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INTRA-SEASONAL CLIMATE PREDICTION - LINKING WEATHER AND CLIMATE FORECASTS

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1. INTRODUCTION

The Madden-Julian Oscillation (MJO) is a tropical atmospheric phenomenon, associated with periods of active convection in the eastern hemisphere tropics. The MJO's temporal scale (22-90 days) coincides with a gap between weather (synoptic forecasts out to 10 days) and climate (seasonal and longer forecasts).Analysis of 35 years of daily rainfall data shows significant modulation of tropical and extra-tropical rainfall by the equatorial passage of the MJO that begins to address the weather-climate forecasting gap.

The BMRC's Real-time multivariate Madden-Julian (RMM) Index((Wheeler and Hendon, 2004) is a good proxy for the amplitude (strength) and location (Phases 1-8) of the MJO in the eastern hemisphere.

As the centre of active convection that distinguishes the MJO travels east along the equator, corresponding rainfall patterns can be identified throughout the tropics and also at higher latitudes. We also observed weather states in standardised MSLP anomaly maps that explain these rainfall patterns.

These weather states provide a mechanistic basis for an MJO-based forecasting capacity that bridges the weather-climate divide. Knowledge of these tropical and extra-tropical MJO-associated weather states can significantly improve the tactical management of climate-sensitive systems such as agriculture.

2. DATA AND METHODS

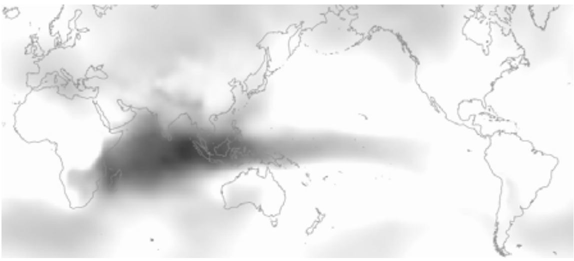
The RMM index was used to objectively represent the MJO, and compared with rainfall and with weather states (mean sea level pressure (MSLP)). For a description of the methods see Donald et al (2006, in press).

3. RESULTS

Figure 1 shows negative anomalies in standardised MSLP (ie cloudiness). As expected, these anomalies,are located in the same regions as those where enhanced rainfall conditions have been identified (Fig 3)

1a

1b



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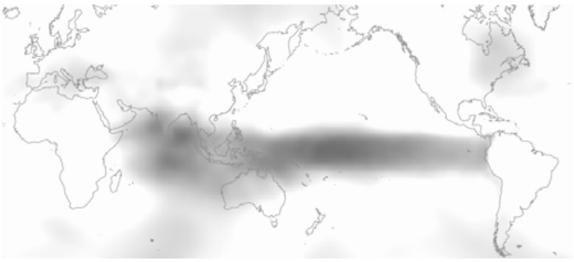

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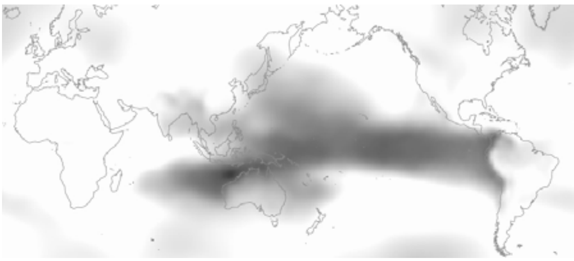

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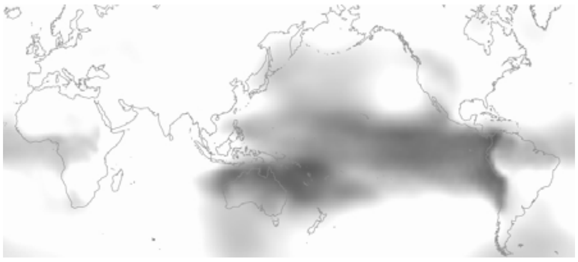
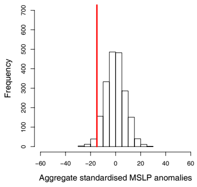


Fig 1 Austral summer standardised low pressure anomalies by RMM Phase a) 1 b) 3 c) 4 d) 5 e) 6

We defined cells around MJO active convection for each RMM Phase. Then we calculated the observed, aggregated standardised MSLP anomalies and constructed stochastically generated null distributions of such anomalies by sampling from synthetic time series represented by Markov Chain Models (MCM; 2000 runs), which maintain the observed frequencies for phase transitions between consecutive days. P-values associated with the observed MSLP anomalies were derived from the MCM-generated null-distributions. Low p-values indicate strong empirical evidence of causal relationships between MSLP patterns and the passage of the MJO (Donald et al,2006, in press) (Fig 2)

