

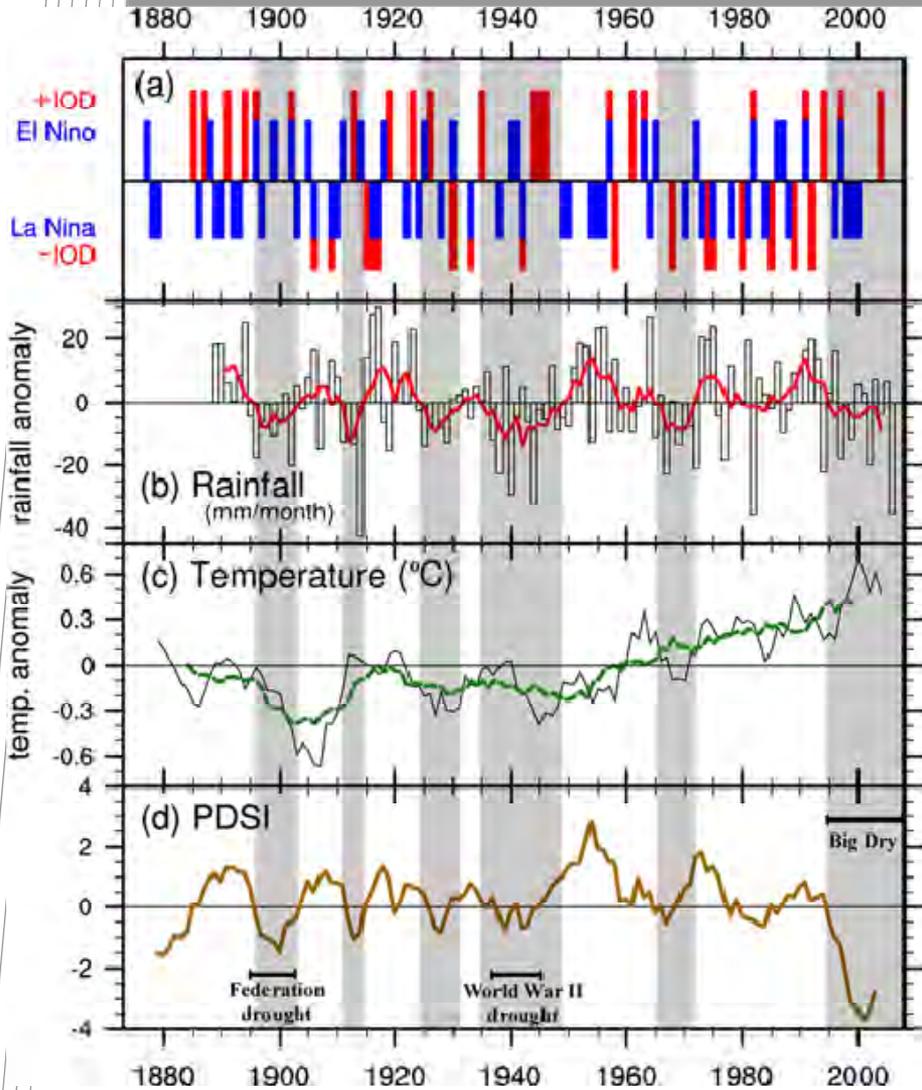
www.csiro.au

The impact of the recent positive IOD events on Australian Climate

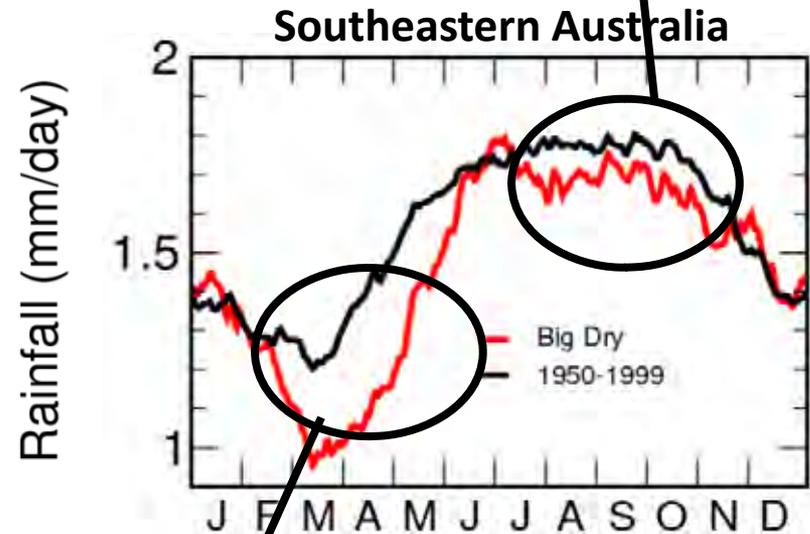
Tim Cowan and Wenju Cai
 CSIRO Marine & Atmospheric Research
 Greenhouse2011: Indo-Pacific climate variability and change workshop
 Cairns, Thursday 7th April 2011.



