Are convective permitting simulations meaningful for VIA work on watershed scale?

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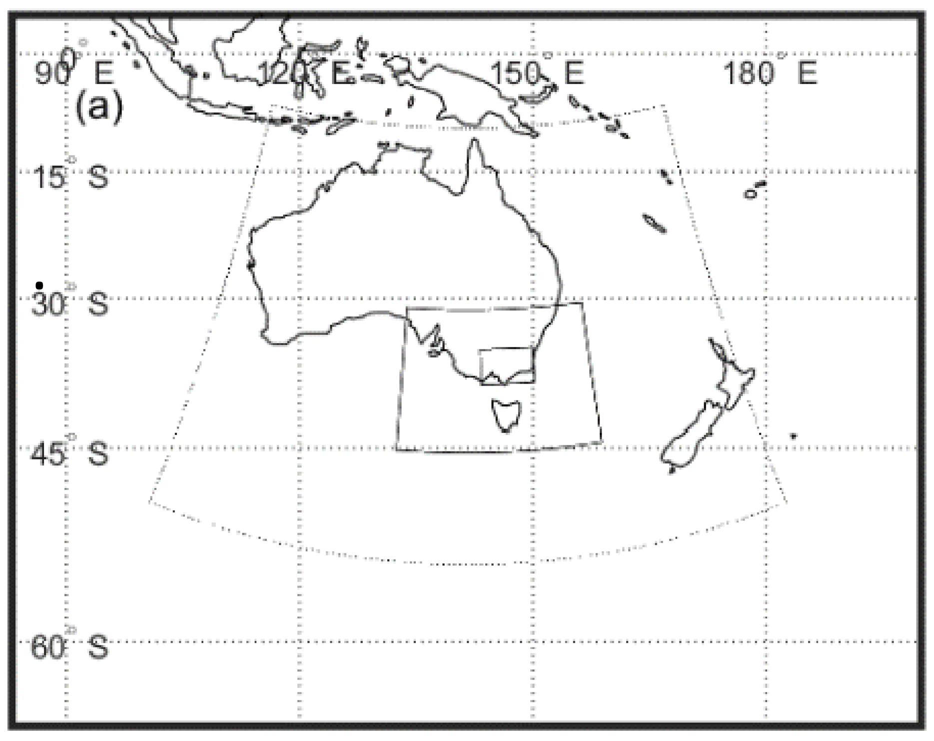
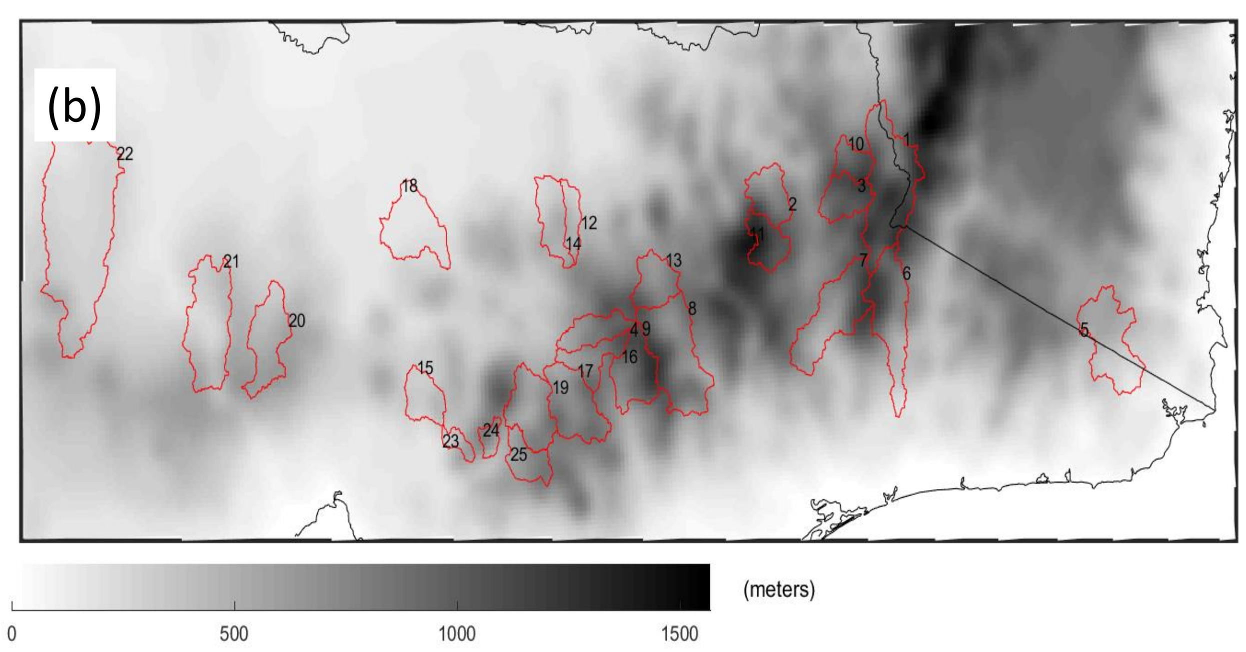
Are convective permitting simulations more skilful in simulating rainfall for the purpose of IAV work in the water resource sector in southeast Australia? Output on 2 and 10 km grid length resolution from a 5-year (2010-2014) regional climate model simulation is assessed for skill in simulating mean climatologies for days with high observed rainfall intensities (>90th percentile). Comparison is conducted on spatial model domain and on 25 catchments across the study region.

