ExaJULES: Model development for a JULES LFRic app

Emma Robinson, Rich Ellis, Doug Clark
UKCEH

Simon Wilson, David Livings, Dave Case, Bryan Lawrence, Grenville Lister
NCAS

JULES Annual Science Meeting

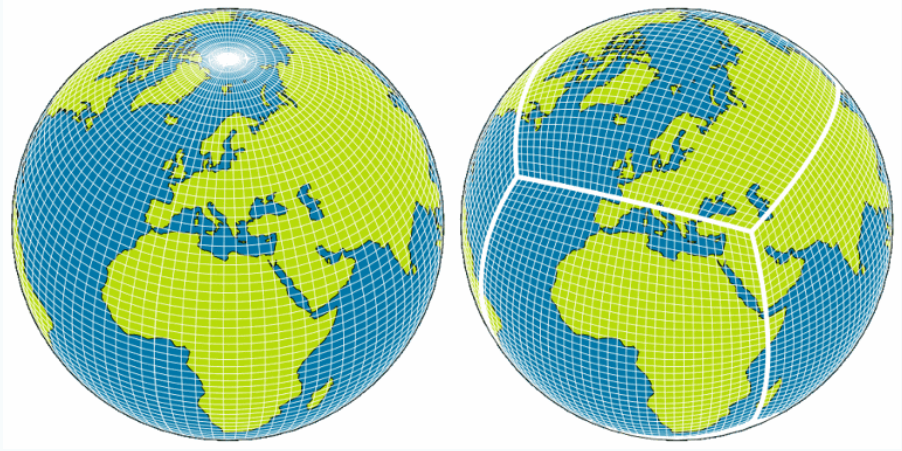
5th September 2024

UK Centre for Ecology & Hydrology

LFRic and Momentum

- LFRic software infrastructure
  - Take advantage of next generation exascale platforms
  - Momentum to replace UM
  - GungHo: New dynamical core
  - Psyclone: Auto-generation of parallel code
  - Xios: New approach to i/o
- Forecasts running in parallel with UM

- ExCALIBUR SPF Weather & Climate Use Case supporting redesign of component model codes



Separation of concerns
Science code should be agnostic to how it's being called

JULES in LFRic

- JULES code is ‘LFRic ready’ in as much as it can be compiled as part of atmosphere BUT
  - Not good ‘separation of concerns’
  - Different implementation for standalone vs atmosphere
  - JULES standalone can’t take advantage of the LFRic technical advances

- LFRic technical infrastructure designed around ‘core’ and ‘apps’

ExaJULES project will design a prototype JULES LFRic app

ExaJULES

Produce prototype app

- Benchmarking
- Performance improvements
- Coupling components on varying grids
- Engage with JULES and ExCALIBUR communities
- Apr 2023 – Oct 2024

UK Centre for Ecology & Hydrology

- Emma Robinson
- Rich Ellis
- Doug Clark

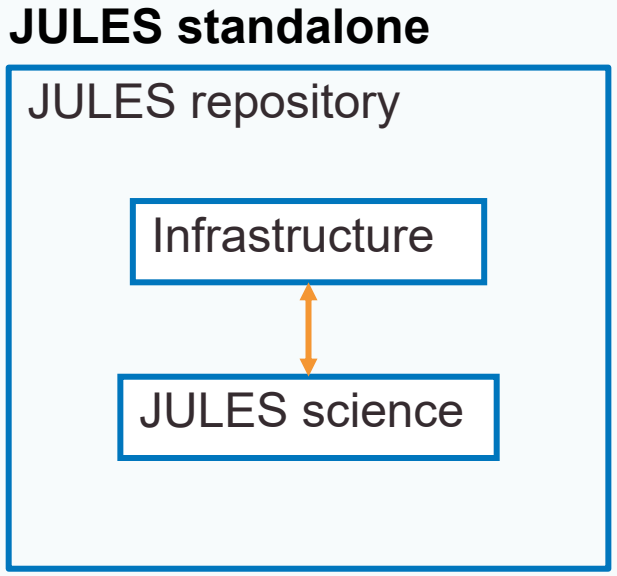
National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

