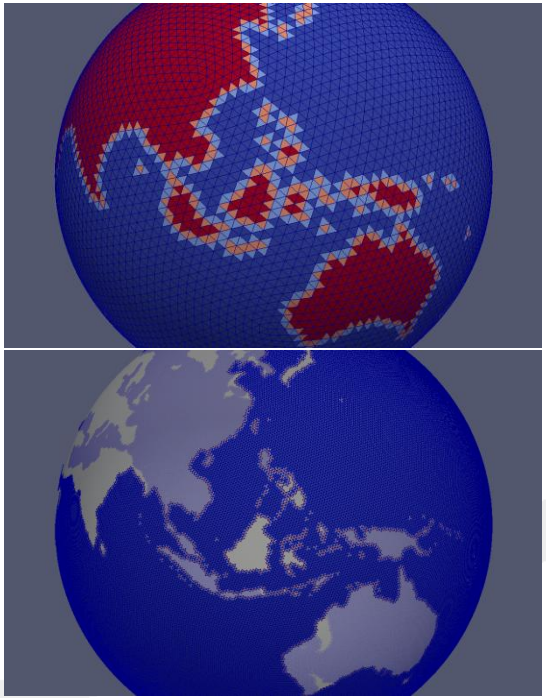
YAC 2 and ICON-ESM



Moritz Hanke (Deutsches Klimarechenzentrum)

Short introduction to YAC (Yet Another Coupler)

- Reseach project after OASIS4 failed together with René Redler (Max Planck Institute for Meteorology)
- YAC 1 first released in 2014-07
  - Concept of user interface similar to OASIS
  - Parallel online weight computation in 2D
    avg[1], nnn[2](avg, distance weighted, gauss weighted, rbf), file, fixed, patch recovery, spmap[3], hcsbb[4], conservative 1st and 2nd order
  - Interpolation stack concept
  - Support great- and lat-circle cell edges

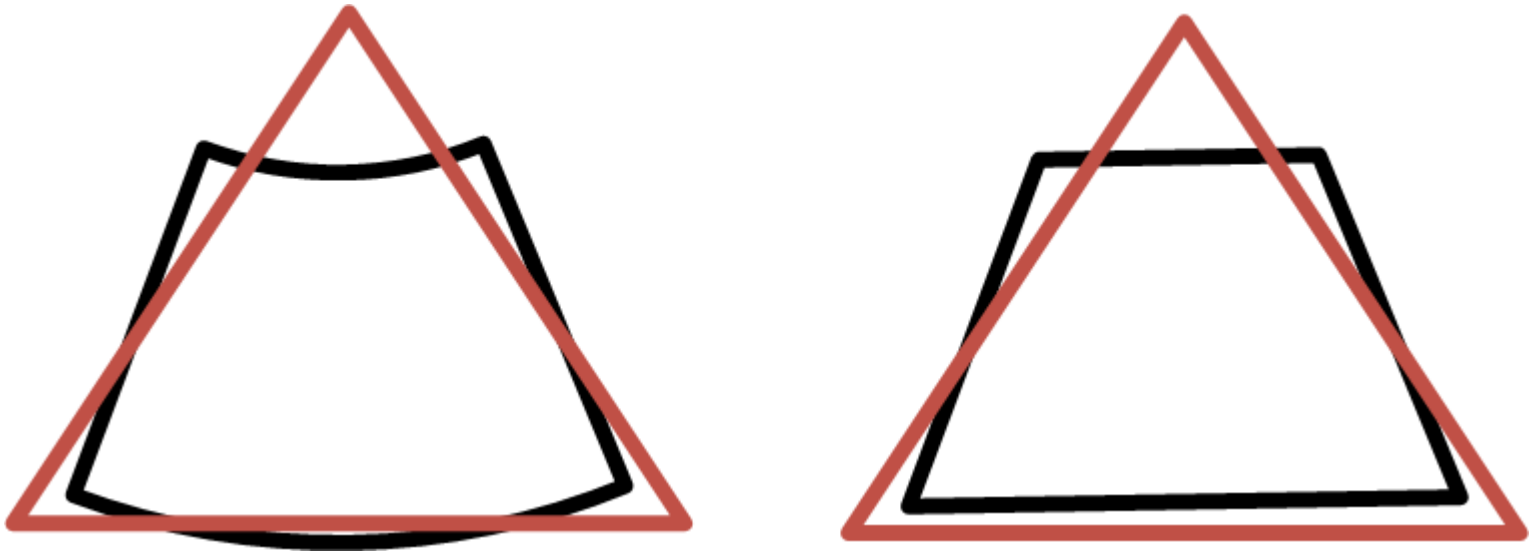
1: bilinear
2: Nearest source to destination
3: Nearest destination to source
4: hybrid cubic spherical Bernstein-Bezier patch

