Modelling drought in south-east Australia using a regional climate model

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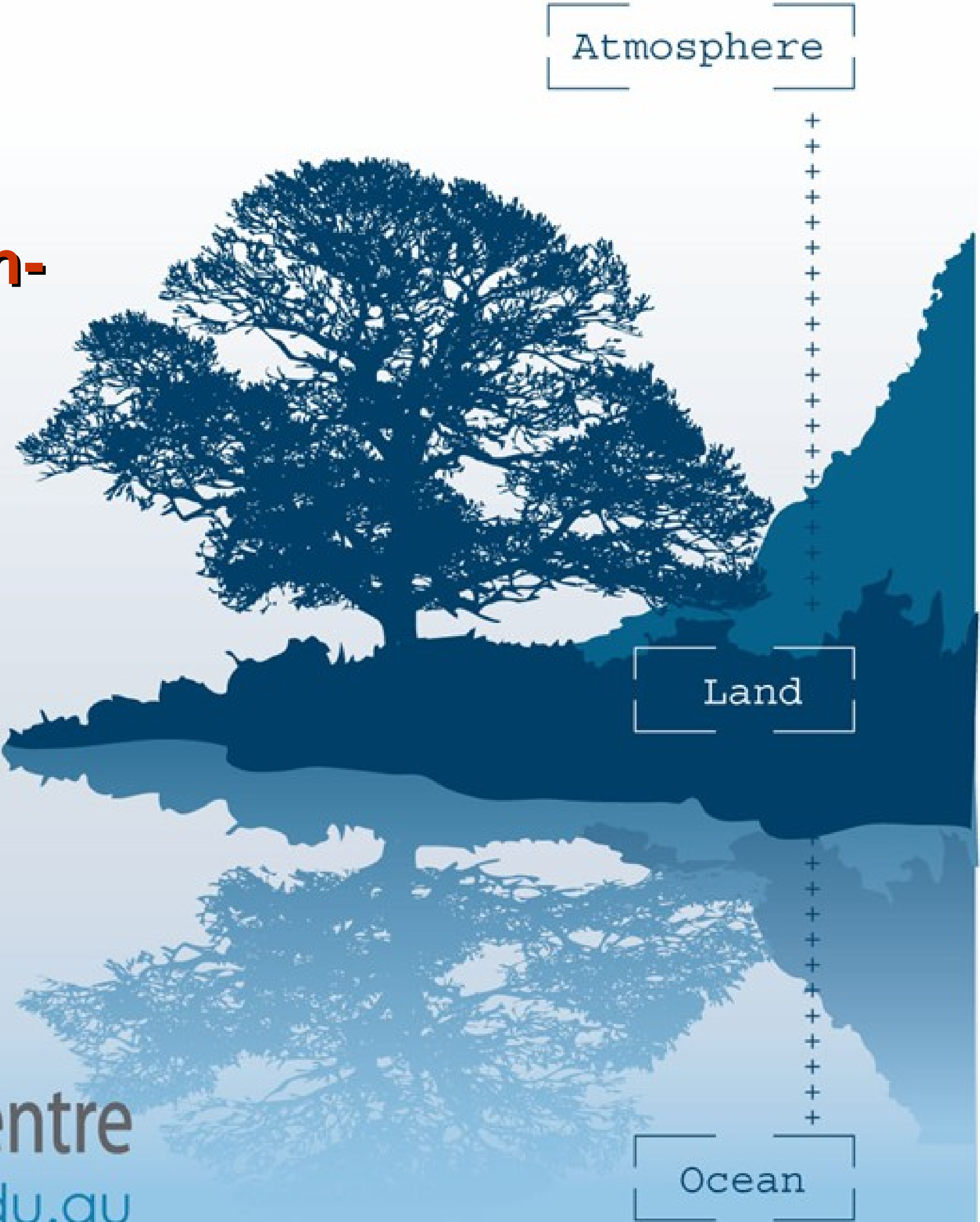
and X.H. Meng



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Objectives

Evaluate the application of dynamic, satellite derived albedo and vegetation fraction for simulating the regional climate of the South-east Australia.

- Does it perform better than the WRF control?
- Can it capture the recent drought in the Murray-Darling Basin of Australia?
- How did it impact the simulation of the drought?