1. Experiment



A 5 -ear simulation is conducted with the Advanced Research Weather Research and Forecasting (WRF) model[1] for southeast Australia using a telescopic one-way nest (a) with three domains: d01 at 50km, d02 at 10km and d03 at 2km. WRF simulations (Box 6) on the two innermost domains (WRF2, and WRF10) are assessed for similarity to observed gridded daily rainfall data of the Australian Water Availability Project (AWAP[2]).

Simulations are stratified according to season and maximum observed grid cell rainfall in AWAP >90th percentile. Mean climatologies are calculated for each set of binned daily data for AWAP, WRF2 and WRF10. Daily catchment averages are calculated and pooled into bins according to season and to AWAP catchment value >90th percentile.

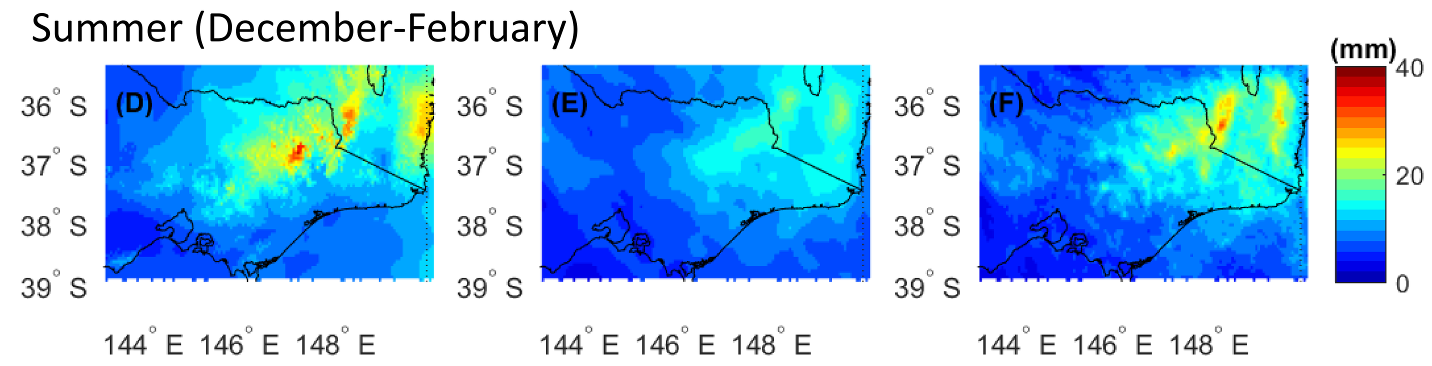


Indices to assess similarity in spatial fields are the Spatial Prediction Comparison test (SPCT) Fractions Skill Score (FSS[3]); calculated on values exceeding 95th percentile for 95km neighbourhood, and a simple variography measure[4].

