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ESMValTool
Earth System Model Evaluation Tool

ESMValTool
A community diagnostic and performance metrics tool for evaluation and analysis of Earth system models

ESMValTool

Best Climate Model Evaluation Tool – FAIR and square

Valeriu Predoi* and Bouwe Andela**
for the ESMValTool developers***

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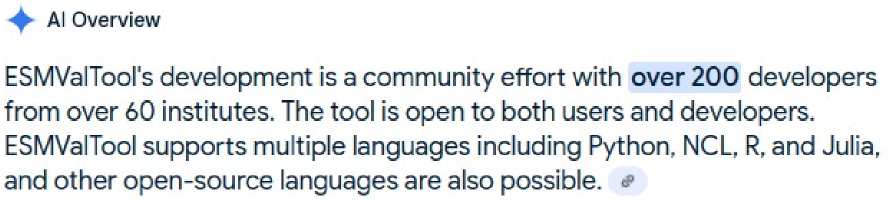
** Netherlands eScience Centre (NleSC), Netherlands
*** 200+ good folk from 60+ institutions, even AI knows this:



AI Overview

ESMValTool's development is a community effort with over 200 developers from over 60 institutes. The tool is open to both users and developers. ESMValTool supports multiple languages including Python, NCL, R, and Julia, and other open-source languages are also possible.

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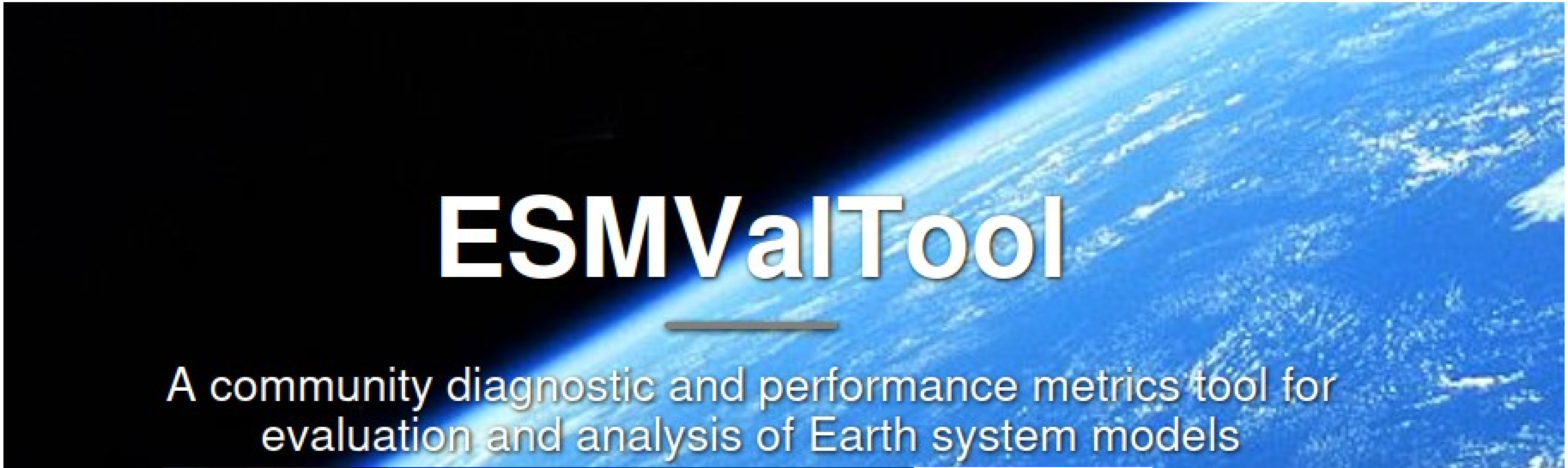

