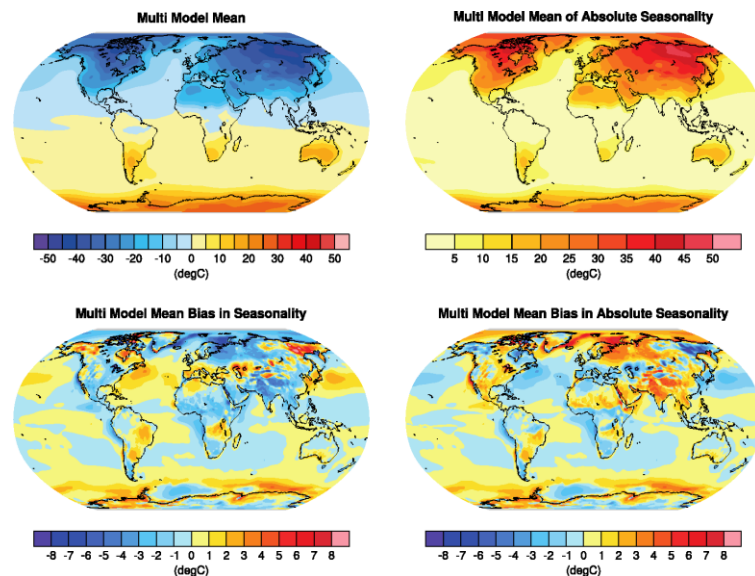
- An understanding of what ESMValTool is and what it can do for you.
- Ability to get started with using existing recipes and diagnostics.
- Writing your own recipes for preprocessing.
- How to parse error messages and get help when stuck.
- How you can contribute to the community (as early as right after this session)!

# What is the ESMValTool?

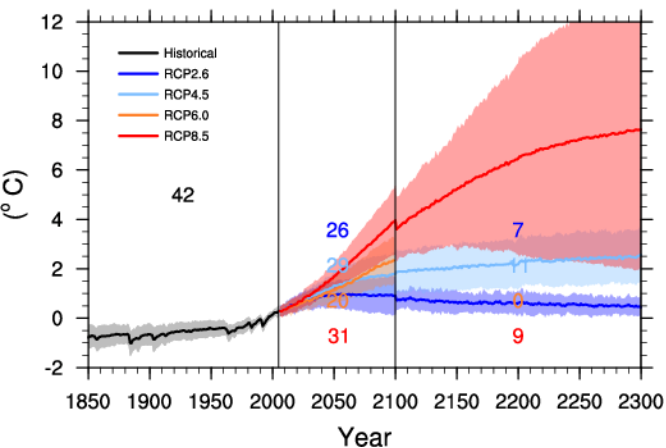
The **Earth System Model Evaluation Tool** (ESMValTool) is a community diagnostics and performance metrics tool for the evaluation and analysis of Earth System Models (ESMs) that allows for routine comparison of single or multiple models, either against predecessor versions or against observations.

- **Community effort** open to both users and developers
- **Wide scope:** includes many diagnostics and performance metrics covering different aspects of the Earth system
- **High flexibility:** new diagnostics and more observational data can be easily added.
- **Multi-language support:** Python, NCL, R, Julia... other open-source languages are possible
- **Reproducibility** of the results (provenance)
- **Well-documented** source code and diagnostics

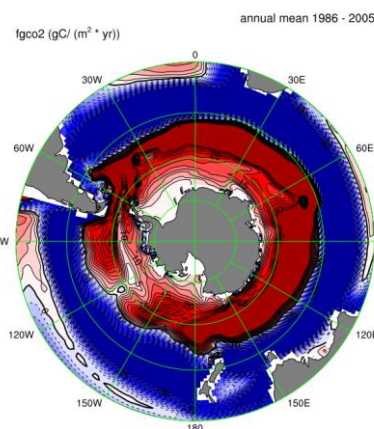
# ESMValTool Gallery (<https://docs.esmvaltool.org/en/latest/>)



