

Urban Water Security Research Alliance



The Impact of Anthropogenic Forcings and El Niño Southern Oscillation on South East Qld Rainfall

Tim Cowan

(Wenju Cai and Peter Van Rensch)

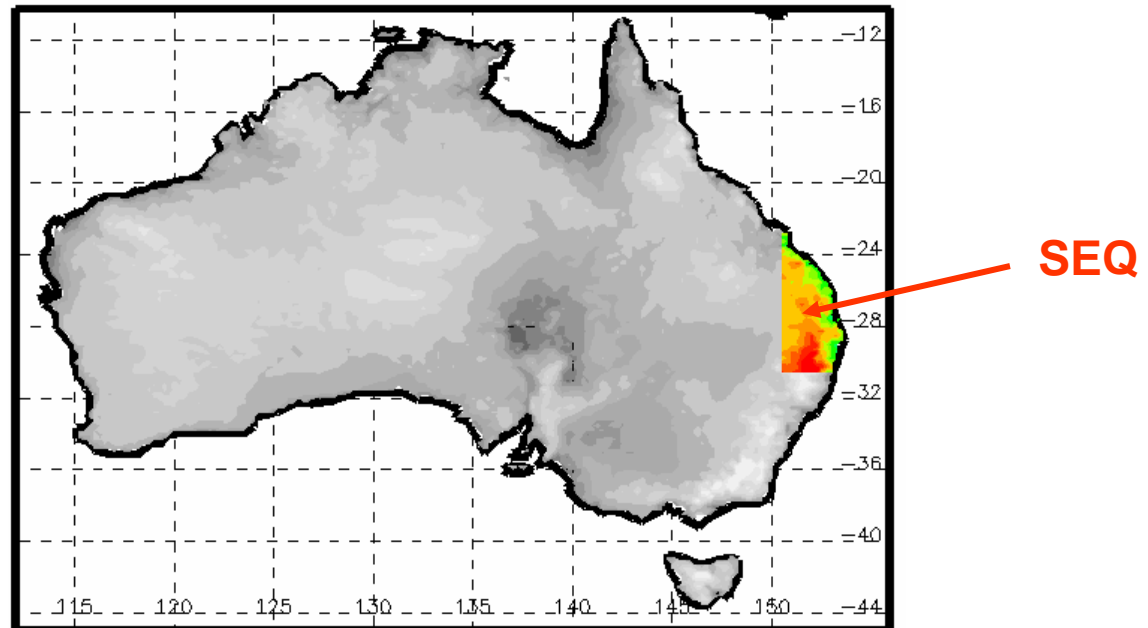
Climate and Water Project

18 August 2009

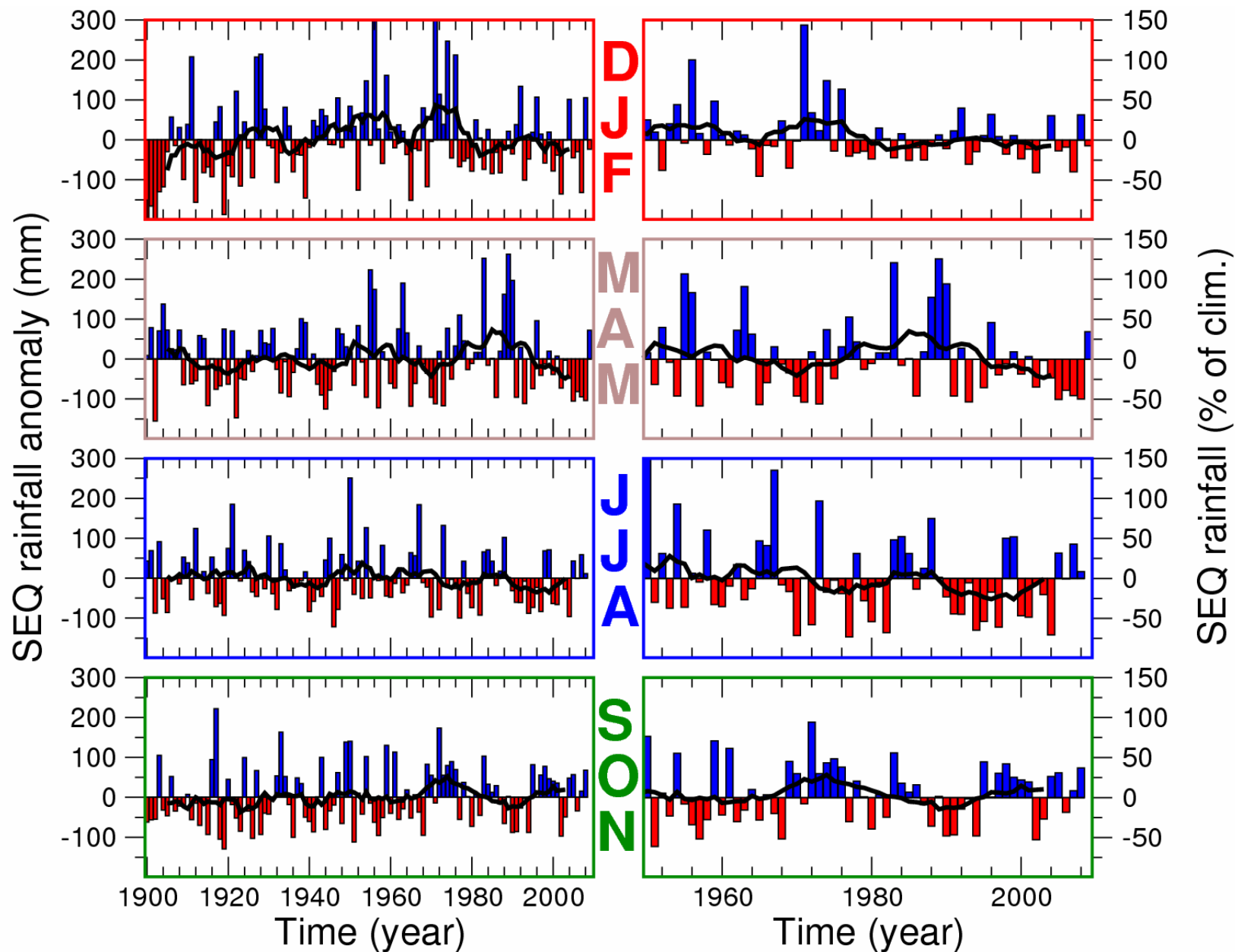


Outline of talk

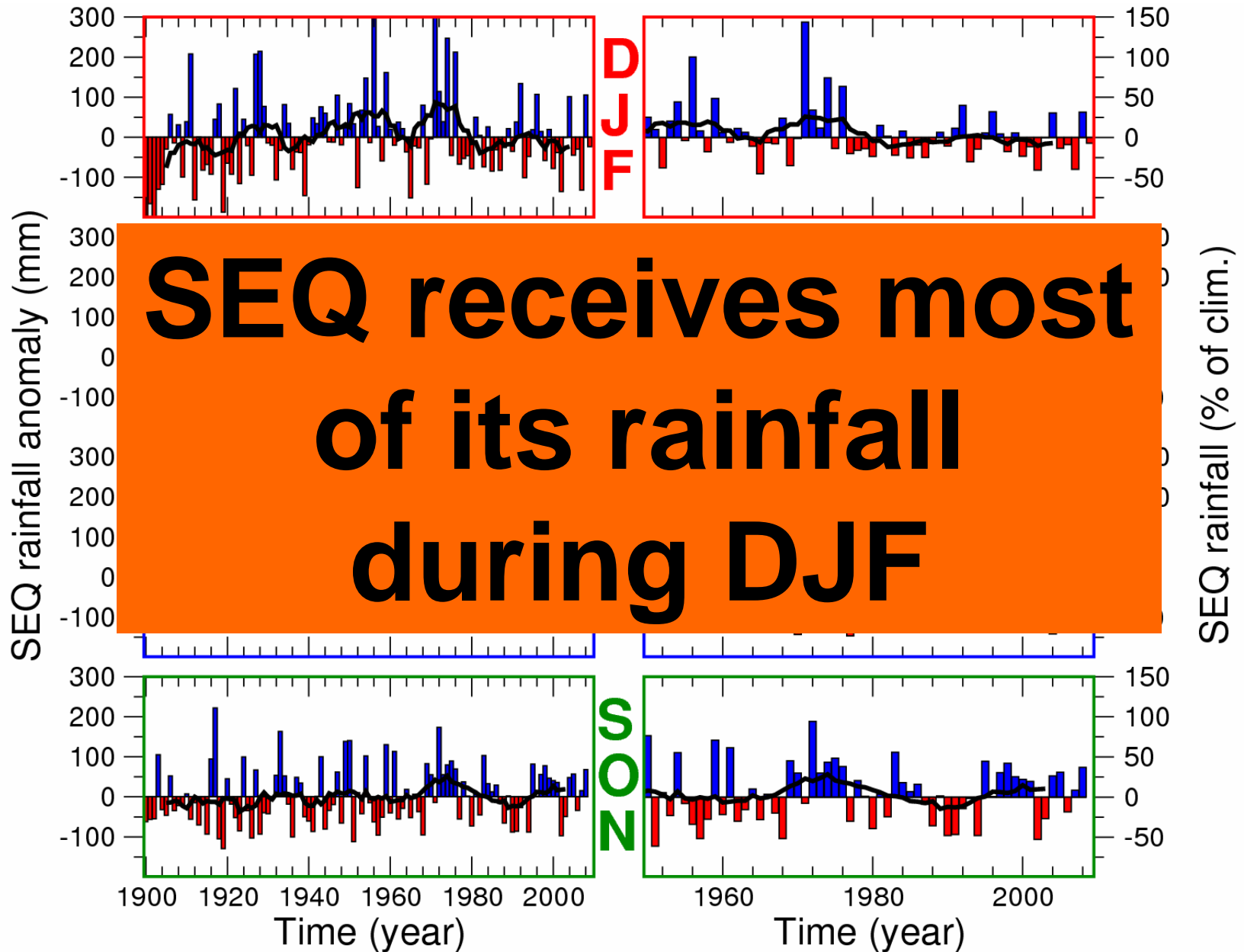
- Seasonal rainfall trends over SEQ
- Climate models – anthropogenic forcings
- Asymmetry of ENSO-rainfall relationship
- Impacts of temperature
- Summary



Seasonal rainfall: Southeast Queensland (SEQ)