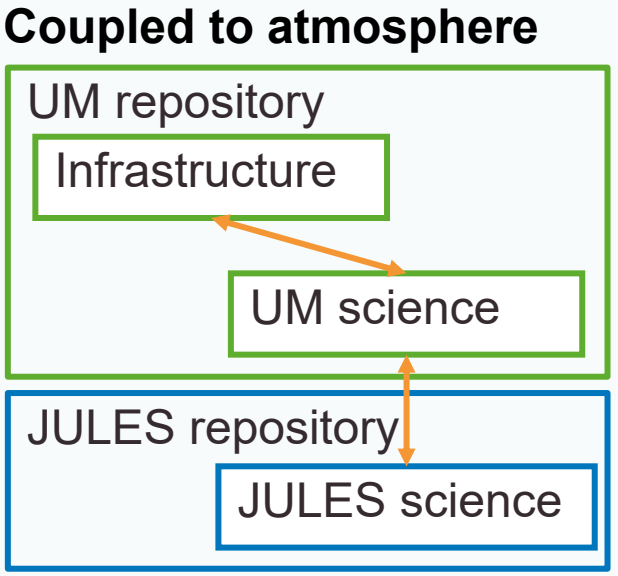
- Bryan Lawrence
- Grenville Lister
- Simon Wilson
- Dave Case
- David Livings

Met Office

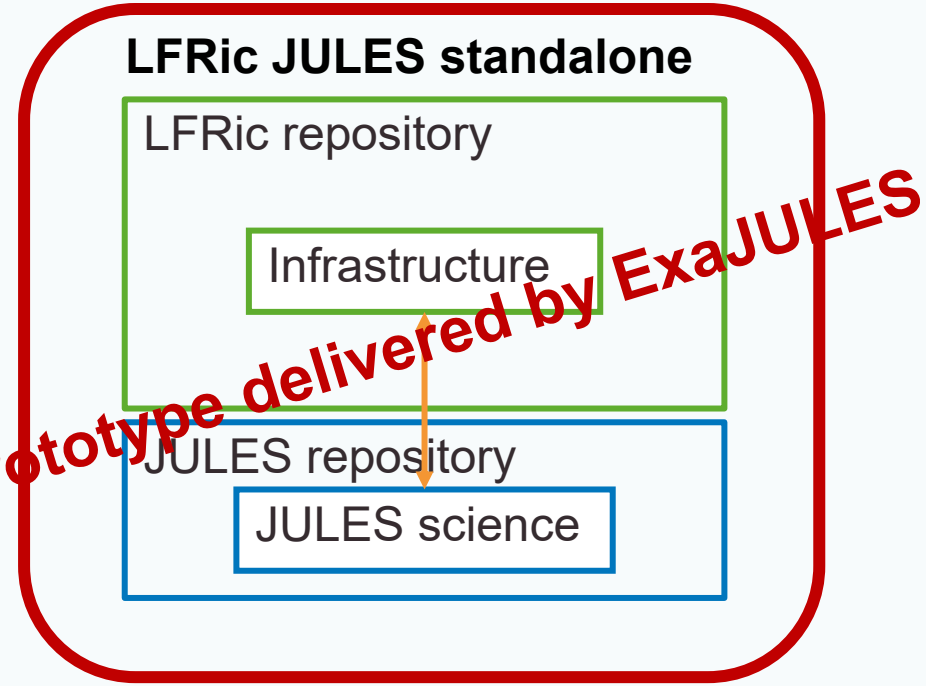
- Giorgia Line
- Rich Gilham
- Martin Best
- Nigel Wood