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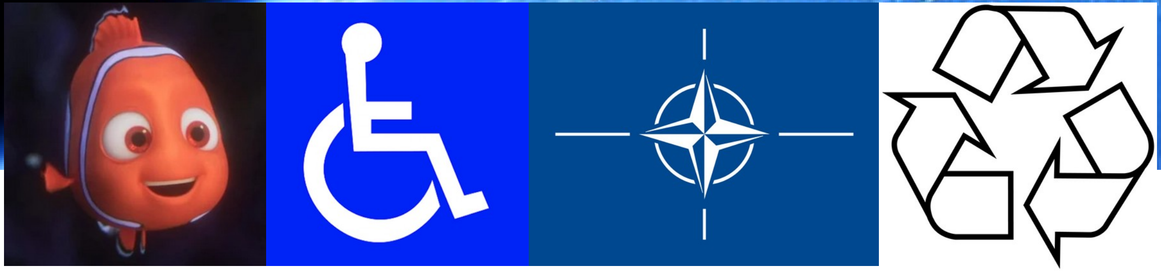

Findable **Accessible** **Interoperable** **Reusable**

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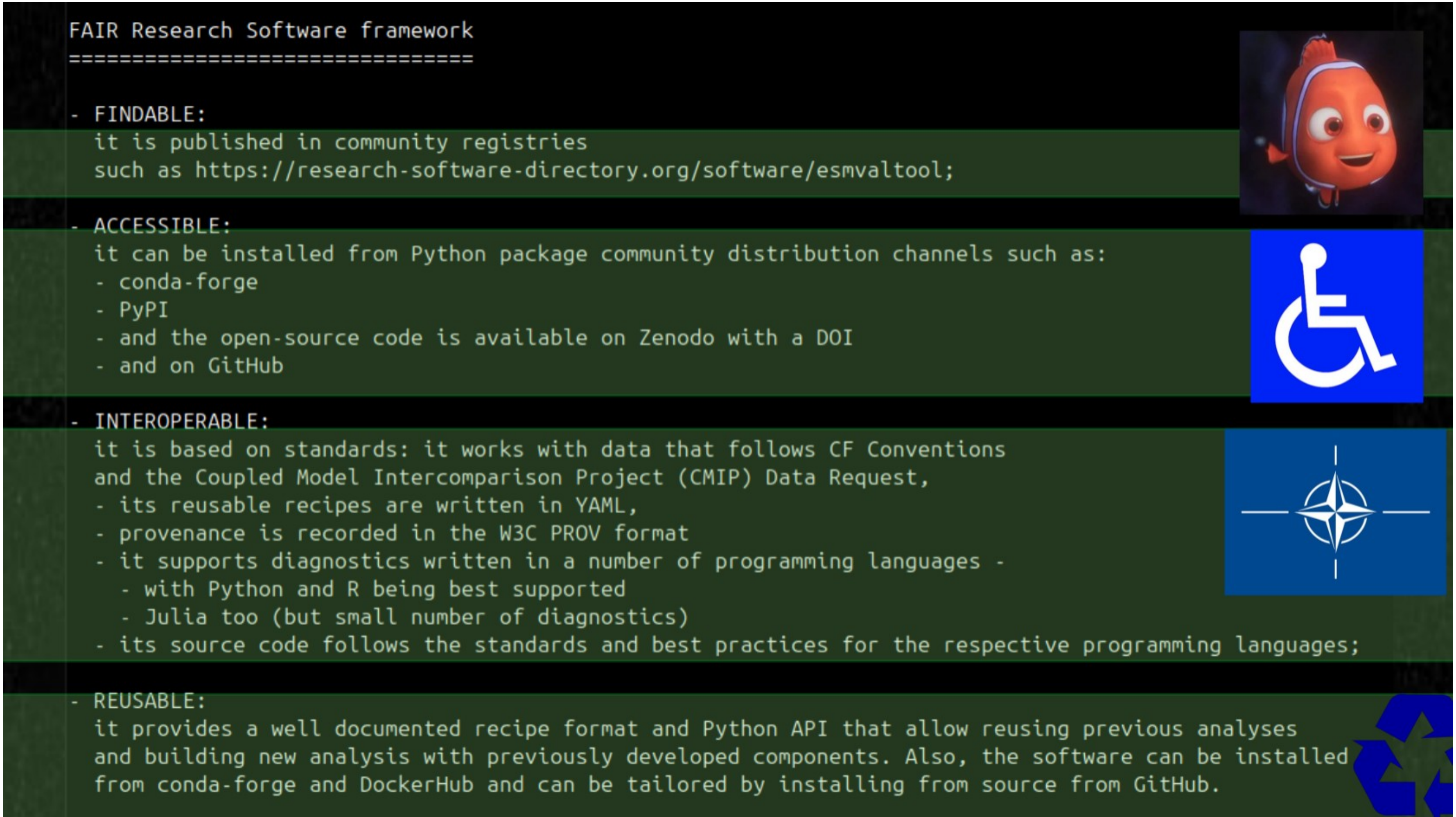

