

# **ESMValTool: Implementation and use**

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# What is the ESMValTool?

- Earth System Model eValuation Tool
- Contains a wide range of different diagnostics
- Focus: Essential climate variables, known biases common to ESMs, CO<sub>2</sub> budgets, tropospheric/stratospheric O<sub>3</sub>, tropospheric aerosols
- Designed to compare one or more models against observations or predecessor versions

# Current status

- The ESMValTool has now been set up on NIRD
- CMIP5 data (~6 TB across 49 models) and observational data sets have been downloaded
- Observations/reanalyses that are not in standard format (obs4MIPs/ana4MIPs) have been reformatted using dedicated reformat scripts
- Lists of data that are currently available on NIRD can be found in the ESMValTool section of the NorESM wiki page

# Currently available observations on NIRD

<https://wiki.met.no/noresm/esmvaltool>

- **AIRS** (temperature and specific humidity)
  - **AURA-MLS-OMI** (tropospheric ozone)
  - **CERES** (radiative fluxes)
  - **CMAP** (precipitation)
  - **Dong08-ARGO** (ocn mixed layer thickness)
  - **ERA-Interim** (various)
  - **ESACCI-AEROSOL** (aerosols)
  - **ESACCI-SST** (SST)
  - **ESRL** (mole fraction of CO<sub>2</sub>)
  - **ETH-SOM-FFN** (sea surface pCO<sub>2</sub>)
  - **GCP** (land plus ocean carbon fluxes)
  - **GLOBALVIEW** (mole fraction of CO)
  - **GPCP** (precipitation)
  - **HadISST** (SST and sea ice concentration)
  - **LandFlux-EVAL** (evapotranspiration)
  - **MERRA** (precipitation)
  - **MODIS** (clouds and aerosols)
  - **NCEP** (various)
  - **NIWA** (total ozone column)
  - **NSDIC** (sea ice concentration)
  - **SeaWIFS** (chlorophyll)
  - **SOCAT** (spco<sub>2</sub>)
  - **Takahashi14** (total alkalinity)
  - **TRMM** (precipitation)
  - **WHOI-OAFlux** (surface fluxes and SST)
  - **WOA09** (ocean salinity and temperature)
  - **Woa2005** (ocean O<sub>2</sub>)
- The ESMValTool user guide contains a complete list of all observational data sets with available reformat scripts:  
[https://www.esmvaltool.org/download/ESMValTool\\_Users\\_Guide.pdf](https://www.esmvaltool.org/download/ESMValTool_Users_Guide.pdf) (Table S9)
  - Wish list? Send it to [kristiani@met.no](mailto:kristiani@met.no) (preferably before the end of September)

# ESMValTool testing

- A selection of the available diagnostics is demonstrated in Eyring et al. 2014:

<https://www.geosci-model-dev.net/9/1747/2016/>

- Namelists that reproduce different figures from Eyring et al. have been ported to NIRD, and are 'ready to run'.
- A list of successfully ported namelists are found on the wiki page

# https://wiki.met.no/noresm/esmvaltool

## NIRD compatible namelists

A number of namelists that reproduce a selection of figures from the [GMD paper](#) (Eyring et al. 2016) have been ported to NIRD and are 'ready to run'. These namelists, with corresponding GMD figures, can be found in the table below. Some of the namelists also produce additional figures related to the GMD figures - these are listed under "By-products" in the table below. The NIRD compatible namelists are all labeled \*\_norstore.xml, and can be found in

`/nird/home/kristiani/NorESMValTool/mods/namelists/`

See above under "Running ESMValTool" for launching instructions.

