



Interoperable rather than seamless: Challenges and opportunities

Ian Harman + many others

Australia's National Science Agency





Interoperable vs seamless: just semantics?

scale-aware: algorithms inherit and use information on spatio-temporal resolution (and application)

assembly: flexible model composition by combining different codebases (versions and sub-models)

modularity: optional model composition by triggering within codebase (also code organisation)

consistency: ensuring choice of science options within an experiment defensible

version control: ensuring repeatability as codebases advance



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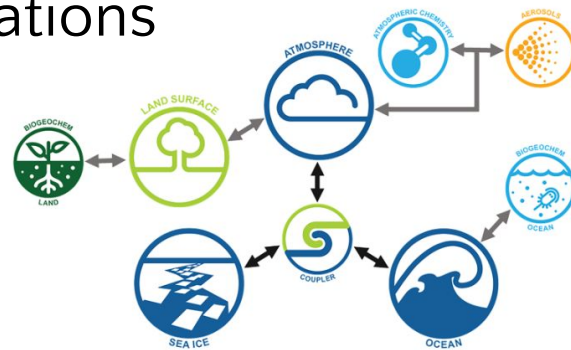
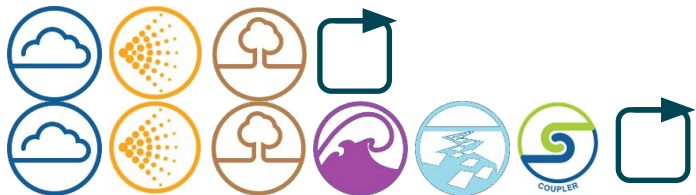
ACCESS family of models aims to be interoperable across combinations of major sub-models and versions of codebases

- experiments to run scientifically sensibly OR fail early
- repeatability



ACCESS family of models and configurations

ACCESS-C, ACCESS-R, ACCESS-S, HadGEM



ACCESS-CM2



ACCESS-ESM1.5

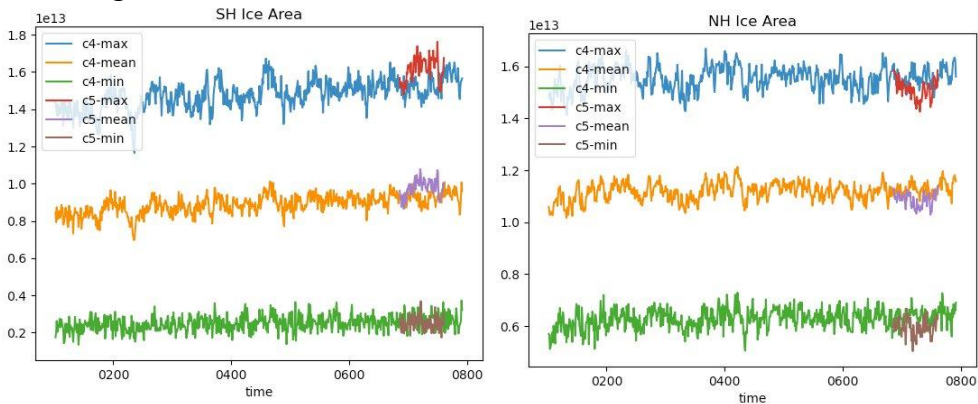


ACCESS-ESM1.6

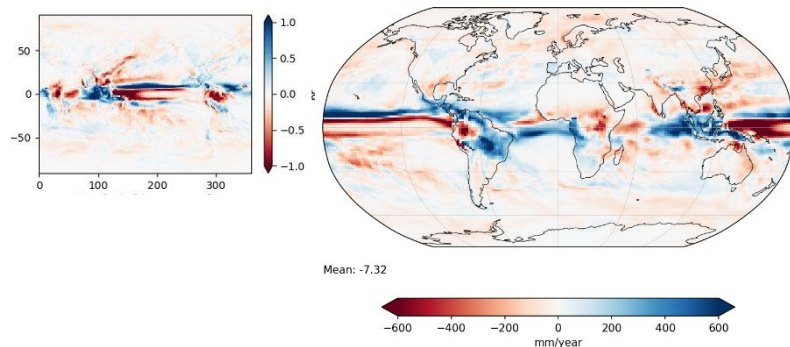


Opportunities – the why?