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FAIR Research Software framework
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- FINDABLE:
  it is published in community registries
  such as https://research-software-directory.org/software/esmvaltool;

- ACCESSIBLE:
  it can be installed from Python package community distribution channels such as:
  - conda-forge
  - PyPI
  - and the open-source code is available on Zenodo with a DOI
  - and on GitHub

- INTEROPERABLE:
  it is based on standards: it works with data that follows CF Conventions
  and the Coupled Model Intercomparison Project (CMIP) Data Request,
  - its reusable recipes are written in YAML,
  - provenance is recorded in the W3C PROV format
  - it supports diagnostics written in a number of programming languages -
    - with Python and R being best supported
    - Julia too (but small number of diagnostics)
  - its source code follows the standards and best practices for the respective programming languages;

- REUSABLE:
  it provides a well documented recipe format and Python API that allow reusing previous analyses
  and building new analysis with previously developed components. Also, the software can be installed
  from conda-forge and DockerHub and can be tailored by installing from source from GitHub.
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Findable

- Research Software Directory: https://research-software-directory.org/software/esmvaltool

- GitHub: https://github.com/ESMValGroup/ESMValTool

- Zenodo: https://zenodo.org/records/14974718

- conda-forge: https://anaconda.org/conda-forge/esmvaltool

- PyPI: https://pypi.org/project/ESMValTool/

- our own website: www.esmvaltool.org

- multiple institutional references: https://help.jasmin.ac.uk/docs/software-on-jasmin/community-software-esmvaltool/

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Accessible

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- open source
- available as Python package, for download, or simple install
- deployed on a number of HPCs
- forked and developed at many sites (as `module`)
- superb support & community
- tested thoroughly

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(my favourite thing: engineering, baby!)

STANDARDS!

Interoperable

- **Input Data Standards**: CF/CMOR netCDF4 (CMIP5/6/7, obs4MIPs, OBS/OBS6, ana4MIPs, GRIB, CORDEX etc); allows for data CMORization
- **Output Data Standards**: CMOR netCDF4 and W3C-PROV
- **Programming Language Standards**: compute core in Python+DASK, diagnostics in Python, R, NCL, Julia
- **Infrastructure Standards**: recipes and configuration in YAML, modern packaging, standard Sphinx documentation
- **Code quality standards**: Ruff+pre-commit, integrated in CI testing
- **Testing Standards**: 95% test coverage, multiple testing platforms, multiple OSs and Python versions; testing with bleeding edge dependencies
- **Versioning Standards**: semantic versioning, regular releases
- **Deployment Standards**: packaged and deployed on multiple Python package indices; containers via DockerHub; deployed on HPCs