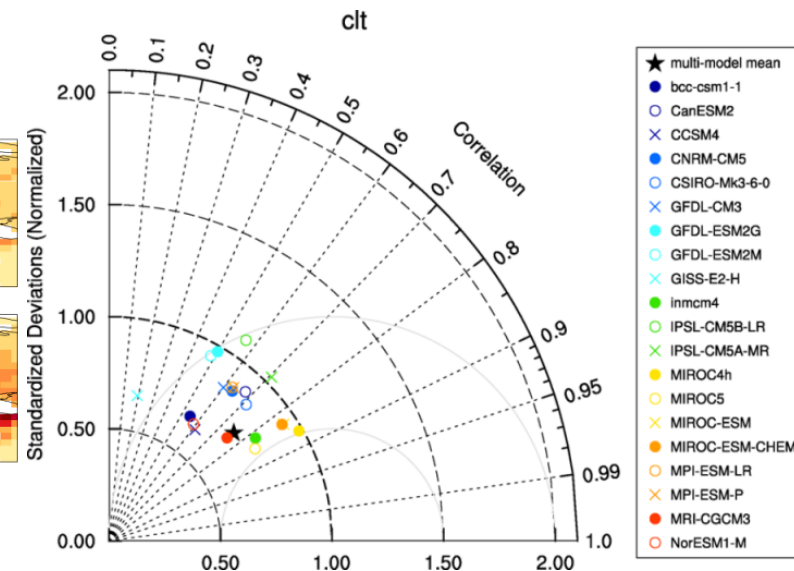
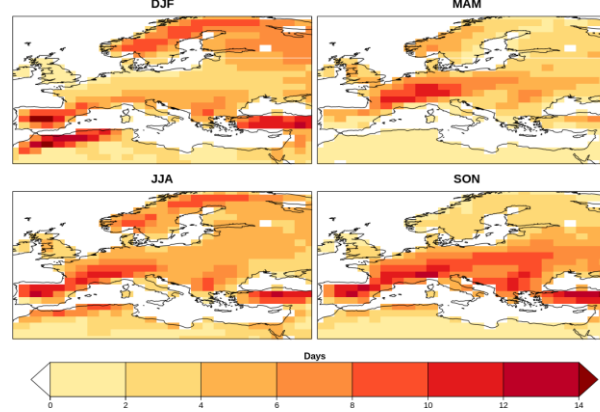
Global surface temperature change (°C)



