



Understanding Climate Variability in Queensland

Ken Day

Manager Information and Knowledge QCCCE

Queensland's Climate Change Strategy



Toward 
Toward's Queensland

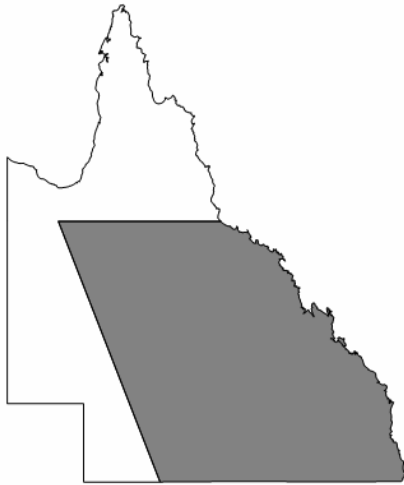
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Introduction

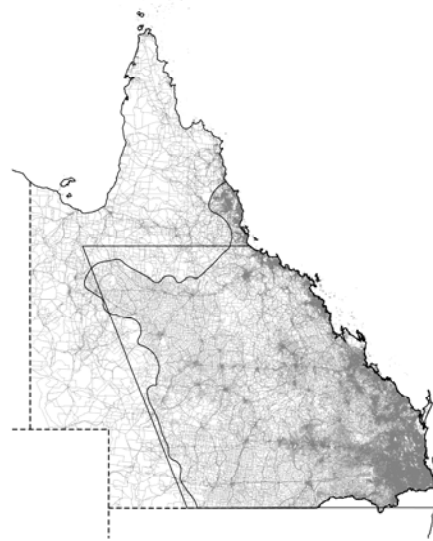
- Index of Queensland summer rainfall
- Relationship between the SOI and rainfall for phases (Warm and Cool) of the Inter-decadal Pacific Oscillation (IPO)
- Implications for SOI-based climate assessments or seasonal outlooks
- Seasonal Pacific Ocean Temperature Analysis version 1 (SPOTA-1)



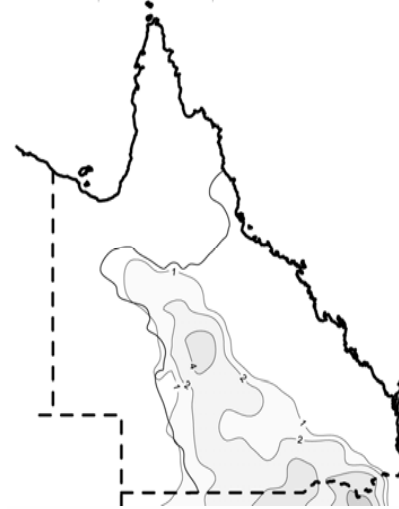
Rainfall Index



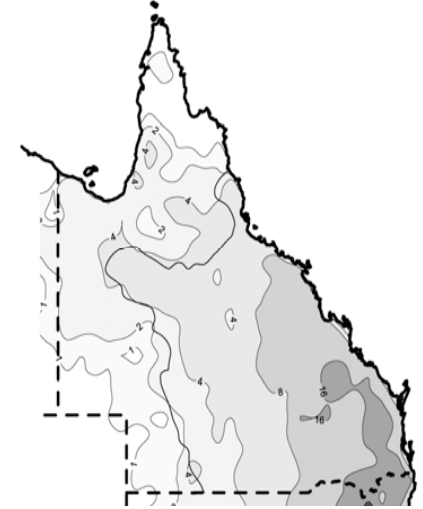
Grazing Land Region



Land Settlement



Sheep Density

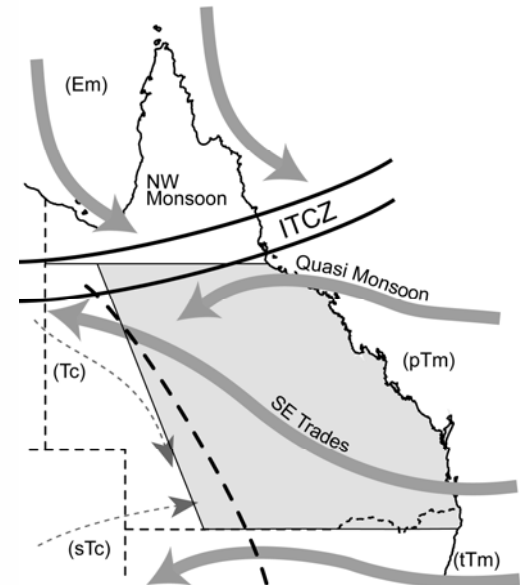
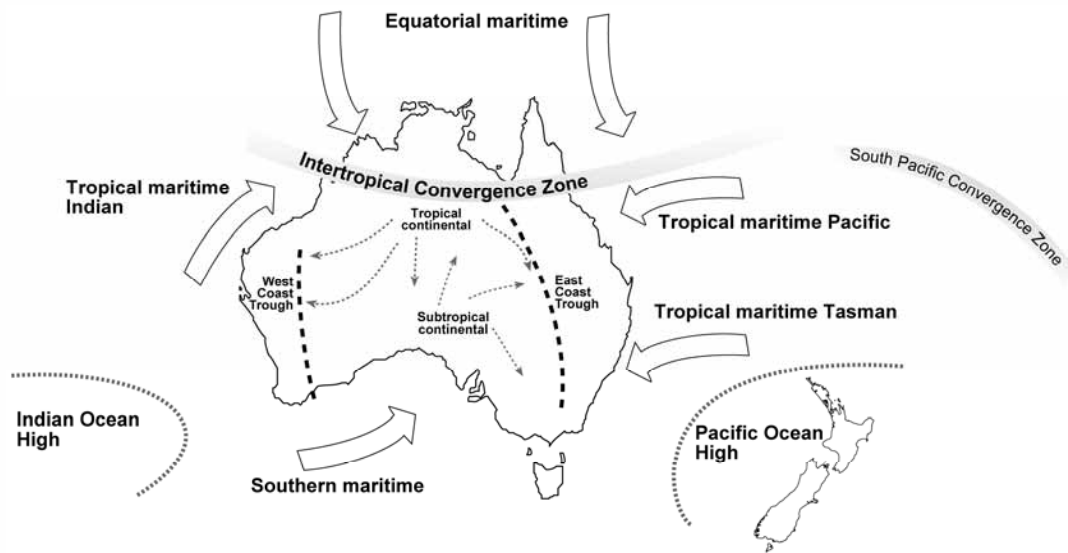


Cattle Density

Rainfall Index: November to March rainfall averaged over grazing land region



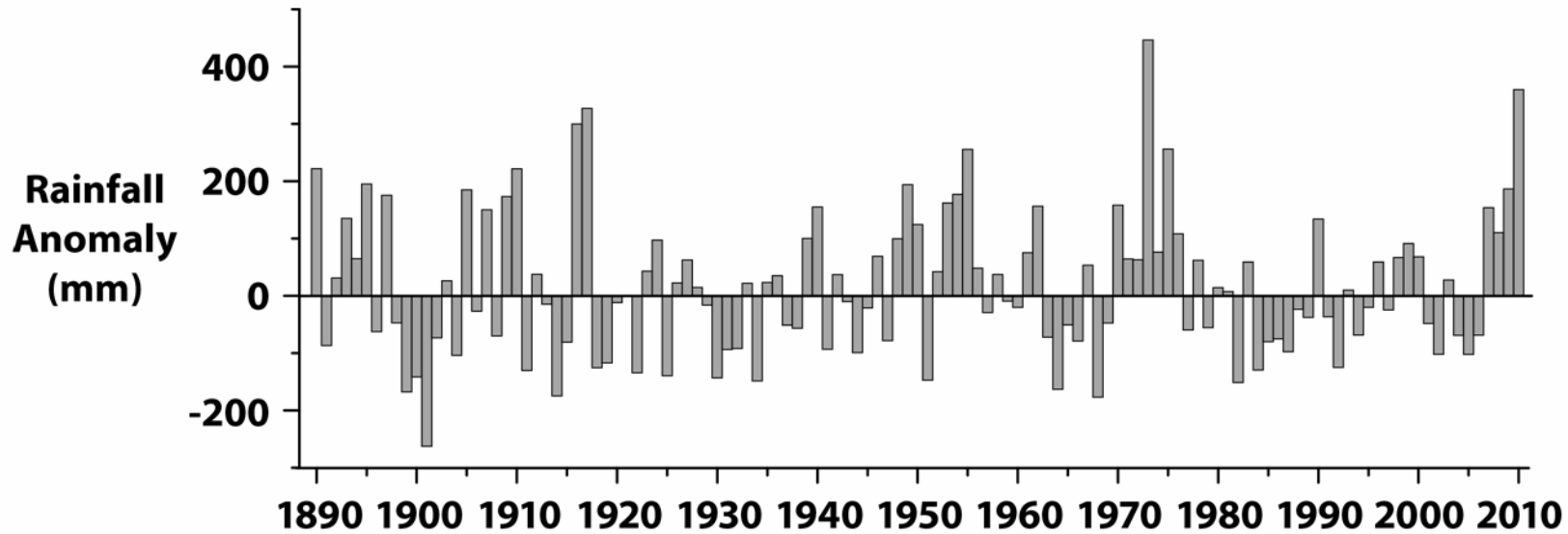
Rainfall Index



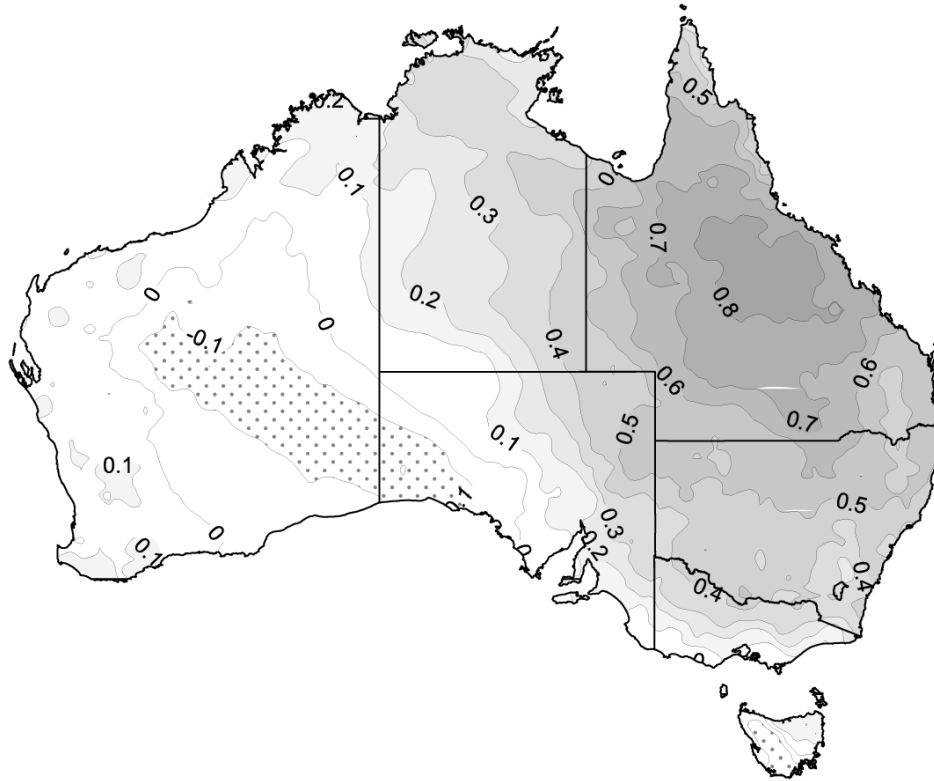
Grazing land region: mean summer extent of Tropical Maritime Pacific air mass



Rainfall Index



Rainfall Index



Rainfall Index: positively correlated with summer rainfall over eastern Australia

