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The Swedish contribution to CMIP and CORDEX

CMIP from a data producer's perspective

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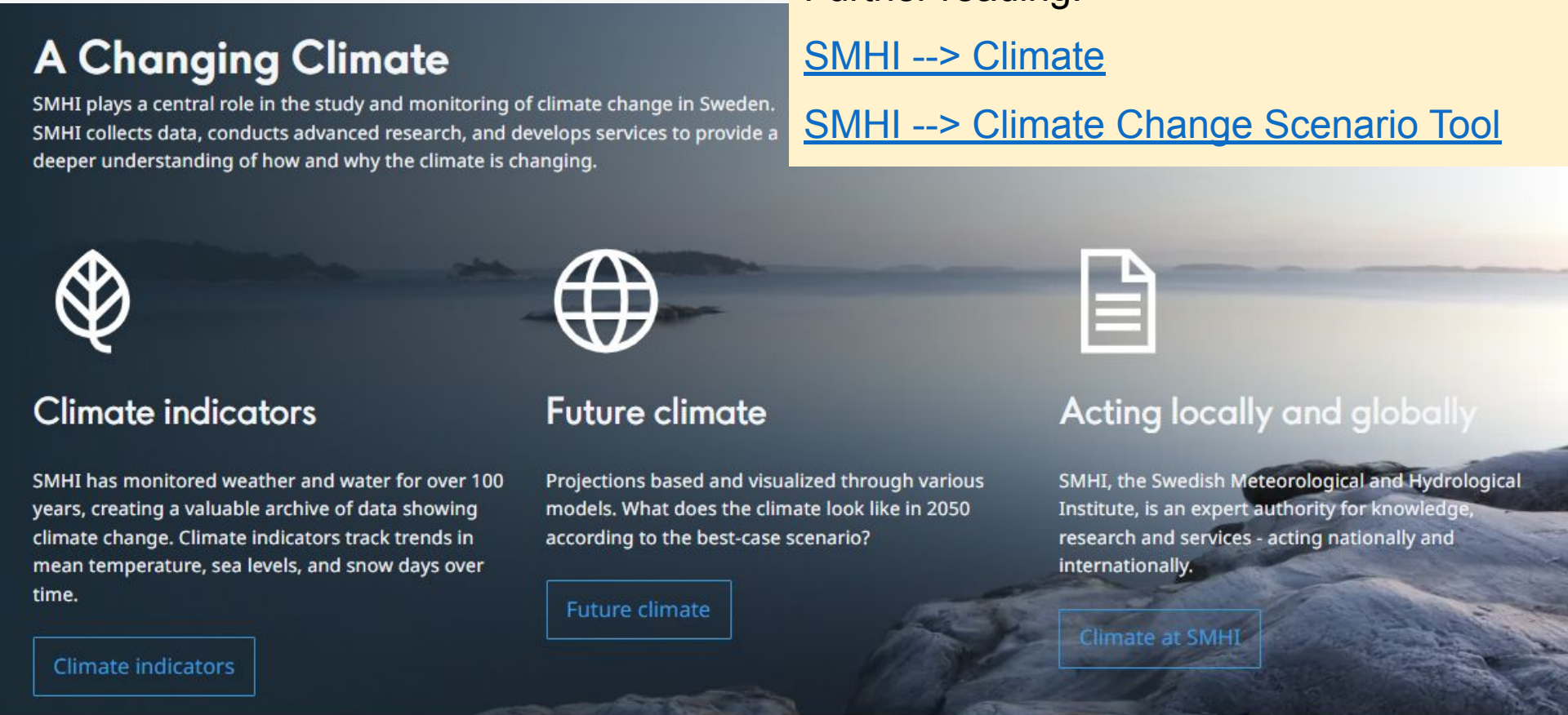
SMHI's mission

Further reading:

