8A.7 GENESIS OF EASTERLY WAVES OVER THE INTRA AMERICAS SEAS AND TROPICAL EASTERN PACIFIC.

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1. INTRODUCTION

Easterly waves (EWs) are westward propagating disturbances found over the tropical atmosphere with time periods of 2-10 days and a wavelength around 2500km. While most of the research of EWs has been focused on African easterly waves (AEWs), research over the Intra-Americas Seas region and eastern Pacific has been explored only recently. The genesis of EWs over the eastern Pacific is one of the topics that remains elusive.

Some mechanims for the genesis of EWs over the IAS/east Pacific have been proposed, the simplest one considering only a continuation of AEWs over this region (Shapiro 1986). However, given that the number of EWs over the eastern Pacific does not account for observed AEWs (Molinari 1997), this theory has been discredited. A recent study has proposed that EWs could be generated *in situ*, primarily forced by the high terrain over the northern mountain ranges of South America next to the Panama bight (Rydbeck 2017). This hypothesis agrees with previous results of EW genesis over Africa. However, this study also highlights the necessity of a pre-existing EW for further development downstream.

While previous research has not made clear the genesis mechanism, we perform a modeling study, similar to Thorncroft et al. (2008) considering different heating profiles. The following sections describe the data and methodology used for these goals, and present results of the most important aspects. The results show that EWs can be generated over the convective region of Panama close to the entrance of the Caribbean low-level jet (CLLJ) to the eastern Pacific, with better results using a shallow convective profile during MJO convective phases.

1. DATA AND METHODS

We use data from ERA-Interim reanalysis (Dee et al. 2011) to ingest a global spectral primitive equation model. This model has a horizontal resolution of T31 and 10 equally spaced vertical sigma levels. Given that it has been documented that the Madden-Julian oscillation (MJO) plays an essential role in modulating the frequency and location of EWs over the IAS/eastern Pacific (Aiiyer and Molinari 2008, Rydbeck et al 2014), two basic states are tested: a climatological one, and a MJO in convective phase during June-September (JJAS) from 1980-2015. Finite-amplitude localized heating perturbations are prescribed via the thermodynamic equation as in Thorncroft et al. (2008) on several points over the study region. Also, three different heating profiles are tested given the different population of convective clouds in the region. For brevity, in this extended abstract we present only the MJO-convective state with deep and stratiform convective profiles at 10ºN, 85ºW. This point was selected based on maximum variance of EWs over the eastern Pacific/IAS region and because of its position downstream of mountains in Central America.

2. RESULTS

Figure 1 shows the mean winds during the MJO convective state along with the streamfunction used for simulations, as calculated from ERAI reanalysis (Fig. 1.a) and from the spectral model (Fig. 1.b) during JJAS. It is observed that the model is able to capture the main features of the environment, such as the CLLJ extending to central US (though with less intensity as expected), and the wind anomalies over the eastern Pacific associated with the MJO in its convective stage. Also, the streamfunction shows similar patterns in the model when compared to reanalysis. Similar results were obtained for the basic mean state. Together, these comparisons gave us enough confidence in the way the model resolves the initial basic state.

Figure 2 shows the results of simulations, presented with the streamfuncion at the sigma level of σ=0.85, of two different heating profiles during the MJO convective phase at 10ºN, 85ºW. On the left (Fig. 2.a), the deep convective profile is observed, while on the right (Fig 2.b), is the shallow convective heating profile. The atmospheric response of the deep convective profile in Fig. 2.a, shows a weak anomaly structure tilted northeast to southwest associated with EWs over this region. However, this structure quickly dissipates in the first five days. At day 6, we observe that the EW-like structure has