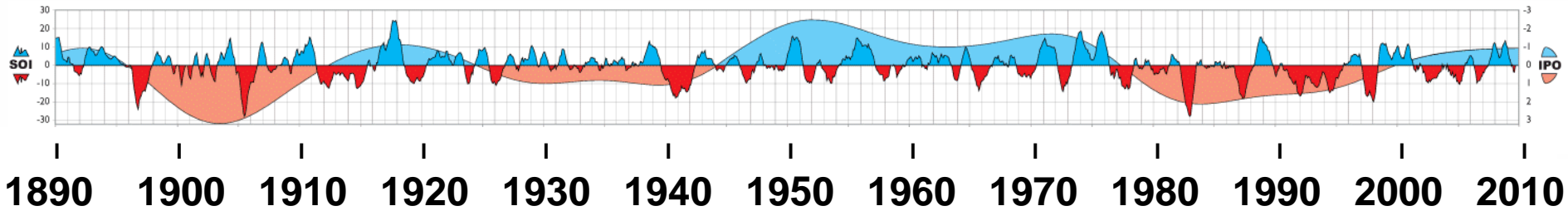
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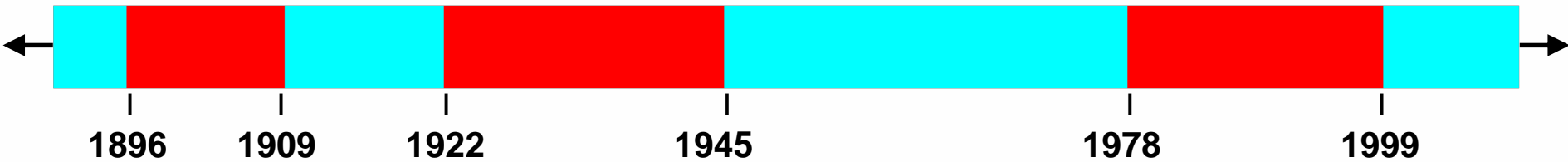
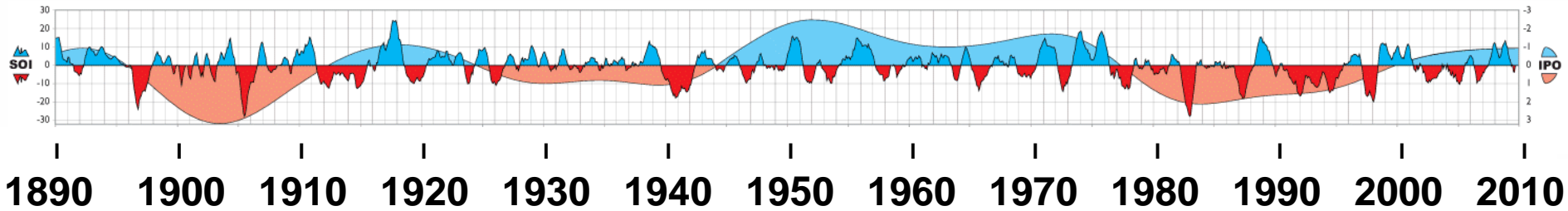
Climate Indices



Relationship between rainfall index and SOI for different phases ('Cool' or 'Warm') of the IPO



Climate Indices

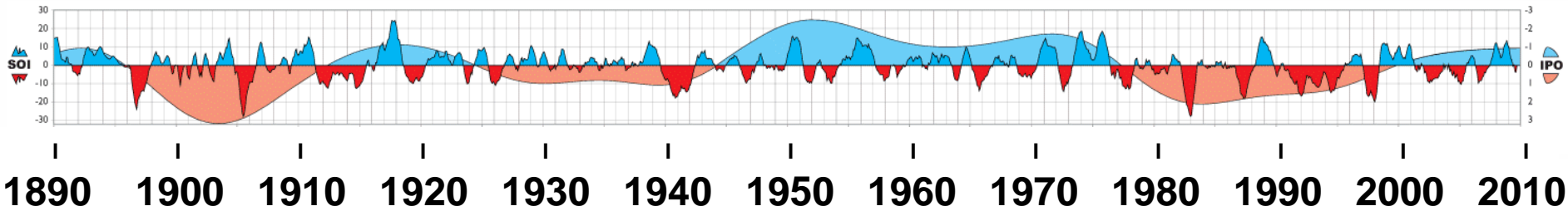


Year IPO phase commences

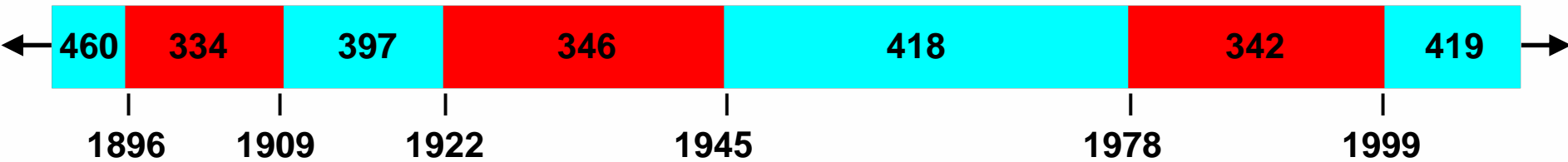
IPO definition: Folland et al 1998 (data courtesy Andrew Coleman UKMO June 2000) consistent with: Power *et al* (1999). Inter-decadal modulation of the impact of ENSO on Australia, *Climate Dynamics* 15



Climate Indices



Average rainfall (mm Nov-Mar) in IPO phases

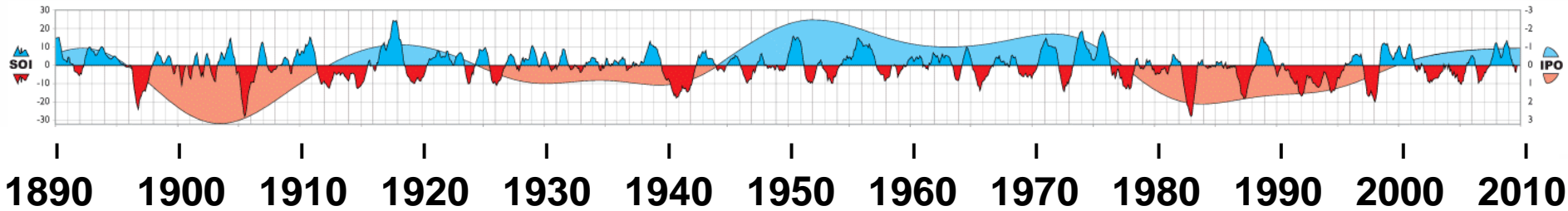


Year IPO phase commences

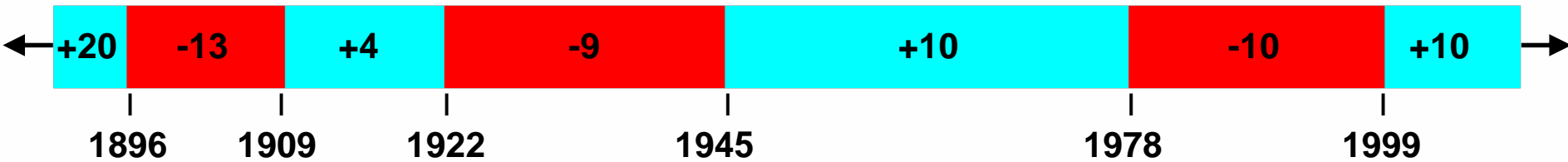
IPO definition: Folland et al 1998 (data courtesy Andrew Coleman UKMO June 2000) consistent with: Power *et al* (1999). Inter-decadal modulation of the impact of ENSO on Australia, *Climate Dynamics* 15



Climate Indices



Rainfall in IPO phases – % shift from long-term mean (382mm)

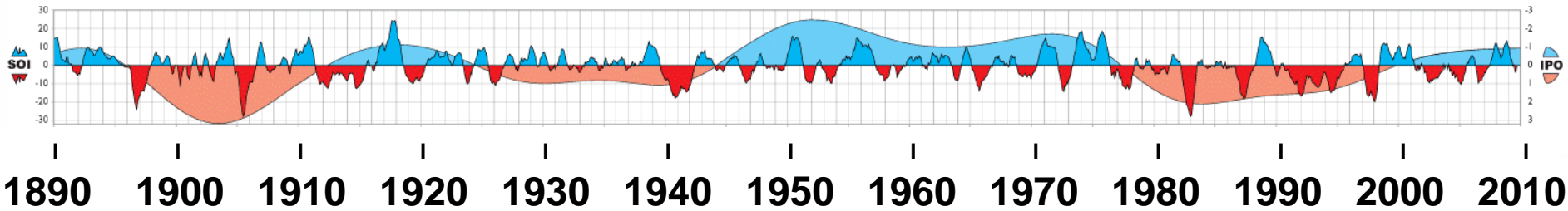


Year IPO phase commences

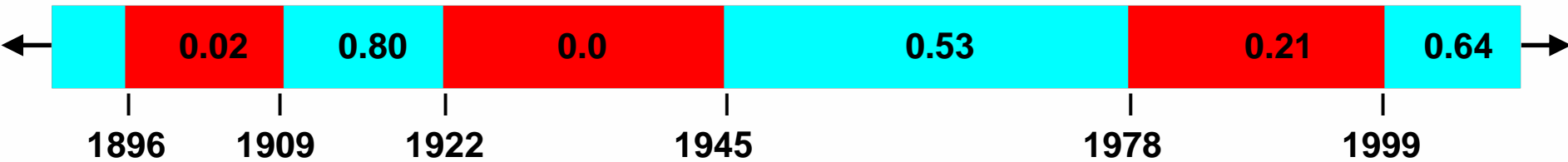
IPO definition: Folland et al 1998 (data courtesy Andrew Coleman UKMO June 2000) consistent with: Power *et al* (1999). Inter-decadal modulation of the impact of ENSO on Australia, *Climate Dynamics* 15



Climate Indices



SOI and Qld rainfall (both Nov-Mar): Coefficient of Determination (r^2)



Year IPO phase commences

IPO definition: Folland et al 1998 (data courtesy Andrew Coleman UKMO June 2000) consistent with: Power *et al* (1999). Inter-decadal modulation of the impact of ENSO on Australia, *Climate Dynamics* 15

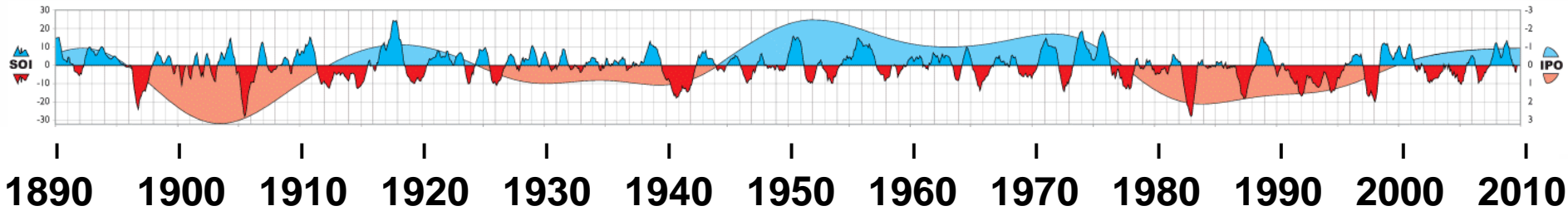
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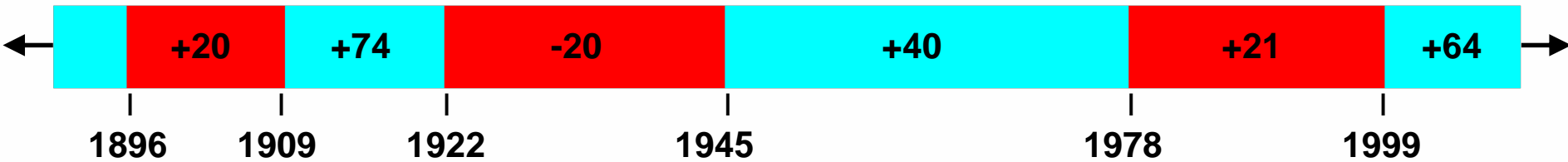
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Climate Indices



