



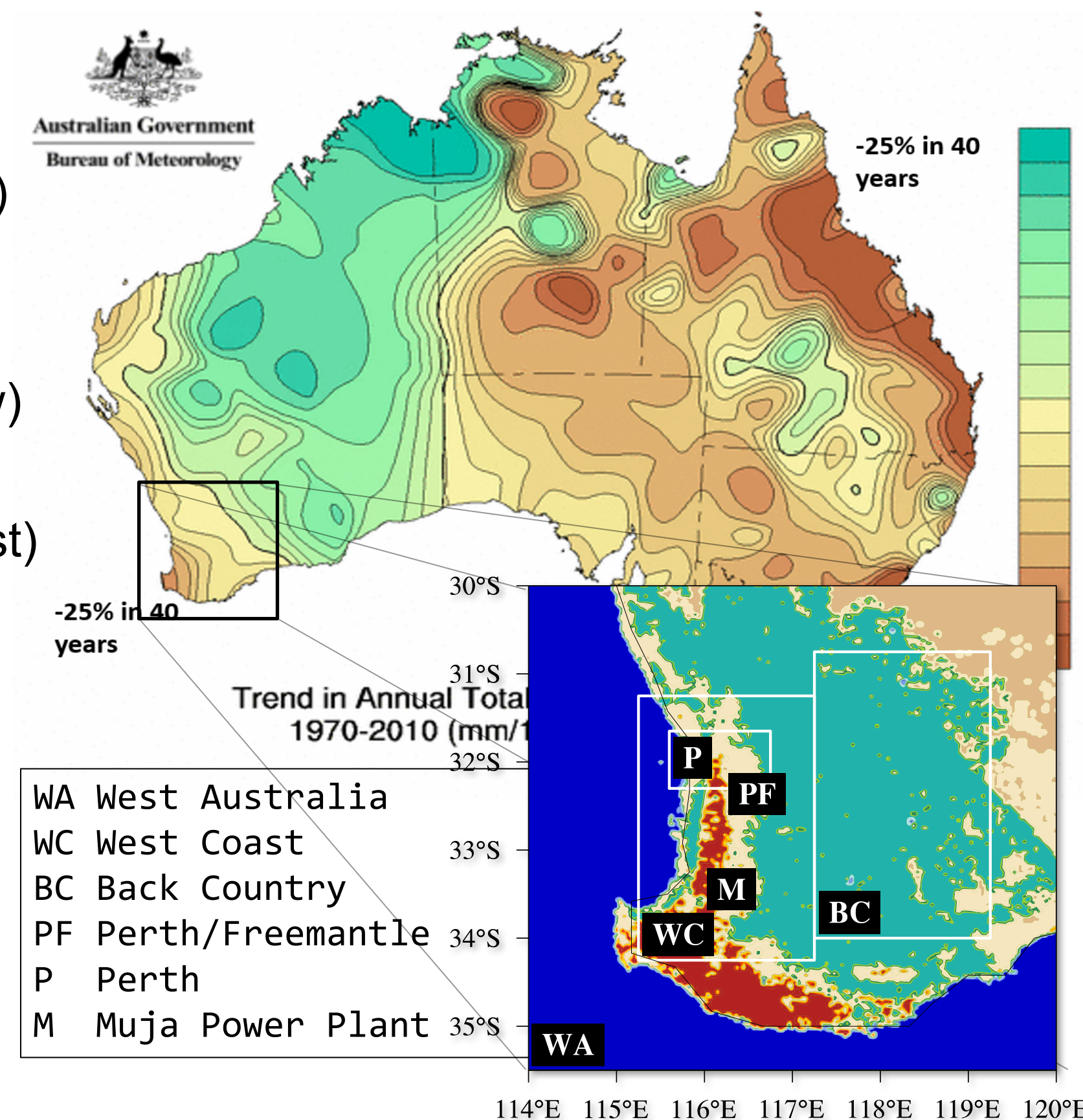
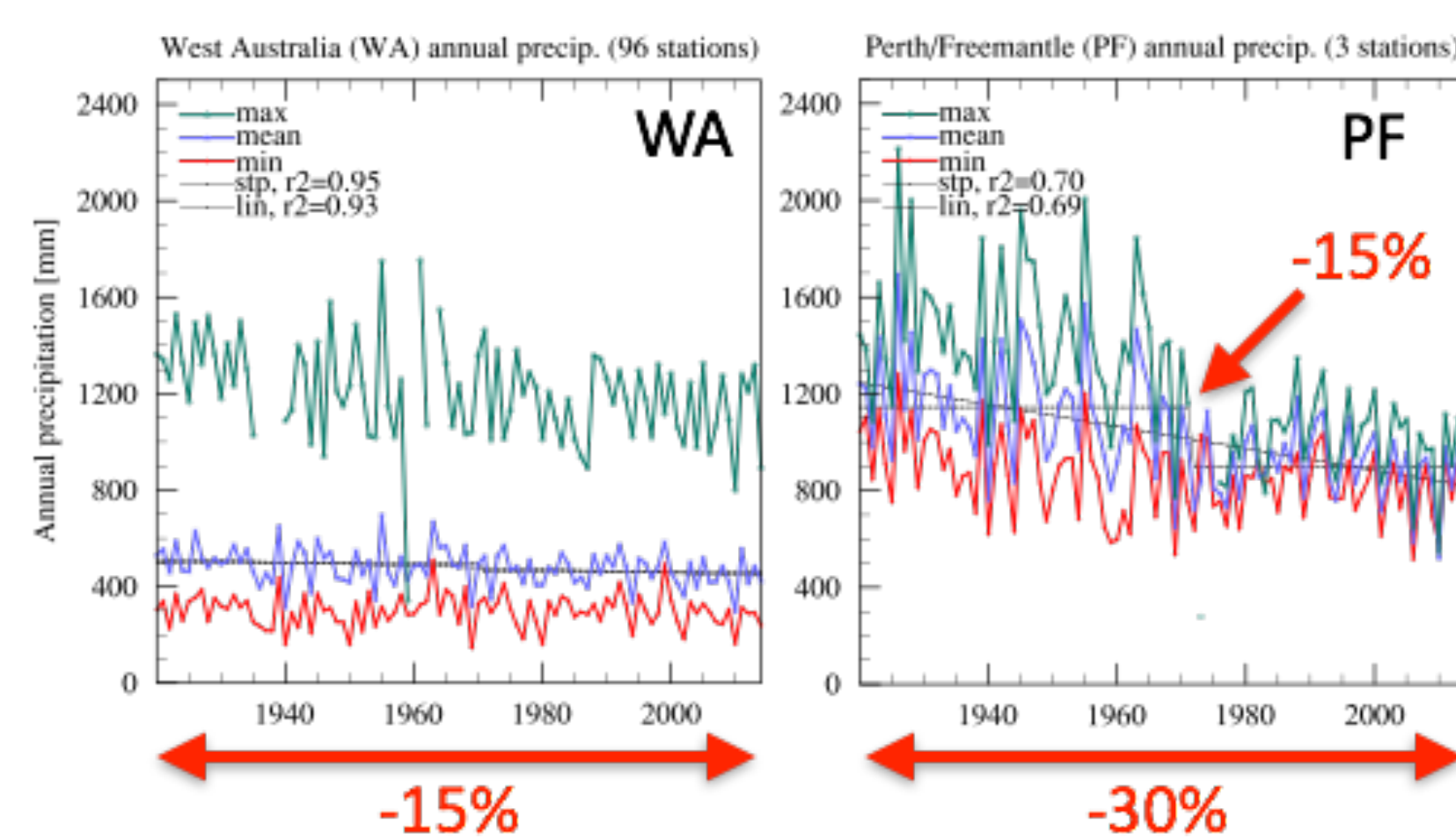
Aerosol-aware, convection-resolving climate modelling