WRF Description

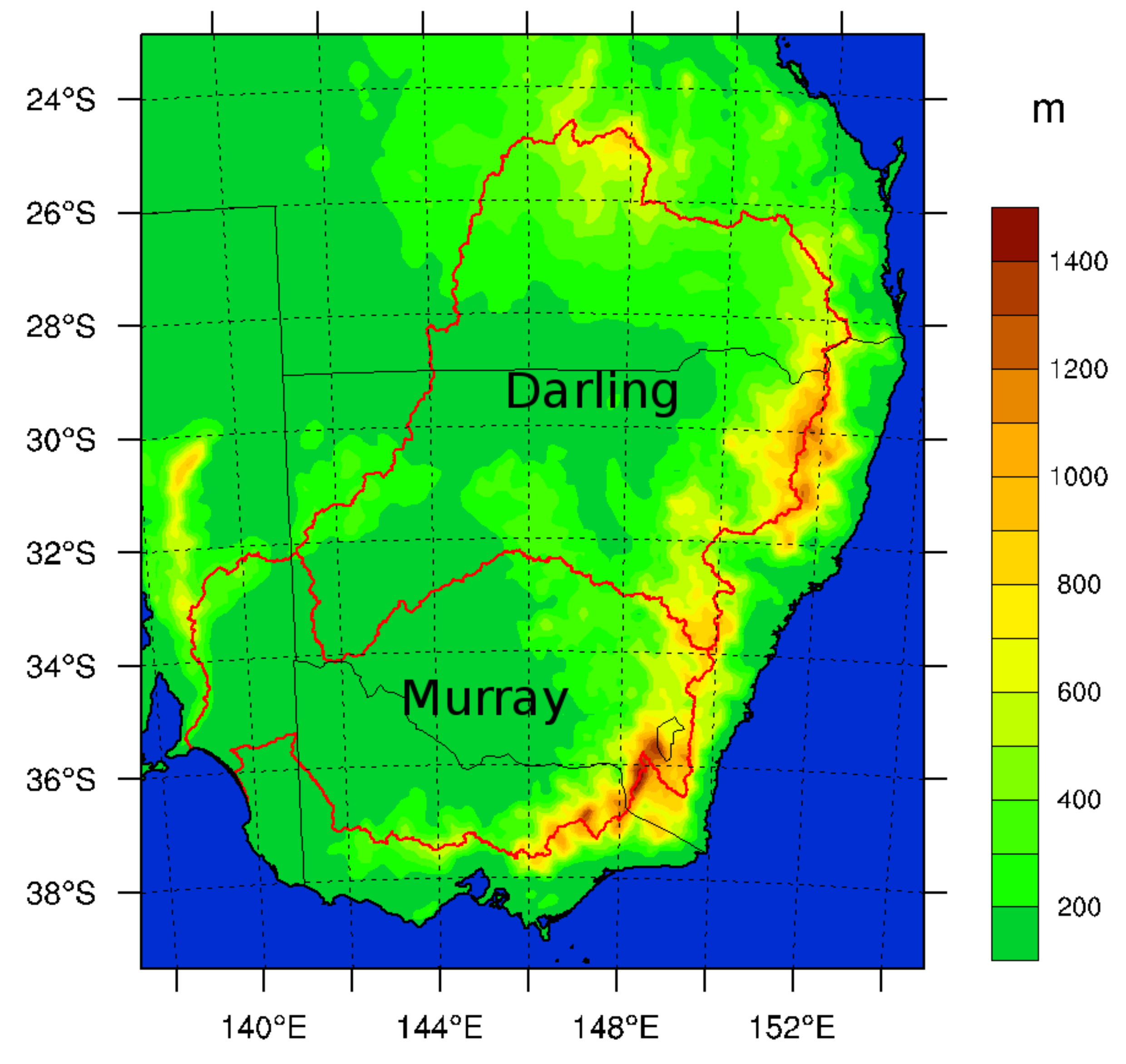
Advanced Research WRF version 3.1.1

- Fully compressible nonhydrostatic dynamics
- Two-way nesting
- Mass-based terrain following vertical coordinate
- 2nd order Runge-Kutta time integration with time-split small step for acoustic and gravity waves
- Physics parametrizations
  - WRF Single Moment 5-class microphysics scheme
  - Rapid Radiative Transfer Model (RRTM) longwave radiation scheme
  - Dudhia shortwave radiation scheme
  - Monin-Obukhov surface layer similarity
  - Noah land-surface scheme
  - Yonsei University boundary layer scheme
  - Kain-Fritsch cumulus physics scheme

WRF Simulation

- Centred at ~32.7S 146.1E
- Topography and land use are interpolated from global 2 min datasets
- Initial and boundary conditions from **NCEP/NCAR reanalysis**
- Covers 2000 through 2008
- 30 vertical levels
- Horizontal resolution = 10km
- Time step = 60 s
- WRF lower boundary input

Model Topography



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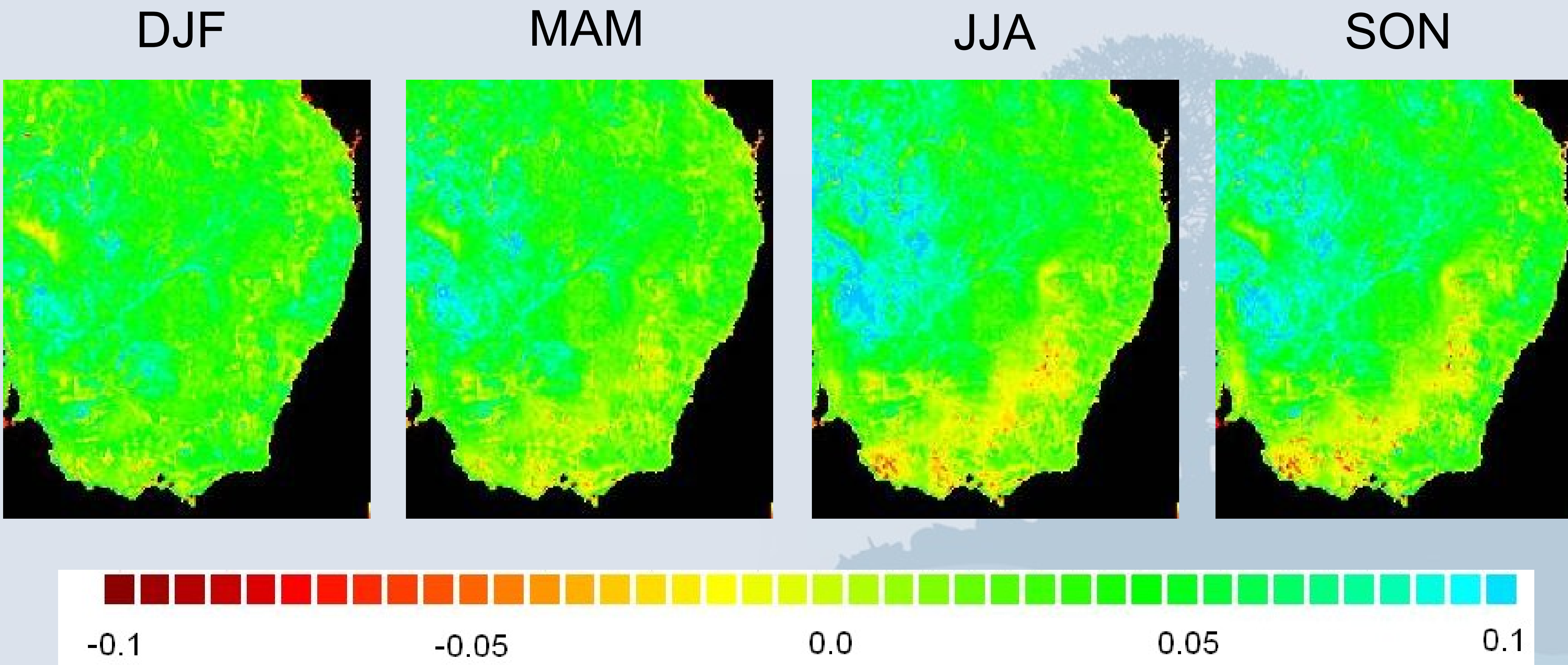
Albedo & Vegetation Fraction data

