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

IS-ENES3 1st General Assembly
25-27th March 2020
Toulouse, France

Model performance: results for CMIP6

Mario Acosta

BSC colleagues

ISENES3 partners

V. Balaji, Niki Zadeh, HPC-TF Group, ...

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

CPMIP metrics for CMIP6

- CMIP6
  - Understanding past, present and future climate changes arising from natural, unforced variability or in response to changes in radiative forcing in a multi-model context.
  - Coordinated CMIP Experiments, designed to understand specific aspects of the model response.
  - Different institutions contribute to CMIP6 with different configurations, resolutions, platforms, members…
    - We have **different models** running similar configurations.
    - We have same models running similar configurations on **different platforms.**
    - We have same model on same platform running **different configurations.**
    - ...

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

CPMIP collection

- About the CPMIP Metrics
  - V. Balaji et al. 2017
  - https://www.geosci-model-dev.net/10/19/2017/gmd-10-19-2017.pdf
- About the ISENES3 collection
  - Adapted by each institution to collect CPMIP metrics during CMIP6 experiments.
  - Coordination and collection from WP4-NA3, including internal and external partners.
  - Analysis and publication of the results (including ES-DOC update).
- About future plans
  - Improvement, extension and portability of CPMIP metrics: learning from the experience.
  - Carbon footprint collaboration.
  - Final collection/analysis will be at the end of 2020, for all CMIP6 experiments for IS-ENES3 and external partners.
  - Working in collaboration with the community (V. Balaji, HPC-TF…).

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

IS-ENES3 1st General Assembly
25-27th March 2020
Toulouse, France

CPMIP metrics

Metric	used to evaluate ...
Simulation Year Per Day (SYPD)	how efficient is your sim job per each year of the simulation
Core-hours Per Year (CHPY)	how efficient is your sim job with respect to the number of parallel resources used
Complexity	the number of prognostic variables per component
Actual SYPD	how affect queue time and interruptions to the complete experiment
Parallelization	total number of cores allocated for the run
Energy Cost Per Year (JCPY)	how much energy is needed per each year of simulation
Memory Bloat	the ratio between actual and ideal memory size
Data Output Cost	how much time and resources are used performing I/O
Data Intensity	the amount of data produced per compute-hour
Coupling Cost	how much time and resources are used in the cost of the coupling algorithm as well as load imbalance

CPMIP metrics

Metric	used to evaluate ...
Simulation Year Per Day (SYPD)	how efficient is your sim job per each year of the simulation
Core-hours Per Year (CHPY)	how efficient is your sim job with respect to the number of parallel resources used
Complexity	the number of prognostic variables per component
Actual SYPD	how affect queue time and interruptions to the complete experiment
Parallelization	total number of cores allocated for the run
Energy Cost Per Year (JCPY)	how much energy is needed per each year of simulation
Memory Bloat	the ratio between actual and ideal memory size
Data Output Cost	how much time and resources are used performing I/O
Data Intensity	the amount of data produced per compute-hour
Coupling Cost	how much time and resources are used in the cost of the coupling algorithm as well as load imbalance

- Improve the computational performance evaluation of our ESMs
  - Compare the performance of models running similar CMIP6 experiments.
  - Evaluate the performance of a model compared to others with a similar complexity.
  - Evaluate the performance of one platform compared to others running the same model.
  - Evaluate the efficiency of a model when the complexity increase (more components, higher resolution…).
  - Evaluate the performance of a model from different points of view and find main bottlenecks.

CPMIP: Community List

Model / Institution	People Involved
CNRM-CM6	E. Maisonnave, S.Valcke, Marie Pierre Moine
IPSL-CM	Arnaud Caubel
EC-Earth	Mario Acosta, Uwe Fladrich, Philippe Le Sager
MetO	Harry Shepherd, JC Rioual
CMCC	Italo Epicoco, Silvia Mocavero
MPI-M-DKRZ	Maria Moreno, Reinhard Budich
U. Read	Grenville Lister, Bryan Lawrence
Nor-ESM	Alok Kumar Gupta
NCAR CESM	Gary Strand
TOPAZ/MOM5	Paulo Nobre
GFDL	Niki Zadeh

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

CMIP6 Summary

CMIP6 Experiments: Institutions/Models	Useful SY	Total SY	Useful Data Produced (PB)	Total Data Produced (PB)	Useful CH (Mh)	Total CH (Mh)	Total Energy Cost (Joules)	Carbon Footprint ($CO2/KWh$)
EC-Earth	17,598	27,568	0.73	1.34	27.2	41.8	$1.27x10^{12}$	162.6t
CNRM-CERFACS	23,620	72,000	1.2	1.98	106.4	325	3.13E+12	49.5t
IPSL	53,000	143,000	1.2	7	100	270	6.16E+12	122t
CMCC	965	NA	0.965	NA	1.99	NA	1.61E+12	
UKMO	23,431	NA	7.3	NA	473	NA	1.76E+13	572.5t
DKRZ	1,276	1,321	0.606	NA	5.52	5.90	4.09E+11	24.8t
NCC-NORESM2	6,484	NA	0.297	NA	11.7	NA	4.75E+11	
NERC	640	NA	0.460	NA	55.497	NA	2.17E+12	
MPI	24,175	35,000	1.9	NA	968.116	NA	6.20E+11	37.6t