YAC 2

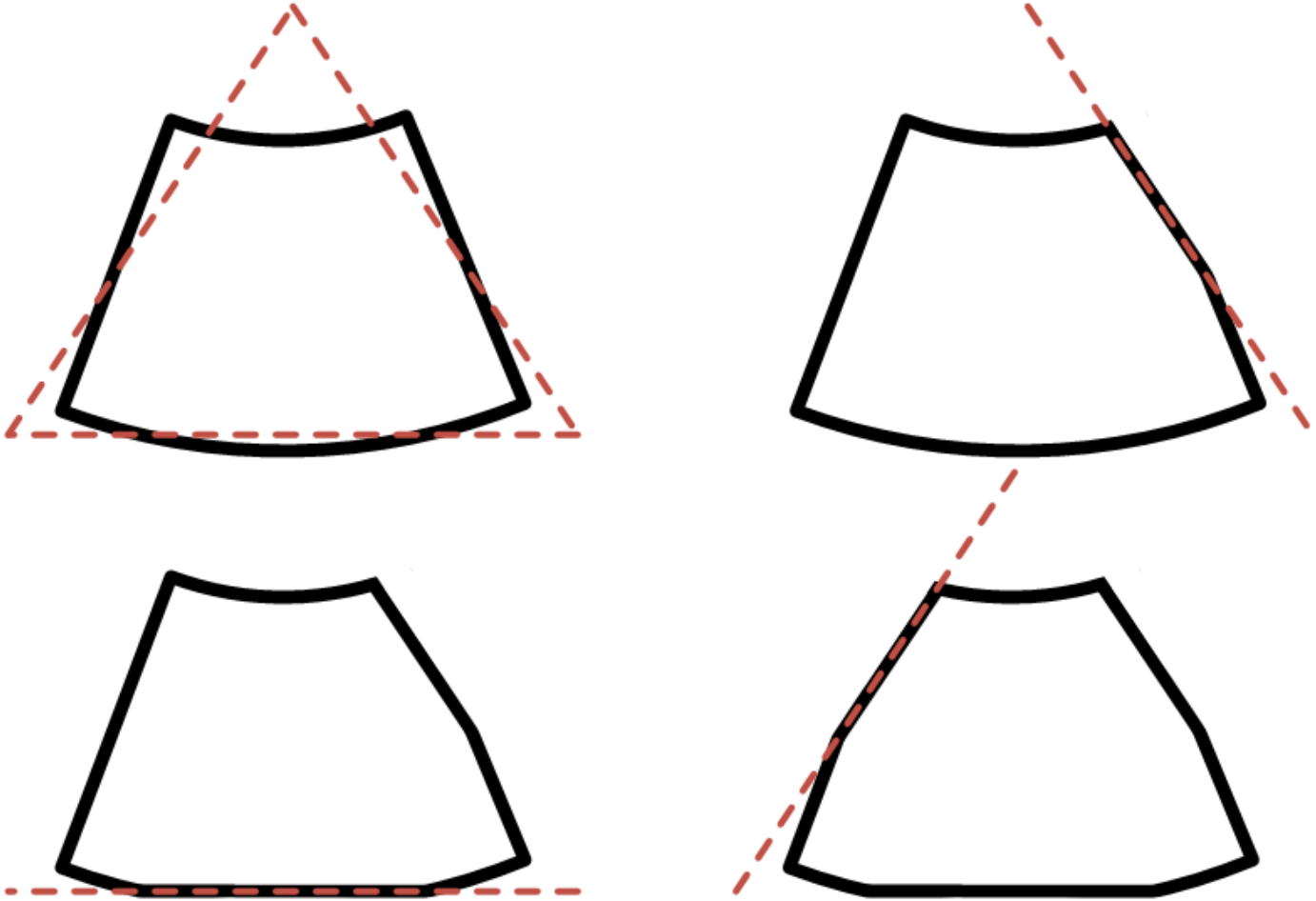
- Uses internal decomposition for each coupled component pair
  - Each process (union of processes of both components) is uniquely responsible for an area on the globe
  - Number of cells (from both components) is similar on all processes
- Weight generation requires little communication because matching source and target cells are mostly on the same processes
- YAC 2.0.0 release end of 2020

YAC technical stuff

- Cell clipping is done using Sutherland-Hodgman algorithm (with support for great- and lat-circle cell edges)