SOI and Qld rainfall (both Nov-Mar): LEPS tercile skill score



Year IPO phase commences

IPO definition: Folland et al 1998 (data courtesy Andrew Coleman UKMO June 2000) consistent with: Power *et al* (1999). Inter-decadal modulation of the impact of ENSO on Australia, *Climate Dynamics* 15

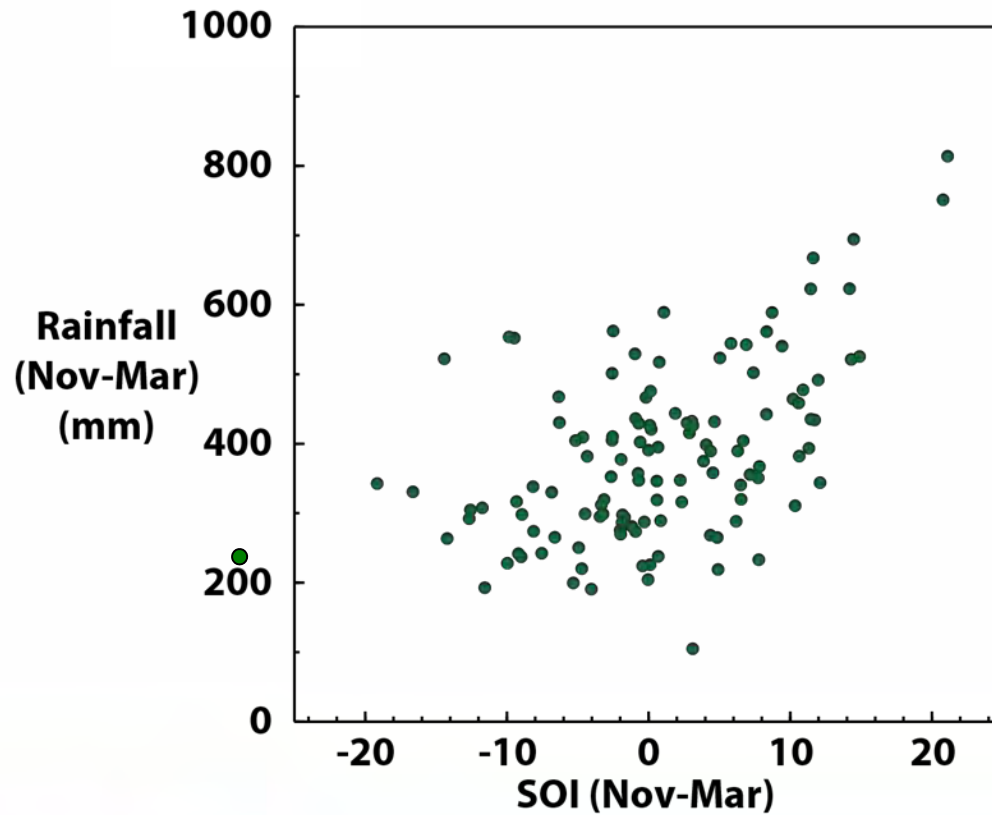
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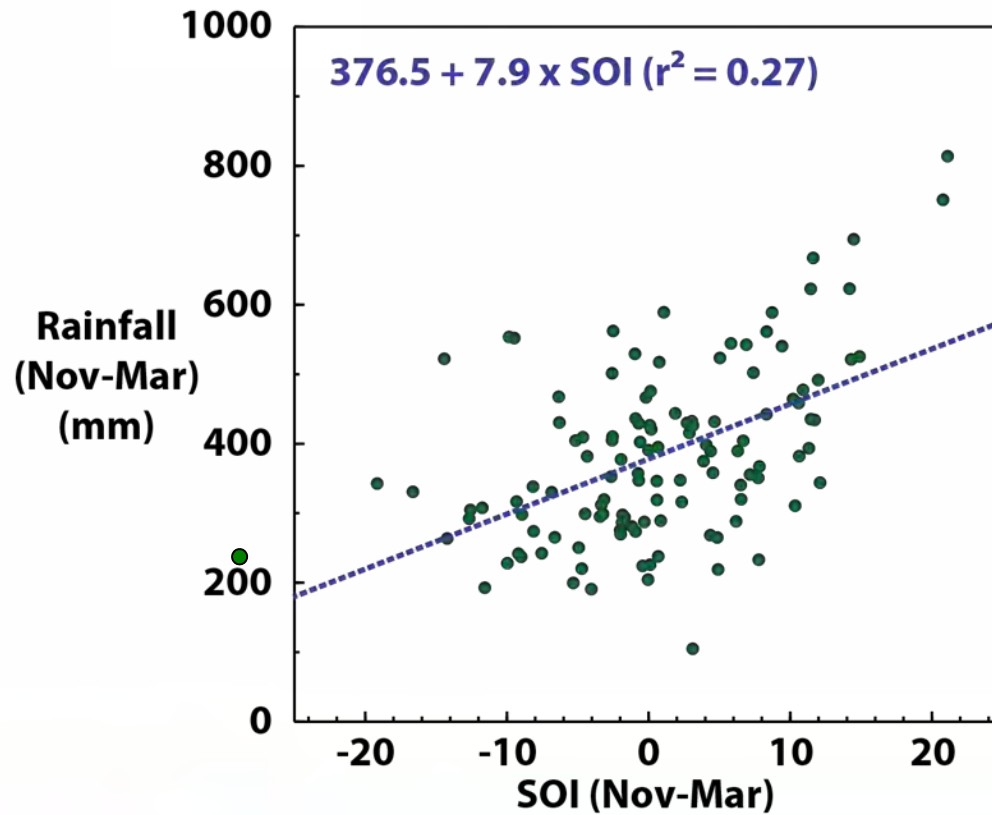
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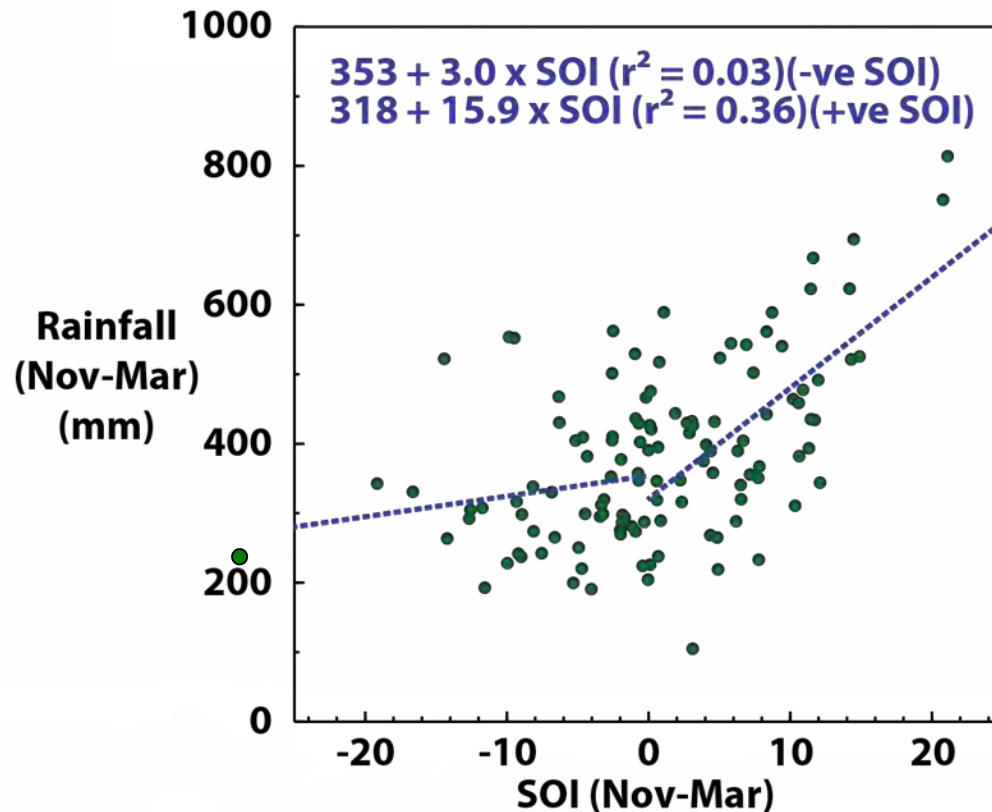
SOI and summer rainfall



SOI and summer rainfall



SOI and summer rainfall

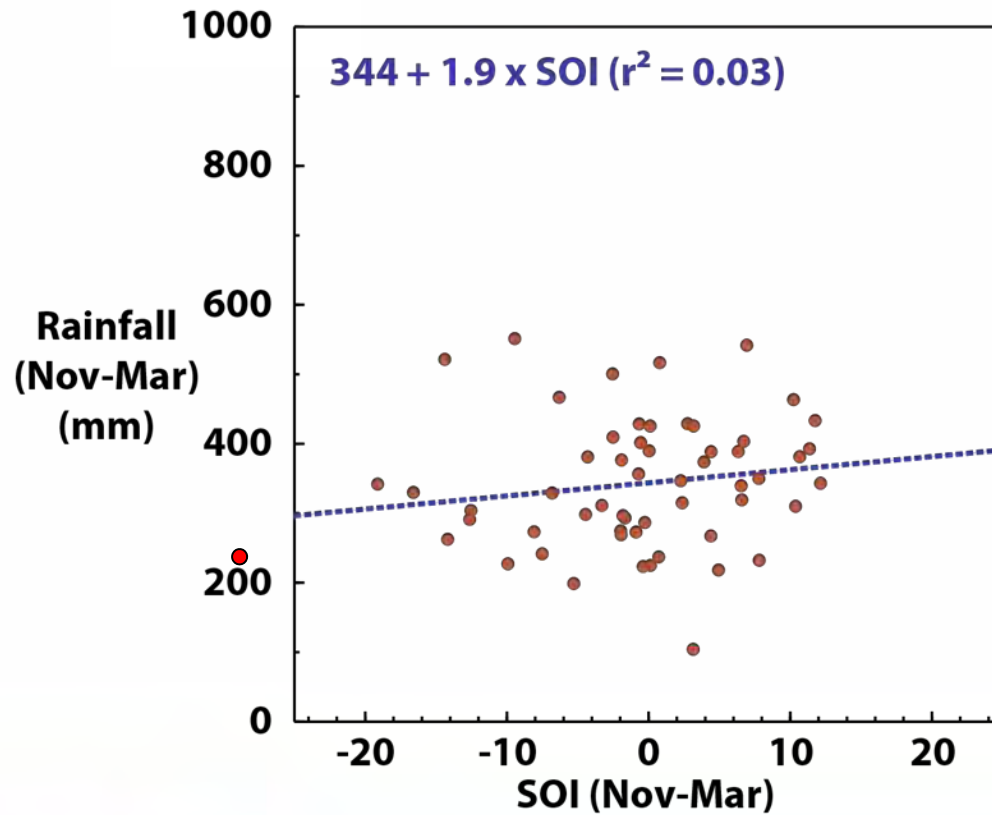


Power et al (2006) Asymmetry in ENSO teleconnection with regional rainfall, its multi-decadal variability and impact. J. Climate 19, 4755-4711

