Convective organization and Madden-Julian Oscillation over Tropical Australia (ocean): AUS2200 MJO simulations

UNSW Climate Change Research Centre

Clemente Lopez-Bravo (CLEX, CCRC-UNSW)
Corresponding: c.lopez_bravo@unsw.edu.au

Introduction

El Niño/Southern Oscillation (ENSO) controls the background through which the Madden-Julian Oscillation (MJO) propagates. Specific MJO events can vary depending on the state of ENSO, e.g., the strength of the MJO convection and propagation speed of the MJO based on ENSO conditions (Tang et al. 2024).

MCS & role of cold pools in convective organization

The role of organization in atmospheric convection has been acknowledged for many years. For example, interactions between deep convective clouds through collisions of their associated cold pools were invoked to explain the formation of new convective cells that allowed the maintenance of thunderstorms (Schlemmer and Hohenegger 2014; Lane and Moncrieff 2015; Tang et al. 2024).

This investigation aims to explore the role of cold pools in convective organization during the wet phase of enhanced convection and precipitation of the MJO.

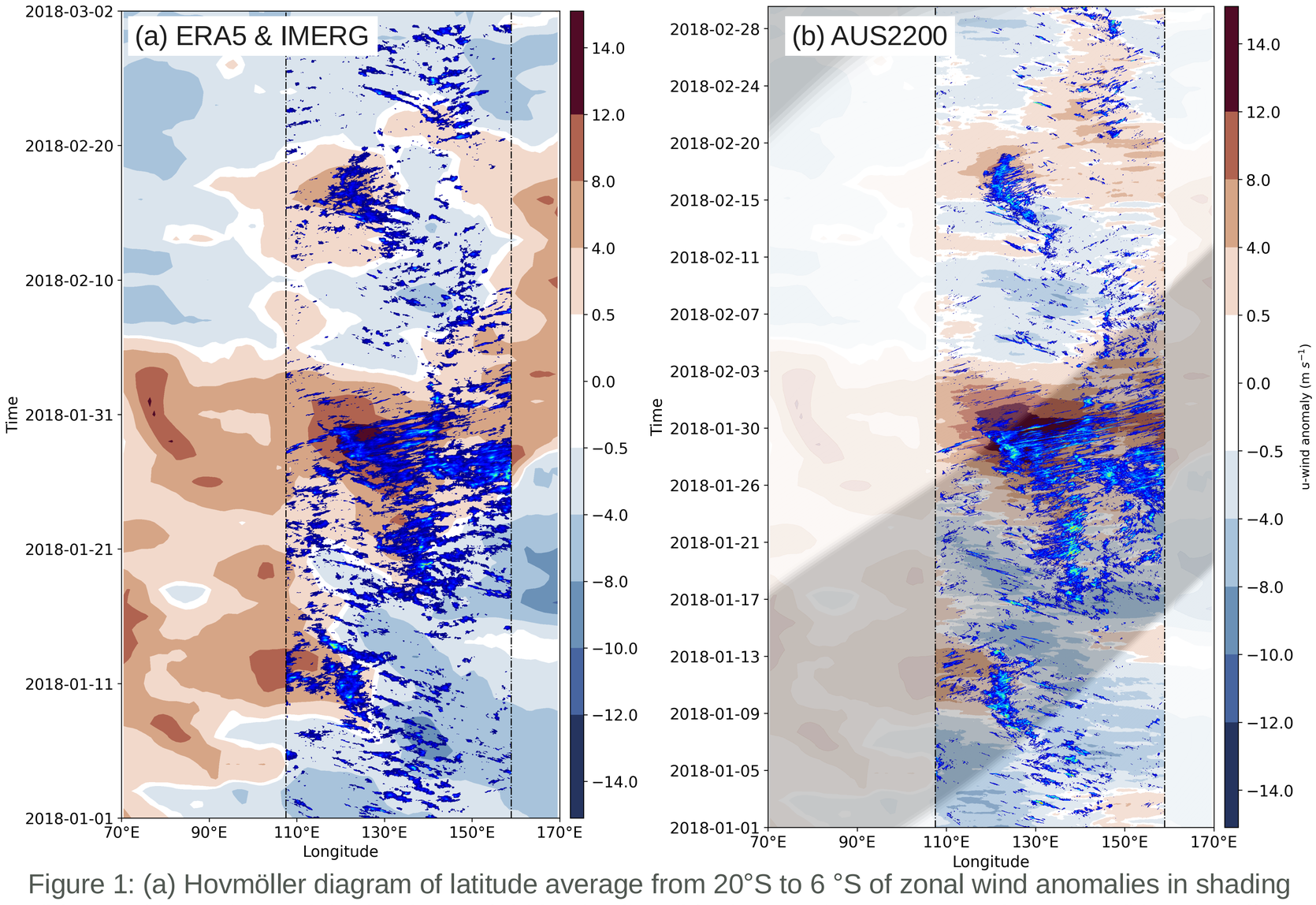


Figure 1: (a) Hovmöller diagram of latitude average from 20°S to 6 °S of zonal wind anomalies in shading (blue and brown), precipitation is overlaid in shading (blue). Data from ERA5 and IMERG. (b) Hovmöller diagram for AUS2200 simulations. Experiment: MJO & ENSO: La Niña.