Anthropogenic aerosol emissions and rainfall decline in South-West Australia

D. Heinzeller, W. Junkermann,
H. Kunstmann, 2016: Journal
of Climate, 29, pp. 8471-8493

Significant decline in precipitation in South-West Australia in the 20th century

- Continuous decline by about 15% for entire region (WA)
 - Sudden drop by further 15% for Perth (PF) in the 70s
- Possible reasons are:
- Continuous changes due to large scale circulation (slow)
 - Deforestation, irrigation (fast)
 - Anthropogenic aerosols from power plants/smelters (fast)

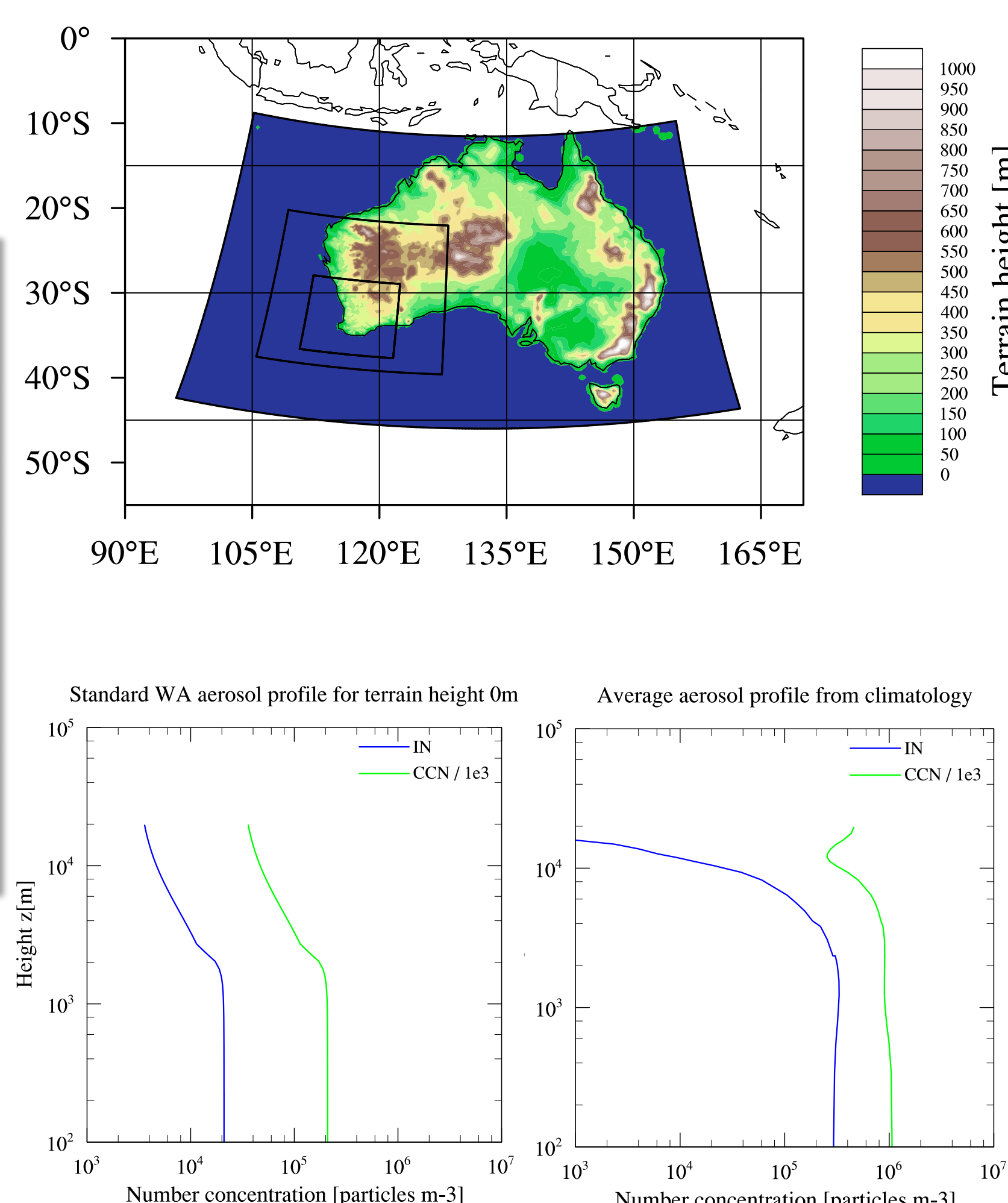


Anthropogenic aerosol emissions and rainfall decline in SW Australia – coincidence or causality?

A high-resolution (3.3km) regional climate modelling study using WRFV3.6.1 with an aerosol-aware microphysics scheme (Thompson and Eidhammer, 2014) for 1970-1974.

Triple-nested WRF domain setup at 30/10/3.3km res.

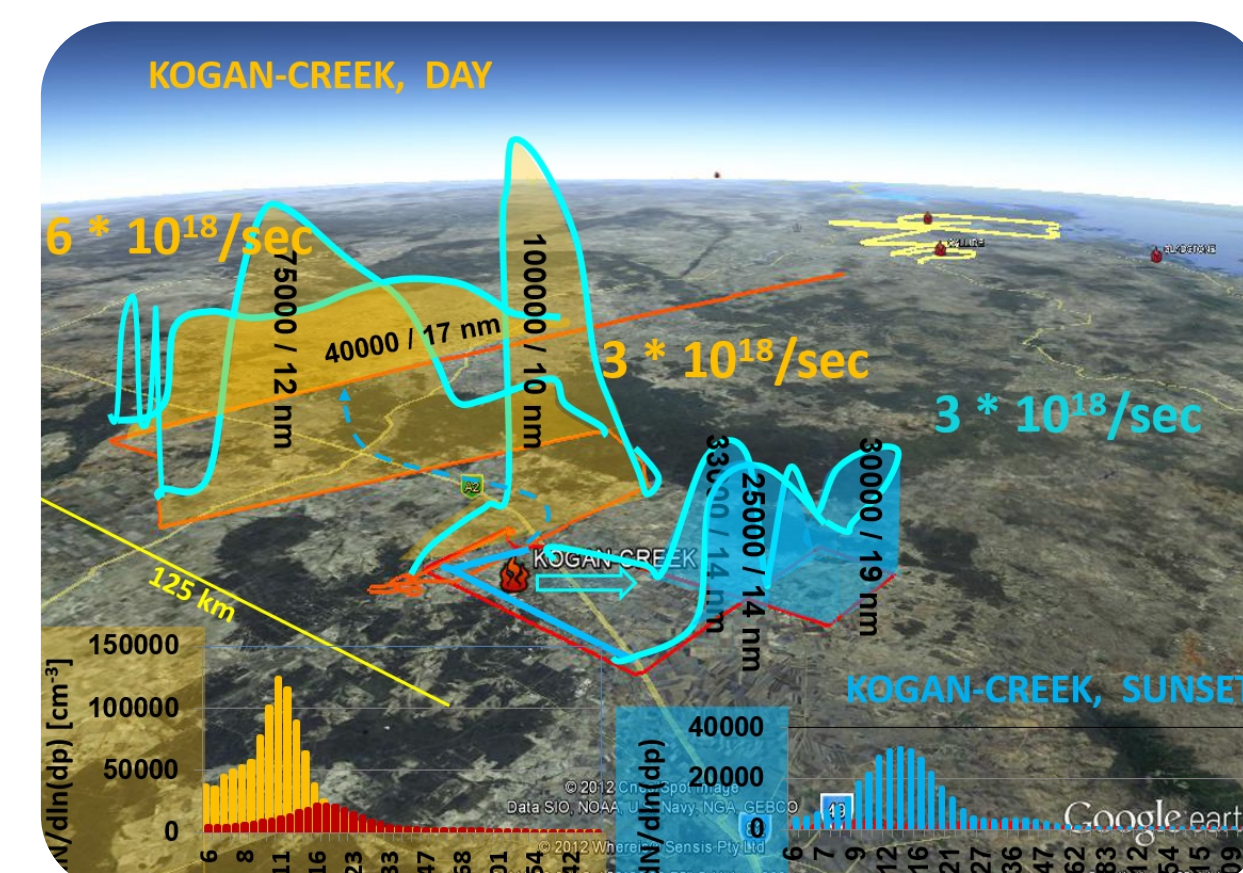
Microphysics
Thompson (d1/2)
T.-Eidhammer (d3)
Radiation
RRTMG LW/SW
Cumulus
BMJ (d1/2), off (d3)
Spectral nudging
on (d1), off (d2/3)



