



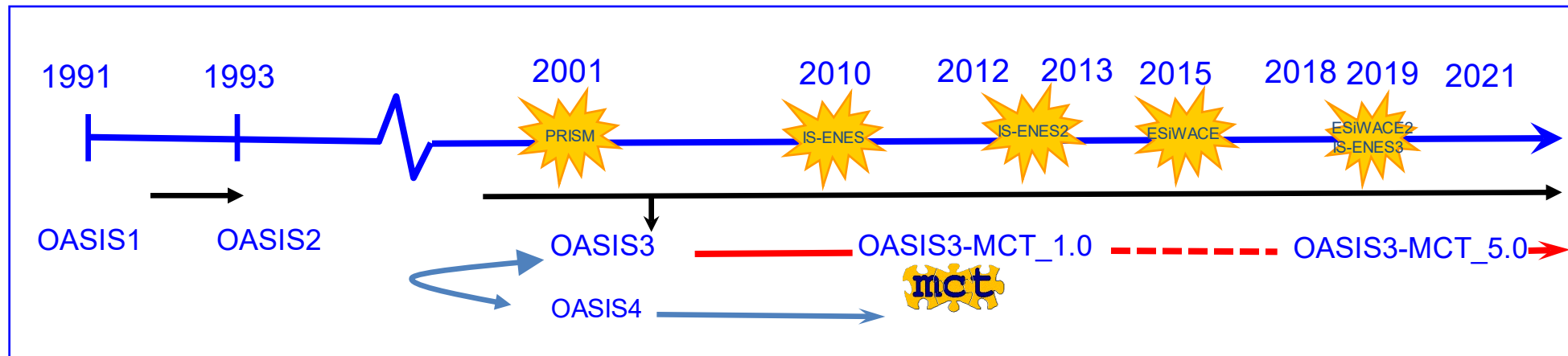
IS-ENES3 starring OASIS3-MCT, XIOS and Cylc

Sophie Valcke (Cerfacs)



current users (2019)
67 climate modelling
groups for more than
80 coupled applications

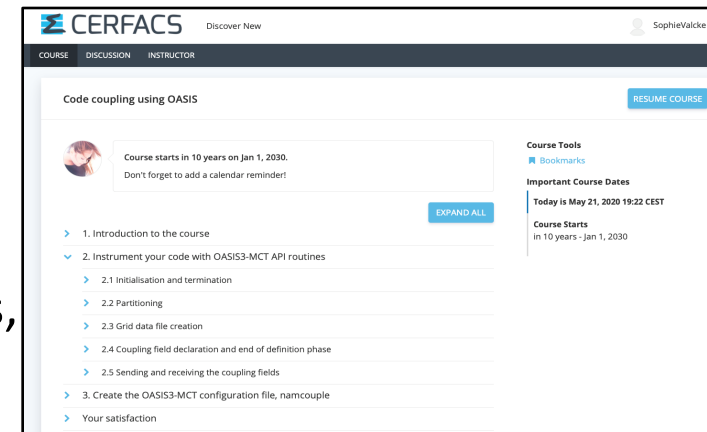
5 of the 7 European
ESMs in CMIP6



OASIS3-MCT_5.0 released December 2021 (deliverable D8.2)