* We have also Useful SY, Useful Data and Useful CH per CMIP6 experiment

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

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

CMIP6 Summary

IS-ENES3 1st General Assembly
25-27th March 2020
Toulouse, France

CMIP6 Experiments: Institutions/Models	Useful SY	Total SY	Useful Data Produced	Total Data Produced	Useful CH (Mh)	Total CH (Mh)	Total Energy Cost (Joules)	Carbon Footprint (CO_2/KWh)
EC-Earth	17,5 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41.8	1.27×10^{12}	162.6t
CNRM-CERFACS	23,6 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]06.4	325	3.13E+12	49.5t
IPSL	53,0 [illegible]	[illegible]	[illegible]	[illegible]	100	270	6.16E+12	122t
CMCC	96 [illegible]	[illegible]	[illegible]	[illegible]	1.99	NA	1.61E+12	
UKMO	23,4 [illegible]	[illegible]	[illegible]	[illegible]	473	NA	1.76E+13	572.5t
DKRZ	1,2 [illegible]	[illegible]	[illegible]	[illegible]	5.52	5.90	4.09E+11	24.8t
NCC-NORESM2	6,484	NA	0.297	NA	11.7	NA	4.75E+11	
NERC	640	NA	0.460	NA	55.497	NA	2.17E+12	
MPI	24,175	35,000	1.9	NA	968.116	NA	6.20E+11	37.6t

Please take these numbers as first (and not accurate) approximation

- Total Energy cost is calculated multiplying useful SY and the proportional average of JPSY for the set of CMIP6 experiment per institution.
- CO_2 is calculated using factor conversion and PUE, proposed by carbon footprint group and yet in discussion.

* We have also Useful SY, Useful Data and Useful CH per CMIP6 experiment

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

CMIP6 Summary

CMIP6 Experiments: Institutions/Models	Useful SY	Total SY	Useful Data Produced (PB)	Total Data Produced (PB)	Useful CH (Mh)	Total CH (Mh)	Total Energy Cost (Joules)	Carbon Footprint (CO_2/KWh)
EC-Earth	17,598	27,568	0.73	1.34	27.2	41.8	1.27×10^{12}	162.6t
CNRM-CERFACS	23,620	72,000	1.2	1.98	106.4	325	3.13E+12	49.5t
IPSL	53,000	143,000	1.2	7	100	270	6.16E+12	122t
CMCC	965	NA	0.965	NA	1.99	NA	1.61E+12	
UKMO	23,431	NA	7.3	NA	473	NA	1.76E+13	572.5t
DKRZ	1,276	1,321	0.606	NA	5.52	5.90	4.09E+11	24.8t
NCC-NORESM2	6,484	NA	0.297	NA	11.7	NA	4.75E+11	
NERC	640	NA	0.460	NA	55.497	NA	2.17E+12	
MPI	24,175	35,000	1.9	NA	968.116	NA	6.20E+11	37.6t

* We have also Useful SY, Useful Data and Useful CH per CMIP6 experiment

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

CPMIP: Community Numbers

Model-Exp-Inst.	Resol	Cmpx	SYPD	ASYPD	CHSY	Paral.	JPSY	Coup. C..	Mem. B.	DO.	DI	Useful Years
EC-Earth3-BSC	1.60 E+07	0.311	15.2	9.87	1119	768	4.41 E+07	0.080	11	1.12	0.03	3765
EC-Earth-KNMI	1.60 E+07	0.311	16.2	16.2	1286	868						1009
EC-EarthVeg-SMHI	1.60 E+07		12.44	6.653	1676	864					0.028	6337
GFDL-CM4-piC	8.35 E+07	31.00	9.98	8.16	15383	6399	5.88 E+08	0.260	16.09	1.24	89.43	657
GFDL-ESM4-piC	2.45 E+07	140.00	8.65	7.46	13570	4893	5.19 E+08	0.270	40.57		43.99	1124
GFDL-OM4-p25	8.16 E+07	11.00	11.50	7.05	9746	4671	3.72 E+08	0.130	47.64		173.96	300
GFDL-OM4-p5	2.18 E+07	13.00	15.90	12.22	1962	1300	7.50 E+07	0.140	33.61		76.86	300
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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