Seasonal rainfall: Southeast Queensland (SEQ)



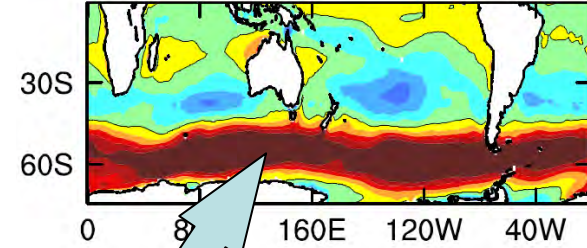
Seasonal rainfall trends since 1950-2007



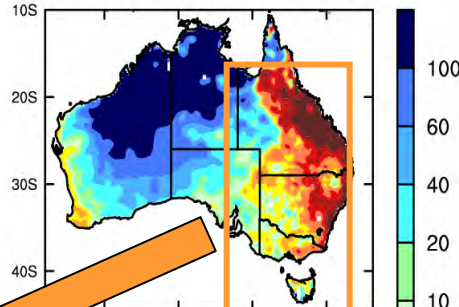
CO₂↑
Aerosols↑
Ozone↓



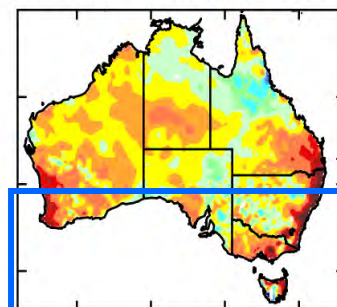
Southern Annular Mode



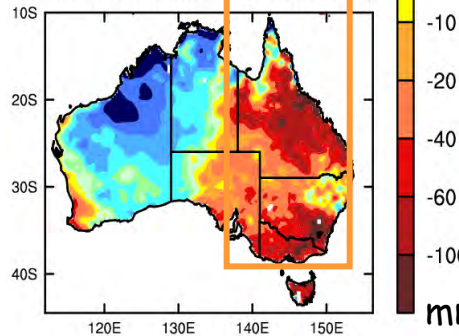
DJF rainfall trend (1950-2007)



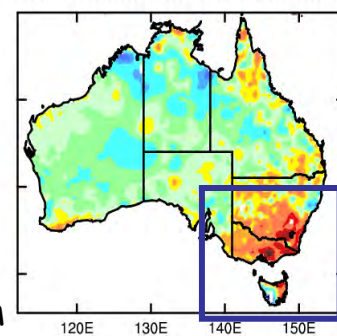
JJA rainfall trend (1950-2007)



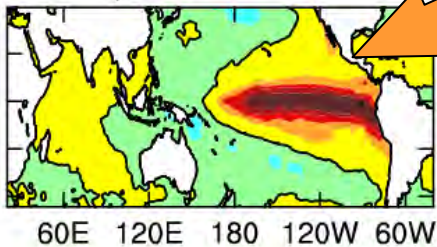
MAM rainfall trend (1950-2007)



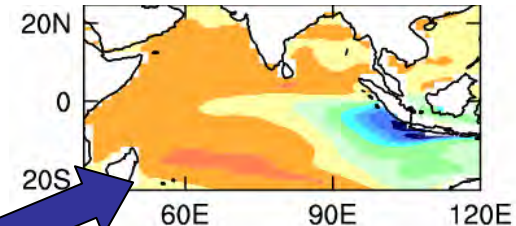
SON rainfall trend (1950-2007)