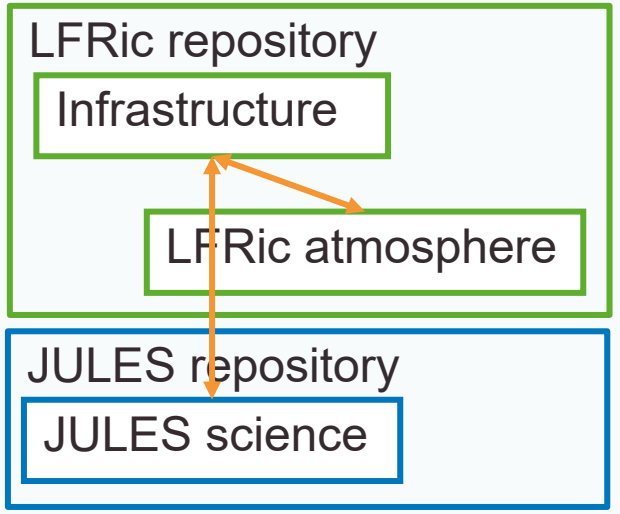
Current JULES





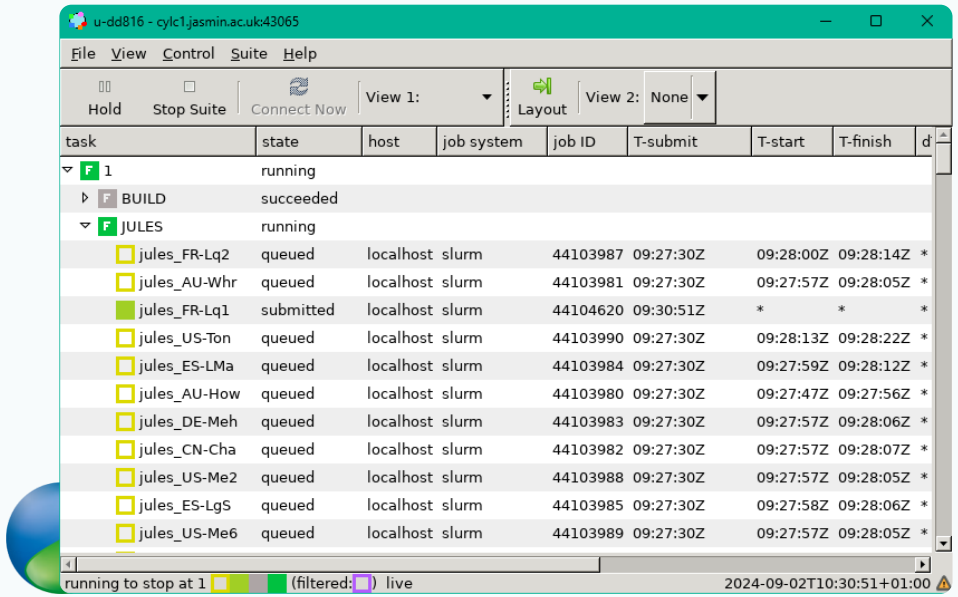
LFRic JULES





Benchmarking

- Adapted JULES-PL benchmarking suite to run with new app
- Testing with selected sites
- Runs on JASMIN with singularity container
- Test runs bit compare with JULES standalone