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

CPMIP: Community Numbers

Model- Exp- Inst.	Resol	Cmpx	SYPD	ASYPD	CHSY	Paral.	JPSY	Coup. C..	Mem. B.	DO.	DI	Useful Years
CNRM-CM6-1	1.02 E+07	181	6.5	5	1920	520	4.80 E+07					
CNRM-CM6-1-atm	2.24 E+06	128	7.3	6.1	1320	393	3.50 E+07					
CNRM-CM6-1-HR	2.79 E+08	181	1.5	1.48	19040	1347	5.28 E+08					
CNRM-CM6-1-HR-atm	1.65 E+08	128	2.2	1.8	8720	781	2.28 E+08					
IPSL-CM6A	1.04 E+07	750	12	11.5	1900	950	1.16 E+08	0.050	10	1.20	0.07	53,000
NorESM2-LM	7.77 E+06		13.84	3.03	1664	960	5.60 E+07	0.035			0.065	5463
NorESM2-MM	9.10 E+06		8.96	6,14	4885	1824	1.65 E+08	0.32			0.06	1021

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

CPMIP: Community Numbers

Model- Exp- Inst.	Resol	Cmpx	SYPD	ASYPD	CHSY	Paral.	JPSY	Coup. C..	Mem. B.	DO.	DI	Useful Years
HadGEM3-GC31-MM-UKMO	1.42 E+08	236	1.65	1.32	62836	4320	2.33 E+09	0.105	120	1.02	0.05	2386
HadGEM3-GC31-LL-UKMO	1.41 E+07	228	4	3.55	13392	2232	4.97 E+08	0.061	46	1.03	0.074	5610
UKESM1-0-LL-UKMO	1.41 E+07	372	4.3	3.6	16074	2880	5.97 E+08	0.098	4.6	1.03	0.019	15435
DKRZ-MPI-ESM1-HR	2.00 E+07		13.33	11	515352		3.21 E+08					1864
MPI-ESM1-LR	3.12 E+06		55.6	22.7	388.7	878	2.56 E+07					18860
MPI-ESM1-LR-ATM	8.67 E+05		45.9	25.2	163.2	312	1.11 E+07					991
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]

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

CPMIP: Community Numbers

Model- Exp- Inst.	Resol	Cmpx	SYPD	ASYPD	CHSY	Paral.	JPSY	Coup. C..	Mem. B.	DO.	DI	Useful Years
UKESM1-0-LL-NERC	1.14 E+07	252	2.02	1.1	8568	720	3.18 E+08	0.078	28	1.19	39	195
UKESM1-AMIP-NERC	2.35 E+06	202	1.64	1.41	7358	504	1.04 E+08	0	52.5	1.31	25.7	45
HadGEM3-GC3.1-SS_NERC	1.14 E+07	150	4.25	1.06	12268	2160	4.33 E+08	0.047	56.8	1.41	194	70
HadGEM3-GC3.1-MM_NERC	1.97 E+08	54	0.58	0.46	192412	4656	7.70 E+09	0.21	154		107	65
HadGEM3-GC3.1-LL_NERC	1.24 E+09	54	0.49	0.34	585540	12024	2.30 E+10		183	1.41	207	65

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

CPMIP metrics

- Improve the computational performance evaluation of our ESMs
  - **Compare the performance of models running similar CMIP6 experiments.**
  - Evaluate the performance of a model compared to others with a similar complexity.
  - Evaluate the performance of one platform compared to others running the same model.
  - Evaluate the efficiency of a model when the complexity increase (more components, higher resolution…).
  - Evaluate the performance of a model from different points of view and find main bottlenecks.

CPMIP: Community Numbers

Platforms: Mistral (DKRZ), MN4 (BSC), Curie (IPSL),

CMIP6 Type Experiment: sspX-X.X

Model- Exp- Inst.	Resol	Cmpx	SYPD	ASYPD	CHSY	Paral.	JPSY	Coup. C..	Mem. B.	DO.	DI	Useful Years
DKRZ-MPI-ESM1-HR	2.00 E+07		13.33	11	515352		3.21 E+08					1864
EC-Earth3-BSC	1.60 E+07	0.31 1	15.2	9.87	1119	768	4.41 E+07	0.080	11	1.12	0.03	3765
IPSL-CM6A	1.04 E+07	750	12	11.5	1900	950	1.16 E+08	0.050	10	1.20	0.07	53,000
NorESM2-LM	7.77 E+06		13.8 4	3.03	1664	960	5.60 E+07	0.035			0.065	5463

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

CPMIP: Community Numbers

Platforms: Rhino (KNMI), [xce,xcf,xcs-r] (UKMO), Beaufix2 (CNRM), SCC (CMCC), Mistral (DKRZ)

CMIP6 Type Experiment: abrupt4xCO2

Model- Exp-Inst.	Resol	Cmpx	SYPD	ASYPD	CHSY	Paral.	JPSY	Coup. C..	Mem. B.	DO.	DI	Useful Years
EC-Earth-Aerchem-KNMI	1.60 E+07	11	3.03	3.03	3549	448			11			730
HadGEM3-GC31-LL-UKMO	1.41 E+07	228	4	3.55	13392	2232	4.97 E+08	0.061	46	1.03	0.074	5610
CNRM-CM6-1	1.02 E+07	181	6.5	5	1920	520	4.80 E+07					
CMCC-CM2-SR5	8.00E +06	844	6.68	6.5	2068	576	1.67 E+09	0.074	17.8	1.04	0.05	965

