THE CONTRAST OF THE EL NINO AND LA NINA EVENTS ON THE CONVECTION OVER EAST ASIA

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1. INTRODUCTION

The 1997-1998 El Nino is one of the strongest El Nino Southern Oscillation (ENSO) events. The warm pool in the western Pacific migrated eastward with the collapse trade winds [Chandora et al., 1998: McPhaden and Yu, 1999]. It is known that the major impact of the sea surface temperature (SST) change during this El Nino event was the shift in convection activities from the western to the central and the eastern Pacific Ocean affecting the response of rain-producing cumulonimbus. It is also known that while El Nino may impact the Asian-Australian monsoon, severe droughts and floods in the region can be due to other factors [Rasmussen and Carpenter, 1983: Webster et al, 1998].

The 1997-1998 El Nino began to develop in March 1997 and strengthened rapidly over the next year. After a gradual decline in the intensity of these thermal anomalies in early 1998, the El Nino event abruptly ended during May–June 1998. After this strongest El Nino event, La Nina event started soon. This La Nina event continued more than a year, and then disappeared in the spring of 2000.

Effrina et al.[2001] asserted that during the El Nino period the lightning activities are more frequent despite less convective storms in East Asia, especially in Indonesia. In this paper, the authors pay their attention to the contrast of the convective activities between El Nino and La Nina periods over the East Asia including the area where Effrina et al.[2001] studied. The effects of El Nino and La Nina events to the precipitation and lightning activities are investigated. Their possible correlation with some parameters of storms is also considered.

2. STUDY DATA AREA AND PERIODS

The 1997-98 El Nino is one of the strongest ENSO events. And after this strongest El Nino event, La Nina event follows. This La Nina event continued more than a year, and disappeared in the spring of 2000. Here after we define January-June, 1998 period as El Nino (because TRMM data is available from the midstream of December 1997), January-June, 1999 period as La Nina, and, for comparison, January-June, 2001 period as Normal (when neither El Nino nor La Nina occurred).

More frequent lightning activity despite less convective storms in Indonesia was confirmed by Effrina et al.[2001]. For verifying the effect of El Nino, we defined the study area as from 20° to 30° in north latitude, and from 120° to 130° in east longitude, including the area where Effrina et al.[2001] studied.

The data of lightning flash and precipitation are obtained from Lightning Imaging Sensor (LIS) and Precipitation Radar (PR) on Tropical Rainfall Measuring Mission(TRMM), respectively. The PR data we used are 3A-25 Planetary Grid 1 which has 0.5° grid intervals in latitude and longitude. These PR data include the storm heights, the number of times of observed precipitation, and the mean intensity of precipitation. These values do not represent the precipitation intensity during the whole period when TRMM observes the study area but represent it only for the periods when precipitations are observed.

3. RESULTS

Figure 1 shows the monthly variation of lightning flashes over the study area during the El Nino,

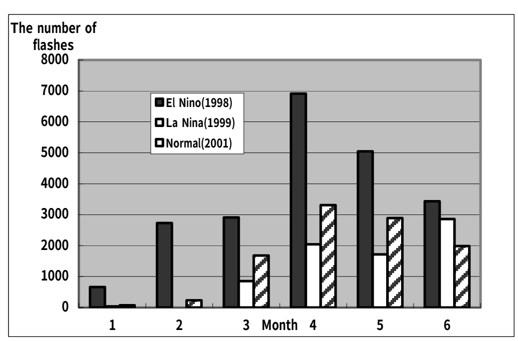

Figure 1. Monthly variation of lightning activity in East Asia.