(left) Pre-1970s CCN/IN emissions from observations
(right) climatology for 2000-2007



Muja Power Station, commissioned 1966, capacity 974MW, $\approx 10^{19}$ CCN/s



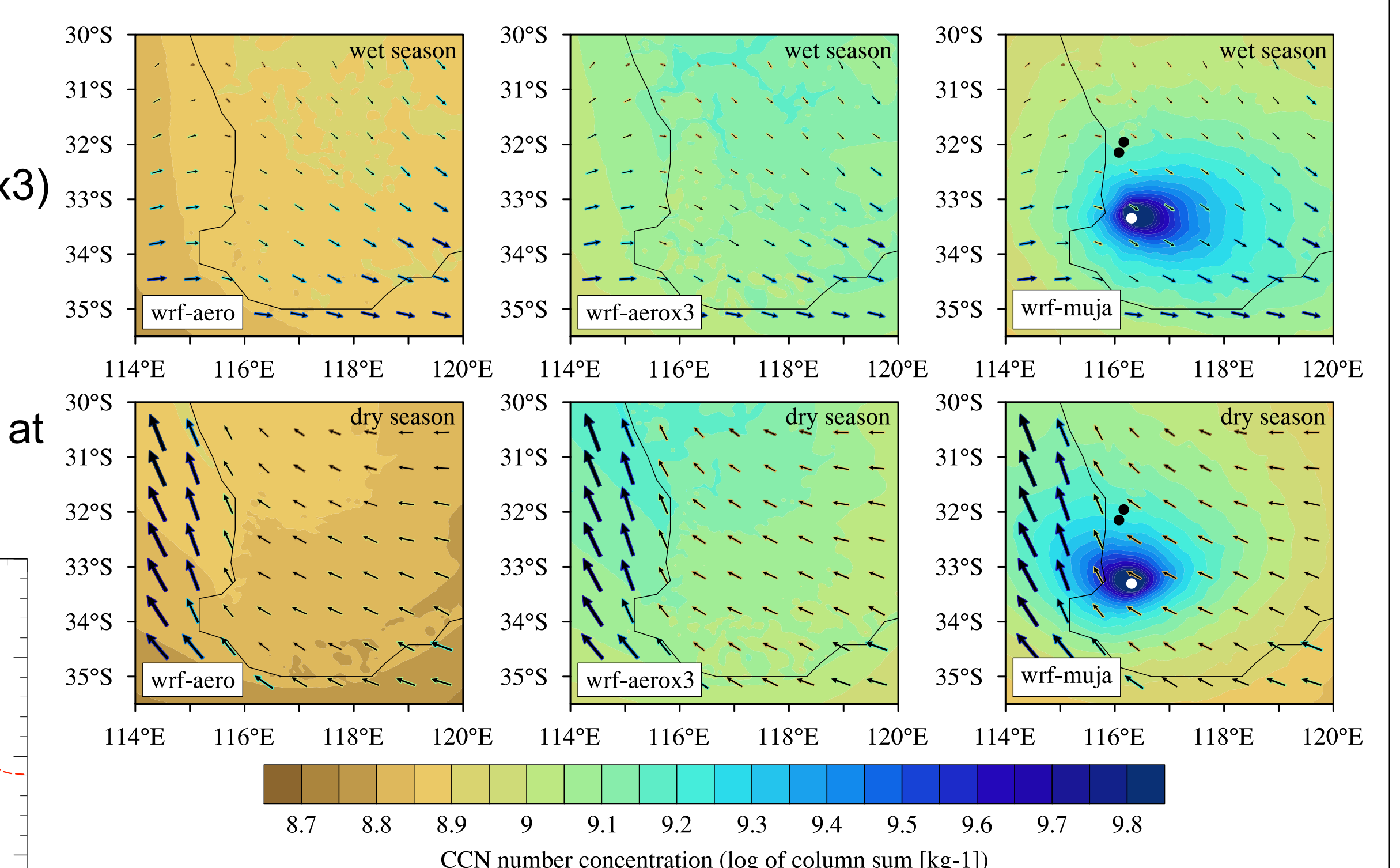