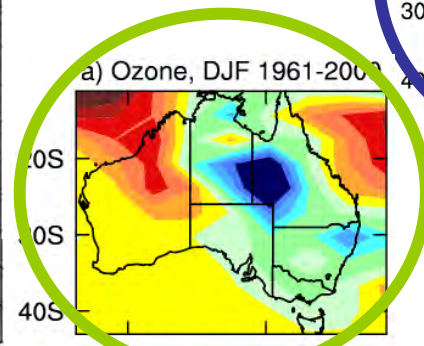
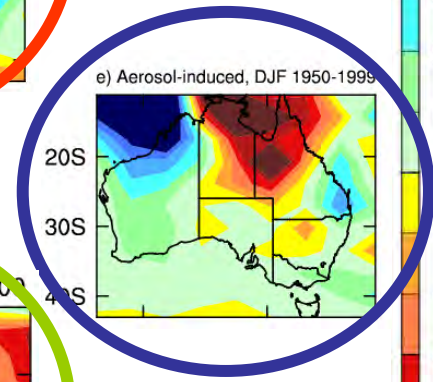
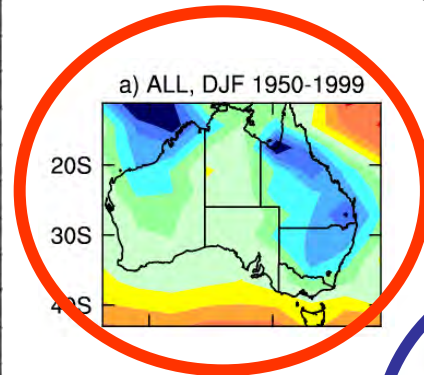
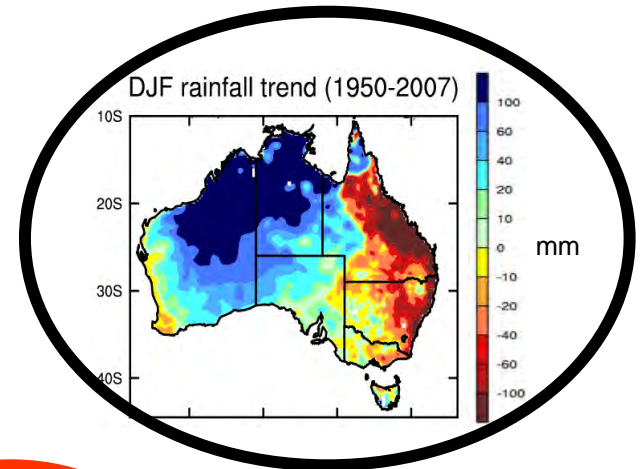
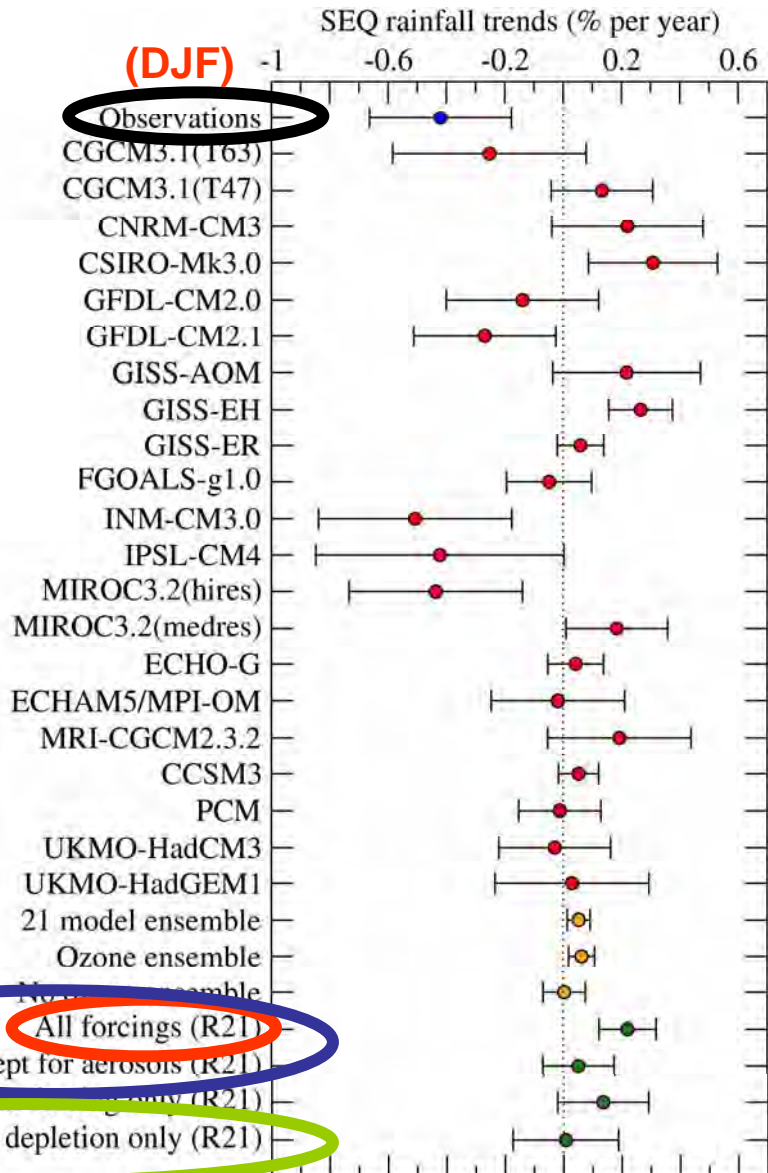
ENSO



Indian Ocean Dipole

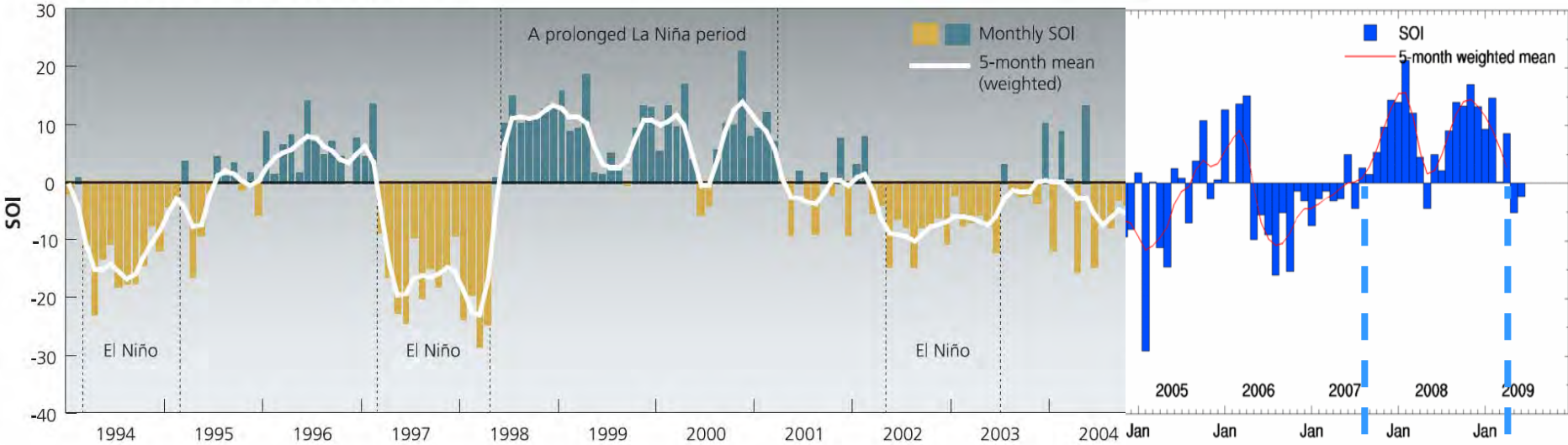


Impact of anthropogenic forcings (from climate model output)



