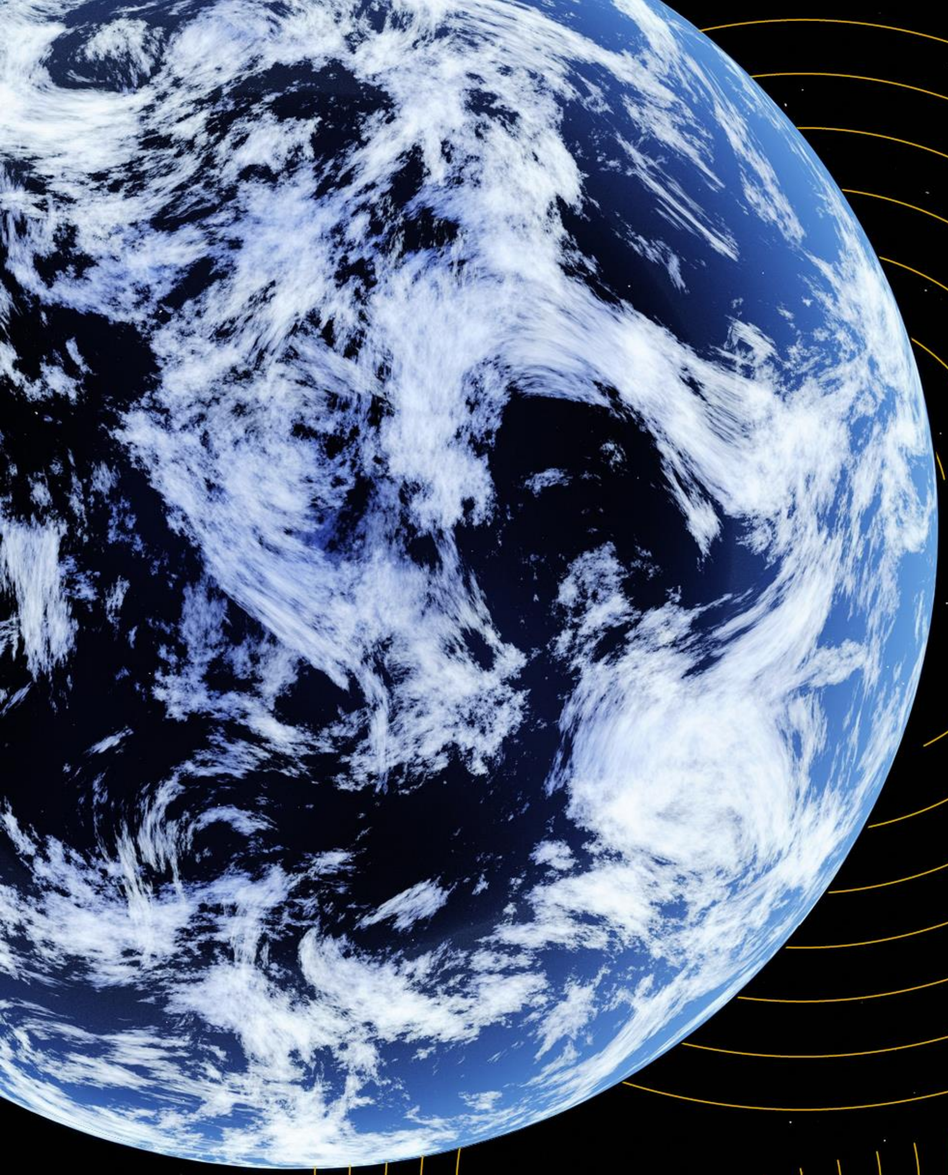


CMIP
Coupled Model Intercomparison Project

Streamlining model selection

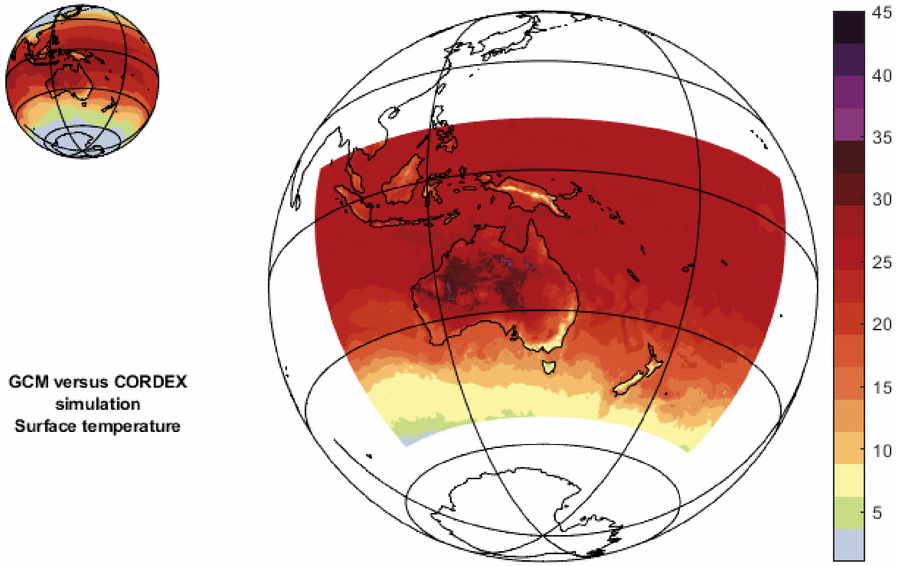
Wednesday 5th February 2025, 19:00–22:00 UTC
Virtual workshop

CMIP6 CORDEX-Australasia for Australian national projections

Michael Grose (CSIRO) on behalf of the National Partnership for Climate Projections (NPCP) working group

NextGen Projections strategy

- Interest in updated national and state-based projections
- Major new resource – a coordinated multi-model, multi-scenario RCM ensemble
- Complemented by CMIP6, large ensembles,
- CORDEX guidelines for production – international benchmarking and comparability
- Requires model selection - three studies performed – useful to compare results



GCM versus CORDEX simulation
Surface temperature

- Grose et al. (2023) A CMIP6-based multi-model downscaling ensemble to underpin climate change services in Australia. Climate Services.
- DiVirgilio et al. (2022) Selecting CMIP6 GCMs for CORDEX dynamical downscaling: Model performance, independence, and climate change signals. Earth's Future.
- Syktus et al. (2022) Dynamical downscaling of CMIP6 global models with a variable resolution climate model in the Australian region. ICHSMO conference