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

CPMIP: Community Numbers

Platforms: Archer (NERC), Beaufix2 (CNRM), [xce,xcf,xcs-r] (UKMO)

CMIP6 Type Experiment: HiRes

Model- Exp- Inst.	Resol	Cmpx	SYPD	ASYPD	CHSY	Paral.	JPSY	Coup. C..	Mem. B.	DO.	DI	Useful Years
HadGEM3-GC3.1-LL_NERC	1.24 E+09	54	0.49	0.34	585540	12024	2.30 E+10		183	1.41	207	65
CNRM-CM6-1-HR	2.79 E+08	181	1.5	1.48	19040	1347	5.28 E+08					
HadGEM3-GC3.1-MM_NERC	1.97 E+08	54	0.58	0.46	192412	4656	7.70 E+09	0.21	154		107	65
HadGEM3-GC31-MM-UKMO	1.42 E+08	236	1.65	1.32	62836	4320	2.33 E+09	0.105	120	1.02	0.05	2386

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

CPMIP metrics

- Improve the computational performance evaluation of our ESMs
  - Compare the performance of models running similar CMIP6 experiments.
  - Evaluate the performance of a model compared to others with a similar complexity.
  - **Evaluate the performance of one platform compared to others running the same model.**
  - **Evaluate the efficiency of a model when the complexity increase (more components, higher resolution…).**
  - **Evaluate the performance of a model from different points of view and find main bottlenecks.**

CPMIP metrics

- Improve the computational performance evaluation of our ESMs
  - Compare the performance of models running similar CMIP6 experiments.
  - Evaluate the performance of a model compared to others with a similar complexity.
  - **Evaluate the performance of one platform compared to others running the same model.**
  - **Evaluate the efficiency of a model when the complexity increase (more components, higher resolution…).**
  - **Evaluate the performance of a model from different points of view and find main bottlenecks.**

EC EARTH

IS-ENES3 1st General Assembly
25-27th March 2020
Toulouse, France

CPMIP: First Analysis

Model Configuration: EC-Earth3 and EC-earth-veg

Platforms: MN4 (BSC), Beskow and Tetralith (SMHI) and Rhino (KNMI)

CMIP6 Type Experiment: historical, piControl, ssp1-2.6, ssp2-4.5, ssp3-7.0, ssp5-8.5, ssp1-1.9, ssp5-3.4-OS

	SYPD	ASYPD	CHSY	Coupling Cost	Data Output Cost	Parallel
CMIP6 Experiments	BSC: 15.2 KNMI:16.2 SMHI:12.4	BSC: 9.87 KNMI:16.2 SMHI:6.65	BSC: 1119 KNMI:1276 SMHI:1676	BSC: 8% KNMI: SMHI:	BSC: 12% KNMI: SMHI:	BSC: 768 KNMI: 864 SMHI: 864

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

CPMIP: First Analysis

Model Configuration: EC-Earth3 and EC-earth-veg

Platforms: MN4 (BSC), Beskow and Tetralith (SMHI) and Rhino (KNMI)

CMIP6 Type Experiment: historical, piControl, ssp1-2.6, ssp2-4.5, ssp3-7.0, ssp5-8.5, ssp1-1.9, ssp5-3.4-OS

	SYPD	ASYPD	CHSY	Coupling Cost	Data Output Cost	Parallel
CMIP6 Experiments	BSC: 15.2 KNMI:16.2 SMHI:12.4	BSC: 9.87 KNMI:16.2 SMHI:6.65	BSC: 1119 KNMI:1276 SMHI:1676	BSC: 8% KNMI: SMHI:	BSC: 12% KNMI: SMHI:	BSC: **768** KNMI: **864** SMHI: 864

Comparing Platforms (BSC and KNMI)

SYPD ↑ **CHSY** ↑

MN4 and Rhino have similar performance

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

CPMIP: First Analysis

Model Configuration: EC-Earth3 and EC-earth-veg

Platforms: MN4 (BSC), Tetralith (SMHI) and Rhino (KNMI)

CMIP6 Type Experiment: historical, piControl, ssp1-2.6, ssp2-4.5, ssp3-7.0, ssp5-8.5, ssp1-1.9, ssp5-3.4-OS

	SYPD	ASYPD	CHSY	Coupling Cost	Data Output Cost	Parallel
CMIP6 Experiments	BSC: 15.2 KNMI:16.2 SMHI:12.4	BSC: 9.87 KNMI:16.2 SMHI:6.65	BSC: 1119 KNMI:1276 SMHI:1676	BSC: 8% KNMI: SMHI: (15%)	BSC: 12% KNMI: SMHI:	BSC: 768 KNMI: **864** SMHI: **864**

Comparing Configurations (KNMI and SMHI)

SYPD ↓ **CHSY** ↑ **Coupling Cost** ↑ **Memory Size** ↑

LPJGUESS is less efficient than IFS or NEMO

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

CPMIP: First Analysis

Model Configuration: EC-Earth3 and EC-earth-veg

Platforms: MN4 (BSC), Beskow and Tetralith (SMHI) and Rhino (KNMI)