CanESM2



Number of days exceeding the DTR by 5 degrees during the period 2030 - 2080



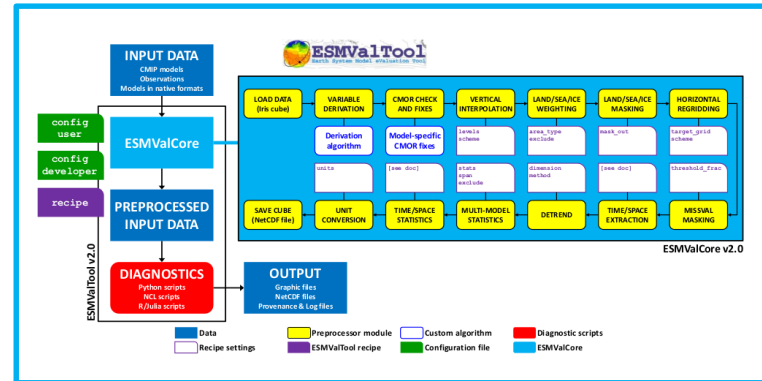


# ESMValTool (v2) scientific documentation

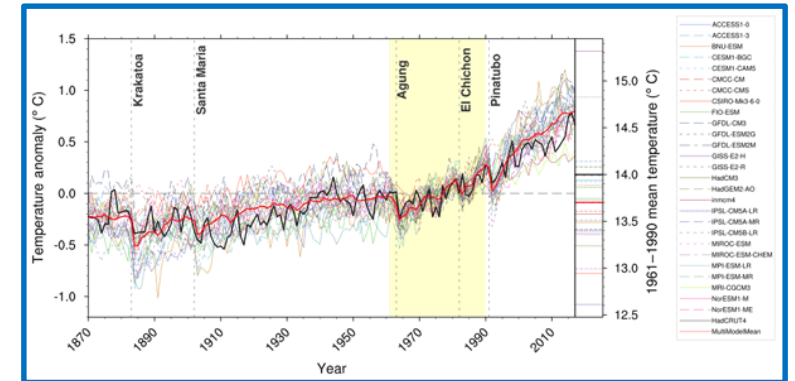
# Release v2.0 August 2020

- 3.5 years of work
- 8 coding workshops
- 416 pages documentation
- 776 solved issues
- 1276 merged pull requests
- 1725 files
- 544,971 lines of code

*Righi et al., 2020*  
**Technical overview**



*Eyring et al., 2020*  
**Large-scale diagnostics**

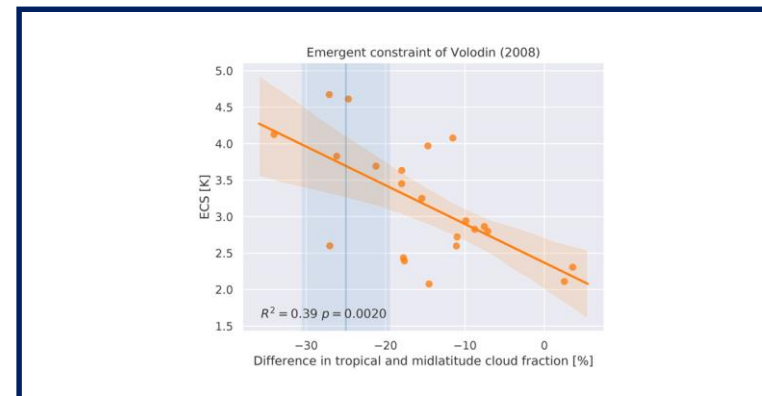


## International ESMValTool development team

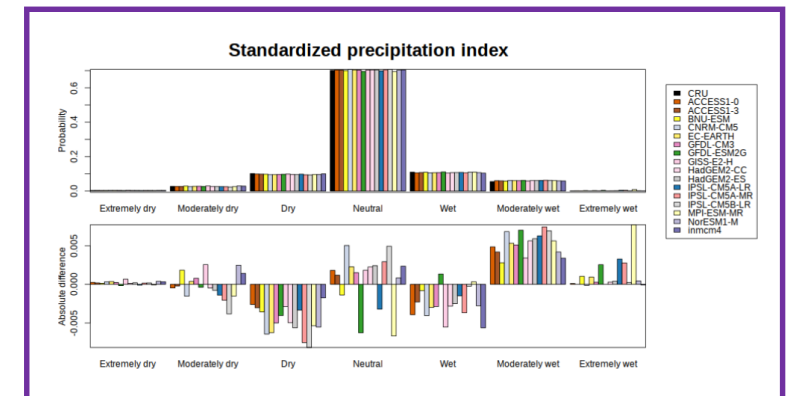
- 17 funded projects
- 63 institutions
- 203 developers