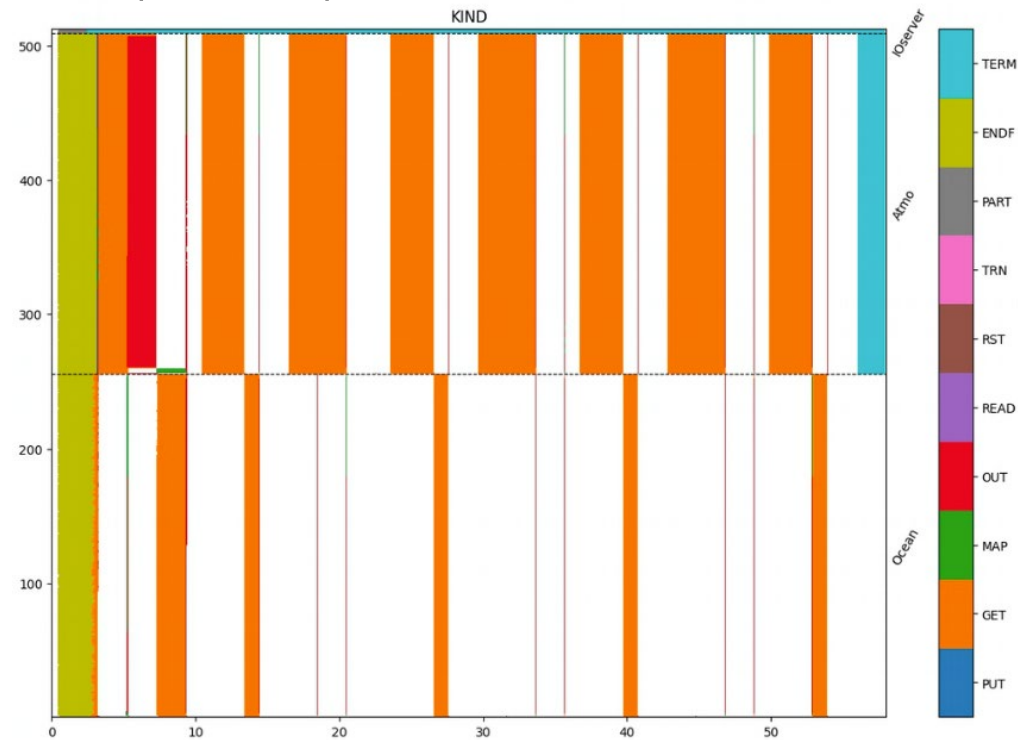
Source management and training

- Migration from SVN to GIT, full history
- New web site: <https://oasis.cerfacs.fr/>
- New Short Private Online Course (SPOC)
 - 20 hours on-line over 2 weeks: theory, videos, quizzes, hands-on with verification
 - instrument two toy models to set-up a coupled model exchanging one field in each direction
 - section on regridding/interpolation
- ✓ 3 sessions (2020, 2021, 2022), 22 participants, good overall feedback



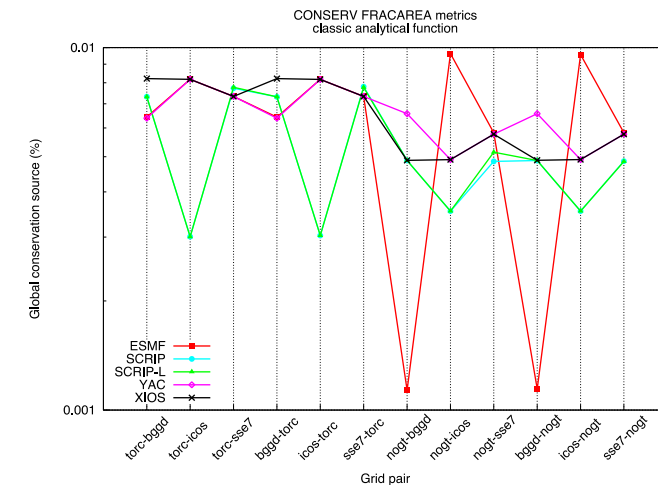
Tools / interface

- New Python, C & C++ bindings
 - SMHI : standalone regridding weight computation tool
 - INRIA: coupling between CROCO ocean model and trained IA model for downscaling atmospheric fluxes
- New load balancing tool (ex lucia)



Regridding / interpolation / ensembles

- Extension of oasis_get_intracomm for coupled models involving XIOS for ensemble simulations
- Locally-conservative runoff interpolation : no surface intersection, every source point needs a target neighbor (and not the opposite, as usual)
- Unified environment to use SCRIP, ESMF or XIOS offline to pre-calculate regridding weights
- Extensive benchmark of the regridding for SCRIP, ESMF, XIOS & YAC:
 - 5 algorithms (1st and 2nd order, conservative, ...)
 - 4 different analytical functions
 - 6 grids used in real ocean or atmosphere models
 - metrics by the CANGA project



Valcke et al 2022, [https://doi.org/ 10.3390/mca27020031](https://doi.org/10.3390/mca27020031)