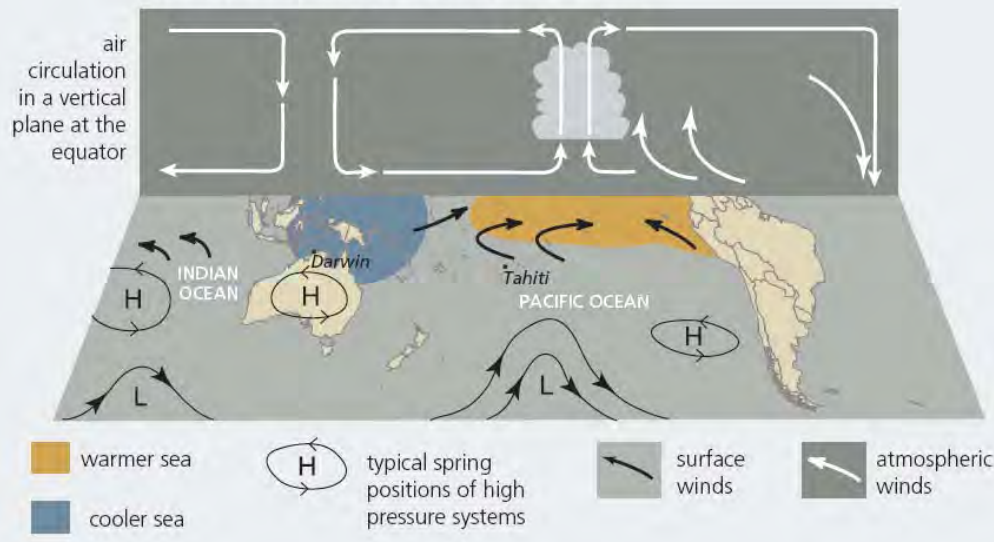
El Niño Southern Oscillation (or ENSO)