	WRF_CTL	WRF_ALB, WRF_VEG
Sensor	AVHRR	MODIS
Time period	Apr 1985-Dec 1987 and Jan 1989-Mar 1991 Climatology	Jan 2000 - Dec 2008
Time step	monthly	8-day interval 16-day composite
Spatial resolution	1.0 / 0.5/ 0.25 degrees	1km

Albedo comparison



Average albedo difference between WRF control and MODIS data (MODIS-WRF_CTL)

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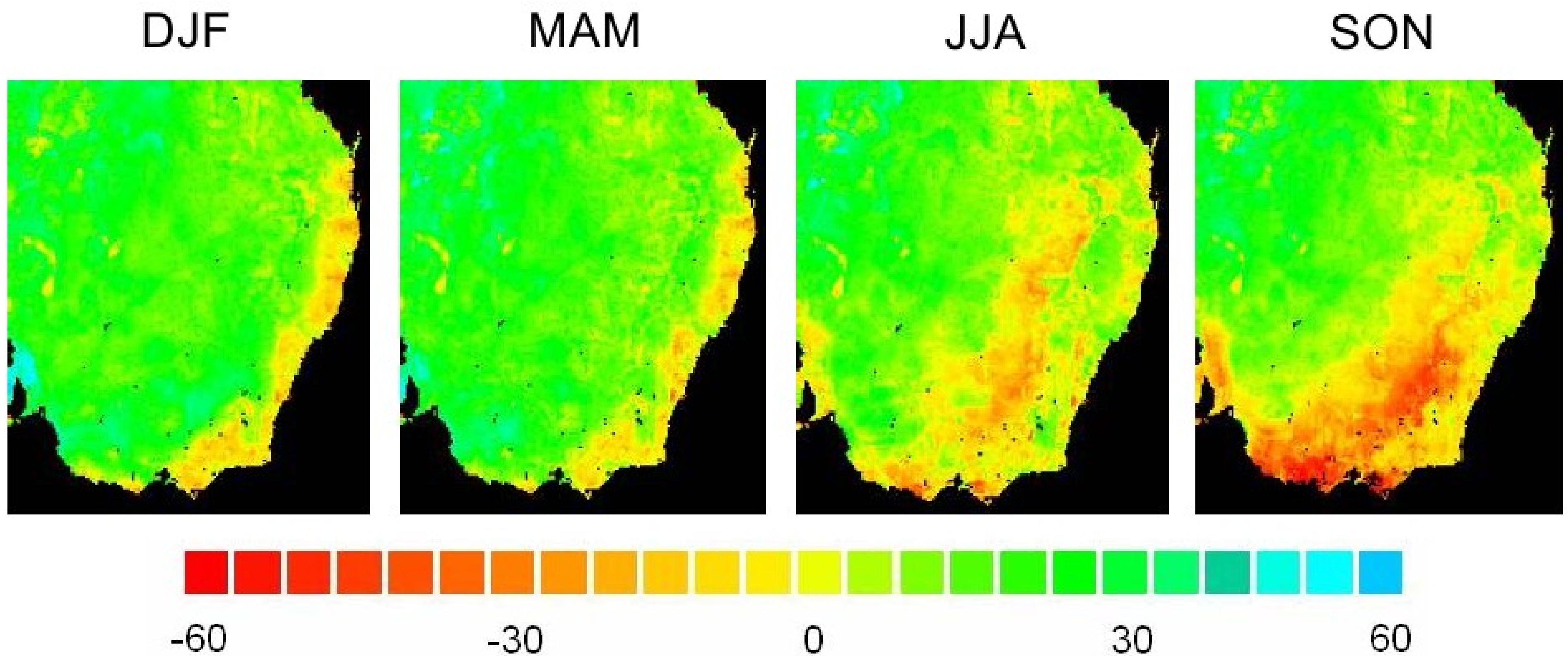
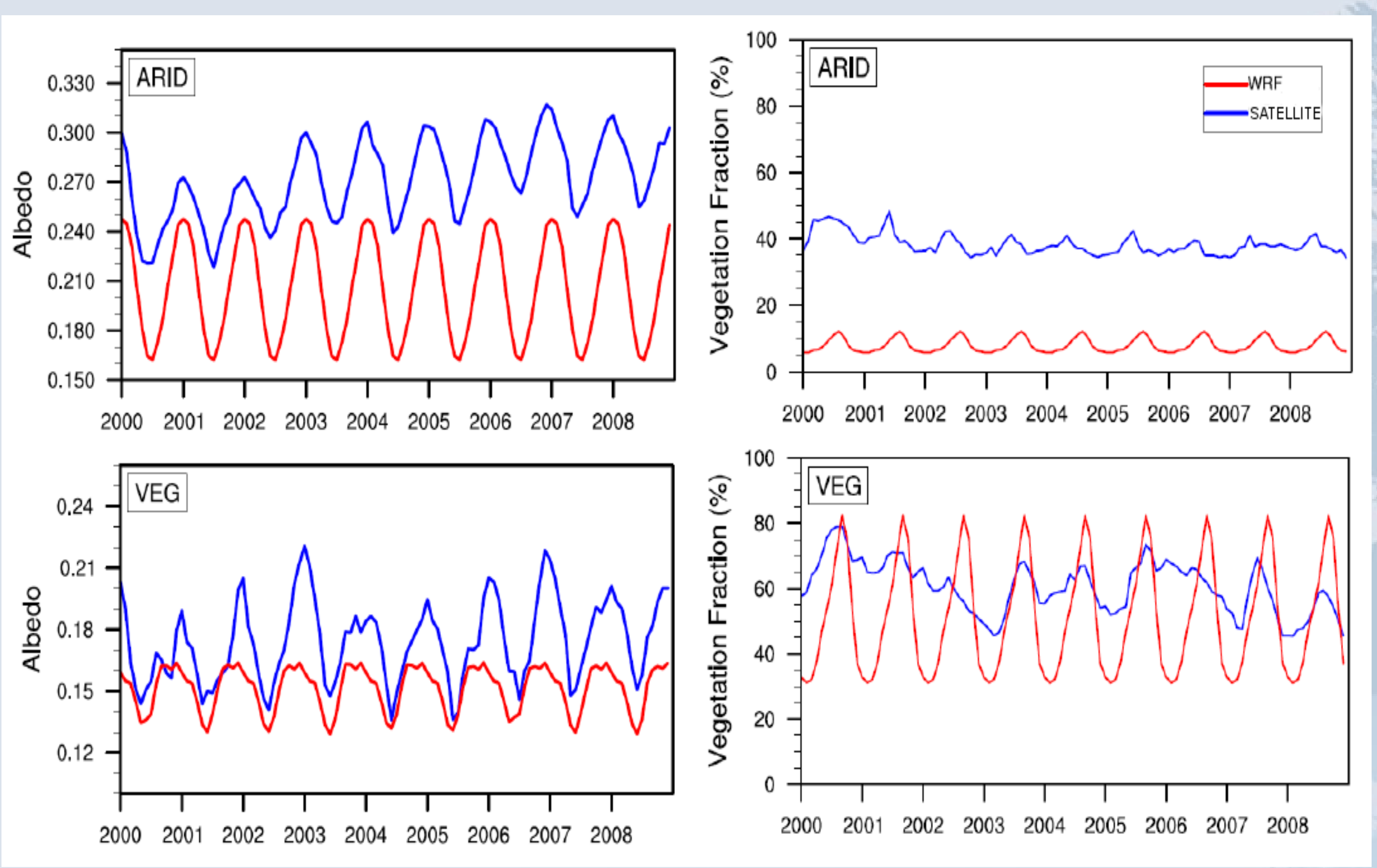
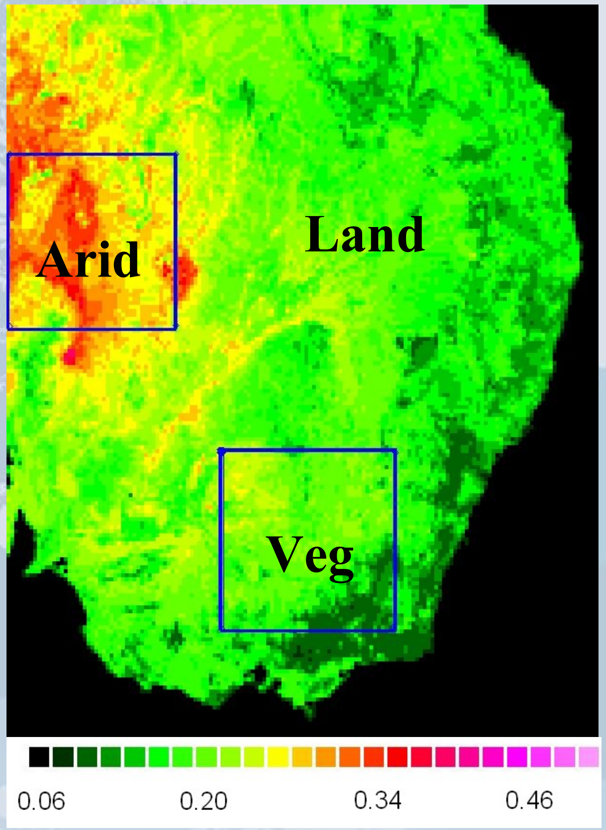
Vegetation Fraction Comparison



