16B.2 INTRA-SEASONAL PERTURBATION OF THE CONVECTIVE ACTIVITY OVER THE INDIAN OCEAN AND RELATION WITH THE SST

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1. INTRODUCTION

There are growing evidences that air-sea interactions may play a large role in the generation and in the characteristics of the intraseasonal variability (ISV; 20-50 days) of the deep tropical convective activity. For example, observational studies (Chen et al 1996; Jones et al 1998; Woolnough et al 2000) have shown or suggested that the propagation of the convective perturbation may be governed or influenced by local interactions between the ocean and the atmosphere. However, more observational studies are requested to confirm if the ocean and particularly the structure of the mixed layer (depth, heat content, presence of a barrier layer), may have a significant role in the ISV characteristics. On the opposite, it is also important to quantify the potential role of the ISV in modifying the heat content of the Indian Ocean. This is a central element to understand the scale interaction between intraseasonal and interannual time-scales in this region.

Mechanisms of the air-sea interaction related to the ISV must be studied considering the non-linear impact of the numerous mesoscale convective systems on the Sea Surface Temperature (SST) field. As a first step, our study gives, for one event in January 1999, a precise description of the modulation of the cloud clusters characteristics and of the associated surface parameters in the different phase of the ISV. Only the modulation of the OLR, the SST and the cloud cluster characteristics are discussed in this short note.

2. THE JANUARY 1999 EVENT

The ISV of the convection is characterized from time series of the NOAA OLR (Liebmann and Smith, 1996). The convective cloud clusters are characterized using the infrared images of Meteosat-5. The Short-term satellite estimates of the SST are now possible thanks to the additional 10-GHz channel of the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) (Wentz et al 2000).

For one particular ISV event, the envelope of the convective perturbation may be defined as the ensemble of regions that have a significant part of their intraseasonal signal with similar time-spectral characteristics. Such an information may be extracted from the Local Mode Analysis (LMA ; Goulet and Duvel 2000) of the OLR signal. For a time section of reduced length L (here 120 days), the LMA analysis gives for each region a signal of the form:

$$M(x,t)= A(x)B(t)\cos(\phi(x)+\chi(t)) \quad (1)$$

where A(x) and $\phi(x)$ are respectively the amplitude and the phase of the first complex eigenvector and B(t) and $\chi(t)$ represents the amplitude and the phase of the complex principal component. This signal represents for each region the part of the local intraseasonal perturbation of the convection that is coherent at large scale. The LMA of the OLR time series is used to extract the spatio-temporal structure of the ISV of the convection during winter 1998-1999. For this winter, there are two persistent events centered respectively the 25 January 1999 and the 11 March 1999. We report here only results relative to the January event.

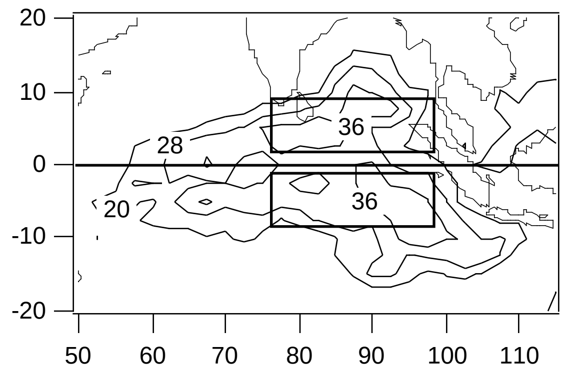

Figure 1: Amplitude (Wm-2) of the OLR ISV event centered on 25 January 1999. The two boxes represent the Southeast and the Northeast regions.

For the January event, the amplitude of the convective perturbation is maximal north and south of the equator (Fig.1). The convective perturbation propagates eastward with an average propagation speed of 10m/s until the Sumatra Island. This event is clearly a modulation of the longitudinal extent of the ITCZ that is most active above Indonesia.

