

## **Effects of ENSO on Precipitation over Northeast Thailand during Rainy Season 1997-1999**

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**Abstract:** *In this paper, the precipitation over Northeast Thailand during 1997-1999 is investigated by using the Regional Atmospheric Model System (RAMS) version 4.3. The study domain covers 72°E to 140 ° E longitudes and 14°S to 45°N latitude with resolution 80×80 km. The model input data are taken from European Center for Medium and Long-Range Weather Forecasts (ECMWF). The observed data from Thai Meteorological department (TMD) are analyzed by using 30-year average (1972 to 2001). The results show that the observed annual precipitations during El Nino year in 1997 and 1998 are below normal by 5.47% and 14.46%, respectively. Especially, in June, 1998, there are below normal by 36.59%. During La Nina in 1999, Northeast Thailand precipitation is about 25%.above normal. The simulated results indicate that they are below the observed values. But, they indicate that, the amount of precipitation is below in 1998 (El Nino event), while the amount of precipitation is more in 1999 (La Nina event) than the normal value, especially, the amount of precipitation shows strong anomalies in early rainy season.*

**Keywords:** ENSO event, Precipitation, RAMS, Northeast Thailand, Rainy Season

### **1. INTRODUCTION**

Northeast Thailand is the largest region of Kingdom which has more than one-third of the area of the country. Over 80% of the people are farmers. The income of this area is mainly from the agricultural products. The important crops are rice, cassava, corn, kenaf, and sugar cane and other oil crops [1-2]. These crops need the water for growth. The main source of water over the country is precipitation which falls almost in the rainy season (April-October). The main mechanism of precipitation is the southwest monsoon. In each year, this monsoon brings vapor and moisture from the Indian Ocean which becomes rainfall during May to October over the country. The abundance of rainfall supports the growing crops. However, in some years, the monsoon brings excessive rains and causes floods and destruction. The opposite way, in some years, there are only sparse precipitations. The result is a drought and crop damage. The causes of variation in southwest monsoon depend on many factors. One of the interesting factors is the ENSO phenomenon which has the center in the equatorial Pacific [3-4]. Glantz[5] defined the ENSO that it is a warming of surface water that appears off the coast of Ecuador, northern Peru and sometimes Chile around Christmas time. There are two oceanic phases of this phenomenon: the warm phase (El Nino event) and cold phase (La Nina event) which are connected to the atmosphere through an atmospheric pressure fluctuation in the south Pacific (Called the Southern Oscillation). When ENSO occurs, it makes a change in the ocean-atmosphere system that affects to the weather variations around the world [6-8].

Although the center of ENSO is in the equatorial Pacific, but many researchers have indicated that the impacts of this phenomenon on the climates cover more than 75% of the earth [9-10]. Some examples include the link between Southwest monsoon and ENSO phenomenon [11-12]. Many researchers have studied the impact of ENSO on southwest monsoon rainfall. Especially, the ENSO that occurred in 1997 and early 1998 was strongest in the 20<sup>th</sup> century [13]. The examples of impact of 1997-1998 are as following. In South Asia, the southwest monsoon was delayed in India and severe flooding in Bangladesh. The other phenomena observed with ENSO appearance include forest fires in Indonesia [14]. In Thailand, Singhrattana et al. [15] said that the dominant mechanism to impact rainfall over Thailand seems to be via the Walker circulation. A study by Kantahiran and Pruksawan [16-17] from the Meteorological Department's Climatology Division reported that there are during May, 1997 to May, 1998, that this phenomenon effects on temperature and precipitation. The southwest monsoon is weak during May to October in 1997 which reduces precipitation during early rainy season (May-October) over Thailand.

