ESMValTool

A successful open-source software for evaluations of Earth system models

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Lorentz workshop, September 2022

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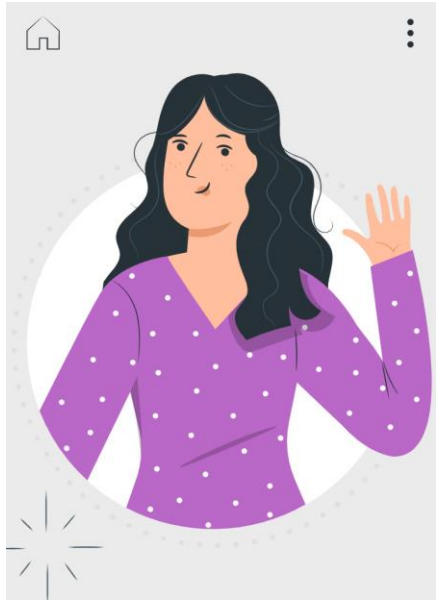
In this presentation:

- Why a community-driven and FAIR software
- What is ESMValTool
- What makes ESMValTool FAIR

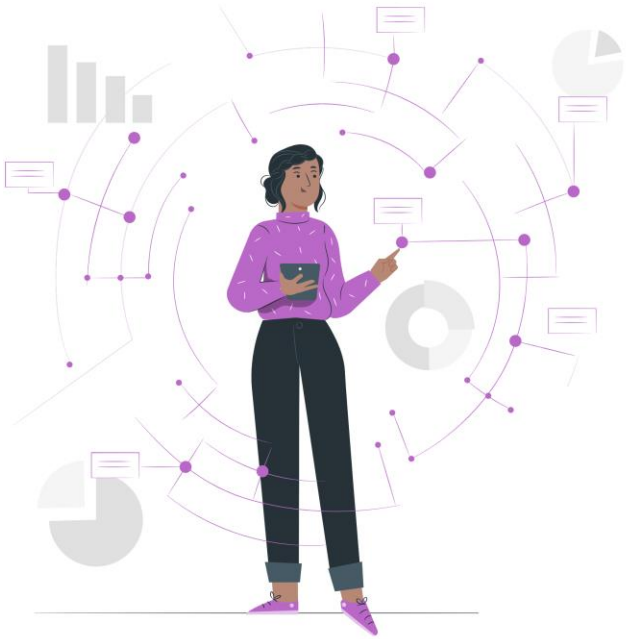
References:

- Guide for Reproducible Research: https://the-turing-way.netlify.app/welcome.html
- ESMValTool: https://www.esmvaltool.org
- Illustrations: https://storyset.com/



Jane.

Researcher in climate science.



Task:

To analyze a time series of 50 years of air temperature in the past and in the future generated by 10 climate models.

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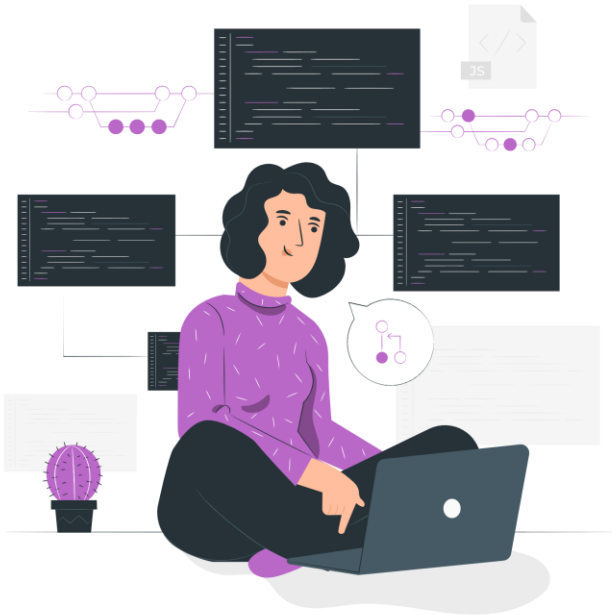
Implementation:

- Finding and downloading data
- Checking data for correctness
- Processing data
- Storing results
- Creating plots



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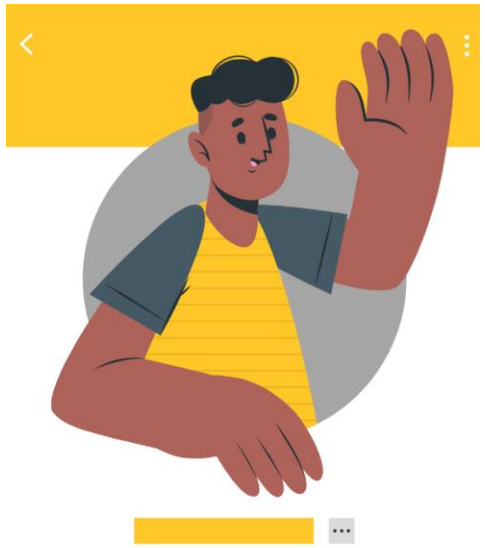
Challenges:

- It takes some time and effort to develop the code.



Ben.

Researcher in climate science.

Task:

To analyze air temperature and precipitation simulated by 5 other different models.

Challenges:

- All the skills needed to write well-structured code.

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“If research data are easily discoverable and re-usable, this lowers the barriers to repeat, verify, and build upon previous work.”

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"A guideline for those wishing to enhance the reusability of their data holdings."