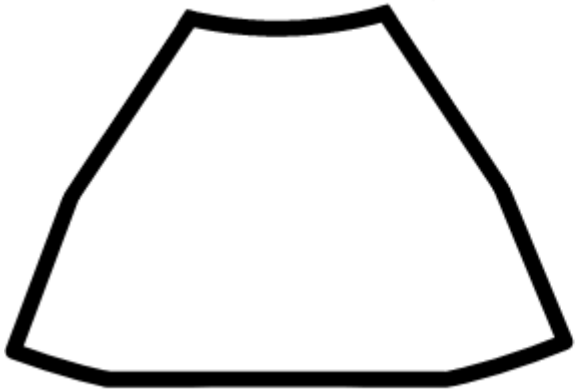


YAC technical stuff

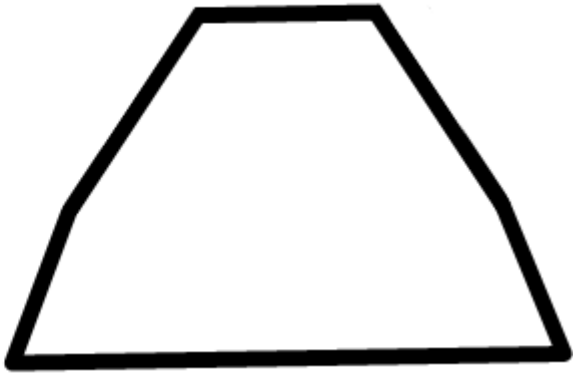


YAC technical stuff

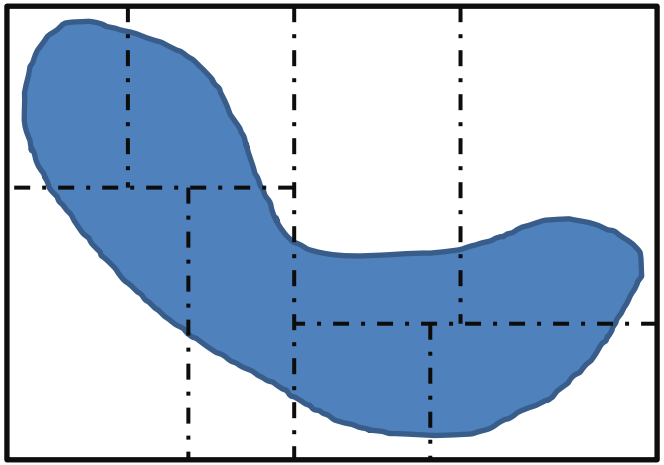
With lat-circle support



Without lat-circle support



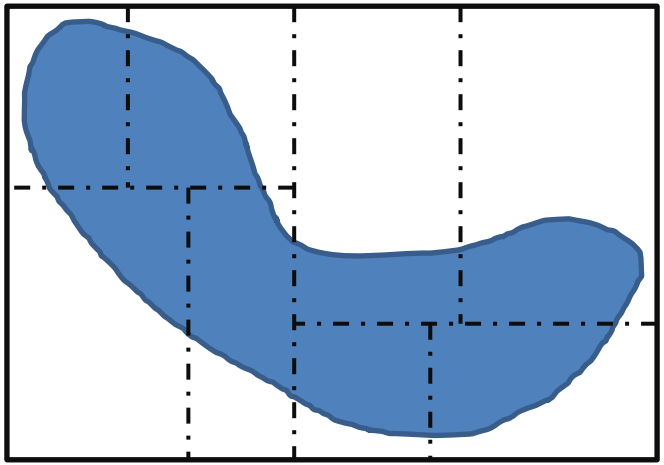
YAC technical stuff



Bisection partioning

- Recursively divide domain into two equally sized child domains
- Each “cut“:
  - is a straight line
  - is orthogonal to previous “cut”
  - goes through centroid of child
- Can be stored as a tree, where each “cut“ is represented by a 2D-coordinate.

YAC technical stuff



Bisection partioning	Sphere part

• Recursively divide domain into two equally sized child domains
• Each “cut“:
  • is a straight line
  • is orthogonal to previous “cut”
  • goes through centroid of child
• Can be stored as a tree, where each “cut“ is represented by a 2D-coordinate.
	• Recursively divide domain into two equally sized child domains
	• Each “cut“:
	  • is a **great circle**
	  • is orthogonal to previous “cut”
	  • goes through centroid of child
	• Can be stored as a tree, where each “cut“ is represented by a **3D-norm-coordinate**.

