16B.3 SURFACE HEAT FLUXES DURING THE MJO AND THEIR EFFECTS ON THE OCEANIC MIXED LAYER IN THE TROPICAL EASTERN HEMISPHERE

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1. INTRODUCTION

The possibility that the Madden-Julian Oscillation (MJO) may be an atmosphere-ocean coupled process necessitates the requirement to study the associated air-sea interactions. Previous studies have deduced the typical cycle of such processes as increased surface insolation, followed by decreased evaporation, then increased SST leading enhanced tropospheric convection coinciding with decreased insolation, followed by increased evaporation and then decreased SST. This cycle was found at certain locations in the oceans of the tropical Eastern Hemisphere (e.g., Woolnough *et al.* 2000). These fluxes were quantitatively analysed by Shinoda *et al.* (1998), who found the largest SST anomaly to occur in the Indonesian region. Surface shortwave radiation was postulated to make a greater contribution to the net surface flux in the Indian Ocean, and being of comparable influence with the latent heat flux further east through to the western Pacific Ocean.

This study aims to further quantitatively describe the spatial and temporal relationships between these surface processes over a larger domain.

2. ANALYSIS

A combined principal component analysis was performed on the DJF intraseasonally bandpassed filtered surface field anomalies of SST, zonal and meridional wind in order to extract the dominant common pattern. This method has the benefit of specifically orientating the definition of the MJO to be used to the surface processes involved.

3. COMPOSITE BEHAVIOUR

The method of defining the MJO by its surface signal produces approximately the same composite life cycle map in OLR as that produced by an OLR based definition given in Matthews (2000), confirming the robustness of the MJO in the surface fields.

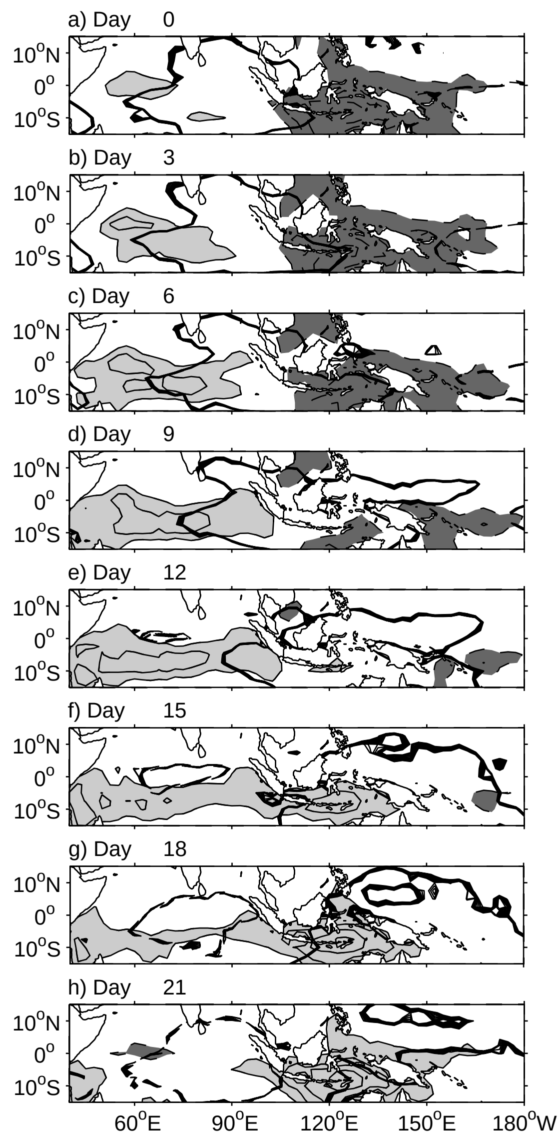

Figure 1: First half of the MJO life cycle regression map of SST anomaly. The second half is the opposite sign of the first. Contour interval is 0.1 K. Light grey contours are positive SST anomaly, dark grey signifies negative SST anomaly. The thickline is the OLR anomaly contoured at $\pm$ 10 W m $^{-2}$. Negative contours are dashed.

