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Geog 133 – Tropical Meteorology

Lab 6 - The Madden Julian Oscillation (26 points)

1. This question addresses the time scale of the Madden-Julian Oscillation (MJO). **Suppose you are in Indonesia and that there is an MJO event going on.** (10 pts total)

a) Assuming this MJO event has a period of 60 days, how long will it take for suppressed convection to be on top of you? (Hint. Look at the OLR plots for question 4. Red indicates regions of low OLR (i.e. high convective activity). (2 pts)

Approximately 25 days (20-30)

b) Suppose that surface winds are easterlies in Indonesia at this time of the year. In what situation do you expect weakening of the surface winds (before or after the enhancement of convection). Why? (4 pts)

The weakening of surface winds would occur before the enhancement of convection. The oscillation, moving eastward though warm tropical areas, trails colder-drier air, which pushes the oscillation forward and does not weaken surface winds

c) Based on the figure below, **draw a series of arrows** showing mean surface winds to the **left** and **right** of the convective region. The arrows in the figure indicate <u>wind anomalies</u>. Compare what is happening with the anomalies and show how they interacting with the trade winds (are they blowing the same way, or the opposite direction)? Will this interaction increase or decrease the magnitude of the easterly wind? Answer this for what is occurring after the enhancement of convection (left) and before enhancement of convection (right). (4 pts)

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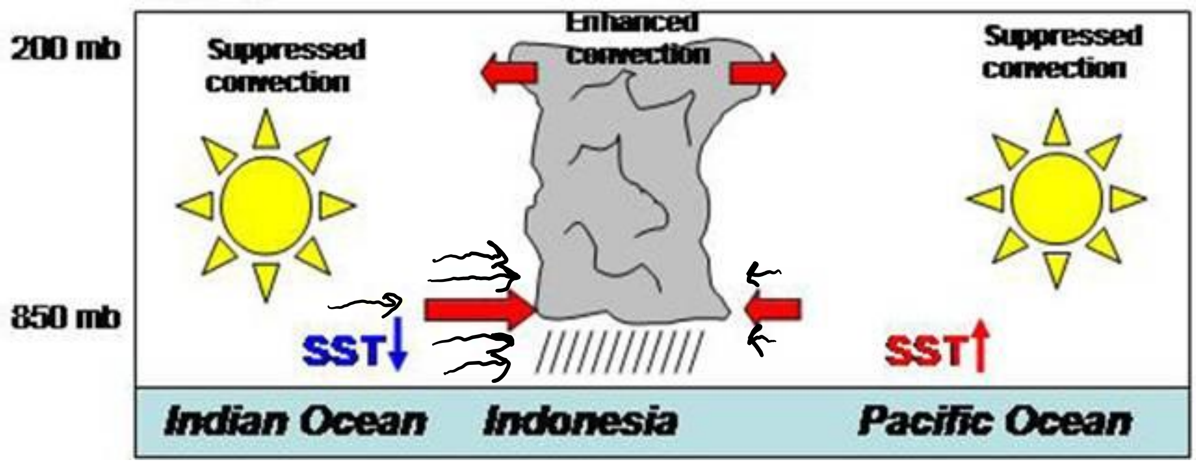

[Enhancement of Convection]:

As convection increases, westerly surface wind anomalies increase the magnitude of high-level trade winds.

[Before Convection Enhancement]:

With an absence of convection and warm/moist air, there is a small magnitude of surface easterly winds. Although these surface winds blow eastward, they end up opposing trade winds as they climb in the atmosphere during convection. Since the Westerly surface wind anomalies dramatically overcome the easterly surface winds, the further development of trade winds is not negatively affected.

2. Explain the relationships among the Madden-Julian Oscillation, “pineapple express”, and heavy precipitation in southern California. (4 pts)

As the MJO continues to move eastward, tropical rainfall in the western and central pacific is increased. This atmospheric moisture is transferred through the pacific jet, to southern California and causes heavy precipitation events.

3. Explain how the Madden-Julian Oscillation affects precipitation in the Monsoon regions. (4 pts)

MJO affects the magnitude of precipitation in monsoon regions. A suppressed MJO convection phase, leads to a drier region, with less precipitation. However, with an enhanced MJO convection phase, the warm/moist air contributes to enhanced rainfall regions.

4. This question asks you to calculate the **velocity** that the intense convection of the MJO propagates eastward. (2pts per part; 8 pts total)

The figure below shows composites of outgoing longwave radiation (OLR) anomalies and demonstrate the life cycle of the Madden-Julian Oscillation. The blue “X” indicates approximately the centers of negative OLR anomalies, which are indicative of enhanced convection.

Estimate the phase speed of the eastward propagation in m/s using the equation:

$$Velocity = \frac{\Delta meters}{\Delta seconds}$$

<u>Hints</u>

1) For each calculation, you need to **estimate how much distance (in degrees of longitude) the center of convection moved eastward**. Remember that 1 degree of longitude at the equator is approximately equal to 110 km. For the calculation, **the distance will need to be in meters!**

2) **Time is also a component in calculating velocity. The time will need to be in seconds.** Please include in your lab all calculations and steps used to solve this question.