Southern Oscillation Index (SOI) 1994–2004



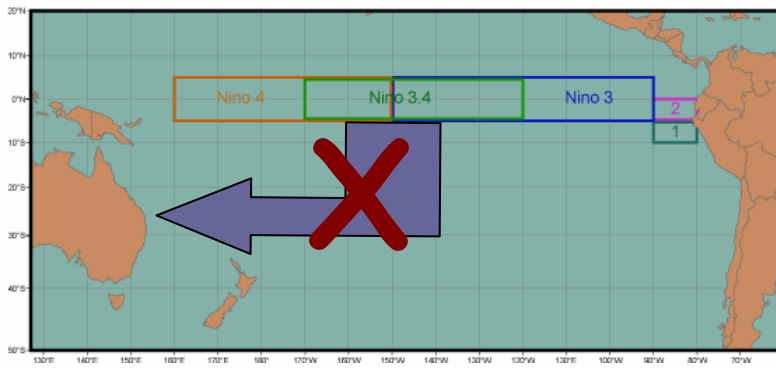
La Niña

Walker Circulation during an El Niño



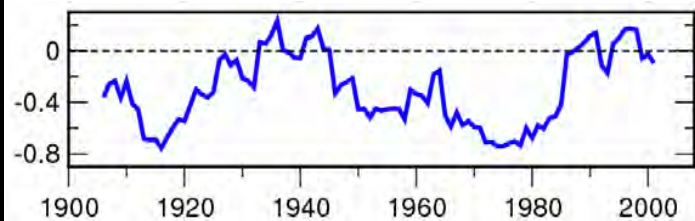
Source: Bureau of Meteorology

Temporal change of ENSO-rainfall teleconnection

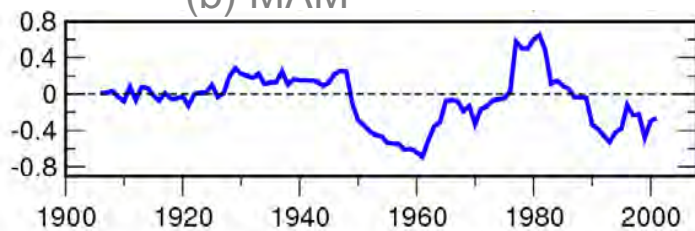


Observations

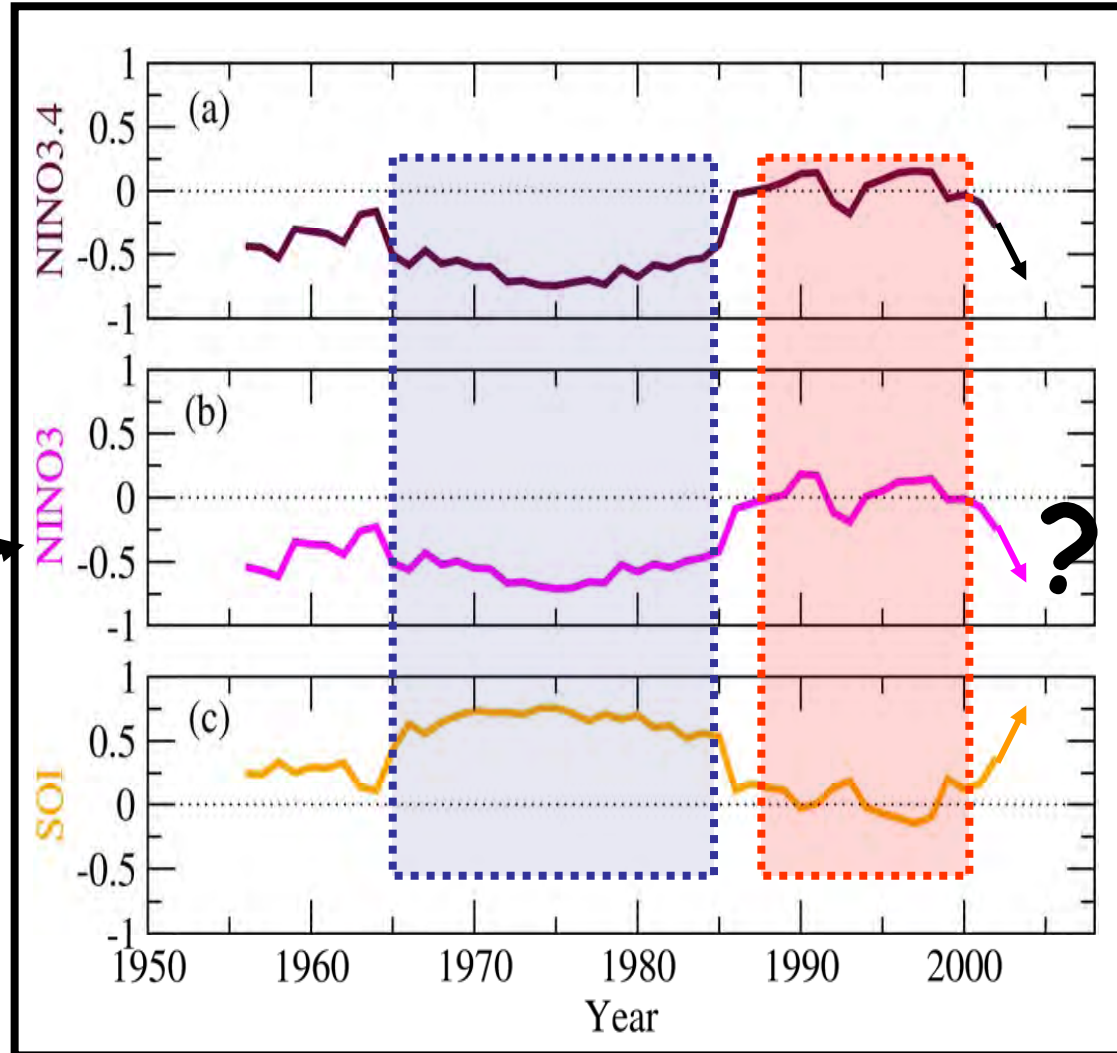
(a) DJF



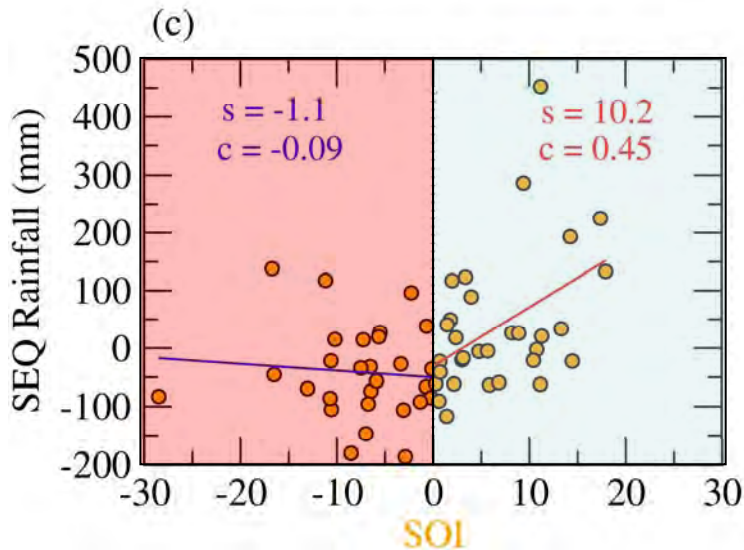
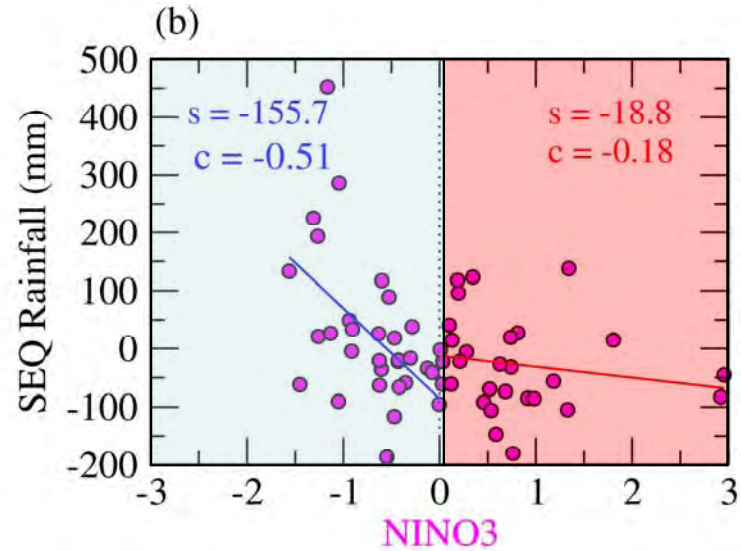
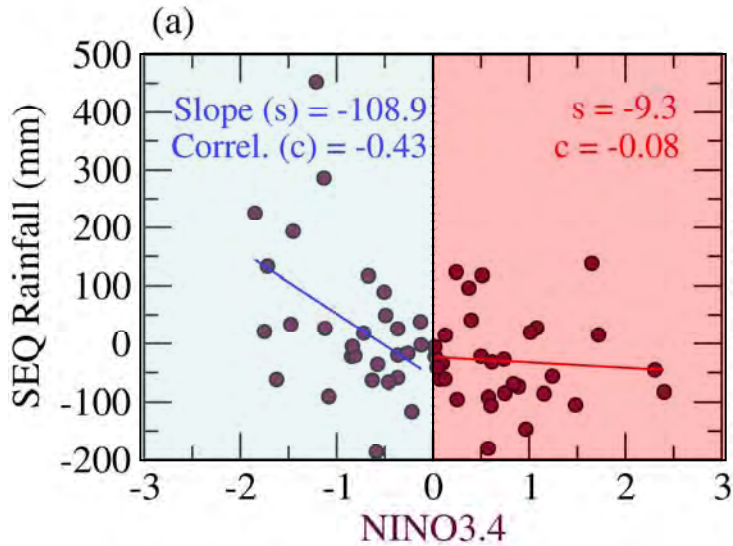
(b) MAM



Time (middle year of 13-yr window)



Asymmetry of ENSO-SEQ rainfall teleconnection (DJF, 1950-2008)



La Niña

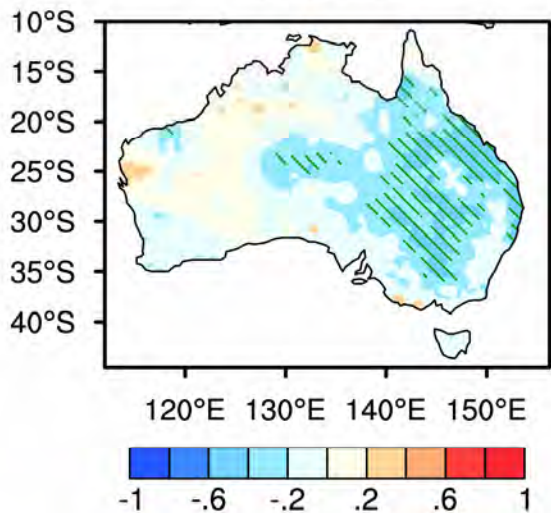
El Niño

Correlations using NINO3.4 SST (1950-2008)

