Benchmarking Downscaled Precipitation to Optimize Stakeholder Resilience to Extremes using the CORDEX-Australasia Ensemble

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Rachael N. Isphording
Lisa V. Alexander
Margot Bador
Joshua-Brent Amoils
Donna Green

EGU Programme: CL5.3.3

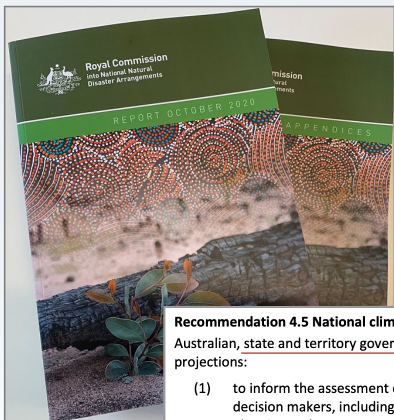
This presentation participates in OSPP
Outstanding Student & PhD candidate Presentation contest

UNSW Climate Change Research Centre

climate extremes
ARC centre of excellence

Motivation

- Added Value uncertainty
- Inconsistent model evaluation methods
- Low model agreement



Recommendation 4.5 National climate projections **126**

Australian, state and territory governments should produce downscaled climate projections:

(1) to inform the assessment of future natural disaster risk by relevant decision makers, including state and territory government agencies with planning and emergency management responsibilities

(2) underpinned by an agreed common core set of climate trajectories and timelines, and

(3) subject to regular review.

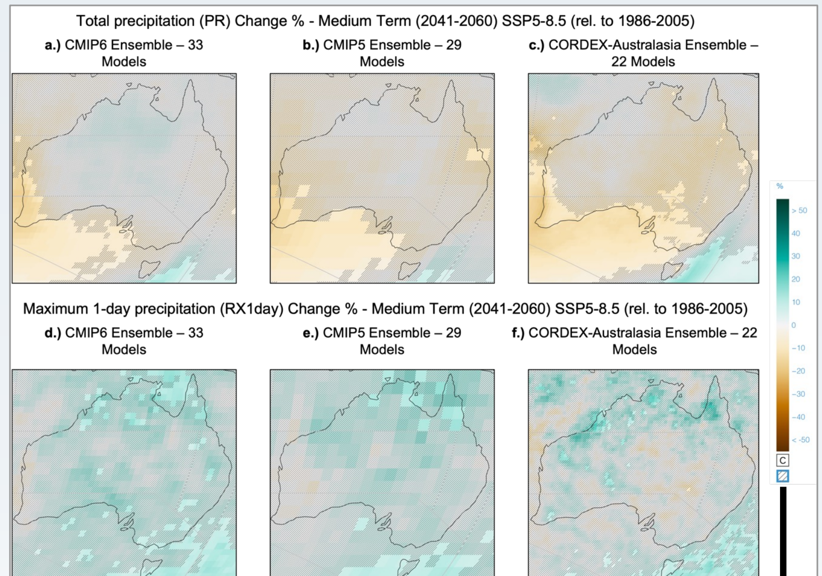
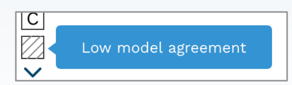
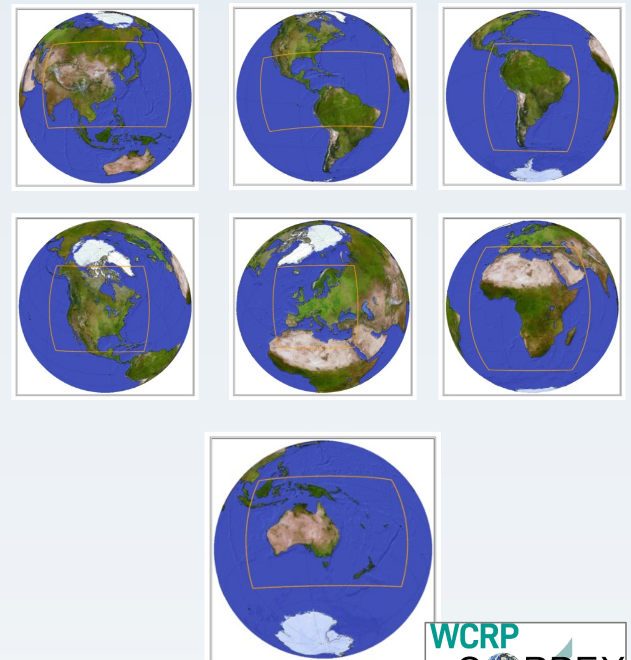