YAC technical stuff

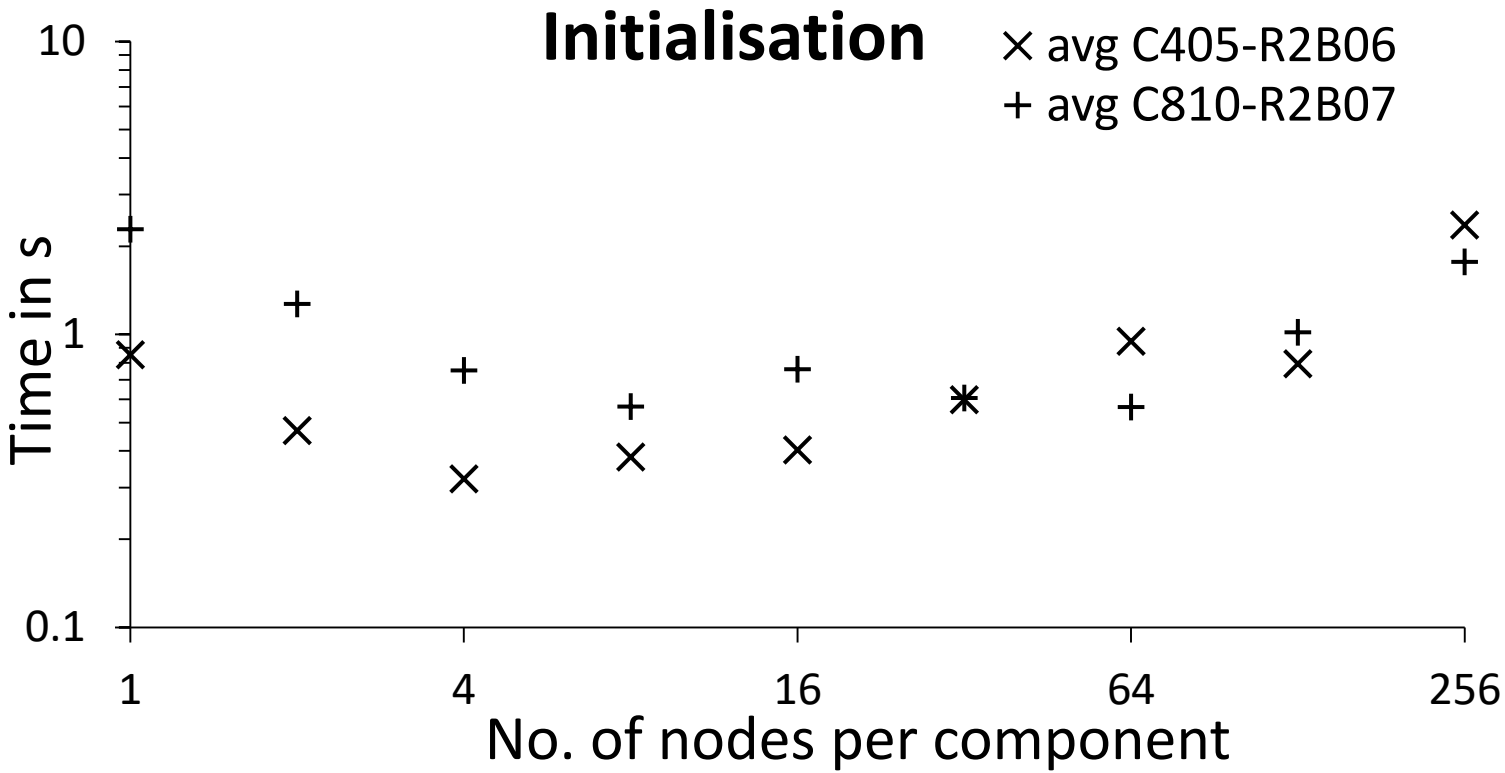
- Sphere part is used to:
  - Generate internal decomposition
    - Tree is stored on all processes, which results in a distributed directory for grid data
  - Speed up weight computation
    - In NNN to find processes that might contribute to local searches
    - In Conserv to pre-select cells for overlap computation
    - In AVG to find matching source cells for target points

