Wide Ranging Climate Impact of Madden – Julian Oscillation

Ismael Dawood Sulaiman AlAmeri
(PhD) Physical Geography
Department of Geography, Education College (Ibn-Rushd)
University of Baghdad

Abstract

The Madden-Julian Oscillation (MJO) is a dominant mode of variability in the Tropical atmosphere with characteristic period of 30 – 60 days , and its discovered in 1971 by Roland Madden and Paul Julian researchers , Madden-Julian Oscillation is a Tropical atmosphere phenomenon in the form of wave occurs mainly in the Indian And pacific oceans , Madden-Julian Oscillation effected atmosphere cycle in the Tropical area , northern pacific ocean and west North America , also Madden-Julian Oscillation effected in the tropical cyclone activity in the pacific and Atlantic ocean , And there's a strong relationship between Madden-Julian Oscillation and El Nino-Southern Oscillation (ENSO) , Many studies show there's a direct link between Madden-Julian Oscillation and monsoon in Asia and Australia .

Keyword: Madden-Julian Oscillation(MJO) - Sea Surface Temperature(SST) - El Nino-Southern Oscillation (ENSO – Upwelling - Ocean-Atmosphere System - Warm Pool - Ekman Divergence - Thermocline

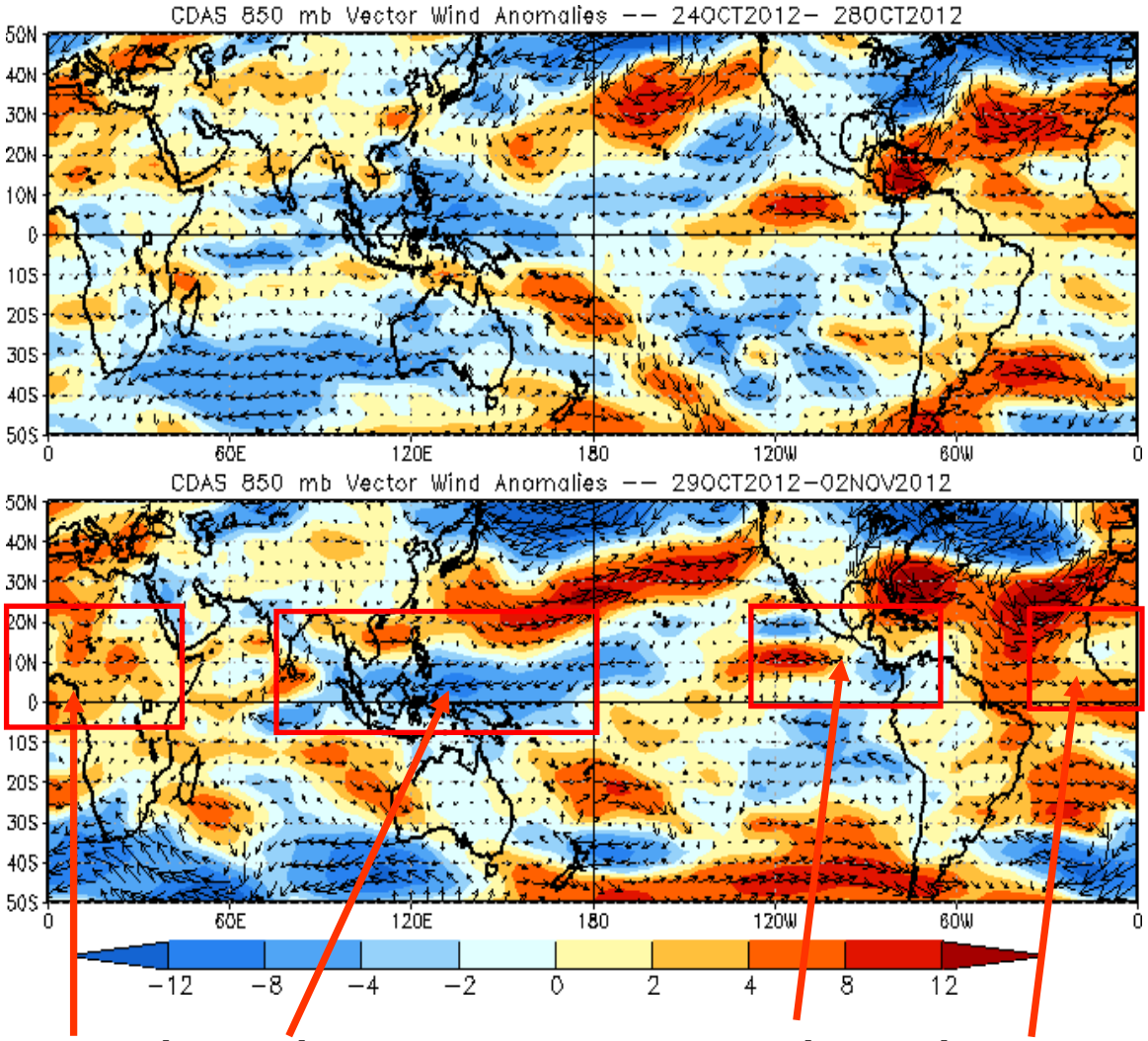
1- Introduction

The Madden-Julian Oscillation (MJO) is a dominant mode of variability In the Tropical atmosphere with characteristic period of 30 – 60 days (1) , Naturally occurring component of couple ocean-atmosphere system , Deep convective tropical rainfall anomalies that propagate slowly Eastward from the Indian ocean through the maritime continent of Indonesia and in to the western pacific where they decay around the date Line , One Madden-Julian Oscillation event taken time typically around 40 Days but its more generally comprised between 30 and 60 days (2) .