The Big Dry (1995-2009)



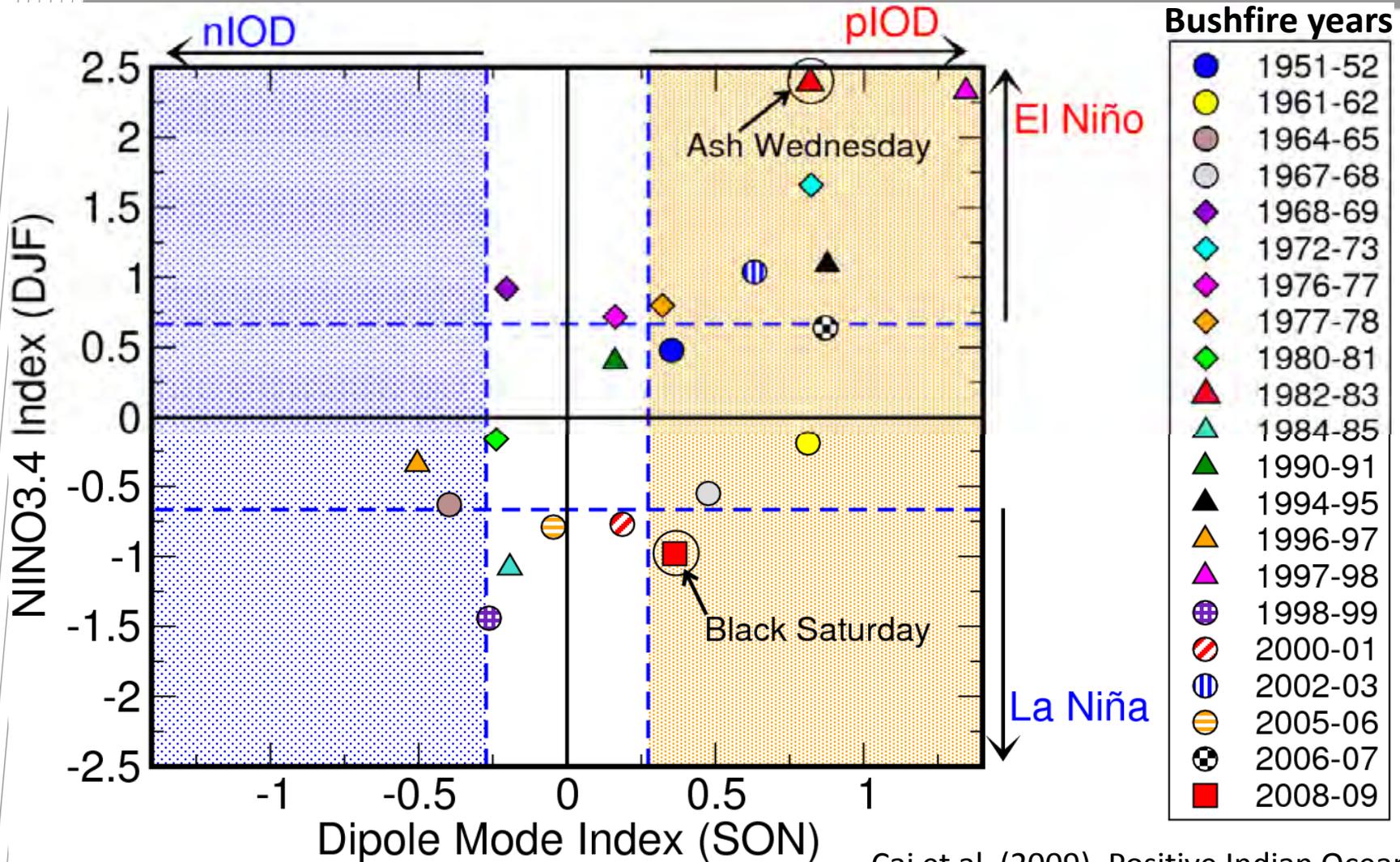
Indian Ocean Dipole



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Ummerhofer et al. 2009, What causes southeast Australia's worst droughts? *GRL*.

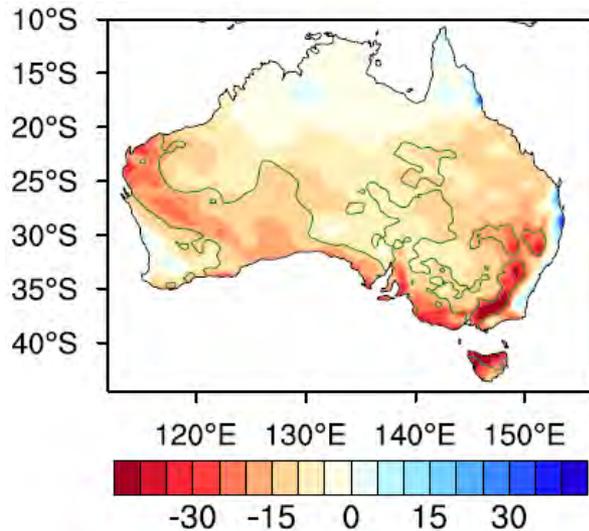
Major bushfires across Victoria associated with the IOD and ENSO