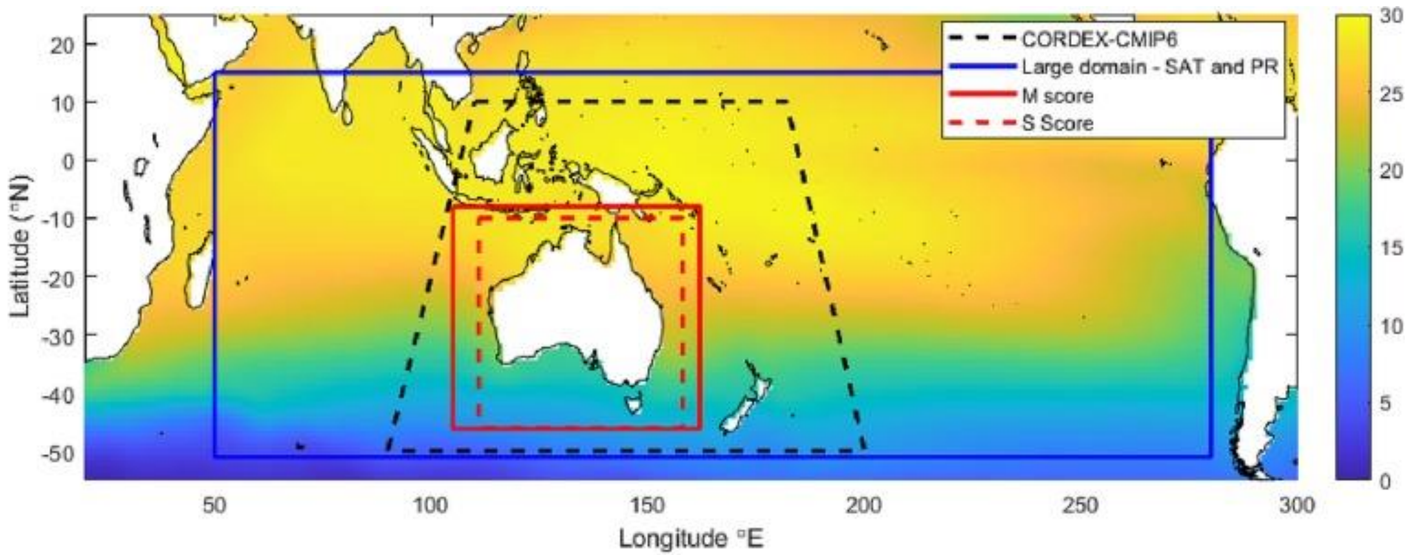
Process of selecting models

- Similarities of the three studies:
  - Standard steps ***evaluation, independence, representativeness***
  - Evaluation used to reject (not select top) – bottom category across many tests
  - Independence – generally simple approach (threshold of similarity)
  - Representativeness – spread of rainfall and temperature, some consideration of circulation, drivers
  - Consideration of 'hot model' problem
- Result – semi-coordinated 'sparse matrix' with some common selections
  - ACCESS-ESM1.5 – very dry projection
  - NorESM2–MM – cooler end
  - EC-Earth3/EC-Earth3–Veg – wet projection
  - Representative hot model

	CCAM-Qld	NARCLIM2.0 (2x WRF configurations)	CCAM	BARPA
ACCESS-CM2	r2i1p1f1oc		r4i1p1f1	r4i1p1f1
ACCESS-ESM1.5	r6i1p1f1 r20i1p1f1oc r40i1p1f1oc	r6i1p1f1	r6i1p1f1	r6i1p1f1
CESM2			r11i1p1f1	r11i1p1f1
CMCC-ESM2	r1i1p1f1		r1i1p1f1	r1i1p1f1
CNRM-CM6.1-HR	r1i1p1f2 r1i1p1f2oc			
CNRM-ESM2-1			r1i1p1f2	
EC-Earth3	r1i1p1f1		r1i1p1f1	r1i1p1f1
