GEWEX, The Hague, The Netherlands, 14-17 July 2014

Disentangling the multiple sources of large-scale variability in Australian wintertime precipitation

Penelope Maher and Steven Sherwood

Climate Change Research Centre and ARC Centre of Excellence for Climate System Science.
University of New South Wales, Australia penelope.maher@unsw.edu.au

Motivation

Numerous precipitation drivers influence Australian regional winter precipitation. Drivers are not independent of one another and this makes attribution, prediction and model evaluation difficult.

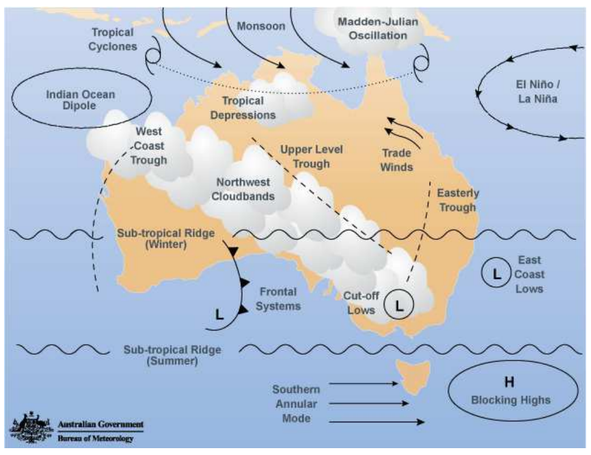


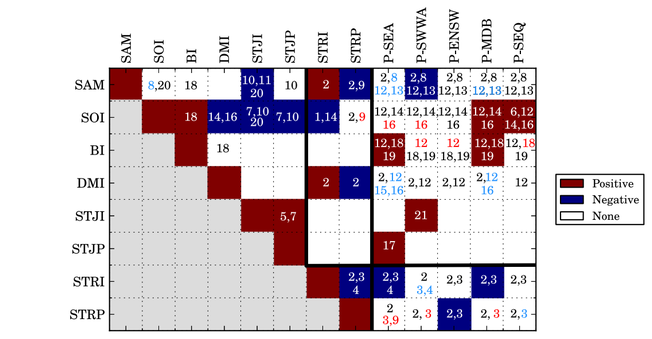
Fig. 1: Precipitation drivers

Acronym	Index
El Niño Southern Oscillation (ENSO)	SOI
Indian Ocean Dipole (IOD)	DMI
Southern Annular mode	SAM
Atmospheric blocking	BI
Subtropical jet position	STJP
Subtropical jet intensity	STJI
Subtropical ridge position	STRP
Subtropical ridge intensity	STRI

Table 1: Index names

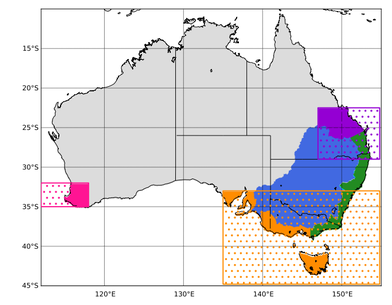
Introduction

Observation studies often do not assess independent contributions from drivers, consider the influence of the tropical edge or systematically evaluate model skill in the same manner.



	Reference	Method (Ridge)		Reference	Method (Ridge)
1	Drosdowsky (2005)	CC (East)	2	Cai et al. (2011b)	BA (East)
3	Timbal & Drosdowsky (2013)	CC (East)	4	Larsen and Nicholls (2009)	BA (Aus)
5	Archer and Caldeira (2008)	Data	6	Murphy and Ribbe (2004)	CC
7	Lu et al. (2008)	Review	8	Meneghini et al. (2007)	CC
9	Williams & Stone (2009)	CC (East)	10	Gallego et al. (2005)	CC
11	Codron (2007)	Data	12	Risbey et al. (2009)	CC and BA
13	Hendon et al. (2007)	Anomaly	14	Cai et al. (2011a)	Anomaly & CC
15	Ummenhofer (2009)	Anomaly	16	Meyers et al. (2007)	Percentile
17	Cai et al. (2012)	CC	18	Cowan et al. (2013)	CC & BA
19	Pook et al. (2013)	CC	20	Bals-Elsholz et al. (2001)	CC
21	Frederiksen and Frederiksen (2007)	Data			