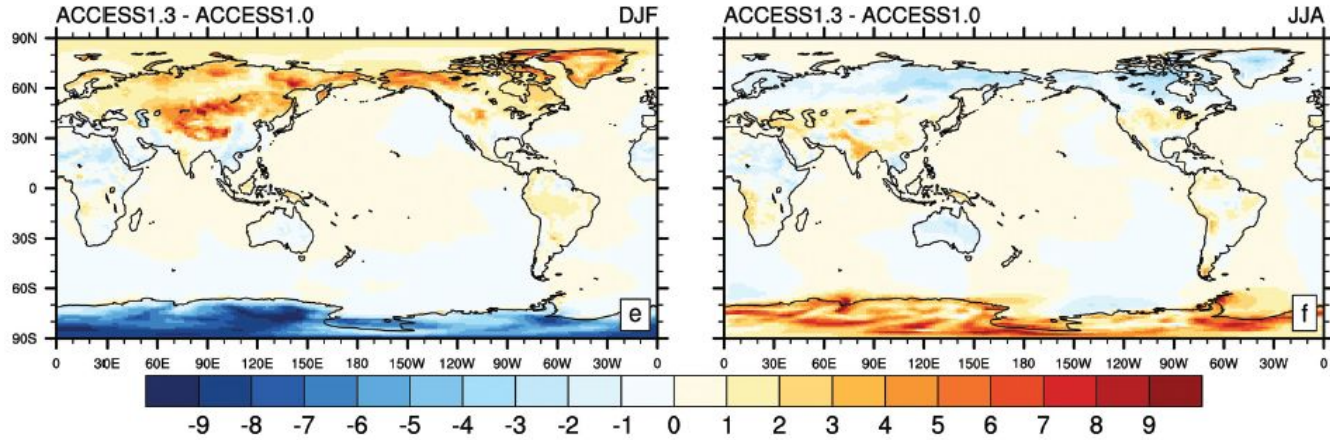
Testing of CICE5 in ESM1.6



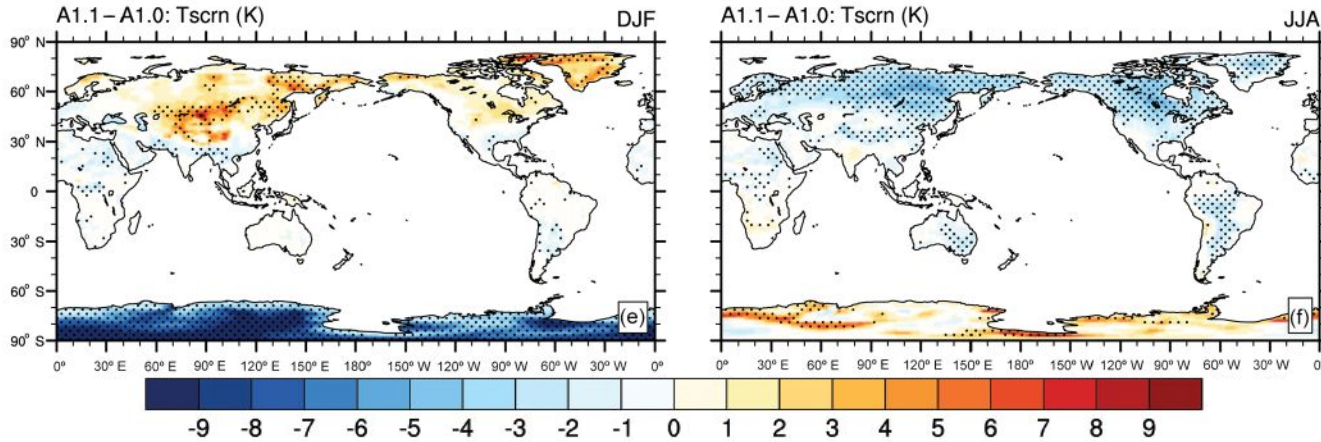
Assessment of CMT choice in ESM1.5 ahead of ESM1.6



- allowed the Australian community to provide unique and tailored contribution
- retained coherence of existing research communities (COSIMA, CABLE)
- facilitate pull through of community-led science into the climate and Earth system model
- provides (some) scope for separation of technical/science concerns
- test bed(s) already exists for developments
- also address a different set science questions



Near-surface climate in ACCESS1.0 (GAL1) and ACCESS1.3 (GAL1.1) markedly different – why?

