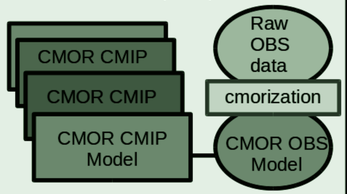
ESMValTool

Community evaluation and diagnostics tool

ESMValTool (Earth System Model eValuation Tool) in a nutshell

- A **community** diagnostics and performance metrics tool for the evaluation of Earth System Models (ESMs);
- allows for routine comparison of single or multiple **models**, either against predecessor versions or against **observations**;
- Framework: highly **modular** and flexible so that additional analyses can easily be added;
- Uses standardized **recipes** that represent specific diagnostics or performance metrics that have demonstrated their importance in ESM evaluation in the **peer-reviewed literature.**

Allows for comparison between CMIP models (different models, same models with different versions) and observational data (OBS):



Diagnostics ecosystem:
- conversion to CMOR standards of OBS data;
- use output from Preprocessor to run diagnostics;
- large collection of standard metrics and peer-reviewed diagnostic routines in multiple languages (Python, NCL, R, Julia);
- outputs netCDF files, plots and metrics;

Diagnostics library: constantly **growing** and evolving based on the **needs** and **contributions** of climate scientists = ecosystem.

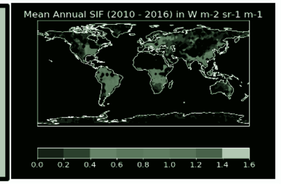
Publication:
- data provenance information is provided by the tool for easy tracking and analysis replication;
- preprocessor output can be reused for diagnostic re-runs, if needed, to save computational resources.

Preprocessing core:
- finds data (CMIP and OBS) in CMOR format;
- applies CMOR checks and fixes;
- derives custom variables;
- runs standard data analysis steps common to all data (time, area, volume extractions, level selections, masking, regridding, multimodel stats etc.);

- outputs netCDF files and summary data files;

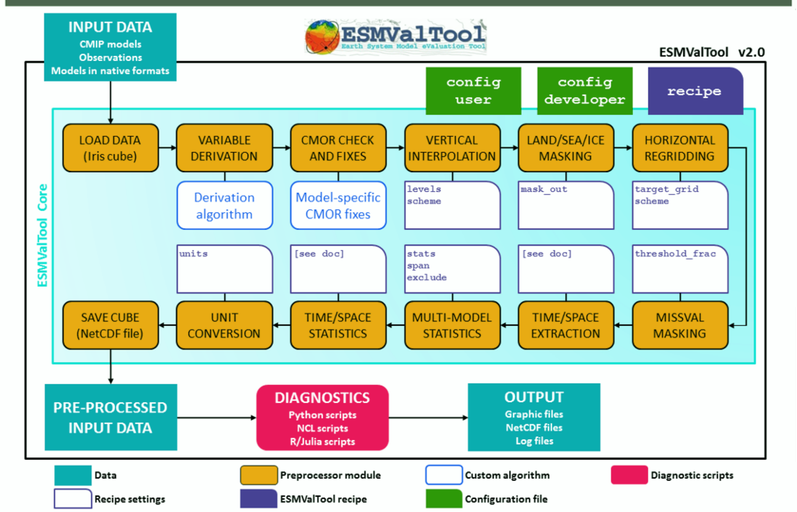
Final output:

-data files
-provenance
-plots
-happiness



Preprocessor schematic (`esmvalcore`)

Group of steps executing standardzied functions in either standard or custom order



USR: CODEBASE and INSTALLATION

Package location:
`https://github.com/ESMValGroup/ESMValTool.git`

The most recent version of ESMValTool source code is hosted on GitHub and is constantly updated when new features are merged and with every new release. GitHub offers a flexible platform for continuous integration via developers' pull requests (PR), issue tracking and resolution and installation, unit and functional testing (via CircleCI in this case):
https://github.com/ESMValGroup/ESMValTool/

ESMValTool is a Python 3 package with cross-language dependencies meant to support diagnostics in various programming languages (Python, NCL, R etc.); it is comprised of the preprocessing core (`esmvalcore`, pure Python package) and of the diagnostics library (cross-language package; this uses `esmval-core` as a dependency). Installed versions are available directly on compute clusters like CEDA-Jasmin or DKRZ or the user can install it via `conda install`

Run command:

```
[user@machine]$ conda install -c esmvalgroup -c conda-forge esmvaltool
```

DEV: ENVIRONMENT SETUP and INSTALLATION

Environment file: `environment.yml`

For diagnostic (and core) developers it will be easier if they create the `esmvaltool` software environment and install the tool for development, testing and contributions to the code base via `git`.

