Evaluating dynamical downscaling and bias correction methods for hydrological impact assessments

Elisabeth Vogel
University of New South Wales, Sydney, Australia

J. Peter, U. Bende-Michl, C. Wasko, W. Sharples, L. Wilson, P. Hope, A. Dowdy, J. Roussis, V. C. Duong, C. Donnelly, Z. Khan, S. Srikanthan

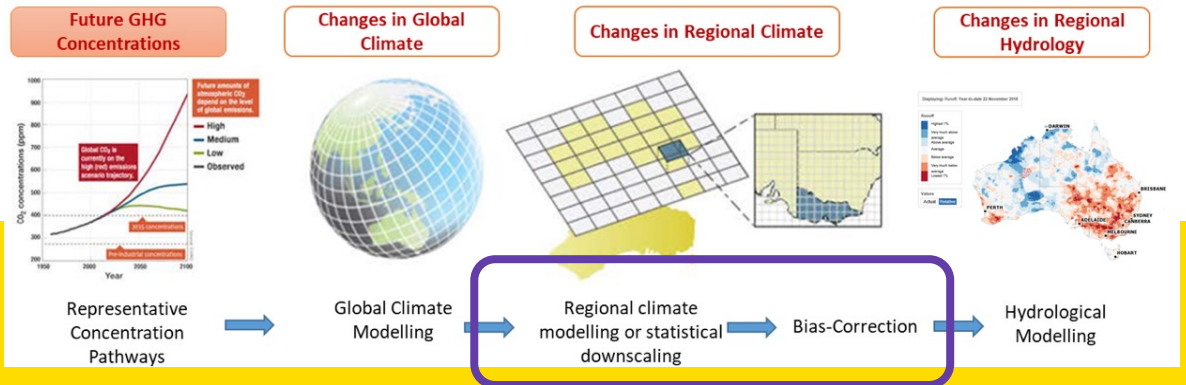
Acknowledgements: L. Marshall, F. Johnson, A. Sharma, R. Mehrotra, S. Lange

Australian Government
Bureau of Meteorology

UNSW SYDNEY

Hydrological impact studies

- Climate change is predicted to affect the availability of water resources, including changes in hydrological extremes, such as drought or flooding risks
- Hydrological impact studies are typically based on hydrological models that are forced with outputs from global climate models
- Generally, global climate models are run at relatively coarse resolution – coarser than what would be required to force hydrological models – and can have systematic biases
- A number of downscaling and bias correction methods have been developed to postprocess GCM outputs to be used in impact models

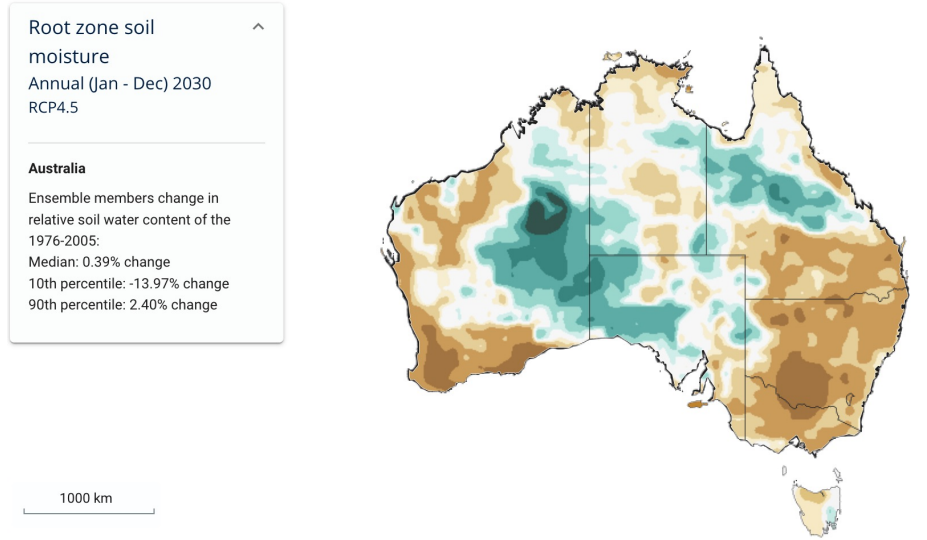


Australian Water Outlook – Hydrological Projections

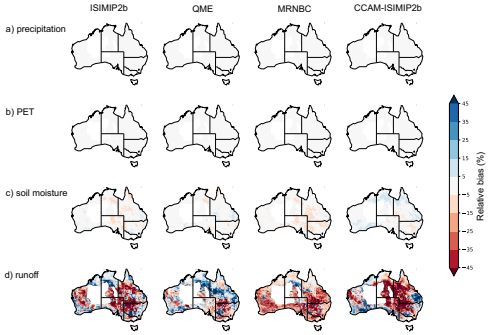
- The Australian Bureau of Meteorology has released a National Hydrological Projections service
- The new service provides information and data on hydrological change across Australia – based on two emission scenarios, four GCMs and the AWRA-L hydrological model
- GCM data post-processed using one dynamical downscaling approach (the CCAM regional climate model) and three statistical bias correction methods:
  - **ISIMIP2b** (Hempel et al., 2013)
  - **QME** (Dowdy, 2019)
  - **MRNBC** (Johnson and Sharma, 2012; Mehrotra and Sharma, 2016)