Average vegetation fraction difference between WRF control and MODIS data (MODIS-WRF_CTL)

Time series of albedo and vegetation fraction





Albedo distribution in DJF

Regions used in analysis

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Results

Murray

	Temperature (K)				Precipitation (mm)			
	WRF (ALB)	WRF (VEG)	WRF (BOTH)	WRF (CTL)	WRF (ALB)	WRF (VEG)	WRF (BOTH)	WRF (CTL)
Bias	0.613	0.489	0.245	0.76	-8.717	-7.06	-8.204	-8.187
RMSE	1.103	1.055	0.951	1.20	12.061	11.94	11.95	12.273
Pattern Correlation	0.935	0.935	0.936	0.936	0.734	0.729	0.736	0.743
Anomaly Correlation	0.241	0.324	0.334	0.245	0.395	0.378	0.397	0.392

Darling

	Temperature (K)				Precipitation (mm)			
	WRF (ALB)	WRF (VEG)	WRF (BOTH)	WRF (CTL)	WRF (ALB)	WRF (VEG)	WRF (BOTH)	WRF (CTL)
Bias	0.802	0.808	0.374	1.188	-7.819	-3.804	-6.88	-5.842
RMSE	1.055	1.118	0.859	1.404	12.50	10.248	11.79	11.456
Pattern Correlation	0.941	0.940	0.941	0.944	0.652	0.654	0.651	0.659
Anomaly Correlation	0.355	0.396	0.422	0.3392	0.426	0.426	0.423	0.432