La Niña

90% confidence level = 0.31

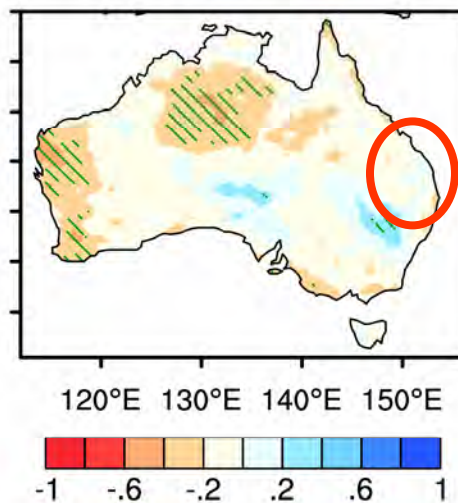
(a) Rainfall



El Niño

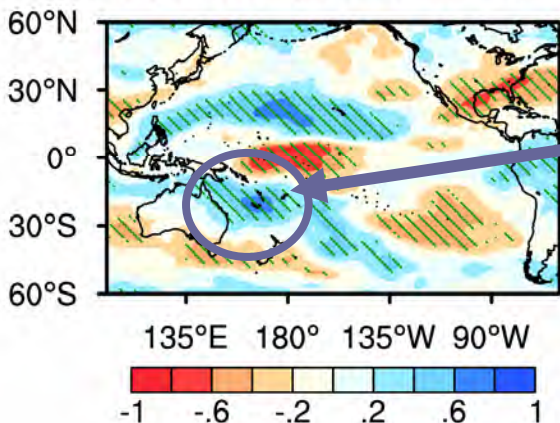
90% confidence level = 0.29

(d) Rainfall

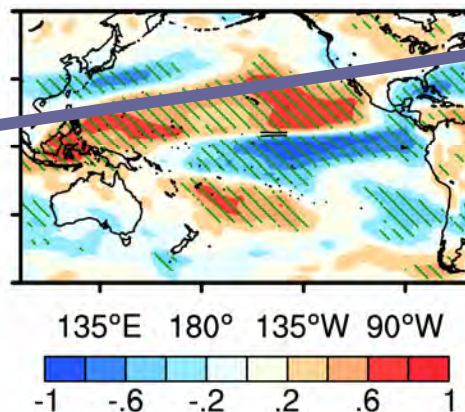


No correlation in El Niño years.

(b) Upward Longwave Radiation Flux

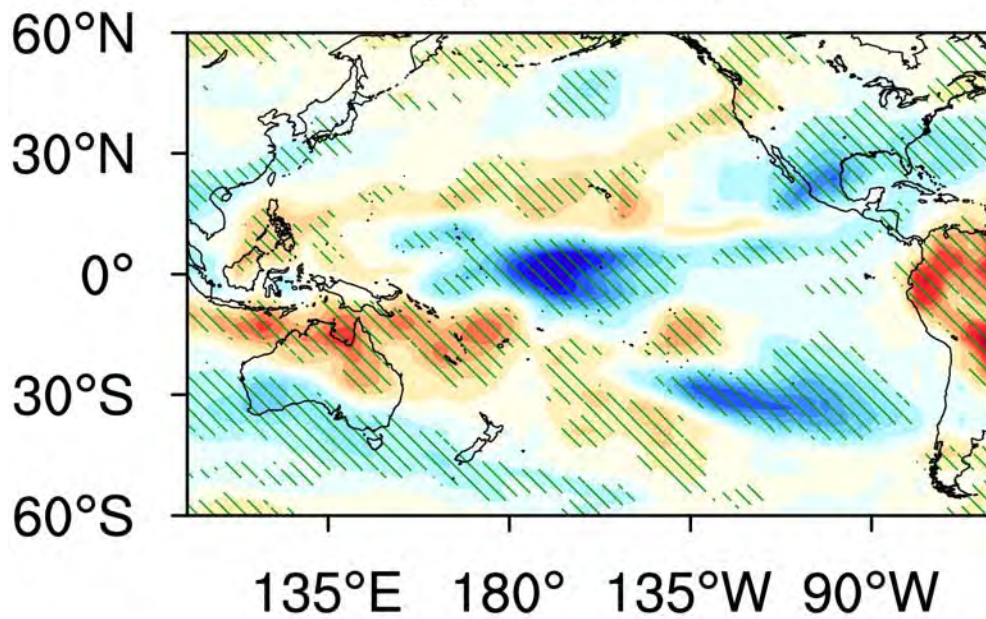


(e) Upward Longwave Radiation Flux

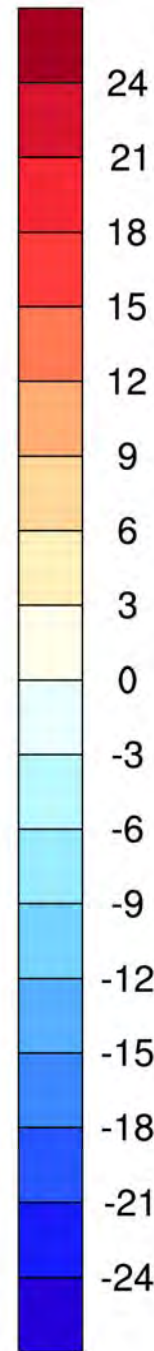
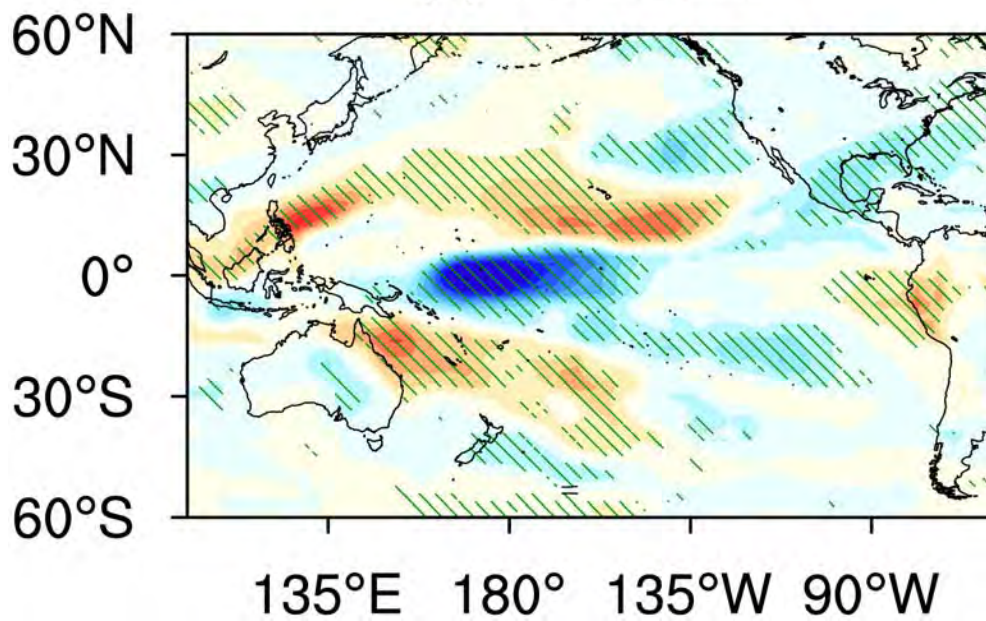


Increased convection and cloud cover.