### **2. METHODOLOGY**

#### **2.1 Data Collection**

The data used in this study are as following:

- The observed monthly precipitation data over Northeast Thailand are taken from Thai meteorological department. These data are in period from 1972 to 2001 which consist of data sets from 16 observed rain gauge stations in the Northeast Thailand. The stations are located in Nong Khai, Loei, UdonThani, Sakon Nakhon, Nakhon Phanom, Khon Kaen, Mukdahan, Kosum Phisai, Chaiyaphum, Roi Et, Ubon Ratchathani, Nakhon Ratchasima, Chok Chai, Surin, Tha Tum and Nang Rong.
- The meteorological datasets are taken from European Center for Medium Range Weather Forecasts (ECMWF) which consist of 5 parameters: east-west (u) velocity component (m/s), north-south (v) velocity component (m/s), temperature (K), geopotential height (m), and relative humidity (%). The levels of all parameters of meteorological dataset are 1000, 925, 850, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20 and 10 mb. These dataset are archived every 6 hours (00:00, 06:00, 12:00, and 18:00 UTC).
- The surface characteristics datasets consist of the topography, landuse and sea surface temperature. The topography and land used data are originated from USGS data. The sea surface temperature dataset was taken from NCAR (ds277.0 dataset) [18].

## 2.2 Analyzing the observed monthly precipitation data

In this study, the 30-year average during 1972 to 2001 is used to represent the normal precipitation. The World Meteorological Organization (WMO) used the average value of a meteorological element over any fixed period. A 30 year period was mandated by the World Meteorological Organization [19].

## 2.3 Model and experiment

The model domains covered 72°E to 140°E longitude and 14°S to 45°N latitude with resolution 80×80 km. (97×83 grid points) (Figure 1). The center of grid was at 105.32°E longitude and 15.27°N latitude. There are 23 levels in the vertical grids. The time steps of 120 seconds were used. The model run were started at 00UTC using 6-hour reanalysis data with a resolution of 2.5×2.5 degrees obtained from the European Center for Medium Range Weather Forecasts (ECMWF) as initial and boundary conditions.

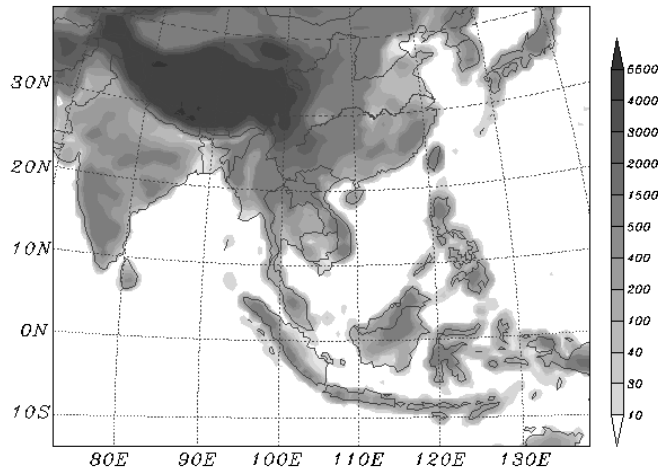


Fig. 1 Topography in the model domain. The unit of interval is meter (m.)

## 3. RESULTS AND DISCUSSION

### 3.1 Observed precipitation results

The precipitation data during the period from 1997 to 1999 was compared with that of a 30-year average (1972-2001). The monthly precipitation data and number of rainy days of 16 observed rain gauge stations over Northeast Thailand were averaged to represent the monthly precipitation and number of rainy day in this region, respectively.

Table 1 shows the average precipitation over Northeast Thailand. The 30-year average total precipitation was 1,390 mm. During El Nino (year 1997 and 1998), the total precipitation was 1,314 mm. (5.47% below normal) and 1,189 mm. (14.46% below normal), respectively. During La Nina year (1999), the total precipitation was 1,542 mm. which was above the average about 25%.

Table 1 The average monthly precipitation (mm.) at 16 observed rain gauge stations in Northeast Thailand

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1997 (El Nino)	2	18	71	89	150	160	285	270	146	124	1	0	1314
1998 (El Nino)	1	32	32	66	165	208	130	234	196	77	46	3	1189
1999 (La Nina)	3	2	68	155	261	222	257	166	250	124	32	2	1542
1972-2001	4	18	42	83	185	207	205	265	247	110	20	4	1390

Table 2 shows the average number of rainy days over Northeast Thailand. The 30-year average number of rainy day was 116 days. During El Nino year (1997 and 1998), the average rainy day was 110 days (5.17% below normal) and 106 days (8.62% below normal), respectively. During La Nina year (1999), the number of rainy day was 135 days which was above the average about 16%.