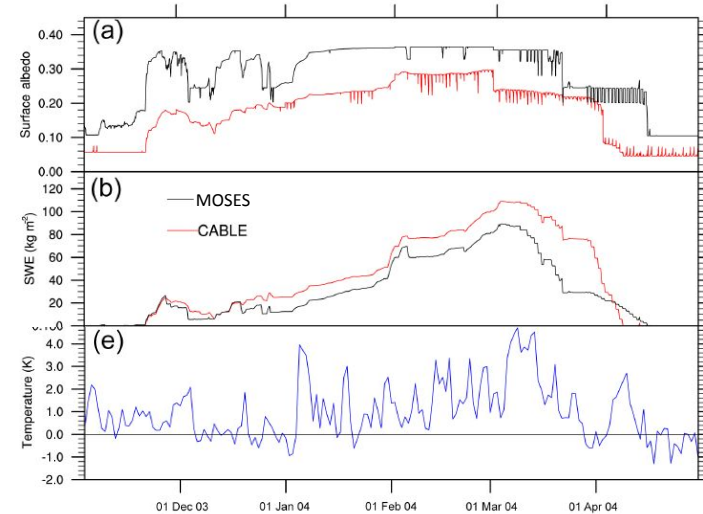


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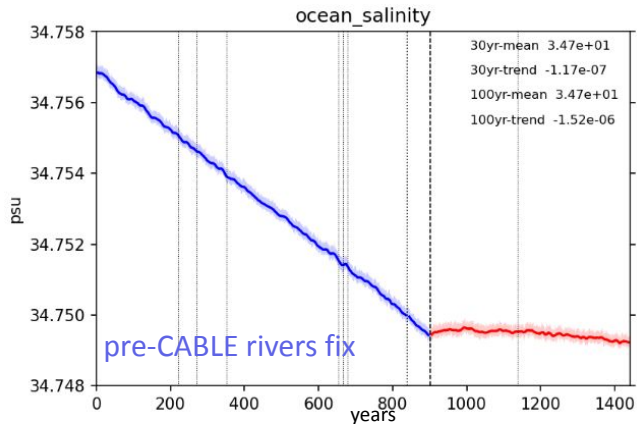
interoperability allowed establishment of ACCESS1.1 (GAL1) and clean comparison where any differences due to ‘land science’

- albedo of (fresh) snow
- infiltration and refreeze of snow melt into snowpack and soil

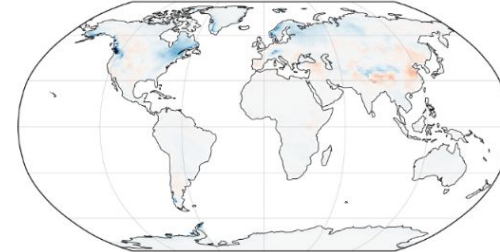
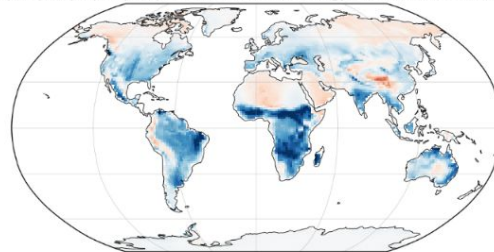
□ adjusted sea-ice and land-ice albedos in later ACCESS GCM/ESMs



Challenges: assumptions across the interface



AprilSpinUp-AprilSpinUp-56aae814 surface energy balance: Years 162-191 AprilSpinUp-AprilSpinUp-56aae814 surface energy balance using netrad: Years 162-191



- basic problems: units, grids
- anticipated problems: CABLE with rivers and inland water basins
- application specific problems: energy balance closure in ESM -
- what's going on here then?

in-depth knowledge of both sides of interface needed



Challenges: community readiness

atmosphere-ocean-sea ice communities:

long history of need for interaction (couplers, mixed grids, definitions etc)

shared awareness of complexities of fluid dynamics algorithms (time stepping, stability)

strong awareness of inherent scale-dependency (dynamics and parameterisations)

land communities:

hydrology, ecology, agriculture, carbon cycle, weather, climate, ESM etc. sub-communities

need for interaction between major sub-models has become increasingly complex

expectation management:

within-model developments still need additional work before use in parent model

who is responsible for maintaining interoperability?

semantic confusion:

'versions', 'configurations', 'suites', 'tags' and 'experiments'



Challenges: unintentional restrictions

- **structure of model and code acting as a strong impediment to new capability**
 - coupling over multiple layers and/or sources (canopies for plant hydraulics, urban; waves)
 - assumption of 1-D relationships (boundary layer closures, lateral flow)
- **technical impediments**
 - differences in i/o
 - stubs/climatology needed for coupling fields if not provided by model configuration
 - any need for additional information sharing not currently supported
- **maintaining true consistency in science as sub-models advance**
 - e.g. fire, impacts of topography





Closing Thoughts

- Interoperable (seamless) is worthwhile - but
 - needs commitment
 - acts to reduce number of 'supportable configurations'
- Sequencing of developments needs careful consideration
- Don't forget to challenge previous scientific assumptions
- Are the boundaries between our interoperable components optimal?
- Testing framework and [organisation of] documentation is critical

Thank you