2a



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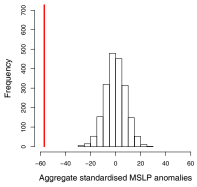

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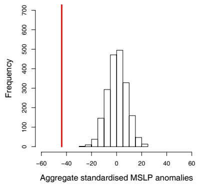

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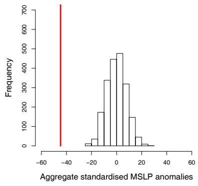

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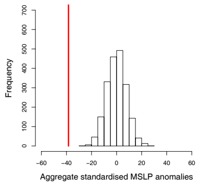
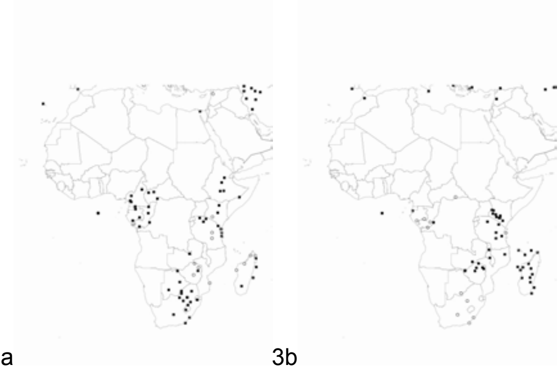


Fig 2 Austral summer aggregate standardised MSLP anomlaies by RMM Phase a) 1 b) 3 c) 4 d) 5 e) 6. The vertical line indicates the relative location of observed MJO-associated MSLP anomalies in respect to the null distributions (histogram) (Donald et al, in press)

Importantly, quantifying the maximum vertical distance between the *unconditional* cumulative conditional distribution function (CDF) and the corresponding *conditional* CDF for each phase (Donald et al, 2006 in Press, Maia et al, 2006, in press) indicates a physical connection between the MJO and rainfall, and MSLP (Fig 3).

3.1 Africa

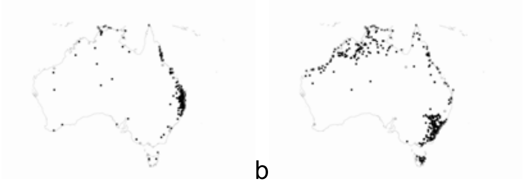
As the MJO initiates over the Western Indian Ocean corresponding enhanced rainfall regions can be identified over central and southern Africa during Austral summer RMM Phase 1(Fig 3a). As the MJO moves away form Africa, eastward over the Indian Ocean (RMM Phase 3(Fig 3b).) the enhanced rainfall response breaks down, compared with RMM Phase 1, and is restricted to the central eastern margin and Madagascar. Some areas of rainfall suppression area are apparent in southern and central western Africa.



3a 3b

Fig 3 Africa: Austral Summer RMM Phases a) 1 and b) 3

During the Austral summer RMM Phases 4 (Fig 4a) and 5 (Fig 4b) have a significant enhanced rainfall impact. Anecdotal evidence has long suggested this MJO associated rainfall pattern.

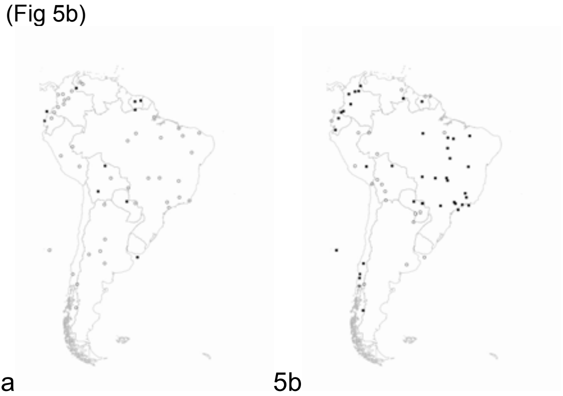


4a b

Fig 4 Australia: Austral Summer RMM Phases a) 4 and b) 5

3.3 South America

When the MJO is in RMM Phase 6 (Fig 5a) in the eastern hemisphere, much of SA reveals suppressed rainfall patterns. Rainfall enhancement over areas of South America is detected during RMM Phase 1 (Fig 5b)



5a 5b

Fig 5 South America: Austral Summer RMM Phases a) 6 and b) 1

4. DISCUSSION AND CONCLUSIONS

Our results demonstrate that the MJO is a significant phenomenon that can influence global weather patterns well beyond the tropics. The teleconnections between the MJO and higher latitudes events need to be established. We have quantified the impact of the MJO on global rainfall, using the RMM Index as an accurate MJO proxy. At this stage the analysis represents a valuable tactical tool for operational climate risk management in many (rural) industries. Ongoing R&D will expand the use of this information to other sectors of the Australian economy (in the first instance).

4.2 ACKNOWLEDGEMENTS

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