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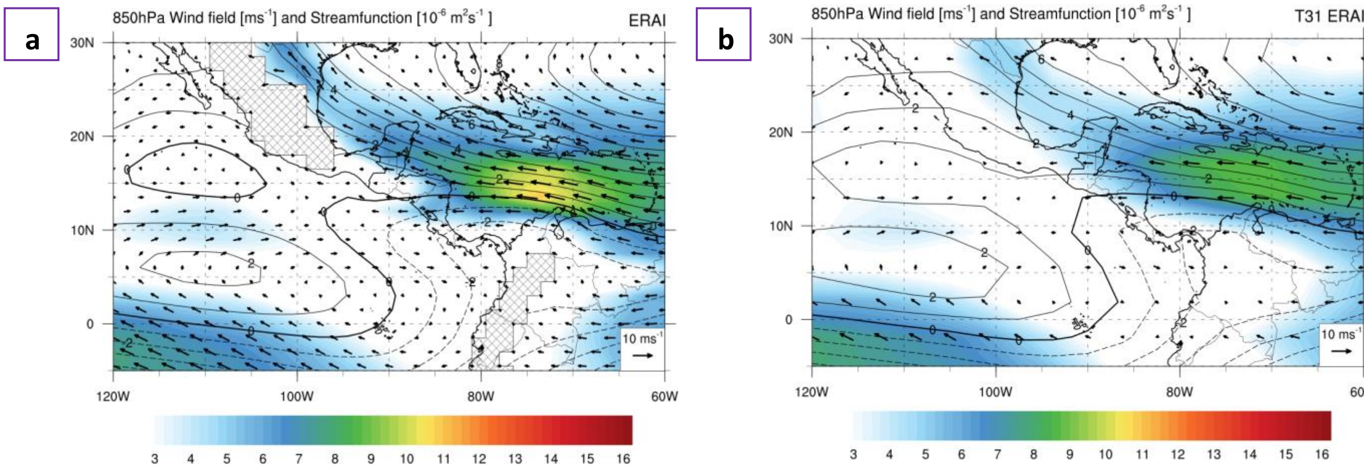

Figure 1. Mean state wind magnitude (shades vectors) [ms^{-1}], and streamfunction (contours) [10^{-6} m^{2}s^{-1}] during summer (JJAS) over the eastern Pacific-IAS region during 1980-2015 during MJO convective phases as seen: **a.** from reanalysis at 850 hPa, and **b.** from the model at T31 level of σ=0.85. Data from ERA-I.

completely dissipated. In comparison, the shallow convective profile in Fig. 2.b, initially shows a more intense streamfunction that strongly persists for a longer time, up to 8 days. It is also observed that the northeast to southwest tilted EW structure is present, and that the initial trough moves along the observed track of EWs over the east Pacific/IAS region. A marked delay when compared to the deep heating is observed and this is due to the response to the atmospheric heating.

These results highlight some important points: despite documentation that deep convection is found over the Panama bight and central America (Zuluaga and Houze 2015), the convection itself is not sufficient for EW genesis over the region. Therefore, it is necessary that a suitable mean environment supportive of wave growth must also exist. When compared with Africa, potential vorticity meridional gradients over the IAS/eastern Pacific are not as strong as over Africa. However, when the convective phase of the MJO is present, potential vorticity at low levels is increased.

Our results show that overall deep convection does not generate a coherent and persistent EWs over the east Pacific/IAS region as happens over Africa. This is reinforced by simulations with a deep convective profile during the presence of the MJO. However, shallow convection creates a more intense initial low-level trough that persist for a longer time in a MJO environment. This is due to a strong overlapping of the low-level trough resulting from the heating, with the associated PV gradients arising from the presence of the MJO. Such interaction works together to create and maintain a favorable convective and supportive environment for EW growth over the IAS/eastern Pacific region.

3. CONCLUSIONS

By using a primitive equation spectral model, we show that heating over the Central America, close to the CLLJ over the eastern Pacific, forces an EW response. This response is better when both conditions, convective and environmental, are suitable in the region. Such conditions require the presence of the MJO and not deep, but shallow convection downstream of the mountain regions of Central America. Overall, this is because increasing the meridional gradients of PV together with enhanced PV anomalies from convection work to generate and sustain EW growth over the IAS region and eastern Pacific.