    …

YAC performance

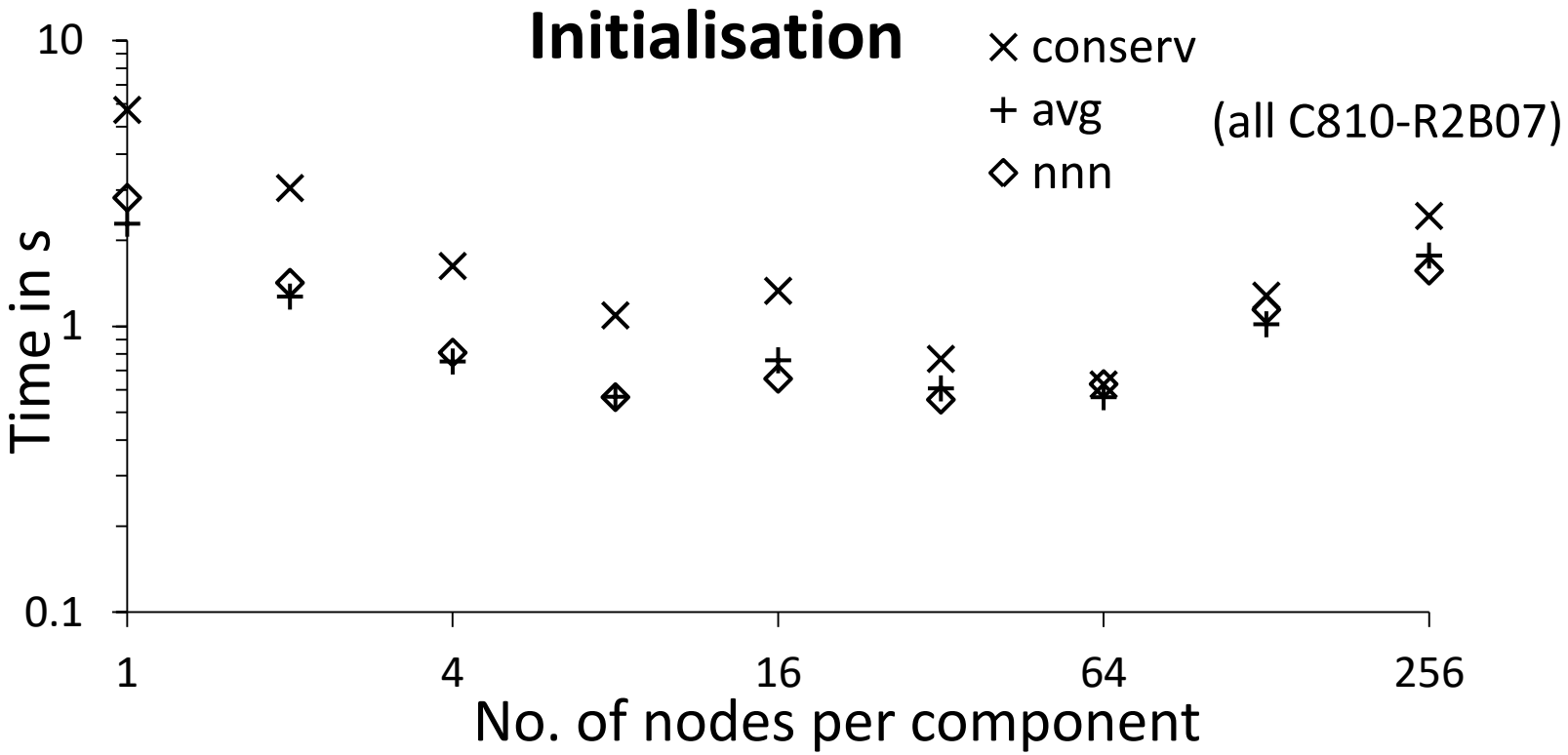
- System
  - bullx DLC 720 with 2 Intel Xeon E5-2680v3 12C 2.5GHz ("Haswell") per node
  - OpenMPI 2.0.2 (with some extra patches)
- Test configuration
  - 24 processes per node
  - Two toy models (global cubed sphere and global icosahedral grid)
  - Online weight computation in both directions
    - AVG = bilinear interpolation
    - NNN = 4 nearest neighbour
    - CONSERV = 1st order conservative interpolation
  - Initialisation: time for internal initialisation for coupling
  - Exchange: average time for exchange of data in both directions

YAC performance



C405	984,150 cells	R2B06	245,760 cells
C810	3,936,600 cells	R2B07	1,310,720 cells