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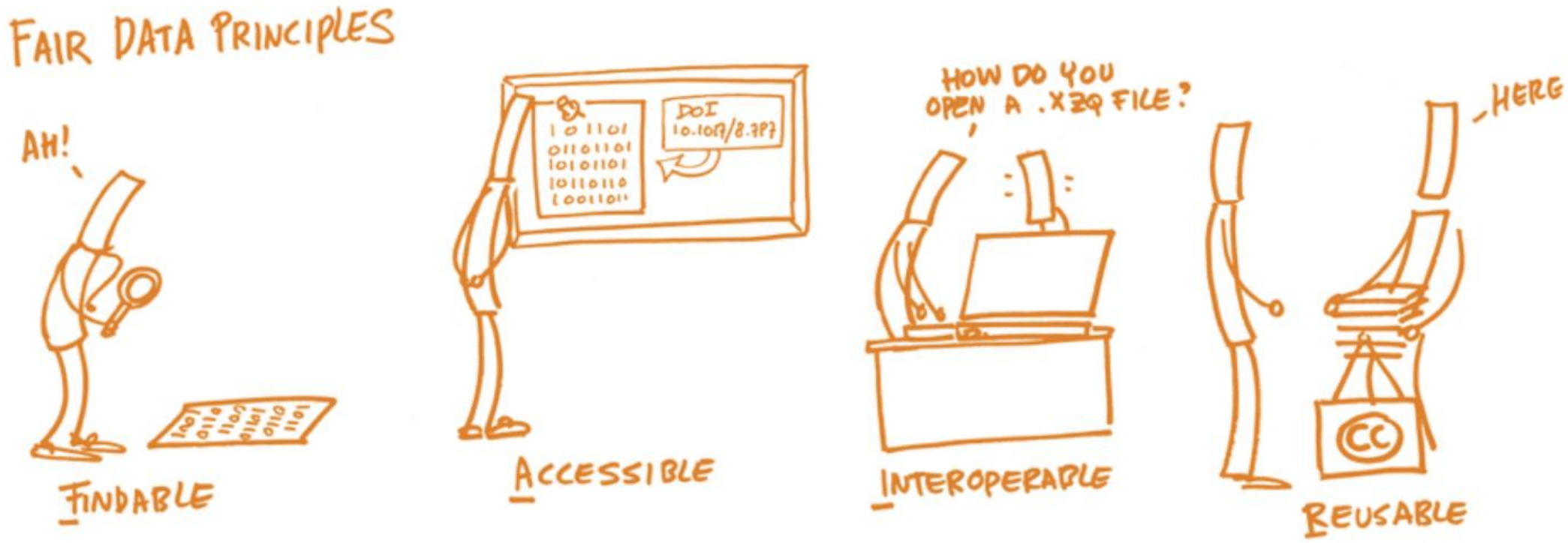
"In general, central to the realization of FAIR are FAIR Digital Objects, which may represent data, software or other research resources."



https://open-science-training-handbook.gitbook.io/book/

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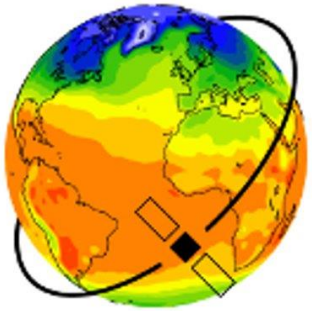
A community-driven and FAIR software in climate science:

Earth System Model Evaluation Tool

https://www.esmvaltool.org



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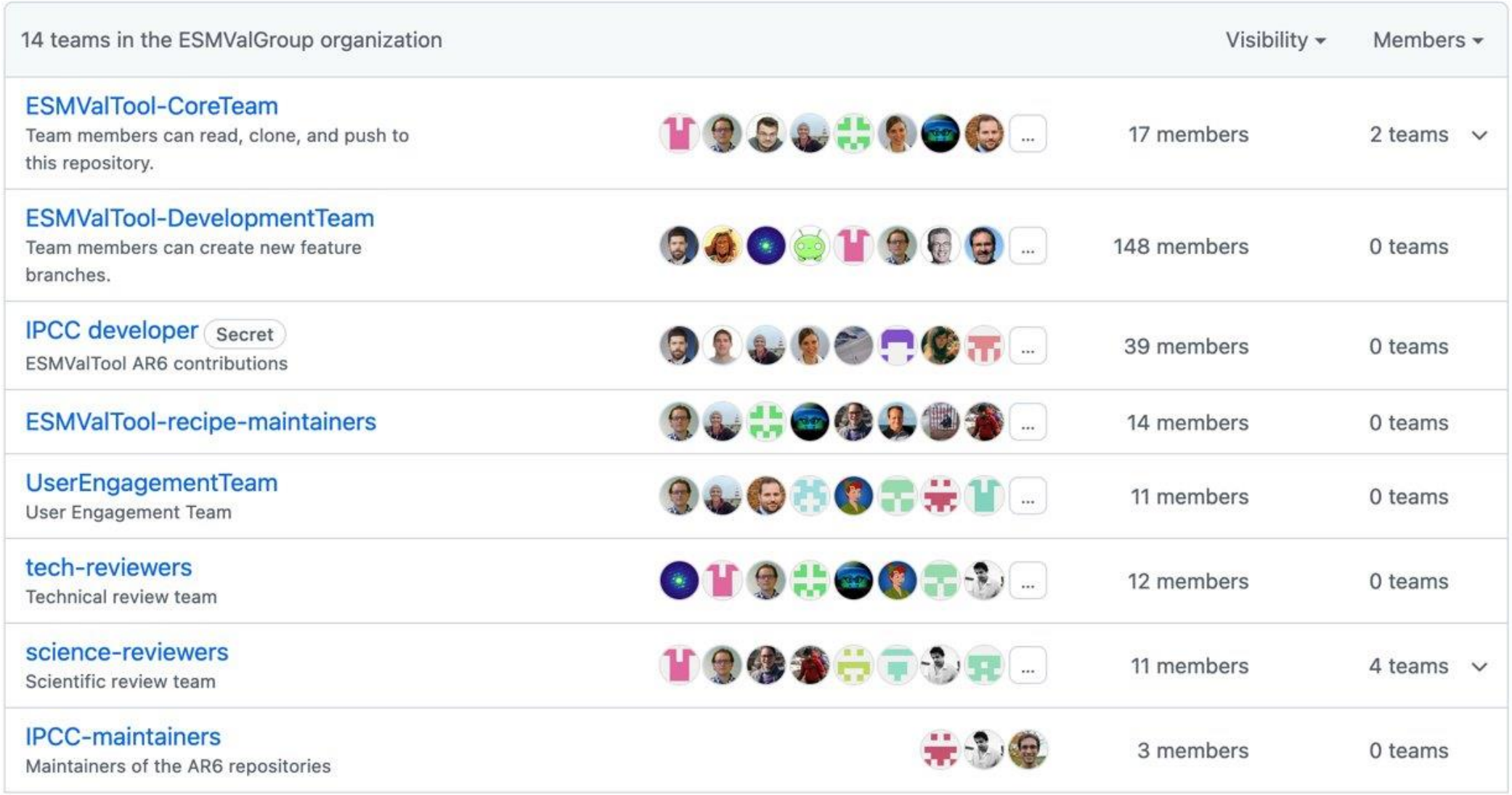
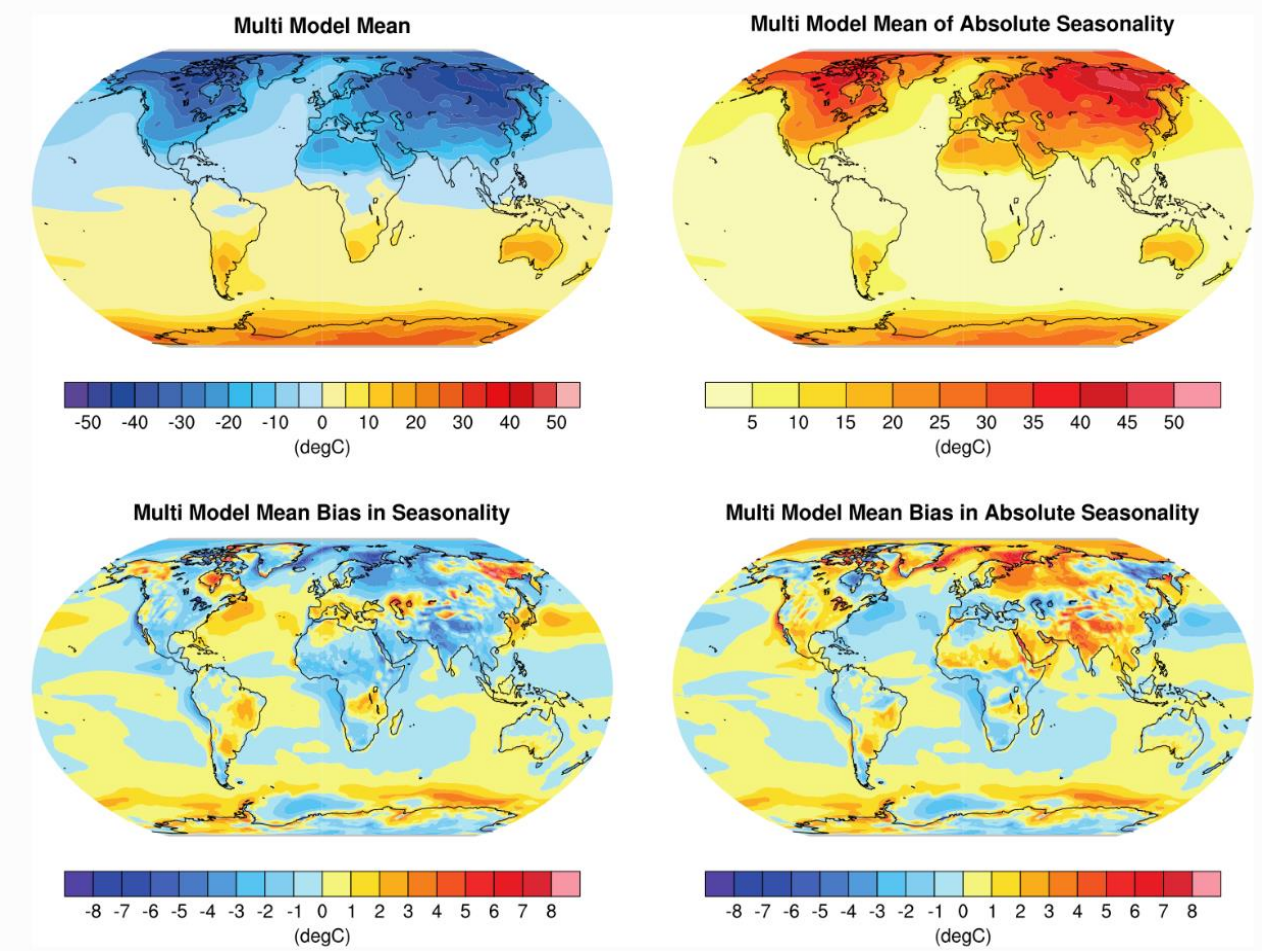
By an international community of scientists and software engineers

ESMValTool
Earth System Model Evaluation Tool



What is ESMValTool?

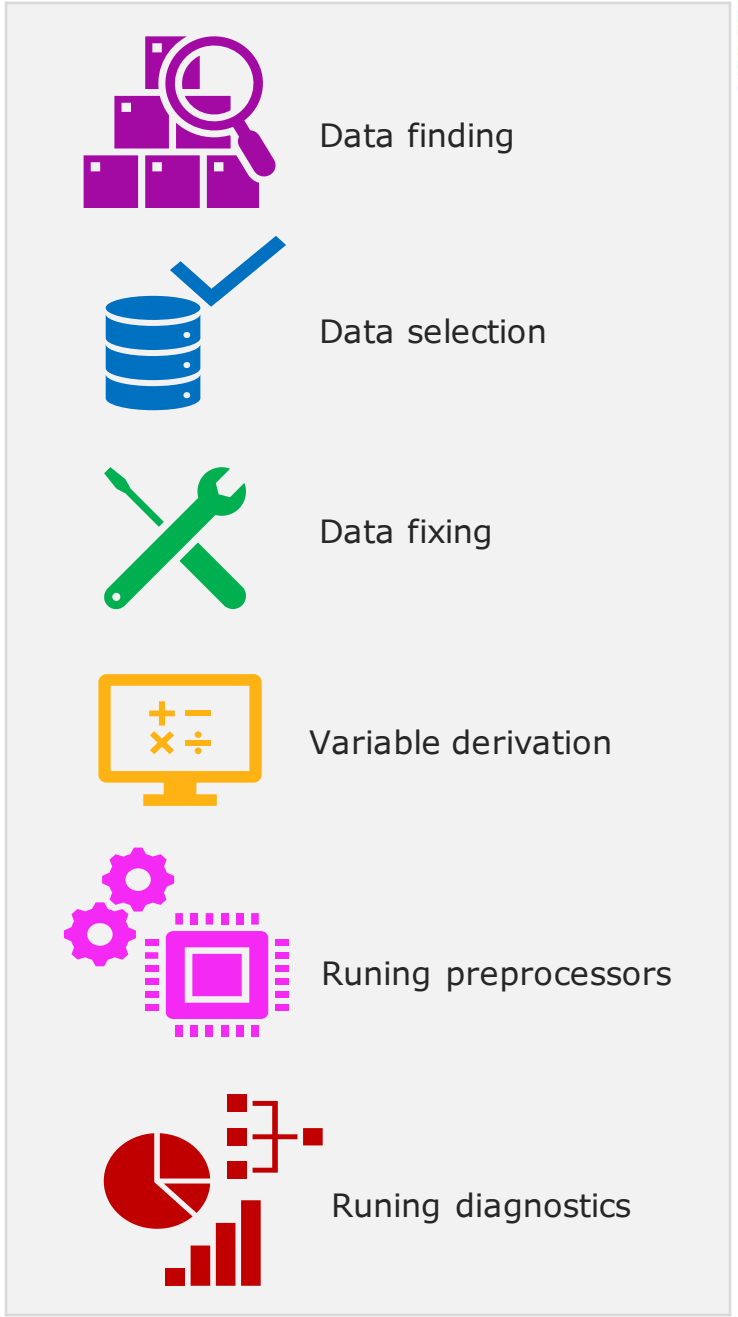
It facilitates the analysis of Earth system model's data.



