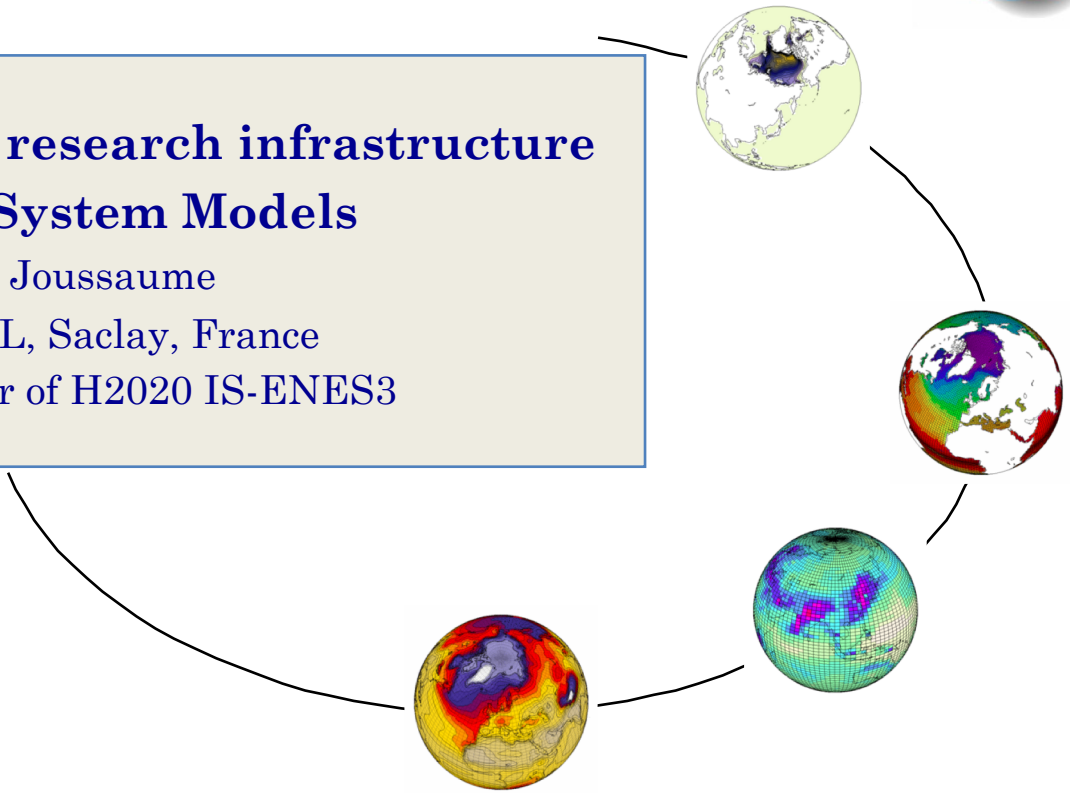
C3S future data services for global and regional projections
29/03/2021, virtual

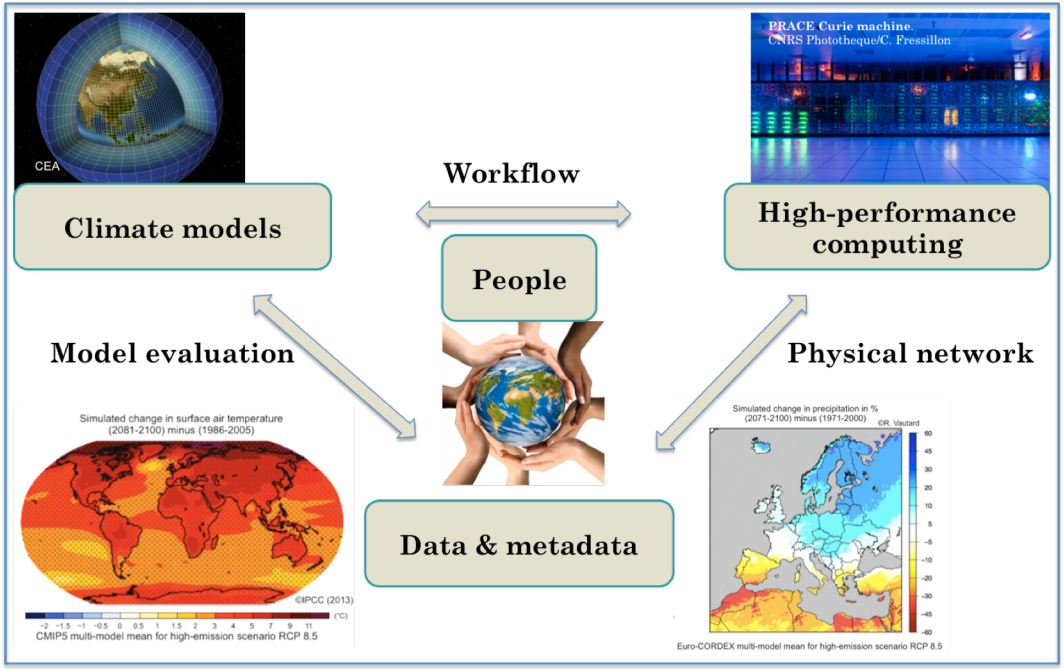
IS-ENES: European research infrastructure for Earth System Models