YAC performance



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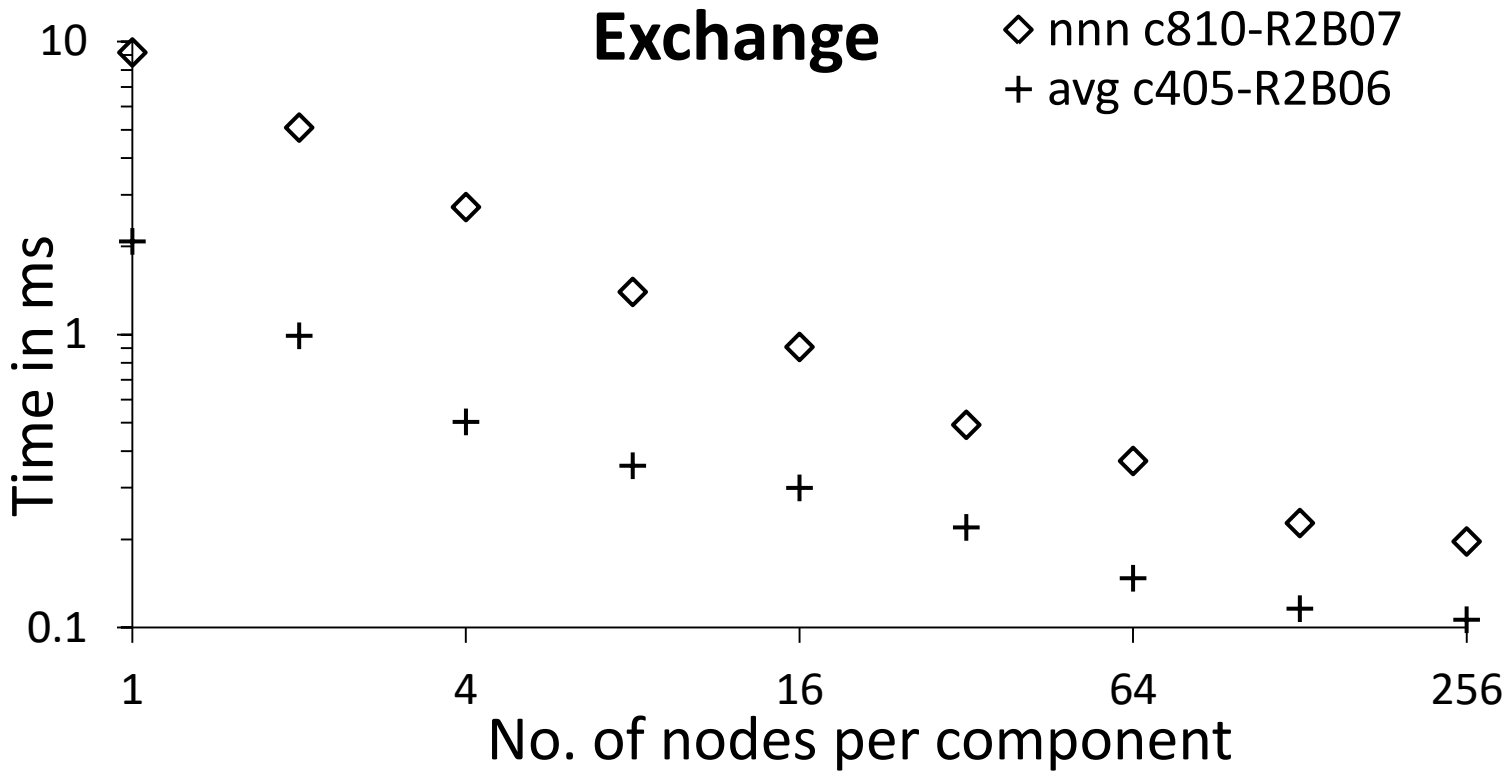
YAC performance



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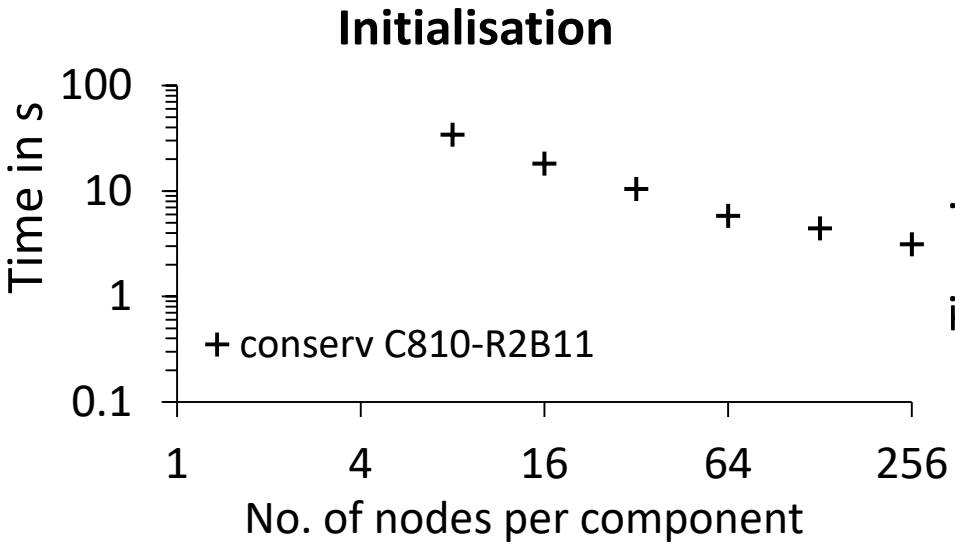
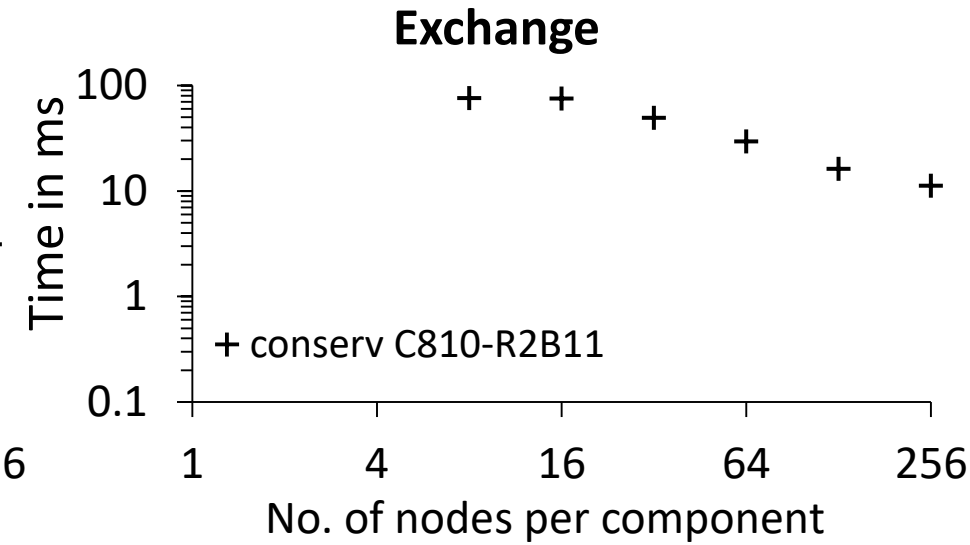
YAC performance