Table 2 The average number of rain days (day) at 16 observed rain gauge stations in Northeast Thailand

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1997 (El Nino)	1	2	6	12	11	13	20	20	15	10	1	0	110
1998 (El Nino)	0	4	4	7	13	15	14	18	16	8	6	1	106
1999 (La Nina)	2	0	6	13	20	16	18	18	20	15	7	1	135
1972-2001	1	2	5	8	15	16	17	19	18	10	3	1	116

Figure 2(a) compares the monthly precipitation between El Nino (in 1998) and that of 30-year average. The monthly precipitation in year 1998 is below the normal around March to October. Especially, there is the largest difference of monthly precipitation in July. But, there is not much difference for summer and winter season. Figure 2(b) compares the monthly precipitation between La Nina (in 1999) and that of 30-year average. The amount of monthly rainfall in this period is opposite to 1998. The monthly precipitation in

1999 is above the 30-year average during March to July. There is more precipitation during summer season in 1999 than summer in 1998. It means that in 1999 the rainy season started earlier than usual.

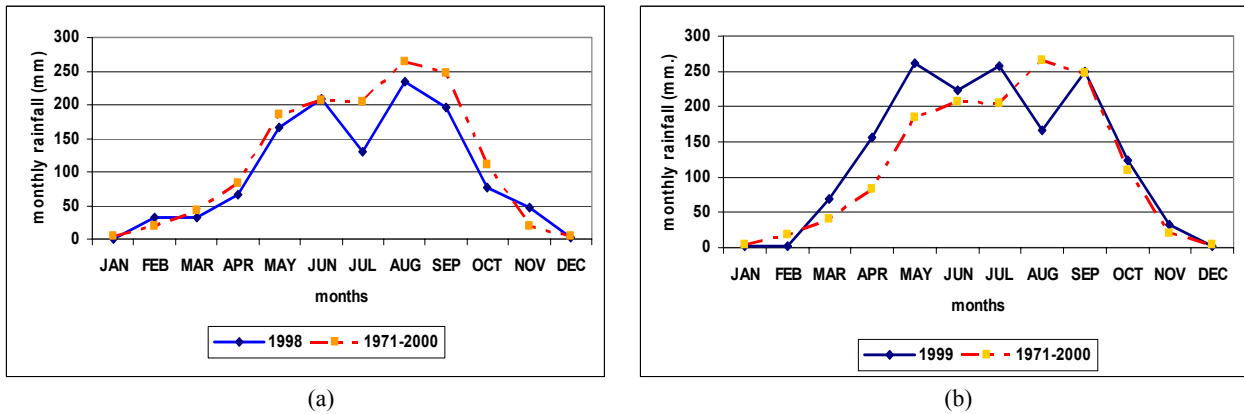


Fig. 2 (a) the monthly precipitation in 1998 and 30 year average and (b) the monthly precipitation in 1999 and 30-year average at 16 observed rain gauge stations in Northeast Thailand. The thick solid lines represent the 30-year average from 1971 to 2001 and the dashed lines represent the monthly precipitation in 1998 and 1999

### 3.2 Result of numerical experiment

Figure 3 shows the simulated results of accumulated precipitation in May and July of 1998 and 1999. Comparing between the same months in 1998 and 1999, the result shows that the amount of accumulated precipitation in 1999 (La Nina year) over Northeast Thailand are higher than year 1998 both in May and July.