A Python 3.x `anaconda3` or `miniconda3` installation is required *a-priori*, since the `esmvaltool` environment is a `conda`-based one.

The software package dependencies needed by esmvaltool are specified in the `environment.yml` file and this one is used to create the software environment.

After the environment has been created and activated, the tool is installed in the usual manner for a Python package.

Run command:

```
[user@machine]$ git clone https://github.com/ESMValGroup/ESMValTool.git
[user@machine]$ conda env create -n esmvaltool -f environment.yml
[user@machine]$ source activate esmvaltool
(esmvaltool) [user@machine]$ pip install -e ".[develop]"
```

USER INPUTS

User config file: `config-user.yml` Recipe: `recipe.yml`

User-defined parameters for the run e.g.: path to root directory for output; desired output graphical file formats (pdf, eps, png etc.); root paths for data and types of DRS.

A single configuration file can be used for a large number of diagnostic runs. It is also optimized for a minimum number of inputs.

Parameters needed by the core preprocessor(s) and diagnostic(s): three groups: **dataset(s) parameters, preprocessor(s) settings** and **diagnostic(s) settings**.

Each diagnostic may use any number of datasets, any number of preprocessors and any combination of variables (standard or derived variables). A single recipe file can be used for a large number of preprocessors and diagnostics.

Run command:

```
(esmvaltool) [user@machine]$ esmvaltool -c config-user.yml recipe.yml
```

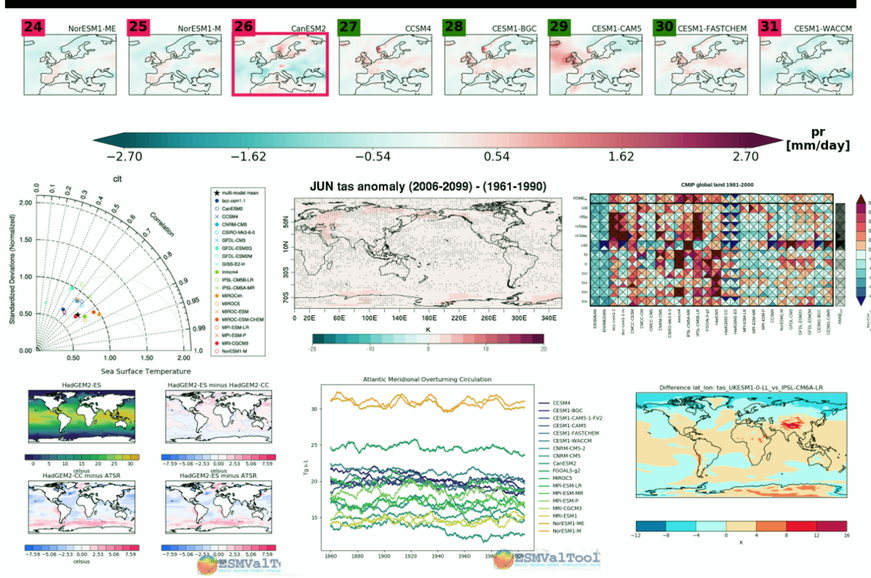
```yaml
diagnostics:
  aa_landsurf_surfrad:
    description: Autoassess test diag for Land-Surface Surfrad.
    variables:
      rsns: # Surf SW net all sky
        field: T2Ms
        derive: true
        force_derivation: false
        fx_files: [sftlf]
      rlns: # Surf LW net all sky
        field: T2Ms
        derive: true
        force_derivation: false
        fx_files: [sftlf]
  additional_datasets:
    - {dataset: CERES-EBAF,  project: obs4mips,  level: L3B,  version: Ed2-7,  start_year: 2001,  end_year: 2012, tier: 1}
scripts:
  autoassess_landsurf_surfrad: &autoassess_landsurf_surfrad_settings
    script: autoassess/autoassess_area_base.py
    title: "Autoassess Land-Surface Diagnostic Surfrad Metric"
    area: land_surface_surfrad
    control_model: MPI-ESM-LR
    exp_model: MPI-ESM-MR
    obs_models: [CERES-EBAF]
    obs_type: obs4mips
    fx: [sftlf]
    start: 1997/12/01
    end: 2002/12/01
```

Name (multiple diagnostics supported)

Variables (derivation or non-CMOR standard supported)

Additional datasets (CMIP, OBS, obs4mips…)

Diagnostic specific parameters



Additional Notes