EC-Earth3-Veg		r1i1p1f1		
FGOALS-g3	r4i1p1f1			
GFDL-ESM4	r1i1p1f1			
GISS-E2-1-G	r2i1p1f2			
MPI-ESM1-2-HR		r1i1p1f1		
MPI-ESM1-2-LR	r9i1p1f1			
MRI-ESM2-0	r1i1p1f1			
NorESM2-MM	r1i1p1f1 r1i1p1f1oc	r1i1p1f1	r1i1p1f1	r1i1p1f1
UKESM1-0-LL		r1i1p1f1		

Process of selecting models

- Differences – open for debate/discussion
  - Evaluation - statistics of surface variables vs. some focus on drivers, processes
  - Domains of evaluation – whole Indo-Pacific region vs. Australia vs. Sub-regions
  - Different measures of relevant representative climate change signal - warming and precip, also circulation indices (e.g., subtropical ridge)

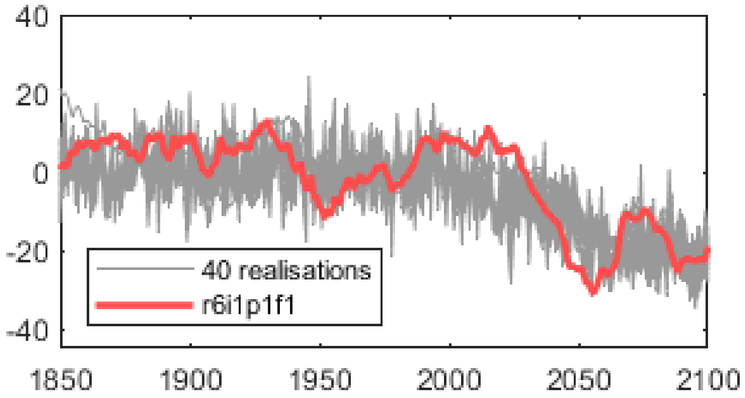


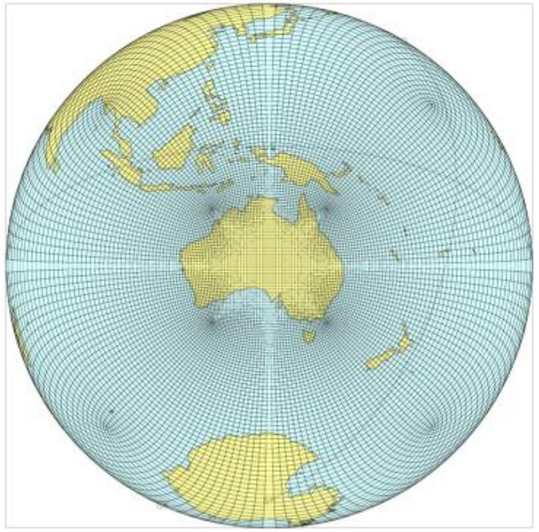
Discussion points

Innovations

- For ACCESS model, we could select realisation and request sub-daily data (selected r6) – *could this be done more widely?*
- Test and compare different RCM configurations – global variable grid vs. limited area, SST bias correction vs. not, ocean coupling