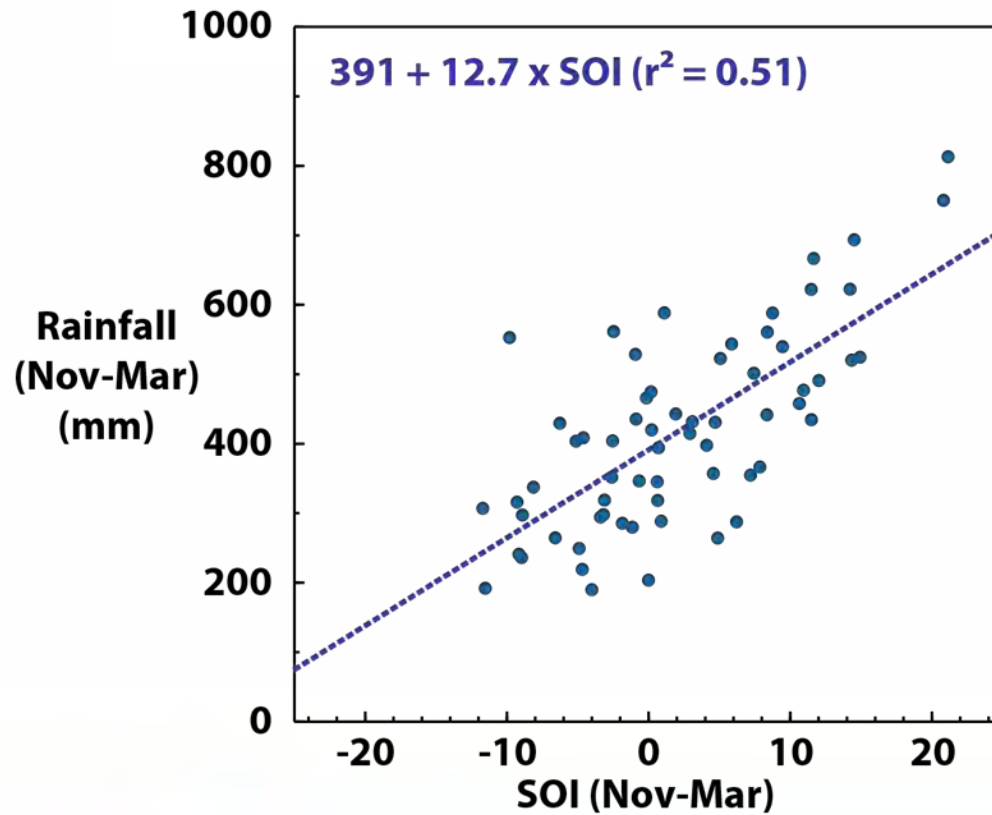
Cai et al (2010) Asymmetry in ENSO teleconnection, its collapse and impact on South East Queensland summer rainfall. J. Climate 23, 4944-4955



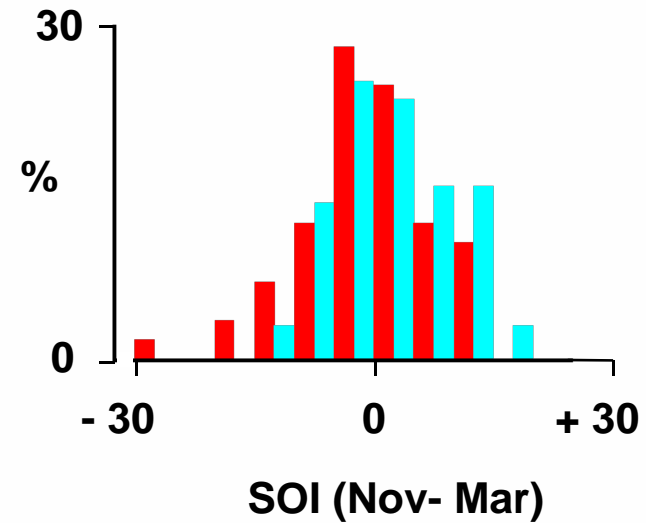
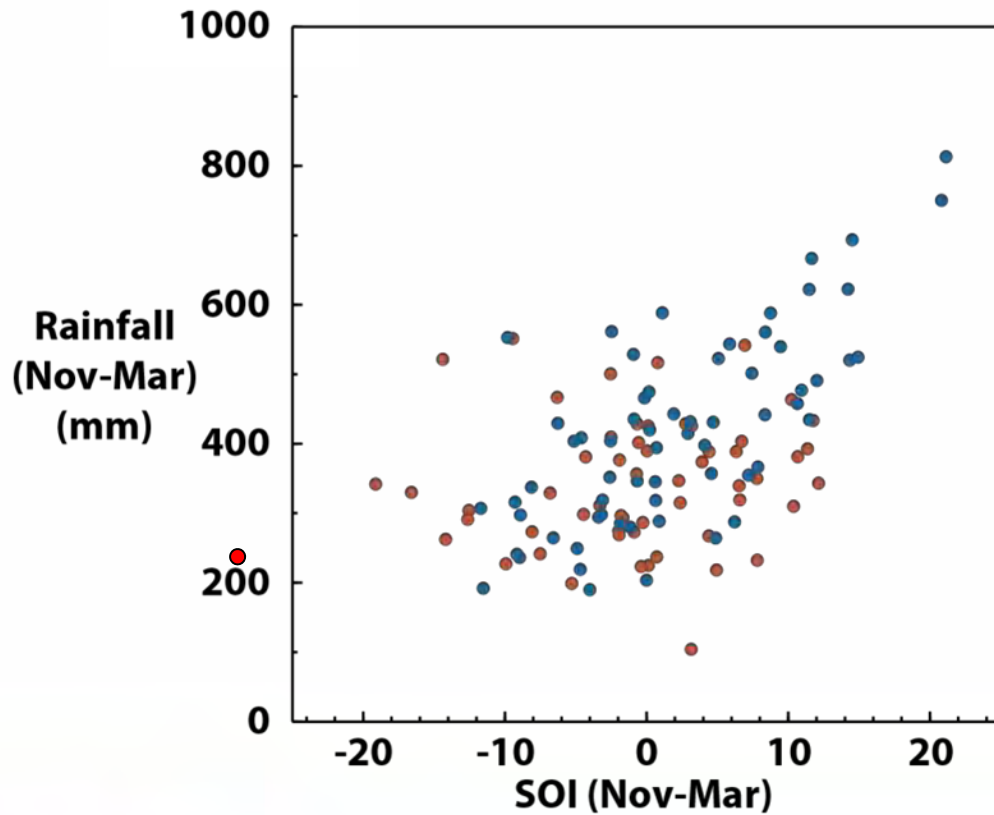
IPO Warm