Sylvie Joussaume
CNRS, IPSL, Saclay, France
Coordinator of H2020 IS-ENES3



The IS-ENES3 project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824084

ENES:
European Network for Earth System modelling Infrastructure



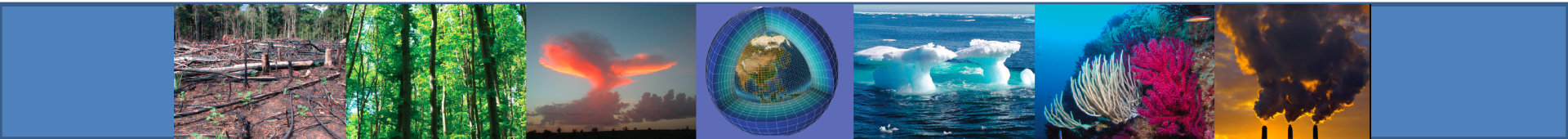
IS-ENES infrastructure projects

- IS-ENES (2009-2013)
- IS-ENES2 (2013-2017)
- IS-ENES3 (2019-2022)

Support WCRP internationally coordinated climate model experiments (CMIP & CORDEX)

Support sharing of expertise on climate models, tools & HPC

https://is.enes.org



World Climate Research Program: CMIP6

CMIP6 (Eyring et al., GMD, 2016)