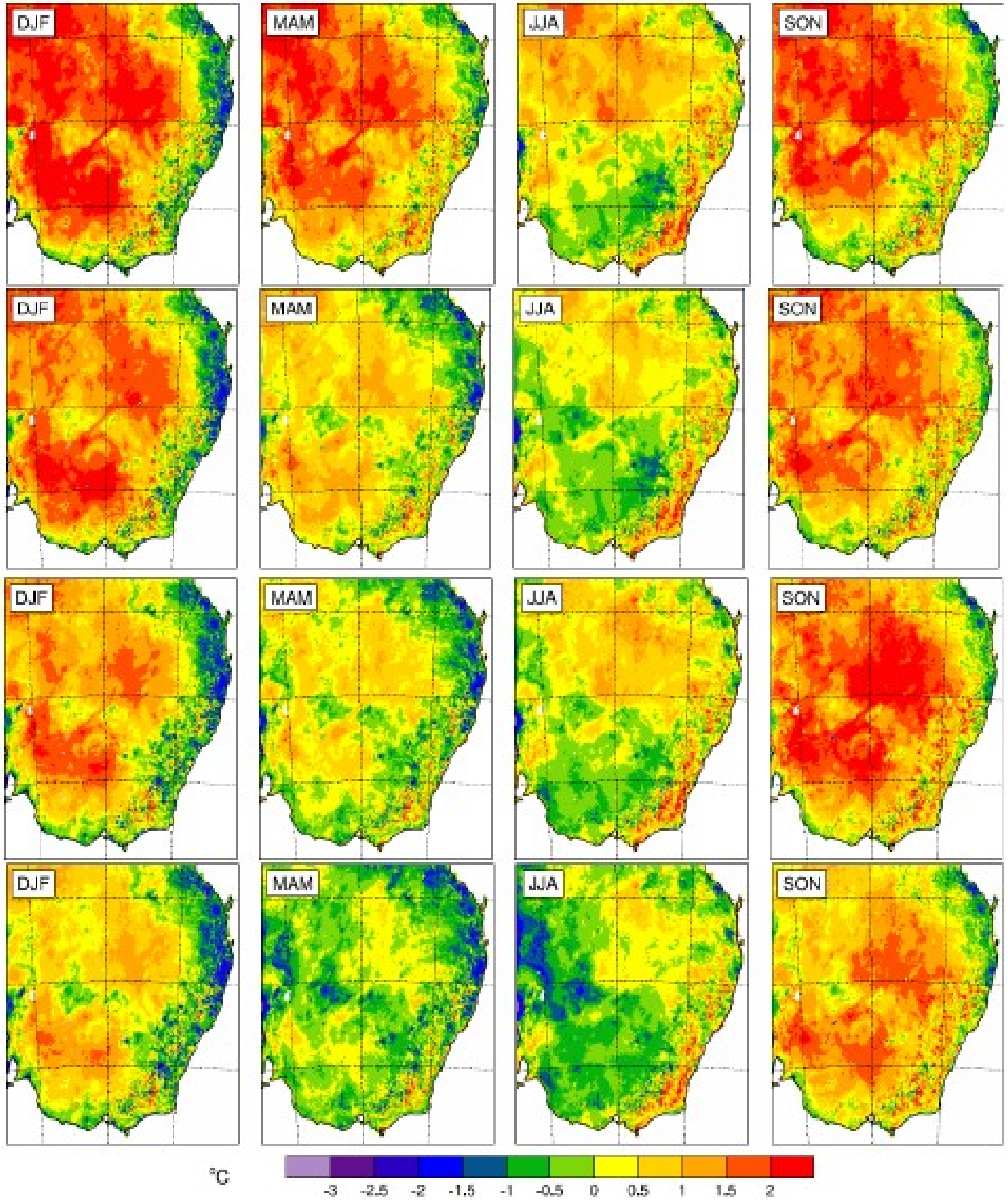
2m Temperature

WRF(CTL)-AWAP

WRF(ALB)-AWAP

WRF(VEG)-AWAP

WRF(BOTH)-AWAP



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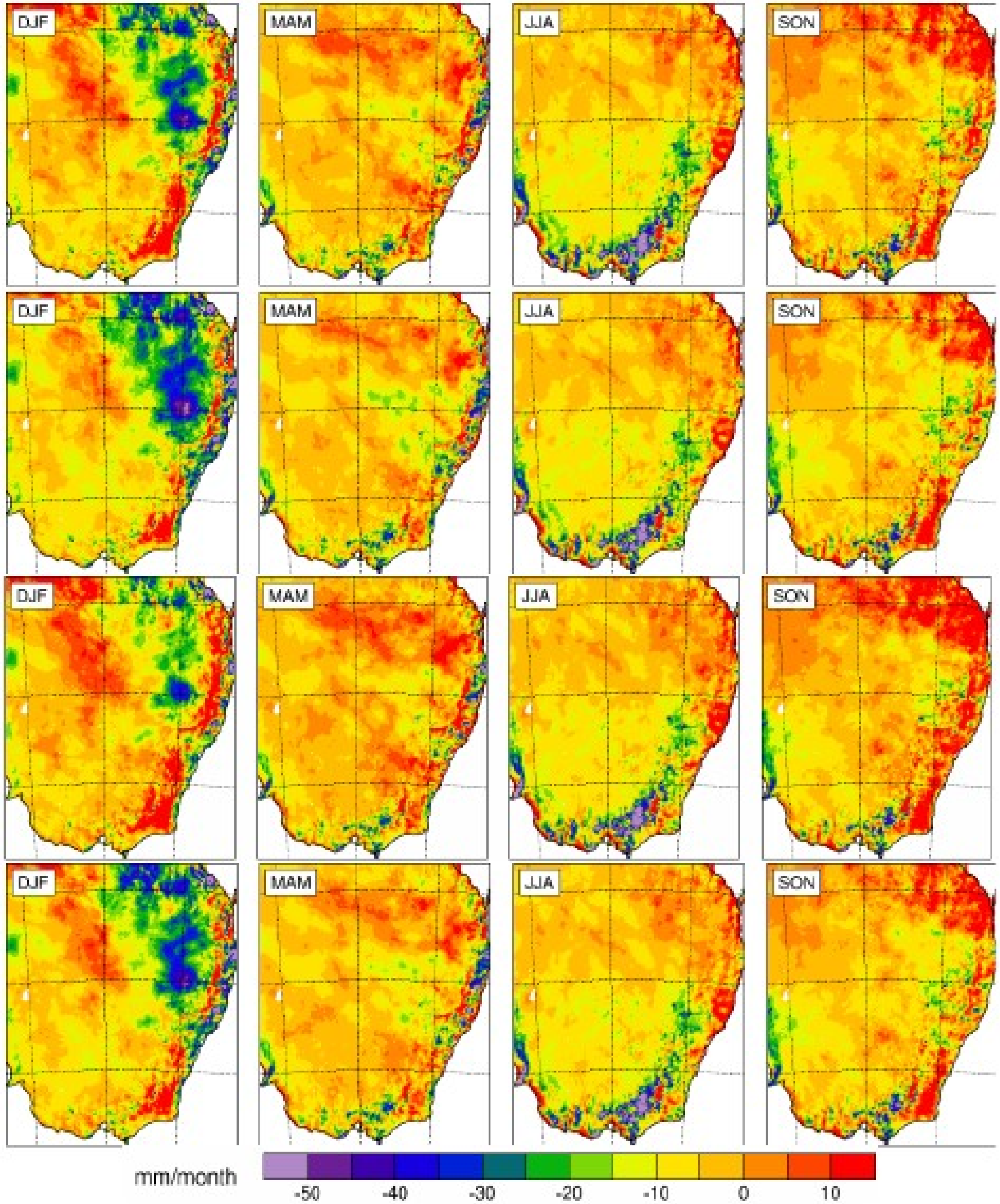
Precipitation