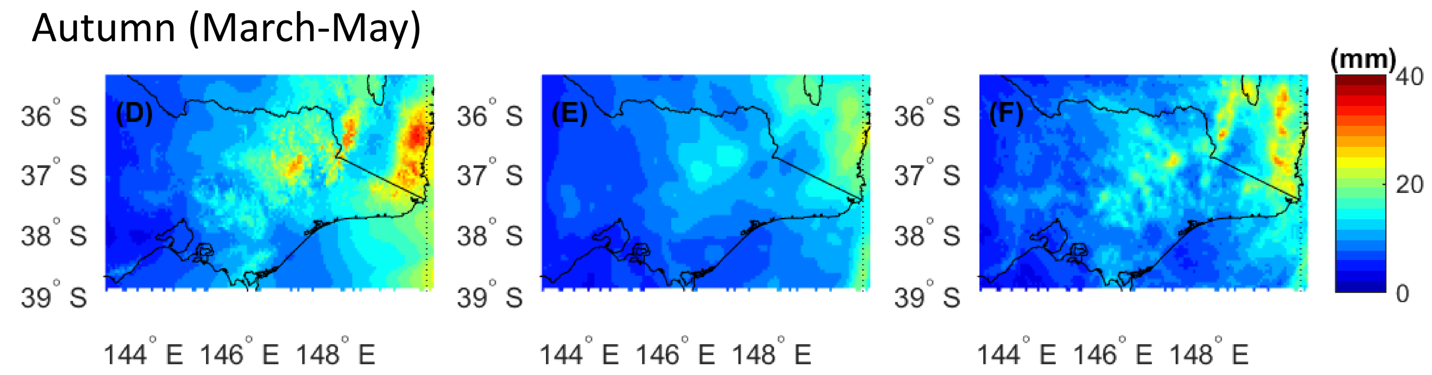
2. Seasonal climatologies for high intensity events

The figures show mean climatologies for days with grid cell exceedance of 90th percentile value, 52.2 mm. In each panel from the left: AWAP, WRF10 and WRF2 (all maps on AWAP 0.05° regular grid).

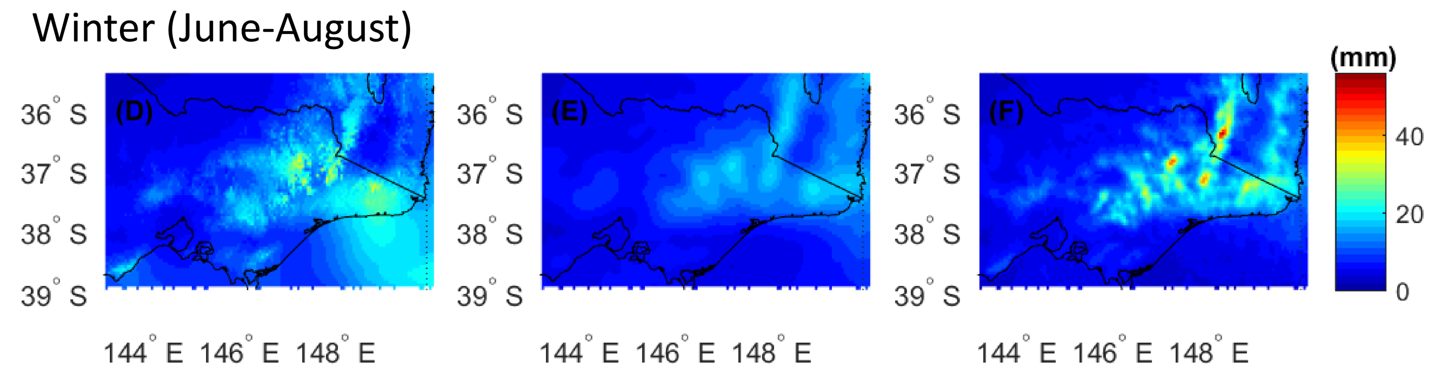
Summer (December-February)