The Madden-Julian Oscillation is mainly confined to a band between (20 S) and (20 N) and propagates eastward across all longitudes with phase speeds on the order of (5-10 MS^{-1}) (3), (Figure 1), Interactions between Madden-Julian Oscillation related anomalies in convection and the large Scale circulation are strongest in the eastern hemisphere over the Indian And western pacific ocean where the oscillation exhibits its greatest Variability and typically reaches its maximum amplitude such Interactions strongly influence the onset and activity of the Asian–Australian monsoon system (4) .

The enhanced convection anomalous easterly wind are observed at low Levels with anomalous westerly winds observed at upper levels Following the enhanced convection anomalous westerly winds are Observed at low levels with anomalous easterly winds observed at

upper Levels (5) . The Madden-Julian Oscillation has wide ranging impact on The patterns of tropical and extra tropical precipitations, atmospheric Circulation and surface temperature around the global tropics and Subtropics, several studies have shown that the Madden-Julian



Westerly anomalies developed across equatorial Africa, while easterly anomalies persisted across the Maritime

Westerly anomalies persisted over the east Pacific and tropical Atlantic during the past ten days.

Figure 1: Shading denotes the zonal wind anomaly Blue shades: Easterly anomalies Red shades: Westerly anomalies
Source: www.cpc.ncep.noaa.gov.

Oscillation can affect the distribution of rainfall and extreme events in Many locations around the world (6).

2- The Madden-Julian Oscillation Mechanism

The Madden-Julian Oscillation affected by many factors such as Land-sea distribution, change of solar insulation, change of sea surface Temperatures and ground temperatures. The most important factors for The Madden-Julian Oscillation are the latitudinal variation of sea Surface Temperature and the warm pool in the Indian western pacific Ocean (7). Convection and clear skies associated with a stronger than normal trade Wind inversion allow more shortwave radiation to reach the ocean Surface causing a slight sea surface temperature increase as the wave Travels eastward (Figure 2,3).