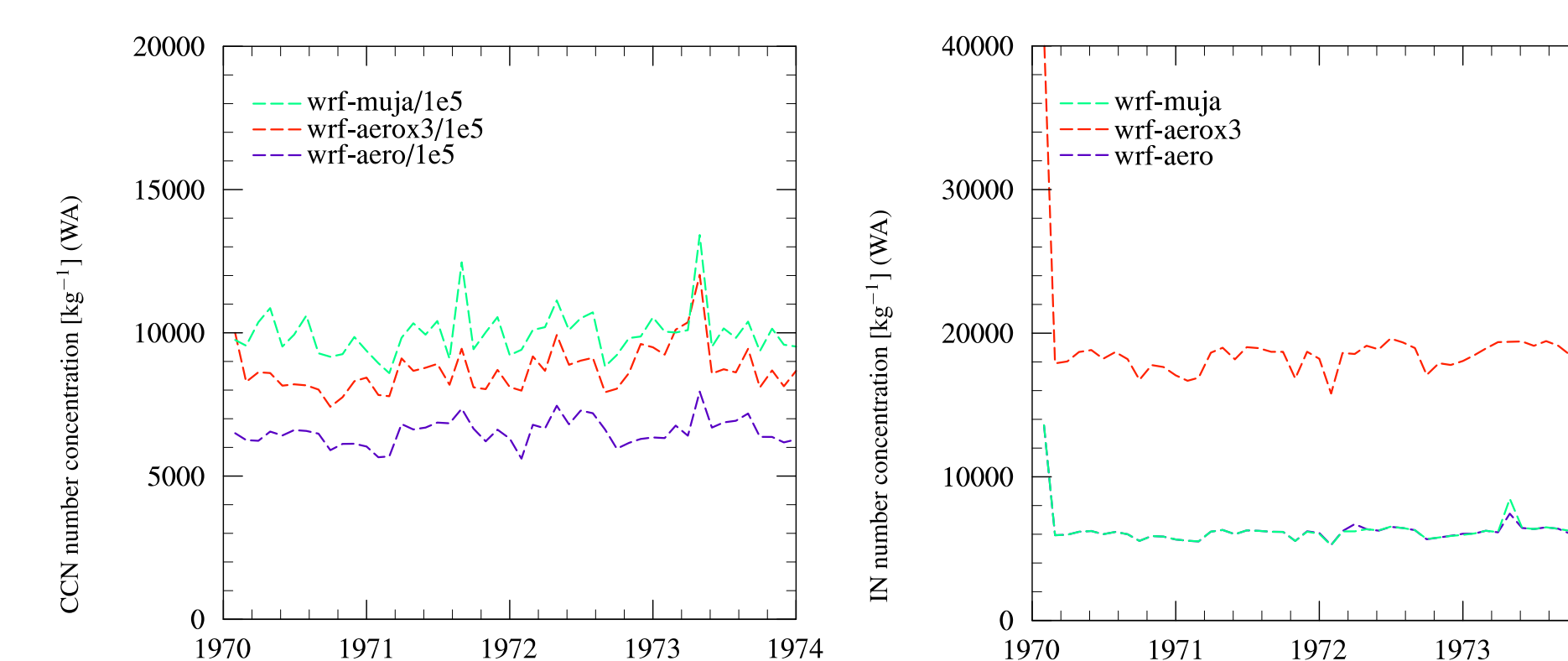
Airborne measurements of CCN emission rates of coal power plants in East Australia with similar size (Junkermann and Hacker, 2015)

