Intra-seasonal climate prediction - linking Weather and Climate Forecasts

Abstract

The Madden-Julian Oscillation (MJO) is a tropical atmospheric phenomenon, associated with periods of active convection in the eastern hemisphere tropics.The MJOs 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 BMRCs Real-time multivariate Madden Julian Index (Wheeler and Hendon, 2004) may be used as 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.To quantify evidence of causality between the passage of the MJO and observed standardised MSLP anomaly patterns, we defined active convection cells around the calculated the observed, aggregated standardised MSLP anomalies. Then stochastically generated null distributions of such anomalies were generated by sampling from Markov Chain Models synthetic time series. Physical connections between MSLP patterns and rainfall are self-evident and do not require inferential testing so we opted for a descriptive approach that quantifies the maximum vertical distance between the unconditional cumulative distribution function (CDF) and the corresponding conditional CDF for a particular phases is sufficient (Maia et al). This measure of distance between cumulative rainfall probabilities indicates positive (negative) divergences that are equivalent to enhanced (suppressed) rainfall associated with that phase. P-values were derived and low p-values indicate strong empirical evidence of causal relationships between MSLP patterns and the passage of the MJO. We do not suggest that all rainfall and MSLP anomalies found here are direct consequences of MJO activity. However, as our results show, the MJO is a very significant phenomenon that can influence global weather patterns even in higher latitudes via yet to be fully established teleconnections.

Wheeler, M. and Hendon, H. H. (2004): An All-Season Real-time Multivariate MJO Index: Development of the index for monitoring and prediction in Australia. Monthly Weather Review,132, 1917-1932

Maia, A.H.N., Meinke, H., Lennox, S. and Stone, R.C. 2005. Inferential, non-parametric statistics to assess quality of probabilistic forecast systems. Monthly Weather Review, submitted.