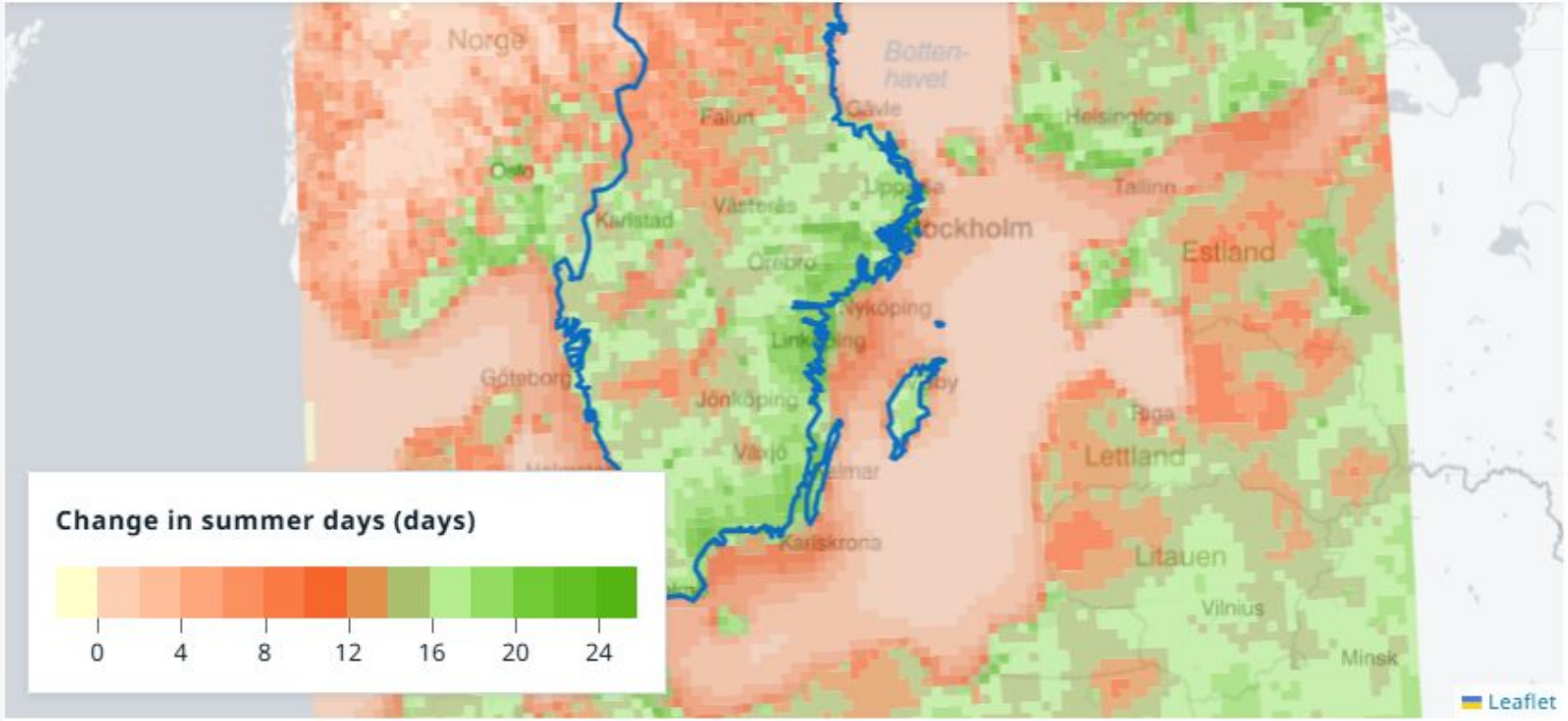
SMHI --> Climate

SMHI --> Climate Change Scenario Tool



Meteorology

Geographic area	Climate indicator	Emissions scenario
Sweden	**Summer days**	**RCP4.5**
Season	Period	Value type
Year	**2071-2100**	**Anomaly**