IPCC AR5 Chapter 9

What is ESMValTool?

It provides a standard format for scientific analysis workflow a.k.a. "recipes".



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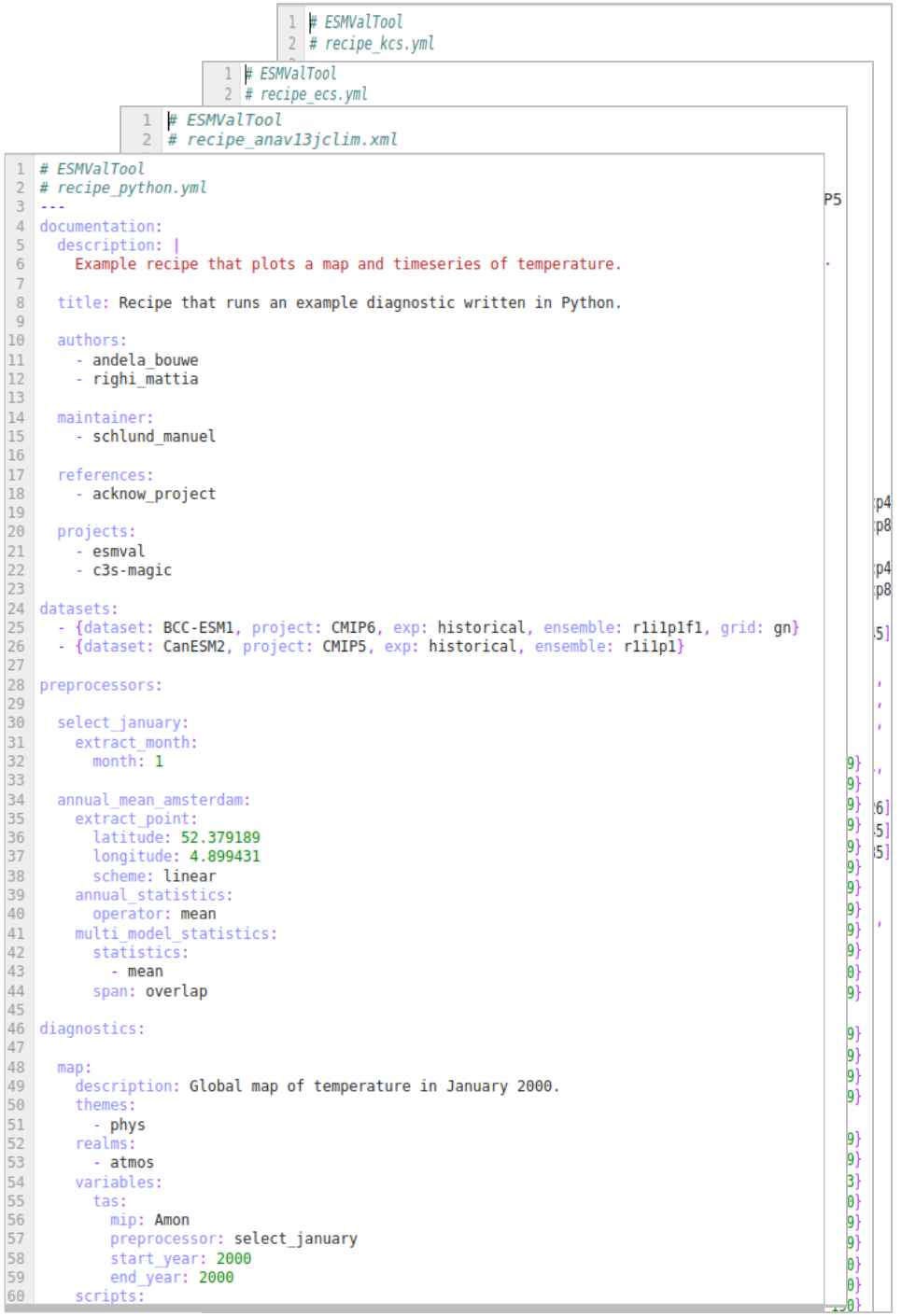
What is ESMValTool?

It also provides a collection of recipes.



```
# ESMValTool
# recipe_kcs.yml
```

```
# ESMValTool
# recipe_ecs.yml
```

```
# ESMValTool
# recipe_anav13jclim.xml
```

```
# ESMValTool
# recipe_python.yml
---
documentation:
  description: |
    Example recipe that plots a map and timeseries of temperature.

  title: Recipe that runs an example diagnostic written in Python.

  authors:
    - andela_bouwe
    - righi_mattia

  maintainer:
    - schlund_manuel

  references:
    - acknow_project

  projects:
    - esmval
    - c3s-magic

datasets:
  - {dataset: BCC-ESM1, project: CMIP6, exp: historical, ensemble: r1i1p1f1, grid: gn}
  - {dataset: CanESM2, project: CMIP5, exp: historical, ensemble: r1i1p1}

preprocessors:

  select_january:
    extract_month:
      month: 1

  annual_mean_amsterdam:
    extract_point:
      latitude: 52.379189
      longitude: 4.899431
      scheme: linear
    annual_statistics:
      operator: mean
    multi_model_statistics:
      statistics:
        - mean
      span: overlap

diagnostics:

  map:
    description: Global map of temperature in January 2000.
    themes:
      - phys
    realms:
      - atmos
    variables:
      tas:
        mip: Amon
        preprocessor: select_january
        start_year: 2000
        end_year: 2000
    scripts:
```