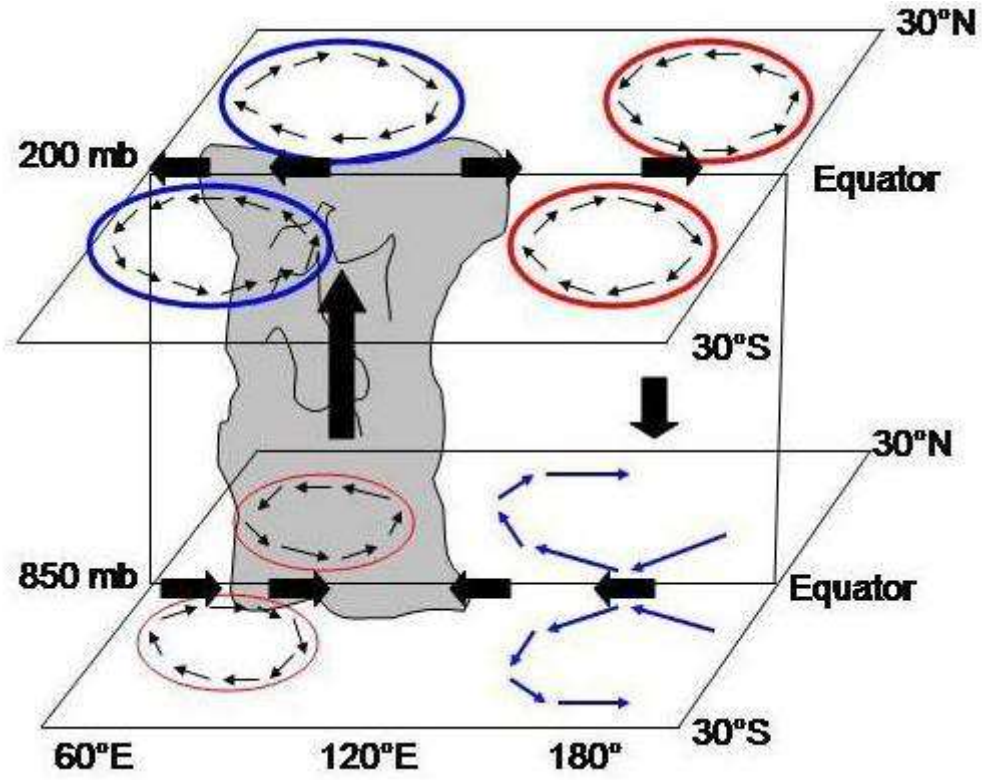


Figure 2: Equatorial vertical cross section of the Madden-Julian Oscillation.
Source: http://s98.photobucket.com

Fluctuations in tropical wind stresses associated with the oscillation are Large and likely play an important role in forcing the oscillation (8).

The Madden-Julian Oscillation spans (50-100) degrees longitude or zonal Wave number (1 to 5) and its speed generally varies from (4 to 6 MS^{-1}) This massive convective disturbance has huge impacts on the weather and Climate of our planet (9).