Eastern Aus rainfall – r6 chosen as a stress test through mid-century





Discussion points

Known limitations

- Not a representative sample for all applications – considers only rainfall, temperature, some broad circulation changes, not land surface, carbon cycle, etc.
- Ensemble generation is messy – CMIP6 an ensemble of opportunity, then sub-sample CMIP6, ‘sparse matrix’ not statistically balanced
- Lack of inter-comparability with other regions (different model list)

Discussion points

Barriers – can they be reduced for CMIP7?

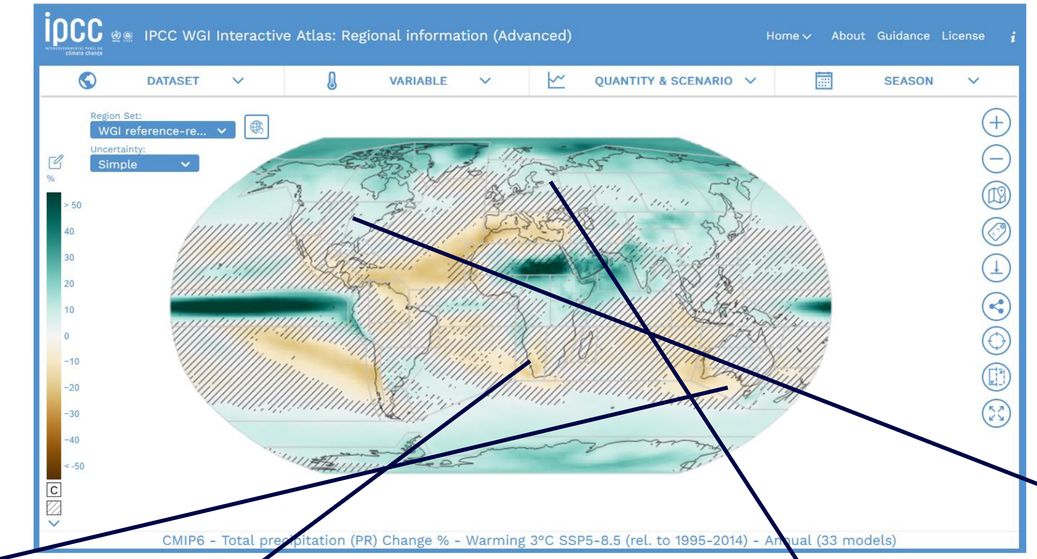
- Data availability! Only 18/50 models with sub-daily data for the SSPs
  - Overcome by the Queensland Future Climate Platrom-v2 project – uses only daily inputs
- Only one realisation available from models – can we request more?
- Lack of centralised, comprehensive lists of required diagnostics etc.
  - Climate sensitivity – found on a github page through personal connection, not all models
  - Global model evaluation – found in various studies in papers, not all models
  - Independence (family tree) – found in additional material from a paper, not all models
- No objective criteria to reject models (bottom in a set of tests not objective) – move to benchmarking?

- *Physical basis for in signal (response to forcing) and added value in the signal – central question for all modelers, especially CORDEX*

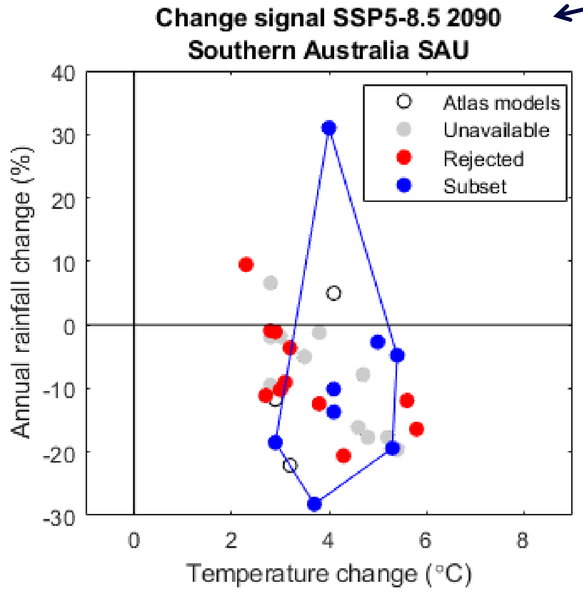
Huge data volume – is it even possible?
Provide at least training data for machine learning?