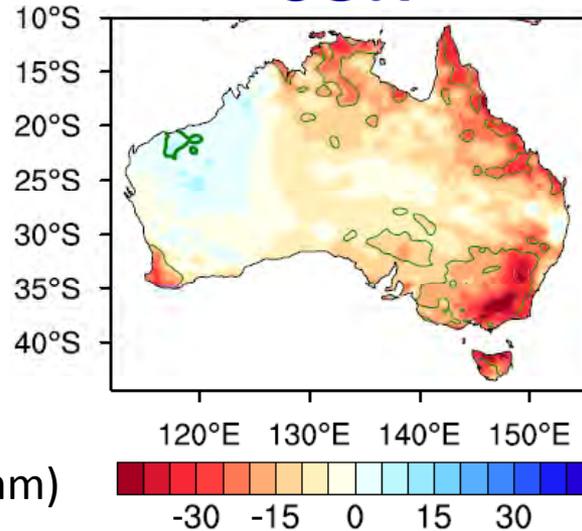
Cai et al. (2009), Positive Indian Ocean dipole events precondition southeast Australia bushfires, *GRL*.

IOD and Australian rainfall

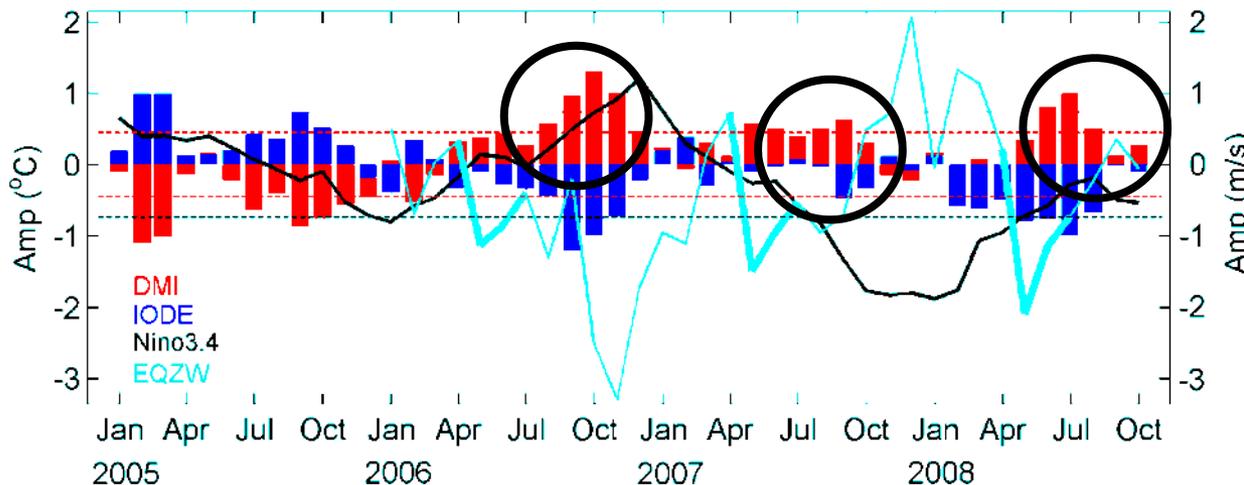
JJA



SON

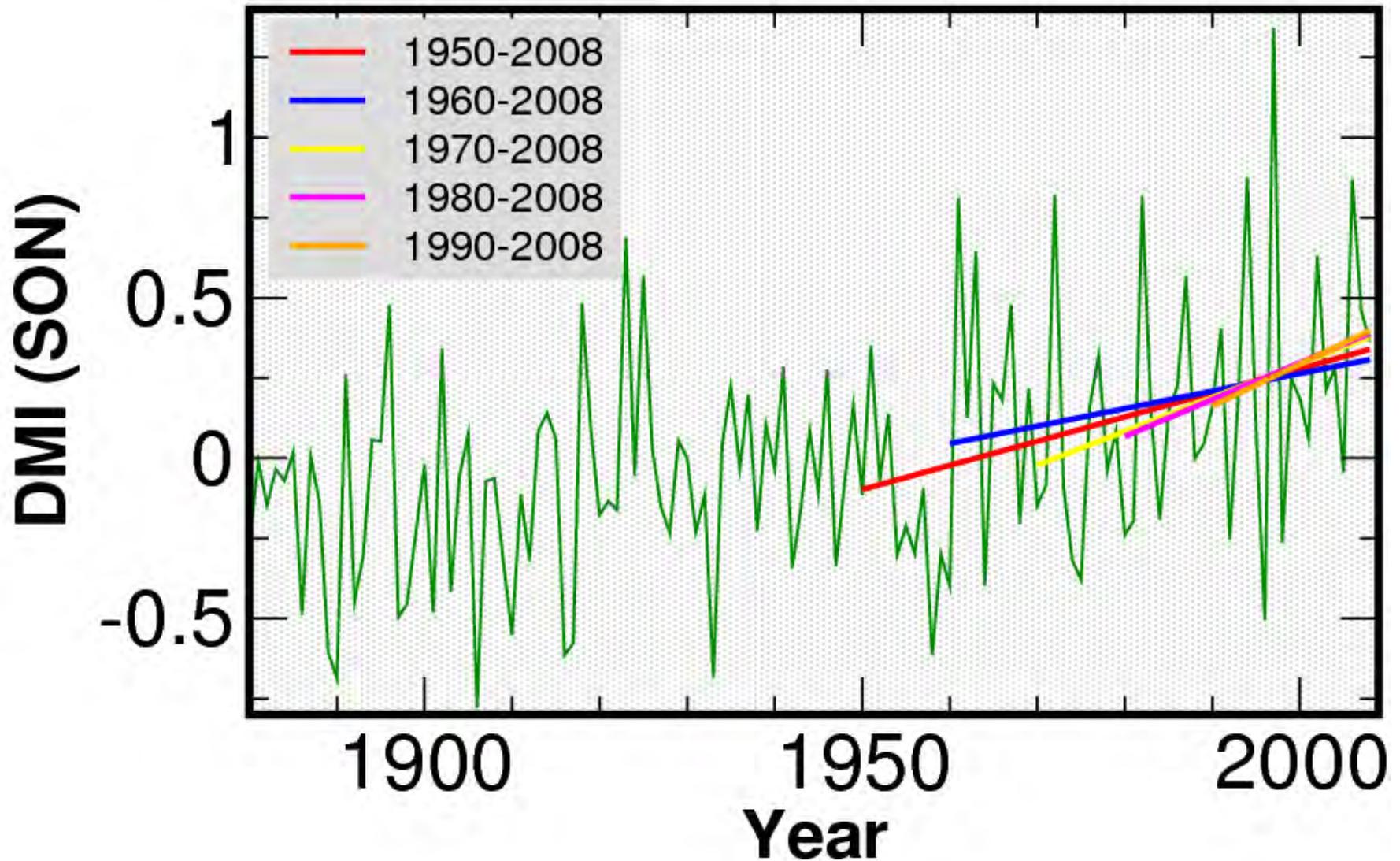


One-standard deviation anomaly pattern of rainfall