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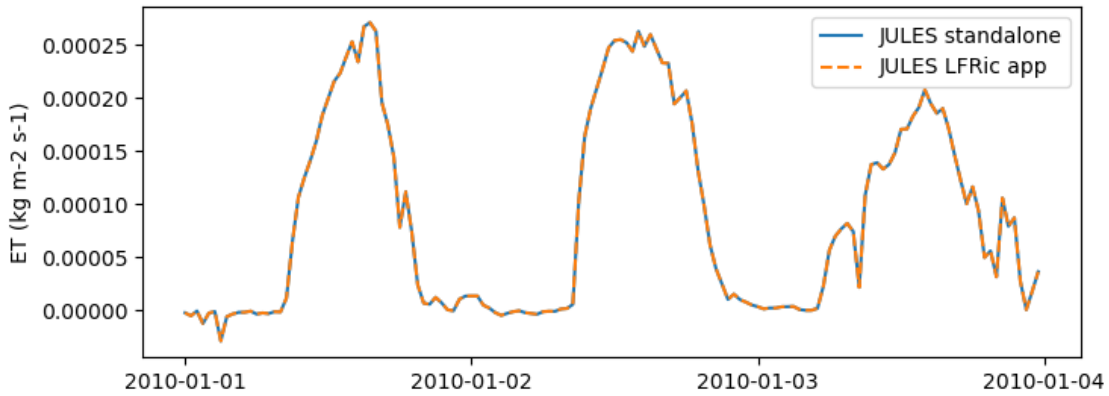
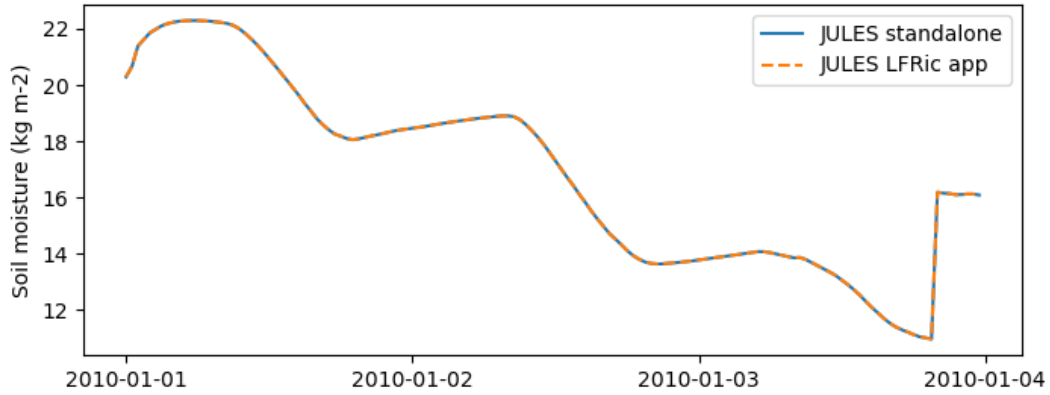
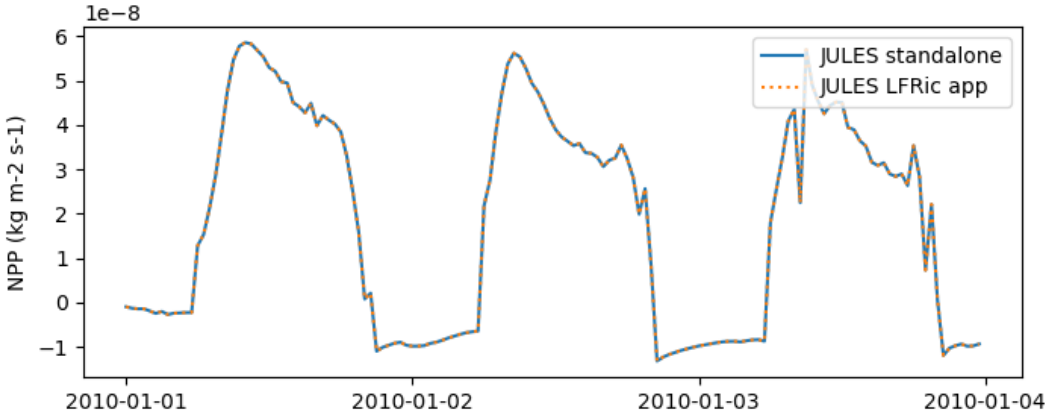
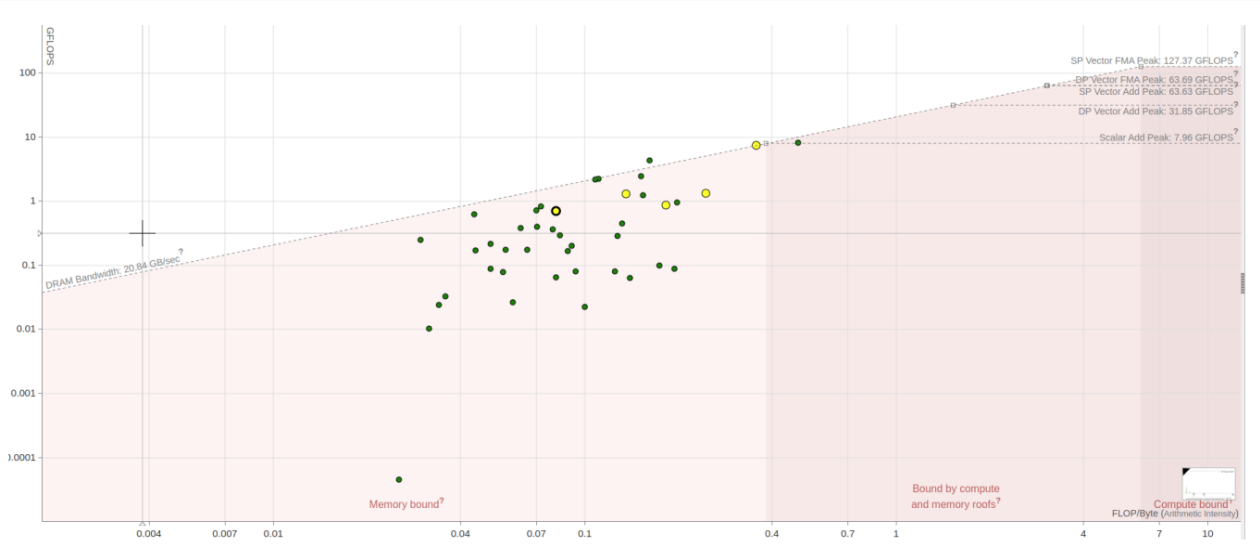