IPO Cool



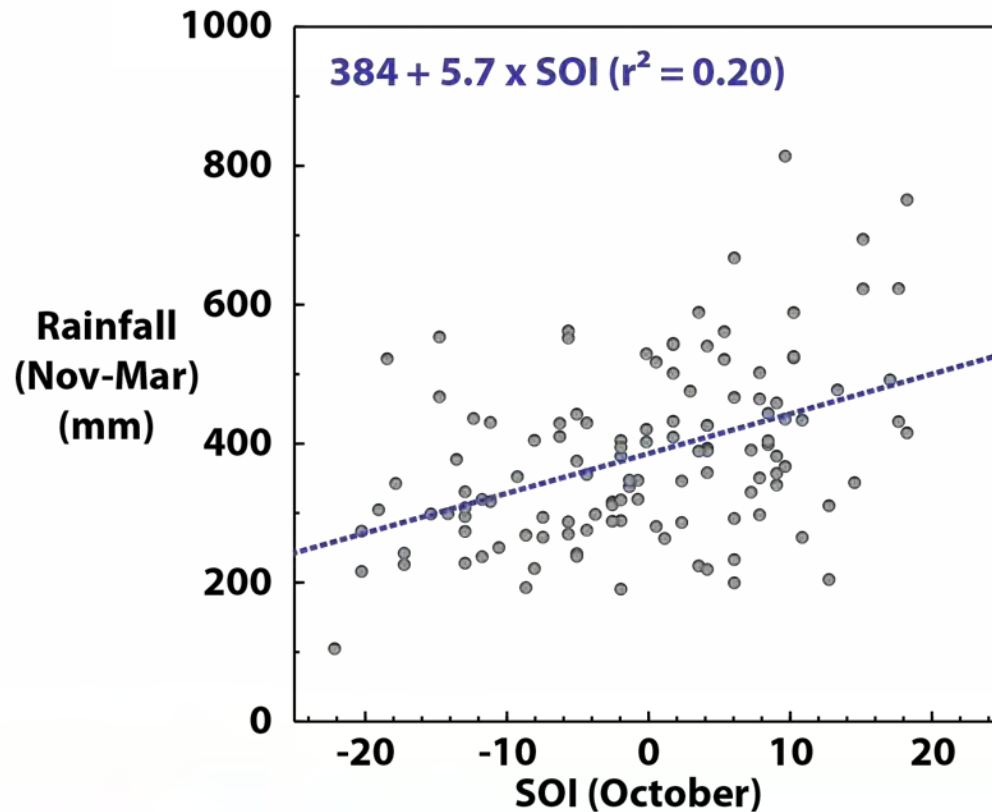
SOI and summer rainfall



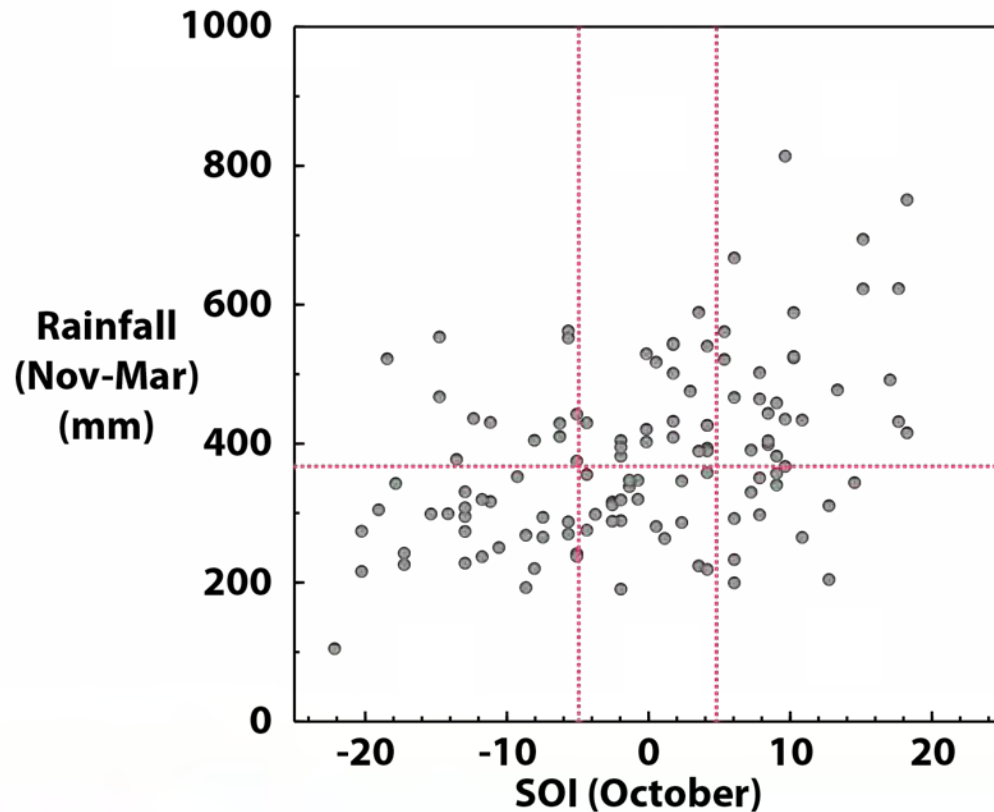
- IPO Warm
- IPO Cool



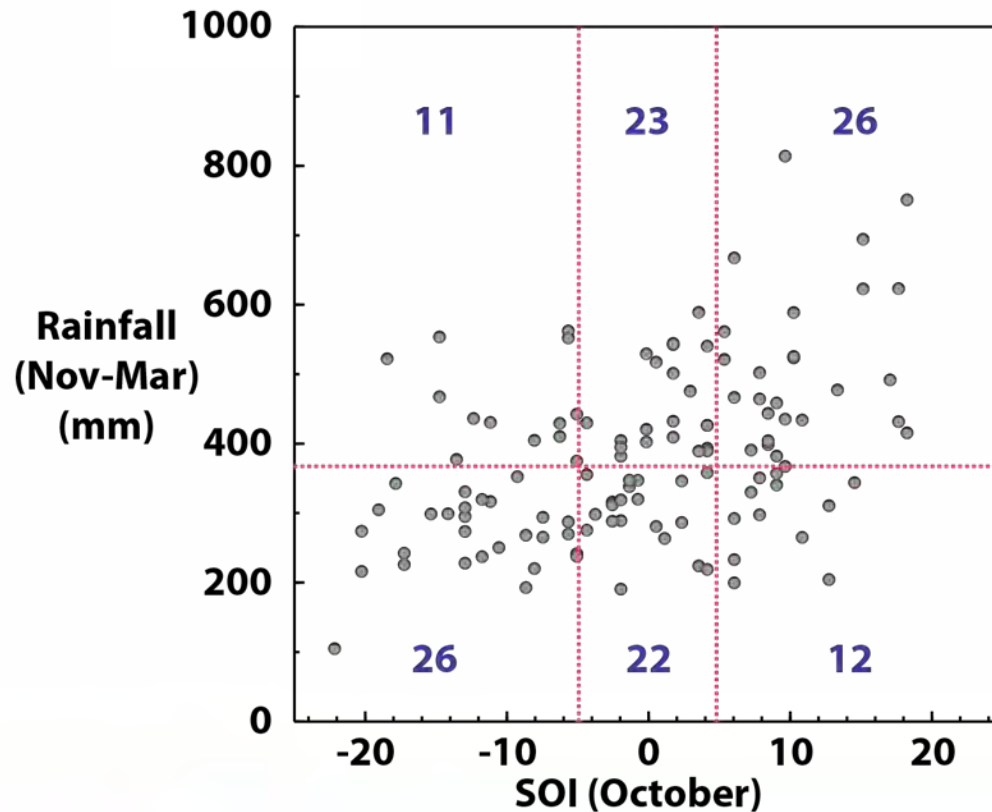
Lagged SOI and summer rainfall



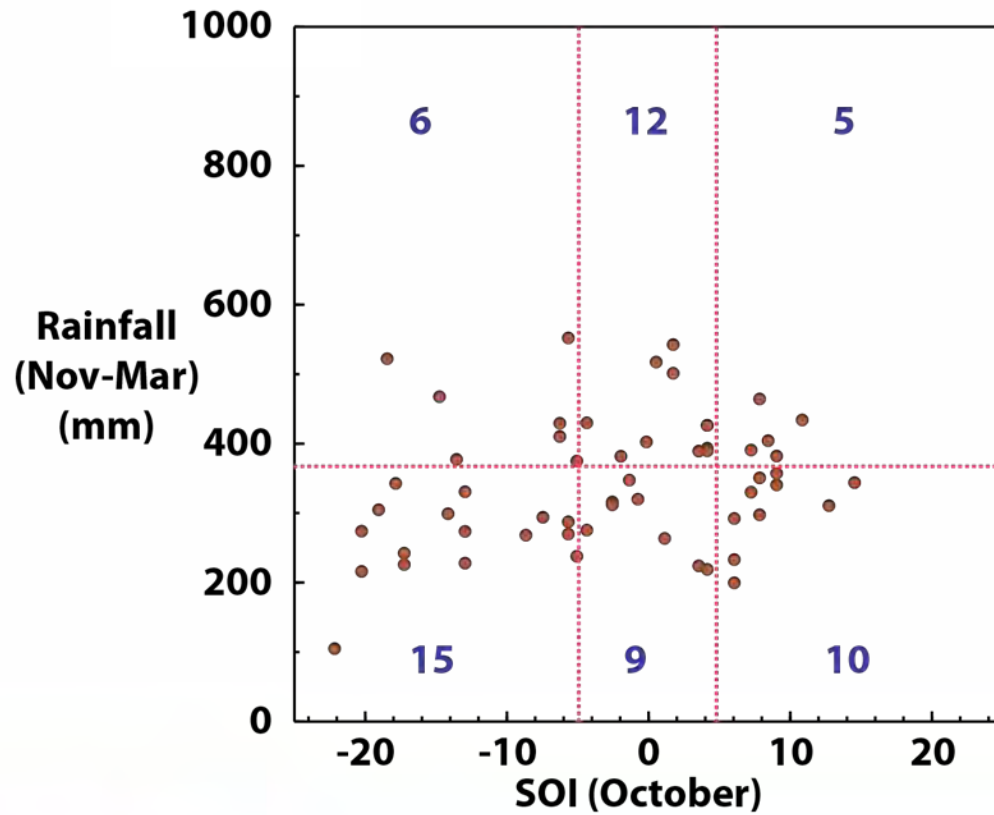
Lagged SOI and summer rainfall



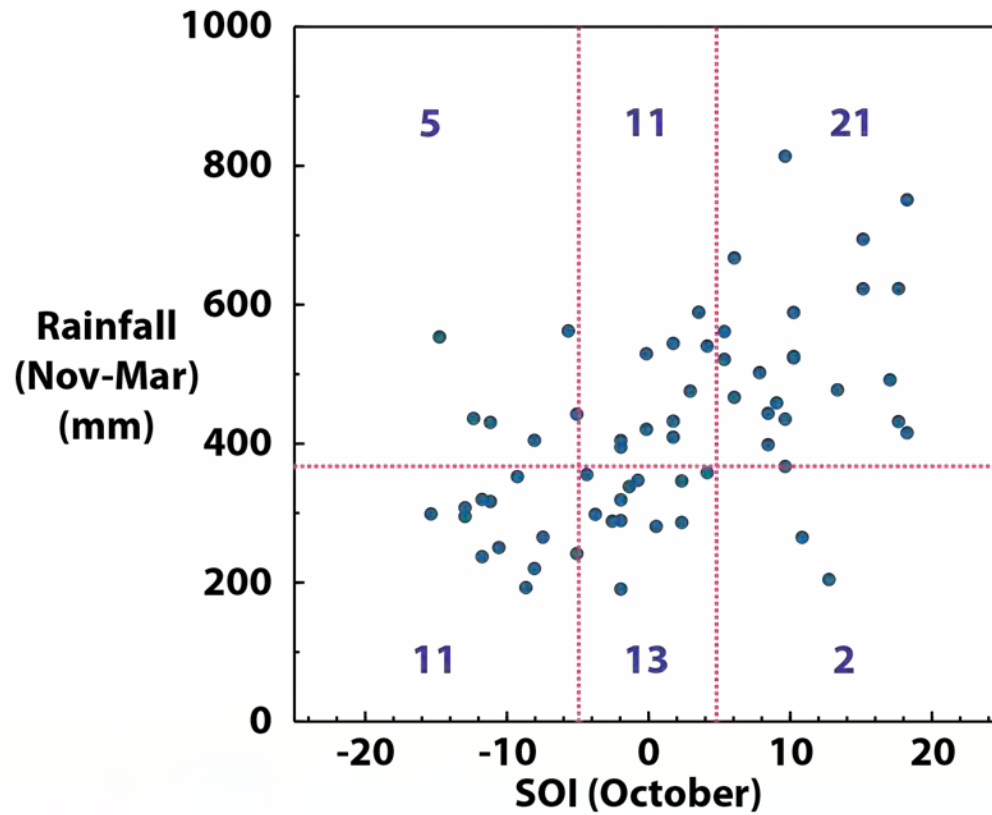
Lagged SOI and summer rainfall



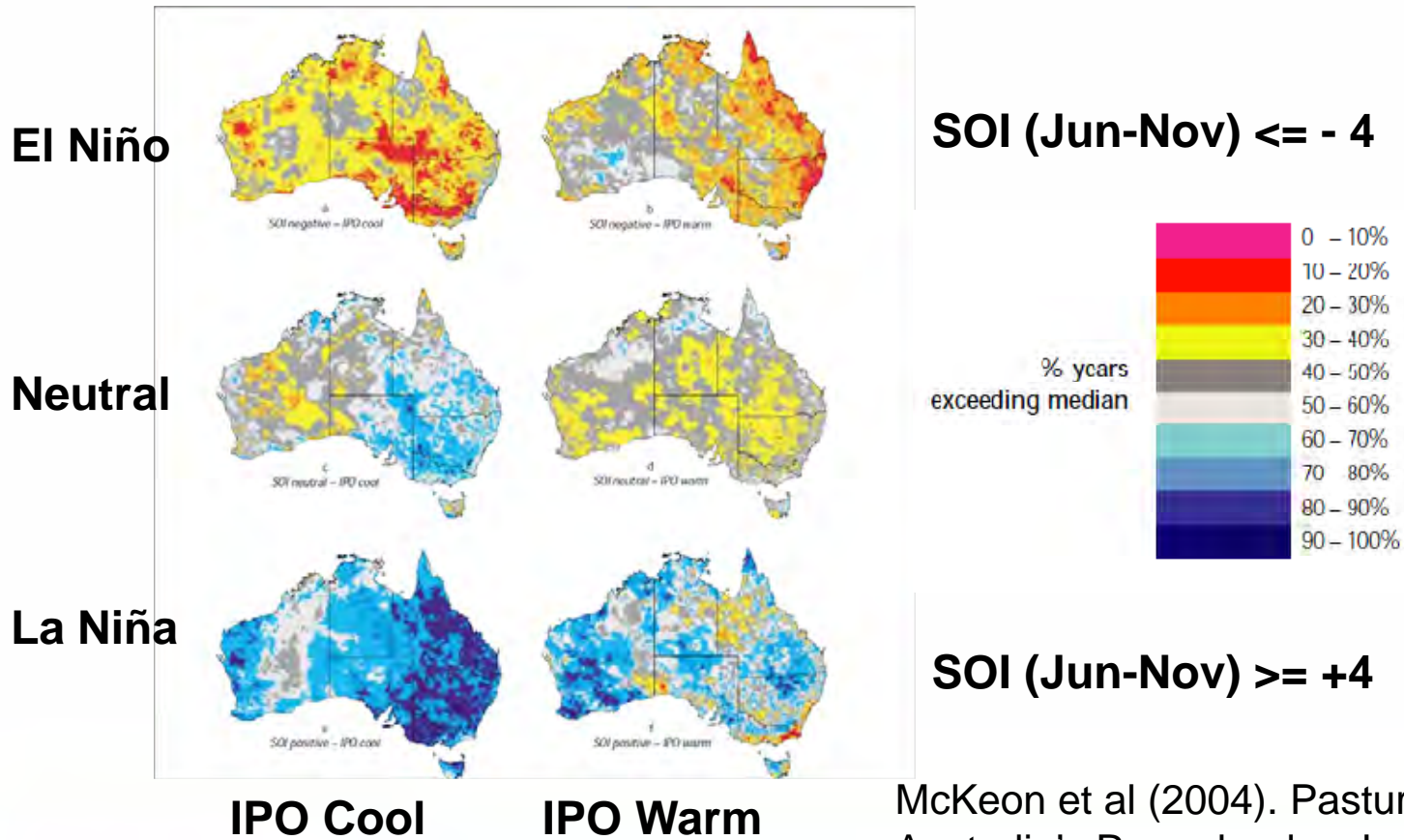
IPO Warm



IPO Cool



Australian Rainfall (March-April)