DATA-Simulations

UK Met-Office Unified Model. AU2200

MJO & ENSO: Neutral

MJO & ENSO: El Niño

MJO & ENSO: La Niña (Fig. 1)

Method to identify cold pool areas (warm environment) in AU2200 simulations

- Detect Negative Potential Temperature Anomalies at surface level 5 (m) $\Delta\theta < -1$
- Assess Wind Divergence and Convergence ($\partial u/\partial x + \partial v/\partial y) > 0$
- Specific Humidity. Cold pools are often associated with increased moisture due to evaporative cooling $q > 0.012$ (kg/kg)
- Vertical velocity. Downdrafts are associated with the formation of cold pools (w < 0)

Method has been adapted from Schlemmer and Hohenegger (2014) and Tang et al. (2024).

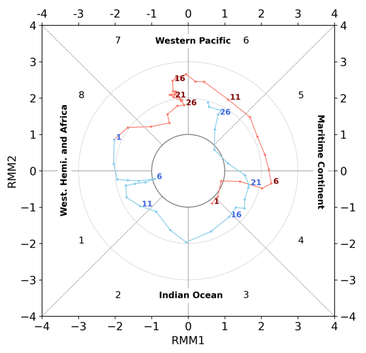


Figure 2a: Areas where cold pools are frequent. AU2200 simulation MJO & ENSO: Neutral January-February 2013

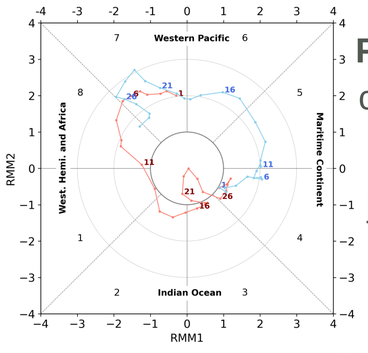


Figure 2b: Areas where cold pools are frequent. AU2200 simulation MJO & ENSO: El Niño January-February 2016

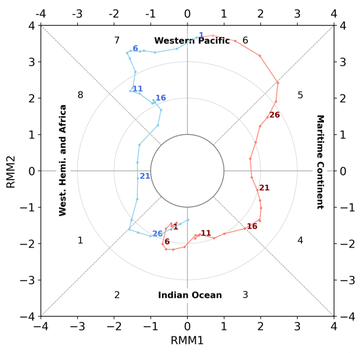
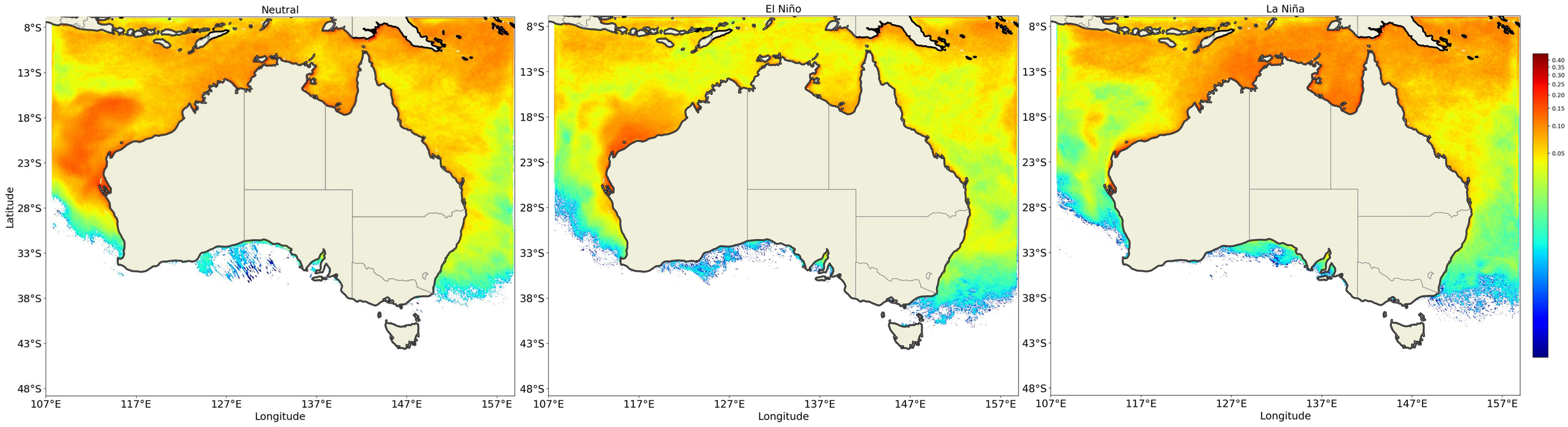


Figure 2c: Areas where cold pools are frequent. AU2200 simulation MJO & ENSO: La Niña January-February 2018



Results

The results present areas associated with the occurrence of cold pools during the simulated period for January and February: 2013 (Fig. 2a), 2016 (Fig. 2b), and 2018 (Fig. 2c).

The cold pools exhibited important differences in spatial area over the ocean offshore western Australia (Figs. 2, panels a and b) and the maximum area is confined in the southern region of the Indo-Pacific sector (Fig. 2b).

Conclusion

The cold pools exhibit differences between ENSO states and active phases of the MJO. However, information about their lifetime and morphological characteristics is necessary to address their role in triggering new convective cells.

Future work

1. Decompose and attribute the cold pool areas to the MJO convective envelope over the tropical region of Australia.
2. Use a metric to calculate the convective organization based on cold pool detection.
3. Analysis of surface fluxes and downdraft characteristics to explain the differences between experiments.

Acknowledgments

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References:

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