Key drivers of Tasmanian climate variability - a brief overview

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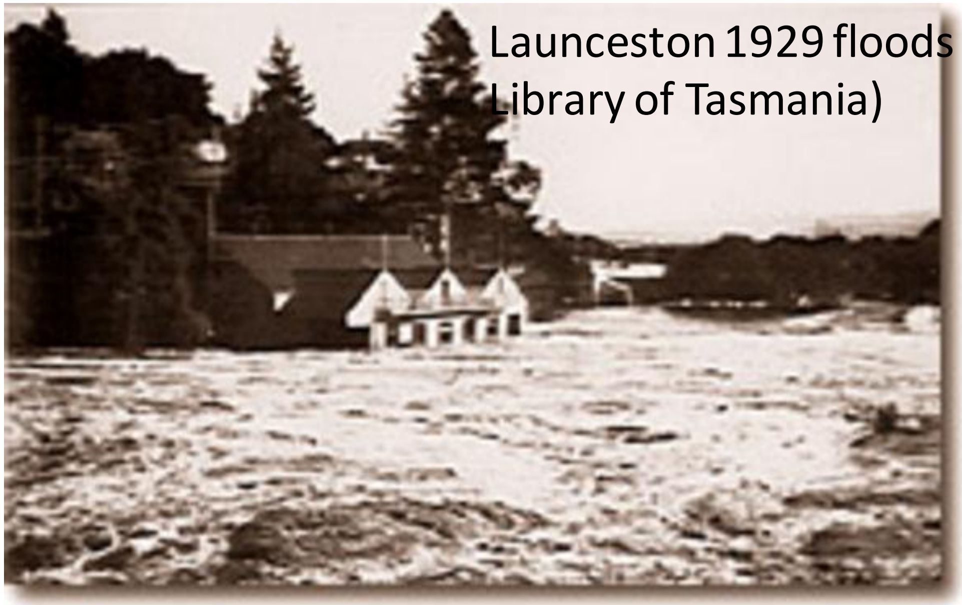
Recent Headlines

Weather Bureau confirms the driest spring on record for Tasmania (ABC)

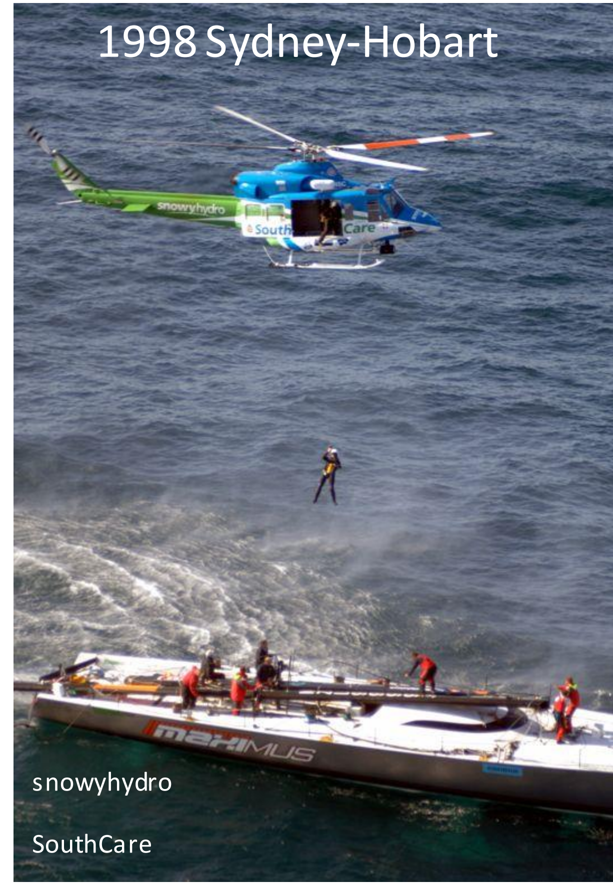
Winter's arrival snaps state's record warm spell (The Mercury)

Wild weather lashes state's North as rivers flood, towns are evacuated and storm warnings mount (The Mercury)

'Old Headlines'



Launceston 1929 floods (State Library of Tasmania)



1998 Sydney-Hobart

snowyhydro

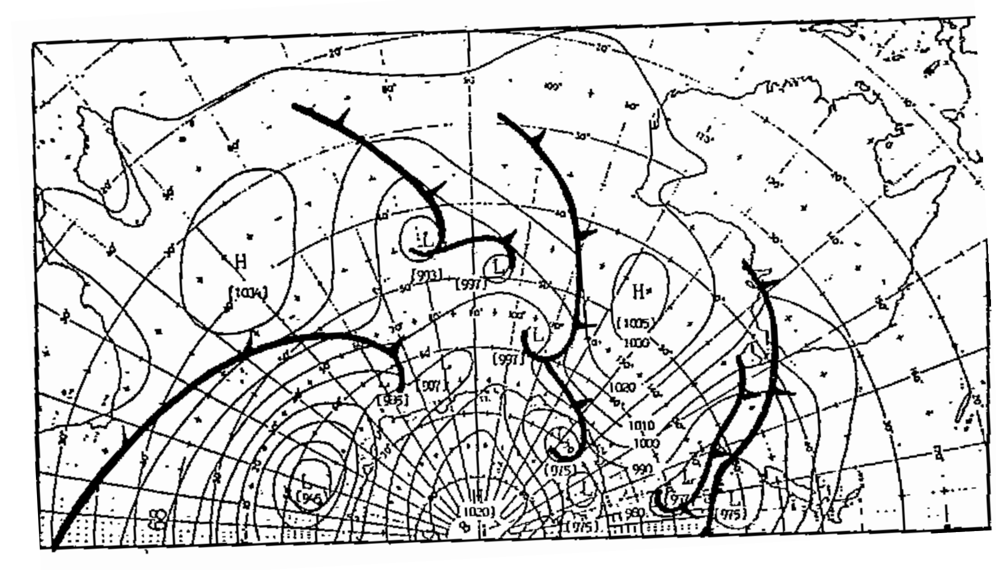
SouthCare

Hobart 1960 floods (The Mercury)

ABC
Catalyst

Cold Outbreak – Heavy Snow 24-25 July 1986

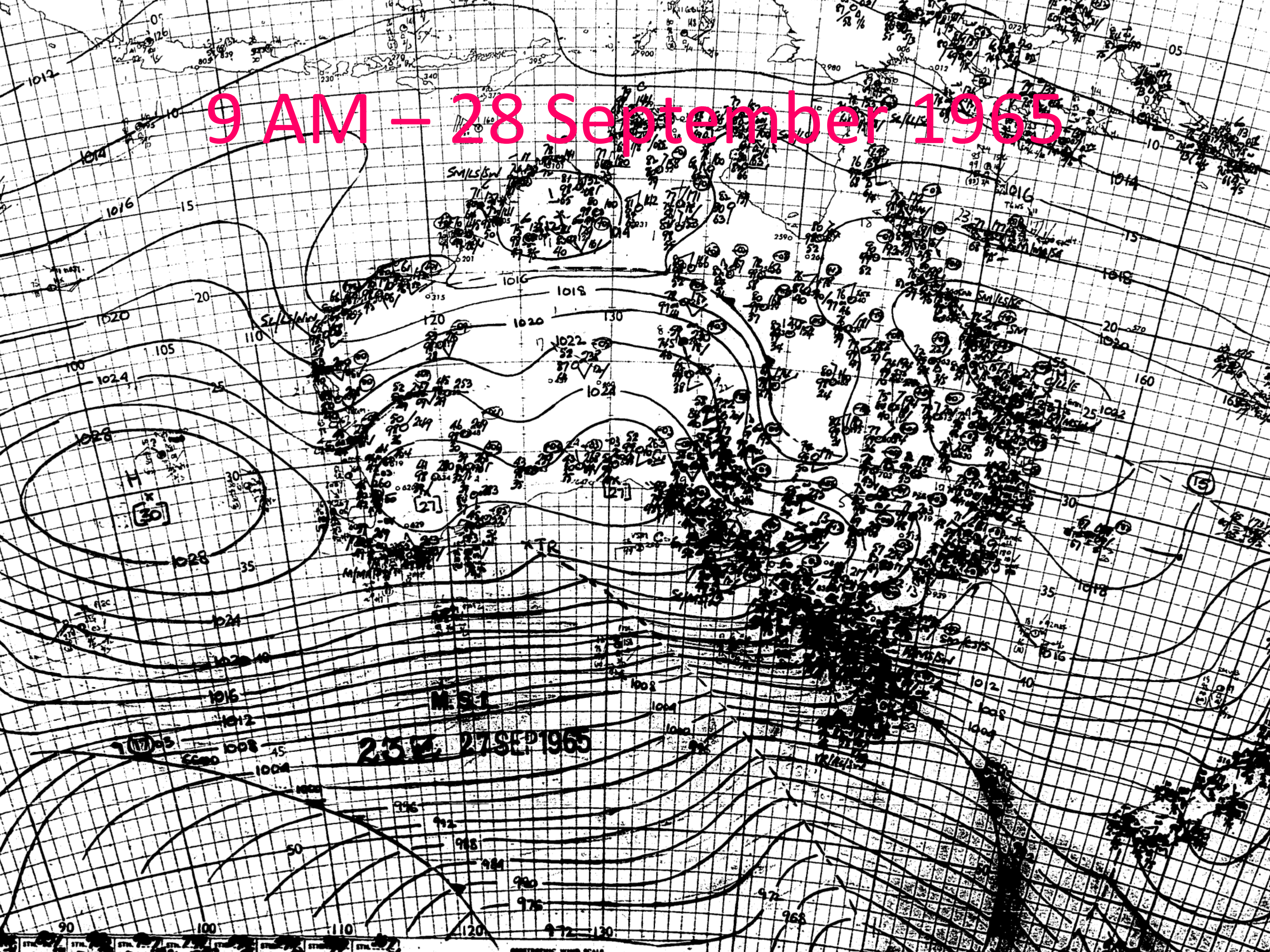
- Snow to 8 cm depth in Hobart at 0900
- SW/Southerly gales from high southern latitudes



12 Noon, 24 July 1986

Violent Winds

- Gales 28 September 1965 – Record maximum gust of 150 kph measured at Hobart
- Tornadoes in NW Tasmania on 22 November 1992


9 AM – 28 September 1965
M.S.L.
23Z 27 SEP 1965
H
1028
1024
1020
1016
1012
1008
1004
1000
996
992
988
984
980
976
972
968

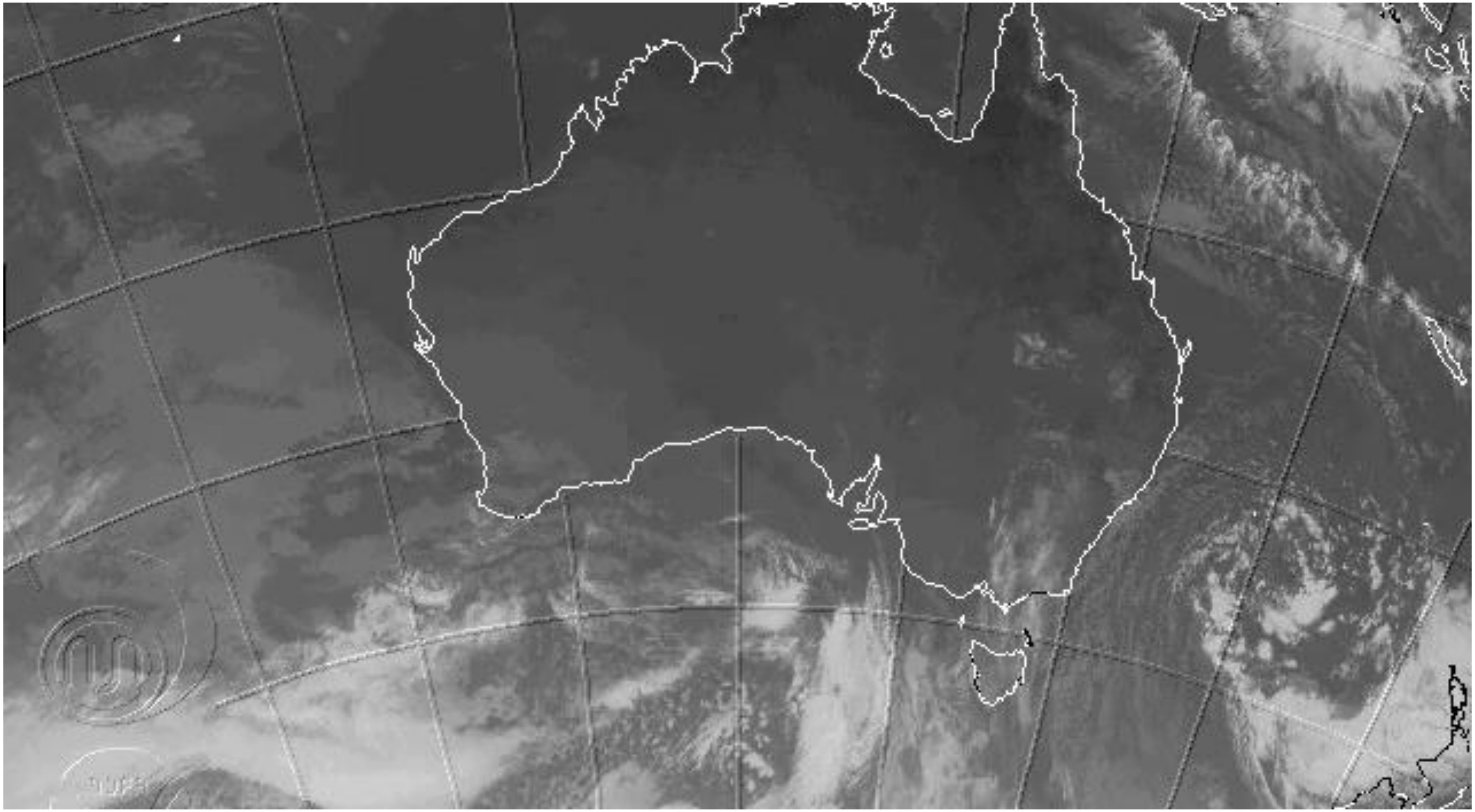
Scales of Variability

- Atmospheric variability occurs on a wide range of time scales – seconds, hours, days, months, seasons, years, decades, centuries, milennia…
- Atmospheric variability also occurs across a range of spatial scales