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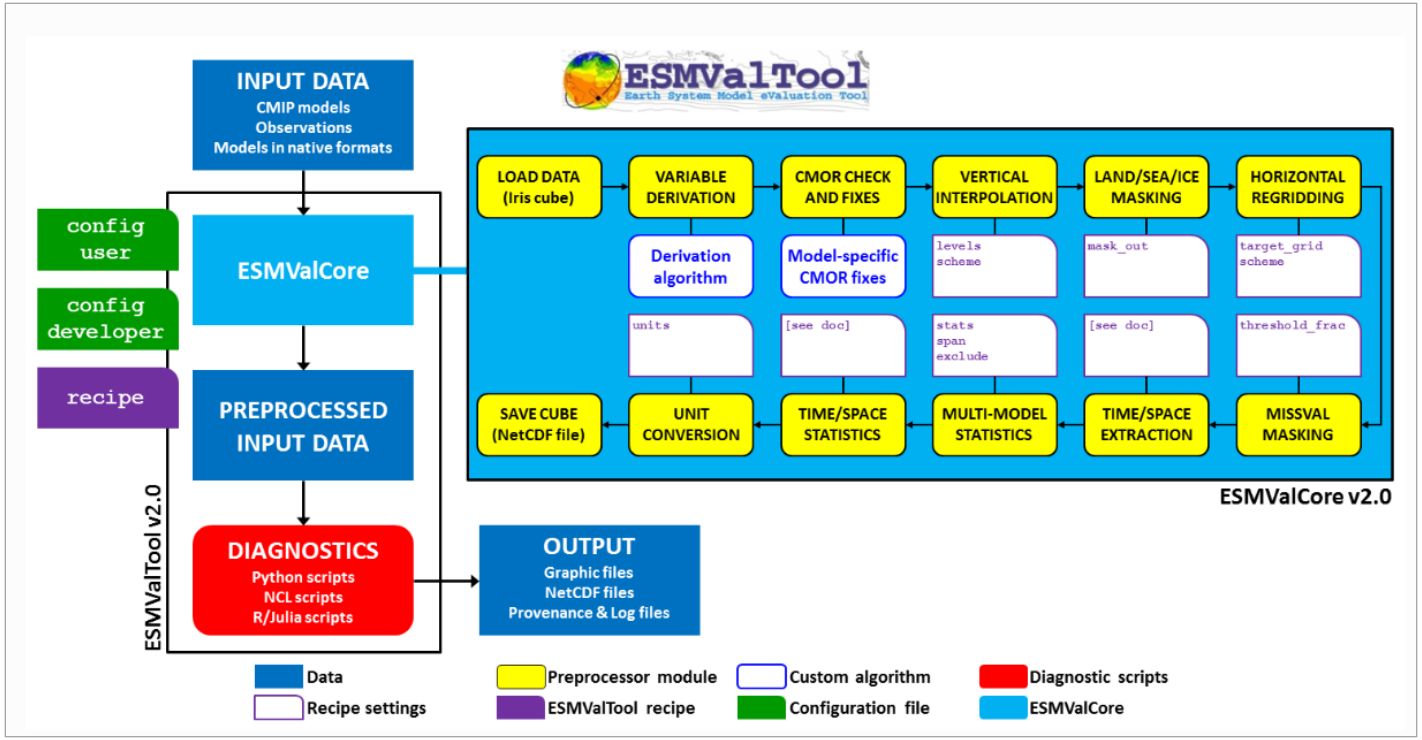
Earth System Model Evaluation Tool

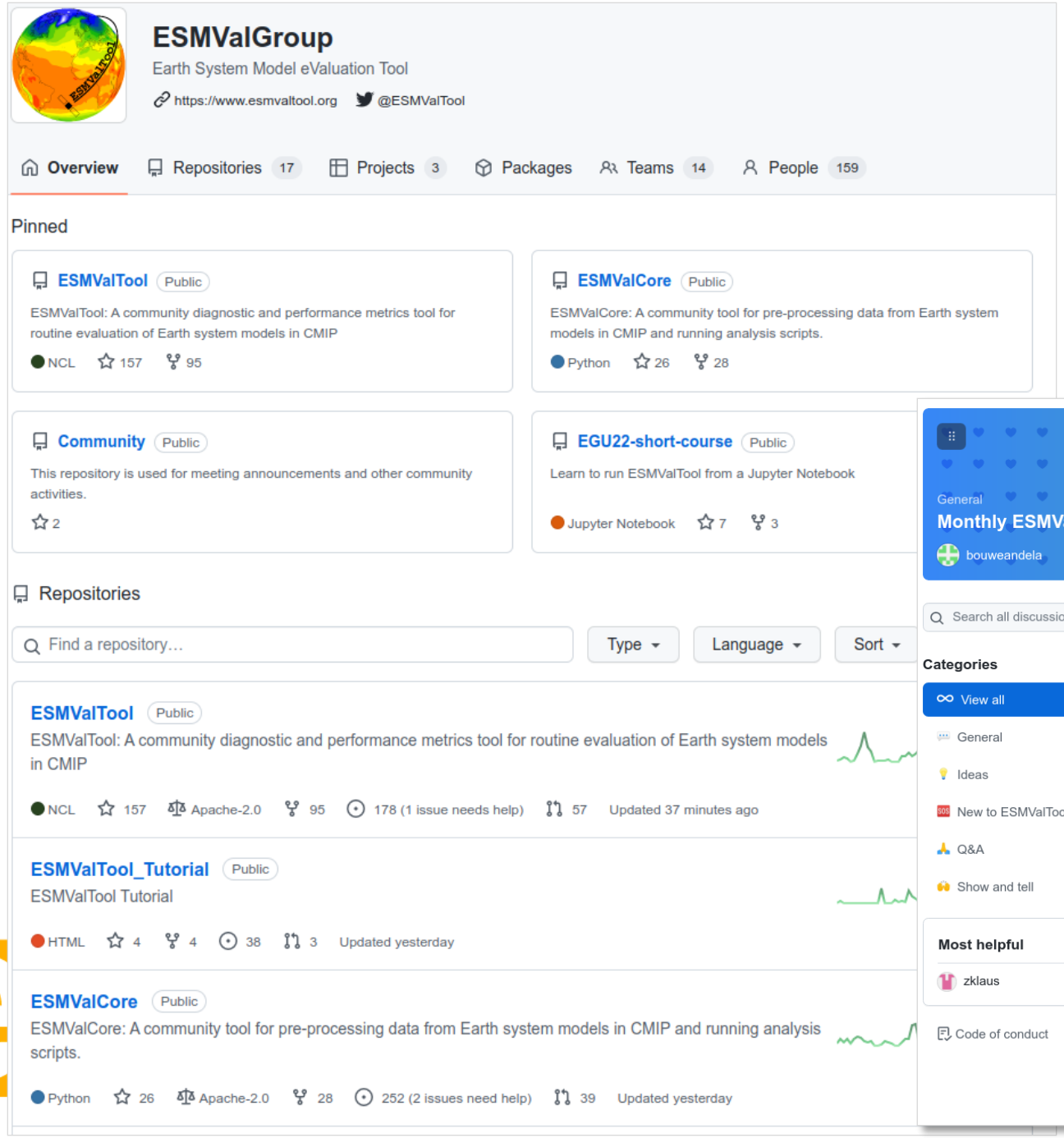
What can ESMValTool do for you?