CMIP6 Type Experiment: historical, piControl, ssp1-2.6, ssp2-4.5, ssp3-7.0, ssp5-8.5, ssp1-1.9, ssp5-3.4-OS

	SYPD	ASYPD	CHSY	Coupling Cost	Data Output Cost	Parallel
CMIP6 Experiments	BSC: **15.2** KNMI:16.2 SMHI:**12.4**	BSC: **9.87** KNMI:16.2 SMHI:**6.65**	BSC: 1119 KNMI:1276 SMHI:1676	BSC: 8% KNMI: SMHI:	BSC: 12% KNMI: SMHI:	BSC: 768 KNMI: 864 SMHI: 864

	SYPD	ASYPD
GFDL-CM4-piC	9.98	8.16
CMCC-CM5-SR5	6.68	6.5
IPSL-CM6	12	11.5
MPI-ESM1-HR	13.33	11

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

CPMIP: First Analysis

Model Configuration: EC-Earth3 and EC-earth-veg

Platforms: MN4 (BSC), Beskow and Tetralith (SMHI) and Rhino (KNMI)

CMIP6 Type Experiment: historical, piControl, ssp1-2.6, ssp2-4.5, ssp3-7.0, ssp5-8.5, ssp1-1.9, ssp5-3.4-OS

	SYPD	ASYPD	CHSY	Coupling Cost	Data Output Cost	Parallel
CMIP6 Experiments	BSC: **15.2** KNMI:16.2 SMHI:**12.4**	BSC: **9.87** KNMI:16.2 SMHI:**6.65**	BSC: 1119 KNMI:1276 SMHI:1676	BSC: 8% KNMI: SMHI:	BSC: 12% KNMI: SMHI:	BSC: 768 KNMI: 864 SMHI: 864

	SYPD	ASYPD
GFDL-OM4-p25 HadGEM3-GC3.1-SS_NERC NorESM2-LM MPI-ESM1-LR	11.50 4.25 13.84 55.6	7.05 1.06 3.03 22.7

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

ASYPD study

experiment	Type	platform	compiler	parallelization
EC-Earth-BSC	AMIP	CCA	Intel	756
EC-Earth-BSC	AMIP	MN4	Intel	516

*Total Times are based on CMIP6-AMIP Test (20 years, 5 member average)

experiment	parallelization	SYPD	ASYPD	RSYPD	CHPSY	Data Volume
cab(CCA)	756	16.57	12.7	9.7	1043.93	21GB
mas(MN4)	516	17.97	17.51	3.97	648.41	21GB

(HH:MM:SS)

experiment	Queue T. Model (Avg)	Run Model (Avg)	Queue Model (Tot)	Run Model (Tot)	Post (Avg)	Queue Post (Avg)	Post (Tot)	Queue Post (Tot)
cab(CCA)	00:23:00	01:26:23	08:20:10	29:01:42	00:16:54	00:00:50	05:35:24	00:19:32
mas(MN4)	00:01:47	01:21:05	00:27:46	26:53:32	00:11:42	01:23:37	04:13:03	34:20:08

ASYPD is considering only queue time of model job
RSYPD is considering queue time, interruptions, clean, data movement and postprocessing

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

ASYPD study

experiment	Type	platform	compiler	parallelization
EC-Earth-BSC	AMIP	CCA	Intel	756
EC-Earth-BSC	AMIP	MN4	Intel	516

*Total Times are based on CMIP6-AMIP Test (20 years, 5 member average)

experiment	parallelization	SYPD	ASYPD	RSYPD	CHPSY	Data Volume
cab(CCA)	756	16.57	12.7	9.7	1043.93	21GB
mas(MN4)	516	17.97	17.51	3.97	648.41	21GB

(HH:MM:SS)

experiment	Queue T. Model (Avg)	Run Model (Avg)	Queue Model (Tot)	Run Model (Tot)	Post (Avg)	Queue Post (Avg)	Post (Tot)	Queue Post (Tot)
cab(CCA)	00:23:00	01:26:23	08:20:10	29:01:42	00:16:54	00:00:50	05:35:24	00:19:32
mas(MN4)	00:01:47	01:21:05	00:27:46	26:53:32	00:11:42	01:23:37	04:13:03	34:20:08

ASYPD is considering only queue time of model job
RSYPD is considering queue time, interruptions, clean, data movement and postprocessing

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

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

ASYPD study

IS-ENES3 1st General Assembly
25-27th March 2020
Toulouse, France

experiment	Type	platform	compiler	parallelization
EC-Earth-BSC	AMIP	CCA	Intel	756
EC-Earth-BSC	AMIP	MN4	Intel	516

*Total Times are based on CMIP6-AMIP Test (20 years, 5 member average)

experiment	parallelization	SYPD	ASYPD	RSYPD	CHPSY	Data Volume
cab(CCA)	756	16.57	12.7	9.7	1043.93	21GB
mas(MN4)	516	17.97	17.51	3.97	648.41	21GB

