On the Propagation of the Intraseasonal Oscillation: A personal view

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Abstract

This presentation summarizes my personal view about the mechanisms responsible for the propagation of the intraseasonal oscillation. It includes the propagation occurring in the following regions and seasons: 1. eastward propagation along the equator in the boreal winter (MJO), 2. northward propagation in South Asia during the boreal summer, and 3. northwestward propagation in the northwestern Pacific during the boreal summer.

Keywords : propagation, intraseasonal oscillation

1. Eastward propagation along the equator in the boreal winter

The MJO was observed to amplify in the central Indian Ocean and the western Pacific and was therefore suggested to comprise both propagating and stationary components. The ampli- ication (and the stationary comp- onent) tends to occur in the regions where the characteristics of the background flow, e.g., high sea surface temperature and abundant moisture, favor the develop- ment of volatile convection activity.

In this study, we re-examine the temporal evolution of the three-dimensional structures of the MJO during the boreal winter. It was found that, when an old updraft dissipates in situ, a new updraft tends to develop downstream in the eastern side of the mountainous regions in the tropics, e.g., Borneo, New Guinea, the Andes and Guiana Highlands, and the Ethiopian Highlands. The easterly flow and the corresponding negative height anomaly, which are located in the lower troposphere and to the east of the deep convection embedded in the MJO, extends quickly eastward and leads to a shallow updraft and near-surface convergence in the eastern slope of the mountainous areas. The shallow updraft flares later and becomes the updraft core of a deep convection when the old convection in the west dissipates. This eastward propagation of the zonal flow and height fields is most evident in the lower troposphere and is particularly evident in the eastern Pacific. This observation helps explain the discrete downstream development of the deep convection associated with the MJO, in addition to the existing wave-CISK mechanism. The lifting effect of the Ethiopian Highlands on the large-scale circulation may also help explain the genesis of the MJO often observed in the eastern Indian Ocean.

2. Northward propagation in South Asia during the boreal summer

This study investigated the characteristics of the evolution and structure embedded in the eastward- and northward-propagating ISO in the Indian Ocean, South Pacific, and the western Pacific. Eastward propagation occurs near the equator while the northward propagation osccurs sequentially in the Arabian Sea, the Bay of Bengal, and the South China Sea. A distinctive northwestward propagation is also observed in the western North Pacific.

The near-surface moisture convergence ahead of the deep convection apparently results in the propagation of the ISO. While the moisture convergence in the eastward propagation can be explained by the frictional Kelvin wave, the moisture convergence in the northwestward propagation is seemingly induced by the frictional effect in the equatorial Rossby wave which is maintained through the circulation-convection interaction. In the latter case, the surface moisture is supplied through the moisture transport from the South China Sea and the Indian Ocean, not by the ocean ahead of the deep convection.

Northward propagation in the Indian Ocean and South Asia occurs sequentially in the following order: the Arabian Sea, the Bay of Bengal, and the South China Sea. The propagation can be understood in the framework of the interaction between the intraseasonal anomaly and the mean southwesterly flow. The anomalously southward moisture transport to the north of the deep convection embedded in a mean flow, which transport moisture northeastward, results in the anomalous moisture convergecne ahead of the deep convection. Our results also indicate that the anomalous sensible heat flux and less stable condition also contribute to the northward propagation from the Arabian Sea to northwestern India. Development of deep convection in the Arabian Sea brings in more moisture to the Bay of Bengal and leads to the northward propagation in the Bay of Bengal. Development of deep convection in the Bay of Bengal in turn brings in more moisture to the South China Sea and leads to the northward propagation in the area. This downstream development results in the impression of eastward propagation of deep convection in the subtropical region.

3. Northwestward propagation in the northwestern Pacific during the boreal summer

The convection of the intraseasonal time scale in the Western North Pacific during the boreal summer tends to propagate northwestward in the Philippine Sea to near 20摸 and then continues propagating westward. The formation of enhanced convection in the

Western North Pacific is a result of the merging of a convective system moving eastward along the equator and a westward-propagating low-level convergence anomaly, which is located to the east of a vortex in the subtropics. A positive feedback between the anomalous circulation and convection leads to a rapid enhancement of the system. The strengthened southwesterly associated with the vortex enhances evaporation over the oceans (e.g., the Eastern Indian Ocean, the Bay of Bengal, and the South China Sea) and transports moisture northeastward. The moisture converges at the northwestern corner of the convection and results in a potentially unstable atmosphere. The result is the northwestward propagation of the coupled circulation-convection system in the Western North Pacific. It was found that the ocean-atmosphere interaction plays an important role in supplying energy to sustain the circulation and convection during the course of propagation. The circulation-convection interaction is the key factor in maintaining the system strength until it reaches the Asian landmass when the supply of moisture is reduced. The atmosphere seems to play a dominant role during the ocean-atmosphere interaction processes, while the ocean plays a more passive role in response to the atmospheric forcing.

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