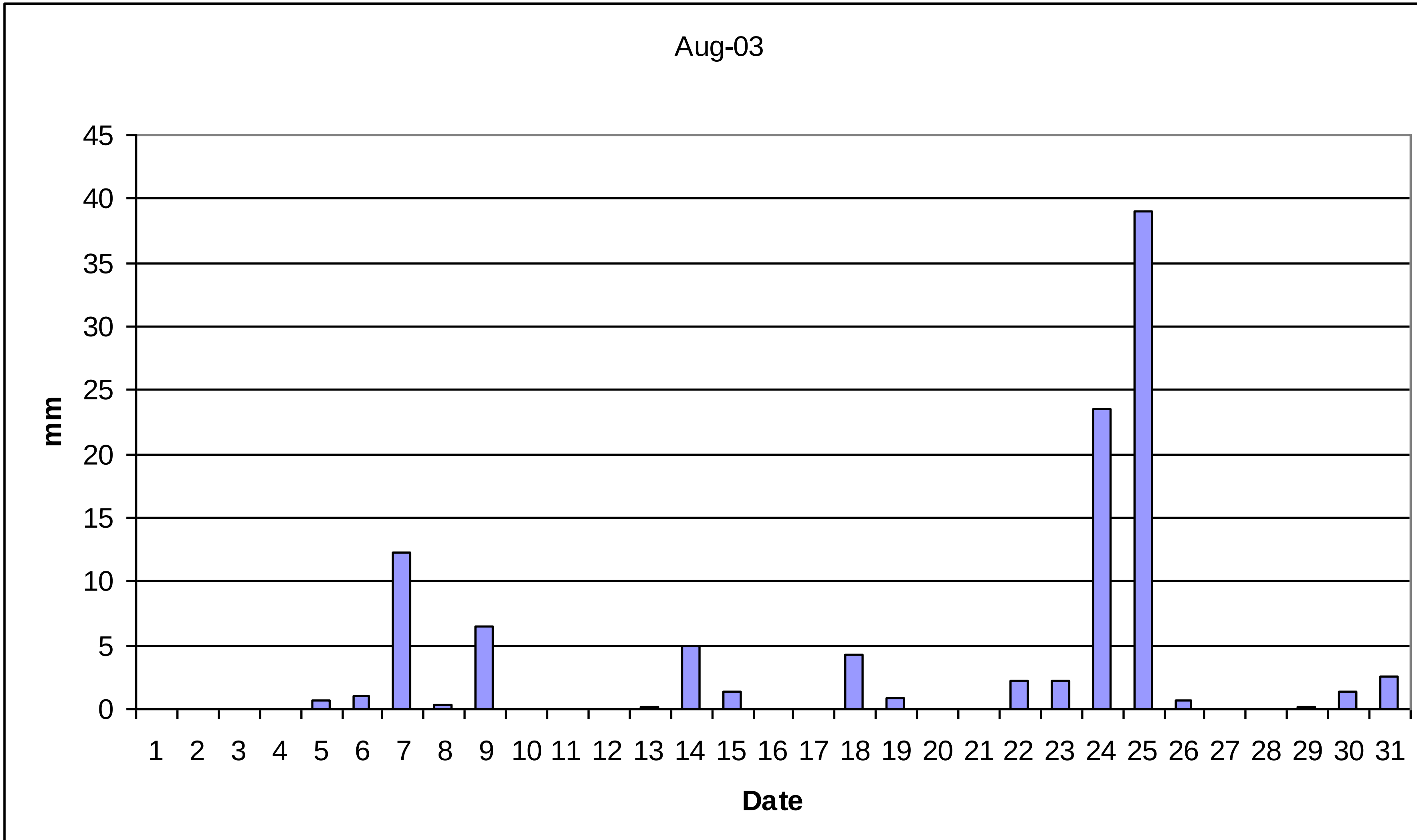
Spatial Scale in Meteorology

- Global
- Broad-scale – hemispheric
- Synoptic – approximately the size of continents and oceans
- Meso-scale – e.g. fronts, clusters or lines of thunderstorms
- Micro-scale – e.g. crops in a paddock, a forest, tornadoes