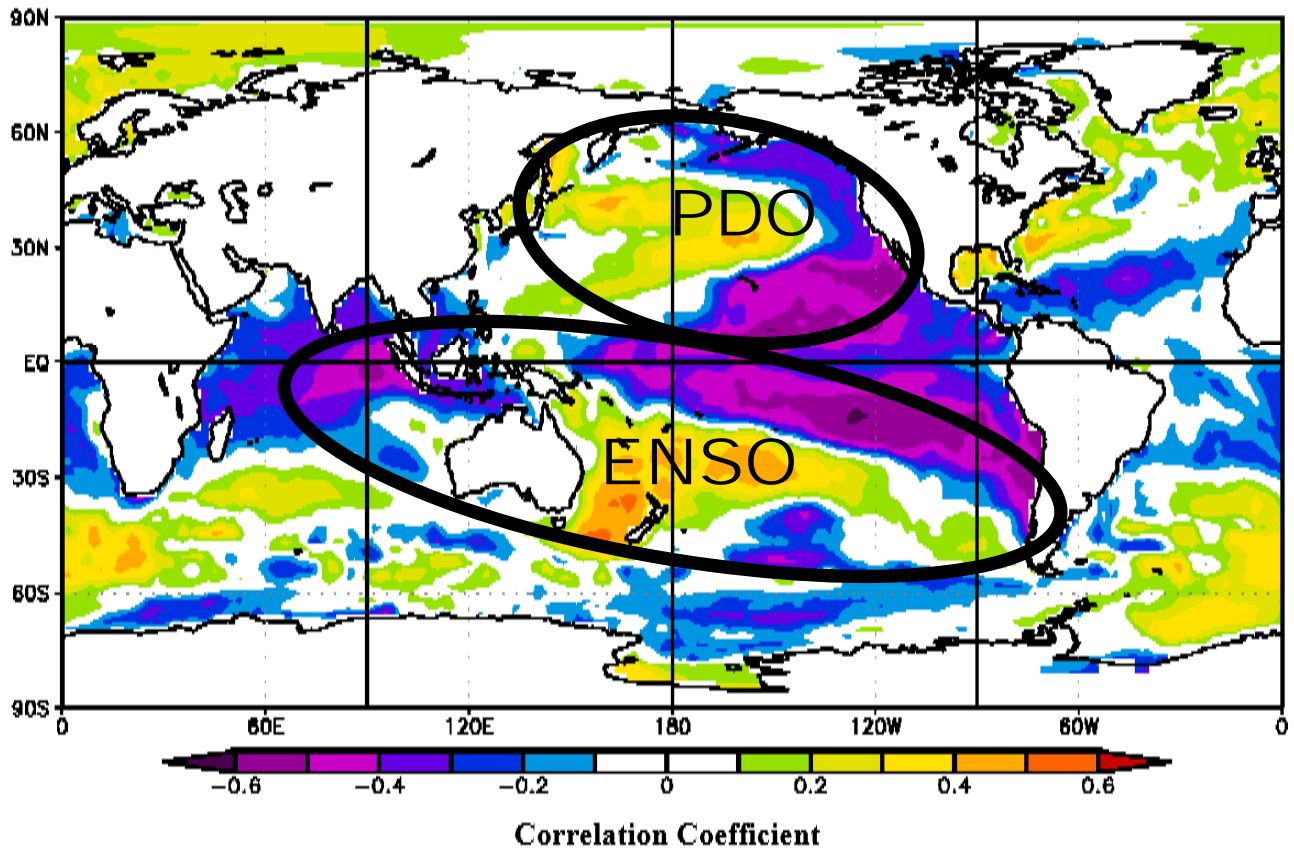
McKeon et al (2004). Pasture Degradation in Australia's Rangelands – Learning from History



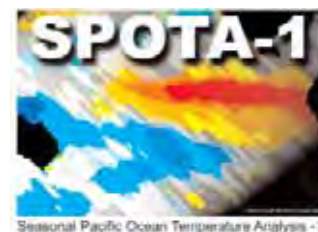
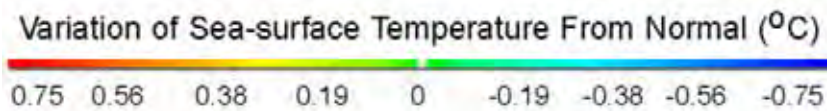
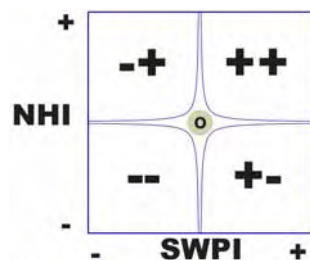
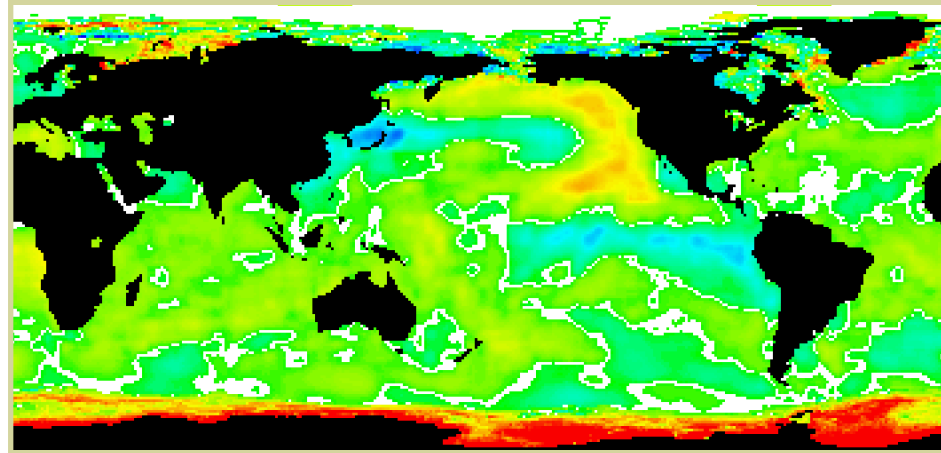
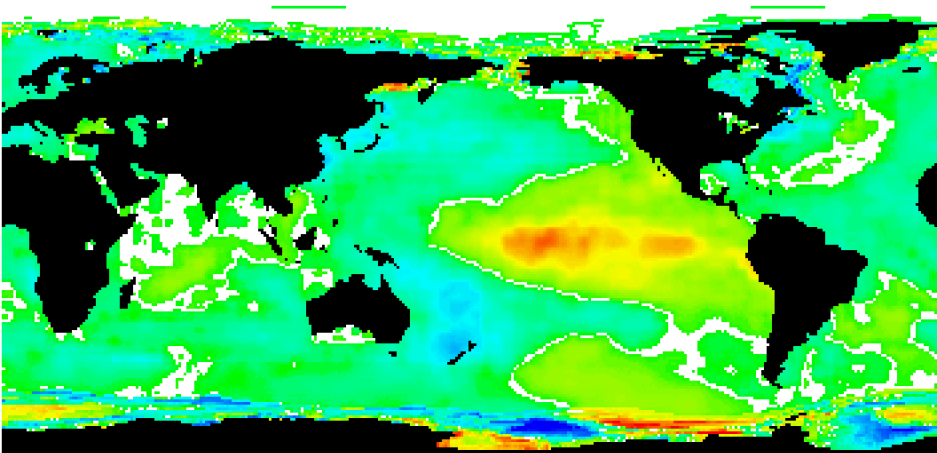
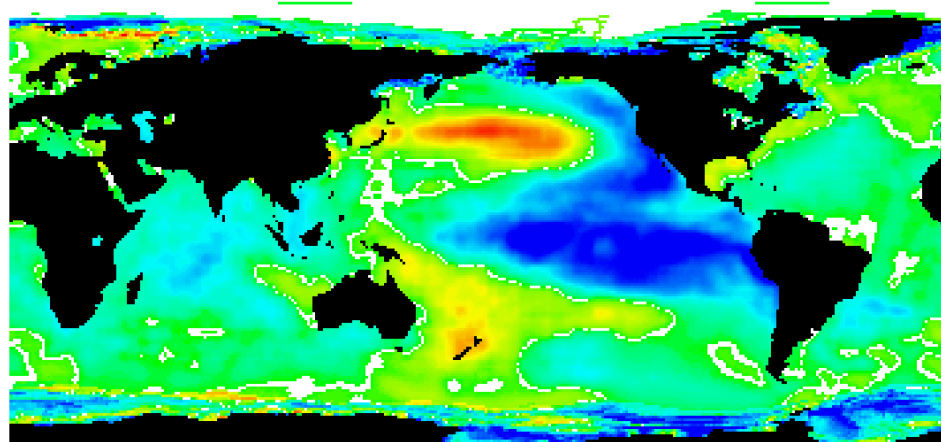
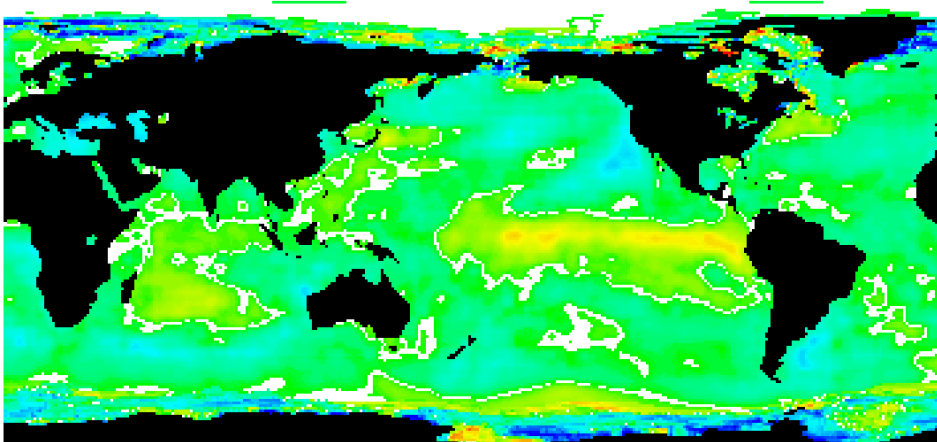
Correlation between Sea Surface Temperatures & Qld Summer Rainfall (Nov-Mar)

inter-decadal

inter-annual

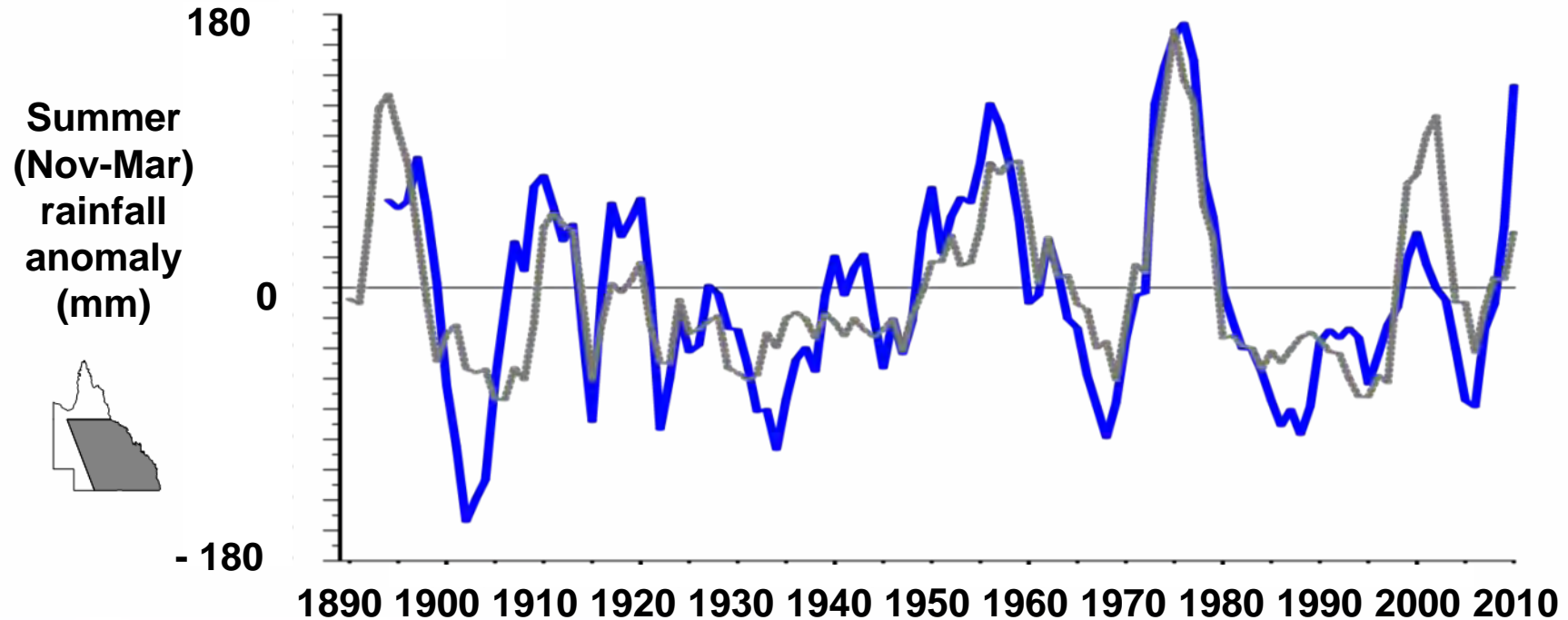


Seasonal Pacific Ocean Temperature Analysis -1



SPOTA-1

— 5 Yr Running Mean Grazing Lands Rainfall
- - - 5 Yr Running Mean SPOTA-1 Index



Crimp and Day (2003) **Evaluation of multi-decadal variability in rainfall for Queensland and other Australian rangeland regions using indices of El Niño-Southern Oscillation and inter-decadal variability** *Proceedings of the National Drought Forum: Science for Drought*, Brisbane, Queensland. pp.106-115.