associated with the Dipole Mode Index (IOD), 1979-2008



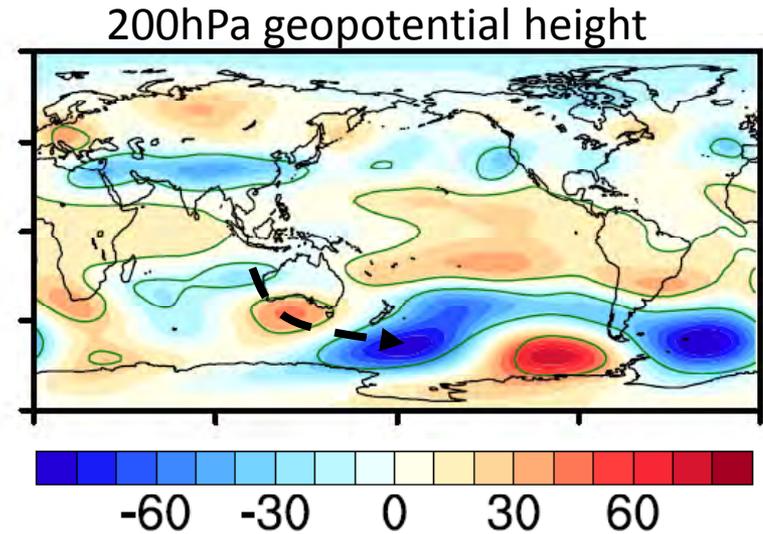
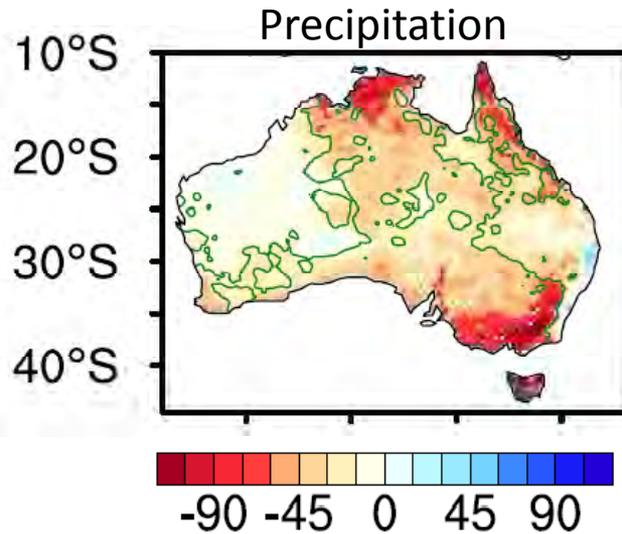
Cai et al. (2009), Argo profiles a rare occurrence of ***three consecutive positive Indian Ocean Dipole events***, 2006–2008, Geophys. Res. Letts., 36, L08701, doi:10.1029/2008GL037038.