Image source: Compilation of plots created using the IPCC Interactive Atlas (Gutiérrez et al. 2021)



Research Objectives

Develop a benchmarking framework to holistically evaluate the skill of downscaled precipitation simulations in the CORDEX ensemble.



WCRP CORDEX
Coordinated Regional Climate Downscaling Experiment

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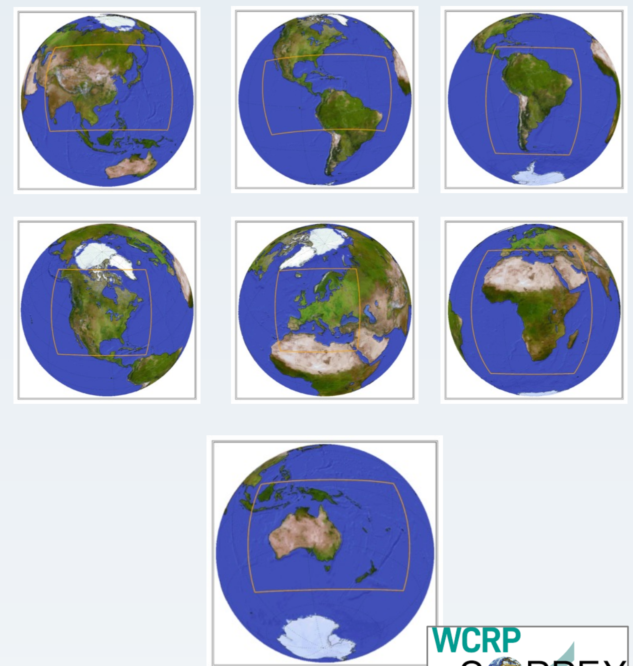
Assess model skill of the CORDEX-Australasia precipitation simulations over terrestrial Australia where we have confidence in observations.



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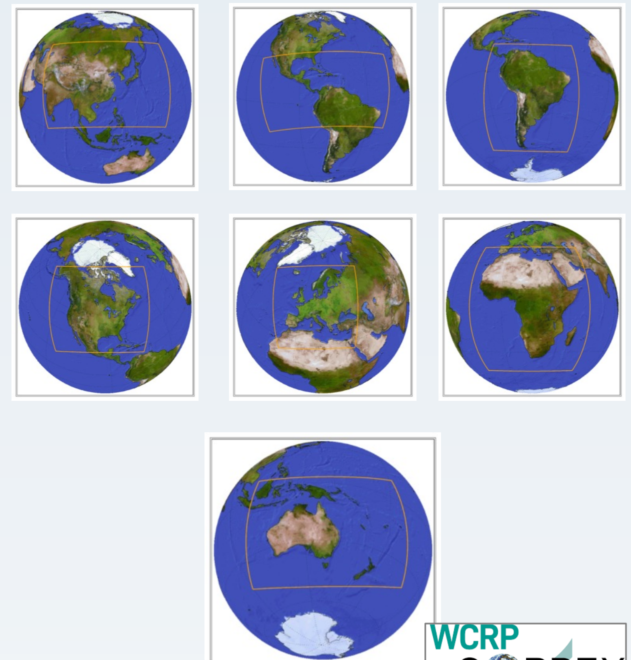
Benchmarking		Evaluation
A priori expectations	≠	Comparison to observations