(HH:MM:SS)

experiment	Queue T. Model (Avg)	Run Model (Avg)	Queue Model (Tot)	Run Model (Tot)	Post (Avg)	Queue Post (Avg)	Post (Tot)	Queue Post (Tot)
cab(CCA)	00:23:00	01:26:23	08:20:10	29:01:42	00:16:54	00:00:50	05:35:24	00:19:32
mas(MN4)	00:01:47	01:21:05	00:27:46	26:53:32	00:11:42	01:23:37	04:13:03	34:20:08

ASYPD is considering only queue time of model job
RSYPD is considering queue time, interruptions, clean, data movement and postprocessing

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

ASYPD study

experiment	Type	platform	compiler	parallelization
EC-Earth-BSC	AMIP	CCA	Intel	756
EC-Earth-BSC	AMIP	MN4	Intel	516

*Total Times are based on CMIP6-AMIP Test (20 years, 5 member average)

experiment	parallelization	SYPD	ASYPD	RSYPD	CHPSY	Data Volume		
cab(CCA)	756	16.57	12.7	9.7	1043.93	21GB		
mas(MN4)	516	17.97	17.51	3.97	648.41	21GB		
experiment	Queue T. Model (Avg)	Run Model (Avg)	Queue Model (Tot)	Run Model (Tot)	Post (Avg)	Queue Post (Avg)	Post (Tot)	Queue Post (Tot)
cab(CCA)	00:23:00	01:26:23	08:20:10	29:01:42	00:16:54	00:00:50	05:35:24	00:19:32
mas(MN4)	00:01:47	01:21:05	00:27:46	26:53:32	00:11:42	01:23:37	04:13:03	34:20:08

(HH:MM:SS)

ASYPD is considering only queue time of model job
RSYPD is considering queue time, interruptions, clean, data movement and postprocessing

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

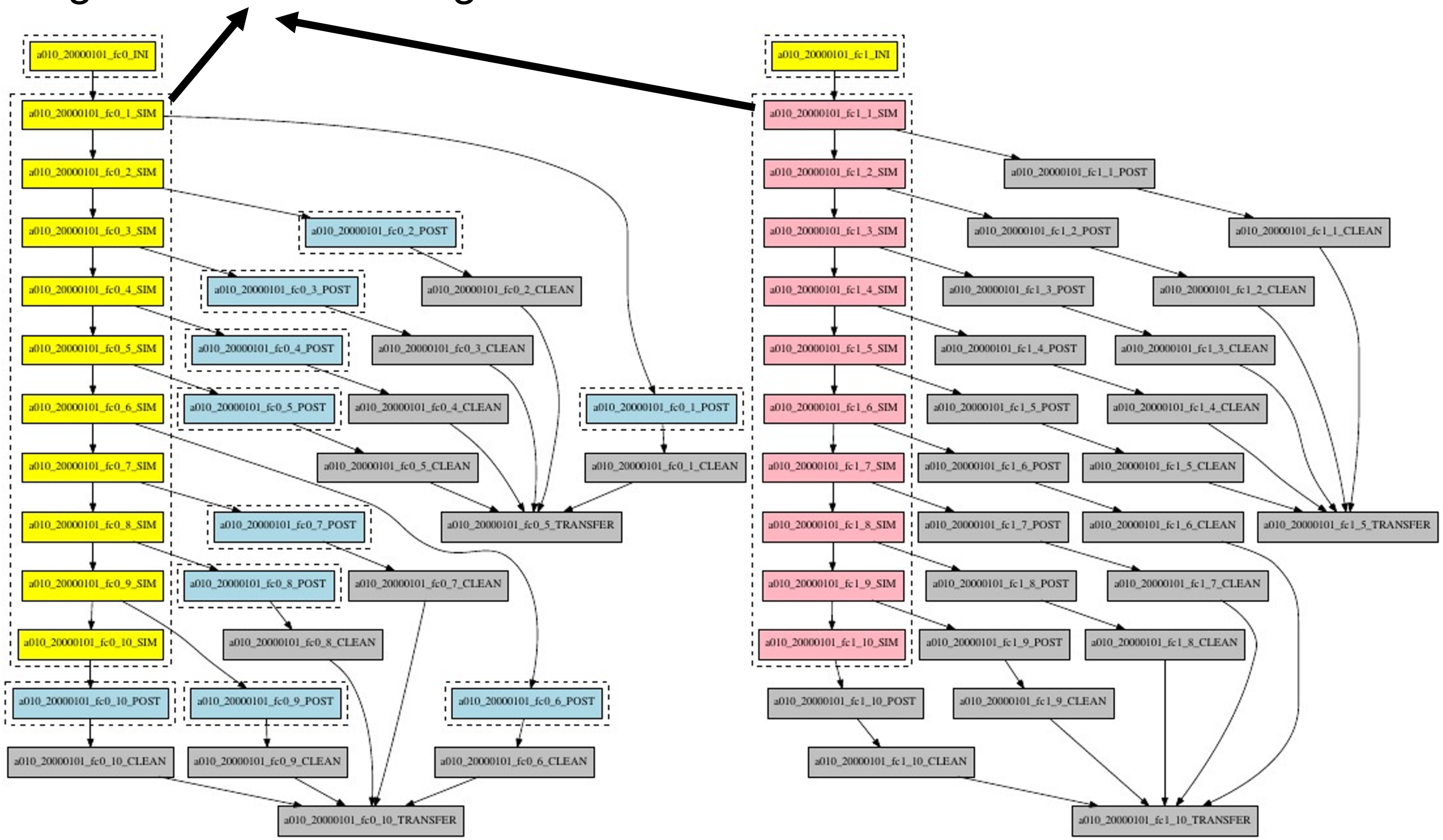
is-enes
INFRASTRUCTURE FOR THE EUROPEAN NETWORK FOR EARTH SYSTEM MODELLING