Unprecedented high number of pIODs, low number of nIODs

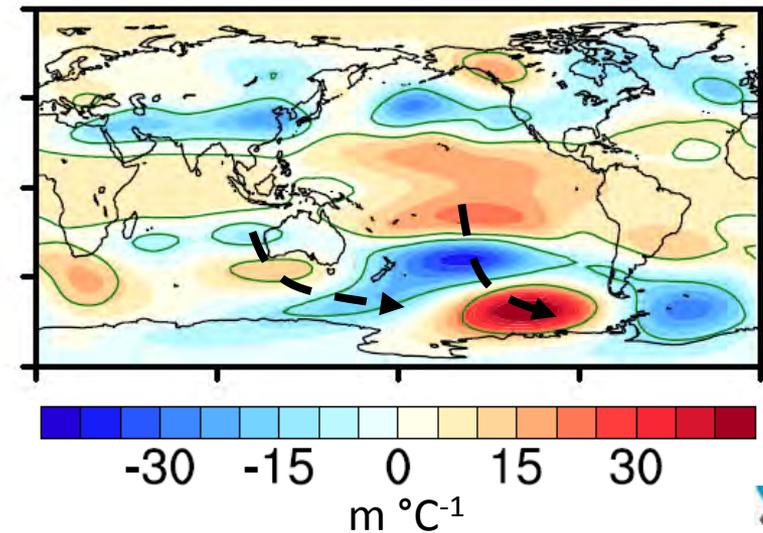
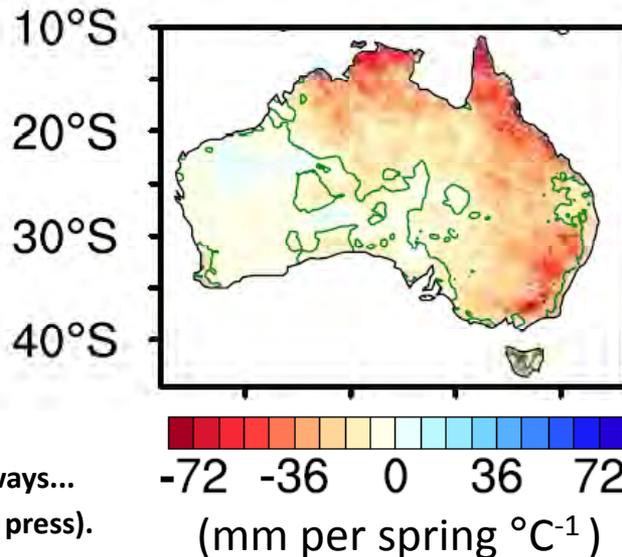


Austral Spring (SON) changes associated with the IOD and ENSO (1950-2009)