WCRP CORDEX
Coordinated Regional Climate Downscaling Experiment

Methodology

***A priori* threshold:** within the range of observational uncertainty

AGCD Obs

Earth Syst. Sci. Data, 11, 1017–1035, 2019
https://doi.org/10.5194/essd-11-1017-2019

Open Access Earth System Science Data

FROGS: a daily 1° × 1° gridded precipitation database of rain gauge, satellite and reanalysis products

Roca et al., 2019

WCRP CORDEX

24 unique simulations

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WCRP CORDEX

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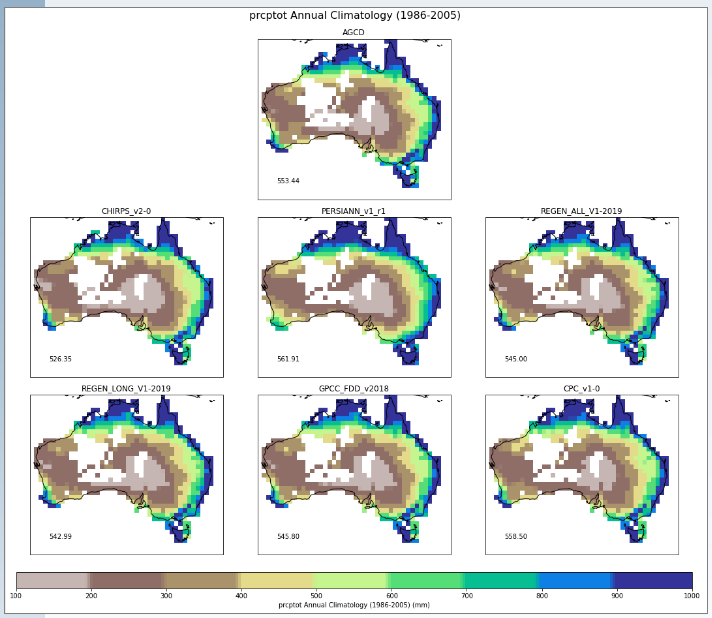
Spatial Distribution	Seasonal Cycle	Variability Across Timescales	Intensity/ Frequency Distributions	Extremes	Drought
RMSE of mean state	Amplitude + phase of seasonal cycle	Standard deviation at different timescales	Simple Daily Intensity Index (SDII)	Rx1day	Frequency of SPI spells below a threshold
Pattern correlation	Monthly score (RMS error)		Uneveness	Rx5day	Consecutive dry days
			Mean and variance of daily precip.	20y return values (from GEV)	
			Perkins score	Seasonal breakdown	
			Fraction of precipitating days		