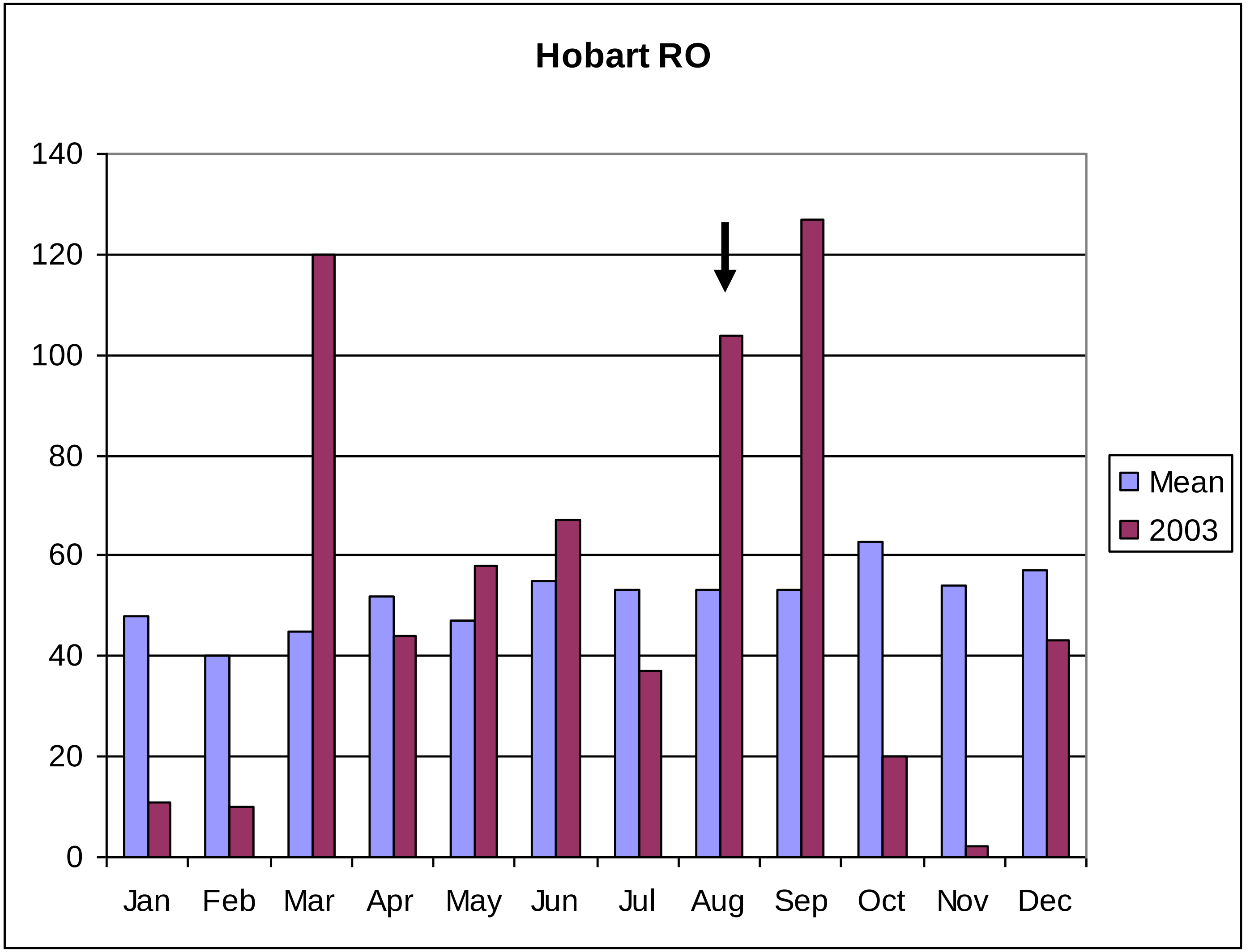
August 2003 – GMS IR Sequence

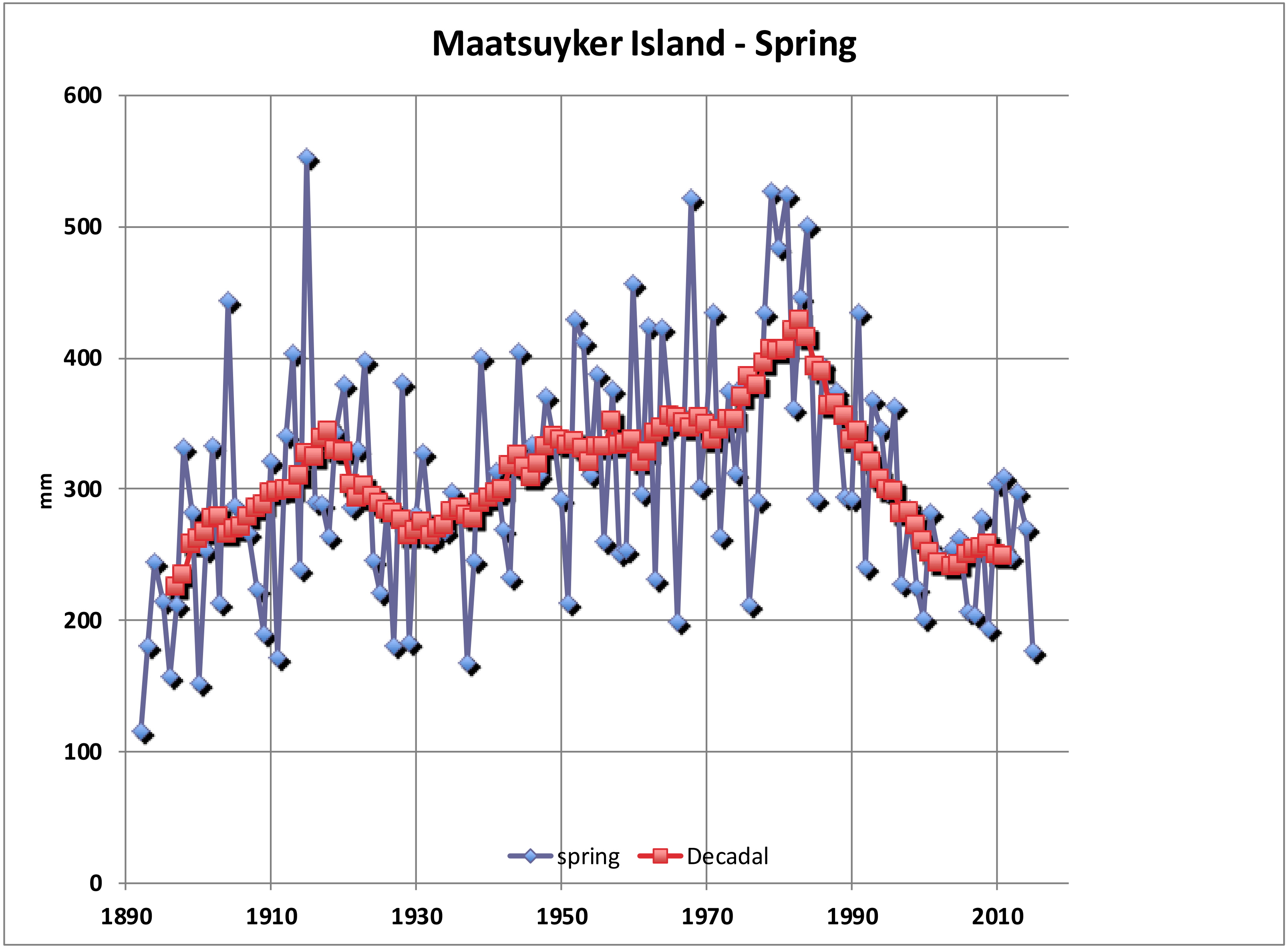


Hobart RO – August 2003



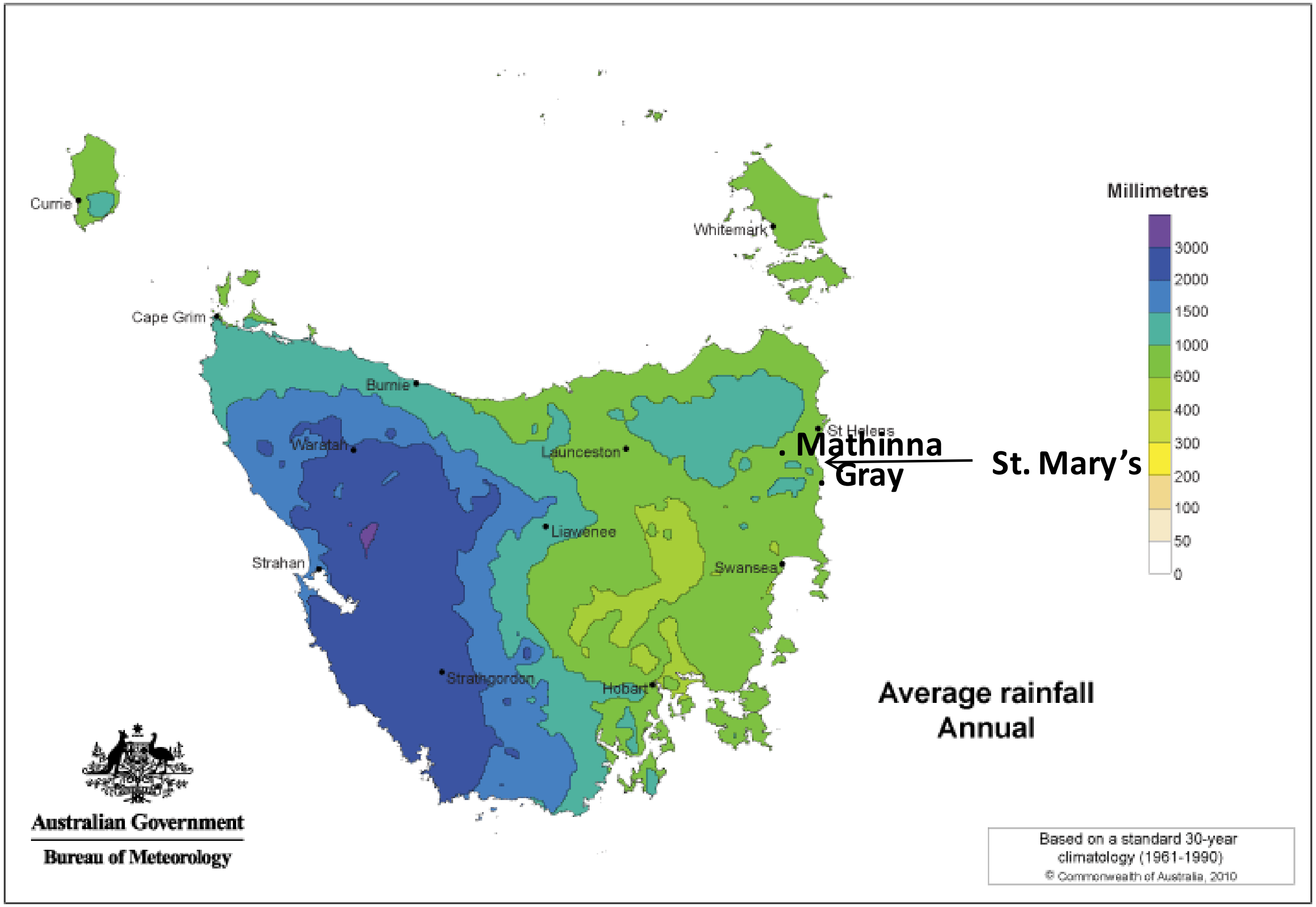
Hobart RO Monthly Rainfall - 2003





Maatsuyker Island - Spring
600
500
400
300
200
100
0
mm
1890
1910
1930
1950
1970
1990
2010
spring
Decadal

Annual Rainfall



Highest Daily Rainfall (Bureau of Meteorology)

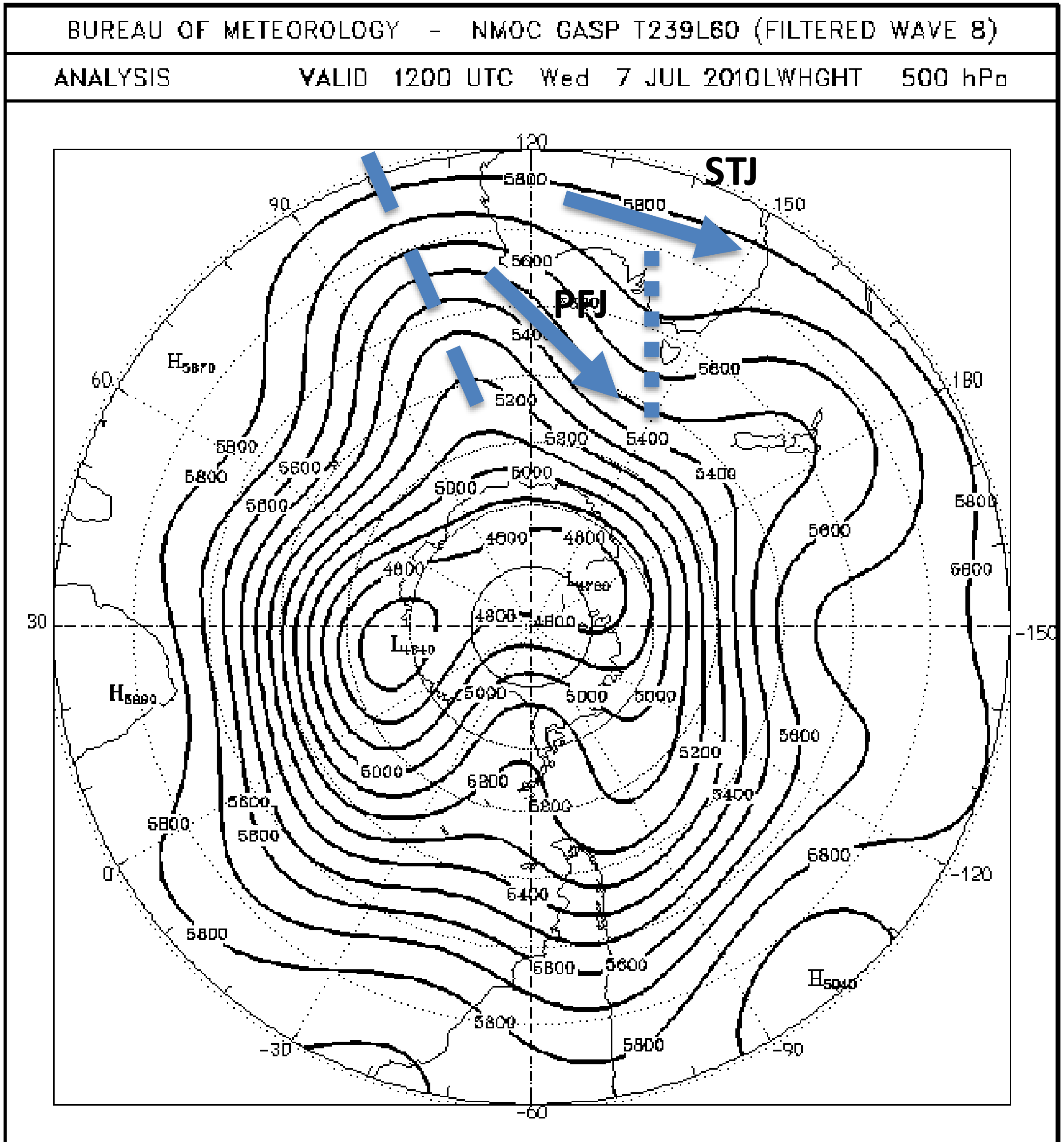
Rank	Rainfall (mm)	Date	Place name	Latitude	Longitude
1	352.0	22 March 1974	St Marys (Cullenswood)	−41.59	148.13
2	336.6	5 April 1929	Mathinna	−41.47	147.89
3	327.2	24 March 2011	Gray (Dalmayne Rd)	−41.63	148.23

Weather v. Climate

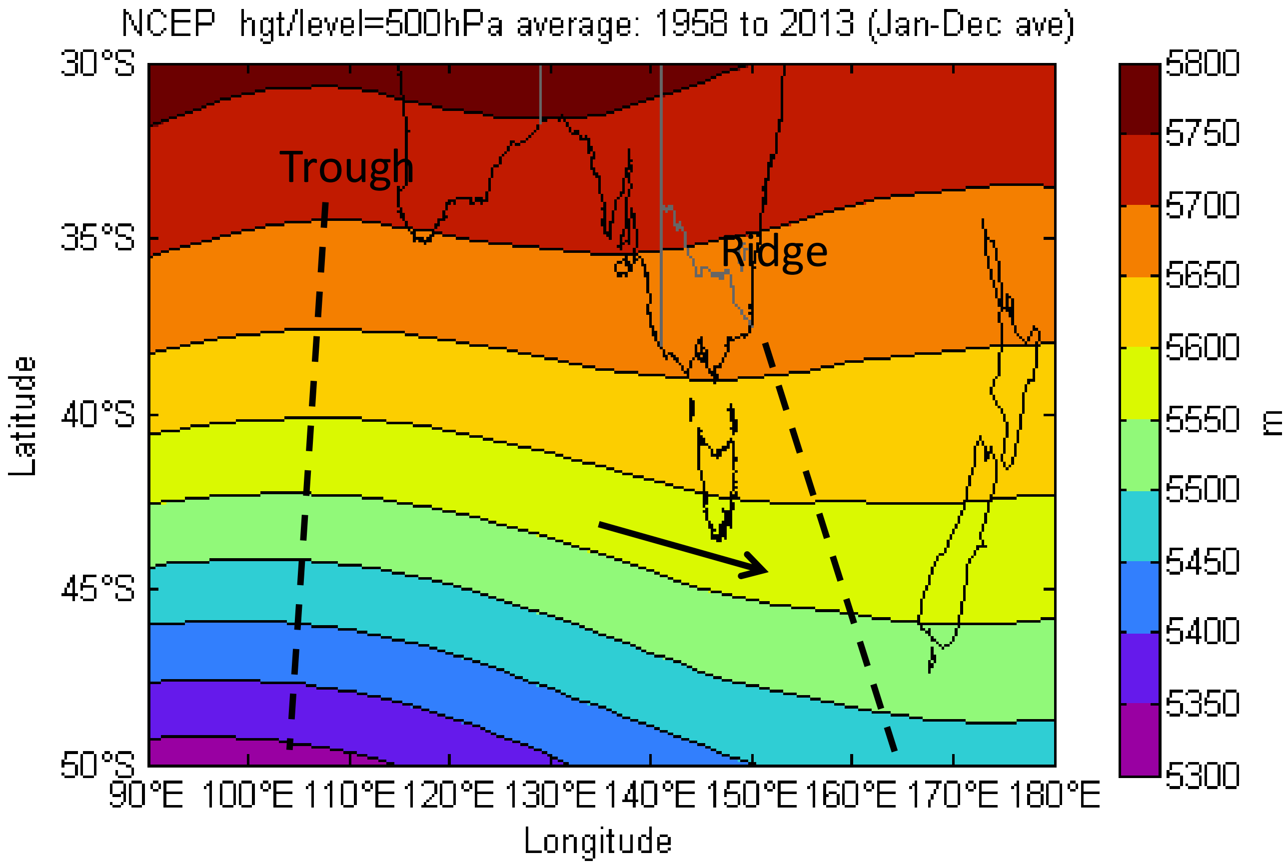
- Weather
  - short timescale (up to 10 days)
  - distinct features - highs, lows, fronts etc
  - is predictable (in theory!) – until 'chaos' intervenes
- Climate
  - longer timescale (months to centuries)
  - averaged over many weather systems
  - individual features not predictable
  - average may be predictable (using statistics or computer models)!
- Climate variability v. Climate change
  - natural variability on all timescales (interannual, decadal etc)
  - natural climate drift and secular changes (long timescale, but can affect shorter timescales)
  - human-induced change