ASYPD study

IS-ENES3 1st General Assembly
25-27th March 2020
Toulouse, France

Using workflow manager/queue system wrappers to avoid unneeded queues

Including several chunks together to increase Time Duration Job

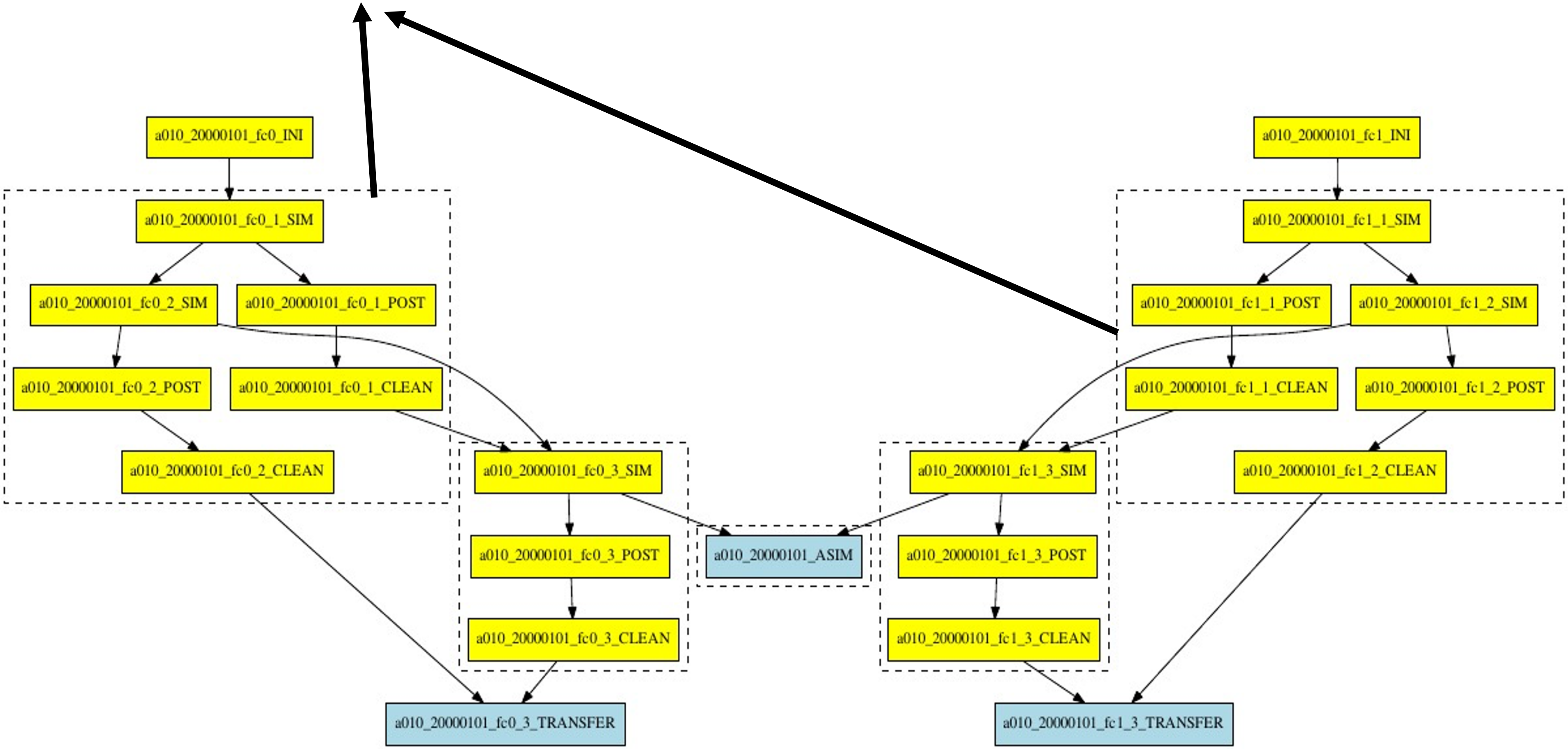


The IS-ENES3 project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824084

ASYPD study

Using workflow manager/queue system wrappers to avoid unneeded queues

Including more tasks together to avoid jobs with few processes

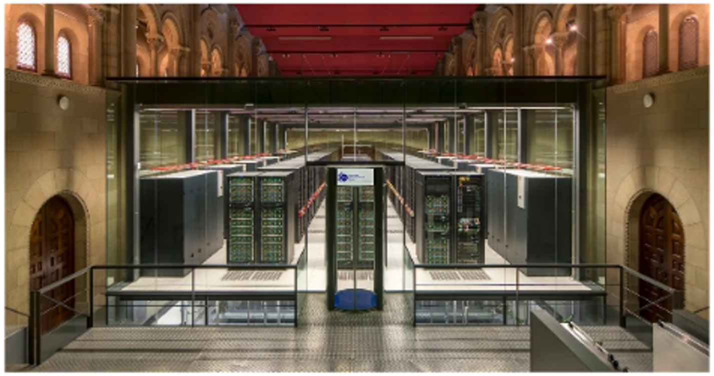


The IS-ENES3 project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824084

EC-Earth ~10km demonstrator

Operational global, coupled ~10 km simulations (T1279 - ORCA12):

- **EC-Earth 3.2** (IFS36r4 + NEMO 3.6 + OASIS3-MCT)
- **5,040 MPI tasks** - 0.44 SYPD, 160 SDPD
  - 3,209 NEMO
  - 1,584 IFS
  - 69 XIOS
  - 1 runoff mapper
- **MareNostrum4** @ BSC



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

CPMIP analysis ~10km Demo

Positive

Negative

Memory size (↑)

- Not a problem if it can be distributed among nodes using domain decomposition.
- XIOS requires a lot of memory → Affinity study and distribution among NEMO nodes are mandatory.

Coupling Cost (↑)

- Interpolation algorithms seem to scale properly.
- Using the number of parallel resources to have a similar SYPD per component waste significant resources (200 unneeded NEMO processes!), Balance study will be mandatory.

Data Output Cost (↑)

- Increase the execution time of IFS up to 50%.
- Moving to IO server alternatives is critical and ensure that these new approaches are efficient for the new challenges

ASYPD: Post-processing (↓)

- Data intensity is so huge that post-processing is almost impossible. Our tools are not ready to process all this data memory.
- Online alternatives and reduction of useful output should be explored → Coarsening methods, online diagnostics, accelerators...

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

Lessons learnt about the first collection

- Although CPMIP collection is important, it is secondary during the CMIP execution.
  - Facilitate portable and automatic processes will ensure the collection for all institutions, such as the integration with workflow managers.
  - In the meantime, your help as an extra effort will ensure the success of this collection.
- Some metrics can be collected after CMIP6 experiments, re-running them...
  - But be careful, some institutions have reported that re-run experiments (even partially) is too much expensive.

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

Lessons learnt about the first collection