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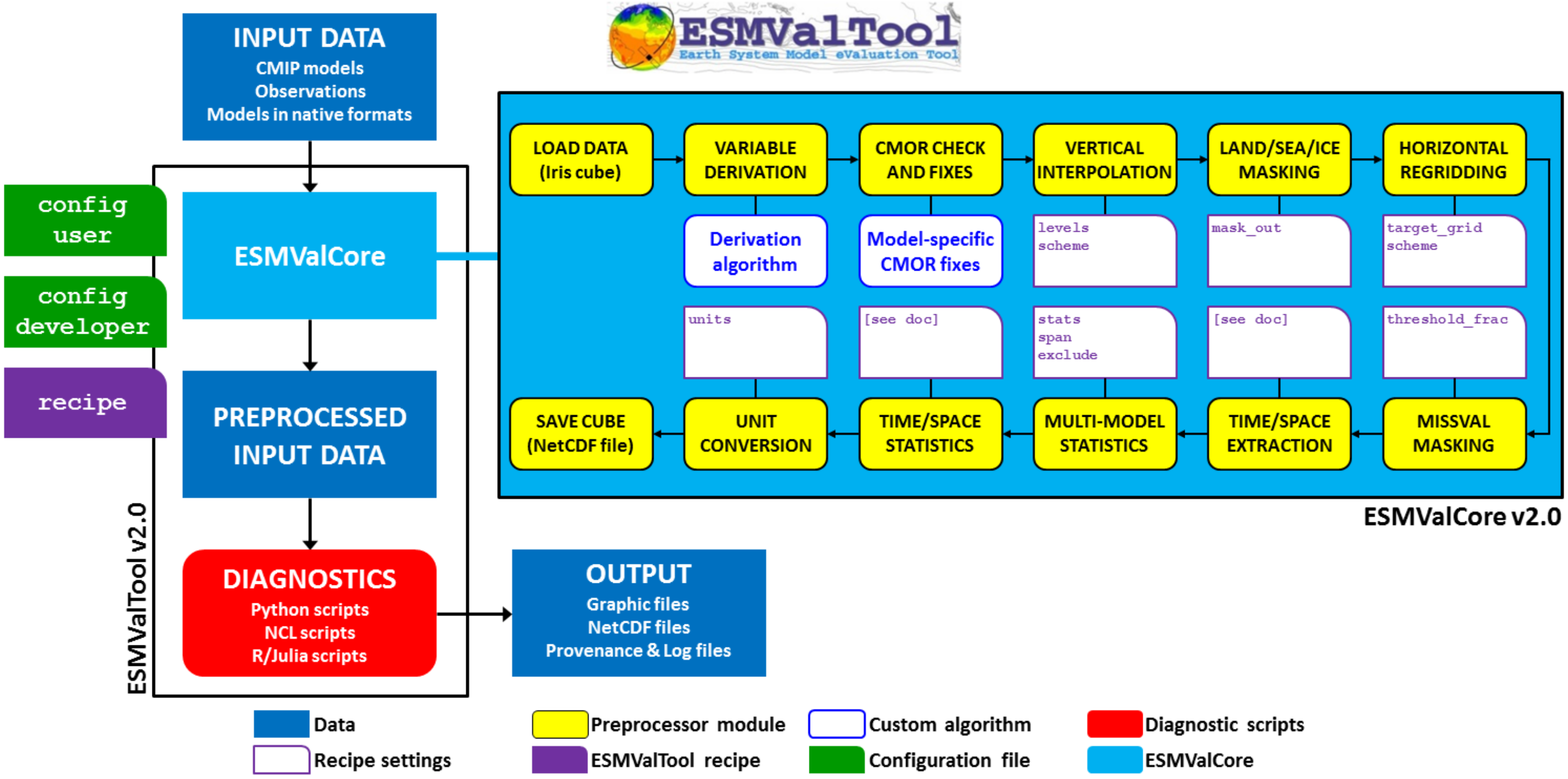
Use OTB - Reuse/repurpose functionality – Adapt with minimal effort



Reusable

- fully exposed Python API
- highly modular
- well-structured recipe format
- simple operational workflow

All these well documented and traceable!

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Valeriu Pred
for the ESM

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** Netherlands eSci

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