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The self-organizing map, a new approach to apprehend the Madden–Julian Oscillation influence on the intraseasonal variability of rainfall in the southern African region

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Abstract

The Madden–Julian Oscillation (MJO) is the major mode of intraseasonal variability (30–60 days) in the tropics, having large rainfall impacts globally, and possibly on southern Africa. However, the latter impact is not well understood and needs to be further explored. The life cycle of the MJO, known to be asymmetric, has been nevertheless analyzed usually through methods constrained by both linearity and orthogonality, such as empirical orthogonal function analysis. Here we explore a non-linear classification method, the self-organizing map (SOM), a type of artificial neural network used to produce a low-dimensional representation of high-dimensional datasets, to capture more accurately the life cycle of the MJO and its global impacts. The classification is applied on intraseasonal anomalies of outgoing longwave radiation within the tropical region over the 1980–2009 period. Using the SOM to describe the MJO is a new approach, complimentary to the usual real-time multivariate MJO index. It efficiently captures this propagative phenomenon and its seasonality, and is shown to provide additional temporal and spatial information on MJO activity. For each node, the subtropical convection is analyzed, with a particular focus on the southern Africa region. Results show that the convection activity over the central tropical Indian Ocean is a key factor influencing the intraseasonal convective activity over the southern African region. Enhanced (suppressed) convection over the central Indian Ocean tends to suppress (enhance) convection over the southern African region with a 10-day lag by modulating the moisture transport.