Key Modes of Climate Variability

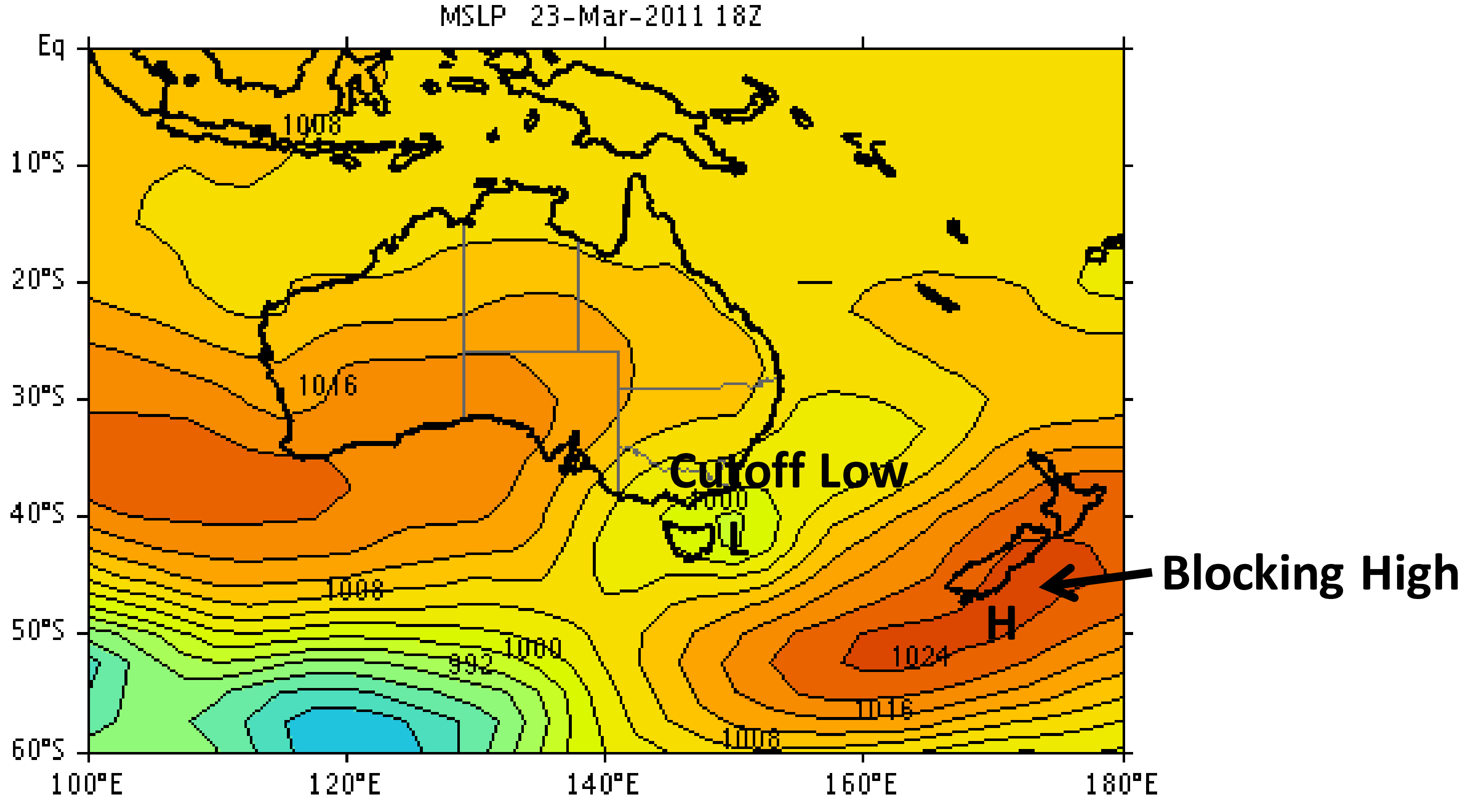
- Atmospheric Long-Wave Pattern (including blocking)
- Seasonal Cycle
- El Niño-Southern Oscillation (ENSO)
- Southern Annular Mode (SAM)
- Indian Ocean Dipole (IOD)
- Madden-Julian Oscillation (MJO)


BUREAU OF METEOROLOGY - NMOC GASP T239L60 (FILTERED WAVE 8)
ANALYSIS VALID 1200 UTC Wed 7 JUL 2010LWHGHT 500 hPa
STJ
PFJ

Annual Mean 500 hPa Geopotential (approx 6 km)

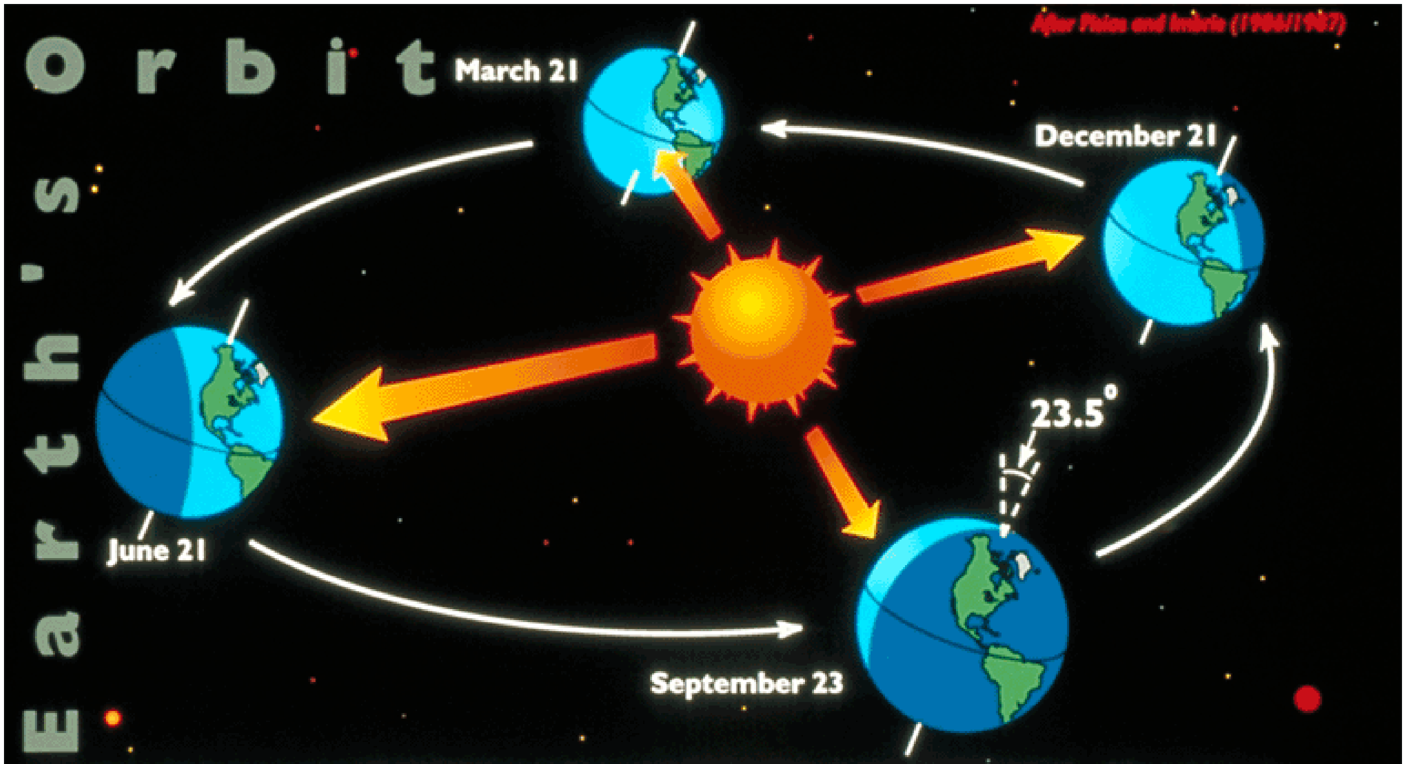


MSLP – 24 March 2011



NCEP 1 Reanalysis

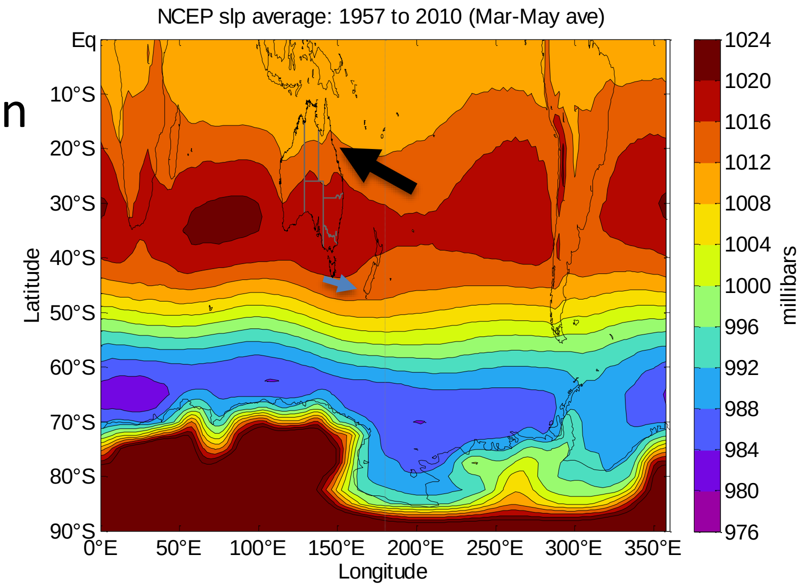
The Solar Radiation Cycle



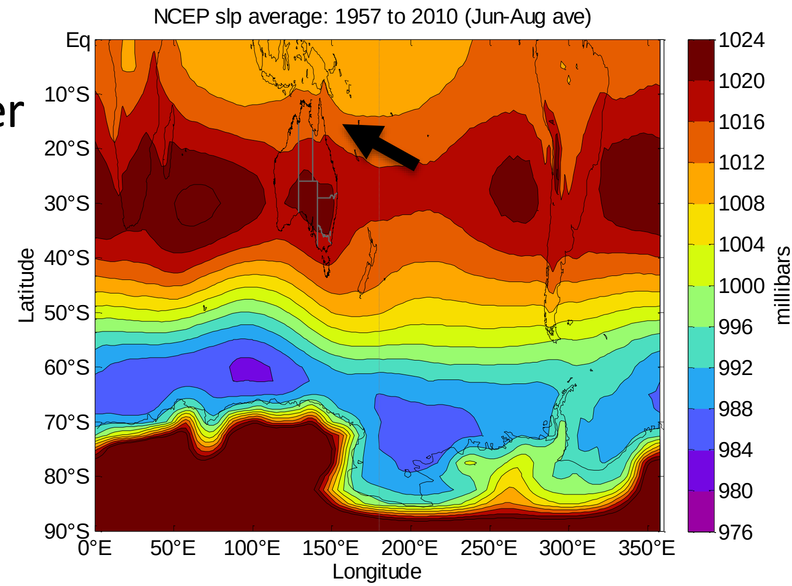
After Pisias & Imbrie (1986/87)