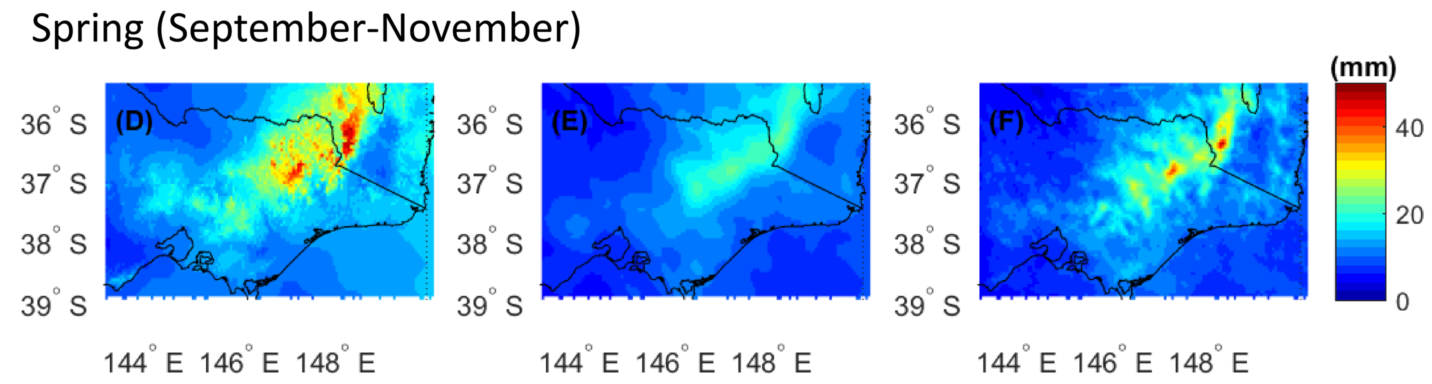
Autumn (March-May)



Winter (June-August)