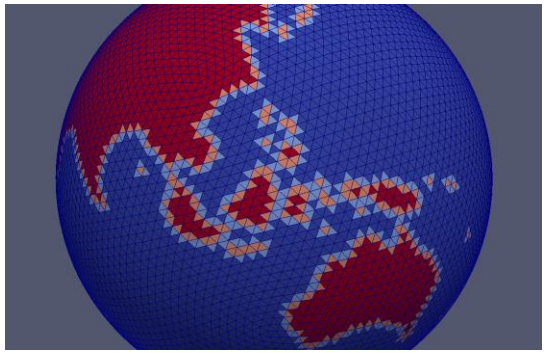
C810 3,936,600 cells R2B11 335,544,320 cells

YAC - some key points

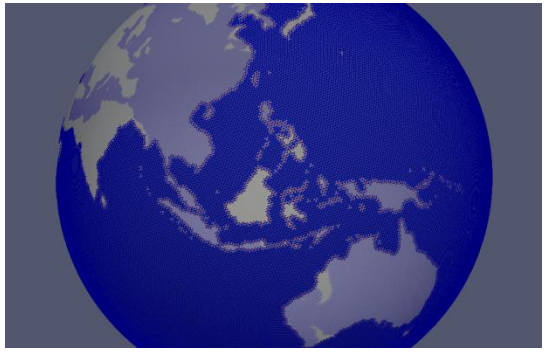
- Has efficient parallel online weight computation
- Used in ICON (YAC 1 will be replaced with YAC 2 at some point)
- HCSBB potential replacement for Patch Recovery?
- Interpolation stack concept for other coupler?

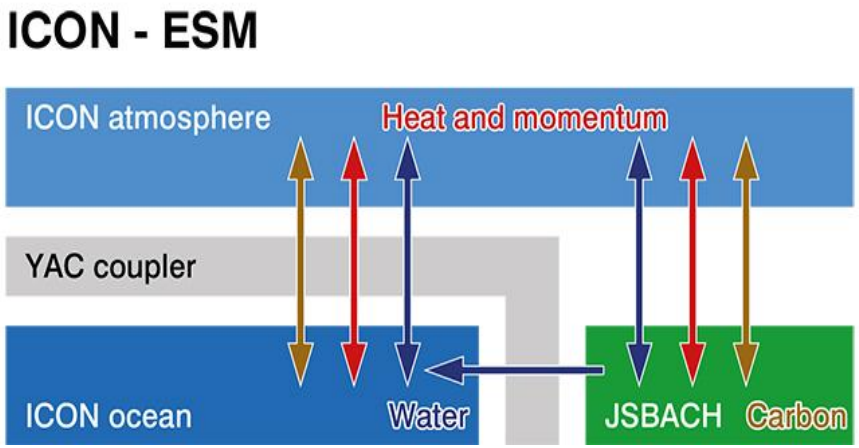
ICON-ESM

R2B4 (160 km)



R2B6 (40 km)