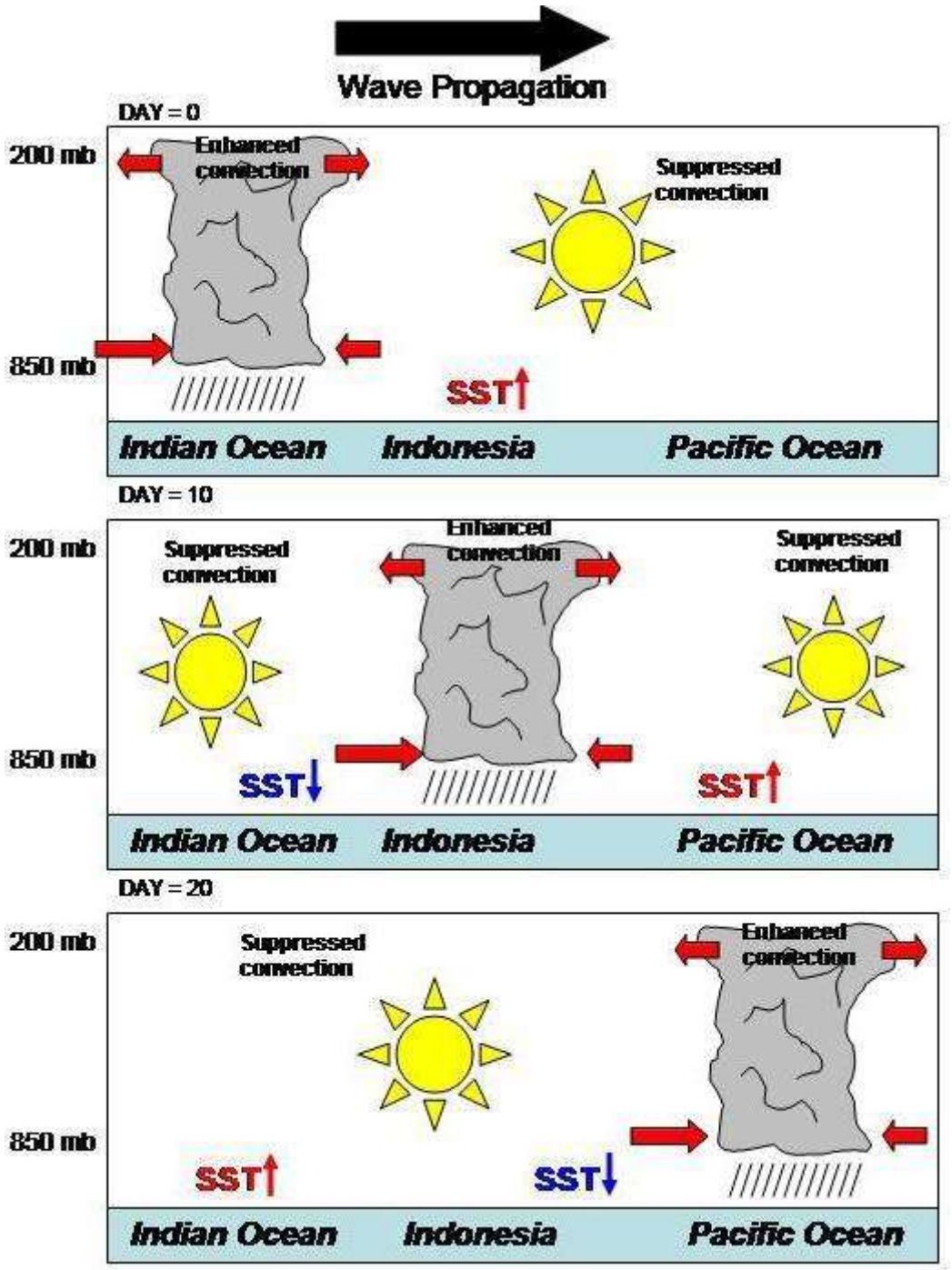


Figure 3: Madden-Julian Oscillation propagates from the Indian Ocean to the western Pacific. Red arrows indicate direction of wind

and red (blue) SST labels indicate positive (negative) SST anomalies respectively.

Source: Philip J. Klotzbach, On the Madden–Julian Oscillation–Atlantic Hurricane Relationship: 2010, Journal of Climate, Volume 23.

The radiation play an essential role, the Convective instability of the Atmosphere can be modified by a clear sky Because of radiation, Propagation velocity of the medium depends on the Madden-Julian Oscillation term stability of moisture and composition After the time, the Atmosphere tends to be more stable in the west of the Center of Convection in the east partly because the Ekman divergence is Related to The equatorial surface of the west and partly by that part dry After the Active convection, (Figure 4).