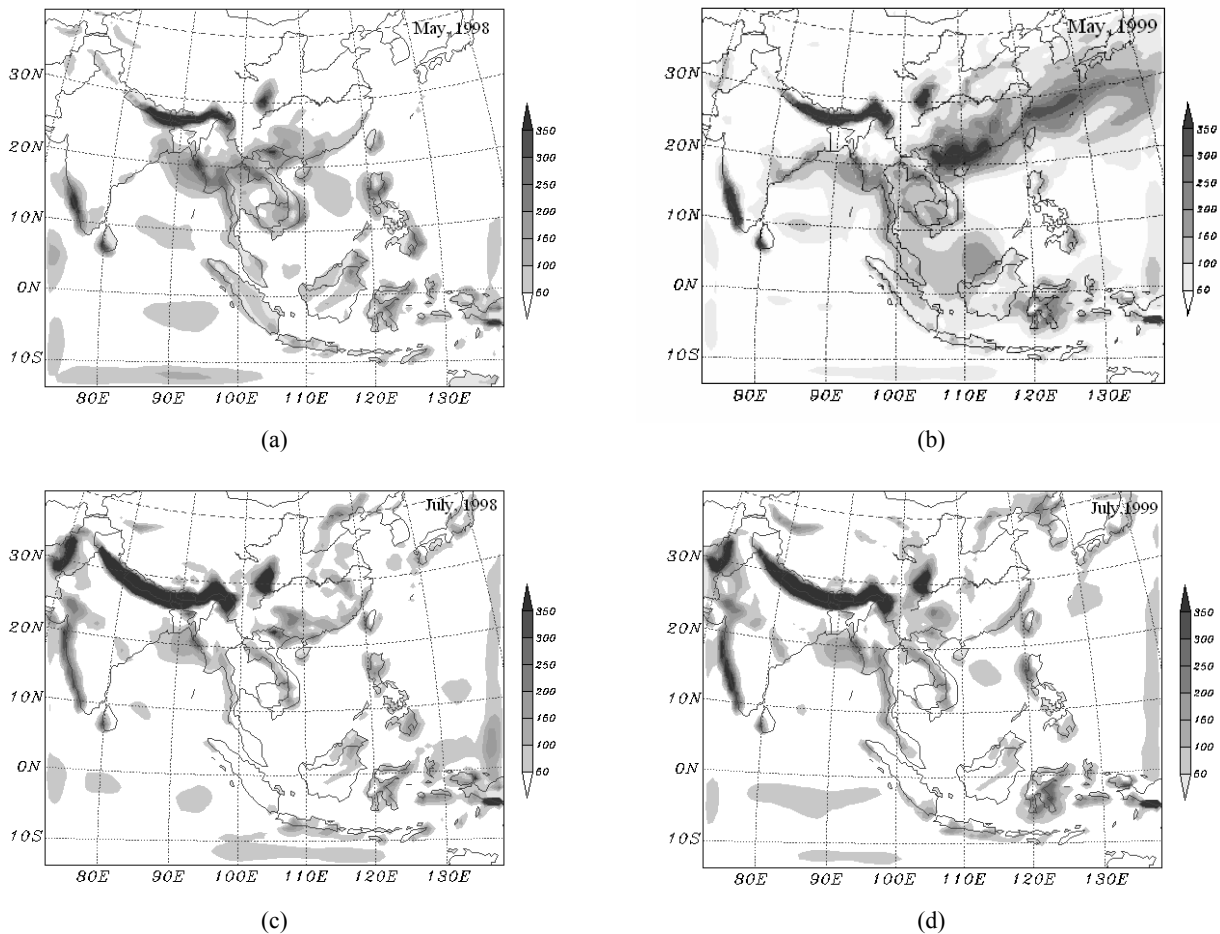


Fig. 3 The simulated results of accumulated precipitation in May 1998 (a), in May 1999 (b), July 1998 (c) and in July 1999 (d) by RAMS model. The units are in mm

Table 3 shows the amount of observed precipitation and simulated precipitation. The amount of observed precipitation in May 1999 increases from May 1998 about 57.18%. The simulated precipitation in May 1999 increases from May 1998 about 57.32%. The

amount of observed precipitation in July 1999 increases from July 1998 about 97.69%. The simulated precipitation in July 1999 increases from July 1998 about 112.50%. It can be said that the increasing trends of observed precipitation compared to the simulated results are not much different.

**Table 3** Comparison of the amount observed precipitation to the simulated precipitation over Northeast Thailand at the same months

Month	Observed value (mm.)	Simulated value (mm.)
May, 1998 (summer season)	165	82
May, 1999 (summer season)	261	129
Percentage of increasing	58.18%	57.32%
July, 1998 (rainy season)	130	24
July, 1999 (rainy season)	257	51
Percentage of increasing	97.69%	112.50%

#### 4. CONCLUSION

The annual precipitation and monthly precipitation in May to October decreased during El Nino in 1997 and 1998. As during La Nina in 1999, the precipitation is above normal. In year 1999, there is more precipitation during summer season until rainy season. It means that in La Nina year 1999 the rainy season starts earlier than normal. All of the average of simulated accumulate precipitation over Northeast Thailand is below that of the observed value. But, the trend from the simulated value in 1998 and 1999 are in agreement with the observed value. The underestimate of accumulated precipitation may be caused from the landuse/land cover period in 1992 to 1993 which is used in simulation.

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