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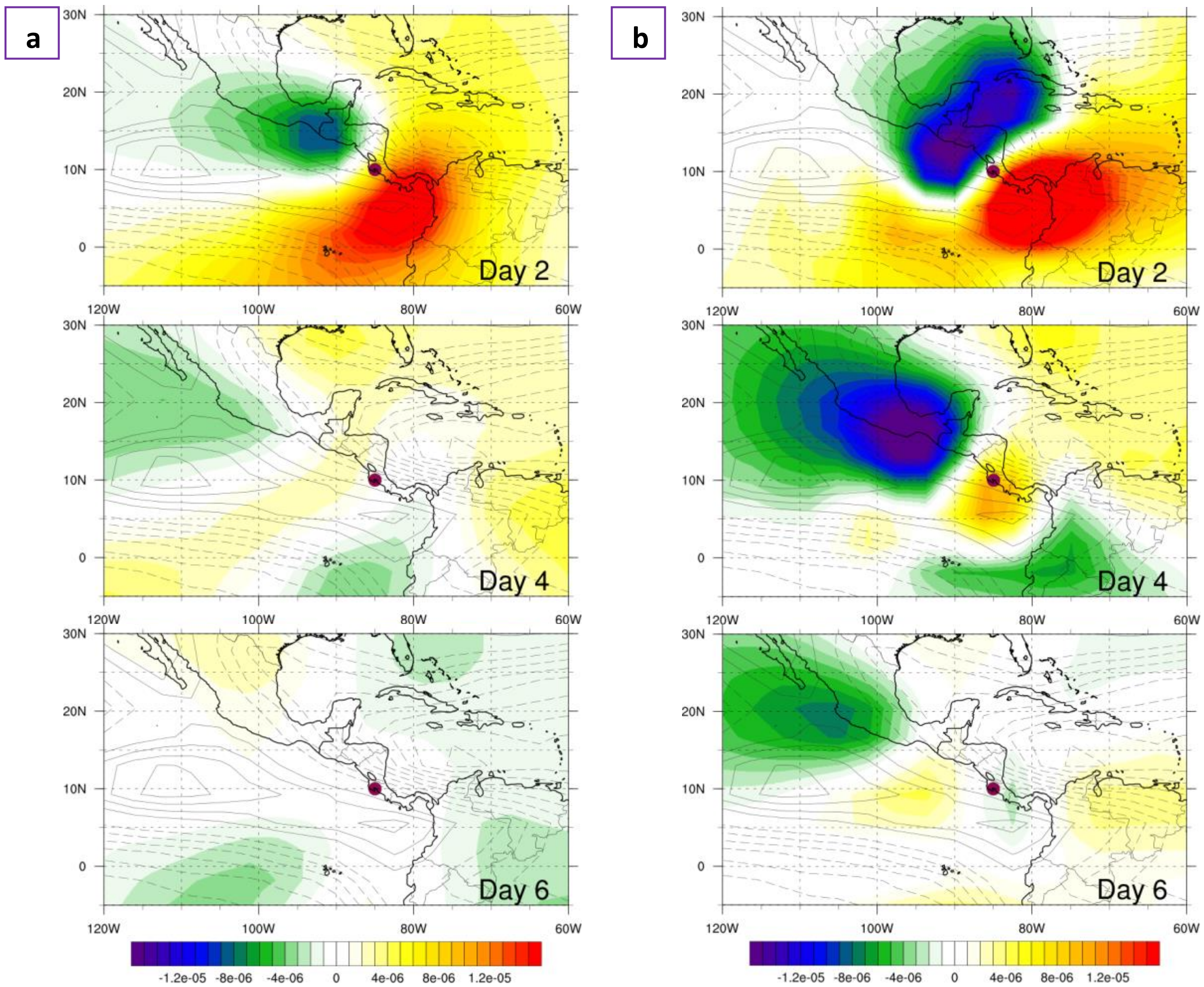

Figure 2. Streamfunction anomalies in shades [m^2s^{-1}], overlaid on zonal wind in contours [ms^{-1}] during MJO convective phases at σ = 0.85 for days 2,4, and 6 at 10°N, 85°W for the response of (left) **a.** deep convective, and (right) **b.** shallow convective.

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