Fig. 2: Interannual austral winter (JJA) drivers†



SEA southeastern Australia
SWWA southwest Western Australia
ENSW eastern New South Wales
MDB Murray-Darling basin
SEQ southeast Queensland

Fig. 3: Regions†

Method: New approach

A multivariate linear independence model is applied to reanalysis and CMIP GCM historical simulations. Method:

- select candidate driver time series,
- calculate the partial correlation matrix,
- set the smallest non-significant element to zero, and
- recalculate the matrix until all links are significant.

Final matrix distinguishes between direct and indirect drivers. Non-significant links are conditionally independent.

Results: Observed interactions

The partial correlation matrices for Era–Interim reanalysis for the a) east coast, b) Australian and c) global ridge domains.

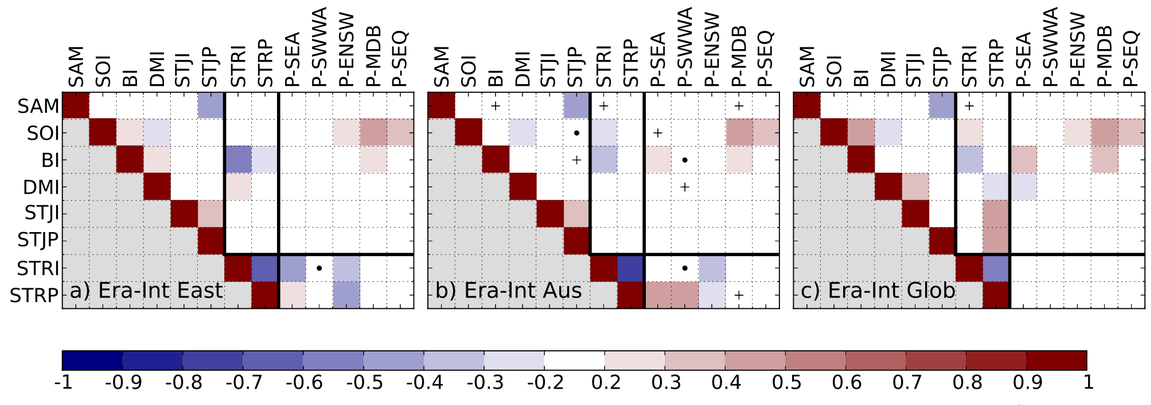


Fig. 4: Partial correlations matrix subplots for winter†

Interpretation: Covariability, impact on precipitation and model skill

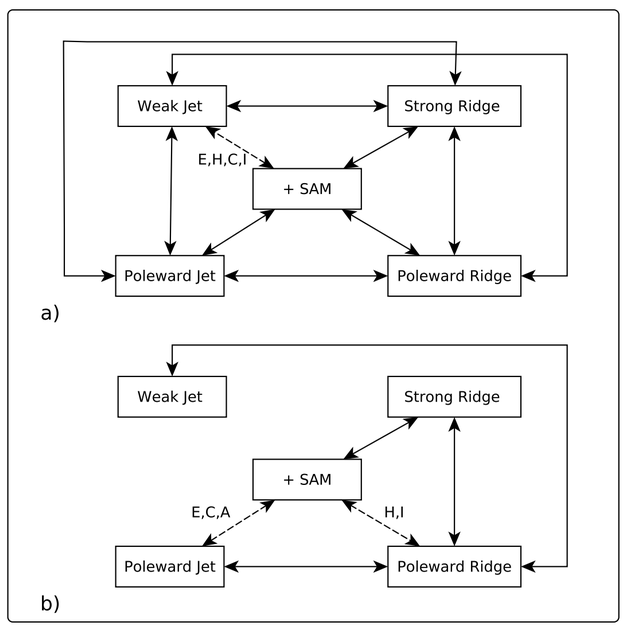


Fig. 5: Tropical edge covariability with SAM a) correlation and b) partial correlation‡