Three different high-resolution aerosol model runs

- Pre-industrial aerosol loads, std. profile (wrf-aero)
- Post-1970s aerosol loads, 3x std. profile (wrf-aerox3)
- Pre-industrial aerosol loads + Muja Power Station emissions (wrf-muja)

Muja Power Station emissions (CCN only):

- 4.6×10^8 particles/kg/s, added to surface emissions at Muja Power Station within 1500m above ground

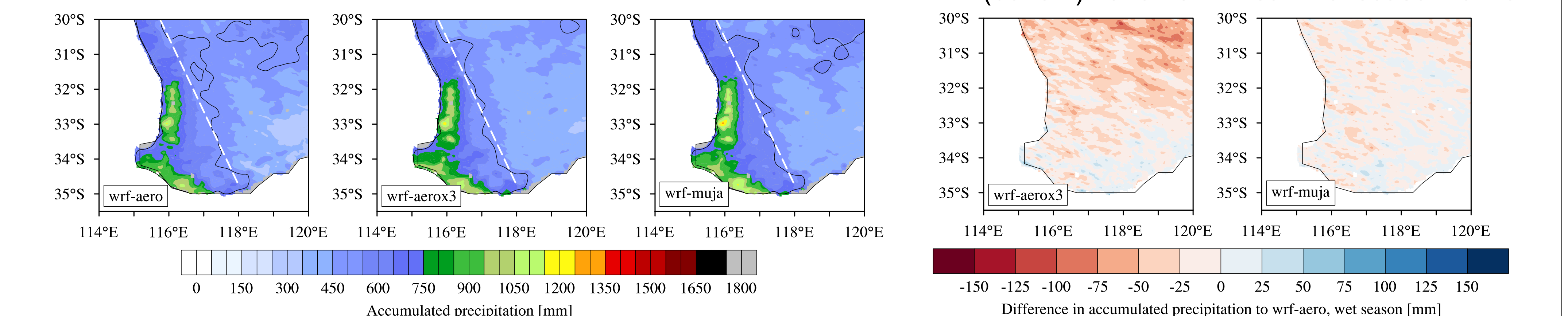


(top) 1970-1974 means of CCN number concentration and near-sfc winds for the rainy season Apr-Sep and the dry season Oct-Mar

(top) Mean value of CCN and IN number concentrations for region WA, summed up over the full column at each grid point