Calculated change of the number of summer days (days) for the period 2071-2100

From emissions to climate services

Population
Technology
Economics

Energy Systems
Land use

Climate information

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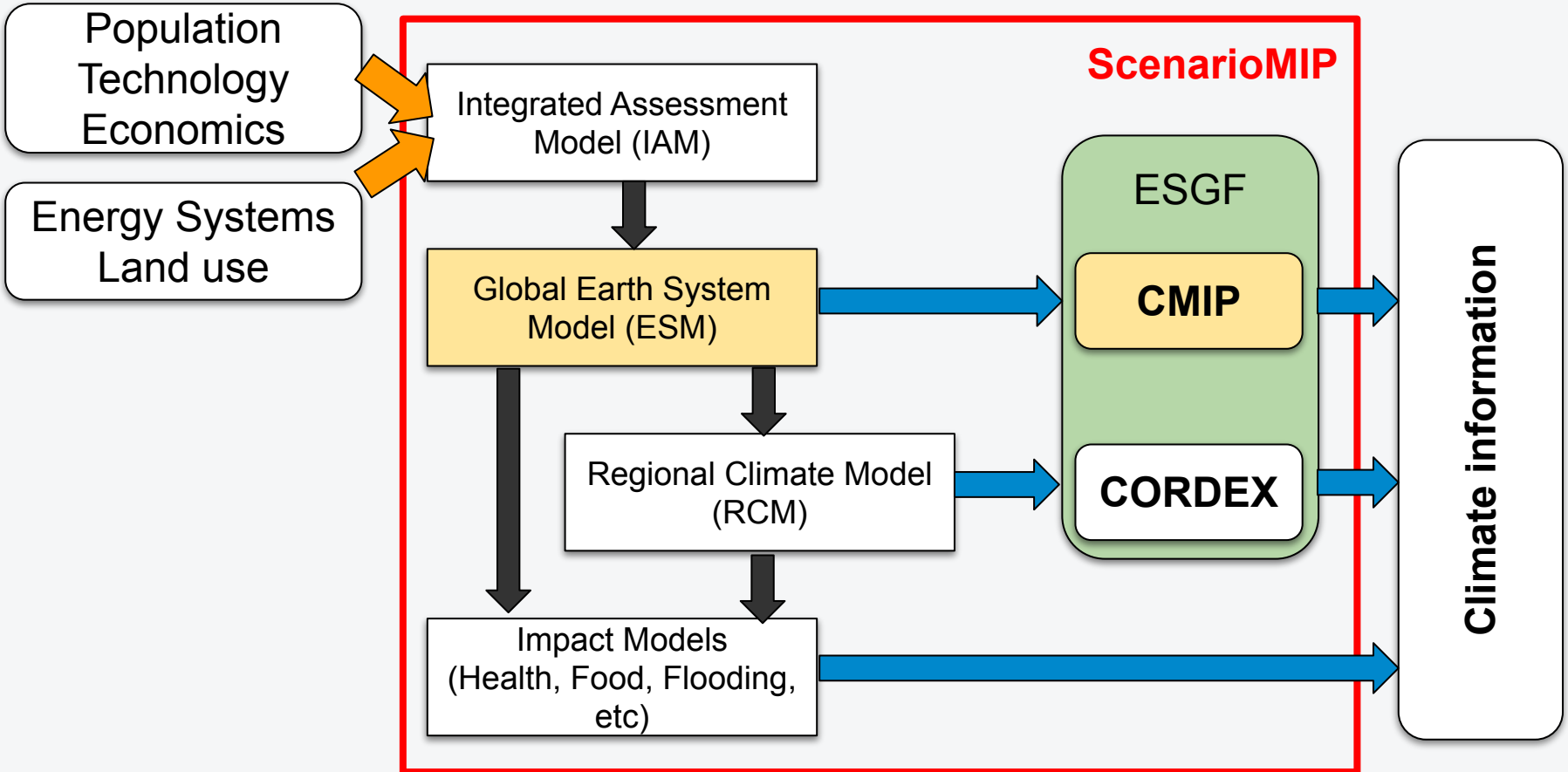
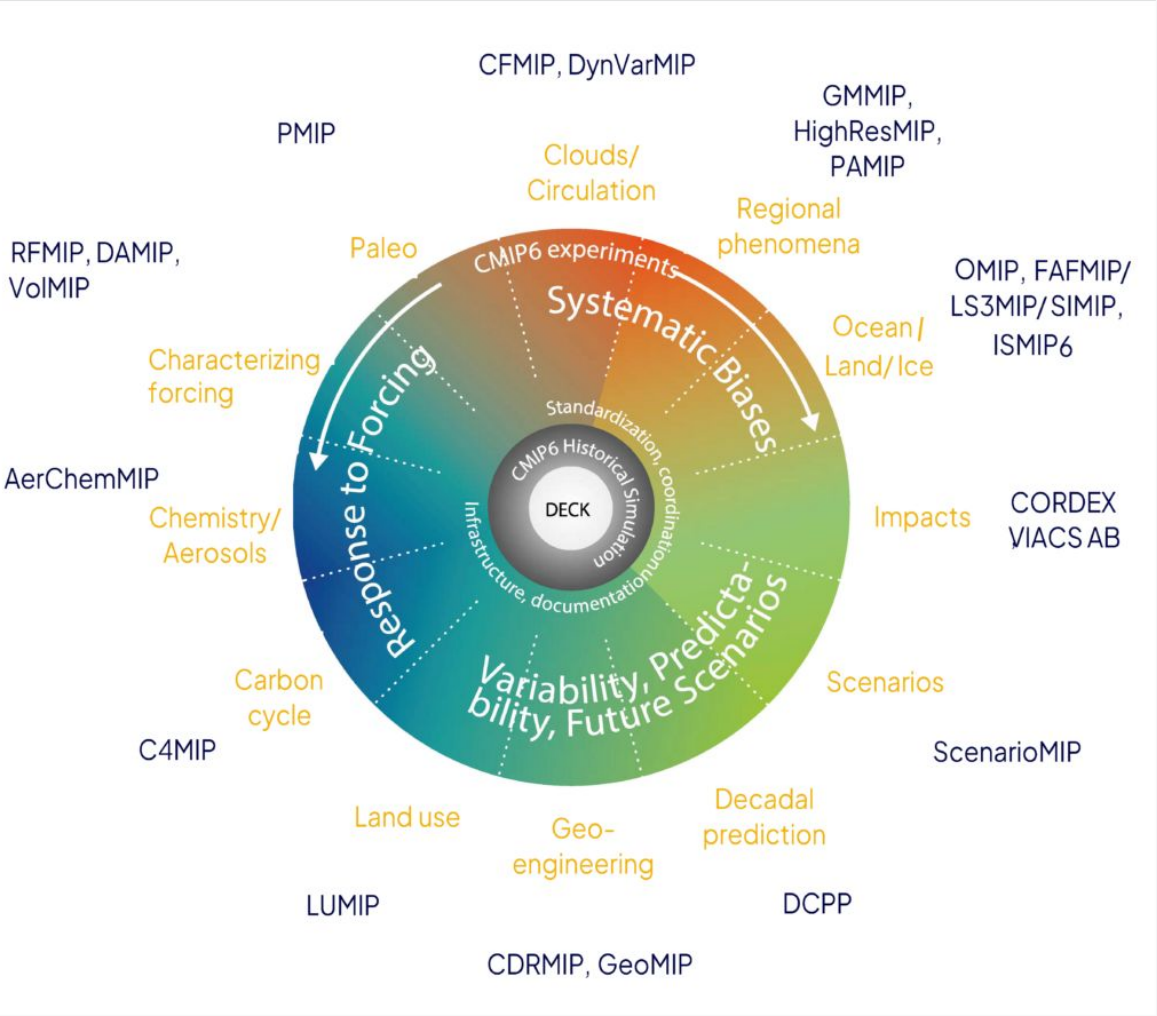
From emissions to climate services