Seasonal Cycle of MSLP in SH

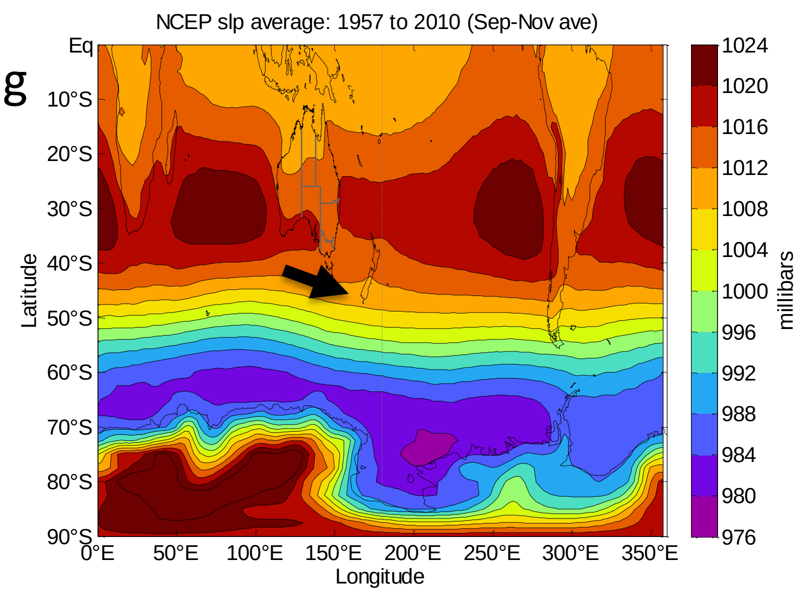
autumn



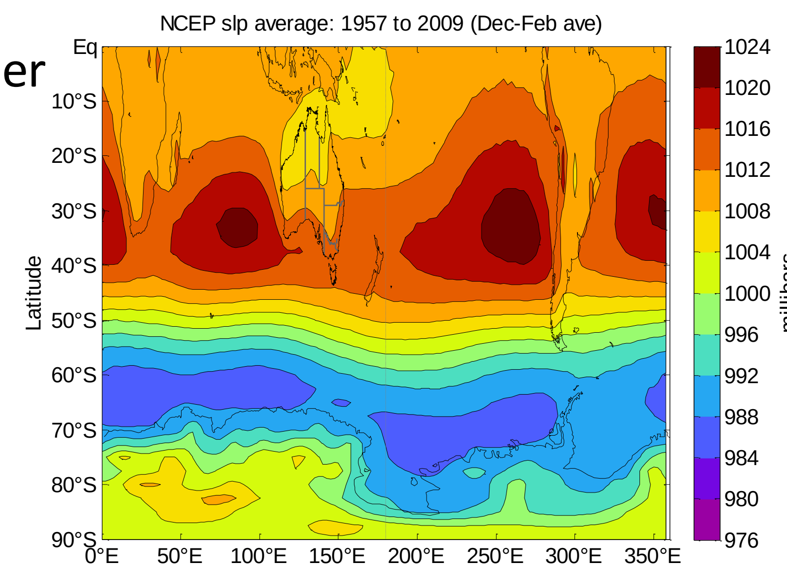
winter



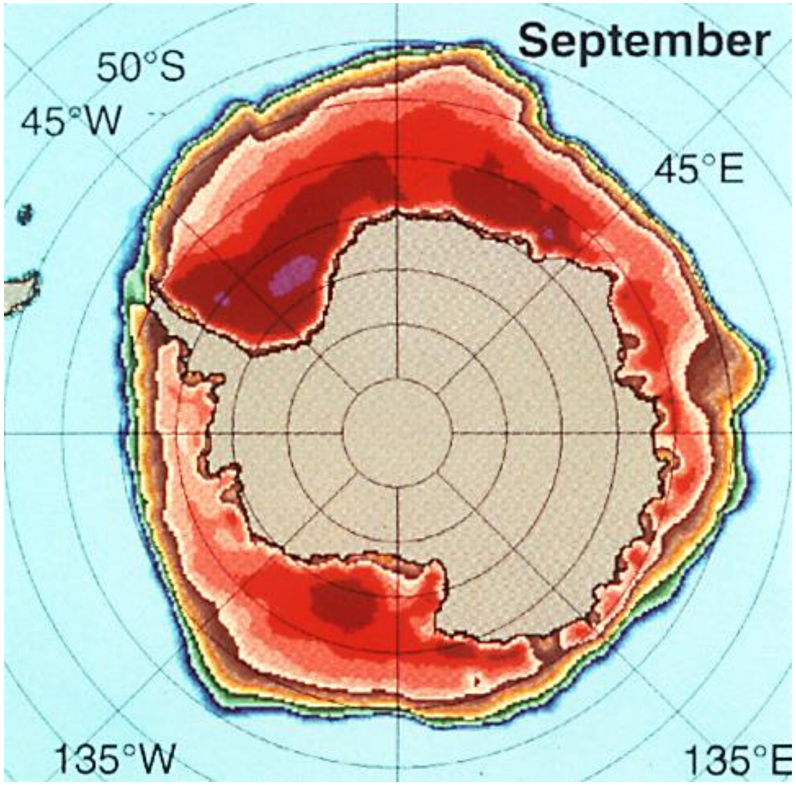
spring

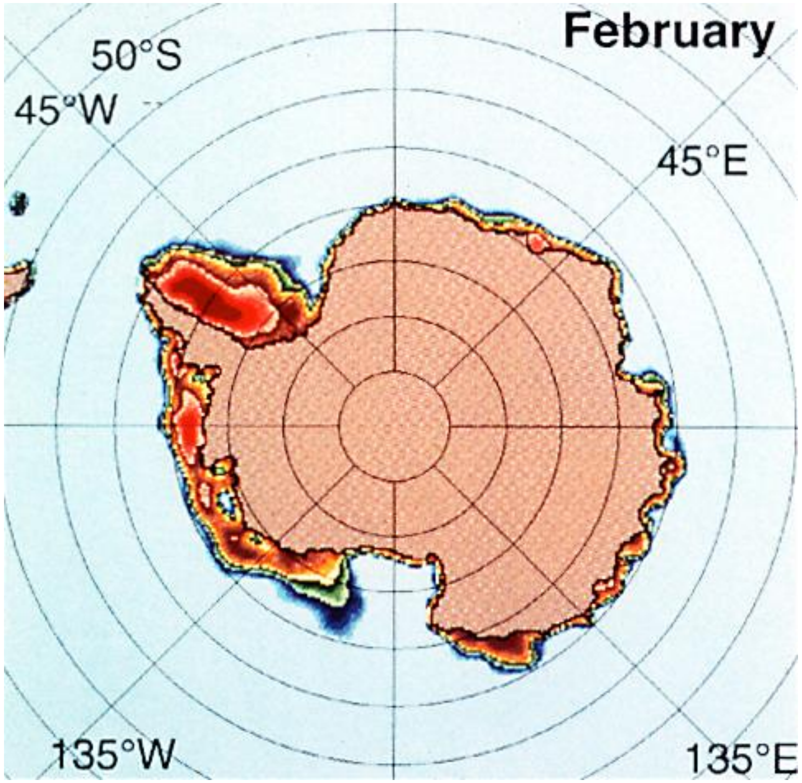


summer



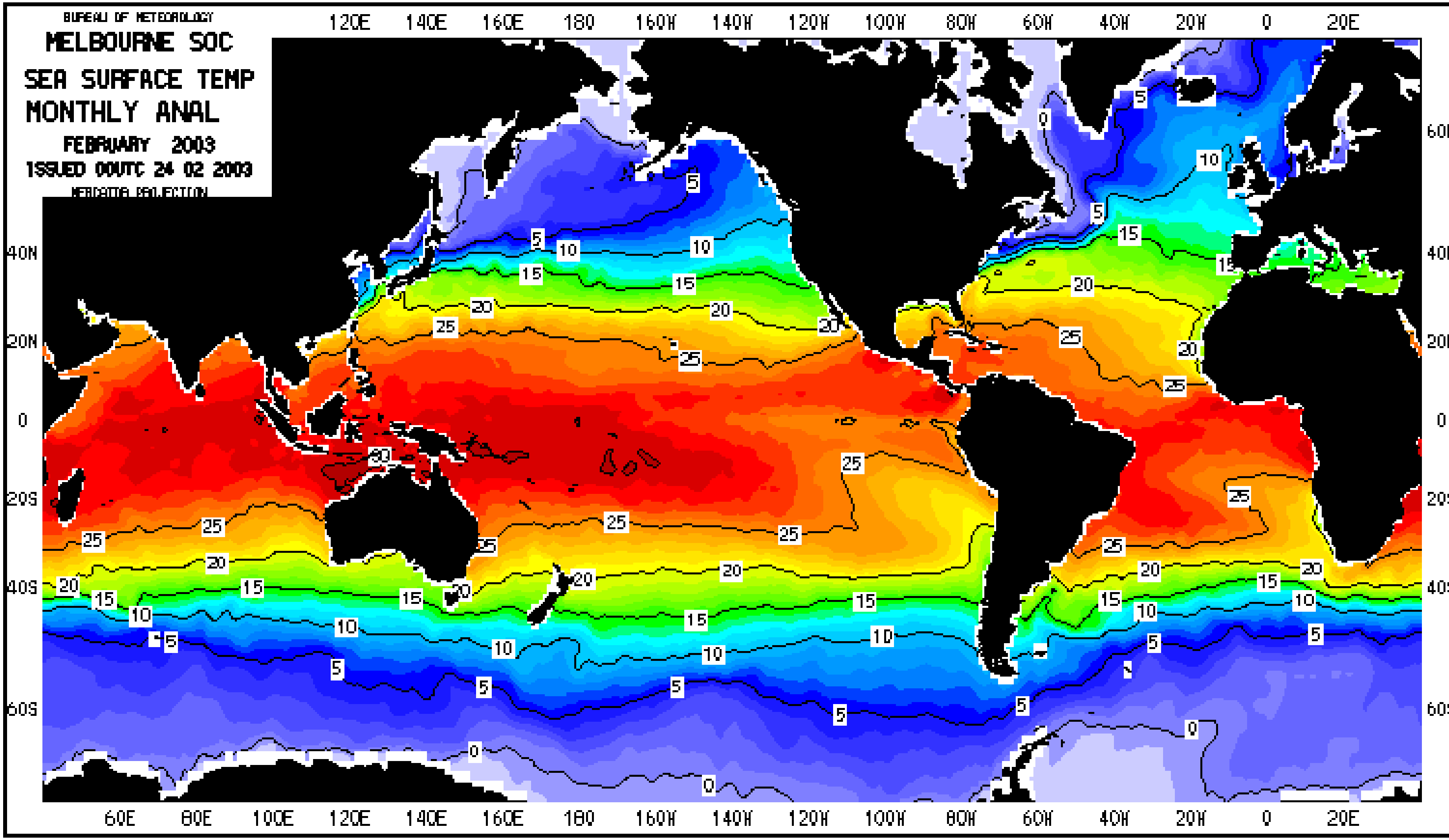
Maximum and Minimum Sea Ice Extent





From Gloersen et al (1992)

Sea Surface Temperature



Why is the Ocean so Important?

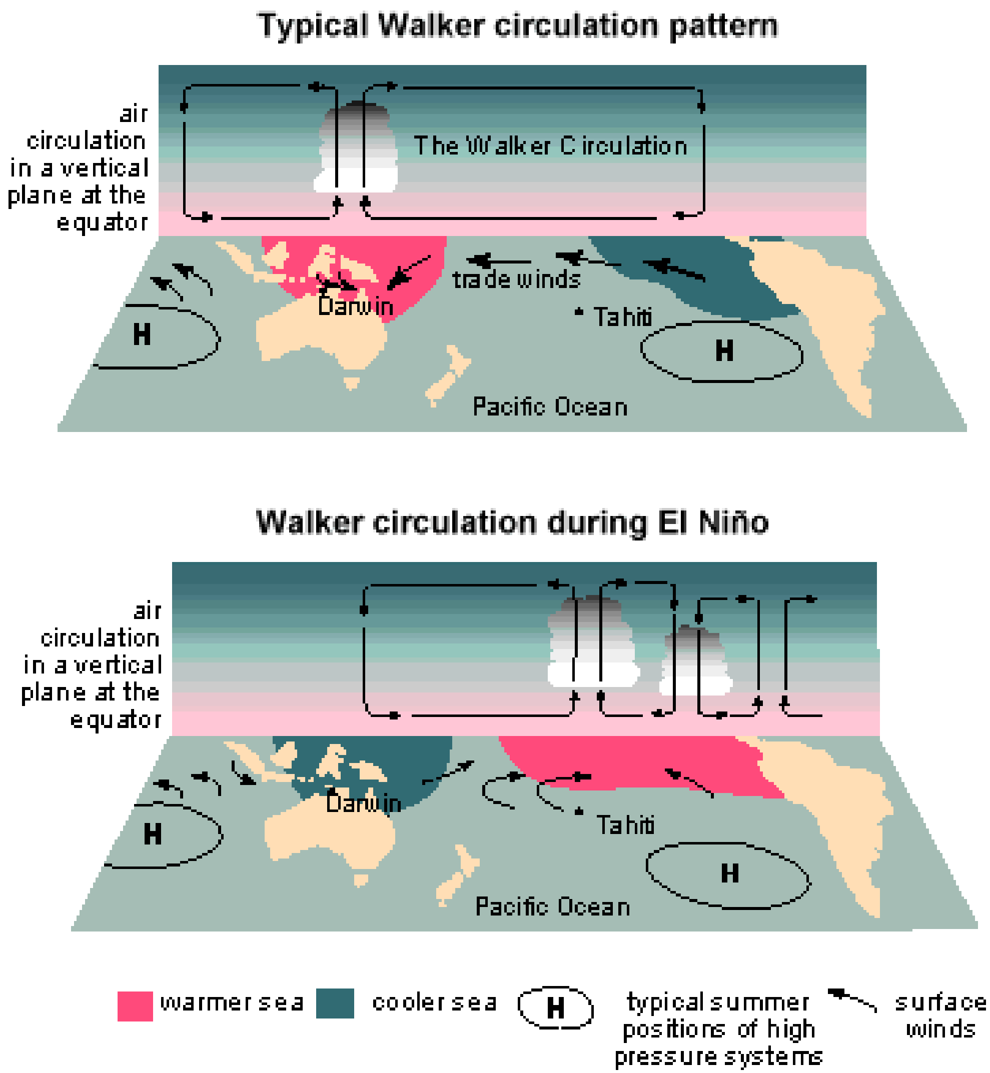
- Sea-surface temperature (SST) is the dominant influence on the atmosphere. It contributes to:
  - atmospheric moisture
  - air temperature
  - clouds and therefore, sunlight
  - pressure patterns and therefore, wind speed and direction
  - rainfall