Valcke et al 2021, Cerfacs Tech Report, TR-CMGC-21-145

- OASIS3-MCT will most probably satisfy a big part of the coupling community needs for at least the next 5 years
- Cerfacs and CNRS plan to keep on providing maintenance, active user support and training (SPOC) but probably no major evolution => in-kind contribution to ENES-RI of ~0.5 FTE
- On-going developments:
 - support for grids with dynamic masks
 - upgrade of compiling environment
 - new automated suite testing
 - environment for atmospheric mask definition based on ocean coastline
- Additional funding - TRACCS French national project (2024-2030, 6 PYs): further evolution and/or merging with XIOS

Come to the CW2023 side-event on the future of OASIS3-MCT (Wednesday Jan 18th, 18h15 at Cerfacs) !

XIOS-3 release

~3 years of intense developments, 60 000 code lines modified/added/deleted

- XIOS-3-beta September 2022 (D8.3 WP8)
- XIOS-3.0 released in few weeks in production mode for IPSL-ESM

⇒ Better transfer protocol fluidity, performance improvement

- Under evaluation : testcase : NEMO 4 configuration 1440 x 1680 x 75, 2000 timesteps, 2688 process, 80 XIOS servers, 2 levels of server, write every 50 ts
 - Whole time NEMO no IO => 350s
 - Whole time NEMO XIOS 2 => 472s : XIOS overhead 122 s
 - Whole time NEMO XIOS 3 => 403s : XIOS overhead 53 s => reduction of the overhead by more a factor 2
- Very preliminary results, very shorts testcase, time including XIOS initialization, strongly configuration dependant

⇒ Memory footprint reduction

- Same NEMO configuration
- XIOS2 Vs XIOS3 client+Model : reduction of 20% of whole memory
 - Cannot separate memory part consumption for model and XIOS































	XIOS2	XIOS3
Client + Model	150 Mo	120 Mo
Server N1	3.75 Go	2 Go
Server N2	30 Go	10 Go

- XIOS2 Vs XIOS3 server side : reduction of memory consumption up to a factor 3

⇒ Improvement of robustness and reliability

Implementation of a non regression suite testcase for continuous integration (compilation and execution)

Table of XIOS unit tests results

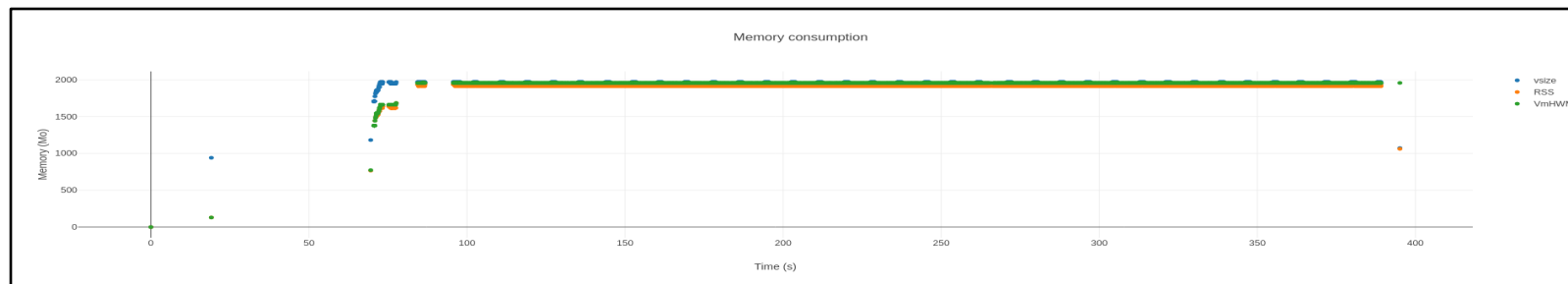
Revision	Jean-Zay	Irene			
2384	X64_JEANY_Z_PGI_prod  X64_JEANY_Z_prod 	X64_Irene_prod 			
		test_scalar_algo 			
		test_grid_algo 			
		CONFIG_AxisMask_false_DomMask_false_Dom_lmdz_Duration_1d_NDITr_false_NbCInt_4_NbSrv_2_OneSided_false_PctSrv2_50_ScaMask_sparse_Srv2_false 			
		CONFIG_AxisMask_false_DomMask_false_Dom_lmdz_Duration_1d_NDITr_false_NbCInt_4_NbSrv_2_OneSided_false_PctSrv2_50_ScaMask_none_Srv2_false 			
		test_dynamic_algo 			
		test_nemo_algo 			
		CONFIG_AxisMask_false_DomMask_true_Dom_nemo_Duration_1d_NDITr_false_NbCInt_4_NbSrv_2_OneSided_false_PctSrv2_50_ScaMask_none_Srv2_false 			
		atm_output_reduce_axis.nc			
		CONFIG_AxisMask_false_DomMask_false_Dom_nemo_Duration_1d_NDITr_false_NbCInt_4_NbSrv_2_OneSided_false_PctSrv2_50_ScaMask_none_Srv2_false 			
		test_domain_algo 			
		test_function 			
		test_axis_algo 			
		test_memory 			
		X64_Irene_GNU_prod 			