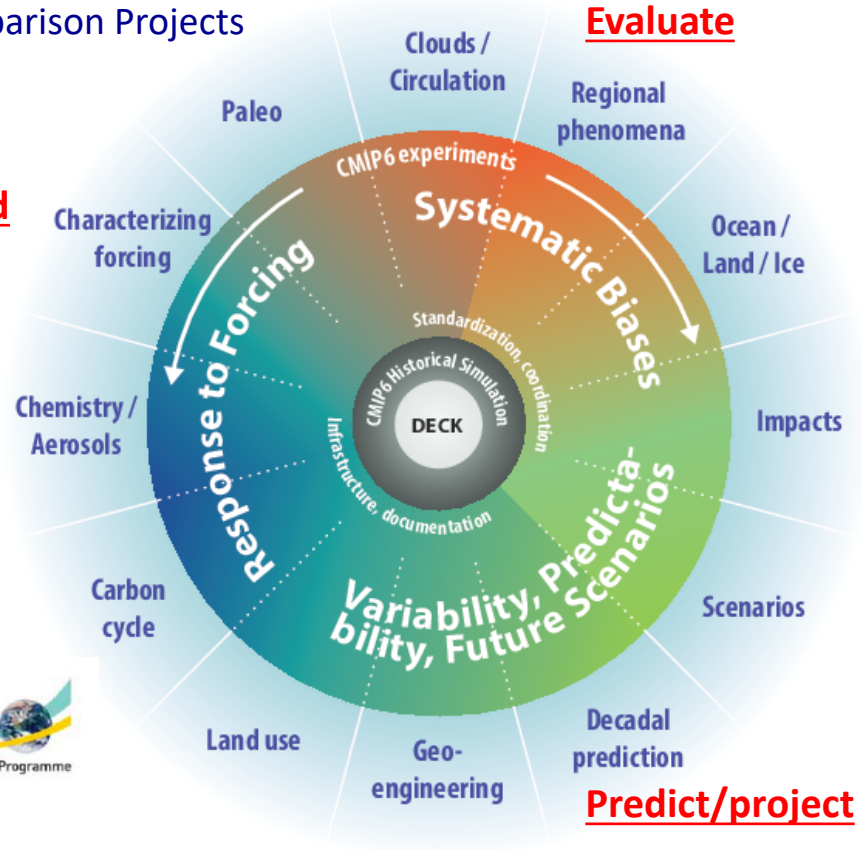
Input to IPCC AR6 2021

CMIP6 (oct 2020)
7 European ESMs & 1 coupled model
22 model versions (DECK)
(All: 30 groups/ 59 versions for DECK)