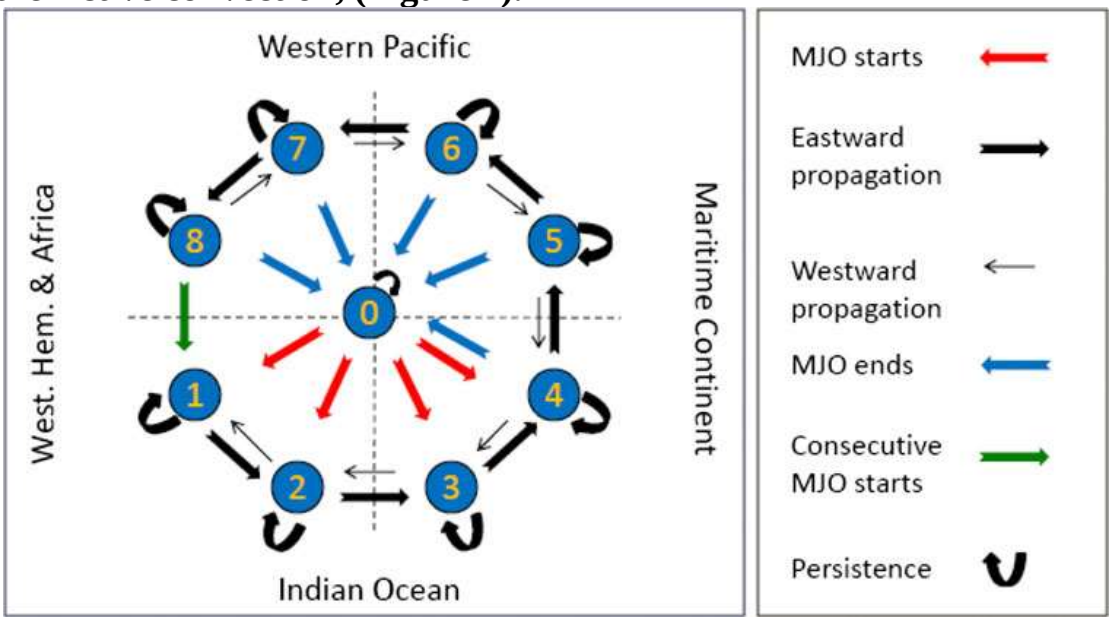


Figure 4:The Madden–Julian oscillation activity.
Source: Charles Jones Æ Leila M. V. Carvalho: 2011, Stochastic simulations of the Madden–Julian oscillation activity, Clim Dyn (2011).

3- Relationship between Madden-Julian Oscillation and El Nino-Southern Oscillation (ENSO)

The development of El Nino-Southern Oscillation (ENSO) is Generally understood as resulting from coupled instability of the tropical Ocean-atmosphere system, in the ocean models used for the coupled Instability analysis, the sea surface temperature (SST) variations are Controlled by dynamic processes associated with thermocline Displacement and temperature advection by currents and upwelling (10).

The regular occurrence of strong intraseasonal oscillation over the Western pacific during the onset of El Nino events has sparked interest in Possibility of a physical connection between two frequencies (11). The Madden-Julian Oscillation is often have a strong relationship with the Cycle phase of El Nino-Southern Oscillation and its can influence the Evolution of the phase of El Nino-Southern Oscillation cycle as Convection influence the ocean –atmosphere coupling by varying the Radiation budget at the surface, evaporation, wind stress and Consequently slow interaction between the limits of the ocean and Atmosphere layers.

The variations of the level of Madden-Julian Oscillation convective Activity occur largely independent of El Nino-Southern Oscillation Except during exceptional warm events when Madden-Julian Oscillation Convective activity is diminished, an eastward shift of both broadband Intraseasonal activity and coherent eastward propagating activity does Occur during warm El Nino-Southern Oscillation episodes (12).

4- Tropical and Mid-latitudes Impact

The Madden-Julian Oscillation impact two important features: Tropical cyclone and monsoon activity across the globe, The enhanced Rainfall phase of the of the Madden-Julian Oscillation result in more Frequent tropical cyclone activity and the suppressed rainfall phase of the Madden-Julian Oscillation generally results in reduced tropical cyclone Activity in these areas and the enhanced rainfall phase of the Madden-Julian Oscillation can also intense the onset of monsoon seasons around The globe (13).