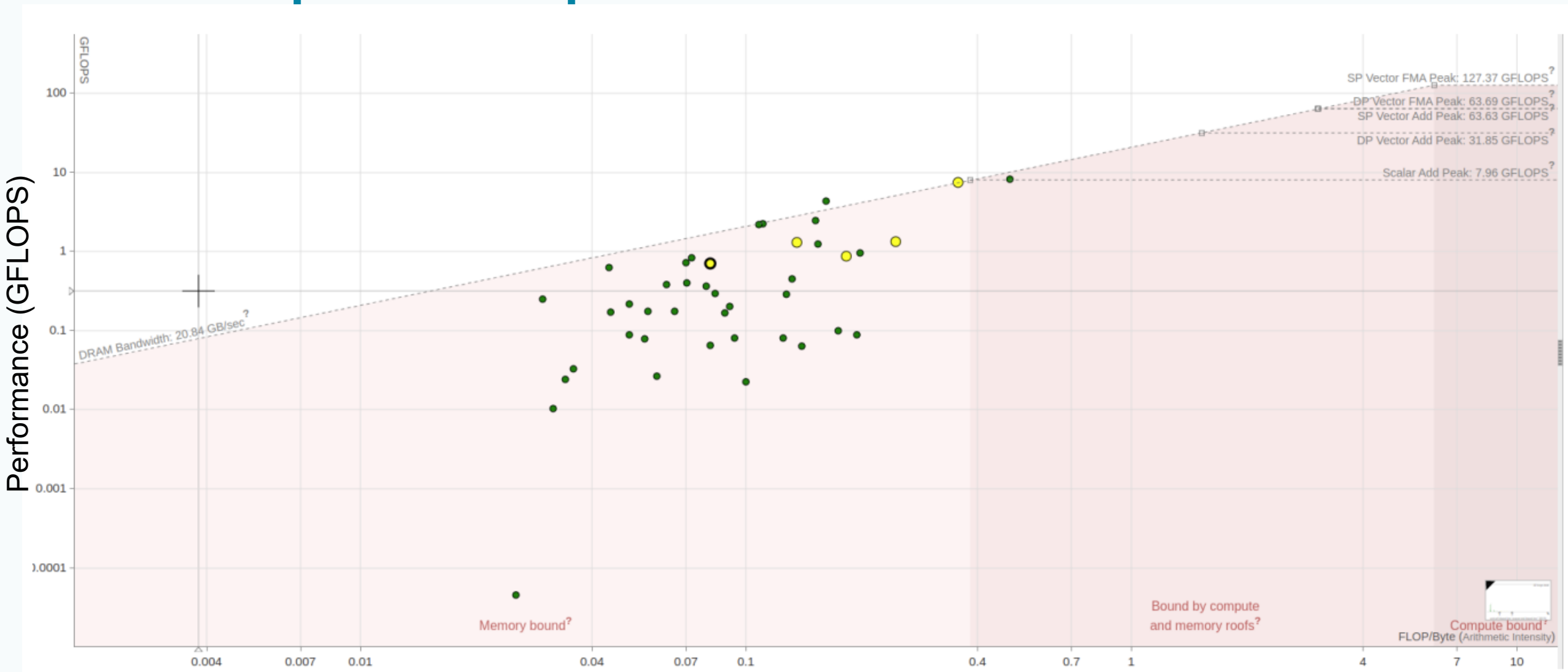
Performance and optimisation

- Aim: identify and seize optimisation opportunities
- JULES is embarrassingly parallel (except rivers)
- Inherits UM parallelisation strategy (MPI, land vector)
- Standalone is I/O limited