Per model:
20 to 50 000 simulated years

Cumulated:
About 13 PB distributed
About 2 250 Mh of CPU time
CMIP6 HPC metrics

23 endorsed MIPs
Model Intercomparison Projects

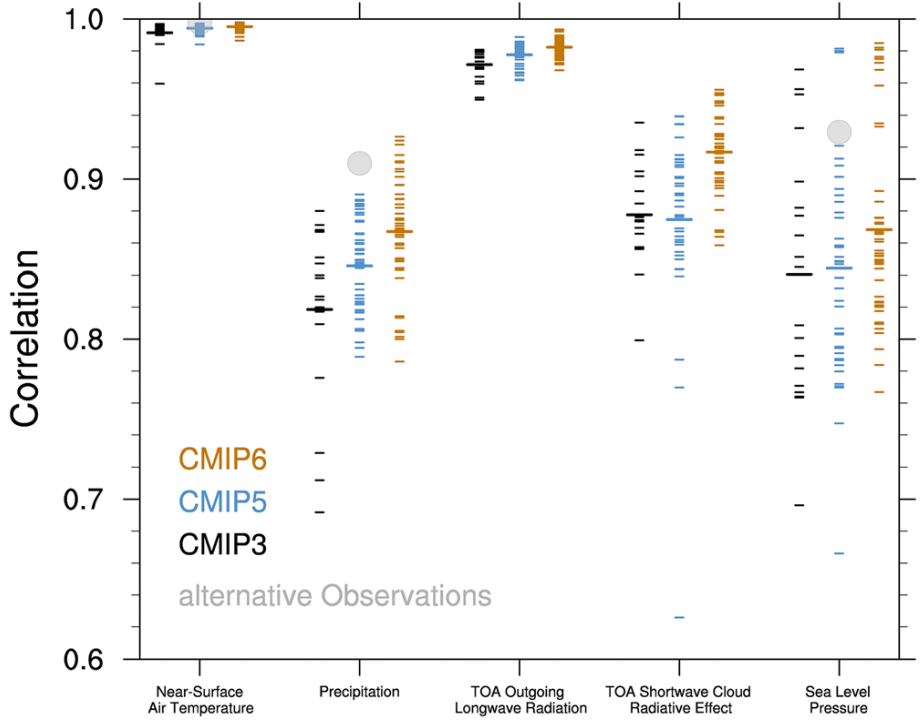


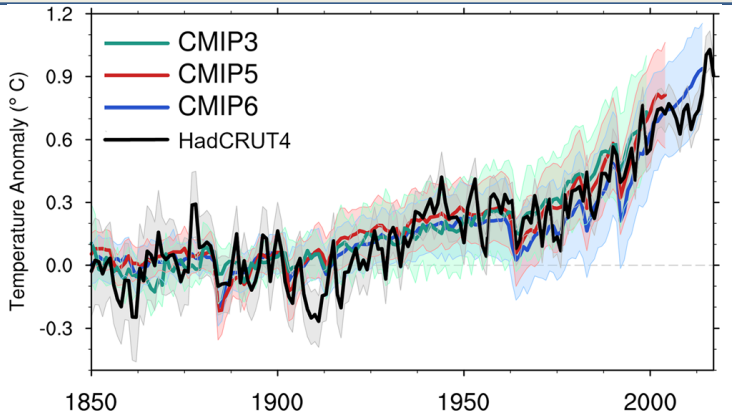
CMIP6 results

IPCC AR6

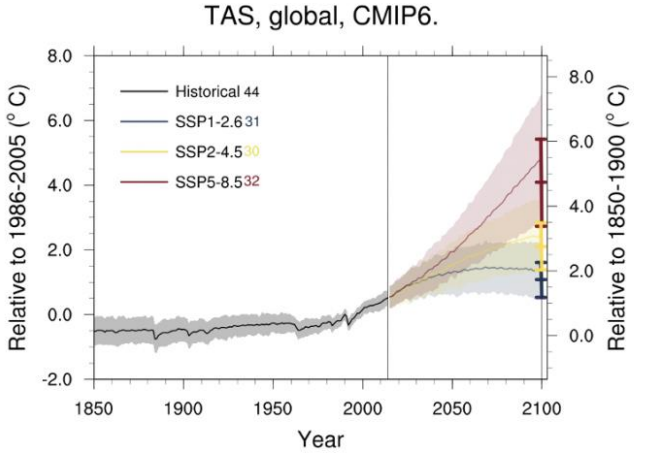
ESMValTool
Earth System Model Evaluation Tool

Bock et al., JGR (2020)

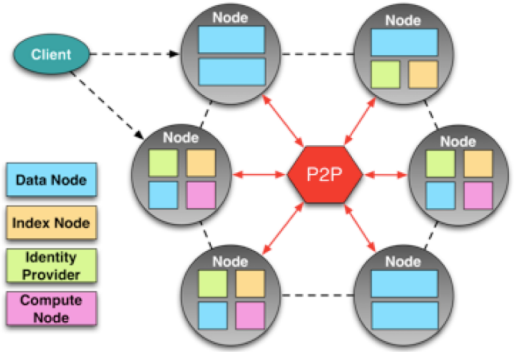




Tebaldi et al., ESD (2021)



Earth system grid federation: A common data infrastructure



Dashboard stat

ESGF: 8 M datasets

23,4 PB (w/o replica 12,7)

CMIP6: 7 M datasets

16,1 PB (w/o replica 9,3)

CMIP5: 5,3 PB (1,5)

ca 15 000 registered users

FAIR data

Open source software, common data and metadata standards

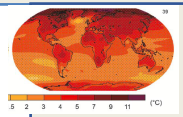
International, Community led : GO-ESSP, WIP

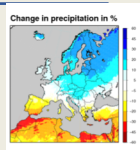
Multi-agencies support: *DOE, NOAA, NASA, IS-ENES, NCI*

Climate projections @ climate data store

Data infrastructure https://enes.org

is-enes
INFRASTRUCTURE FOR THE EUROPEAN NETWORK FOR EARTH SYSTEM MODELLING





Data access services

To providers and users
CMIP5, CMIP6 & CORDEX

ESGF data access and publication
Citation & PID, statistics
Long-term archival and replica

Compute services: access to large data pools and evaluation diagnostics

Service on Data and metadata standards
CF convention & Data Request

Model documentation: ES-DOC

Climate4impact portal

Support to
Networking &
Joint Research Activities

ESGF Earth System Grid Federation

Europe:
11 data nodes and
4 index nodes

ESMValTool
Earth System Model Evaluation Tool

es-doc
Earth System Documentation

Documentation
Models, Experiments, MIPs

Ease access to CMIP and CORDEX data
for climate impact studies

DKRZ

Centre for Environmental Data Analysis
SCIENCE AND TECHNOLOGY FACILITIES COUNCIL
NATURAL ENVIRONMENT RESEARCH COUNCIL

