# CHAPTER III

# METHODOLOGY

This chapter described about location and climate of study area, data and methodology in this study.

## 3.1 Study Area

The AERONET site in Bangkok, Chulalongkorn was selected as the main study site. The results from Chulalongkorn site have been used to compare with other AERONET sites: Omkoi, Mukdahan, Pimai and Hua_Hin.

Chulalongkorn site is located at Chulalongkorn University, Bangkok. This urban area is affected by many sources of aerosol such as fuel combustion, road dust, construction and manufacturing process. For other sites, Omkoi and Mukdahan, the surrounding land covers are some mixture of forest and agricultural areas. Pimai is agriculture area and Hua_Hin is coastal area.

The climate of Thailand is under the influence of prevailing winds such as southwest monsoon and northeast monsoon. The southwest monsoon usually onsets in mid-May and withdraws in mid-October. The southwest monsoon brings a current of warm moist air from the Indian Ocean toward Thailand causing cloudy sky and rainfall over the country. The southwest monsoon begins to be weakened and retreated to lower latitude in October, and then the northeast monsoon prevails over Thailand. The northeast monsoon normally onsets in mid-October and withdraws in mid-February. The northeast monsoon brings the cold and dry air from the Republic of China to cover the upper part of Thailand such as northern, northeastern, central and eastern part.

Also, whenever it comes across the Gulf of Thailand to the southeast coast part, the monsoon causes a lot of rainfall in the southeastern area.

Normally, the climate of Thailand may be divided generally into three seasons as follows;

Rainy season (mid-May to mid-October) is the period of the southwest monsoon prevailing over Thailand. Rainfall during this period is caused by the southwest monsoon, the Intertropical Convergence Zone (ITCZ) and Tropical cyclone. These phenomena can produce large amount of rainfall over the upper part of Thailand. The wettest period of the year is in August and September.

Winter season (mid-October to mid-February) is the period of the northeast monsoon prevailing over Thailand. The monsoon brings cold and dry air from the Republic of China to cover the upper part of Thailand. It will be effect on the area in decreasing of air temperature to be cool and cold air. The quite cold period is in December and January.

Summer season (mid-February to mid-May) is the transition period from the northeast to southwest monsoon. The weather becomes warmer, especially in the upper part of Thailand. April is the hottest month.

### 3.2 Data Used

The study of aerosol variation with time in Bangkok was characterized on the atmospheric aerosol condition by using:

- AOT at wavelength of 500 nm which corresponds to the maximum of solar spectrum intensity
- Angstrom exponent derived from the slope of the logarithm value of AOT against the logarithm value of wavelength (based on four wavelengths in the range 440-870 nm)
- The volume size distribution.

All data were derived from the measurement by automatic sun and sky scanning radiometers at Chulalongkorn site and other AERONET sites of Thailand during 2003 – 2004. The data were available from the AERONET website (http://aeronet.gsfc.nasa.gov/).

The AOT data are consisted of three levels as follows;

- Level 1.0 is raw data or unscreened data
- Level 1.5 is automatic cloud screened data
- Level 2.0 is pre and post field calibration, automatic cloud screened and manually inspected or quality assured data

From the examination of derived data, the level 2.0 were the best data for usage in this study. The level 2.0 data would be provided an after-field calibration and reprocess with applying of the linear interpolation between pre-field and after-field coefficients. In particularly for the field instrument, which generally return to NASA for calibration every 6 to 12 months. Due to The data set from Chulalongkorn site was less than 1 year. Therefore, it was necessary to select and use the level 1.5 data which was much more period of data. The data set was during February 2003 to September 2004

This study also used PM10 data that were recorded by Pollution Control Department during 1997-2004 at Nonsi Vitthaya School, nearby Chulalongkorn site.

In addition, the meteorological data such as air temperature, wind direction and speed at 850 hPa and 3 hourly accumulated rainfalls which were measured nearby the AERONET sites during February 2003 to September 2004 were used in this study. Only Chulalongkorn site in Bangkok, the Metrological data from Queen Sirikit station of Thai Meteorological Department were used because it was the most nearby station. Apart from this, the upper wind data which measured at Bangna station were used because it was the only one site in Bangkok. All Meteorological data were supported by Thai Meteorological Department and Bureau of Royal Rainmaking and Agricultural Aviation.

### 3.3 Methodology

3.3.1 In this study, we selected to use AOT level 1.5 data because the more period of data that was suitable than the level 2.0 data. The level 1.5 data have not been pre and post field calibration applied and manually inspected. Therefore, the data has been considered during the selection process before analysis with the following criterions;

1) To select the daily average AOT data by using the method which was introduced by Esposito et al. (2004). The data are including of two standard deviations and other data outside these two standard deviations are excluded.

2) To select the daily average AOT data that is averaged from the number of measurement data greater than 2.

3) To select the daily average AOT data that is averaged from the measured data for the time period of measurement longer than 45 second.