WRF(CTL)-AWAP

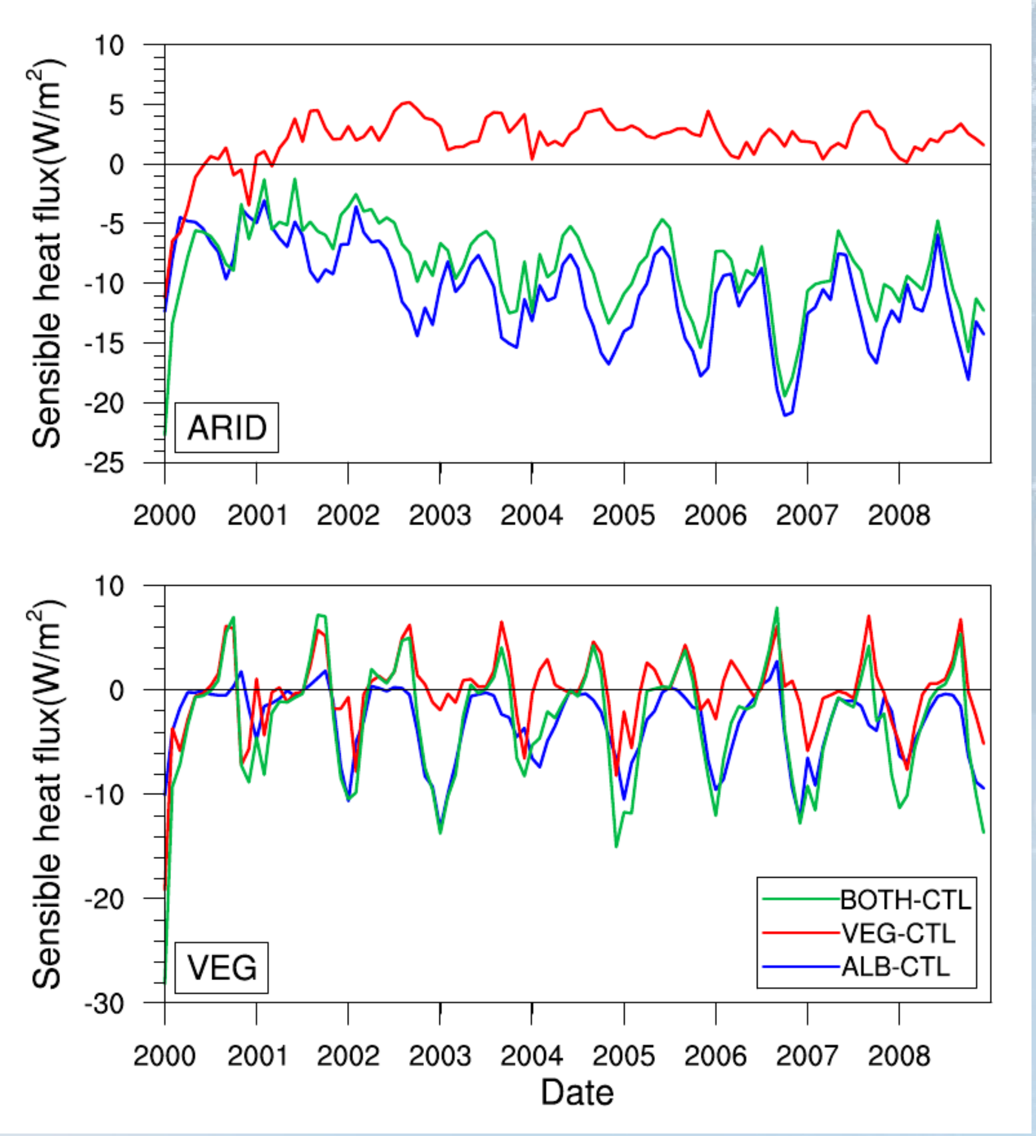
WRF(ALB)-AWAP

WRF(VEG)-AWAP

WRF(BOTH)-AWAP



Sensible Heat Flux



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