Coupled Model Intercomparison Project (CMIP)



CMIP = DECK + MIPs

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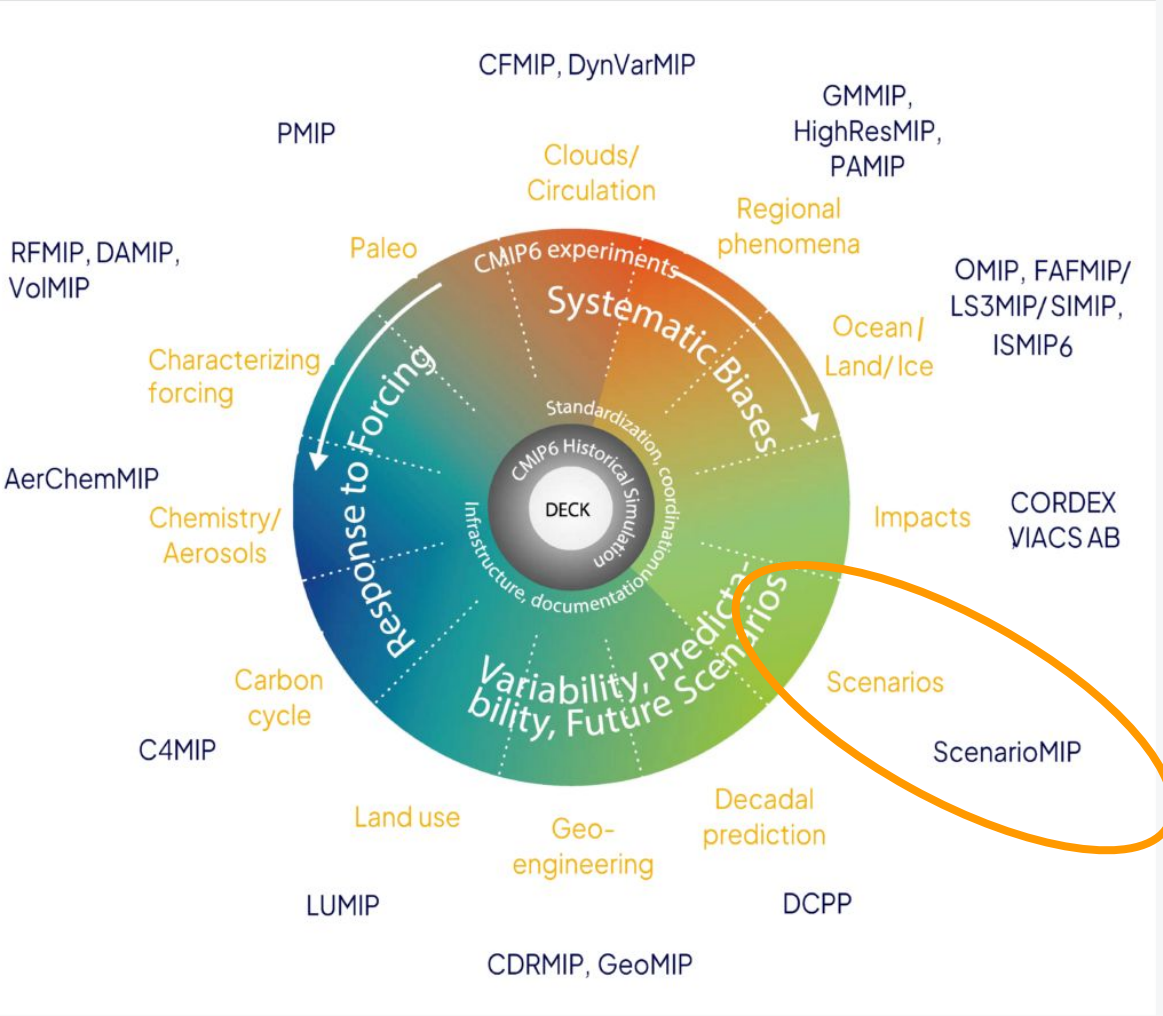
DECK: mandatory experiments for all participating model (e.g. piControl, amip, etc)

MIP: Model Intercomparison Projects
Models can voluntarily participate in one or several MIPs
MIPs aim at understanding of climate process and/or provide climate information



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ScenarioMIP is one MIP, providing input to ISIMIP, CORDEX and IPCC

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Contributing to CMIP - step by step

1. Register climate model (https://wcrp-cmip.github.io/CMIP6_CVs/docs/CMIP6_source_id.html)
2. Launch climate simulations following experiment protocol (e.g. https://gmd.copernicus.org/articles/9/3461/2016/gmd-9-3461-2016.pdf)
   - start date
   - initial conditions
   - length
   - forcing
3. Save requested output (https://clipc-services.ceda.ac.uk/dreq/index.html)
4. Re-format output for CMOR compliance (“cmorisation”)
5. Publish results on an ESGF datanode

CMORise model output

Climate Model Output Rewriter (CMOR)

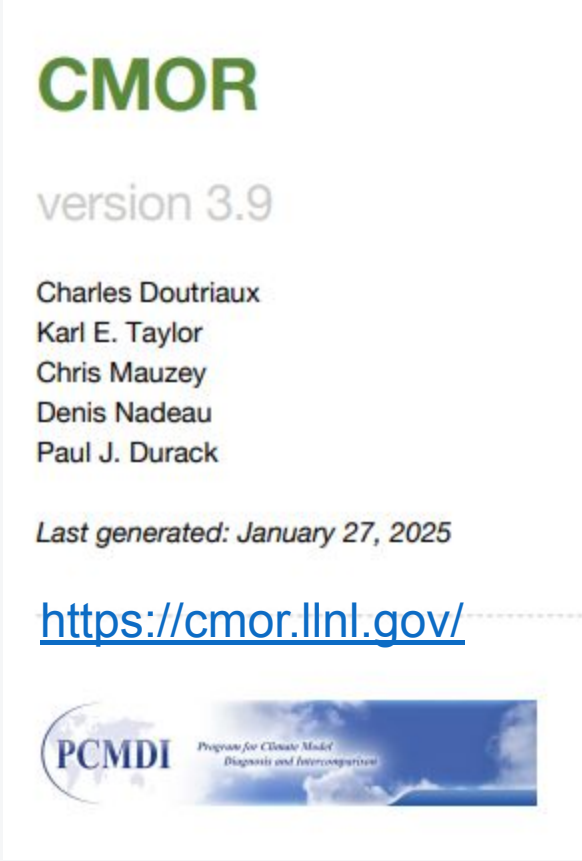
Each climate model has its own way of saving output:

- file format (netCDF, GRIB,…)
- directory structure
- metadata

To facilitate model intercomparison projects the data have to be in a common format. All data in the CMIP and CORDEX archives are CMOR compliant.

The CMOR library can be used to rewrite climate model output in a common format.

CMOR provides only a library with functions for writing data. It has to be integrated in a model specific application with an interface for reading model output (aka “cmorisation”).



CMIP controlled vocabulary (CV)

Standardised metadata (attributes) that uniquely describe the model, the experiment, the variable, etc

Additional attributes are possible

The metadata are organised in MIP tables provided by CMIP (https://github.com/PCMDI/cmip6-cmor-tables/blob/6a30acaea9b63fdecbe08894d7e50ef36879a993/README.md)

User input to CMOR has to match the settings in the CMIP6_CV table (see http://goo.gl/v1drZl)

FAIR : Findable, Accessible, Interoperable, and Reusable

Examples for CVs in MIP tables

An experiment


```
"ssp245":{
    "activity_id":[
        "ScenarioMIP"
    ],
    "experiment":"update of RCP4.5 based on SSP2",
    "experiment_id":"ssp245",
    "parent_activity_id":[
        "CMIP"
    ],
    "parent_experiment_id":[
        "historical"
    ],
    "required_model_components":[
        "AOGCM"
    ]
},
```


A variable


```
"tas": {
    "frequency": "mon",
    "modeling_realm": "atmos",
    "standard_name": "air_temperature",
    "units": "K",
    "cell_methods": "area: time: mean",
    "cell_measures": "area: areacella",
    "long_name": "Near-Surface Air Temperature",
    "comment": "near-surface (usually, 2 meter) air temperature",
    "dimensions": "longitude latitude time height2m",
    "out_name": "tas",
    "type": "real",
    "positive": ""
},
```

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Selected metadata (attributes)

mip_era	e.g. CMIP6
activity_id	name of MIP (or CMIP)
experiment_id / experiment	short / long name of experiment
source_id / source	short / long name of model
institute_id / institute	short / long name of institute
parent_mip_era parent_activity_id	same information but for the parent model from which the child has branched off
branch_time_in_parent branch_time_in_child	time when branching (time axes can be different in parent and child!)
variant_label	RIPF identifier, e.g. r1i1p1f1 where “r” denotes the member, “i” the initialisation method, “p” the model physics and “f” the forcing
variant_label_info	usually only provided if “i” or “p” or “f” are not 1