- The ocean has a long memory compared to the atmosphere
  - seasonal to decadal compared to a few weeks
  - high heat capacity (top 3m is equivalent to the entire atmosphere)
  - internal waves and currents move relatively slowly

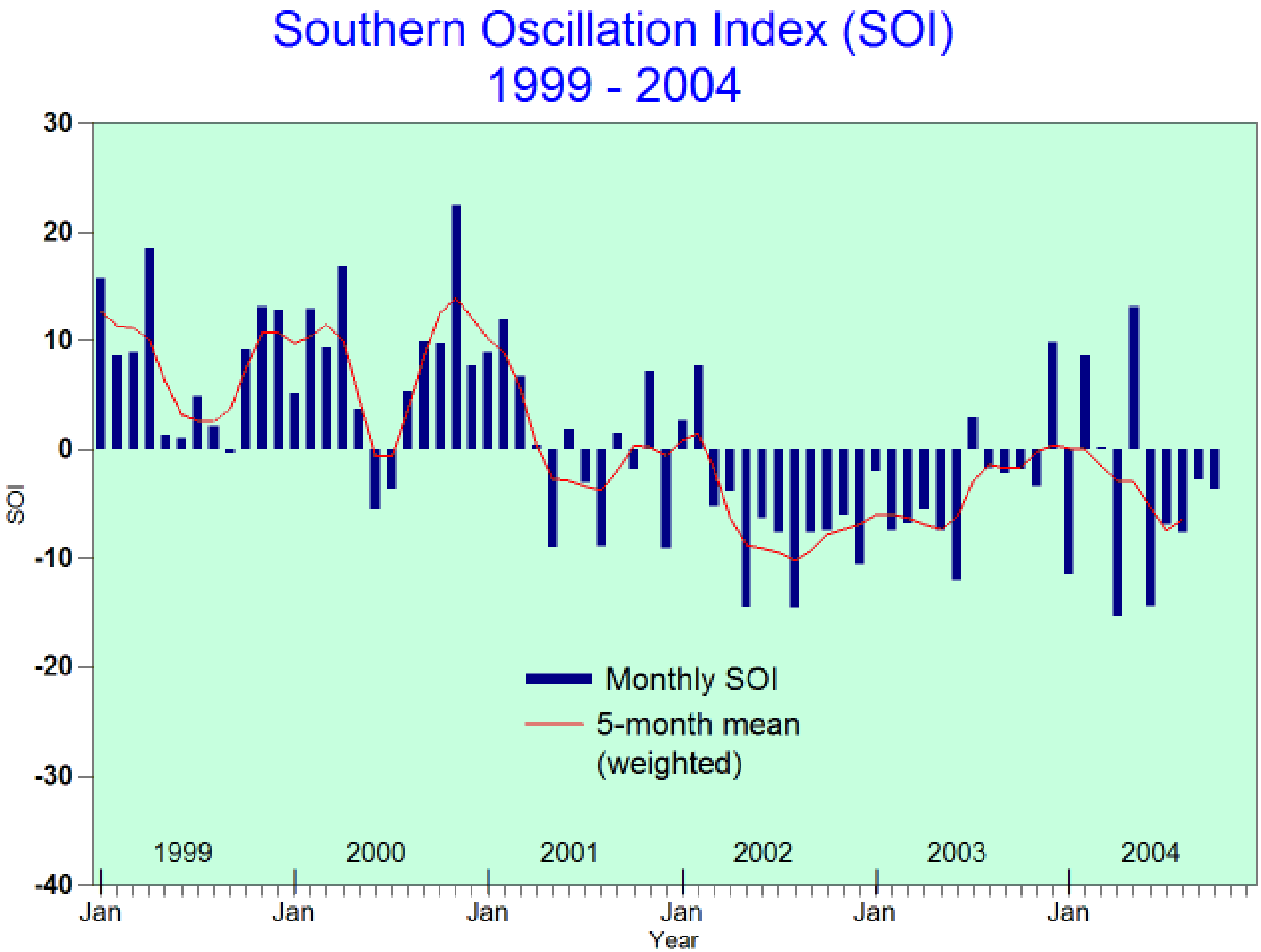
El Niño – Southern Oscillation

From Bureau of Met.

www.bom.gov.au



Southern Oscillation Index



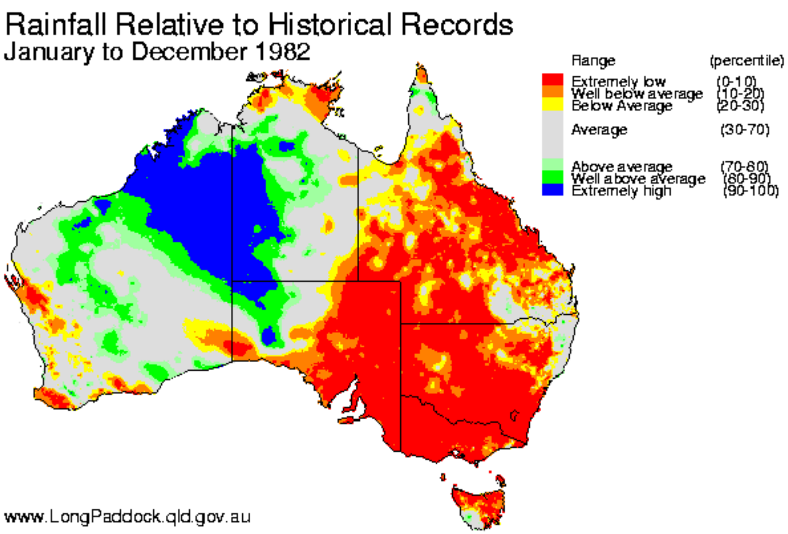
ENSO – El Niño Southern Oscillation

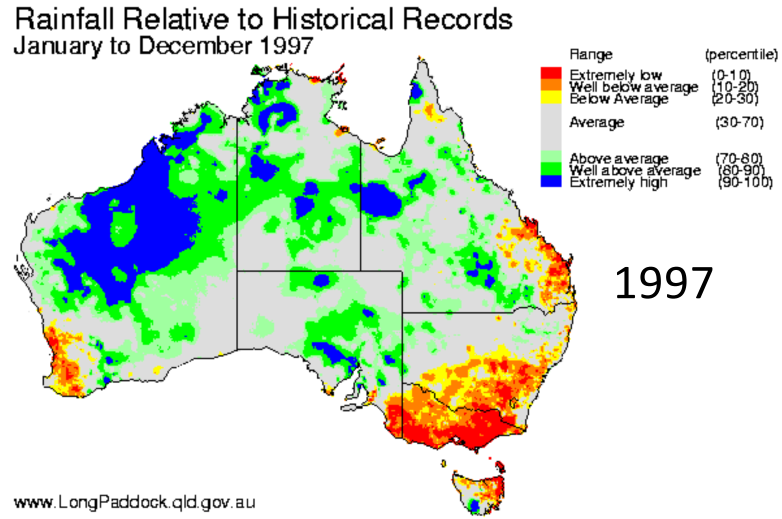
- El Niño – warm ocean current off Ecuador and Peru
- Southern Oscillation – see-saw in atmospheric pressure and rainfall in equatorial Indo-Pacific region
- ENSO is a coupled ocean-atmosphere oscillation (every 4-7 years)

- ENSO is a tropical phenomenon
  - biggest climate signal on the planet
  - every ENSO is different
  - the impact of similar-strength ENSOs is different
  - its effect decreases away from the equator
  - ENSO modifies mid-latitude weather/climate – via ‘teleconnections’

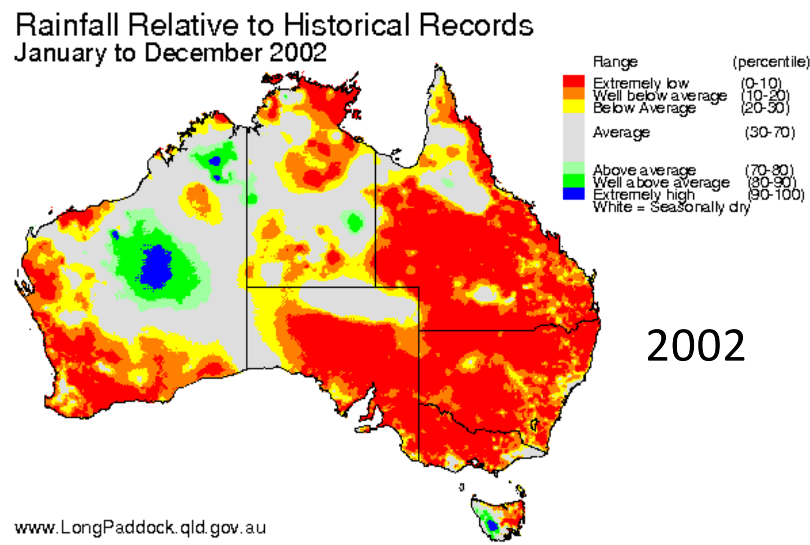
Every El Niño is different!

1982





1997

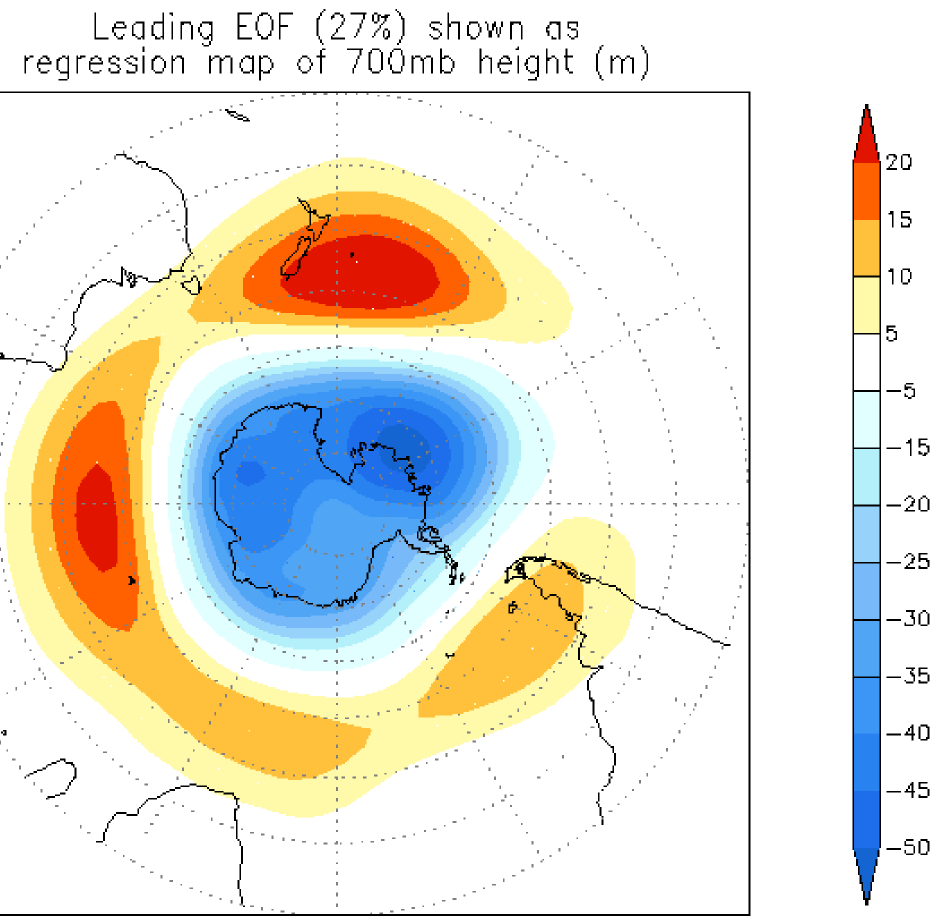


2002

Southern Annular Mode (SAM)