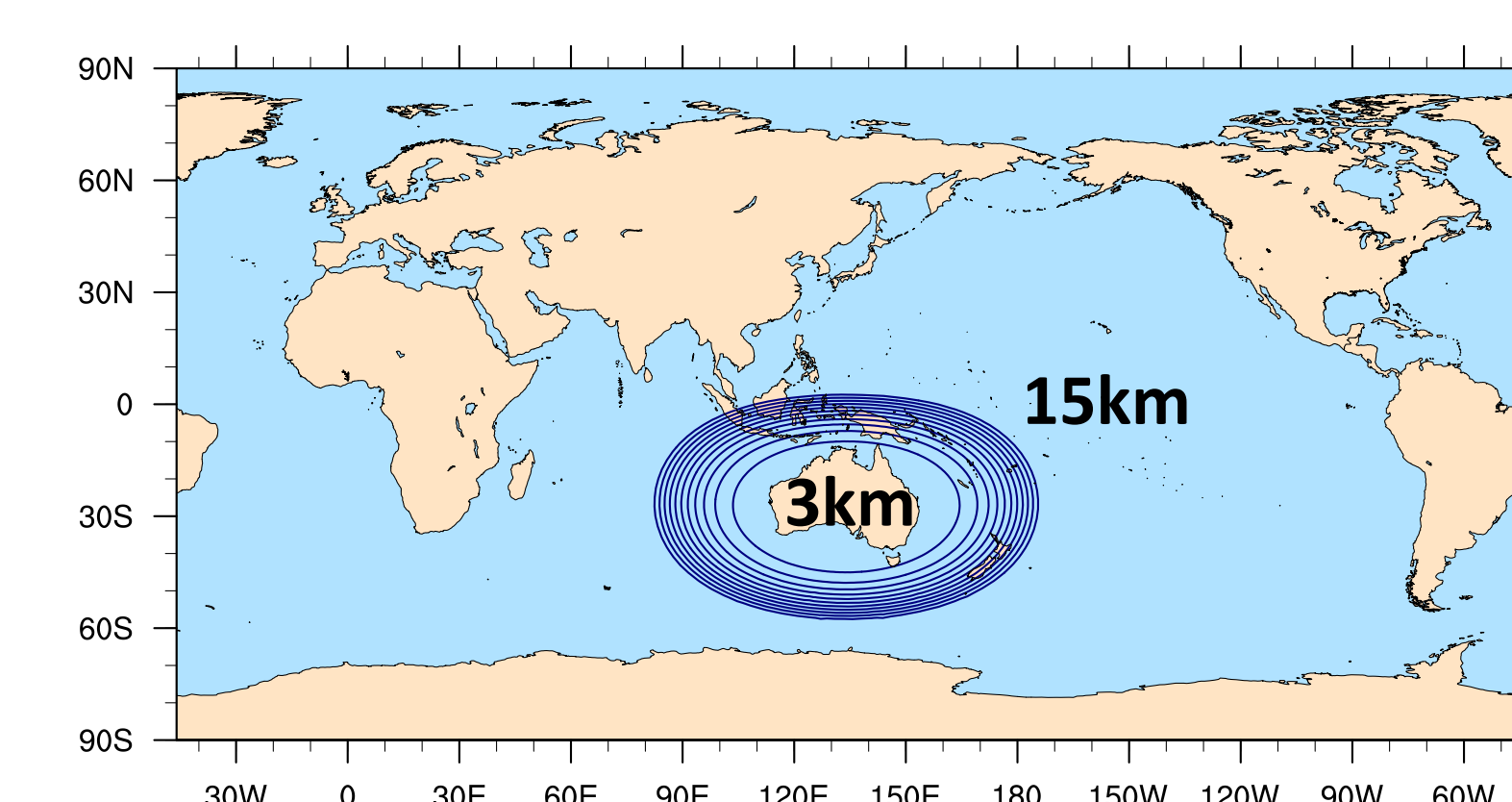
	wrf-muja >3xCCN	wrf-muja dry/wet	wrf-aerox3 3xCCN/IN
WA	-2.0%	3.1	-5.3%
WC	-1.7%	3.3	-3.1%
BC	-2.8%	2.9	-6.5%
PF	-1.7%	11.0	-4.0%

(top) 1970-1974 decline in rainfall relative to wrf-aero and ratio of decline dry vs. wet season
(bottom) 1970-1974 mean wet season rainfall



Future work

- Separating the effects of anthropogenic aerosols, land clearing and global climate change in AU
- Airborne measurement campaign to quantify aerosol emissions of modern power plants in different regions (West/East Coast, Victoria)
- Global and regional modelling studies for the East Coast and West Coast with WRF and MPAS



Variable 15-3km MPAS mesh with 3.2 Mio grid cells