3.PERTURBATION OF CONVECTION AND SST

The temporal modulation of the OLR, the SST and convective cloud characteristics (number of convective systems and size of these systems; Roca et al, 2002) are computed from spatially averaged values over the two regions outlined on figure 1. For this event, the amplitude of the perturbation of the SST is maximal south of the equator between 5°S and 10°S with values larger than 3K for some regions. The difference between the SST perturbations north and south of the equator is quite surprising taking into account the somewhat symmetric distribution of the perturbation of the convective activity relative to the equator (fig.1 and 2). A remarkable aspect of the evolution of the cloud characteristics is the progressive increase of the number of small systems that corresponds to the gradual decrease of the mean OLR value. These systems then tend to merge into a few very large convective complexes at the time of the minimum OLR corresponding to the most active phase of the ISV. The evolution of these cloud characteristics is quite similar for the SE and the NE regions (fig.2), suggesting that the surface radiative perturbation of these convective clouds should be similar. The difference in the SST response north and south of the equator is thus rather due to turbulent flux perturbation (mainly related to the intraseasonal modulation of the surface wind) and to a perturbation of the ocean dynamics through Ekman forcing.

The role of these two factors in the modulation of the SST is estimated using, climatology of the Indian Ocean structure, analyses of the European Centre for Medium range Weather Forecast (ECMWF) and other satellite estimates (SSM/I). First results (not shown) indicate that the difference in the response of the SST to the forcing induced by the ISV is mainly related to differences in the mean state of the ocean and to differences in the Ekman pumping perturbation. This may explain the strong cooling observed over the SE region. A remaining problem is now to find the physical processes that stratifies and warm the mixed layer of the SE region at the end of the convective event. There is actually an inconsistency between the time evolution of the SST and that of the net surface flux estimated using ECMWF analysis and satellite measurements. This inconsistency certainly demonstrates that more in-situ measurements in this region are required to fully describe and understand the coupling between the ocean and the atmosphere at the intraseasonnal time scale.

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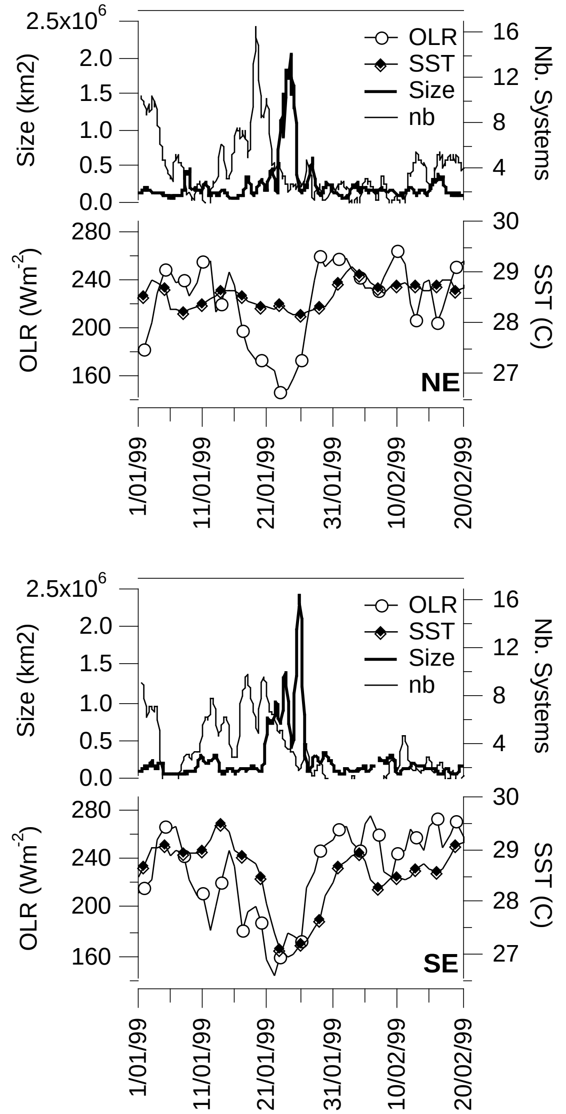

Figure 2 : Modulation of the OLR, the SST, the number of cloud systems and of the size of these cloud systems for the January 1999 ISV event.

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