| GMD figure | Namelist                                     | By-products   | Notes  |
|------------|--|---|--|
| Figure 2   | namelist_perfmetrics_CMIP5_norstore.xml      |   |  |
| Figure 3   | namelist_perfmetrics_CMIP5_fig3_norstore.xml | tas: annual climatologies, individual models - reference                            |  |
| Figure 4   | namelist_flato13ipcc_norstore.xml            |   |  |
| Figure 5   | namelist_SAMonsoon_norstore.xml              | Mean intensity, global mean   |  |
| Figure 6   | namelist_SAMonsoon_norstore.xml              |   |  |
| Figure 7   | namelist_WAMonsoon_norstore.xml              |   |  |
| Figure 8   | namelist_CVDP_fig8_norstore.xml              | PDO timeseries  |  |
| Figure 9   | namelist_CVDP_fig9_norstore.xml              |   |  |
| Figure 11  | namelist_DiurnalCycle_box_pr_norstore.xml    |   |  |
| Figure 12  | namelist_flato13ipcc_norstore.xml            |   |  |
| Figure 13  | namelist_williams09climdyn_CREM_norstore.xml |   |  |
| Figure 14  | namelist_SouthernOcean_norstore.xml          | Models and observations individually  | Figures 14 (d) and (e) need model output (but should work)             |
| Figure 15  | namelist_SouthernHemisphere_norstore.xml     | Same figure for rlds, rlut, rsut  | Install 'basemap' and 'pyproj' python modules                          |
| Figure 16  | namelist_TropicalVariability_norstore.xml    | Same figure for Atlantic and Indian ocean, scatter plots for individual models      |  |
| Figure 17  | namelist_Sealce_norstore.xml                 | Sea ice area  |  |
| Figure 18  | namelist_Evapotranspiration_norstore.xml     | Individual model mean (all months individually)                                     |  |
| Figure 19  | namelist_runoff_et_norstore.xml              | Bias of ET, bias of ET coefficient, bias of precip, bias of runoff                  | Install 'cdo-1.3.0' python module (does not work with latest version!) |
| Figure 22  | namelist_GlobalOcean_norstore.xml            | mean, mean-diff, stddev-diff  |  |
| Figure 24  | namelist_righi15gmd_tropo3_norstore.xml      | Individual models - AURA-MLS-OMI, Trop. Col. Ozone annual cycle (individual models) |  |
| Figure 25  | namelist_eyring13jgr_norstore.xml            |   |  |
| Figure 26a | namelist_wensel14jgr_norstore.xml            | Figure 1, 2a, 2b, 3 and 4 from Wenzel et al. 2014                                   |  |

# Using ESMValTool with new NorESM output

- NorESM output must be CMOR-ized before use:

## Syntax

```
$HOME/NorESMValTool/scripts/cmorize case folder start year  
end year
```

- Once CMOR-ized, the NorESM output can easily be implemented in the available namelists

# Conceptual namelist example

<GLOBAL>

controls the general settings

</GLOBAL>

<MODELS>

<model> CMIP5 ACCESS1-0 Amon historical r1i1p1 1980 2005 @{MODELPATH}/CMIP5/ACCESS1-0 </model>

:

:

<model> CMIP5 NorESM1-ME Amon historical r1i1p1 1980 2005 @{MODELPATH}/CMIP5/NorESM1-ME </model>

<model> CMIP5 NorESM-version Amon CMORized r1i1p1 start\_year end\_year /path/to/cmorized/output </model>