IOD



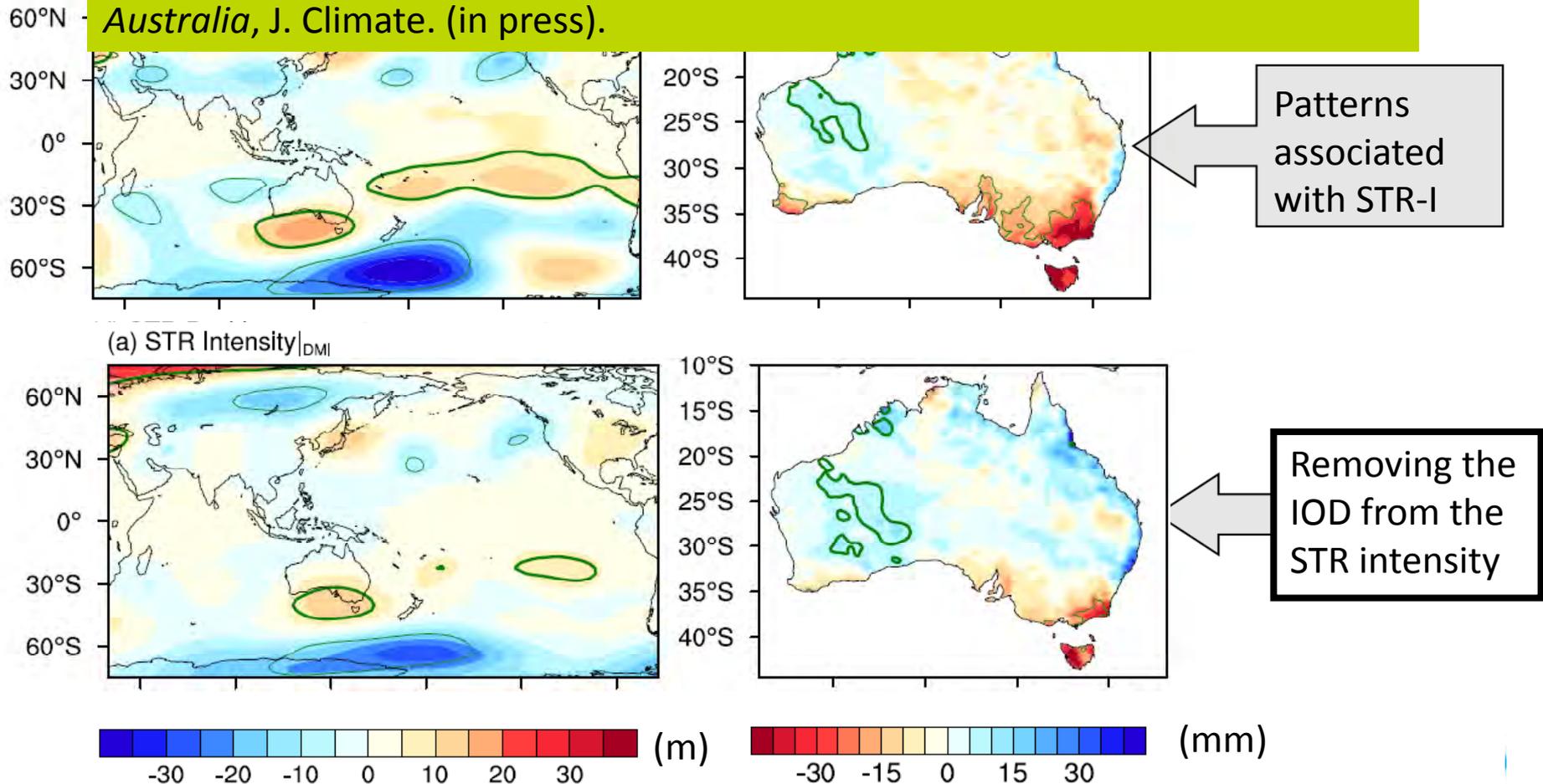
ENSO



Cai et al. (2011),
Teleconnection pathways...
Journal of Climate (in press).

Impact of IOD via through the subtropical ridge

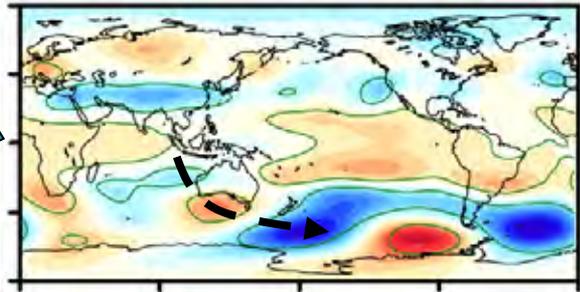
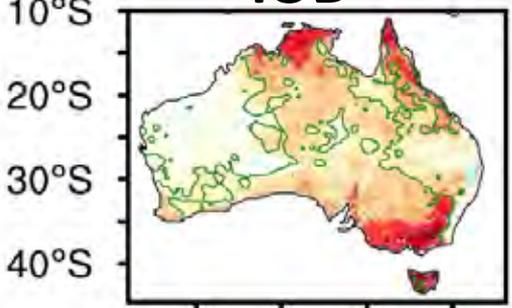
The STR intensity accounts for about 90% of the observed spring rainfall decline (not significant) since 1979, all due to the IOD trend (Cai et al. 2011 - *Influence of global-scale variability on the subtropical ridge over southeast Australia, J. Climate. (in press).*)



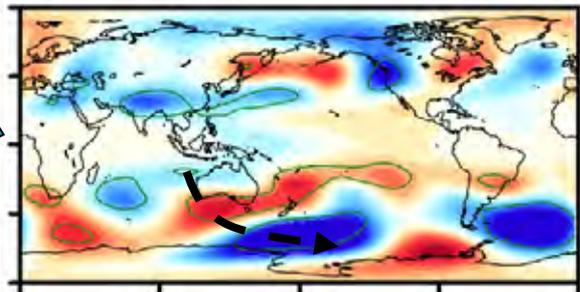
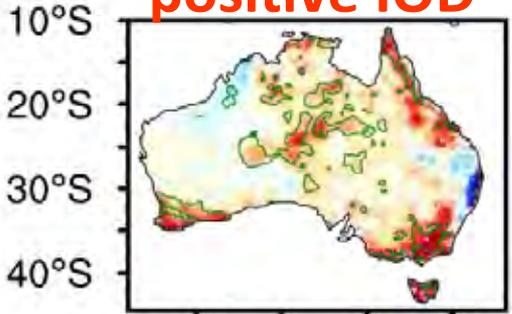
Phases of the IOD..

IOD

200hPa geopotential height

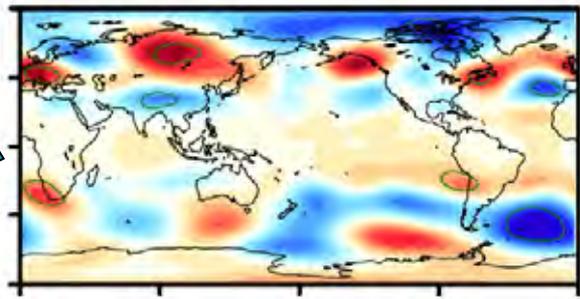
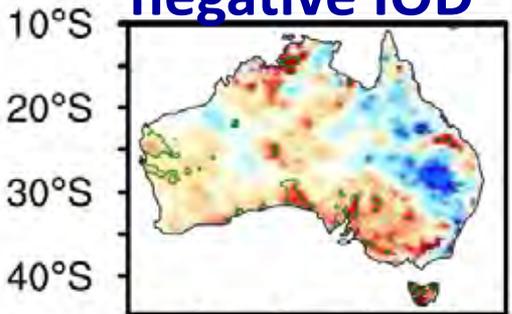


positive IOD

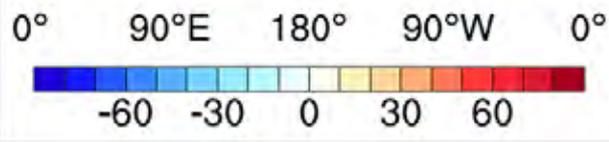
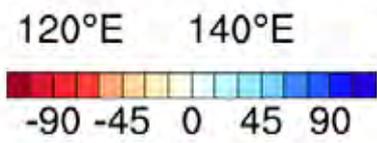