*Lauer et al., 2020*

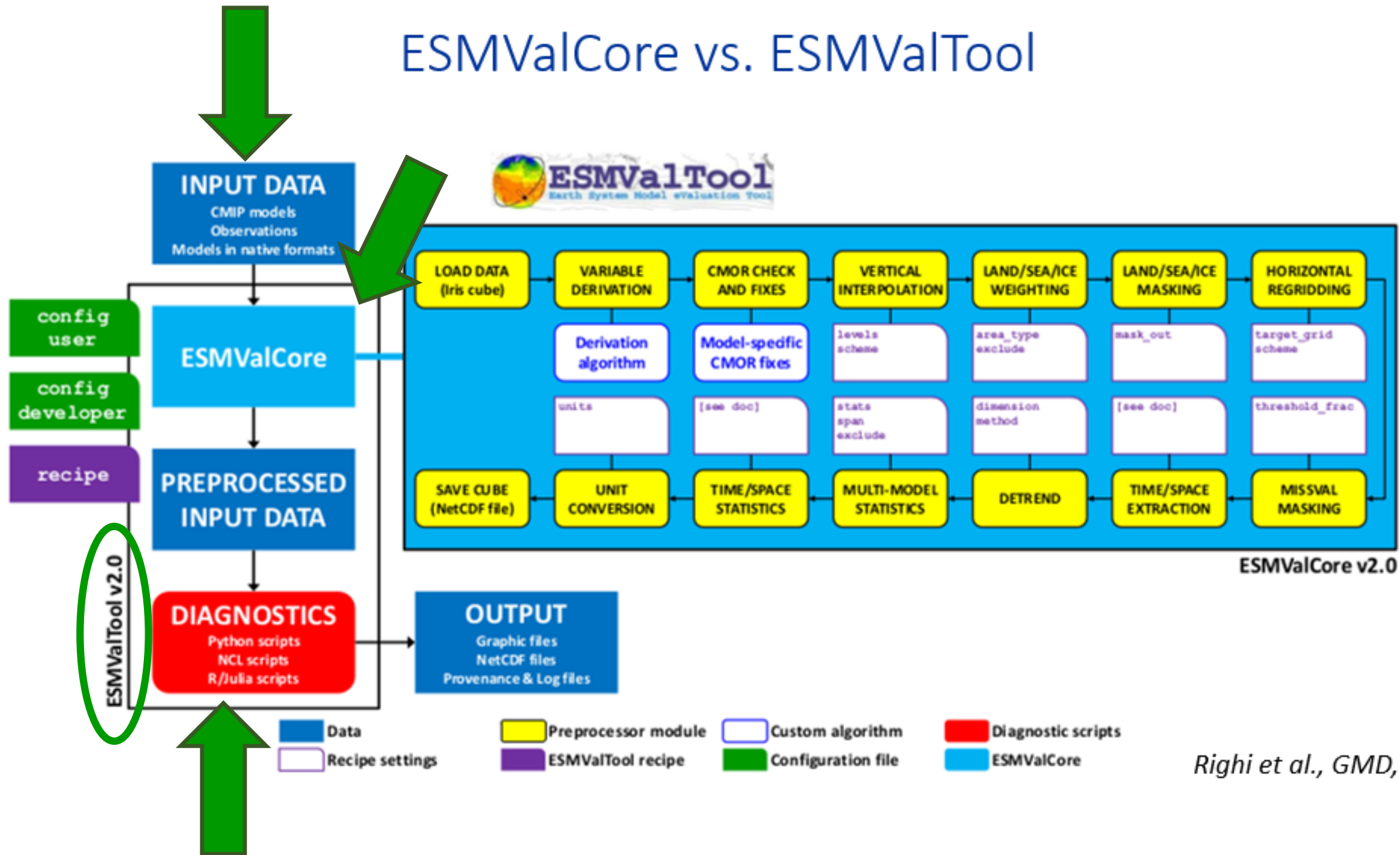
**Diagnostics for emergent constraints and future projections**



*Weigel et al., 2021*  
**Diagnostics for extreme events,  
regional and impact evaluation**