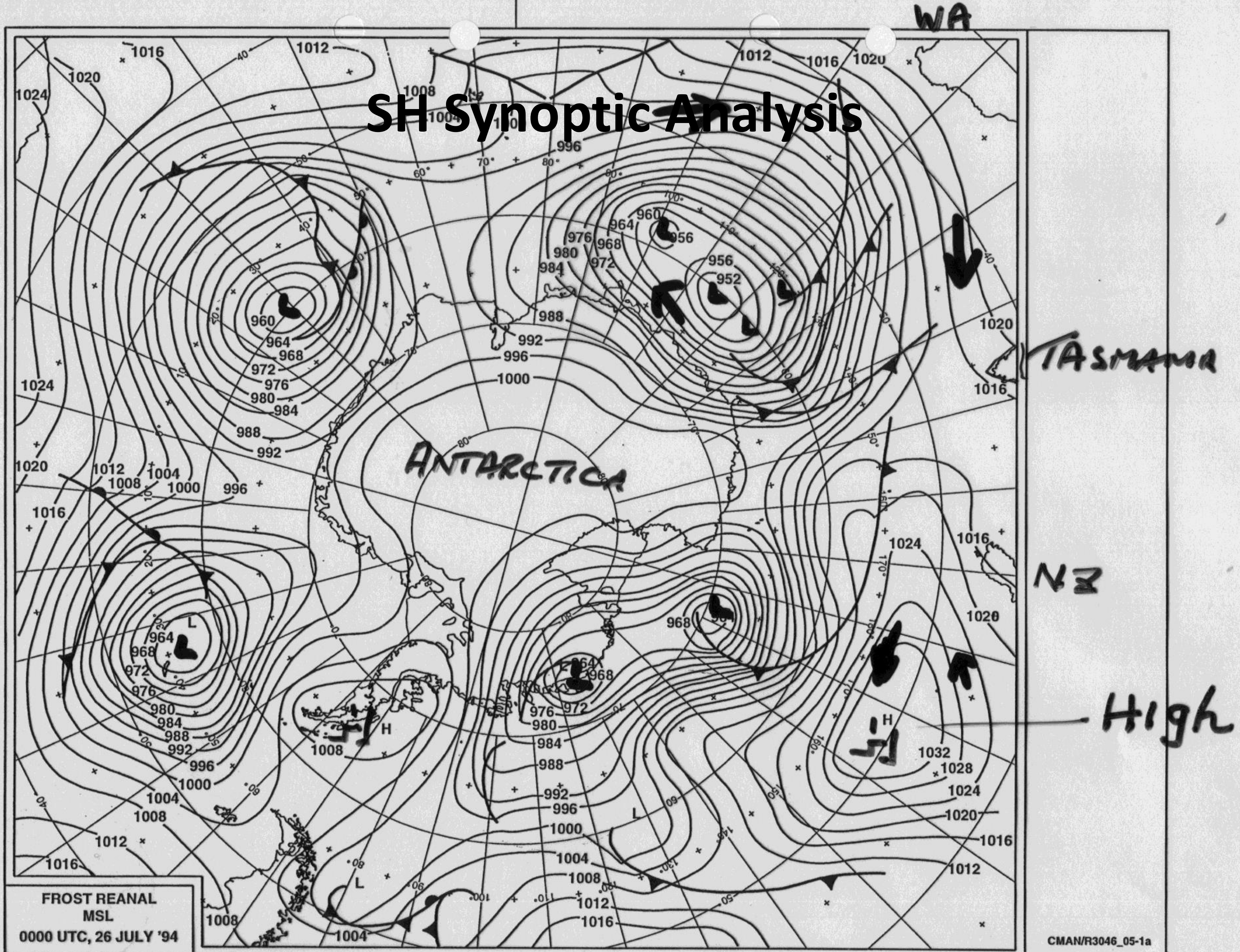
SAM Facts

- The largest influence on the strength of the westerly winds over the middle latitudes of the SH
- In the positive phase, the strongest westerly winds move closer to Antarctica
- In the negative phase, the strongest westerly winds occur in the mid-latitudes
- The SAM cycle has a period of weeks
- There has been a trend to an increasing frequency of the positive phase of SAM in the recent past