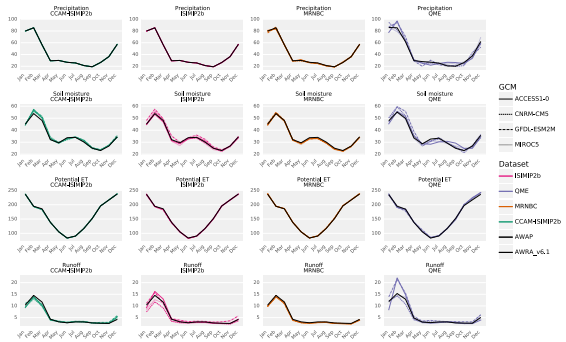
→ Evaluation in terms of their suitability for hydrological impact studies

https://awo.bom.gov.au/products/projection



Evaluation framework for climate change impacts studies



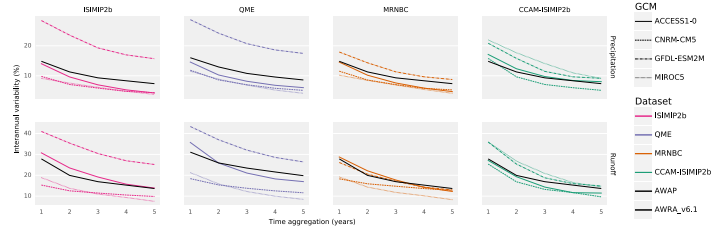


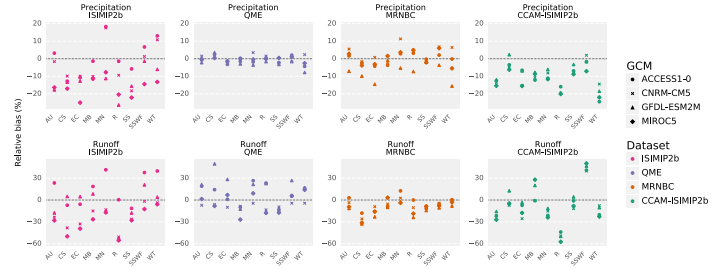
Evaluation approach:

- Evaluation period: 1976-2005
- Comparison of:
  1. hydrological simulations using downscaled and bias corrected climate inputs
  2. historical reference simulation (using observed climate data - AWAP)
- Evaluation of: precipitation, potential evapotranspiration, soil moisture, runoff

Evaluated statistics:

- Mean (annual, seasonal)
- Climatology
- Inter-annual variability
- Temporal auto-correlation
- Extreme indices (drought, flooding risk)





Statistical feature	Variable group	ISIMIP2b	MRNBC	QME	CCAM-ISIMIP2b
1 - Mean	Climate forcings	9.7	**8.4**	8.6	7.4
2 - Climatology	Climate forcings	8.1	7.2	**12.5**	**6.1**
3 - Inter-annual variability	Climate forcings	**9.7**	6.4	8.5	9.4
4 - Lag-1 correlation	Climate forcings	9.7	5.5	8.9	**9.9**
5 - Wet day frequency	Climate forcings	**11.5**	**5.1**	8.5	8.9
6 - Extreme percentiles	Climate forcings	11.4	6.9	**5.3**	10.3
7 - Multi-annual drought	Climate forcings	9.0	7.0	**9.2**	8.7
8 - P-Tmax cross correlation	Climate forcings	7.5	7.4	7.7	**11.5**
9 - Change signal	Climate forcings	**7.0**	6.6	7.2	**13.2**
1 - Mean	Water balance variables	9.4	7.4	**9.7**	7.6
2 - Climatology	Water balance variables	9.0	6.8	**10.7**	7.5
3 - Inter-annual variability	Water balance variables	9.1	6.9	8.6	**9.3**
4 - Lag-1 correlation	Water balance variables	**9.5**	6.4	9.0	9.1
5 - Extreme percentiles	Water balance variables	**10.0**	7.5	7.7	8.9
6 - Multi-annual drought	Water balance variables	**9.5**	7.3	8.8	8.4

UNSW SYDNEY

Key findings

- Low/zero biases in climate forcings do not mean low biases in hydrological impacts → hydrological impact studies require evaluation of hydrological output variables
- Multi-variate and multi-time scale bias correction (MRNBC) performed best in reducing biases in hydrological output variables
- Dynamical downscaling combined with bias correction is useful to reproduce realistic spatial and temporal patterns but may change the climate change signal and can reduce estimates of uncertainty

- Access of the Bureau of Meteorology's Hydrological Projections data: **awo.bom.gov.au**
  - Underlying data also available via a data collection – please get in touch, if you are interested in using them

Thank you!

If you have any questions please feel free to get in touch:

Elisabeth Vogel
e.vogel@unsw.edu.au