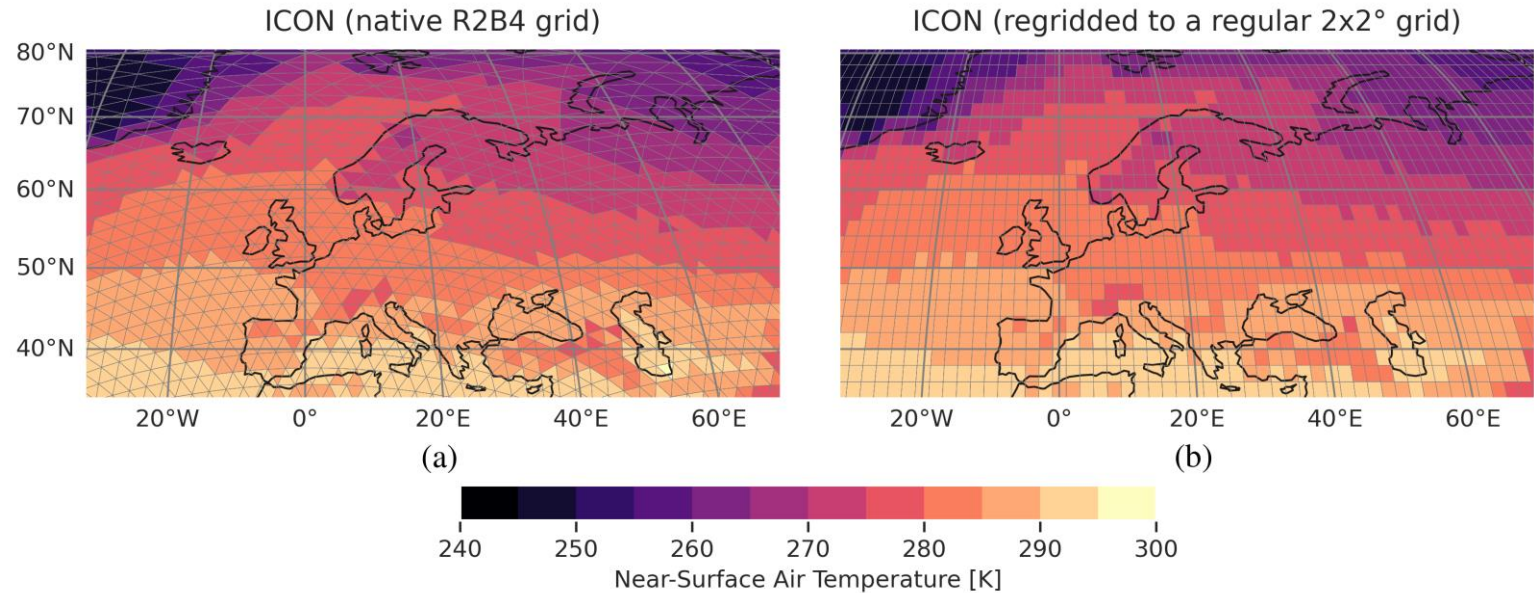


# ESMValCore vs. ESMValTool



# Latest ESMValTool features

- **Working with native model output:** no CMORization of model data necessary anymore; four models are supported at the moment, but more can be added
- **Working with unstructured grids:** possible now
- **Monitoring capabilities:** model simulations can be checked while they are still running





# ESMValTool Tutorial

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

This lesson is being piloted (Beta version)

Home

Setup

Episodes ▾

Extras ▾

License

Improve this page 

## ESMValTool Tutorial

This tutorial helps you to use ESMValTool.

The Earth System Model Evaluation Tool (ESMValTool) is a community developed software toolkit that aims to facilitate the diagnosis and evaluation of the causes and effects of model biases and inter-model spread within the CMIP model ensemble.

This tutorial is structured such that the main body of the tutorial, up to the episode 7, can be done in one sitting. From episode 8, each episode is a mini-tutorial covering an advanced aspect of working with ESMValTool. These mini-tutorials can be appended to the main tutorial or worked through independently.

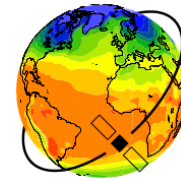
### What will you learn in this course

- What is ESMValTool
- How to install ESMValTool
- How to configure ESMValTool for your local system
- How to run ESMValTool
- How to work with ESMValTool's suite of preprocessors
- How to debug your recipes
- How to access and deploy recipes from the ESMValTools gallery (Advanced)
- How to develop your own diagnostics and recipes (Advanced)
- How to contribute your recipes and diagnostics back into ESMValTool (Advanced)
- How to include new observational datasets (Advanced)

### Prerequisites

The prerequisites for the tutorial are listed on the [tutorial setup page](#).