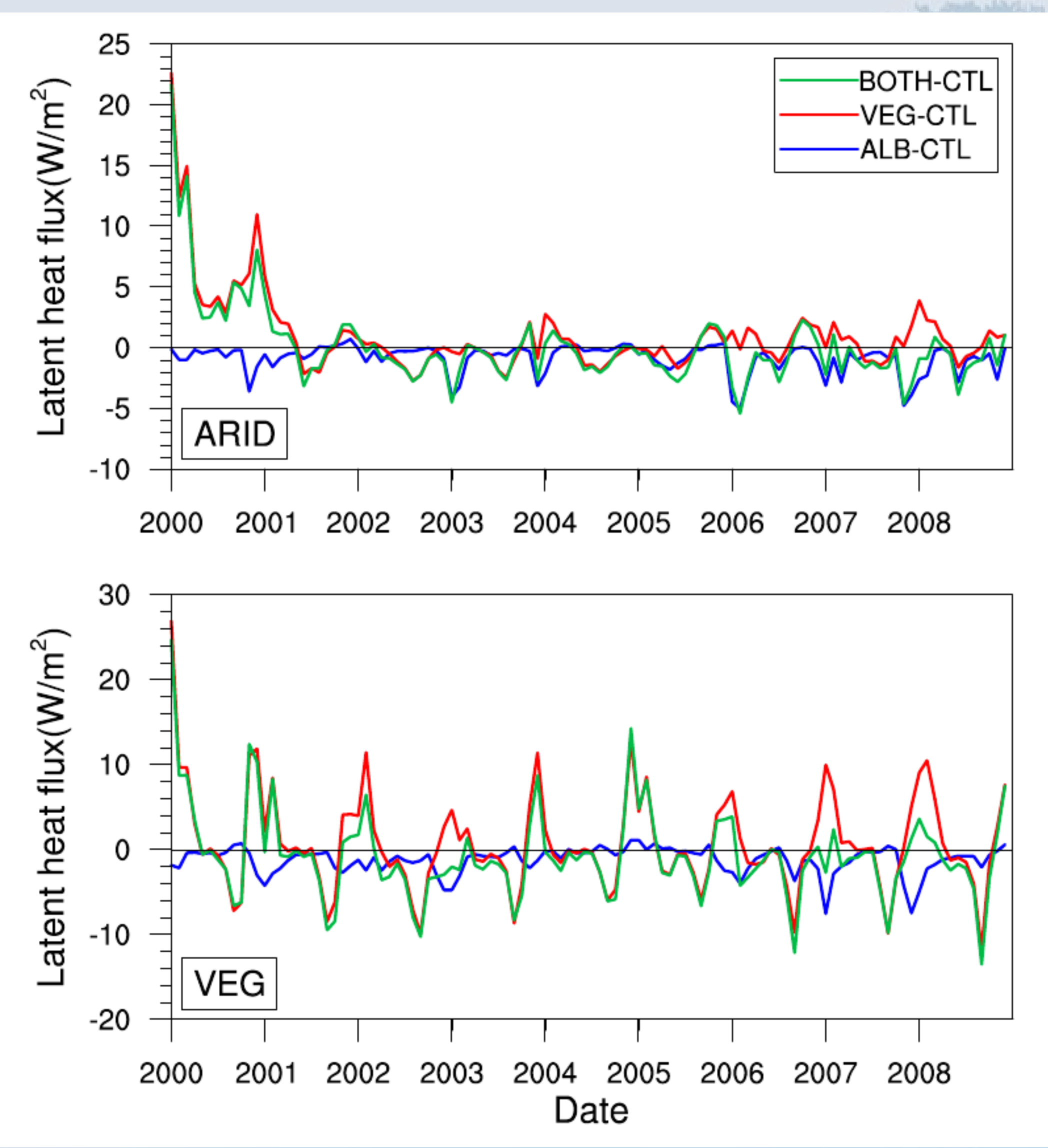
Latent Heat Flux



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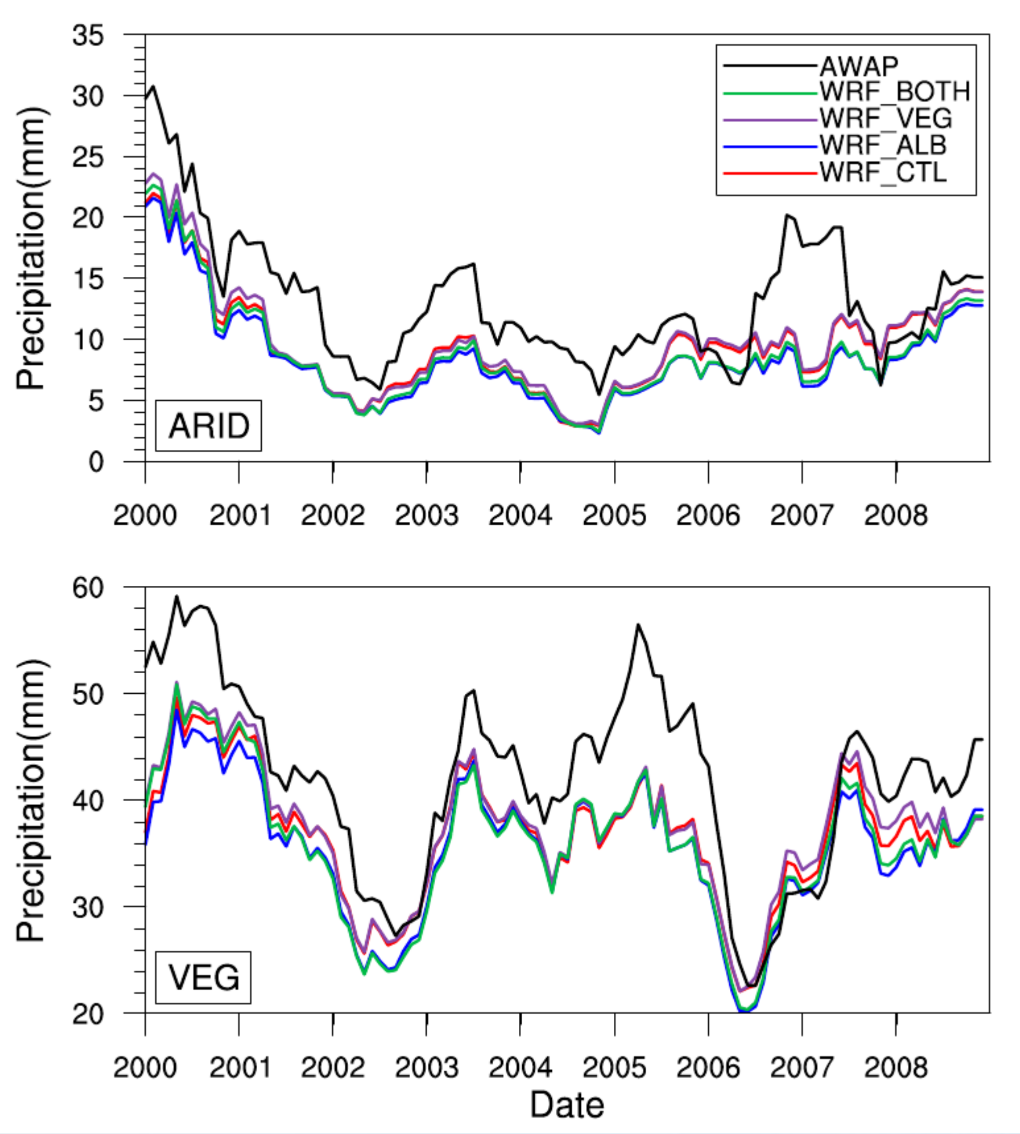
Precipitation Times Series