4) To exclude the daily average AOT data that has the one period of measurement was greater or lower values than other periods.

The criterions in 2-4 are modified from the method of averaged data in Thai Meteorological Department.

These criterions have applied for the 5 AERONET sites data.

3.3.2 The analysis of AOT, angstrom exponent and volume size distribution data at Chulalongkorn and other AERONET sites in Thailand, and also meteorological data in the same period were as follows;

1) To analyze the variation of AOT and Angstrom exponent by means of daily average and monthly average value, seasonal frequency histogram, in addition to analyze seasonal average aerosol volume size distribution.

2) To analyze the variation of daily average AOT data and meteorological data such as daily average daytime temperature, wind direction and speed at 850 hPa and 3 hours accumulated rainfalls in the same periods.

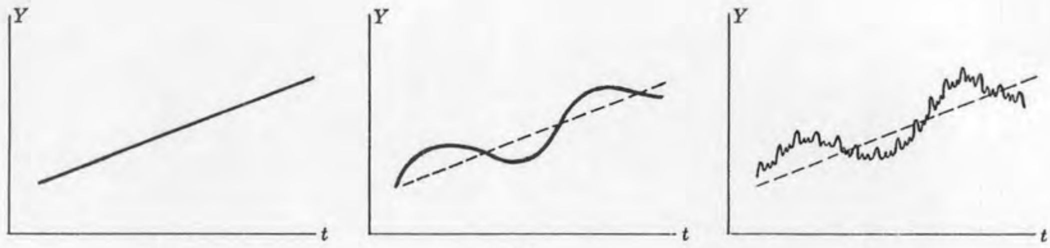
3.3.3 The analysis of AOT data at Chulalongkorn site and PM10 data at Nonsi Vitthaya School are as follows;

1) To investigate and analyze the relationship between daily average data of AOT and PM10 during February 2003 and September 2004.

2) To analyze the relationship between PM10 and time by analysis of time series, using daily average PM10 data during 1997-2004 to find out a variable that effected on PM10 variation. At the results, characteristic variation of time series may be classified into four main types, which often call components of times series as follows;

- The trend or long-term trend (T) refers to the general direction in which data to be going over a long interval time.
- The cyclical variation (C) refers to the long term oscillations or swings about a trend line or curve. These cyclical may or may not be a periodic, i.e. they may or may not follow exactly similar patterns after an equal interval of time.
- The seasonal variation (S) refers to the identical or almost identical patterns which a time series appears to follow by a period of corresponding time as months of year. The periodicity of seasonal variation could be extended to include any interval of time such as daily, hourly, weekly, etc., depending on the type of data available.
- The irregular variation (I) refers to the variation of data with no pattern. This irregular variation may be influenced from an unusually events such as floods, strikes, election, etc.

The graphs of long-term trend, cyclical and seasonal variation are shown on figure 3.1.




(a) (b) (c)

Figure 3.1 (a) long-term trend (b) long-term trend and cyclical variation (c) long-term trend, cyclical and seasonal variation. (From Theory and problems of statistics, Spiegel, 1961)

The times series (Y) is a product of trend (T), cyclical (C), seasonal (S) and irregular (I) variations. In symbols as:

$$Y = T \times C \times S \times I \qquad (3.1)$$

The analysis of time series consists of an investigation of the factors (T, C, S and I) and is often referred to the decomposition of a time series into its basically component variations.

The methodology of time series analysis is as follows;

1. To construct a graph of data, noting the qualitatively presence of long-term trend, cyclical variation and seasonal variation.

2. To calculate a seasonal variation by

- Construct a moving average (MA) data set to eliminate seasonal and irregular variation (S and I) from data, and is thus equivalent to a given values by trend and cyclical variation or $MA = T \times C$

For example: given a set of data is

$$Y_1, Y_2, Y_3, \ldots.$$

Define a moving average of order N to be given by the sequence of arithmetic means as follows:

$$\frac{Y_1 + Y_2 + \ldots + Y_N}{N}, \frac{Y_2 + Y_3 + \ldots + Y_{N+1}}{N}, \frac{Y_3 + Y_4 + \ldots + Y_{N+2}}{N}, \ldots$$

It is customary to locate each number on the moving average at position of (N+1)/2

- Then, division the original data by MA yields SI

$$\frac{Y}{MA} = \frac{Y}{T \times C} = S \times I \qquad (3.2)$$

- To eliminate the irregularity I by an averaging of $S \times I$ over corresponding days with eliminate the highest and lowest value before the average is computed and thus result in a seasonal index (S).

3. To calculate a trend, which is the relationship between trend and time variation by using the method of least squares.

4. To calculate a cyclical variation. According to equation (3.1) which division Y by ST, which gives CI, i.e. cyclical and irregular variation, then, apply an appropriate moving average for serving to smooth out the irregular variation (I) and leave only the cyclical variation.