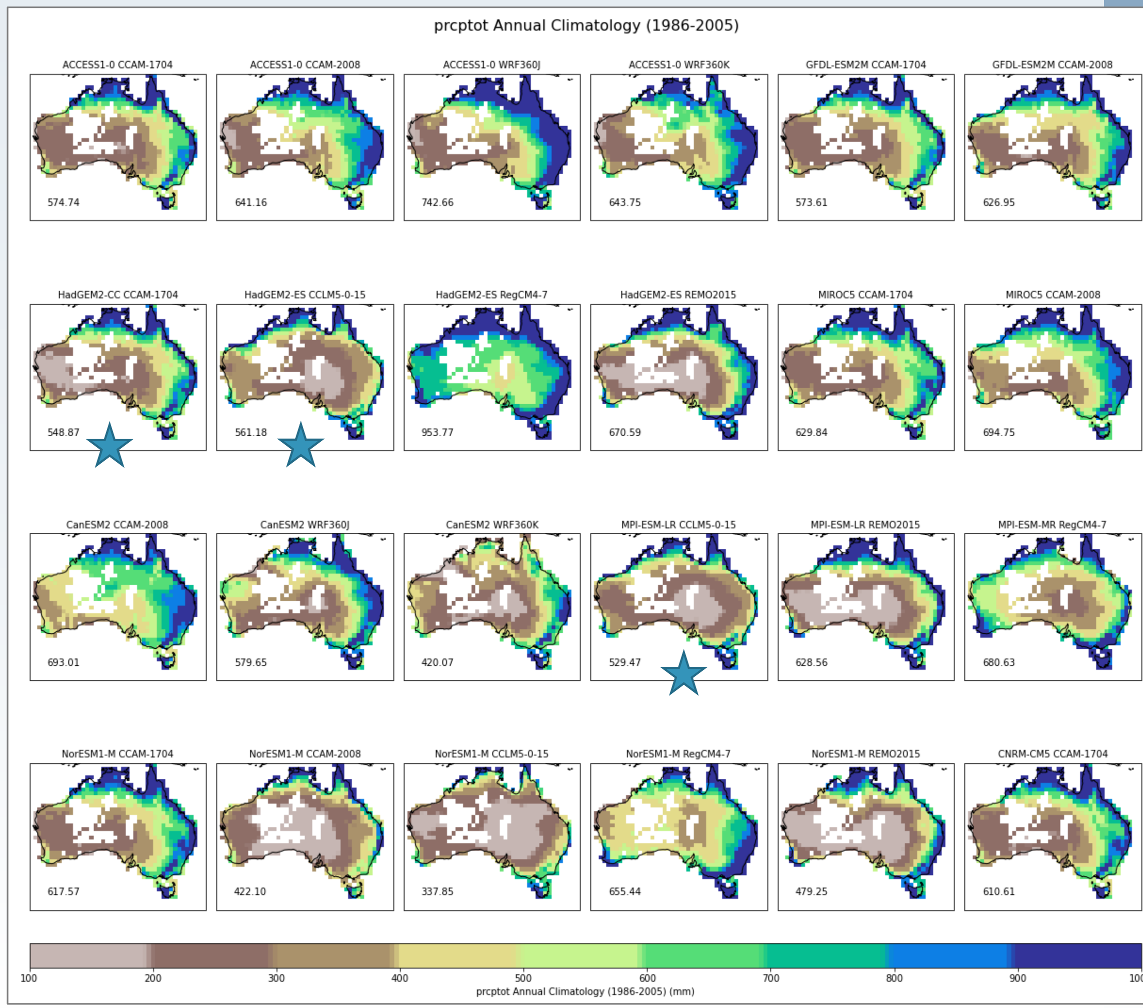
Adapted from DOE, 2020

* High-level; only precipitation used

Results

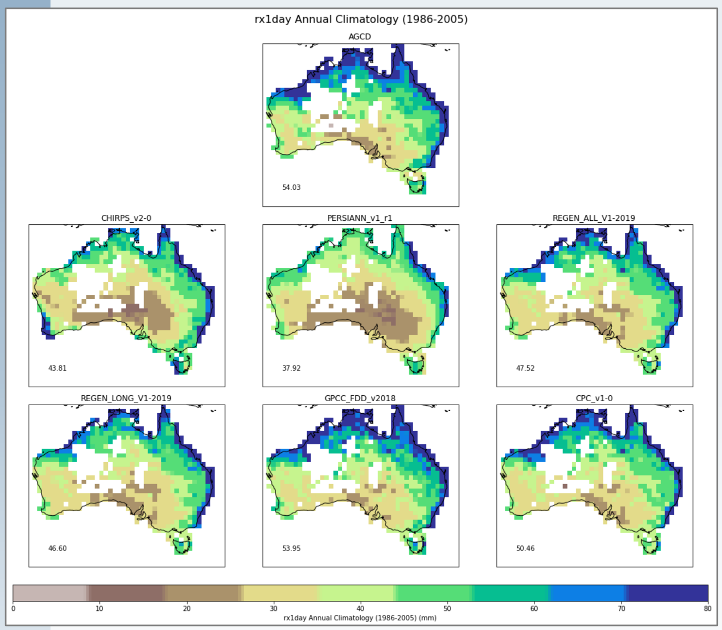


Range: 526.35 mm/year – 561.91 mm/year

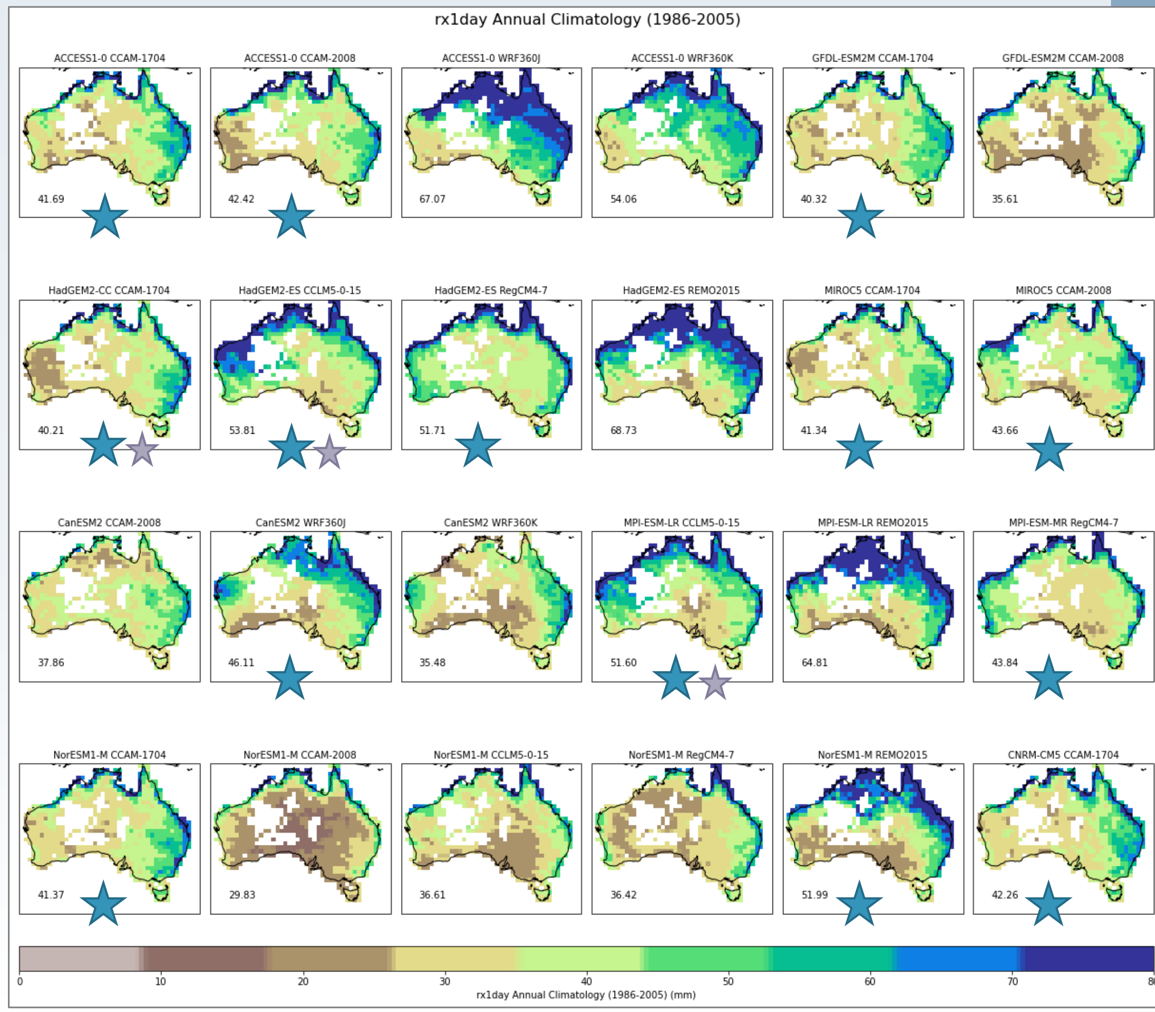


Range: 337.85 mm/year –953.77 mm/year

Results

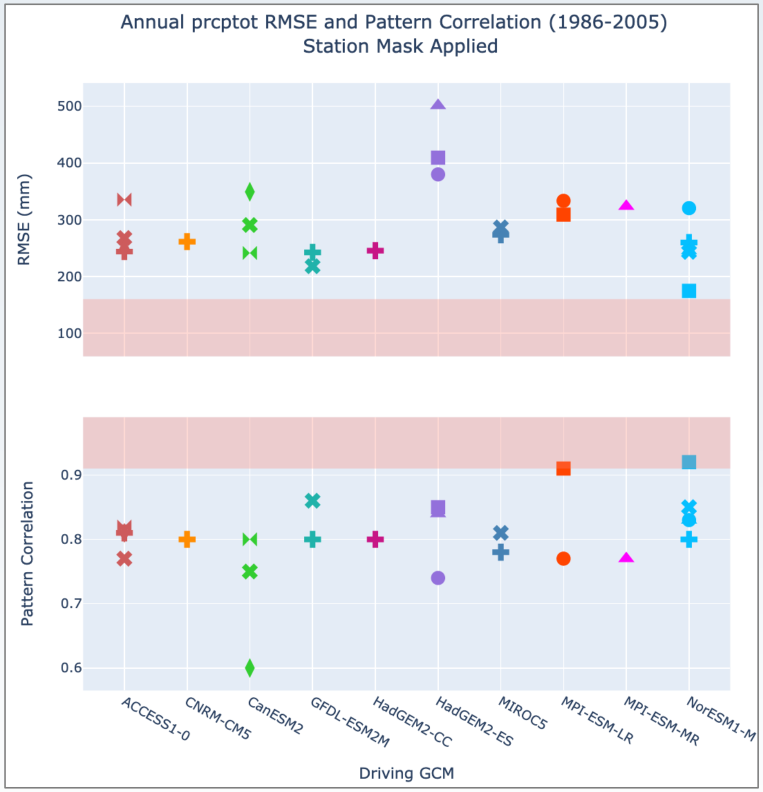


Range: 37.92 mm – 54.03 mm