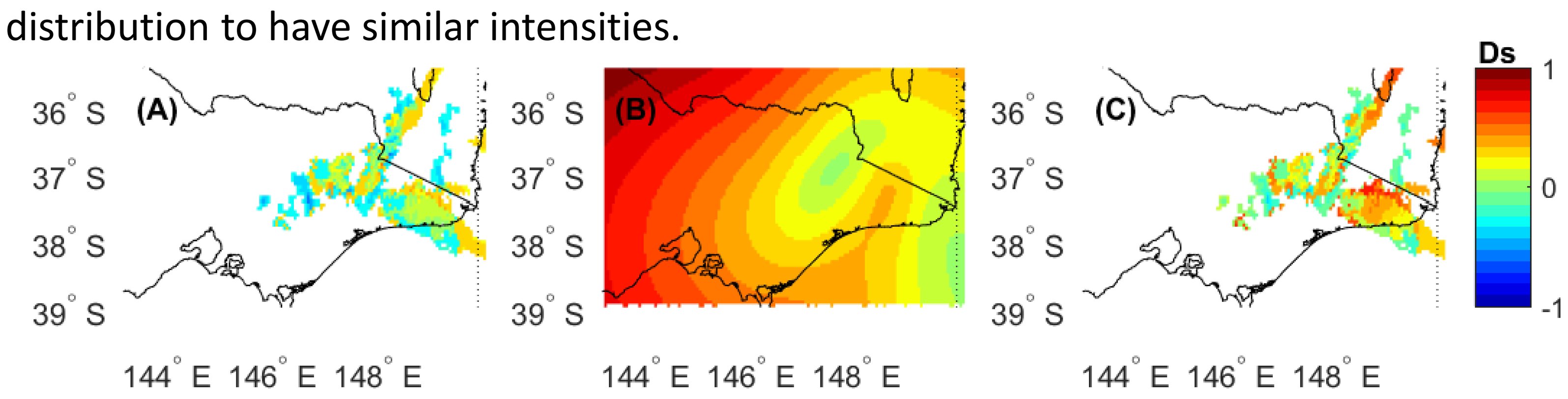


Spring (September-November)



3. Skill measure results

Illustrating the loss differential (Ds) for the mean winter climatologies (see Box 2) based on absolute error (AE) loss (calculated using warped simulated fields) for values exceeding the 90th percentile in each field (A), difference in location distortion for WRF10 and WRF2 (B), combined loss differential (AE loss including location distortion) (C). All fields are scaled by the range of their respective distribution to have similar intensities.



	Summer		Autumn		Winter		Spring	
	Metric	P-value	Metric	P-value	Metric	P-value	Metric	P-value
Full field	0.15	0.88	0.18	0.86	-0.11	0.91	0.24	0.81
>90	0.01	0.99	0.18	0.86	-0.02	0.98	-0.02	0.98
>90 + warping	0.16	0.87	0.32	0.75	0.71	0.48	-0.52	0.60

SPCT based on AE loss and associated P-values for climatologies in Box 2. Negative/positive values indicative of smaller AE for WRF10/WRF2.

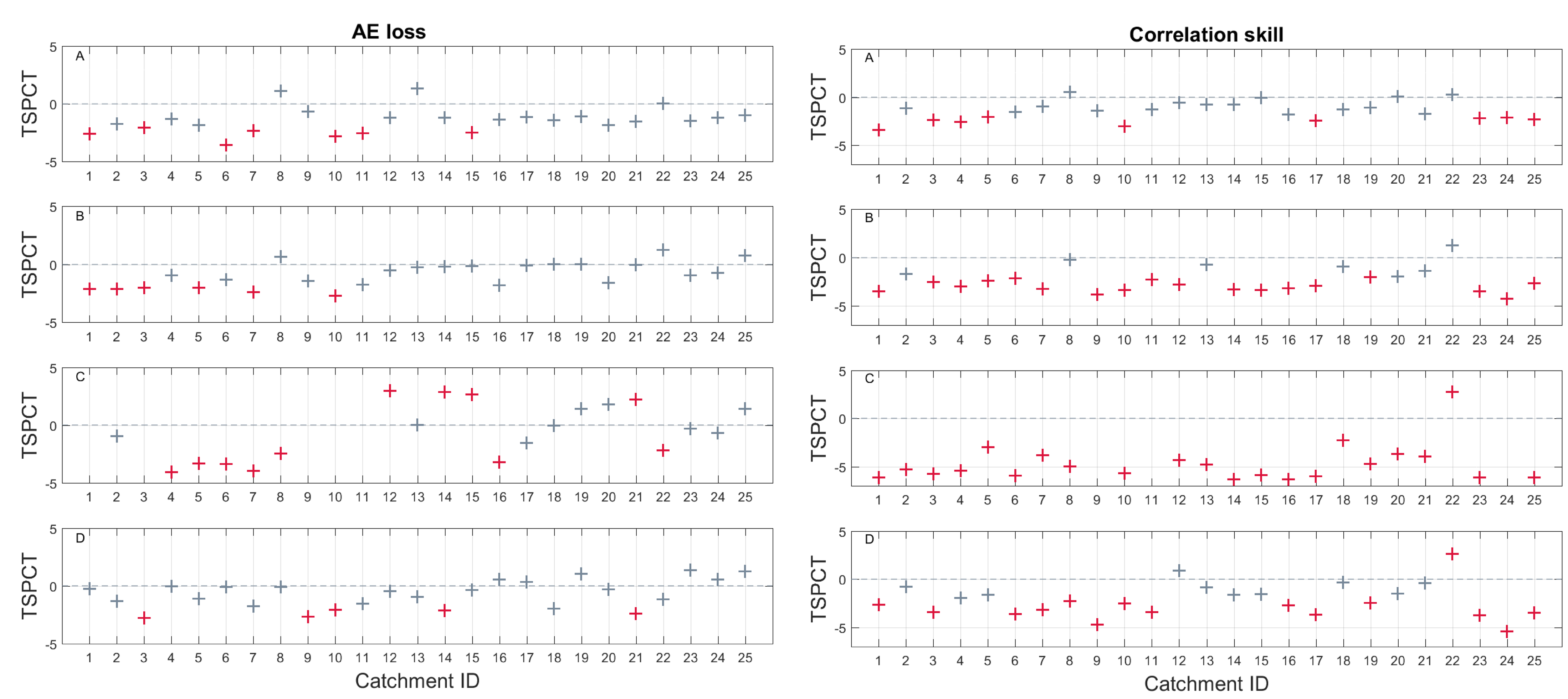
Measure	Summer	Autumn	Winter	Spring
FSS (applied to 95th percentile exceedances using a 95km neighbourhood)				
WRF10	0.85	0.67	0.76	0.98
WRF2	0.74	0.70	0.90	0.95
Variography measure				
WRF10	0.46	0.51	0.85	0.39
WRF2	0.78	1.02	0.53	0.80