# ESMValTool Resources

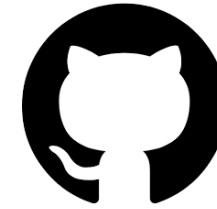


**ESMValTool**  
Earth System Model Evaluation Tool

Decreasing complexity

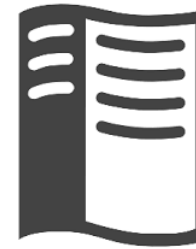
## 1. Github repositories

<https://github.com/ESMValGroup/ESMValTool>



## 2. Documentation

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

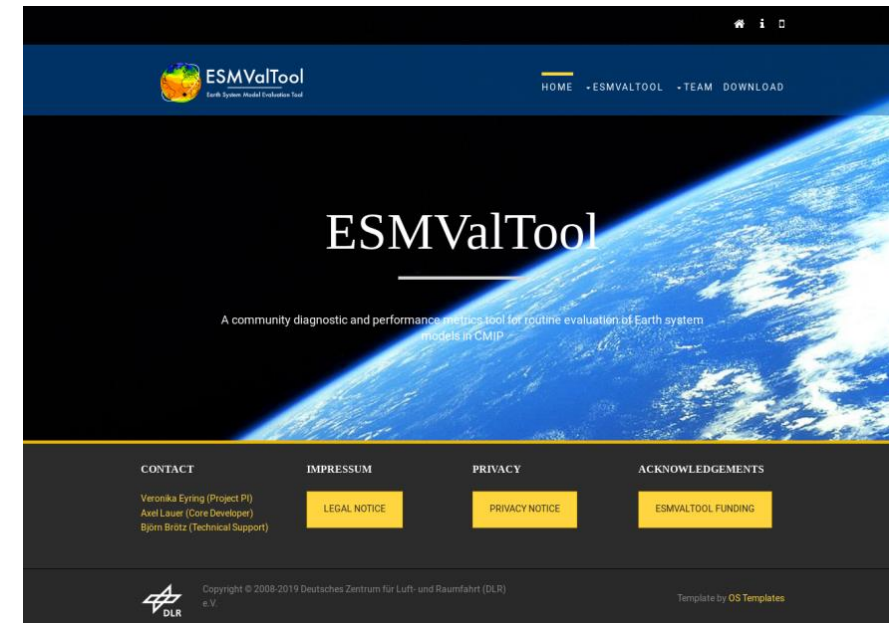


## 3. Tutorial

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

## 4. Webpage

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



# ESMValTool Discussions

(<https://github.com/ESMValGroup/ESMValTool/discussions>)

## ➤ Github Discussions/FAQs

- Frequently encountered problems of new users are discussed and answered
- Easy way to get in contact with ESMValTool developers

The screenshot shows the GitHub repository page for ESMValGroup/ESMValTool. The 'Discussions' tab is selected, showing a 'General' discussion titled '5 years ESMValTool' by axel-lauer. A callout box on the left highlights the 'Categories' section, which includes a 'View all' button and icons for General, Ideas, New to ESMValTool, Q&A, and Show and tell. Arrows point from the 'New to ESMValTool' and 'Q&A' categories to the 'Discussions' tab. Another callout box at the bottom right shows a detailed view of the 'Categories' list, including the 'View all' button and the same category icons.