The Madden-Julian Oscillation also effects weather and climate outside The tropics in particularly in the mid-latitude between 40 and 70 in both Hemisphere where the prevailing wind are westerly and the atmospheric Flow pattern is highly variable with alternating low and high pressure Systems.

5- Flood

The Madden-Julian Oscillation might had influences on certain Major flood event include a series of severe floods during the summer of 1998 in eastern china, Afghanistan flood of April 2002, the extreme flood 2006-2007 in the southern peninsula of Malaysia and the largest floods On record at Jakarta in 2002,2007 and 2008 (14).

6- Fire

The Madden-Julian Oscillation effects on fire (biomass burning Due both to wildfire and manmade fire in agriculture practice) come Obviously from its modulation on rainfall that may help prevent delay or Terminate fire.

7- Other Effects

The Madden-Julian Oscillation also cast significant influences on Many other phenomena in the earth system, the Madden-Julian Oscillation deep convection casts substantial influences on the variability In upper-tropospheric and lower stratospheric water vapor. And the Madden-Julian Oscillation can induce intraseasonal fluctuations in Atmospheric CO,CO2,O3 (15).

8- Summary and discussion

The Madden-Julian Oscillation is a global –scale convectively Coupled eastward moving disturbance with roots in the tropics, Convective aspects are most obvious in the Indian and western pacific Oceans and easterly wind anomalies exist in the lower troposphere to the East of the active convection and in the upper troposphere to the west While westerly anomalies occur to the west of the convection in the lower Troposphere and to the east in the upper troposphere(16). The Madden-Julian Oscillation affects rainfall patterns in Indonesia and surrounding Areas, The strongest tropical cyclones tend to develop when the Madden-Julian Oscillation favors enhanced precipitation as the Madden-Julian Oscillation progresses eastward the favored region for tropical cyclone Activity also shift eastward from the western pacific to eastern pacific And to Atlantic ocean during the northern hemisphere summer.

There is a strong relationship between Madden-Julian Oscillation and El Nino-Southern Oscillation cycle phase and its can influence the evolution Of the phase of El Nino-Southern Oscillation, and there is a direct link Between Madden-Julian Oscillation and monsoon in Asia and Australia.

Madden-Julian Oscillation is not well understood and several physical Mechanisms have been proposed to explain it and also its difficult to Predict because its occurring very irregularly.

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التأثيرات المناخية الواسعة النطاق لذبذبة مادين – جولين

م.د.اسماعيل داود سليمان العامري

دكتوراه في الجغرافية الطبيعية

المستخلص

ذبذبة مادين–جولين هي حالة من التقلب او التغير في الغلاف الجوي في المنطقة المدارية وشبة المدارية لمدة تتراوح بين 30–60 يوم وقد اكتشفت هذه الظاهرة في عام 1971 من قبل الباحثين رولاند مادين Roland Maddenو باول Paul Julian .جولين

وتعد هذه الظاهرة نتاج لتفاعل الجو مع المحيط في المنطقة المدارية والتي تؤثر بشكل مباشر في دورة الغلاف الغازي في المنطقة المدارية فضلاً عن تأثيرها في القسم الشمالي من المحيط الهادي وغرب اميركا الشمالية ، كما تؤثر ذبذبة مادين وجولين بنشاط الاعاصير في المحيطين الهادي والاطلسي فضلاً عن وجود علاقة ترابط بين ذبذبة مادين وجولين والطور الدافئ للانسو ، وقد اثبتت العديد من الدراسات تاثير ذبذبة مادين وجولين في نشاط الامطار الموسمية في اسيا واستراليا ، كما اثبتت تأثيرها في نشاط الفيضانات وحرائق الغابات ، لذا فأن ذبذبة مادين وجولين من الظواهر المناخية الواسعة النطاق من حيث التأثير والمحدودة زمنياً من حيث مدة البقاء فمن الضروري التعرف على هذه الظاهرة والتنبؤ بنشاطها.