Representation of XIOS workflow execution in the form of graphs, viewable through a web browser

Help for debugging : output of the XIOS software stack in case of a crash, with relevant information

Additional internal output timers at the end of the simulation for better performance profiling

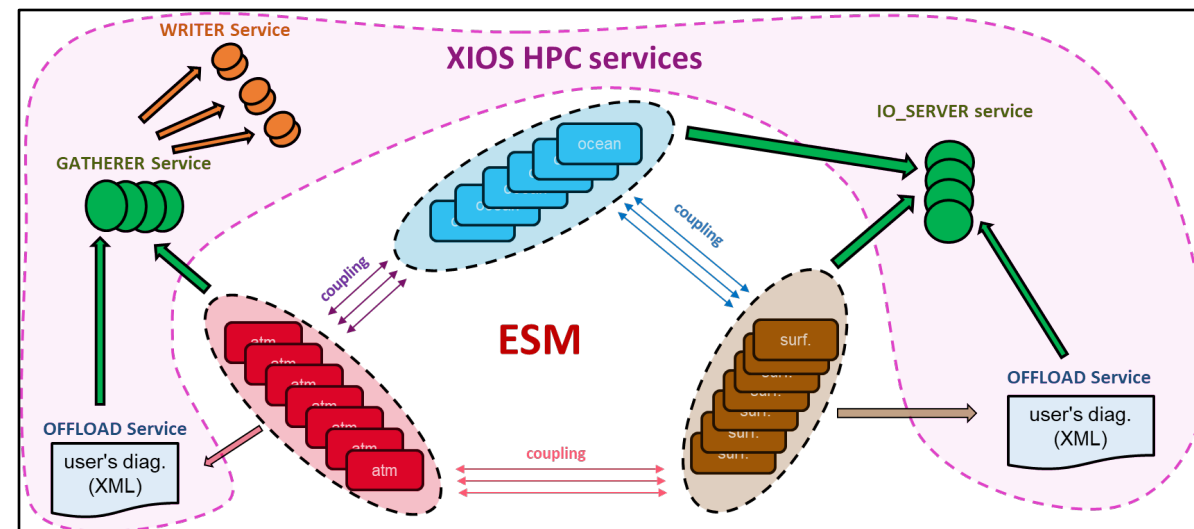
Tools to track internal memory usage and memory leak, time line visualization through web browser



⇒ New infrastructure introduce the HPC services

- Services are running asynchronously on a part of an available free pool resources or can totally overlap an other service
- XIOS provides mechanisms to exchange grid and data between services and models
- Previous XIOS2 services => gatherer, writer and reader services
- A model is now see as a specific service that provide data
- Model coupling is achieved by exchanging data between sender and receiver model/service
- Rationalized way to exchange data flux through MPI partition
 - model<->service, service<->service, model<->model

Description of services launching and models coupling described in a flexible way through external XLM files



- Developments:
 - Continue to improve performance and memory footprint reduction
 - Consolidate new services infrastructure, developing new services (ensembles, AI, python interface)
 - Consolidate coupling functionalities
 - Revisit the XIOS time line management (restartability)
 - Make the GPU port, preparing the arrival of exascale computer
- Support to the community
 - Best effort, even without founding : collaboration, development requirement, user list support
 - in-kind contribution to ENES-RI of 1.5 FTEs
- Additional funding - TRACCS French national project (2024-2030, 6 PYs)