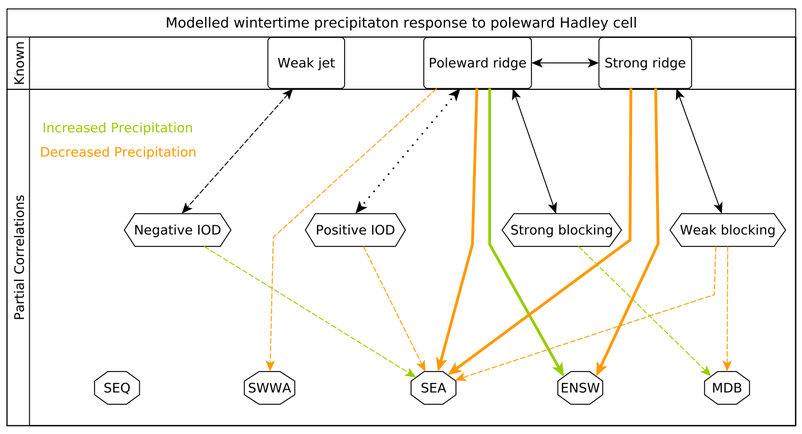


Fig. 6: Precipitation response to poleward Hadley cell. Solid, dash or dot lines for CMIP5 models reproducing obs in each, at least one or no models.‡

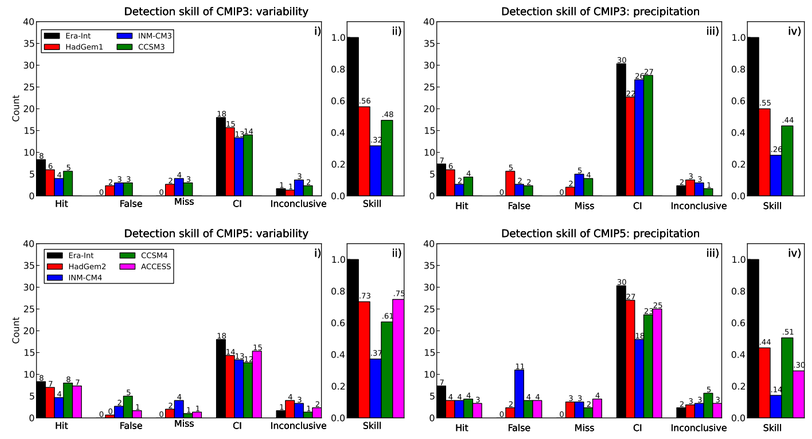


Fig. 7: Model skill scores for driver covariability structure (left) and regional precipitation response (right) for CMIP3 (top) and CMIP5 (bottom)‡

† Disentangling the multiple sources of large-scale variability in Australian wintertime precipitation, Maher and Sherwood (2014a), Journal of Climate.
‡ Covariability of tropical edge metrics and their impact on Australian precipitation in GCMs, Maher and Sherwood (2014b), manuscript in preparation.

Conclusions

1. The subtropical ridge position plays a central role in joining tropical edge metrics. Conditional independence occurs between the jet intensity and its position, the SAM with the jet intensity and ridge position. This suggests that perturbations to the subtropical jet intensity and ridge position, to first order, are not due to changes in the mid-latitude eddies (Fig. 5).
2. The observed precipitation response to a poleward Hadley cell is detected in the representative subset of CMIP5 models. Drying in SEA occurs via direct and indirect pathways primarily associated with the ridge position and intensity (Fig. 6).
3. The skill of CMIP5 models to represent the observed variability interactions has improved since CMIP3, however their skill in representing the influence of drivers on precipitation has not improved (one improved and two deteriorated) (Fig. 7).