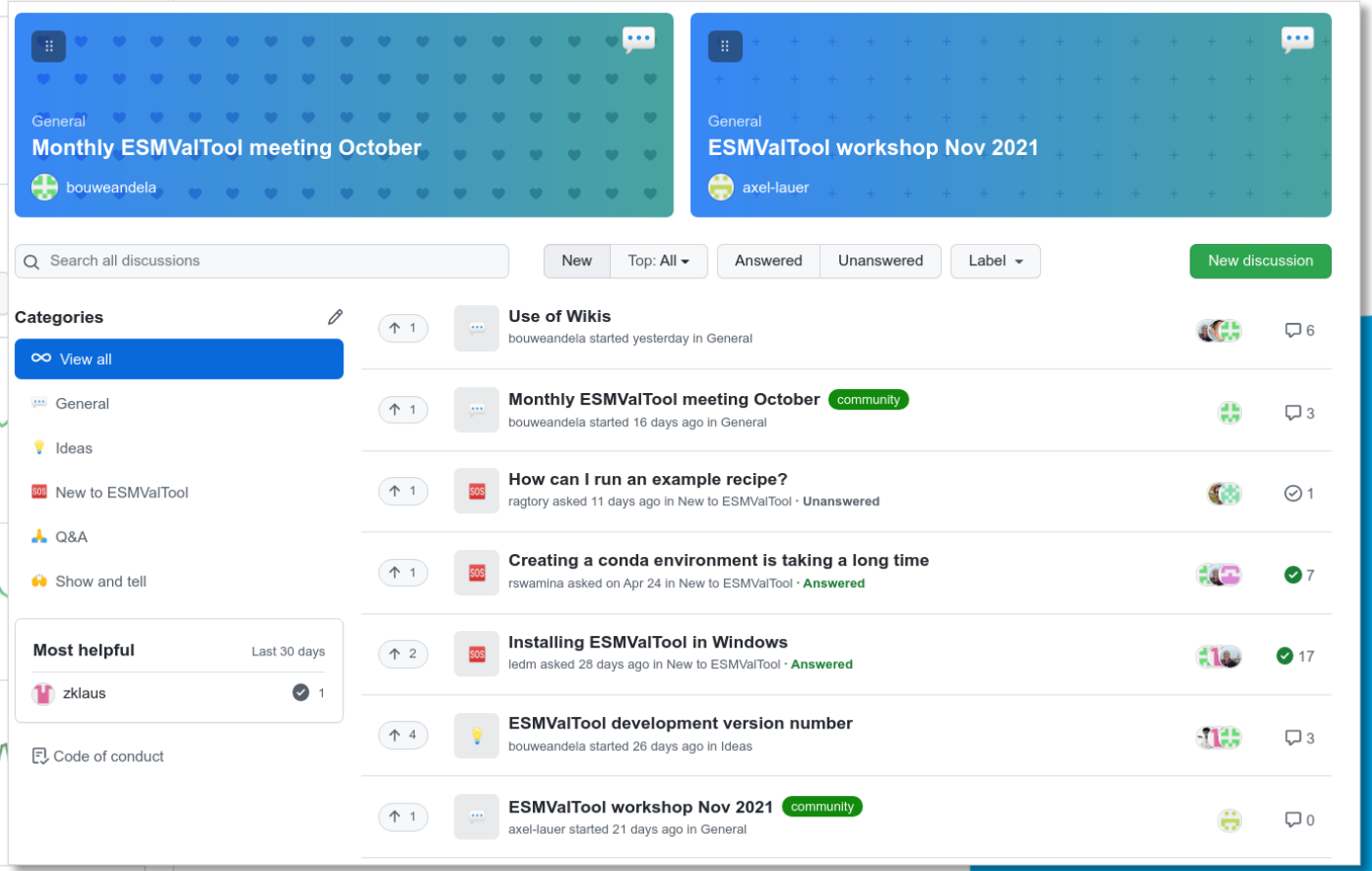
- Helps to analyze climate data
- Provides provenance and citation information.
- Supports several programming languages and operating systems.
- Helps efficient data processing.