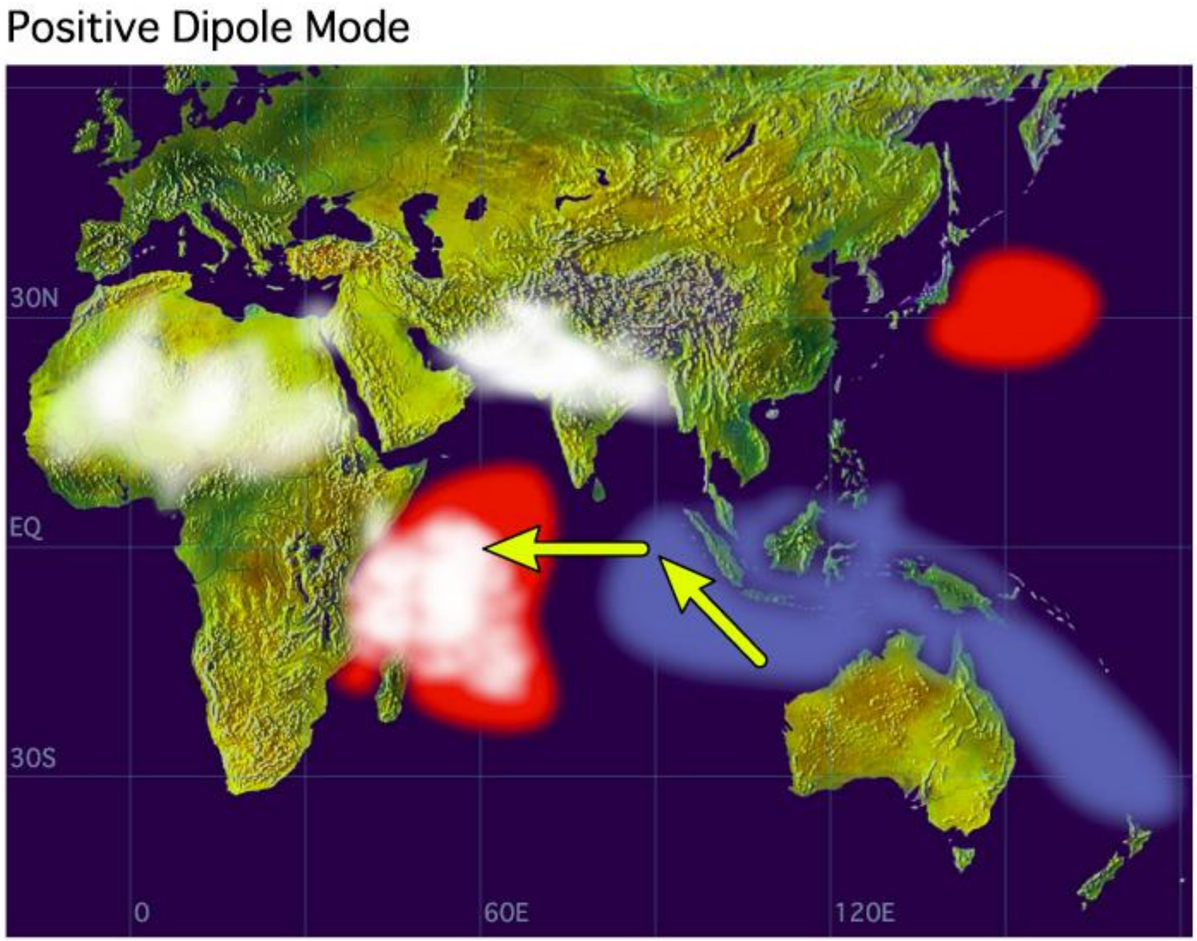


From NOAA CPC

SH Synoptic Analysis



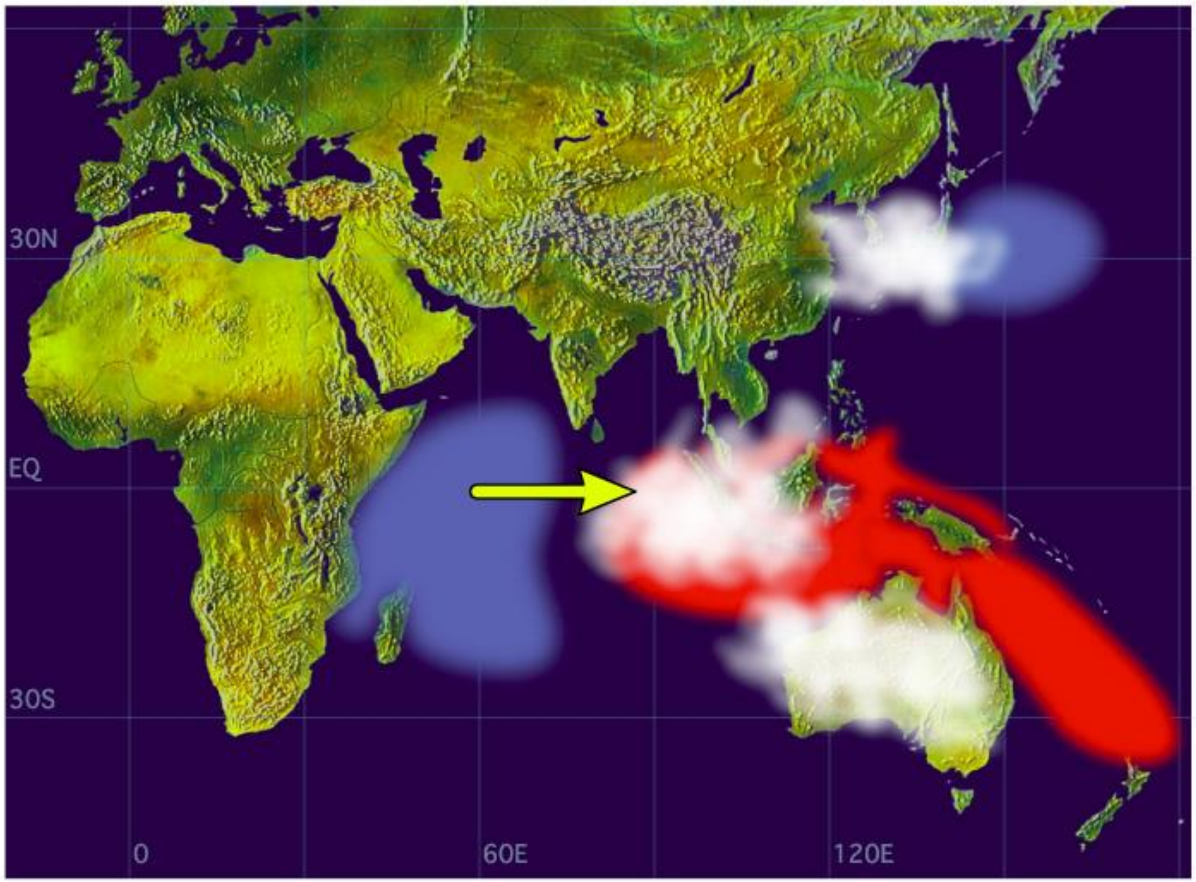
IODM – Positive Phase



FRCGC web site

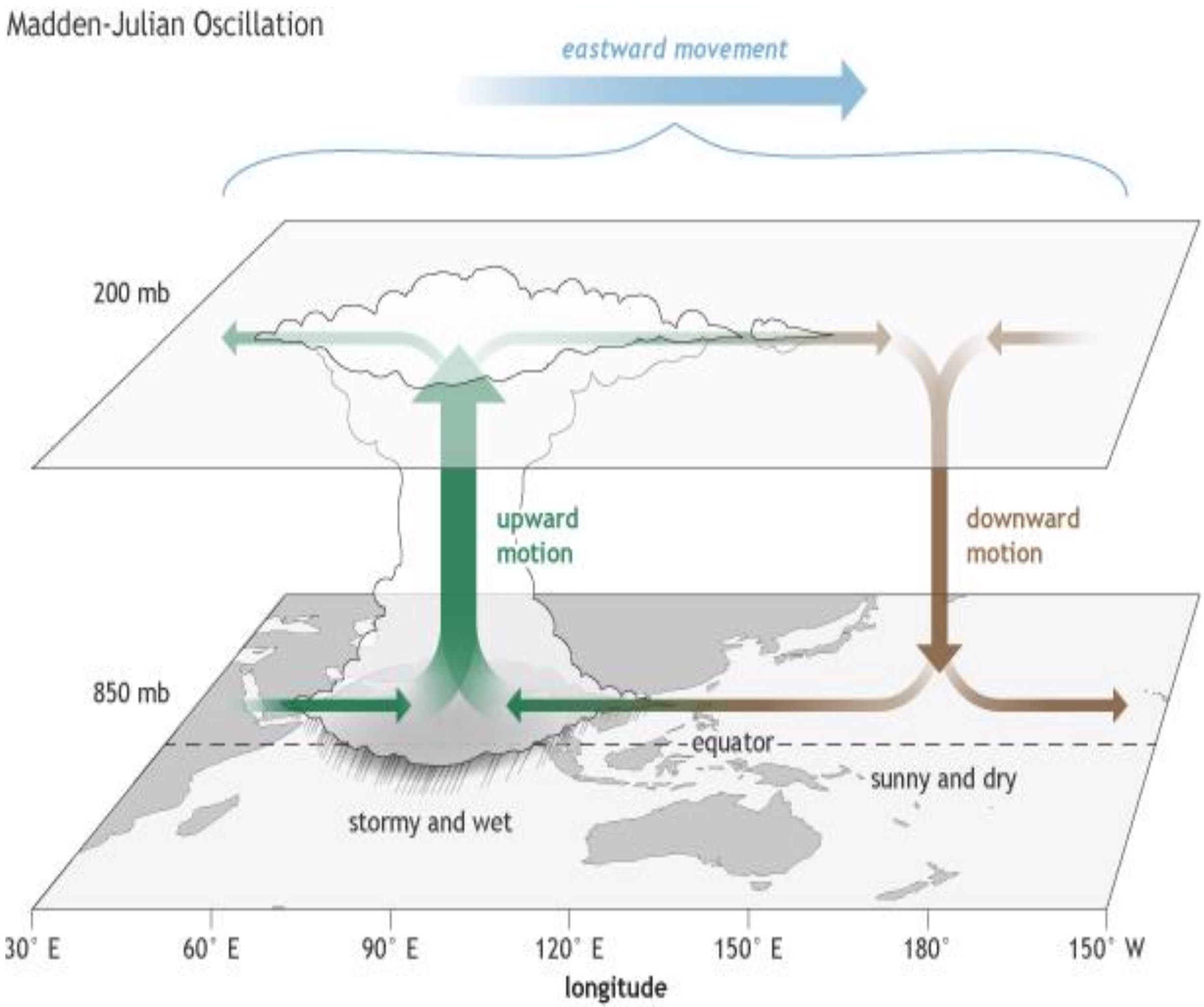
IODM – Negative Phase

Negative Dipole Mode



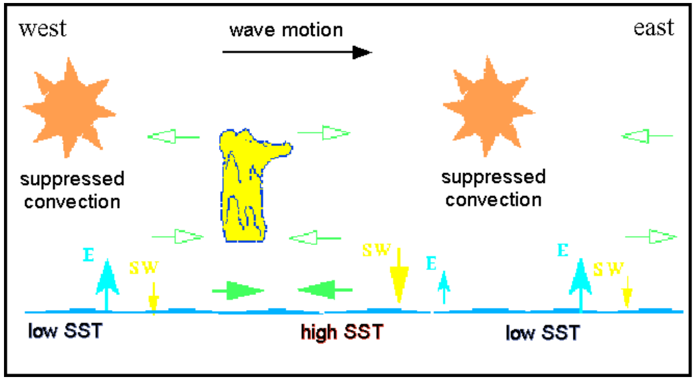
FRCGC web site

Madden-Julian Oscillation

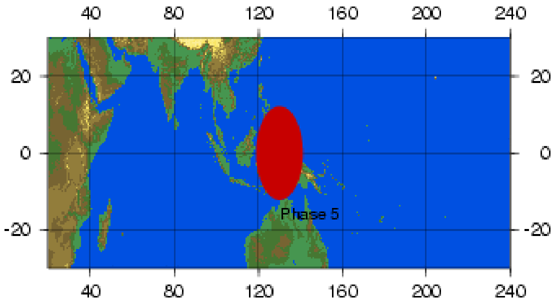


NOAA Climate.gov

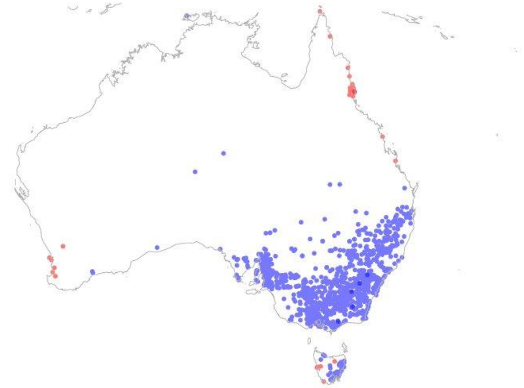
Madden Julian Oscillation (MJO)



MJO phase

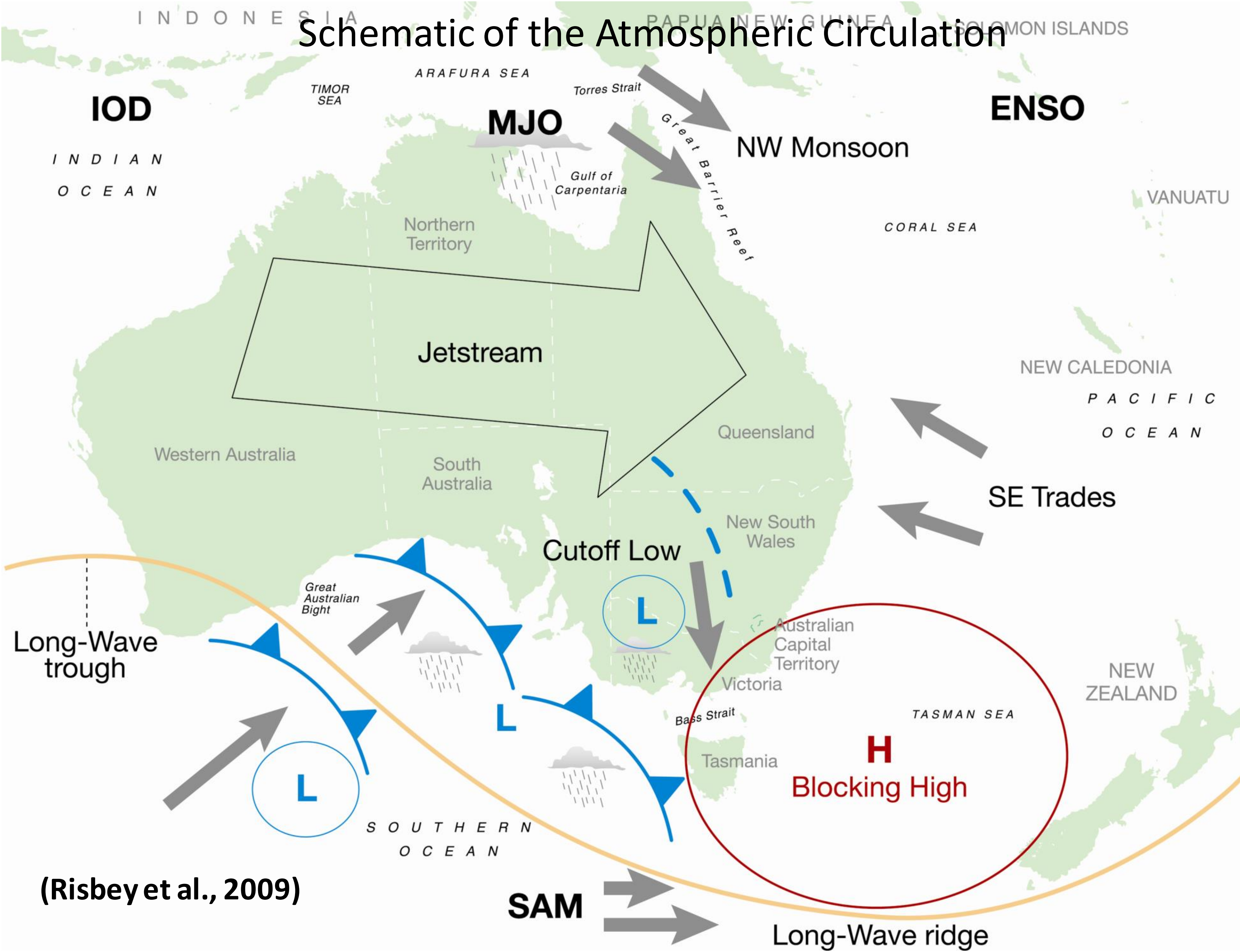


Winter Rainfall Correlation



http://www.apsru.gov.au/mjo/explore.asp

Schematic of the Atmospheric Circulation



(Risbey et al., 2009)

Risbey et al. (2009)

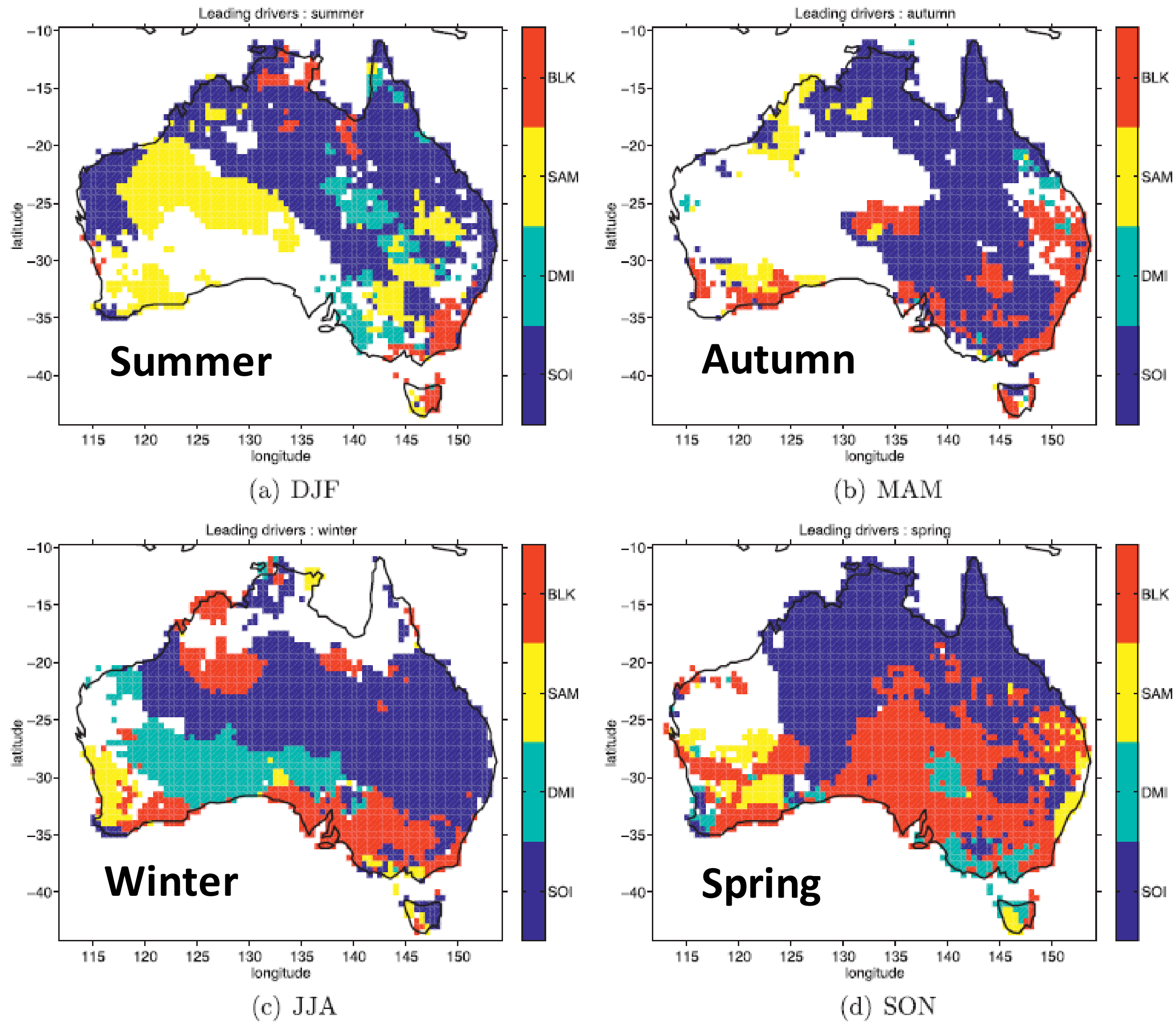


FIG. 15. Each map shows the climate driver with the highest correlation to monthly rainfall at each grid cell across the continent for each season (a) DJF, (b) MAM, (c) JJA, and (d) SON. The drivers included are blocking (BLK), SAM (SAM), IOD (DMI), and ENSO (SOI). Only correlations significant at the 95% level were included in selecting the driver with the highest correlation. In the blank areas none of the drivers has a significant correlation with rainfall. The data span the period 1957–2006.

Conclusion

- The day to day weather reveals a constantly changing atmosphere at Tasmania's latitudes
- Climate represents the average of many weather systems and is also variable and subject to several influences
- The main proximate influence is the long-wave pattern and blocking
- The main remote driver is ENSO with some assistance from the IOD
- The SAM mainly affects the southwest of Tasmania

Thank You