(c) 1950-1979



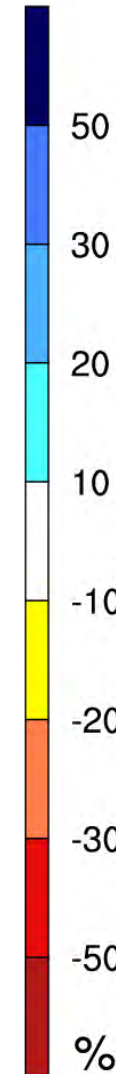
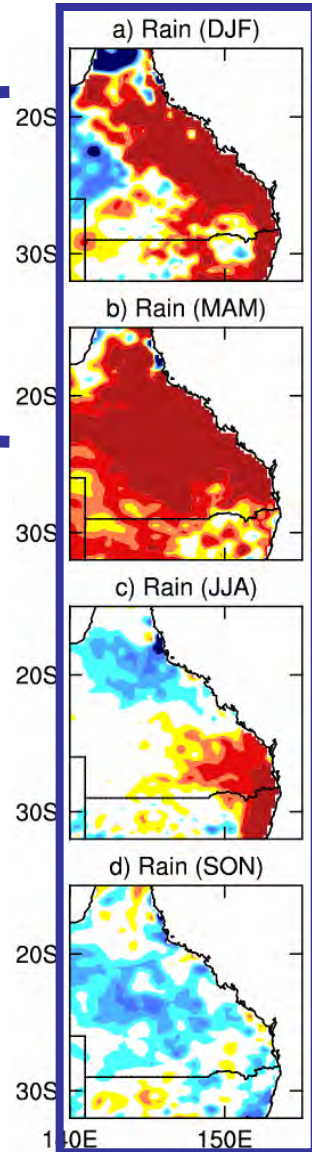
(d) 1980-2008



Changes: rainfall and soil moisture (1950-2008)