- Use Intel Advisor tool on Archer and JASMIN to identify possible code improvements

Roofline plot for loops in JULES



Performance (GFLOPS)

Operational intensity (FLOPS/Byte)

Outcomes

- Identified code changes to improve performance
  - calc_fsat worst performance – code changes can lead to 20-25% improvement
  - root_frac_jls less important overall – bigger relative improvement of 60%
- More scope for improvement by changing compiler optimisation flags
  - But these will change results

- Have identified possible changes to compiler flags on JASMIN (~30% speed up)
- Will investigate the upcoming changes on JASMIN (new OS, new intel compiler)
- Should continuously monitor performance with code/optimisation changes

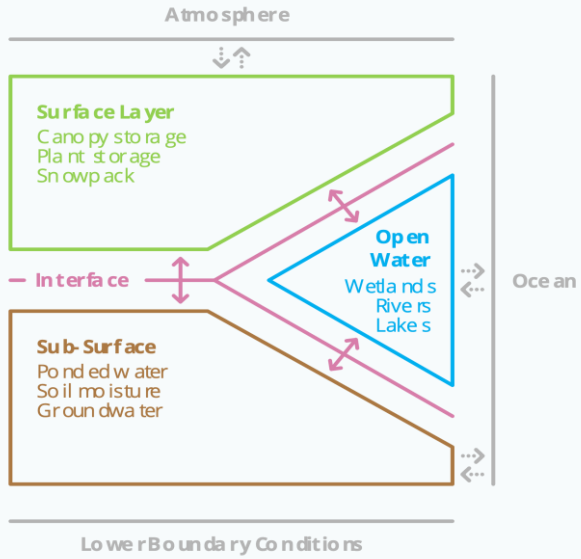
- New project NG-ARCH will be investigating parallelisation for W&C codes

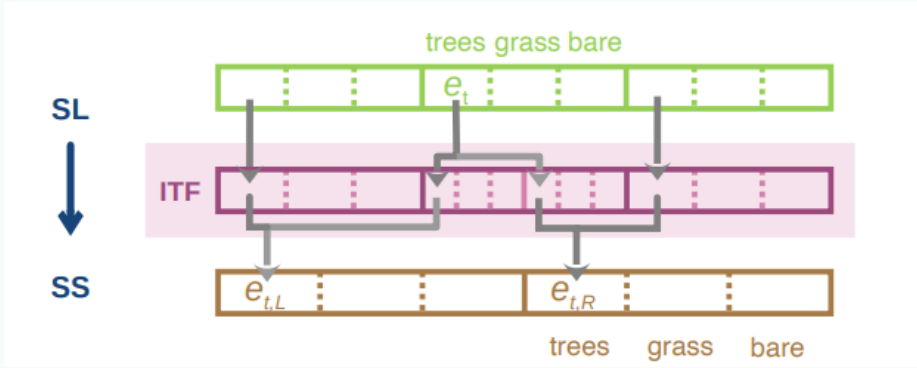
Coupling on multiple meshes

- Investigate options for coupling land to atmosphere on different meshes
- Informed by Hydro-JULES / UnifHy work

Recommendations

➔ Task-based parallelisation
➔ Interaction of tiles and gridboxes
➔ Need exchange grid / supermesh to handle non-linear processes
➔ Combine with formal coupling





Prototype JULES app

Potential benefits:

- Shared technical infrastructure
- Simplified pull through of science from JULES to coupled model
- Allows JULES to exploit developments in supercomputer infrastructure
- Potential performance gains

Potential concerns:

- Technical overhead for running standalone
- Does it simplify development?
- Coupling and parallelisation

Next steps

- ExaJULES…
  - Merge changes to latest LFRic/JULES versions
  - Create tickets to get infrastructure into trunk

- …and beyond
  - Work towards consistent calling code in standalone and atmosphere
  - Finish interpolation and other outstanding issues
  - Consider different options for coupling to atmosphere
  - Liaise with JULES standalone users

ExaJULES

- Early prototyping of standalone JULES in LFRic
- Exploring options for future development

- No immediate change to JULES working practices
- Any future change to be supported with required training

Thank You

For more information please contact:

emrobi@ceh.ac.uk

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