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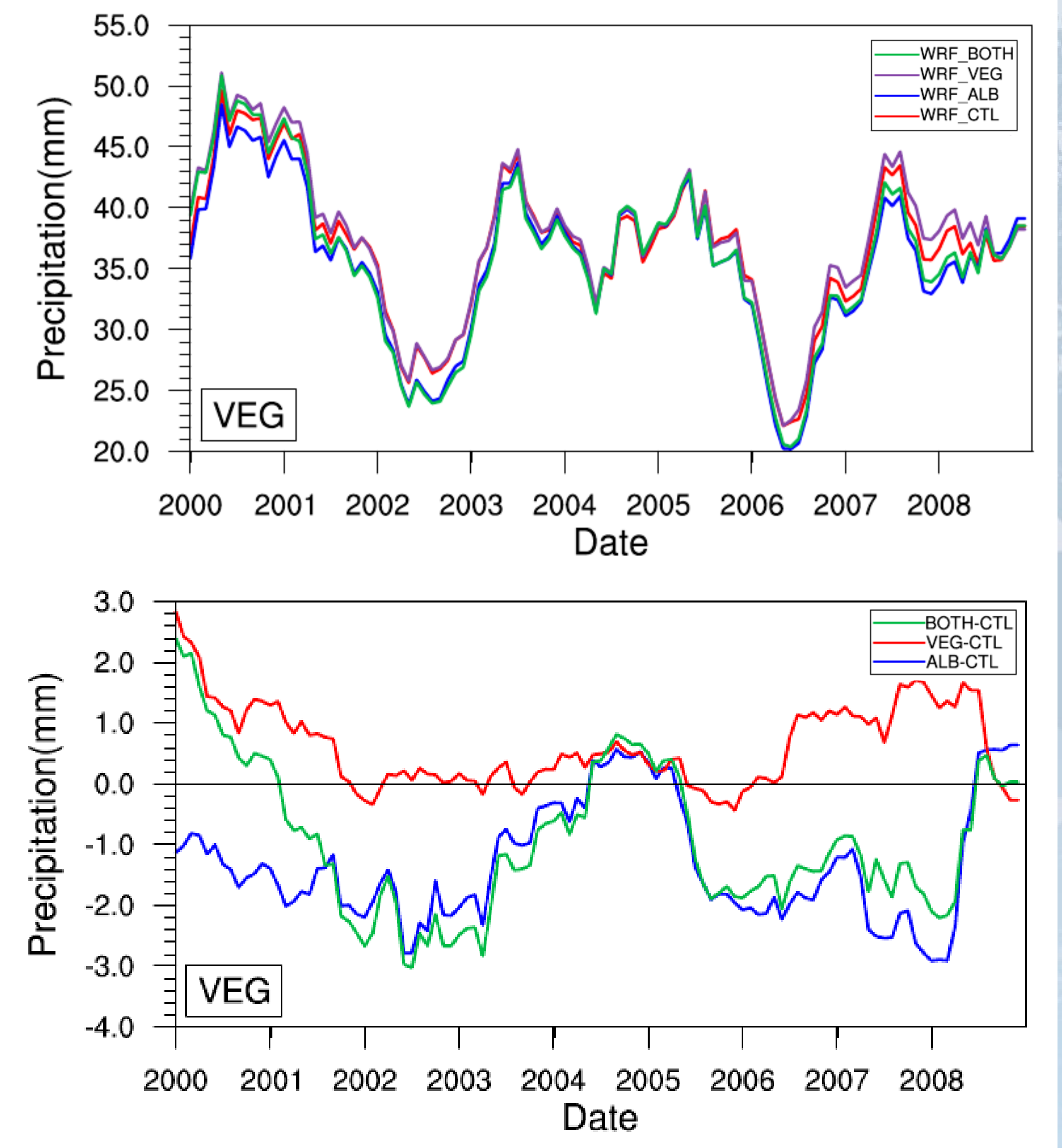
Precipitation



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Conclusions

- WRF is able to capture the drought
- WRF with dynamic albedo and vegetation fraction produces a better simulation of the 2m temperature but no overall improvement in precipitation
- The contributions of dynamic albedo and vegetation fraction to the evolution of the drought is relatively minor
- The albedo feedbacks tend to hasten the onset of the drought and deepen the severity

Thank you