Rainfall

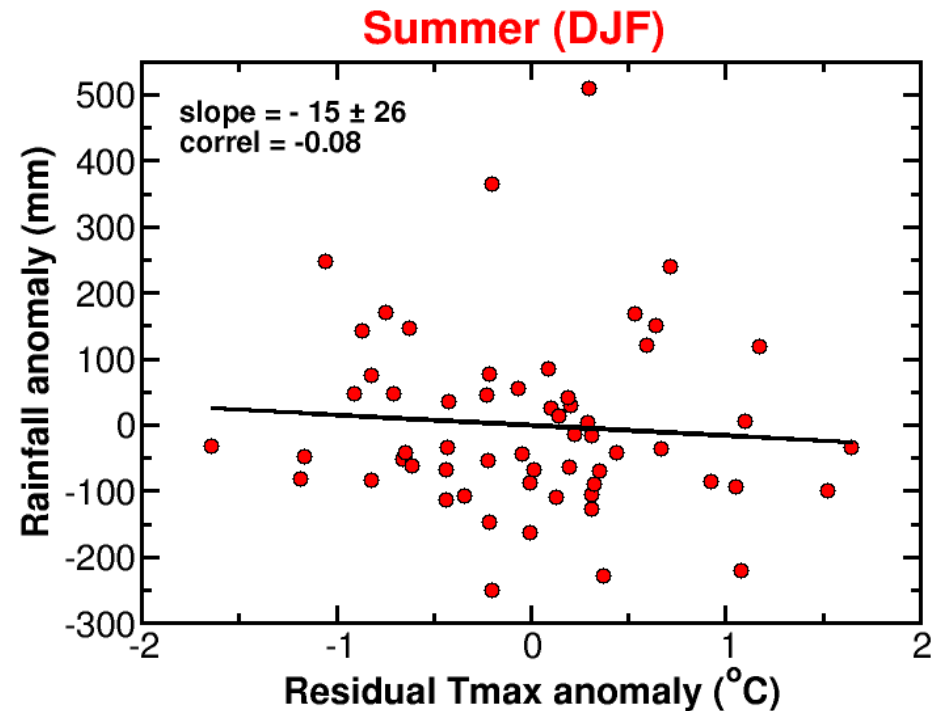
Greatest impact
in DJF & MAM



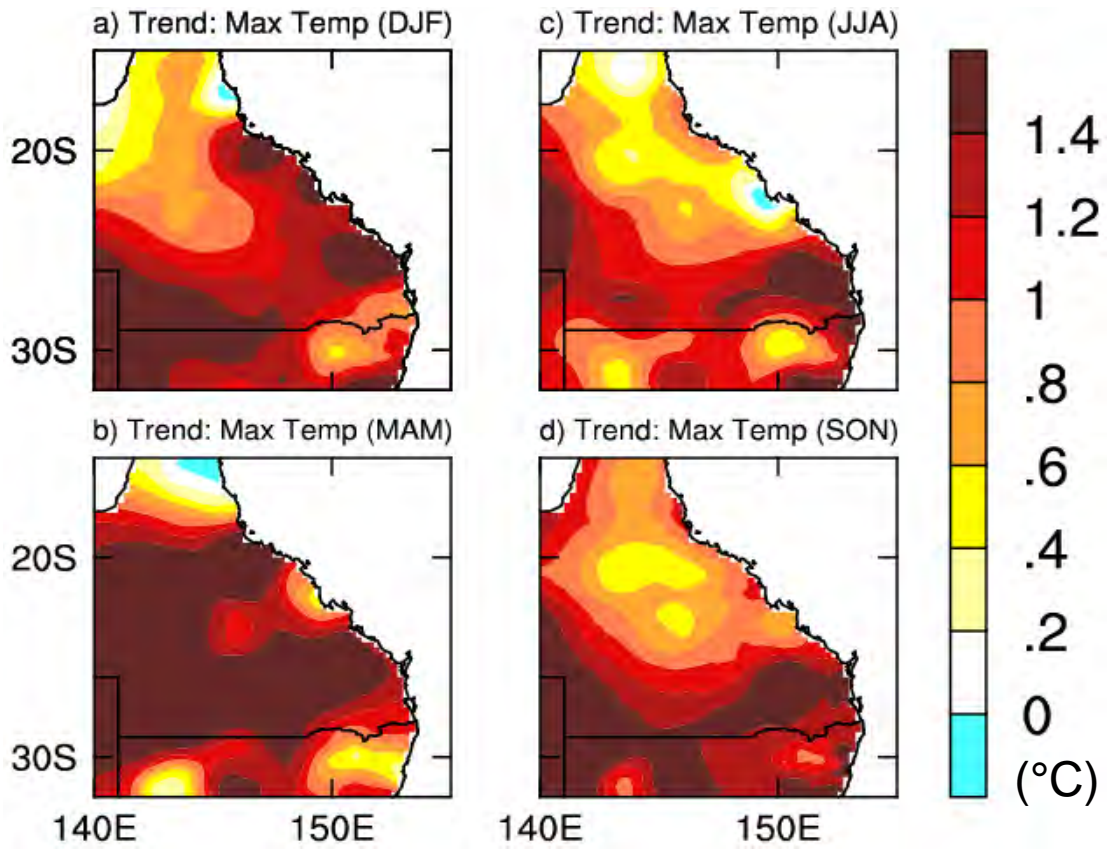
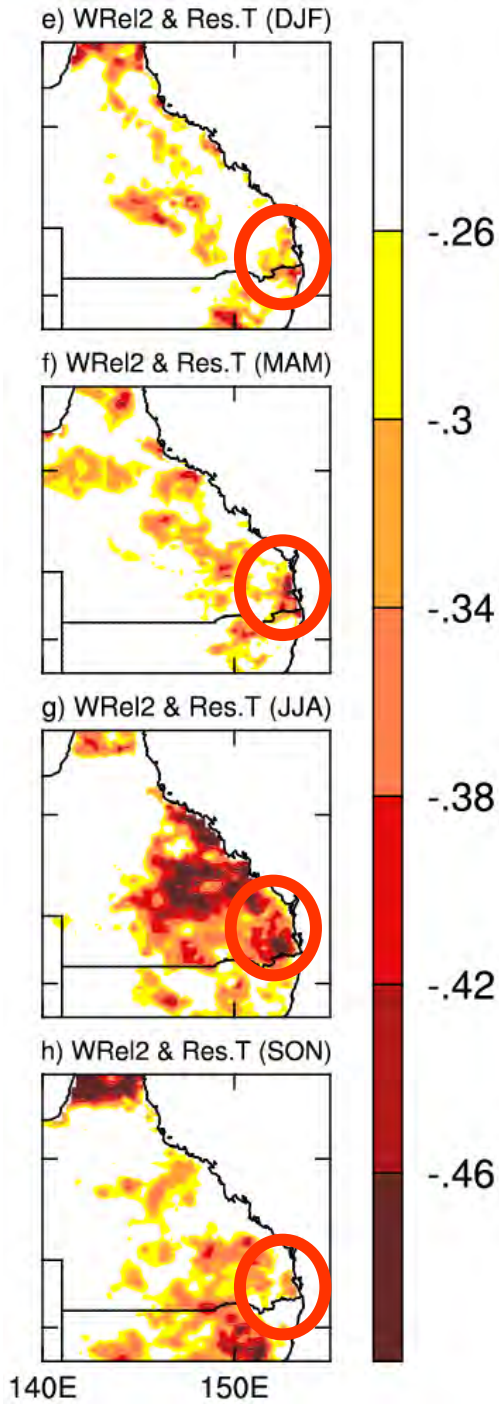
Greatest impact
in MAM & SON

Temperature & rainfall

- Use maximum temperature (Tmax) instead of pan evaporation, as it is more extensive and reliable.
- \uparrow rainfall (soil moisture)
 \downarrow Tmax (due to evaporative cooling and cloud cover).
- Remove the seasonal rainfall component from Tmax which is called: residual Tmax
- DETRENDING data is important!

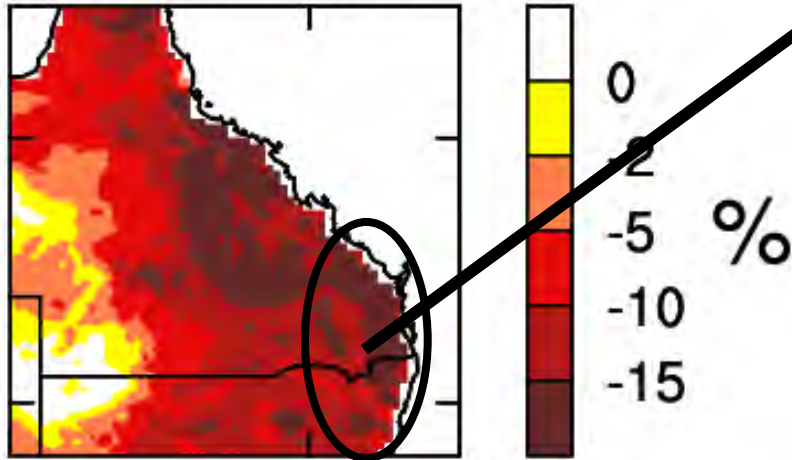


Coherence of temperature with soil moisture (1950-2008)



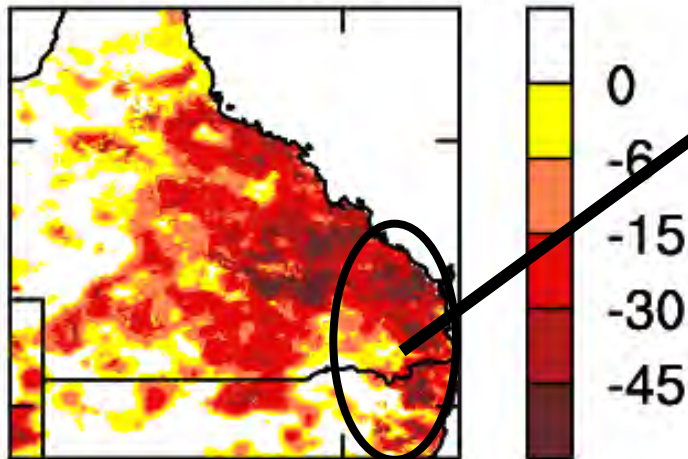
Impact of temperature on lower soil moisture

a) Temp-induced WRel2 (1950-2008)



15.7%
temperature-
induced reduction

b) WRel2 reduction (1950-2008)



23% reduction
in lower soil
moisture

150E

Summary

- Rainfall across SEQ exhibits multi-decadal changes.
- These cannot be explained by climate models, through anthropogenic forcings.
- ENSO is the dominant driver of variability, however an asymmetry exists:
 - ENSO good for rainfall across SEQ;
 - El Niño has minimal impact (statistically);
 - Since 1980s impact of La Niña has collapsed; and
 - Decline in number of La Niñas (depends on definition).
- Impact of **temperature** on soil moisture:
 - high correlations in all seasons;
 - warming of more than 1°C since 1950s;
 - induces 15% reduction in lower soil moisture;
 - future of water availability in a warming climate?

Thank you

www.urbanwateralliance.org.au



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Gold Coast flooding, June 2005

Comparing climatology of R21 to observations