Cylc/Rose developments



Cylc 8 & Rose 2 released July 2022 (deliverable D8.4)
~3.5 years of planning and development
~19 contributors



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Environment

- Replace obsolete PyGTK based GUIs with a new Web UI
- New Terminal UI in addition to the Web UI
- Easier installation via modern packaging systems (Conda and pip)
- Major overhaul of the User Documentation



Cylc Web UI

- Built as a Jupyter Server extension.
- Can be used standalone or via Jupyterhub

generic running [Add View](#)

Filter by t Filter t + -

tree x graph x

table x

Filter by task name Filter by task state

Task	Jobs	Cycle Point ↓ 1	Platform	Job System	Job ID	T-submit	T-start	T-fini
bar		20191210T1200Z						
bool		20191210T1200Z						
cycle_end		20191210T1200Z						
foo	▼	20191210T1200Z	localhost	background	59882	2022-11-04T11:21:24Z	2022-11-04T11:21:24Z	2022-11-04T11:21:24Z
fool	▼	20191210T1200Z	localhost	background	59883	2022-11-04T11:21:23Z	2022-11-04T11:21:24Z	2022-11-04T11:21:24Z
foot	▼	20191210T1200Z	localhost	background	59884	2022-11-04T11:21:23Z	2022-11-04T11:21:24Z	2022-11-04T11:21:24Z
pub		20191210T1200Z						
wipe_bar		20191210T1200Z						

DEVELOPMENT Cylc UI 1.3.0

Cylc TUI (terminal UI)

- Particularly useful on low bandwidth connections

```

Cylc8 - oliverh@niwa-10078231:~/cylc
democ8/run1 - running ( 1 11 )
TUI is experimental and may break with large flows

+ ● waz_a
+ ○ waz_b
+ ○ waz_c
- ○ 3002
+ ● BAR
- ○ QUX
+ ● qux_a_n1
+ ● qux_a_n2
+ ● qux_a_n3
- ● qux_a_n4
+ #05
+ #04
+ #03
- #02
    id
    submitNum
    state
    host
    jobRunnerName
    jobId
    startedTime
+ #01
+ ● qux_a_n5
+ ● qux_b_n1
+ ● qux_b_n2
+ ● qux_b_n3
+ ● qux_b_n4
+ ● qux_b_n5

Action
< [cancel] >
< hold >
< release >
< kill >
< trigger >
q to close

_n4|2

quit: q help: h context: enter tree: - ← + → navigation: ↑ ↓ ↵ Home End filter: F f s r
0 < 2* > python3 ↑ 2d 22h 28m < 2.1 1.9 1.2 < 2021-04-01 < 12:06 < niwa-10078231
  
```

Cylc 8 & Rose 2 released July 2022 (deliverable D8.4)

~3.5 years of planning and development

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Code and functionality

- Migration to Python 3
- Support for platforms consisting of group of hosts
- New scheduling algorithm ("spawn on demand")
- Support for required & optional outputs => workflows with branching



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New support for workflow installation (replacing functionality provided by Rose)



- The Met Office plan to keep on developing and providing user support and training => in-kind contribution to ENES-RI of ~2 FTE
- Plans for further developments :
 - Support for running multiple tasks in a single job
 - Better support for sub-workflows
 - Better “cloud” support
 - Workflow analytics
 - Better job log housekeeping
 - Python API

IS-ENES Cylc Webinar: planned for Thursday 16 March @10h00



THE CONSORTIUM

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



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/>



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is-enes@ipsl.fr



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IS-ENES3 H2020

IS-ENES3 DoW – WP8/JRA1: Models & Tools developments :

- T3: OASIS3-MCT development

- ★ Parallel and higher-accuracy library for the calculation of the interpolation weights.
- ★ Further development of LUCIA, the load balance analysis tool.
- ★ Diagnostics and pre - and post-processing transformations.
- ★ Development of Python bindings.