FSS and simple variography measure applied to climatologies in Box 2. Better skill denoted by red colour.

4. Catchment comparison

A time series prediction comparison test (TSPCT[5]) was carried out for each catchment (Box 1, Fig. b) based AE loss (left panel below) and correlation skill (right panel below) for catchment means stratified according AWAP catchment mean >90th percentile and season: summer (A), autumn (B), winter (C), and spring (D).

For AE loss, a positive test metric indicate smaller AE for WRF2 relative to WRF10. For correlation skill, a negative test metric indicate higher correlation for WRF2 relative to WRF10. Red markers indicate significant difference (α= 0.05).



5. Conclusions

- There is no significant difference between WRF2 and WRF10 mean spatial climatologies for stratified across seasons and maximum grid cell intensity in observations (>90th percentile). However, the sign of test metric indicate somewhat smaller AE for WRF2 in summer, autumn and winter (after warping) for the 90th percentile exceedances in the maps. Other measures indicate that WRF2 has smaller positional error in autumn and winter, and more similar spatial characteristics in all seasons but winter compared to WRF10.
- On catchment resolution, absolute errors in WRF2 are occasionally large, more so in winter with numerous catchment indicating significant difference in skill (α=0.05).
- There is some concern that AE results are overly pessimistic for WRF2 on catchment resolution due to the smoothness in the verification data.

6. WRF setup

WRF simulation uses boundary conditions from reanalysis ERA Interim[6]. The following physics schemes were used in the 5-year simulation: ***short and long wave radiation schemes***: the rapid radiative transfer model for GCMs for long and short wave radiation (RRTMG); ***land surface model scheme***: Noah Land surface model; ***cumulus scheme*** (d01 and d02): Betts-Miller-Janjic (BMJ); ***surface physics scheme***: fifth generation Penn State/NCAR Mesoscale Model (MM5); ***microphysics scheme*** : WRF double moment 6-class (WDM6) scheme; ***planetary boundary layer (PBL) scheme:*** the local Mellor-Yamada Nakanishi and Niino (MYNN). References for each parameter scheme are given at: http://www2.mmm.ucar.edu/wrf/users/wrfv3.5/phys_references.html

FOR FURTHER INFORMATION

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