Institut Pierre Simon Laplace

cmcc Centro-euro-Mediterraneo sui Cambiamenti Climatici

Linköpings universitet

DLR

BSC

eScience center

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

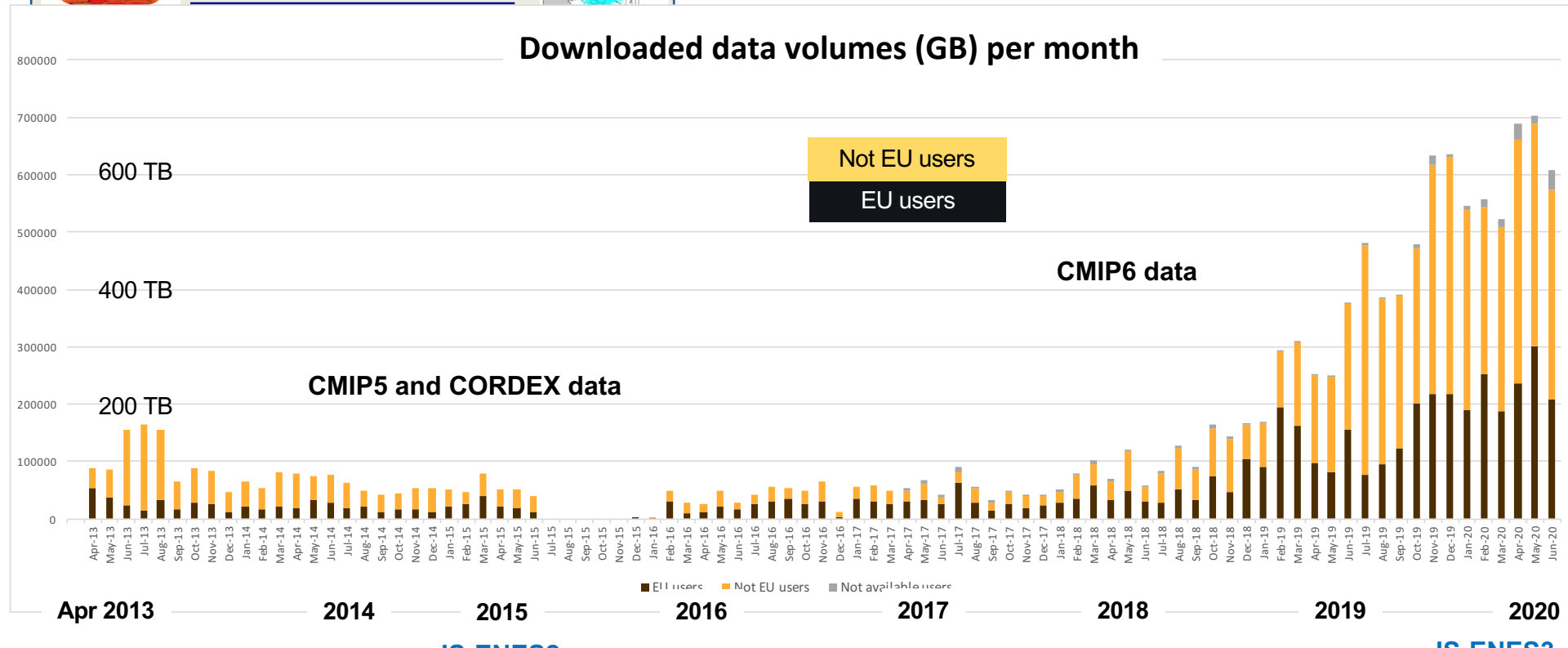
CERFACS

Royal Netherlands Meteorological Institute
Ministry of Transport, Public Works and Water Management

Support exploitation of model data

Data access services

ESGF data statistics from all European ESGF nodes



IS-ENES2 — IS-ENES3

is-enes
INFRASTRUCTURE FOR THE EUROPEAN NETWORK FOR EARTH SYSTEM MODELLING

Earth system documentation
https://es-doc.org/

& Errata service
https://errata.es-doc.org

Modifier Afficher

https://search.es-doc.org/

100 % Ven. 18:04

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MIP

es-doc
Earth System Documentation

Project / MIP Era: CMIP6 | Document Type: MIP | Document Version: Latest

Total Documents = 22. Filtered Documents = 22.

Name	Description
AerChemMIP	Aerosols and Chemistry MIP
C4MIP	Coupled Climate Carbon Cycle MIP
CDRMIP	The Carbon Dioxide Removal Model Intercomparison Project
CFMIP	Cloud Feedback Model Intercomparison Project
CMIP	Climate Model Intercomparison Project
CMIP6	Climate Model Intercomparison Project Number 6
DAMIP	Detection and Attribution Model Intercomparison Project
DCPP	Decadal Climate Prediction Project
DECK	Diagnosis, Evaluation, and Characterization of Klima (Climate)
FAFMIP	Flux-Anomaly-Forced Model Intercomparison Project
GeoMIP	The Geoengineering Model intercomparison Project
GMMIP	Global Monsoons Modeling Inter-comparison Project
HighResMIP	High Resolution Model Intercomparison Project
ISMIP6	Ice Sheet Model Intercomparison Project for CMIP6

Model

es-doc
Earth System Documentation

Project / MIP Era: CMIP6 | Document Type: Model | Document Version: Latest

Total Documents = 34. Filtered Documents = 34.