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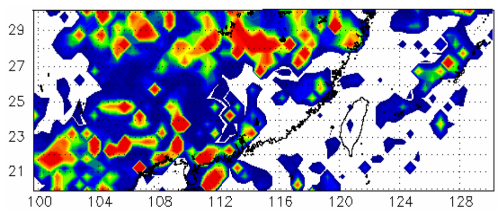
La Nina, and Normal period. From the figure 1, it is obvious that the number of flashes is the most during the El Nino period, and the least during the La Nina period (except June).The number of lightning flashes during the El Nino period is nearly three times as many as it during the La Nina period. The difference in the number of lightning flashes shows that the lightning during El Nino period is more active than

(a) April 1998(El Nino)



(b) April 1999(La Nina)

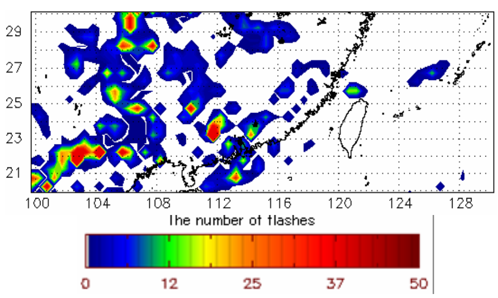


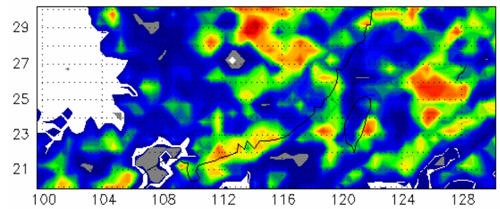
Figure 2. The spatial distributions of lightning flashes. The number of flashes is sampled every 0.5°grid.

it during La Nina period. This feature is especially prominent in April. The difference between El Nino and La Nina periods is the clearest in the six months (April 1998; 6916, April 1999; 2041 flashes). After this we discuss about April in terms of some other parameters, and define El Nino period shows as April 1998, La Nina period as April 1999.

The spatial distribution of lightning flashes in El Nino and La Nina periods are shown in figure 2. As is expected from figure 1, the spatial distribution in El Nino period spread more extensive area and intenser than in La Nina period.

Figures 3 and 4 show the spatial distribution of the number of times of observed precipitation and the mean intensity of precipitation, respectively. Though the lightning activity is harder in El Nino period as shown in figures 1 and 2, figure 3 indicates that the number of precipitation is less than that in La Nina period. To the contrary, figure 4 shows that the mean intensity of precipitation in El Nino period is heavier than that in La Nina period. To sum up the feature of precipitation the times of precipitation in El Nino period is less, but once it begins to rain, it rains harder than La Nina period.

(a) April 1998(El Nino)



(b) April 1999(La Nina)

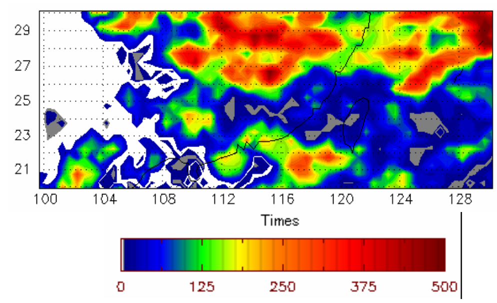
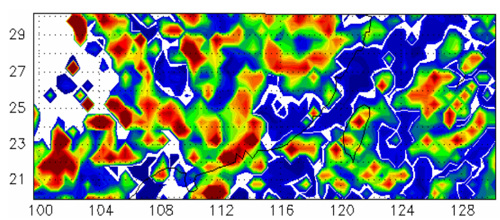


Figure 3. The spatial distributions of the number of times of observed precipitation.

(a) April 1998(El Nino)



(b) April 1999(La Nina)

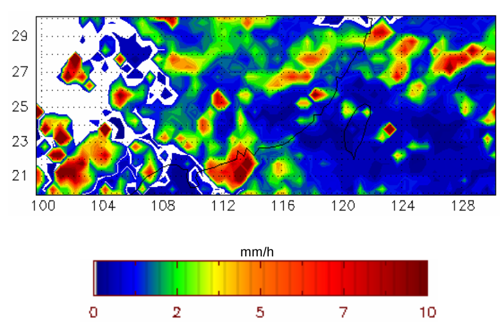
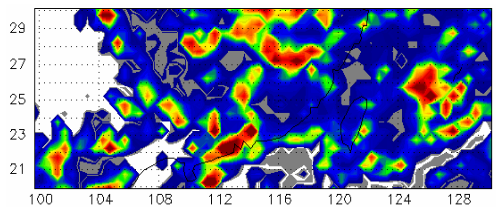


Figure 4. The spatial distributions of the mean intensity of precipitation.