</MODELS>

<DIAGNOSTICS>

defines which diagnostics to run

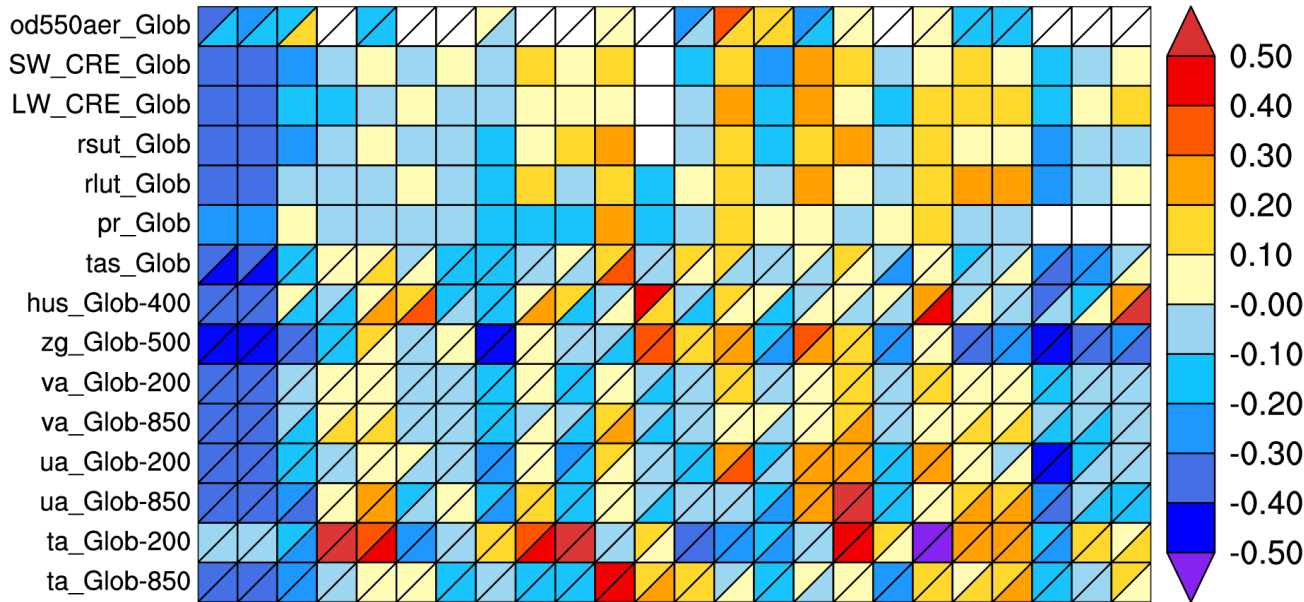
</DIAGNOSTICS>



# Portrait diagram

namelist\_perfmetrics\_CMIP5\_norstore.xml

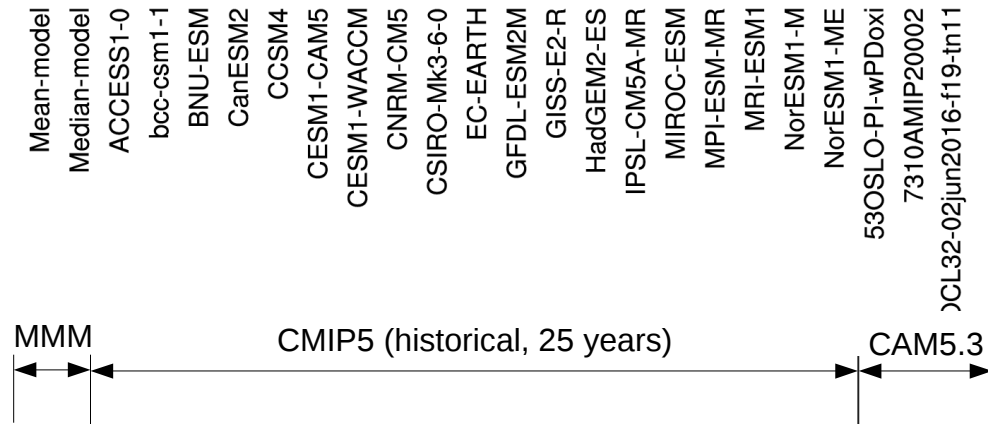
RMSD - Global



$$E'_{mfr} = \frac{E_{mfr} - \overline{E}_{fr}}{\overline{E}_{fr}}$$

$E_{mfr}$  = RMS error of model  $m$   
 $\overline{E}_{fr}$  = typical model error

(Gleckler et al. (2008))