Developments, maintenance, discussions, and collaborations in **public**

https://github.com/esmvalgroup





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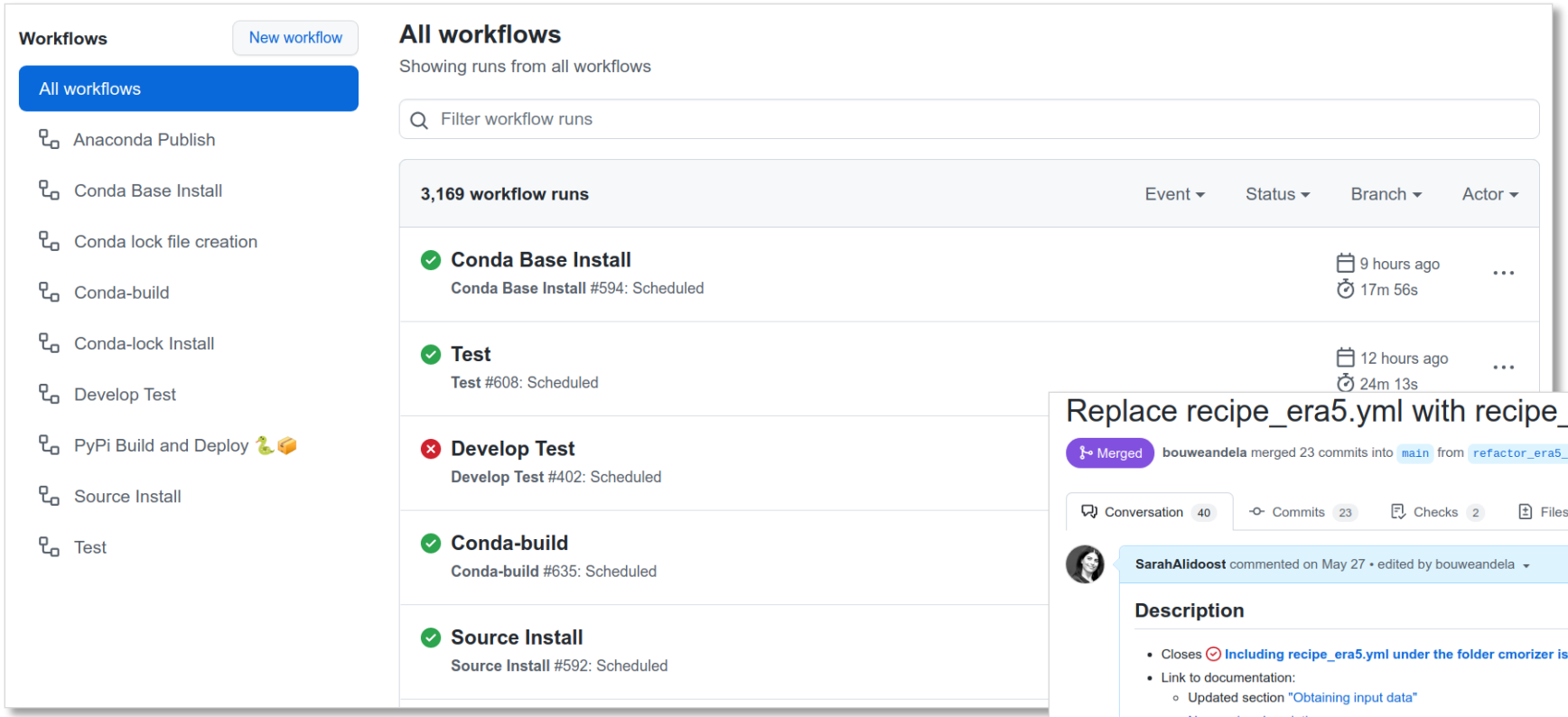
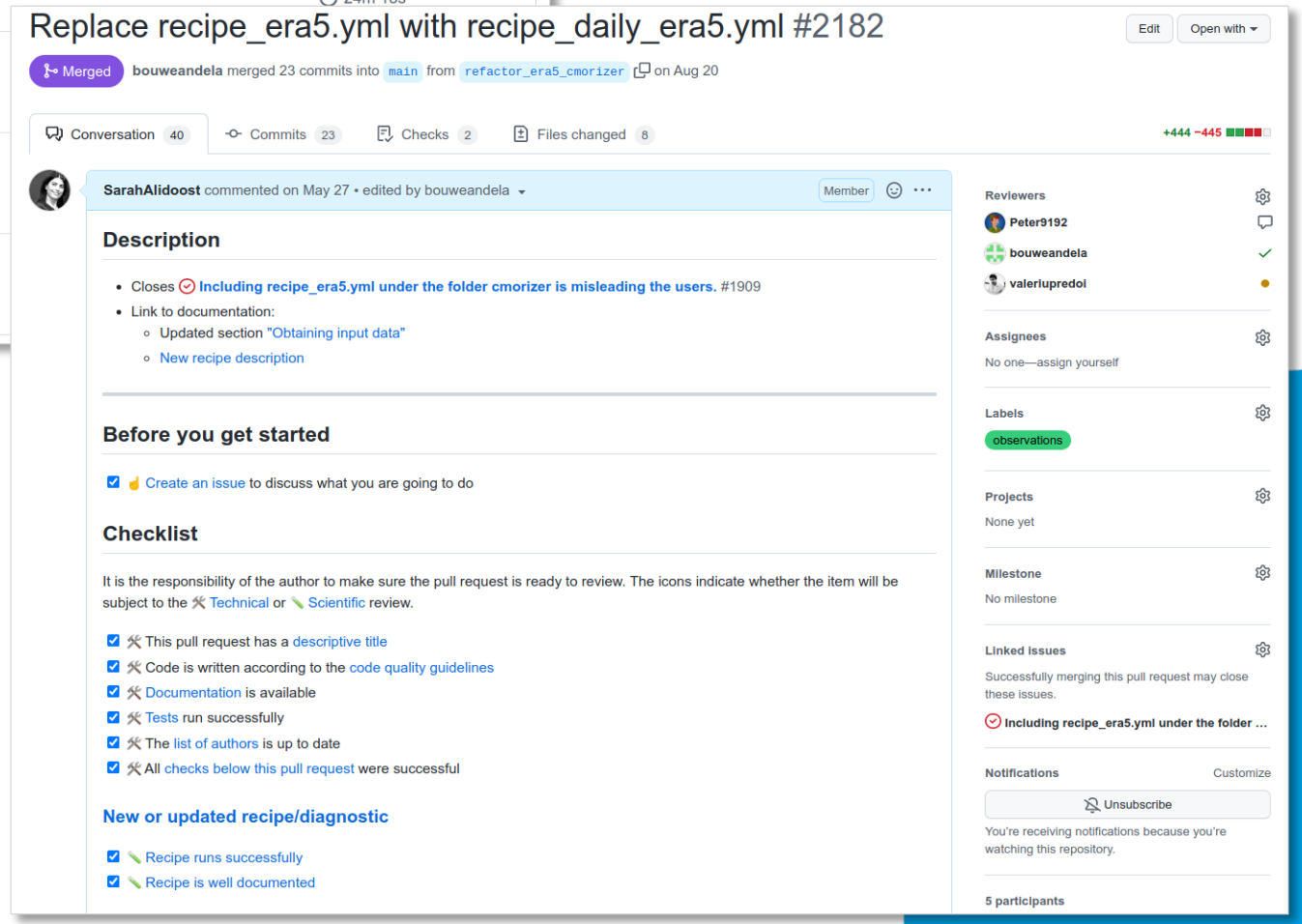
Earth System Model Evaluation Tool





Automated **testing**
and
review processes.