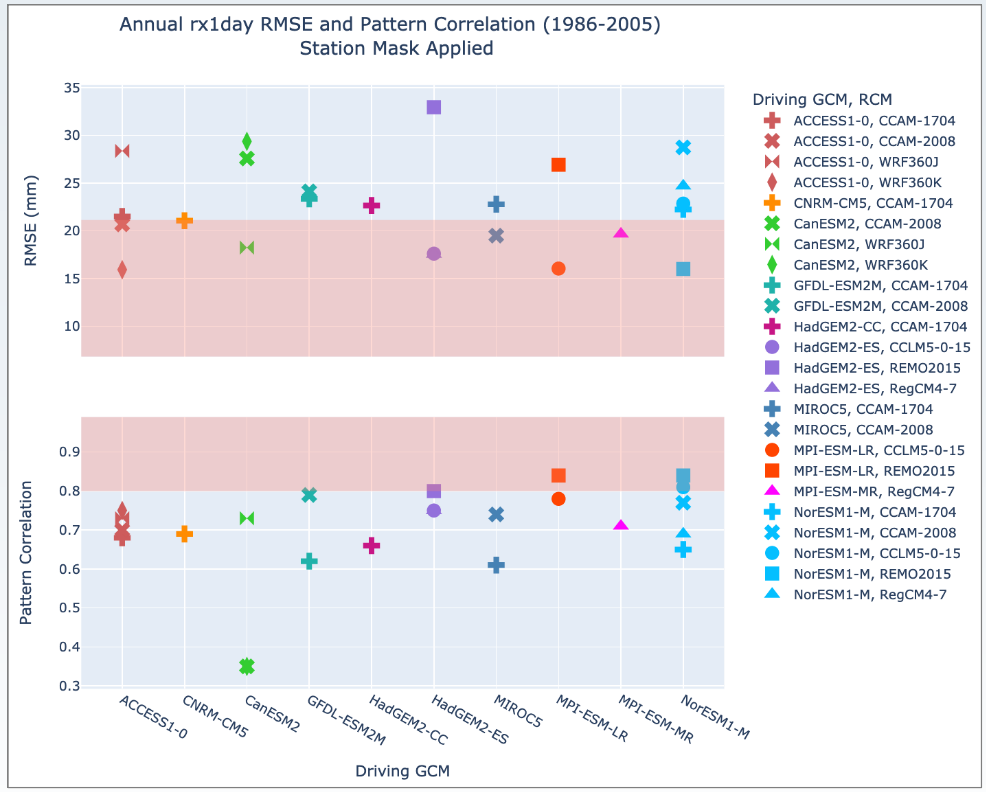


Range: 29.83 mm – 68.73 mm

Results



Annual prcptot RMSE and Pattern Correlation (1986-2005)
Station Mask Applied
RMSE (mm)
500
400
300
200
100
Pattern Correlation
0.9
0.8
0.7
0.6
ACCESS1-0
CNRM-CM5
CanESM2
GFDL-ESM2M
HadGEM2-CC
HadGEM2-ES
MIROC5
MPI-ESM-LR
MPI-ESM-MR
NorESM1-M
Driving GCM



Annual rx1day RMSE and Pattern Correlation (1986-2005)