As mentioned before these parameters do not represent the total precipitation. So we define the term “the total amount of precipitation” as the product of the number of times of the precipitation and the mean intensity of precipitation. Figure 5 shows the total amount of precipitation. This figure shows it rained more in La Nina than El Nino period.

(a) April 1998(El Nino)



(b) April 1999(La Nina)

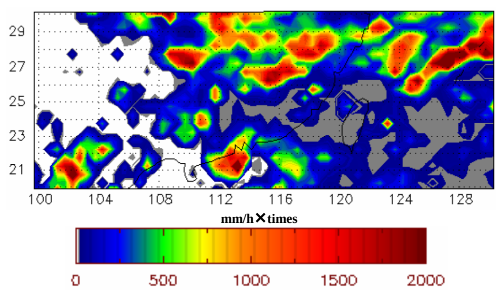
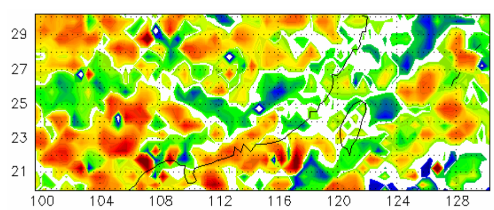


Figure 5. The total amount of precipitation

(a) April 1998(El Nino)



(b) April 1999(La Nina)

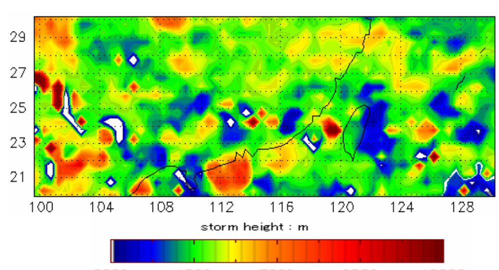


Figure 6. The distribution of the mean storm height

From the spatial distribution of storm height in figure 6, it is shown that the storms were more widely distributed in La Nina period, while the storm did not develop as high as that of in El Nino period. Figure 7 is the number of pixels of storm at various altitudes. One pixel corresponds to an instantaneous field of view during TRMM PR scanning, that is similar to 4.3 ×4.3 km^2 at ground level. In figure 7 it is obvious that more storms were generated in La Nina period, however the storms grew up over 7000m were less than El Nino period.

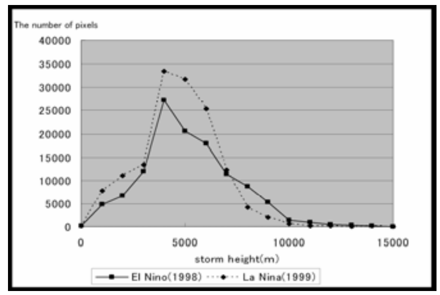


Figure 7. The number of pixels of storm at various altitudes. One pixel corresponds to an instantaneous field of view during TRMM PR scanning.

4. SUMMARY

The increase in number of lightning flashes during El Nino over East Asia has been studied by making a comparison of convective activities between April 1998, corresponding to an El Nino period, and April 1999, corresponding to a El Nino period. The main differences are summarized as follows;

1) During the El Nino period/La Nina period the number of lightning flashes increases/decreases.

2) During the El Nino period/La Nina period the times of precipitation decreases/increases, but the mean intensity of precipitation is stronger/weaker than Normal period. So the total amount of precipitation is low /high.

3) During the El Nino period/La Nina period the storms arise less/more, but the higher storms over 7000m are generated more/less.

These results lead to the conclusion that during the La Nina period many storms arise and make a lot of precipitation, but storms do not grow up so high as make heavy lightning activity. On the contrary, during the El Nino period the storms do not arise so frequently and consequently it does not rain so often. But more storms grow up to high altitude, and those storms increase the lightning flashes.

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