Shifts to the new abnormal: riding the waves of climate change

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Shifts to the new abnormal

1. Climate forms a series of regimes, where steady-state conditions are separated by abrupt regime changes.

2. Climate change and variability are not separate processes, all energy follows the same pathway.

3. Warming follows a step-ladder like pattern – as a series of shifts to higher energy (warmer) states, separated by periods of relative stability.

4. These are shifts to a new ‘abnormal’ state of heightened risk.

5. To ride the waves of change, we have to understand them.
Climate as a series of heat engines

Lutgens et al. 2006
A shift to the new norm: riding the wave of change

Moist, warm air ascends

Trade winds blow warming water from the cold tongue to the warm pool

Cool, dry air descends

Warm pool Niño 3.4 Cold tongue

2°C, 200 mm gradient 6–8°C, 500 mm gradient

Upwelling deep water

Thermocline

Subsurface return flow

Clouds pettycon from pixabay
Pacific Ocean heat engine
How it works

- Upwelling cold water
- Trade winds
- Massive uplift
- Low barrier
East-central Pacific

Western Pacific warm pool

Global mean surface temperature

Warm pool, GMST & east-west difference
Key dates

- 1901–03  abrupt ocean cooling
- 1920–21  NH warming, land dominated
- 1925–26  NH warming ocean-dominated
- 1937–38  Ocean warming global
- 1968–69  Warm pool and SH
- 1976–79  Pacific shift, SH then NH
- 1986–89  NH some ocean, mainly land
- 1995–98  Pacific-Atlantic lock then shift, warm pool, SH then NH
- 2010     Minor shift SH
- 2012–15  Warm pool, some SH mainly NH
Shifts in sea surface temperatures
Shifts in Australian regional temperature

Observed shifts
National average change

Maximum temperature

Minimum temperature

Average temperature
Shifts attributed to greenhouse gas forcing

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Attributed shifts
Shifts in rainfall

1973 14% <0.01
1973 19% <0.01
1995 27% <0.01
1947 9% >0.25
1969 -13% <0.01

1973 27% <0.01
1973 20% <0.05
1997 -9% >0.25
1976 -7% >0.25

1949 8% >0.25
1949 7% >0.25
1947 11% >0.25
1947 13% <0.25
1994 -6% >0.25

A shift to the new norm: riding the wave of change
Why does it matter? Ask the adaptoraptor

Smooth!

Maybe I should be on a mountain bike

O0!

$&@!!

Anomaly (°C)


-0.4 -0.2 0 0.2 0.4 0.6 0.8 1.0 1.2
Very high FFDI or greater – 9 Vic sites

Days of high to catastrophic fire danger

Fire Year

Conclusions

• Climate change is driven by a network of heat engines, governed by the one in the tropical Pacific Ocean.

• When they need to move more heat to the top of the atmosphere and the poles, they will shift to a new steady-state

• Australia is just to the south of the heat engine, so is in the first line of a shifting climate

• We need to explore what this means for the future planning and delivery of emergency services

We need to plan smarter

Don’t let the adaptoraptor go extinct again
Thank you
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Acknowledgements
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