- CPMIP collection is not only a dissemination process. It could be a very powerful tool to analyze the computational efficiency of a model across platforms, configurations…
- A proper CPMIP analysis needs some background
  - Specific details for each component of a model will facilitate the analysis.
- We thought that machine variability could be a problem for the comparison.
  - The range of variability is similar for most of the platforms, between 6-10%.

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

Lessons learnt about the first collection

- Normalize some metrics such as ASYPD could be helpful for future analysis.
  - Many institutions are including queue time and interruptions, but others are including only queue time or adding data movement, cleaning…
  - How much does each one of these sub-metrics affect to the set?
  - Post-processing could affect to ASYPD for some specific configurations, should it be studied? even though it is not included in the critical path of the execution...

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

Future

- Normalize results and be ready for the ES-DOC update.
- Prepare final collection at the end of 2020.
  - Not only for people finishing CMIP6 experiments but also for institutions who has not provided all metrics yet.
  - More institutions will join us (Sarat Sreepathi-E3SM model, indian and/or chinese models?).
- Interact with each institution to learn more about the particularities of each model for a proper analysis.
- Evaluate the possible improvement of some of the metrics (ASYPD, coupling cost, energy cost…).
- Final analysis, dissemination and publication of the results.

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

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

The Consortium

Coordinated by **CNRS-IPSL**, the IS-ENES3 project gathers **22 partners** in **11 countries**

CNRS with CEA, Sorbonne Université
Met Office
National Centre for Atmospheric Science – Natural Environment Research Council
DKRZ – Deutsches Klimarechenzentrum
BSC
CERFACS
CMCC – Centro Euro-Mediterraneo sui Cambiamenti Climatici
Koninklijk Nederlands Meteorologisch Instituut – Ministerie van Infrastructuur en Waterstaat
SMHI
UK Research and Innovation
UC – Universidad de Cantabria
DLR
netherlands eScience
Norwegian Meteorological Institute
METEO FRANCE – Toujours un temps d'avance
Manchester 1824 – The University of Manchester
Wageningen University & Research
Charles University
NORCE
LiU – Linköping University

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°824084

Our website
https://is.enes.org/

Follow us on Twitter !
@ISENES_RI

Contact us at
is-enes@ipsl.fr

Join the community on ZENODO !