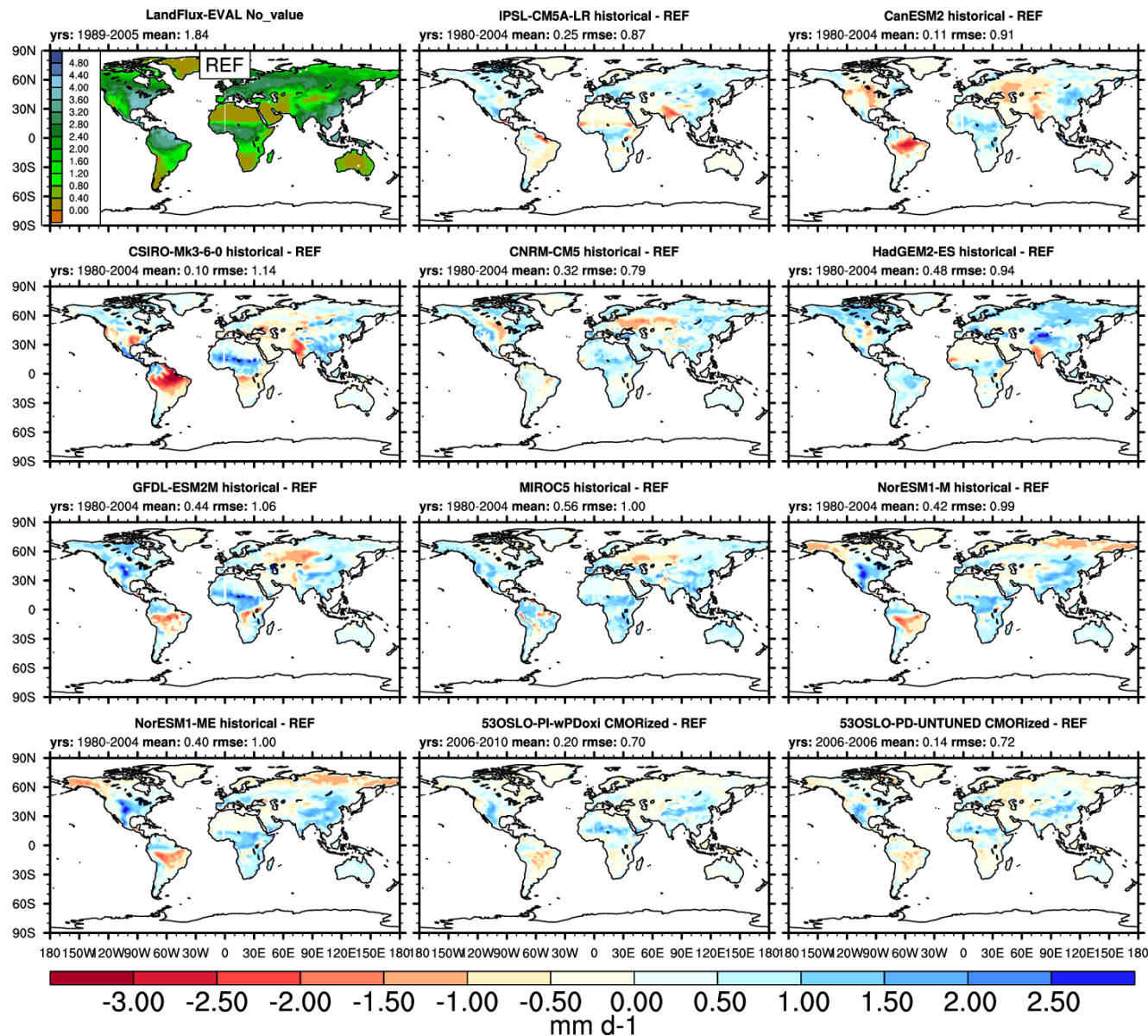


| Simulation   | NorESM version        | Forcing               |
|--|-----------------------|-----------------------|
| <b>53OSLO-PI-wPDoxi</b><br>(5 years, prescribed SST and sea ice) | CAM5.3-Oslo (nudged)  | P.I. aero<br>P.D. oxi |
| <b>7310AMIP20002</b><br>(25 years, prescribed SST and sea ice)   | CAM5.3-Oslo (AMIP)    | Present day           |
| <b>N1850C5OL45OCL32_02jun2016_f19_tn11</b><br>(25 years)         | CAM5.3-Oslo (coupled) | Pre-industrial        |

# Bias in evapotranspiration

namelist\_Evapotranspiration\_norstore.xml

Jul-mean of Evapotranspiration



# Resources

- NorESMValTool wiki page:  
<https://wiki.met.no/noresm/esmvaltool>
- ESMValTool home page: [www.esmvaltool.org](http://www.esmvaltool.org)
- ESMValTool user guide:  
[https://www.esmvaltool.org/download/ESMValTool\\_Users\\_Guide.pdf](https://www.esmvaltool.org/download/ESMValTool_Users_Guide.pdf)
- ESMValTool paper:  
<http://www.geosci-model-dev.net/9/1747/2016>