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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

Docs » Welcome to ESMValTool's documentation!

Welcome to ESMValTool's documentation!

ESMValTool

- Introduction
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  - Contact
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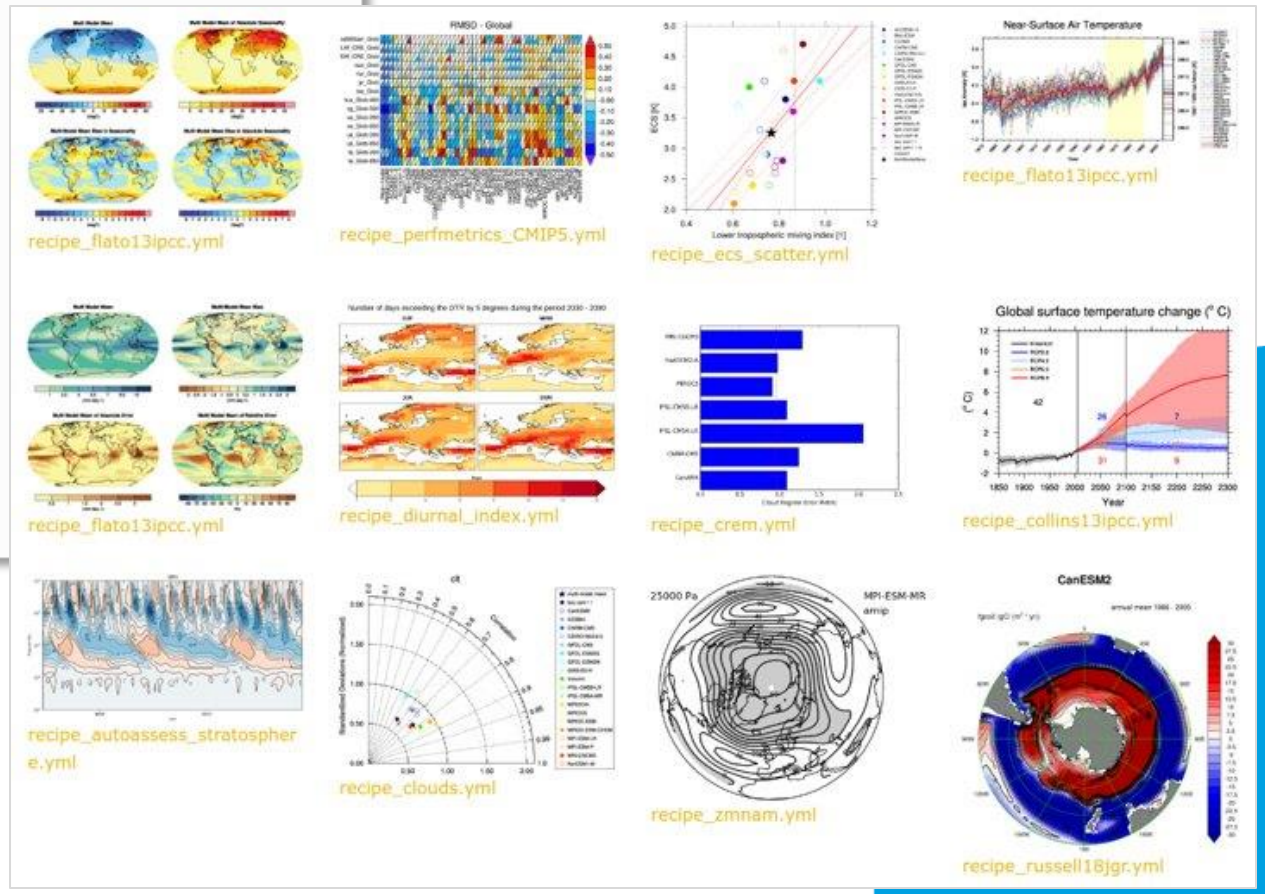
  - What ESMValTool can do for you
- Getting started
  - Installation
  - Configuration
  - Running
  - Output
- Gallery
- Available recipes
  - Atmosphere
  - Climate metrics
  - Future projections
  - IPCC

A collection of recipes with extensive **documentation**.

https://docs.esmvaltool.org/



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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.

	Setup	Download files required for the lesson
00:00	1. Introduction	What is ESMValTool? Who are the people behind ESMValTool?
00:15	2. Installation	What are the prerequisites for installing ESMValTool? How do I confirm that the installation was successful?
00:35	3. Configuration	What is the user configuration file and how should I use it?
00:55	4. Running your first recipe	How to run a recipe? What happens when I run a recipe?
01:25	5. Conclusion of the basic tutorial	What do I do now? Where can I get help? What if I find a bug? Where can I find more information about ESMValtool? How can I cite ESMValtool?
01:35	6. Writing your own recipe	How do I create a new recipe? Can I use different preprocessors for different variables? Can I use different datasets for different variables? How can I combine different preprocessor functions?
02:20	7. Development and contribution	What is a development installation? How can I test new or improved code? How can I incorporate my contributions into ESMValTool?
02:50	8. Writing your own diagnostic script	How do I write a new diagnostic in ESMValTool? How do I use the preprocessor output in a Python diagnostic?
03:40	9. CMORization: adding new datasets to ESMValTool	CMORization: what is it and why do we need it? How to use the existing CMORizer scripts shipped with ESMValTool? How to add support for new (observational) datasets?
04:40	10. Debugging	How can I handle errors/warnings?

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Earth System Model Evaluation Tool

An online **tutorial**

https://esmvalgroup.github.io/ESMValTool_Tutorial/

Using ESMValTool:

- Others can understand Jane's analyses

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Using ESMValTool:

- Others can understand Jane's analyses
- Ben can re-use code instead of re-implementing it

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Using ESMValTool:

- Others can understand Jane's analyses
- Ben can re-use code instead of re-implementing it
- They spend less time developing code

What lessons can the S2S community draw from ESMValTool's approach to community-driven scientific analysis workflows?

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Let's stay in touch

https://www.esmvaltool.org

https://github.com/ESMValGroup/