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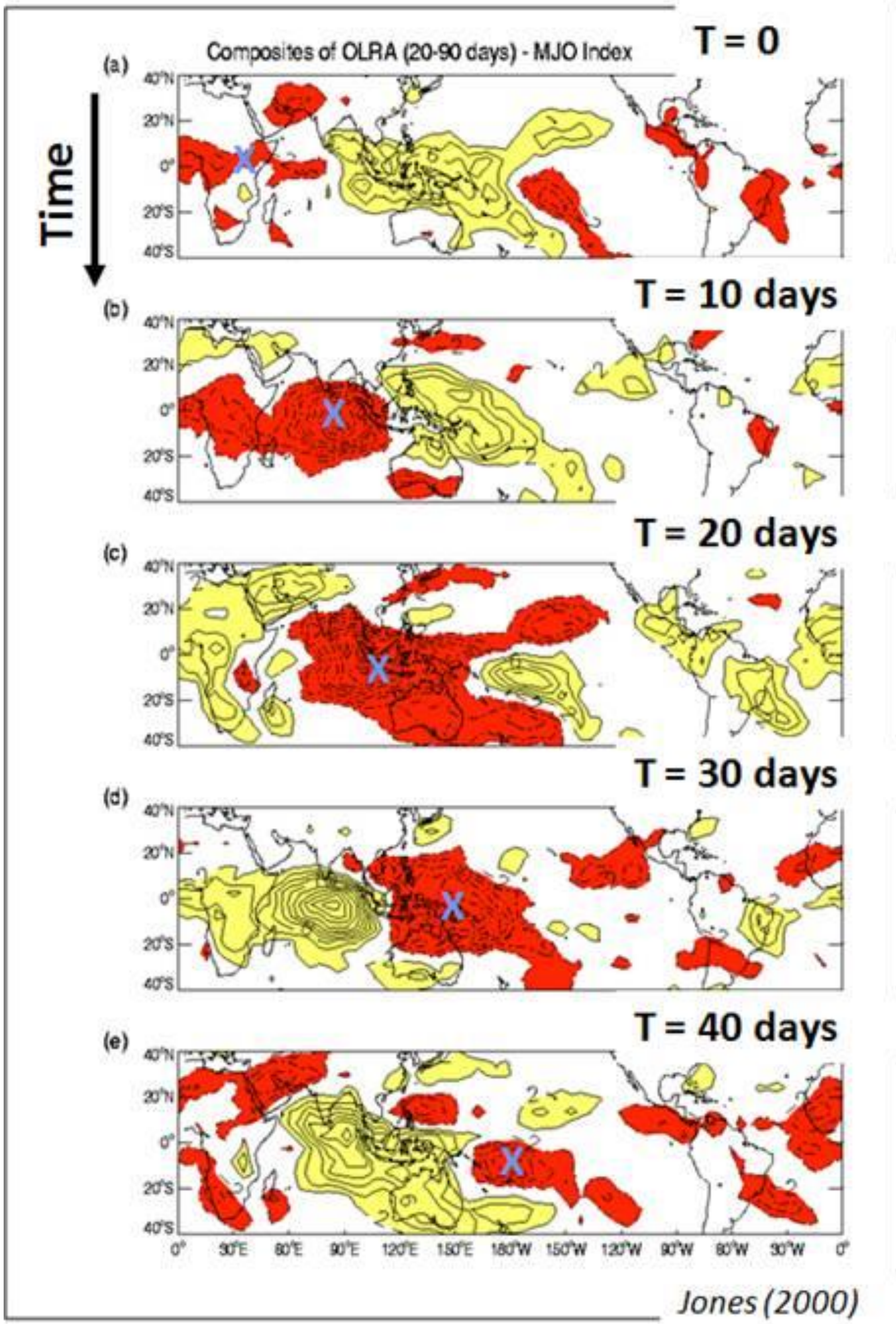

Composites of OLRA (20-90 days) - MJO Index
T = 0
T = 10 days
T = 20 days
T = 30 days
T = 40 days
Time
(a)
(b)
(c)
(d)
(e)
40°N
20°N
0°
20°S
40°S
0°
30°E
60°E
90°E
120°E
150°E
180°W
150°W
120°W
90°W
60°W
30°W
0°
Jones (2000)

a) 0 and 10 days,

- $Velocity = \frac{\Delta meters}{\Delta seconds} = \frac{(LN^{o} * 110 * 10^{3} m)}{(\# \ days * 24 * 60 * 60)} = \frac{(88^{o} - 35^{o})(110 * 10^{3} m)}{(10-0)(24hrs * 60min * 60s)} = \mathbf{6.75} \, \frac{\mathbf{m}}{\mathbf{s}}$

b) 10 and 20 days,

- $Velocity = \frac{(LN^{o} * 110 * 10^{3} m)}{(\# \ days * 24 * 60 * 60)} = \frac{(110^{o} - 88^{o})(110 * 10^{3} m)}{(20-10)(24hrs * 60min * 60s)} = \mathbf{2.80} \, \frac{\mathbf{m}}{\mathbf{s}}$

c) 20 and 30 days

- $Velocity = \frac{(LN^{o} * 110 * 10^{3} m)}{(\# \ days * 24 * 60 * 60)} = \frac{(180^{o} - 110^{o})(110 * 10^{3} m)}{(30-20)(24hrs * 60min * 60s)} = \mathbf{8.91} \, \frac{\mathbf{m}}{\mathbf{s}}$

d) 30 and 40 days.

- $Velocity = \frac{(LN^{o} * 110 * 10^{3} m)}{(\# \ days * 24 * 60 * 60)} = \frac{(-175^{o} W + 180^{o} E)(110 * 10^{3} m)}{(30-20)(24hrs * 60min * 60s)} = \mathbf{0.64} \, \frac{\mathbf{m}}{\mathbf{s}}$