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SPOTA-1 independent validation

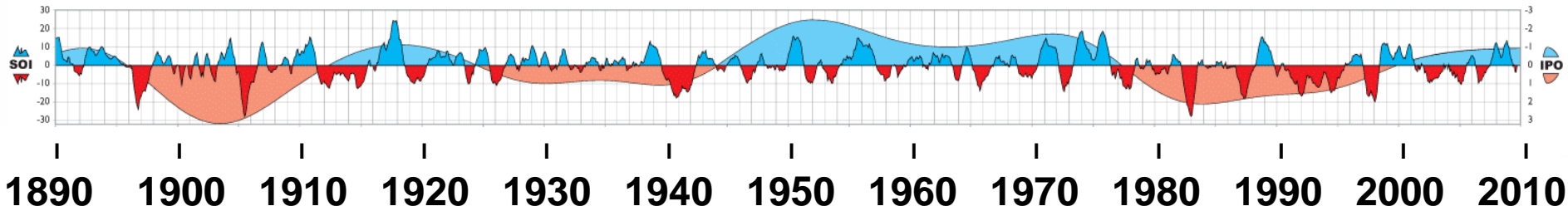


LEPS tercile skill score outlooks for summer (Nov-Mar) rainfall

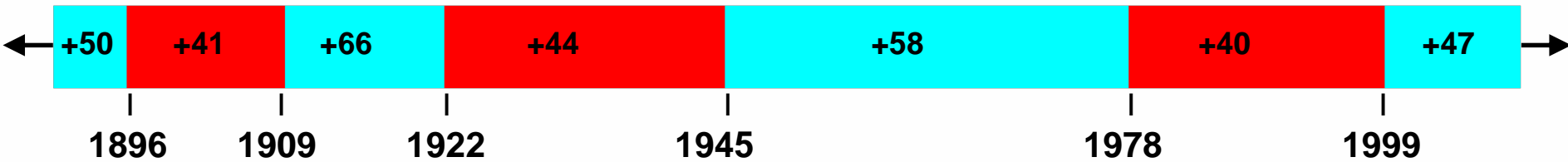
	Calibration	Independent validation	
	96 years LEPS skill 1900/01-1995/96	15 years LEPS skill 1996/97-2010/11	25 years LEPS skill 1890-99+1996-2010
Apr 1	30.8	32.4	22.4
Jun 1	41.7	44.2	36.6
Jul 1	40.1	47.1	34.8
Aug 1	39.1	35.4	31.3
Sep 1	46.4	53.0	40.1
Oct 1	48.5	55.9	55.9
Nov 1	49.5	44.2	48.9
Average	42.3	44.6	38.5



SPOTA-1



LEPS tercile skill score for SPOTA-1 (Oct) and rainfall (Nov-Mar)



Year IPO phase commences

IPO definition: Folland et al 1998 (data courtesy Andrew Coleman UKMO June 2000) consistent with: Power *et al* (1999). Inter-decadal modulation of the impact of ENSO on Australia, *Climate Dynamics* 15

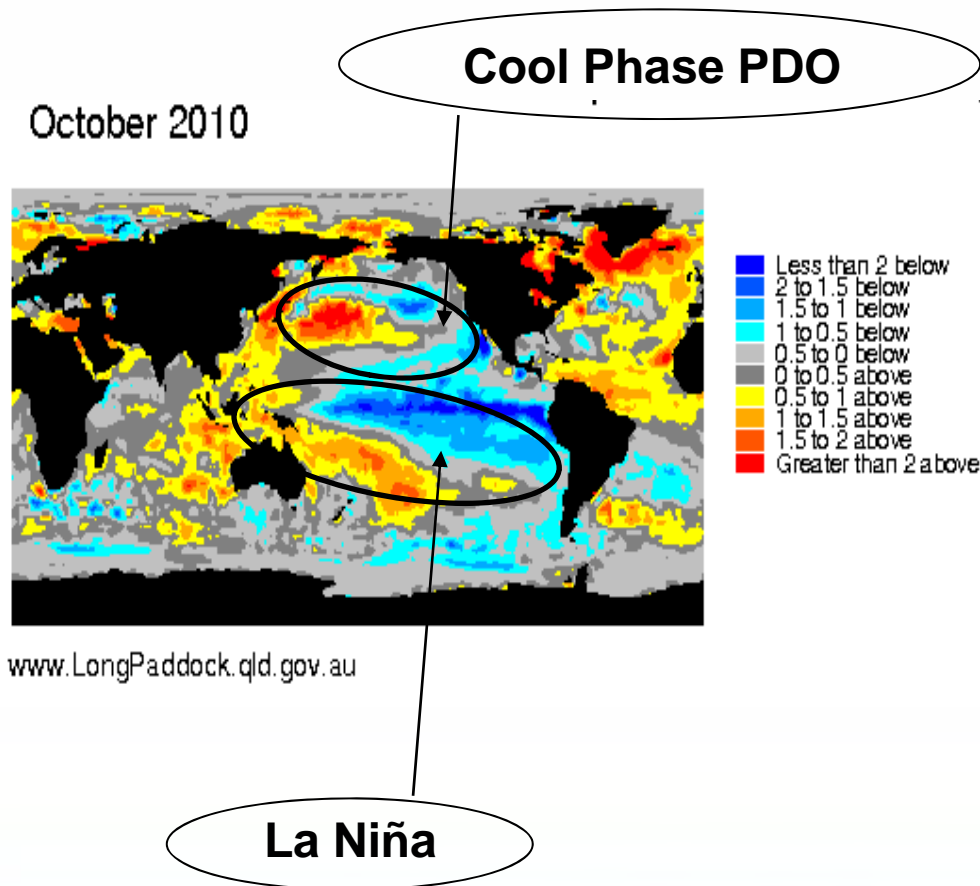
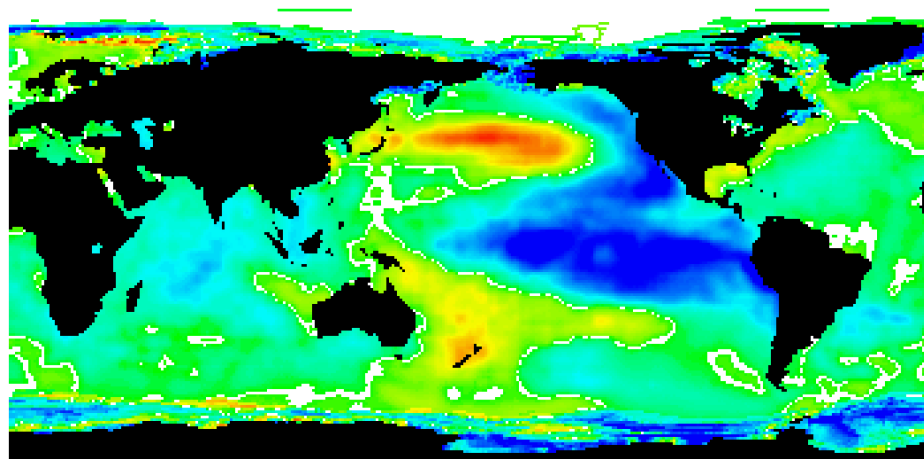
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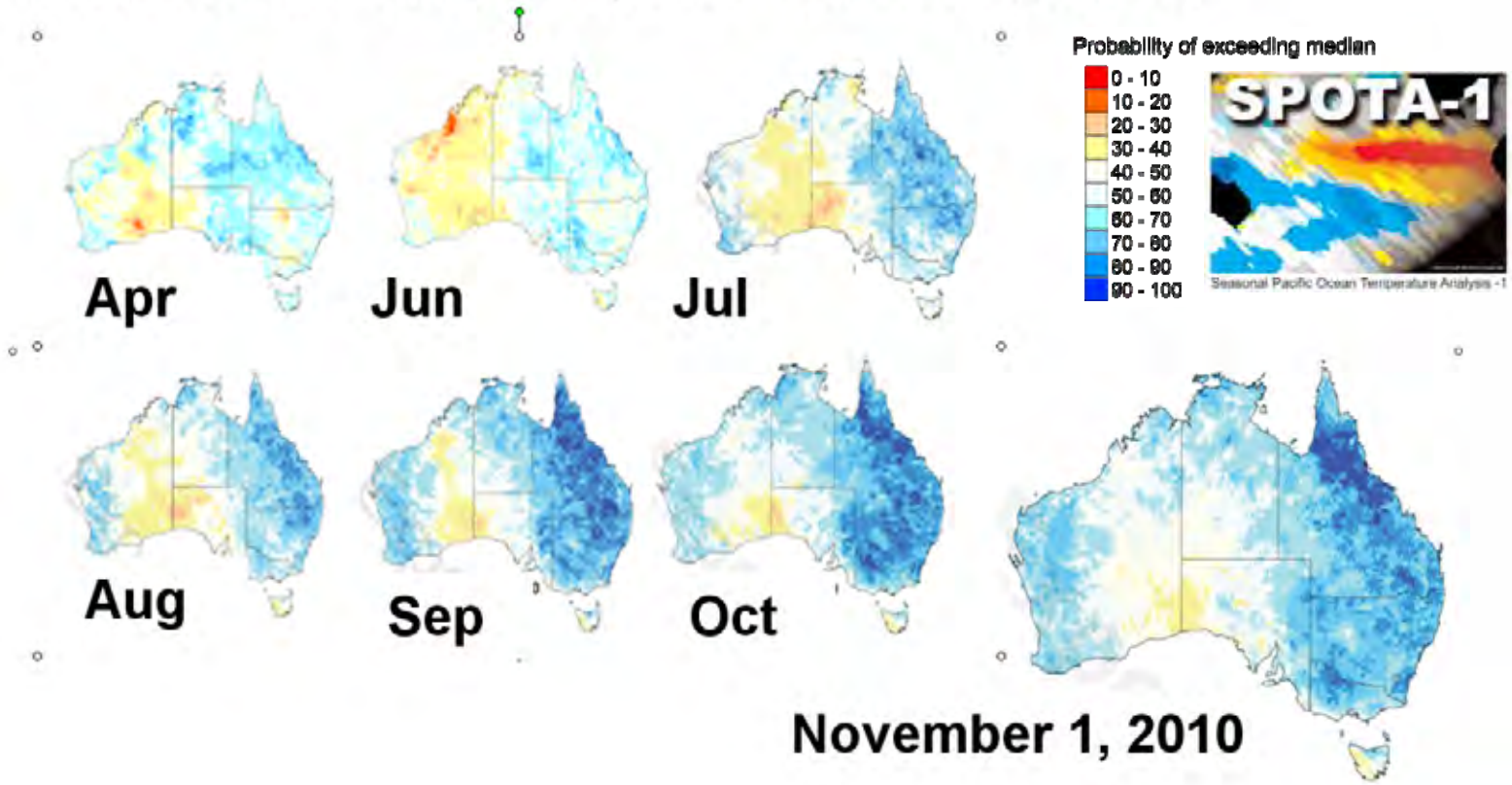
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SPOTA-1



SPOTA-1

Probability of Exceeding Median Summer Rainfall
November 2010 – March 2011, based on the SPOTA-1 Index



Seasonal Pacific Ocean Temperature Analysis -1 (SPOTA-1) as at November 1, 2010

Issued 11/01/2011 by
K.A. Day, D.G. Ahrens, A. Peacock
Queensland Climate Change Centre of Excellence
Queensland Department of Environment and Resource Management
Enquiries: Ken.A.Day@climatechange.qld.gov.au
Website: (www.LongPaddock.qld.gov.au)

A description of the SPOTA-1 Index is provided on the LongPaddock website (www.LongPaddock.qld.gov.au)

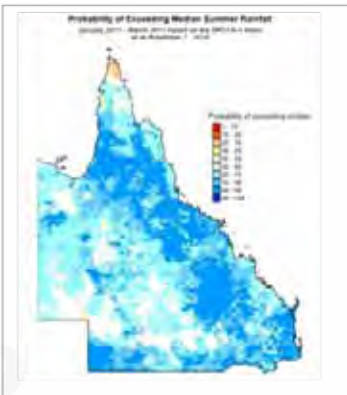
Current Indices

Current SPOTA-1 Index (0-100)	106
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SST Indices		SST Anomalies	
NHI ¹	0.38°C (as at April 1, 2010)	West of Norfolk	24.42°C
		Near Hawaii	24.05°C
SWPI ²	-6.88°C (as at Nov 1, 2010)	South-Western Pacific	20.31°C
		SPDZ	27.18°C

¹ The NHI is based on the difference in SST anomalies between the South-Western Pacific (near Norfolk Island) and the North Pacific (near Hawaii). The NHI is calculated once a year in March.