Station Mask Applied
RMSE (mm)
35
30
25
20
15
10
Pattern Correlation
0.9
0.8
0.7
0.6
0.5
0.4
0.3
ACCESS1-0
CNRM-CM5
CanESM2
GFDL-ESM2M
HadGEM2-CC
HadGEM2-ES
MIROC5
MPI-ESM-LR
MPI-ESM-MR
NorESM1-M
Driving GCM
Driving GCM, RCM
ACCESS1-0, CCAM-1704
ACCESS1-0, CCAM-2008
ACCESS1-0, WRF360J
ACCESS1-0, WRF360K
CNRM-CM5, CCAM-1704
CanESM2, CCAM-2008
CanESM2, WRF360J
CanESM2, WRF360K
GFDL-ESM2M, CCAM-1704
GFDL-ESM2M, CCAM-2008
HadGEM2-CC, CCAM-1704
HadGEM2-ES, CCLM5-0-15
HadGEM2-ES, REMO2015
HadGEM2-ES, RegCM4-7
MIROC5, CCAM-1704
MIROC5, CCAM-2008
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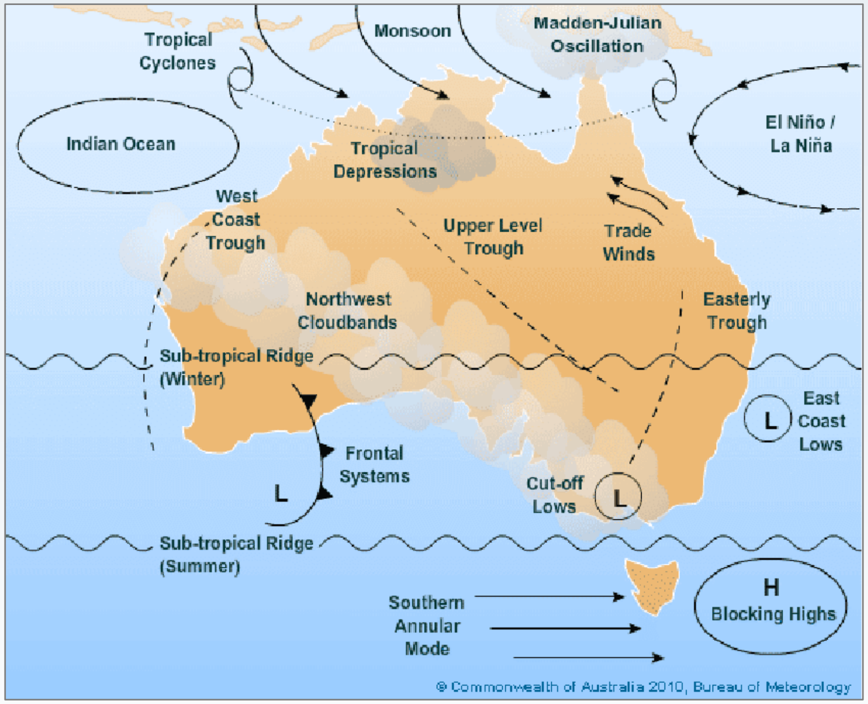
MPI-ESM-MR, RegCM4-7
NorESM1-M, CCAM-1704
NorESM1-M, CCAM-2008
NorESM1-M, CCLM5-0-15
NorESM1-M, REMO2015
NorESM1-M, RegCM4-7