Strong wavetrain activity

negative IOD

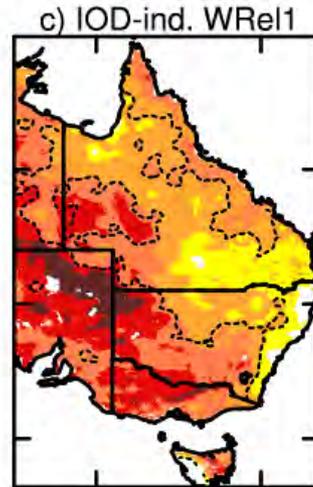


Is it case of a lack of the negative IOD events (Ummenhofer et al. 2009) or an increase in pIOD events (Cai et al. 2009)?

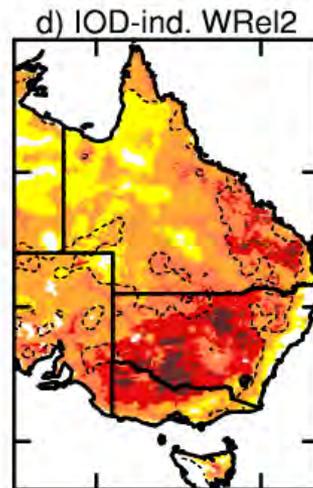


IOD-induced changes in soil moisture (Aust. spring and summer combined)

Upper Soil
Moisture
(top 20cm)



Lower Soil
Moisture
(20-150cm)



140E 150E

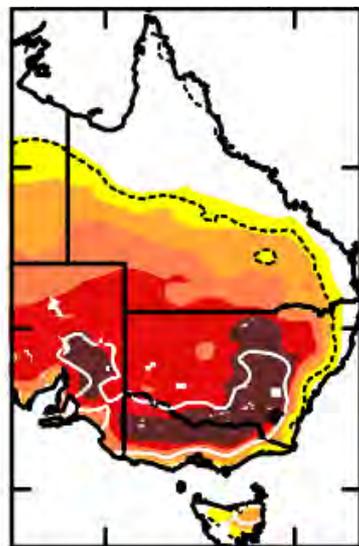


%

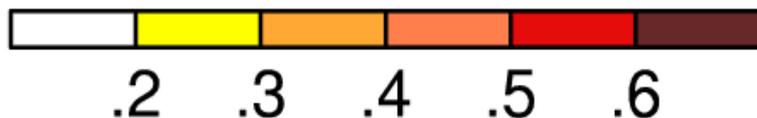
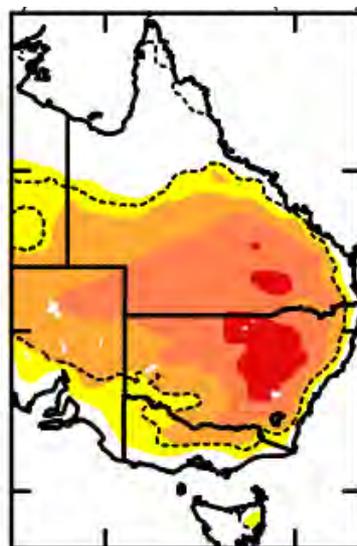
Cai et al. (2009), Positive Indian Ocean dipole events precondition southeast Australia bushfires, *GRL*.

Maximum temperature patterns associated with IOD & ENSO (spring)