**Categories**

- ∞ View all
- General
- Ideas
- New to ESMValTool
- Q&A
- Show and tell

**ESMValGroup / ESMValTool**

Code Issues 170 Pull requests 60 **Discussions** Actions Projects 3 Wiki Security Insights

Search all discussions

New Top: All Answered Unanswered

**Categories**

- ∞ View all
- General
- Ideas
- New to ESMValTool
- Q&A
- Show and tell

**Version numbers**  
bouweandela started 12 days ago in Ideas 5

**Resources on climate indices**  
bouweandela started 11 days ago in Ideas 0

**Website**  
bouweandela started 11 days ago in Ideas 0

**Image gallery**  
bouweandela started 11 days ago in Ideas 1

# Where to find help if there are problems or questions?

## ➤ Documentation

- Contains information about all functionalities of the ESMValTool and ESMValCore
- Very detailed

The screenshot shows the ESMValTool documentation website. The left sidebar contains a navigation menu with sections for ESMVALTOOL and ESMVALCORE. The main content area displays the 'Welcome to ESMValTool's documentation!' page, which lists various topics under 'ESMValTool'. A callout box on the right highlights the 'Making a recipe or diagnostic' section, which includes links to 'Introduction', 'Recipe', 'Diagnostic', and 'Dataset'.

ESMValTool

latest

Search docs

ESMVALTOOL

- Introduction
- Getting started
- Gallery
- Available recipes
- Obtaining input data
- Making a recipe or diagnostic
- Contributing to the community
- Utilities
- Diagnostics API Reference
- Frequently Asked Questions
- Changelog

ESMVALCORE

- Getting started
- The recipe format
- Diagnostic script interfaces
- Development
- Contributing
- ESMValCore API Reference

Read the Docs v: latest

Docs » Welcome to ESMValTool's documentation! Edit on GitHub

### Welcome to ESMValTool's documentation! 🔗

#### ESMValTool

- Introduction
  - About
  - Contact
  - License
  - What ESMValTool can do for you
- Getting started
  - Installation
  - Configuration
  - Running
  - Output
- Gallery
- Available recipes
  - Atmosphere
  - Climate metrics
  - Future projections
  - IPCC
  - Land
  - Ocean
  - Other
- Obtaining input data
  - Models
  - Observations
- Making a recipe or diagnostic
  - Introduction
  - Recipe

#### Making a recipe or diagnostic









- Introduction
- Recipe

#### Diagnostic

- Instructions for personal diagnostic
- Functionality
- Example of config dictionary

#### Dataset

# Organization and Community Participation

14 teams in the ESMValGroup organization		Visibility ▾	Members ▾
<b>ESMValTool-CoreTeam</b> Team members can read, clone, and push to this repository.		17 members	2 teams ▾
<b>ESMValTool-DevelopmentTeam</b> Team members can create new feature branches.		148 members	0 teams
<b>IPCC developer</b> <span>Secret</span> ESMValTool AR6 contributions		39 members	0 teams
<b>ESMValTool-recipe-maintainers</b>		14 members	0 teams
<b>UserEngagementTeam</b> User Engagement Team		11 members	0 teams
<b>tech-reviewers</b> Technical review team		12 members	0 teams
<b>science-reviewers</b> Scientific review team		11 members	4 teams ▾
<b>IPCC-maintainers</b> Maintainers of the AR6 repositories		3 members	0 teams



# Questions?

## Contact the user engagement team at

[esmvaltool\\_user\\_engagement\\_team@listserv.dfn.de](mailto:esmvaltool_user_engagement_team@listserv.dfn.de)

# ESMValTool: Motivation I

## ➤ Easier and faster evaluation of complex Earth System Models

- Easy analysis of CMIP models
- Fast overview due to standard diagnostics, figures and variables
- Easy comparison of new model simulations with already existing runs and observations (e.g. obs4MIPs, ESA CCI)

### Development and documentation



GitHub repository allows development with many users



Issue tracking system (GitHub)



Online documentation (readthedocs)

### Automatized quality control



Automatized code checking (Codacy)



Automatized testing (CircleCI)

# ESMValTool: Motivation II

## ➤ Improved quality standard for model evaluation

- Growing number of included diagnostics
- Reproduction of special reports or scientific papers with standard recipes
- Traceability and reproducibility of results

## ➤ Easily expandable

- Synergy with other software projects to expand the ESMValTool (e.g. NCAR CVDP )

## ➤ Coupling to Earth System Grid Federation (ESGF)

- Complete and timely analysis of CMIP simulations with observations