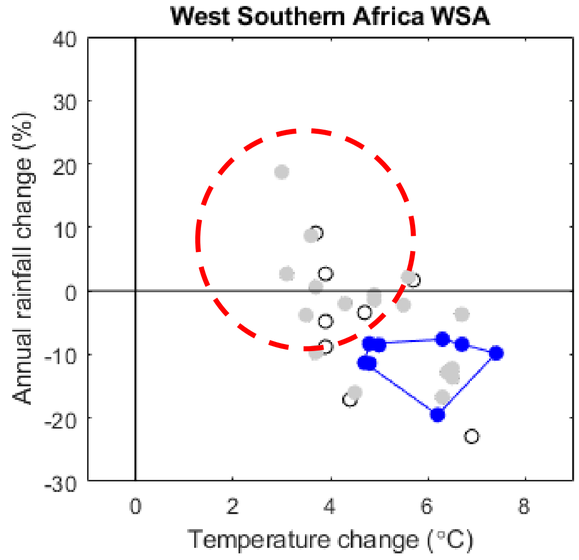
What if we applied our selection everywhere?

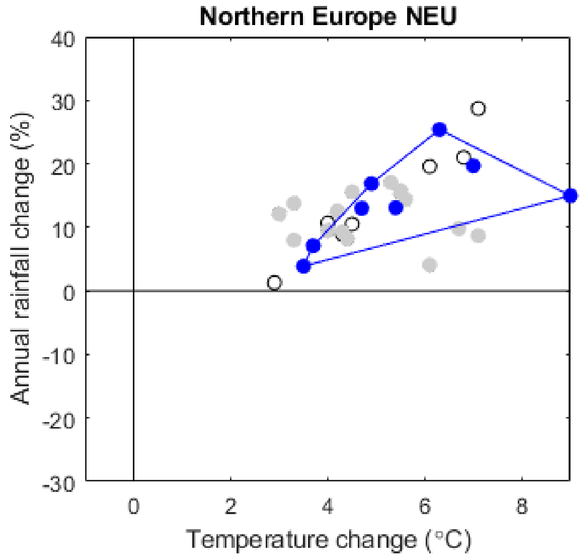
Simple example - spread of warming and rainfall change, SSP5-8.5 2090
IPCC Atlas results

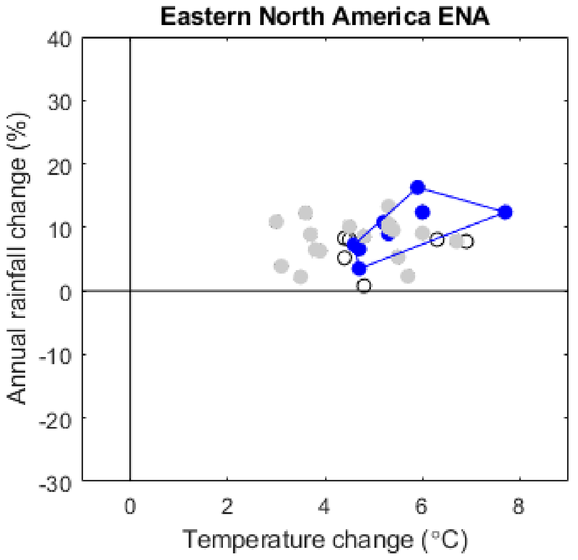


What about extremes, ice sheets, oceans? Can a subset of models suit all purposes?









Selection for Australia (SAU example here)
Selected to cover spread (including wet outlier) after model rejection
Sub-daily data unavailability a minor problem

Applying to WSA
Not a representative sampling*
Data availability a major problem
*Will depend on model rejection

Applying to NEU
Not bad, except two outliers*
*Will depend on model rejection

Applying to ENA
Quite poor – but mainly due to data unavailability!

CMIP | WCRP

Thank You

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