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The MJO signal in anomalous SST is manifested as a positive anomaly following the passage of suppressed convection (positive anomaly of OLR), and a negative anomaly following enhanced convection (Figure 1). The basin wide anomaly in the Indian Ocean reaches 0.2 K in magnitude over a large area. As it travels east a standing oscillation component develops in the Maritime Continent that grows to approximately 0.4 K. A weaker anomaly continues to propagate through to the west Pacific Ocean.

Throughout the equatorial region of the Eastern Hemisphere the SST peaks one quarter of an MJO cycle later than increased insolation, with enhanced convection peaking a further quarter cycle later. This may suggest a self sustaining relationship contained in this region of insolation anomalies that drive SST change in quadrature, which subsequently drives convection in quadrature.

The pattern of the MJO in surface latent heat flux anomalies depends on the relationship betweeen the climatological and anomalous surface winds. The DJF climatology of surface winds includes a change from easterlies to westerlies traveling east over the 110°E line of longitude in the southern tropics (Figure 2). This leads to a standing oscillation component of the latent heat flux appearing in this region as large scale MJO surface wind anomalies propagate through (Figure 3). The fact that the apparent SST standing oscillation occurs in the same area suggests that this may be a result of this climatological/anomalous surface wind relationship and its ramifications on the net surface latent heat flux.

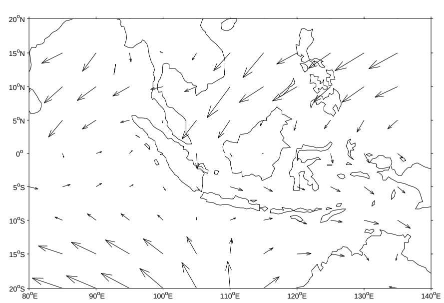

Figure 2: DJF climatology of surface winds. Maximum wind vector is 8 m s^{-1}.

A basic model involving a fixed mixed layer depth forced by these composites does not account for the temperature changes generated in the SST composite. An interactive mixed layer model is therefore used to investigate whether it can more faithfully simulate MJO SST behaviour.

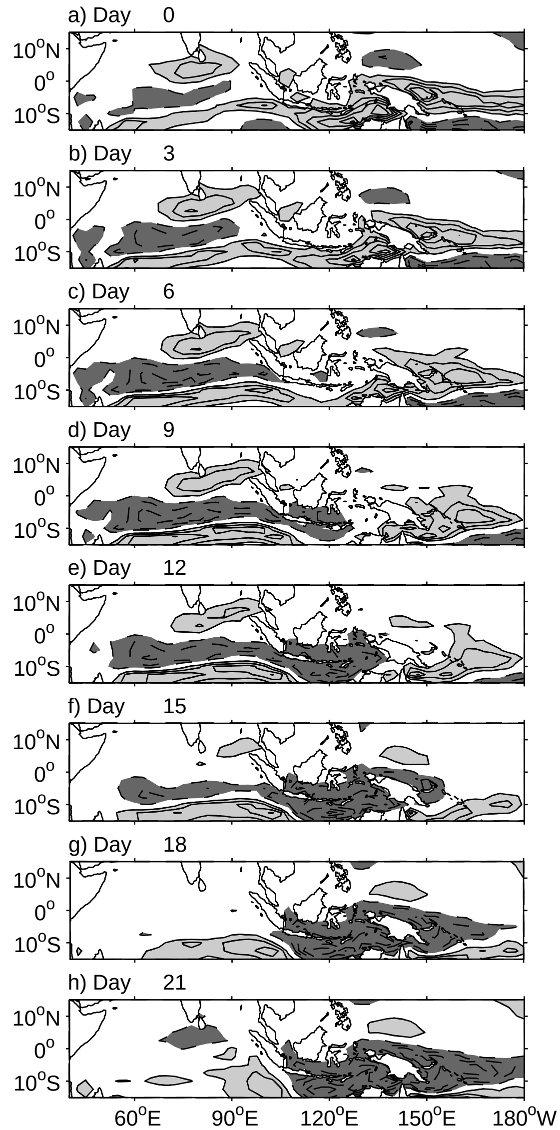

Figure 3: As Figure 1 for latent heat flux. Contour interval is 10 W m $^{-2}$. A positive anomaly represents increased evaporation.

4. REFERENCES

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