Institute	Name
CCCR-IITM	IITM-ESM
CNRM-CERFACS	CNRM-CM6-1
CNRM-CERFACS	CNRM-ESM2-1
CSIRO	ACCESS-ESM1-5
EC-EARTH-CONSORTIUM	EC-EARTH3
EC-EARTH-CONSORTIUM	EC-EARTH3-AERCHEM
EC-EARTH-CONSORTIUM	EC-EARTH3-CC
EC-EARTH-CONSORTIUM	EC-EARTH3-GRIS
EC-EARTH-CONSORTIUM	EC-EARTH3-HR
EC-EARTH-CONSORTIUM	EC-EARTH3-LR
EC-EARTH-CONSORTIUM	EC-EARTH3-VEG
EC-EARTH-CONSORTIUM	EC-EARTH3-VEG-LR

Experiment

es-doc
Earth System Documentation

Project / MIP Era: CMIP6 | Document Type: Experiment | Document Version: Latest

Total Documents = 314. Filtered Documents = 314.

Name	Alternative Name	Description
1pctCO2	--	1 percent per year increas
1pctCO2-4xext	--	extension from year 140 o
1pctCO2-bgc	--	biogeochemically-coupled
1pctCO2-cdr	CDR-reversibility	1 percent per year decreas
1pctCO2-rad	--	radiatively-coupled versio
1pctCO2Ndep	--	1 percent per year increas
1pctCO2Ndep-bgc	--	biogeochemically-coupled deposition
1pctCO2to4x-withism	--	Experiment with interactiv (subsequently held fixed)
a4SST	--	control plus warming patte
a4SSTice	--	control plus warming patte
a4SSTice-4xCO2	--	control plus warming patte
abrupt-0p5xCO2	--	Abrupt halving of the atmo

Climate4impact

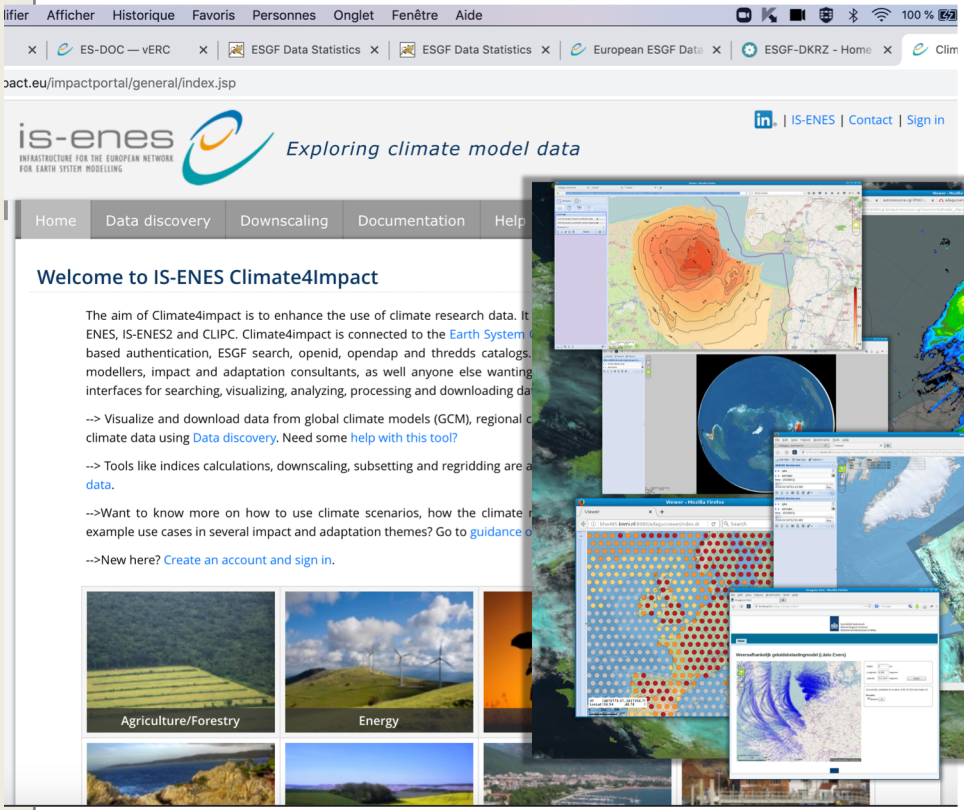
http://climate4impact.eu/

Platform for impact researchers

Explore climate data & perform analysis

Including:

- In-depth documentation and guidance
- Use cases from impact researchers
- Perform calculations / Data processing: WPS
- Downscaling portal



is-enes
INFRASTRUCTURE FOR THE EUROPEAN NETWORK FOR EARTH SYSTEM MODELLING

Analytical software

CDO
Climate Data Operators
https://code.mpimet.mpg.de/

code.mpimet.mpg.de/projects/cdo/wiki

Accueil Projets Imprint + Privacy Policy Aide

Max-Planck-Institut für Meteorologie **CDO**

Aperçu Activité Annonces **Wiki** Forums Fichiers Embedded

Welcome to the Climate Data Operators

CDO is a large tool set for working on climate and NWP model data. NetCDF 3/4, GRIB 1/2 including SZIP (or AEC) and JPEG compression, EXTRA, SERVICE and IEG are supported as IO-formats. Apart from that CDO can be used to analyse any kind of gridded data not related to climate science.
CDO has very small memory requirements and can process files larger than the physical memory.

CDO is open source and released under the terms of the GNU General Public License v2 (GPL).

Documentation

Full documentation is available as **pdf** and **html**.

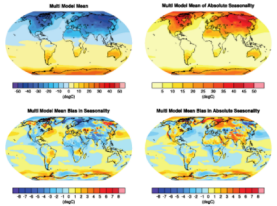
There is no man-page since operator descriptions are built into the interpreter:

```
cdo -h [operator]
```

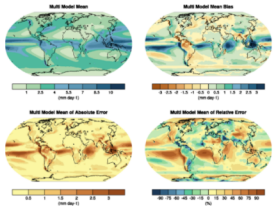
More documentation is available:

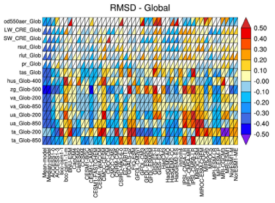
- **Tutorial**, continuously under development
- **FAQ**, continuously under development
- **Reference card**, for everyone with a really large coffee mug
- **ECA** Climate Indices Package
- Plotting with Magics++
- Operator News - Subscribe to keep yourself up-to-date!
- **CDO CMOR** handson slides by Fabian Wachsmann
- Em português [Author: Guilherme Martins]:
  - Tutorial