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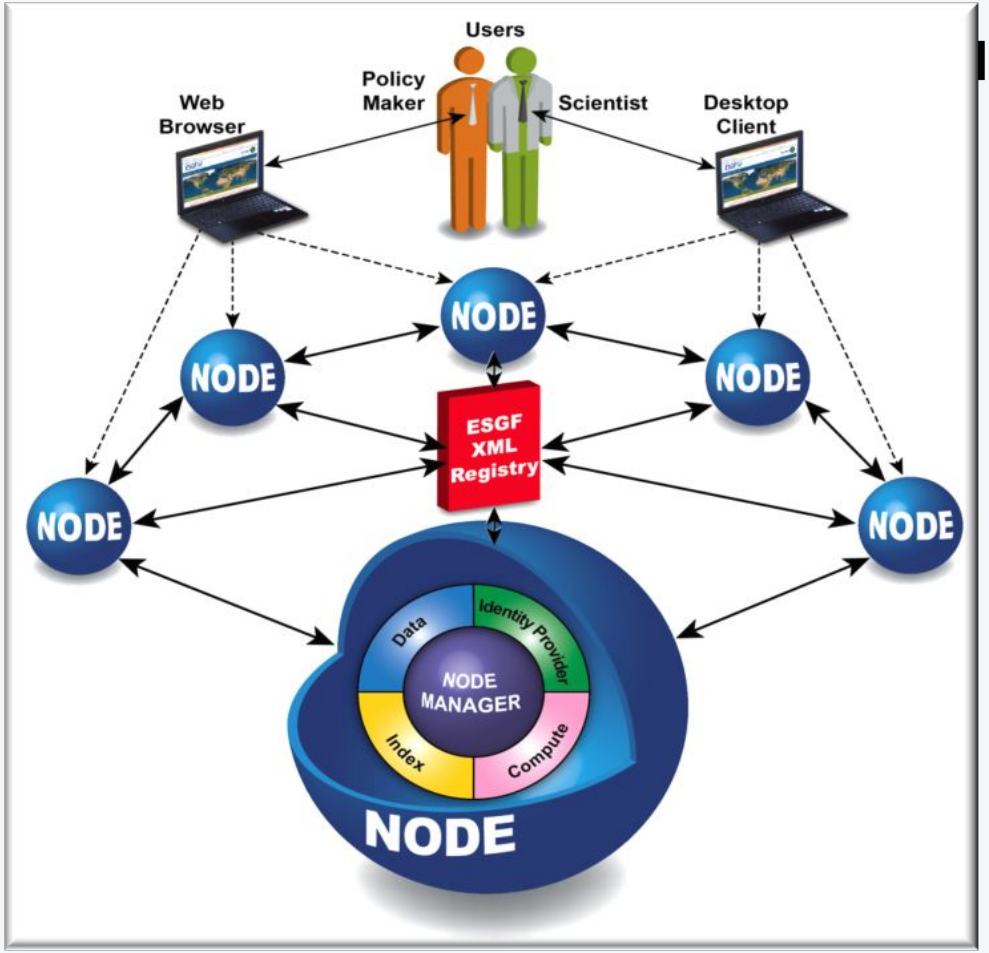
Sharing data with the community
$\Rightarrow$ publishing on the ESGF

ESGF
Earth System Grid Federation

ESGF manages the first-ever decentralized database for handling climate science data, with multiple petabytes of data at dozens of federated sites worldwide.

Using a system of geographically distributed peer nodes—independently administered yet united by common protocols and interfaces—the ESGF community holds the premier collection of simulations and observational and reanalysis data for climate change research.



https://esgf.llnl.gov/mission.html

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CMIP Modelling Centres and ESGF Nodes

https://wcrp-cmip.org/map/

Finding and downloading data

ESGF portals

- Each portal provides information about all CMIP6 or CORDEX data even if data are distributed over different datanodes
- Downloading data automatically takes into account the distributed nature of the archive (different URLs, multiple wget scripts)
- Some datasets are replicated on multiple datanodes for redundancy. Furthermore, replication enables for multi-model evaluation at the data center that operates the datanode (e.g. for making plots for IPCC reports)
- In general datasets need to be downloaded for any diagnostic.

- Note on the side: some portals may hold additional projects (e.g. input4mips at DKRZ)

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ESGF portals come in 2 flavors (and soon 3)

Version 1 (CoG): e.g. https://esg-dn1.nsc.liu.se/search/cmip6-liu/

Version 1.5 (metagrid): e.g. https://esgf-metagrid.cloud.dkrz.de/search

Version 2: coming soon

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Problems with downloaded data ?

1. Check errata server: https://errata.ipsl.fr/static/index.html
2. Check the contact information in any netCDF file of the dataset and contact the data producer directly

```
// global attributes:
                    :contact = "cmip6-data@ec-earth.org" ;
```

3. Problems with downloading entire datasets from ESGF? Search for contact information under PID (old portal) or Citation (new portal) when displaying search results

1. **CMIP6.DCPP.EC-Earth-Consortium.EC-Earth3-HR.dcppA-hindcast.s1991-r7i2p1f1.Omon.hfx.gn**
Data Node: esg-dn1.nsc.liu.se
Version: 20201205
Total Number of Files (for all variables): 6
Full Dataset Services: [Show Metadata] [List Files] [THREDDS Catalog] [WGET Script] [Show Citation] [PID] [Further Info]
Add to Data Cart

CMIP6.C4MIP.NOAA-GFDL.GFDL-ESM4.1pctCO2-bgc.r1i1[illegible]Amon.ps.gr1

wget

Files Metadata Citation Additional

Data Citation Page

Identifier DOI: http://doi.org/10.22033/ESGF/CMIP6.8475

Creators: Krasting, John P.; Blanton, Chris; McHugh, Colleen; et al.