² The SWPI is based on the difference in SST anomalies between the South-Western Pacific (north of New Zealand) and the central equatorial Pacific (the South Pacific Dry Zone: SPDZ). The SWPI is calculated monthly from May through to October.



Rainfall probabilities for Queensland

Rainfall class	Probability of summer rainfall being in this class
Above-median ¹	Higher than normal for most parts of Queensland
Below-median ¹	Lower than normal for most parts of Queensland
Dry ²	Lower than normal for most parts of Queensland
Moderate ³	Lower than normal for most parts of Queensland
Wet ⁴	Higher than normal for most parts of Queensland

¹ Median rainfall, by definition, means the middle of the range of rainfall totals recorded for November to March between 1900 and 1999.
² Dry rainfall-by our definition, means the lowest 30% of rainfall totals recorded for November to March between 1900 and 1999.
³ Moderate rainfall, by our definition, means the middle 40% of rainfall totals recorded for November to March between 1900 and 1999.
⁴ Wet rainfall, by our definition, means the highest 30% of rainfall totals recorded for November to March between 1900 and 1999.

Other information attached (or see our web-page: www.LongPaddock.qld.gov.au)

- Historical analogue years (there are 19 analogue years this month)

Historical Years (1900-1999) in order of SPOTA-1 Index as at November 1, 2010

The current SPOTA-1 Index value is 95 (range 0-100)
 'Analogue' years have a calculated rainfall anomaly within 138.3 mm of the current calculated value of 202.7 mm
 Summer rainfall is averaged over the major grazing region in Queensland

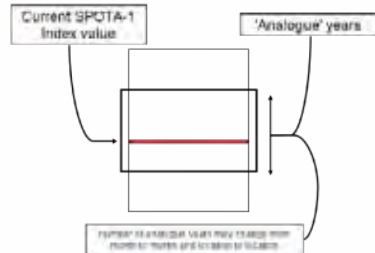
Year	Rainfall anomaly		SPOTA-1 Index ³	Percentile rank	Analogue Order
	Actual ¹ (mm)	Calculated ² (mm)			
1900	188.2	188.2	1	100	1
1901	187.2	187.2	2	99	2
1902	186.2	186.2	3	98	3
1903	185.2	185.2	4	97	4
1904	184.2	184.2	5	96	5
1905	183.2	183.2	6	95	6
1906	182.2	182.2	7	94	7
1907	181.2	181.2	8	93	8
1908	180.2	180.2	9	92	9
1909	179.2	179.2	10	91	10
1910	178.2	178.2	11	90	11
1911	177.2	177.2	12	89	12
1912	176.2	176.2	13	88	13
1913	175.2	175.2	14	87	14
1914	174.2	174.2	15	86	15
1915	173.2	173.2	16	85	16
1916	172.2	172.2	17	84	17
1917	171.2	171.2	18	83	18
1918	170.2	170.2	19	82	19
1919	169.2	169.2	20	81	20
1920	168.2	168.2	21	80	21
1921	167.2	167.2	22	79	22
1922	166.2	166.2	23	78	23
1923	165.2	165.2	24	77	24
1924	164.2	164.2	25	76	25
1925	163.2	163.2	26	75	26
1926	162.2	162.2	27	74	27
1927	161.2	161.2	28	73	28
1928	160.2	160.2	29	72	29
1929	159.2	159.2	30	71	30
1930	158.2	158.2	31	70	31
1931	157.2	157.2	32	69	32
1932	156.2	156.2	33	68	33
1933	155.2	155.2	34	67	34
1934	154.2	154.2	35	66	35
1935	153.2	153.2	36	65	36
1936	152.2	152.2	37	64	37
1937	151.2	151.2	38	63	38
1938	150.2	150.2	39	62	39
1939	149.2	149.2	40	61	40
1940	148.2	148.2	41	60	41
1941	147.2	147.2	42	59	42
1942	146.2	146.2	43	58	43
1943	145.2	145.2	44	57	44
1944	144.2	144.2	45	56	45
1945	143.2	143.2	46	55	46
1946	142.2	142.2	47	54	47
1947	141.2	141.2	48	53	48
1948	140.2	140.2	49	52	49
1949	139.2	139.2	50	51	50
1950	138.2	138.2	51	50	51
1951	137.2	137.2	52	49	52
1952	136.2	136.2	53	48	53
1953	135.2	135.2	54	47	54
1954	134.2	134.2	55	46	55
1955	133.2	133.2	56	45	56
1956	132.2	132.2	57	44	57
1957	131.2	131.2	58	43	58
1958	130.2	130.2	59	42	59
1959	129.2	129.2	60	41	60
1960	128.2	128.2	61	40	61
1961	127.2	127.2	62	39	62
1962	126.2	126.2	63	38	63
1963	125.2	125.2	64	37	64
1964	124.2	124.2	65	36	65
1965	123.2	123.2	66	35	66
1966	122.2	122.2	67	34	67
1967	121.2	121.2	68	33	68
1968	120.2	120.2	69	32	69
1969	119.2	119.2	70	31	70
1970	118.2	118.2	71	30	71
1971	117.2	117.2	72	29	72
1972	116.2	116.2	73	28	73
1973	115.2	115.2	74	27	74
1974	114.2	114.2	75	26	75
1975	113.2	113.2	76	25	76
1976	112.2	112.2	77	24	77
1977	111.2	111.2	78	23	78
1978	110.2	110.2	79	22	79
1979	109.2	109.2	80	21	80
1980	108.2	108.2	81	20	81
1981	107.2	107.2	82	19	82
1982	106.2	106.2	83	18	83
1983	105.2	105.2	84	17	84
1984	104.2	104.2	85	16	85
1985	103.2	103.2	86	15	86
1986	102.2	102.2	87	14	87
1987	101.2	101.2	88	13	88
1988	100.2	100.2	89	12	89
1989	99.2	99.2	90	11	90
1990	98.2	98.2	91	10	91
1991	97.2	97.2	92	9	92
1992	96.2	96.2	93	8	93
1993	95.2	95.2	94	7	94
1994	94.2	94.2	95	6	95
1995	93.2	93.2	96	5	96
1996	92.2	92.2	97	4	97
1997	91.2	91.2	98	3	98
1998	90.2	90.2	99	2	99
1999	89.2	89.2	100	1	100

¹Actual rainfall anomaly - Rainfall anomaly for Queensland grazing region
²Calculated rainfall anomaly - Rainfall anomaly calculated from NHI and SWPI
³SPOTA-1 Index - Percentile rank of calculated rainfall

The major grazing region in Queensland:



Markings on table:



Shading on table:

Wet 30% of summers
Average 40% of summers
Dry 30% of summers

Probability of 'wet', 'dry' or 'average' summer

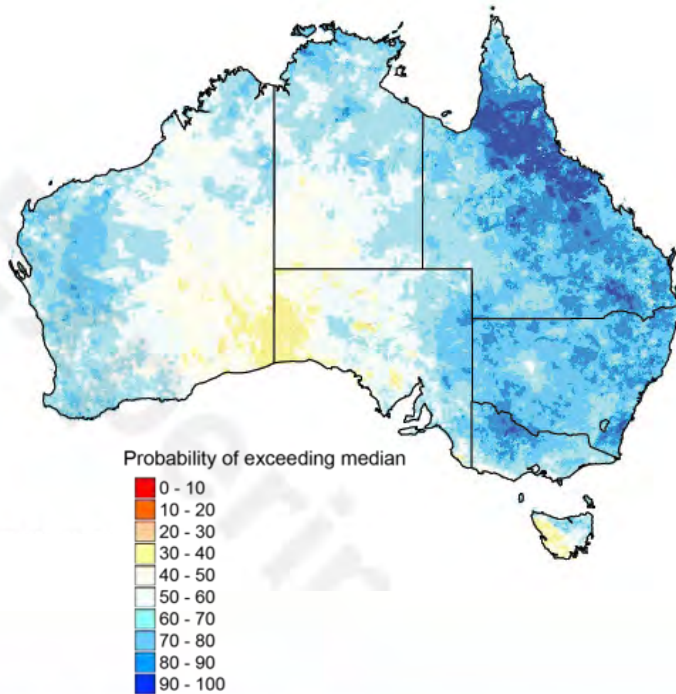


Percent of years in this category (B) (wet) or (C) NOT (black) significantly different (p=0.05) from 'all' years

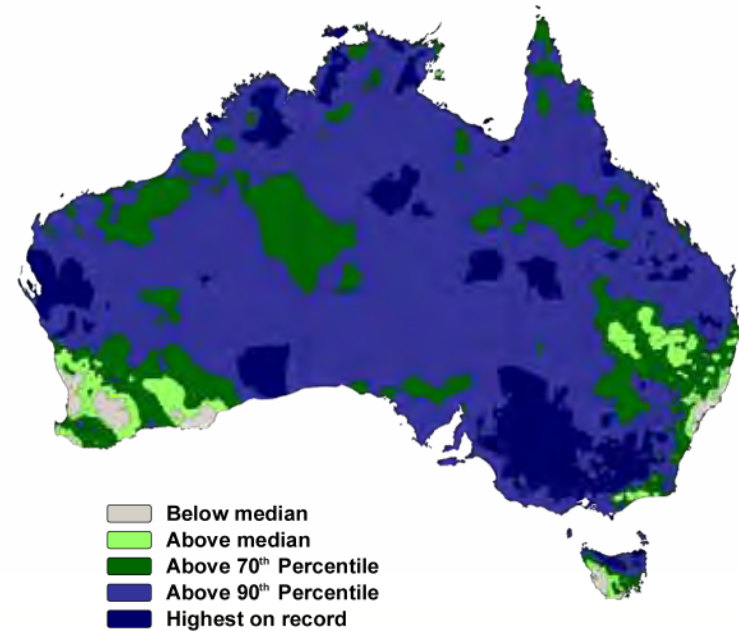


SPOTA-1

Outlook November 1, 2010



Rainfall Nov-Mar, 2010-11



Conclusions

- Inter-decadal fluctuations in Queensland's summer rainfall, as well as inter-decadal fluctuations in the relationship between the SOI and rainfall, are associated with a shift in the frequency distribution of SOI values between 'IPO-Warm' and 'IPO-Cool' phases, coupled with a non-linear relationship between the SOI and rainfall
- Assessment of rainfall probabilities based on simple (e.g. tercile) classifications of rainfall and SOI values is therefore problematic, particularly for high SOI values
- However this may not mean the 'end of the world' for statistically-based climate risk assessments
- In fact, gaining a measure of the 'IPO' through direct SST observations can overcome problems associated with non-stationarity in the ENSO-rainfall relationship and improve both the lead time and accuracy of statistically based climate risk assessment.



Thank you

Questions?