- T4: XIOS development

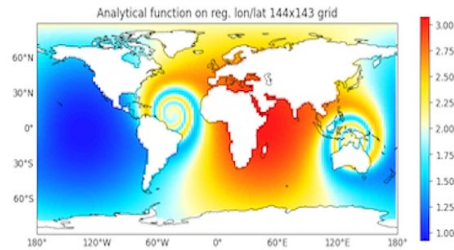
- Additional spatial transformations, time interpolation
- Restartability, multi threading
- ★ Robustness and reliability
- ★ Coupling
- ★ Extension of dr2xml package

- T5: Cylc/Rose development

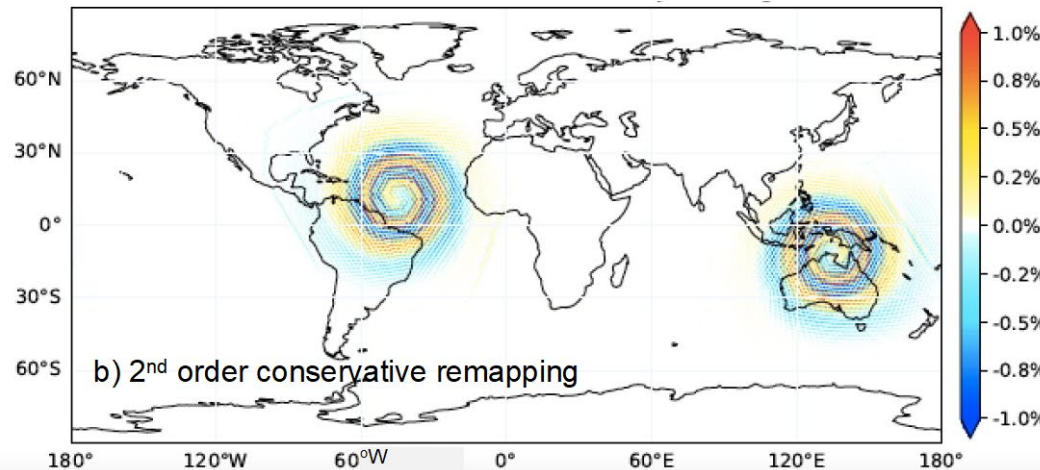
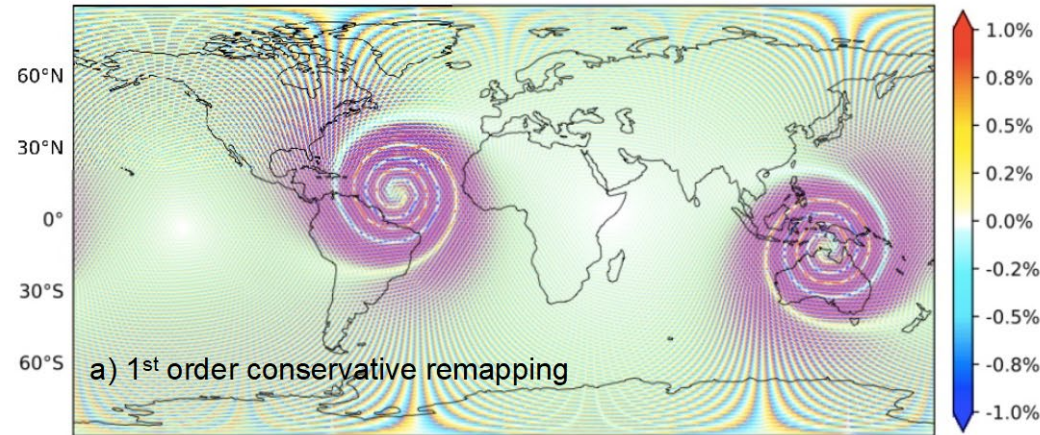
- ★ Improvements to the performance and scalability of Cylc to address the needs of increasingly complex workflows.
- ★ Addressing new requirements resulting from emerging applications
- ★ Adoption of new GUI technologies to replace the deprecated GTK+ 2 based GUIs.
- ★ Migration from Python 2 to 3.



Comparison between 1st and 2nd O conservative remapping error



vortex function



Error (%) for FRACAREA a) 1st & b) 2nd order conservative remapping with YAC for the vortex function from low- to high-resolution icosahedral grid

SCRIP, ESMF, XIOS, YAC
regridding benchmark