Synoptics and climate dynamics over Australia during extreme ENSO events: A case study

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La Nina flooding events: Januarys 1974 and 2011

- Most intense flooding periods during two extreme La Niñas: 1973-1976 and 2010-2012
- 1974: “biggest continent-wide drenching since European settlement” (BoM)
- 2011: Victoria received its average summer rainfall totals in six days
Queensland daily precipitation

• Upper level low combined with moist easterly flow
• Daily totals of 304mm in Murray River Catchment on Jan 8th
• Jan 10-12: widespread flooding near Brisbane
• 3-day totals 648mm at Mt. Glorious
• >60mm in 1 hour near Brisbane
NSW daily precipitation

Victoria daily precipitation

Bureau of Meteorology Monthly Weather Reviews, NSW and Victoria
Circulation features associated with flooding

Sea Level Pressure during El Niño, neutral and La Niña conditions.

January 1974
Sea level pressure during flooding in January 1974 and 2011

January 2011
Circulation features associated with flooding

Sea Level Pressure during El Niño, neutral and La Niña conditions.

January 1974

Sea level pressure during flooding in January 1974 and 2011

January 2011
Tropical westerly winds intensified and were drawn down around the low, bringing large amounts of tropical moisture.
IOD was negative in both 1973-74 and 2010-11 La Niñas, however, it was very strongly negative only in 2010-11. The increased amount of atmospheric moisture could have increased the impact of 2011 flooding beyond what it would have been otherwise.
Continuous series of blocking highs in the Tasman Sea

• Quasi-stationary waves result in NZ being a 'typical' blocking location
• High pressure systems can sit in the Tasman Sea, pairing with the unstable easterly flow to block the movement of the lows out into the Pacific
• The lows sit longer over Australia, delivering more precipitation and exacerbating flooding.
Dynamical Modes of Instability

- Derived based on two-level linearized primitive equation instability model developed by Frederiksen and Frederiksen (2005, 2007, 2011)
- Fast-growing storm track and slow-growing cyclogenesis modes returned to cross southeastern Australia
- Kelvin waves moving 3 times as fast as 1979 basic state (Frederiksen 2002)

Explosive Kelvin wave: 4.2 day e-folding time, period 18 days
300hPa streamfunction
300hPa velocity potential
Dynamical systems associated with La Niña January 2011

Intraseasonal oscillation: 6.6 day e-folding, period 50 days

300hPa streamfunction

300hPa velocity potential

300hPa geopotential height differences
Jan 2011 vs. Jan 1949-2009

Leading monsoonal mode 47

300hPa streamfunction (inverse)
Kelvin and MJO wave extraction

Courtesy of Matt Wheeler BoM
Thank you