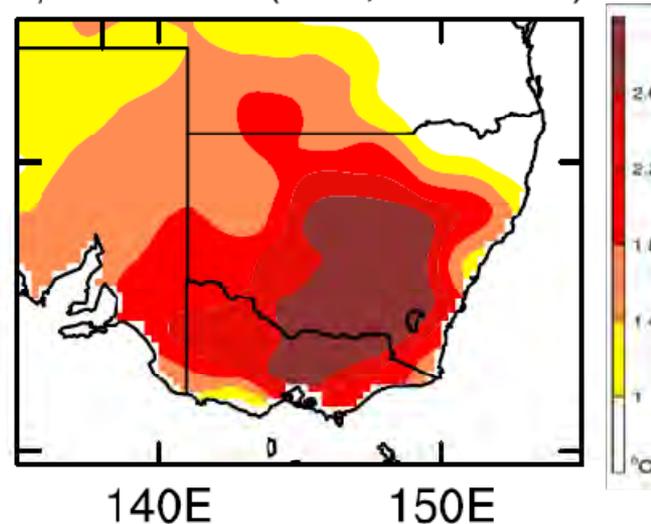
IOD



ENSO



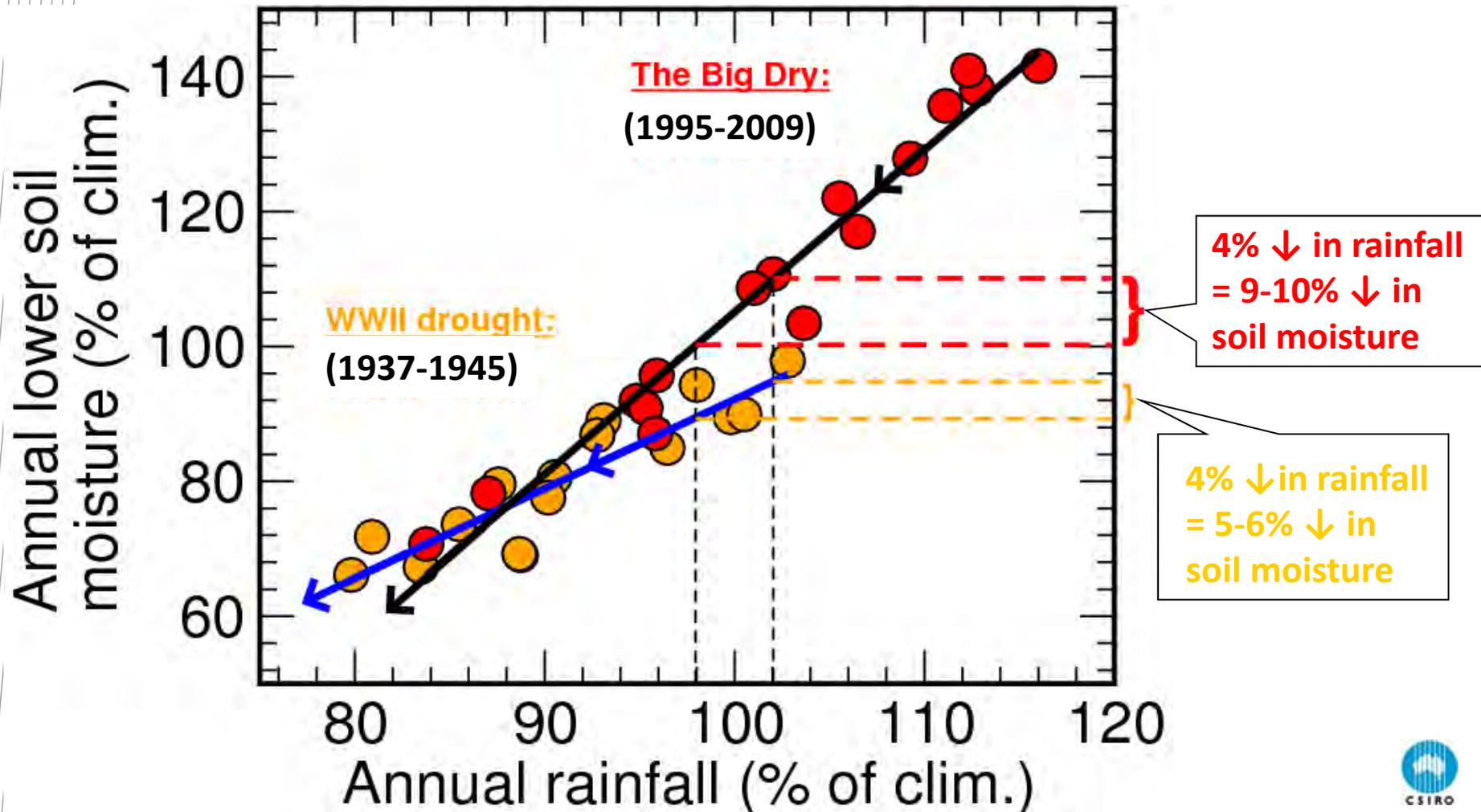
h) Tmax trend (SON, 1990-2008)



Cai et al. (2009), Rising temperature depletes soil moisture and exacerbates severe drought conditions across southeast Australia, *GRL*.

Changing nature of drought due to temperature

'...severity of the "Big Dry" is still exceptional; this appears to be linked to recent large increases in air temperature' (Ummenhofer et al. 2009 - What causes southeast Australia's worst droughts?, *GRL*)



Conclusions

- **There has been a recent increasing frequency in positive IOD events:**
 - four per 30 years in the early 20th century, ten over the last 30 years
- **Positive IOD events in austral spring → lower rainfall in southeast Australia → higher temperatures → increase fuel loading → create perfect conditions for major summer bushfires:**
 - Since 1950, 11 out of 16 positive IODs were followed by major bushfires in Victoria
- **The primary impact of the IOD (and ENSO) on spring rainfall across southeast Australia is via the tropical Indian Ocean:**
 - Equivalent barotropic Rossby wavetrains → high pressure centre south of Australia → weakens rain-bearing systems → observed as an intensification of the subtropical ridge
- **Any further increase in positive IOD occurrences as a result of climate change, will further increase the risk of bushfires and exacerbate the drought**

THANK-YOU!