ESMValTool examples

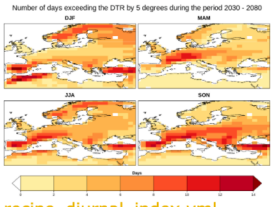


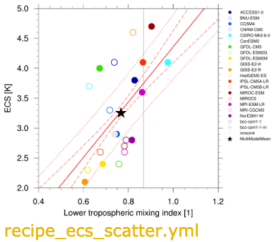
recipe_flato13ipcc.yml



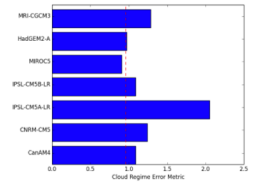


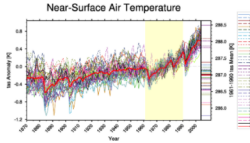
recipe_perfmetrics_CMIP5.yml



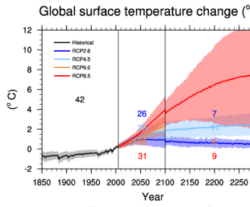


recipe_ecs_scatter.yml



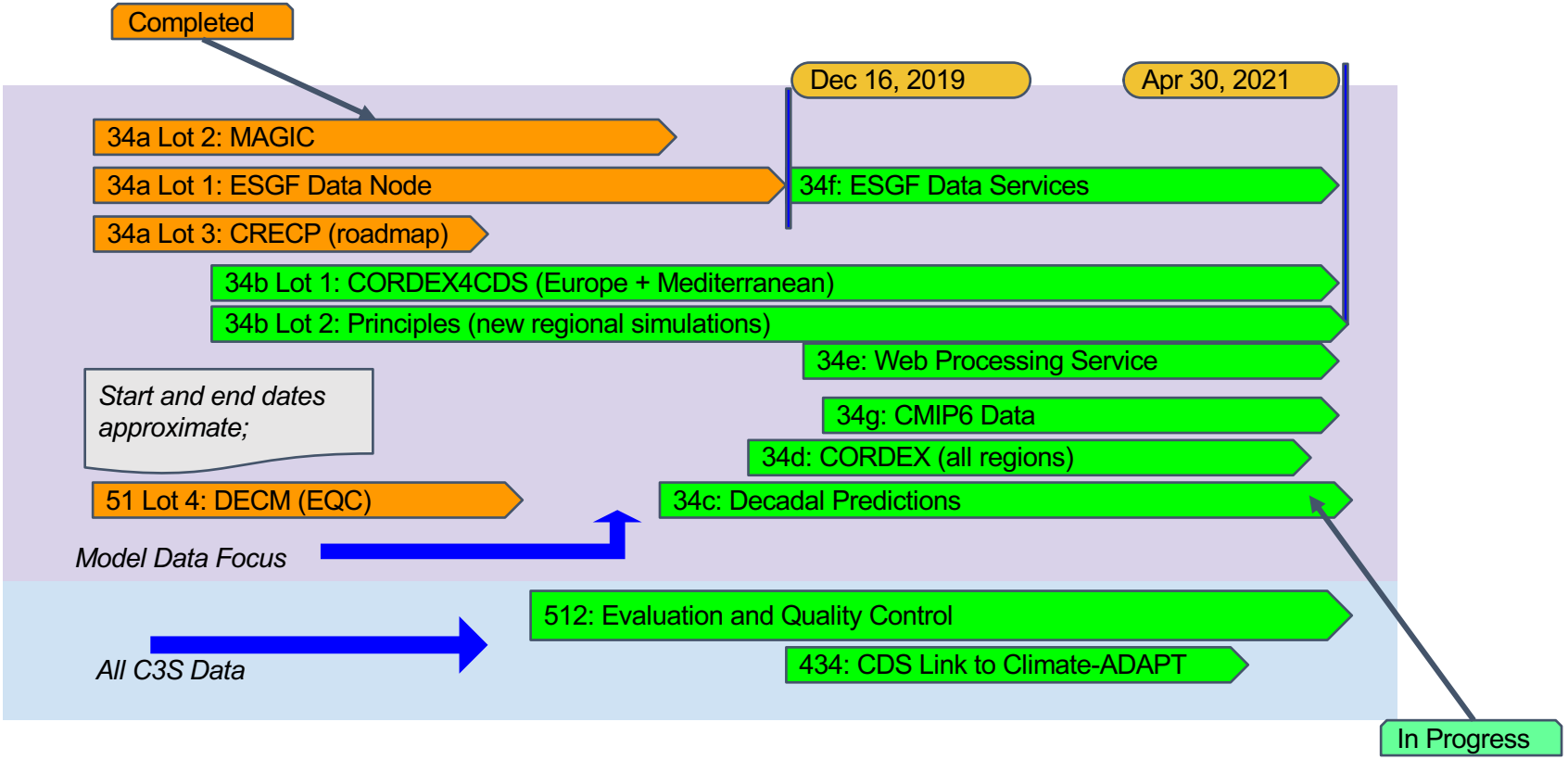


recipe_flato13ipcc.yml



A community diagnostic and performance metrics tool for routine evaluation of Earth system models in CMIP
https://www.esmvaltool.org/

Overview of ENES consortium activities in C3S



Courtesy of Martin Juckes

Conclusions

- CMIP: strong basis to IPCC (WMO, 2019)
  Evaluation / Understanding / Projections

- Importance to continue supporting shared standards data base (ESGF) and tools
  IS-ENES: need for a long term sustained infrastructure
  (under discussion)

- **Strong complementarity with C3S:**
  IS-ENES brings expertise and support to C3S
  C3S brings reanalyses and observations to climate modelling