Titles: NOAA-GFDL GFDL-ESM4 model output prepared for CMIP6 C4MIP 1pctCO2-bgc

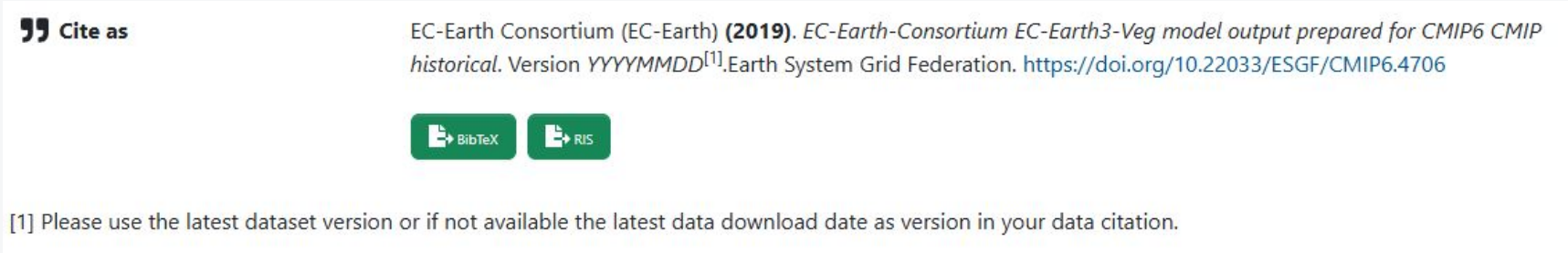
Publisher: Earth System Grid Federation

Publication Year: 2018

License: Creative Commons Attribution 4.0 International License (CC BY 4.0)

Versioning

- All CMIP and CORDEX datasets are versioned, the version number is “v” followed by date close to the publication date
- Version is per dataset, datasets from one experiment can have different versions (e.g. monthly temperature and monthly precipitation, or daily temperature and monthly temperature)
- Datasets are retracted and re-published with a new version if necessary (check errata server for retracted data)
- Important: always cite the exact version when publishing articles, consult landing page,e .g.



Peeking at CMIP and CORDEX datasets without downloading

IPCC Working Group I (WGI): Sixth Assessment Report

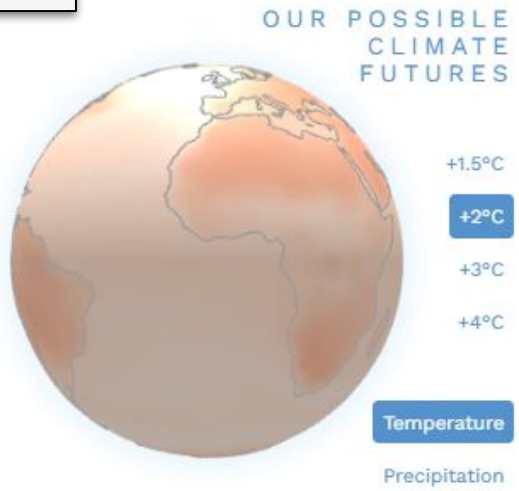
Selected datasets are available in the IPCC WG1 interactive atlas:

https://interactive-atlas.ipcc.ch/

IPCC WGI Interactive Atlas

A novel tool for flexible spatial and temporal analyses of much of the observed and projected climate change information underpinning the Working Group I contribution to the Sixth Assessment Report, including regional synthesis for Climatic Impact-Drivers (CIDs).

Errata and problem reporting | License, data and citation | Contact



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Other alternatives for accessing CMIP and CORDEX data

Copernicus → Interactive Atlas (as IPCC WG1 atlas, newer)

Copernicus → Data Store (quality checked data)

SMHI --> Climate Change Scenario Tool (additional climate indicators)

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Suggestions for exploring a CMIP dataset

Find monthly mean precipitation flux for SSP2-4.5 from NorESM2-LM at an ESGF portal

- How many members are there?
- What is the model resolution of the atmosphere component?
- Available variants?
- Available dataset version(s) for say r1i1p1f1?
- On which server are the data located? Are there any replicas anywhere?
- How many files are in r1i1p1f1?
- Download the r1i1p1f1 dataset
  - Inspect metadata in one of the netCDF files with ncdump
  - Look at the data with ncview
  - Load data in jupyter notebook and make plots (maps and timeseries)