Discussion and Future Work

- Observational Uncertainty insufficient benchmark alone
- Ranking of model performance
- Regional subsets
- Process-based understanding



Thank you!

Rachael Isphording
r.isphording@unsw.edu.au

EGU Programme: CL5.3.3

Supplemental Slides

Data

Observations

A priori threshold: within observational uncertainty

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Observational Daily Precipitation Datasets			
Dataset	**Data Source**	**Years Available**	**Reference**
AGCD_v1	*In situ*-based	1900-2019	(Jones et al., 2009); (Australian Bureau of Meteorology, 2020)
REGEN_ALL_V1-2019	*In situ*-based	1950-2016	(Contractor et al., 2019)
REGEN_LONG_V1-2019	*In situ*-based	1950-2016	(Contractor et al., 2019)
GPCC_FDD_v2018	*In situ*-based	1982-2016	Ziese et al (2018)
CPC_v1-0	*In situ*-based	1979-2017	Xie et al (2010)
CHIRPS_v2-0	Satellite with corrections to *in situ*	1981-2016	Funk et al (2015)
PERSIANN_v1_r1	Satellite with corrections to *in situ*	1983*-2017	Ashouri et al (2015), Sorooshian et al (2014)

Time Period Considered: 1986-2005

Data

CORDEX-Australasia Simulations

Native Domain	Institute	RCM Model	Driving CMIP5 Model	Available Experiments	Time Period
AUS-22 (22° curvilinear grid with a rotated pole)	CLMcom-HZG	**CCLM5-0-15**	MOHC-HadGEM2-ES	historical, rcp85	1950-2099
			MPI-M-MPI-ESM-LR		1950-2100
			NCC-NorESM1-M		
	GERICS	**REMO2015**	MOHC-HadGEM2-ES	historical, rcp85	1970-2100
			MPI-M-MPI-ESM-LR		
			NCC-NorESM1-M		
	ICTP	**RegCM4-7**	MOHC-HadGEM2-ES	historical, rcp85	1970-2099
			MPI-M-MPI-ESM-MR		
			NCC-NorESM1-M		
AUS-44 (44° curvilinear grid with a rotated pole)	CLMcom	**CCLM4-8-17-CLM3-5**	MPI-M-MPI-ESM-LR	historical, rcp45, rcp85	1951-2100
AUS-44; AUS-44i (0.5° standard grid)	UNSW	**UNSW-WRF360J, UNSW-WRF360K**	CCCma-CanESM2	historical, rcp45, rcp85	1951-2099
			CSIRO-BOM-ACCESS1-0		1951-2100
			CSIRO-BOM-ACCESS1-3		
AUS-44i (0.5° standard grid)	CSIRO	**CCAM-2008**	CSIRO-BOM-ACCESS1-0	historical, rcp45, rcp85	1960-2099
			NOAA-GFDL-GFDL-ESM2M		
			NCC-NorESM1-M		
			CCCma-CanESM2		
			MIROC-MIROC5		1961-2099
		CCAM-1704	NCC-NorESM1-M	historical, rcp45, rcp85	1960-2099
			CSIRO-BOM-ACCESS1-0		
			CNRM-CERFACS-CNRM-CM5		
			MIROC-MIROC5		
			MOHC-HadGEM2-CC		
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Results – Seasonal PRCPTOT