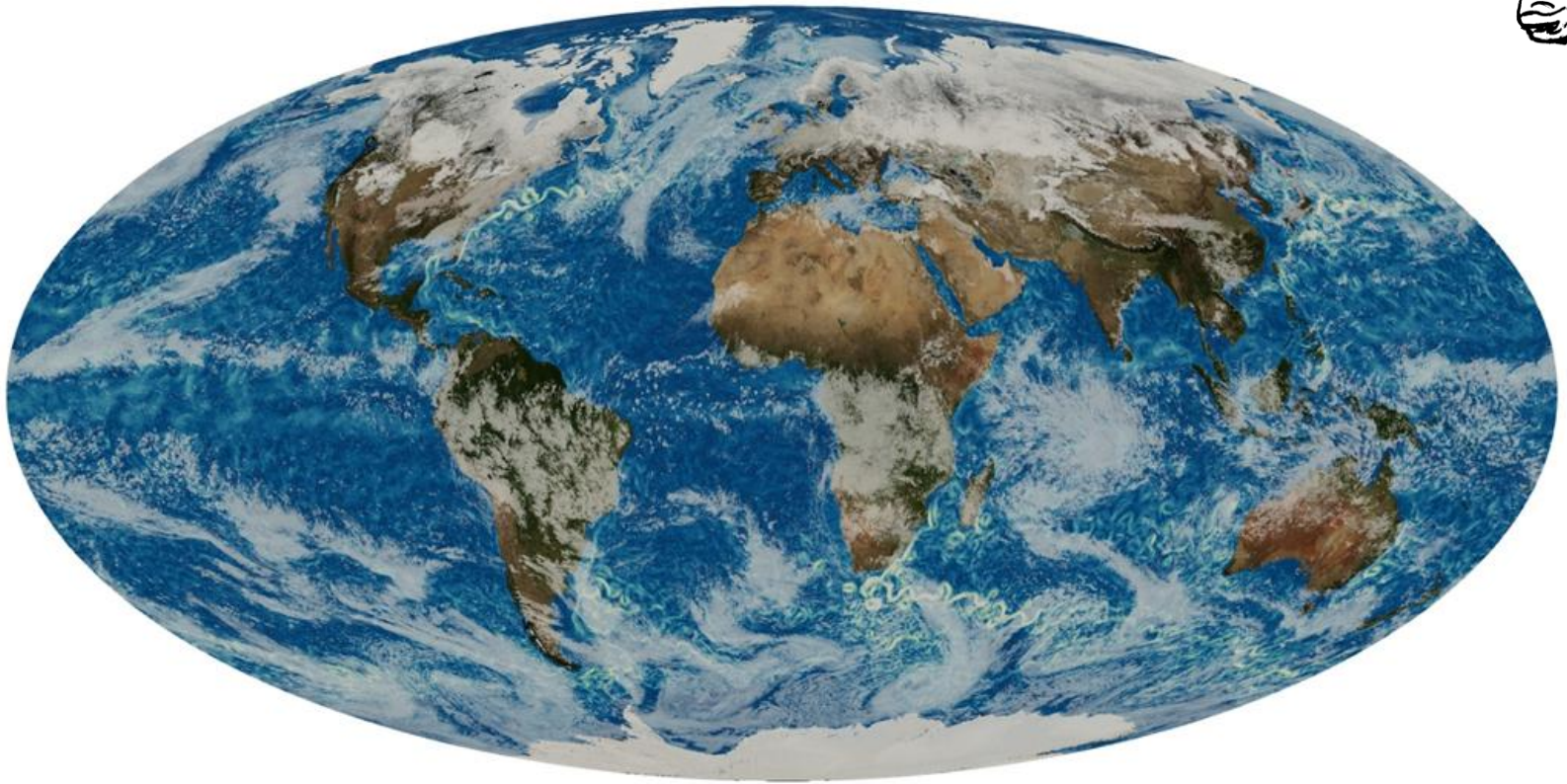


Typical grid configuration for the Indonesian region in the 160 km ICON-A and the 40 km ICON-O that are coupled to form ICON-ESM.

ICON-ESM configurations

CMIP6 “DECK” experiment + historical	A: 160 km O: 40 km	long control runs, transient paleo simulations; idealized set-ups. O(10.000 yrs)
Ruby-MiKlip	A: 80 km O: 20 km	Seasonal to decadal predictions, intialized ensembles, data assimilation, CMIP6. O(1.000 yrs)
Ruby-HighRes	A: 40 km O: 10 km	Southern Ocean Carbon experiments, idealised experiments on ocean-atmosphere interactions with eddy-resolving ocean. O(100 yrs)
Low-res version	A: 320 km O: 160 km	for training purposes and long paleo integrations. O(several 10.000 yrs)
DYAMOND	A: 5km O: 5km	Global storm and eddy resolving

ICON-ESM



ICON DYAMOND Winter coupled simulation at 5 km resolution
Visualisation by Florian Ziemen (DKRZ)

End

- Questions?
- References

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