The Correlation Between Climatic Factors Over Bangkok

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ABSTRACT

This study investigated the correlations between each climatic factors (temperature, cloud cover, cloud type, air pressure and humidity). Temperature and humidity data were collected using thermometer and hygrometer, respectively. Cloud cover and cloud type were measured by observing the sky over football field in Triamudomsuksa school, Bangkok at noon (+7 UTC). For the air-pressure data and additional data of temperature, humidity and cloud cover were drawn from Chaloemprakiet Meteorological Station. The data range from Jan, 1st, 2013 to Dec, 31st, 2016. To analyze the correlations between each factor, we use regression analysis, consider trendline, R-square and P-value in Microsoft Excel. There are two parts of analysis. In part one, we analyzed correlation between 1 dependent and 3 independent variables. There is no significant correlation between them. In part two, we analyze the correlation between 5 pairs of climatic factors separated in three Thai seasons. We found the high correlation between humidity and temperature in rainy season; air pressure and temperature in summer. Others have some but not significant correlations. These results thus indicate that each climatic factor affects others and can use these results to further develop the regression equation to forecast one climatic factor from other climatic factor.

Keywords: Bangkok; climatic factors; linear regression; multiple linear regression; R square; P-value; weather forecasting; correlation

1. Introduction

The weather conditions are things which greatly affect our daily life. They have a substantial impact on many different ways. They play an important role in the distributions of humans, animals and other living organisms. For example, we cannot live in extremely hot or cold area resulting in high people density in tropical regions. The weather conditions also control the distribution of rain and thunderstorm on earth which are very vital especially for economy of agricultural countries such as Thailand; farmer's life depends largely on them. If there is little rain water in that year, the crops may not grow well and Thailand's income may be greatly reduced. Weather can also have serious impacts on life. Natural disasters such as tornadoes, typhoons and hurricanes, which can injure a large number of people and damage ecosystem, result from certain weather conditions. Because of all these reasons, accurate weather forecasting is necessary and very important.

Weather forecasting means predicting weather conditions in particular location. To be able to predict the weather and understand the weather patterns, we can prepare for disaster. More generally, if we can predict tomorrow's temperature, we would know how to dress. If astronomers can predict the cloud cover at night, they would know whether they will set up their telescope or not. If the farmers and gardeners know the amount of rainfall, they can plan crop irrigation and protection. All in all, accurate weather prediction is important to our everyday life.

Living and non-living things are all dependent on weather predictions. To develop these weather forecasting models efficiently, we would like to know the correlations between these climatic factors. So our research work mainly focuses on finding the correlation between two or more climatic factors using method of linear regression, multiple regression analysis and polynomial regression analysis. Multiple Linear Regression (MLR) is used to develop a model for forecasting weather parameters. The proposed model is capable of forecasting the weather conditions for a particular station using the data collected locally (Paras, Sanjay Mathur, 2012). And in further research, we can use these data and analyses to develop forecasting models (predict one climatic factor from others) so that they will be an accurate and efficient way for weather forecasting.

According to these reasons, we were inspired to study about The correlation between climatic factors over Bangkok. The objectives of this study are (1) to find the correlation between two or more climatic factors in different seasons (2) to use the knowledge we get in further studies about weather forecasting.

2. Materials and Methods

Data Collection

We collected temperature and humidity data by using thermometer and digital hygrometer, respectively. We also observed the sky over football field in Triamudomsuksa school, Bangkok at noon (+7 UTC), collected cloud cover percentage and cloud type from May-August, 2016 and filled all data in Globe data sheet. We drew the air-pressure data and additional data of temperature, humidity and cloud cover from Chaloemprakiet Meteorological Station. The data range from Jan, 1st, 2013 to Dec, 31st, 2016.

Data analysis

We used Microsoft Excel to analyse the data. Linear Regression analysis, Multiple Linear Regression (MLR) analysis and Polynomial regression analysis were used to test the associations between two and more climatic factors. We considered R-square to evaluate the correlations between them. For the correlation between more than 2 climatic factors, we also considered P-value of each factor to indicate how largely one factor affect another. The P-value criterion was significant at $P < 0.05$ for all parameters in model. (Teresa, Josh, Neil, 2009)

3. Results

Part 1 Climatic factors (Temperature and humidity) and cloud (cloud type, level and cover)

We observed that, when we set temperature as dependent variables, temperature has relatively small correlation with other three factors ($R^2 = 0.17$, $P > 0.05$ for every independent variables). When we set relative humidity as dependent variables, we also observed that it has smaller correlation with other factors ($R^2 = 0.15$, $P > 0.05$ for every independent variables). (Fig. 1a-b)

Part 2 Climatic factors (Temperature, humidity, air pressure and cloud cover)

We observed that there is high correlation between temperature and relative humidity in rainy season. (Fig. 2c) ($R^2 = 0.68$, $P < 0.05$, $y = -0.1658x + 42.334$).

We also observed that these two factors have some but not significant correlations; temperature and relative humidity in winter (R^2 = 0.34); temperature and relative humidity in summer (R^2 = 0.30); cloud cover and relative humidity in winter (R^2 = 0.39); cloud cover and relative humidity in rainy season (R^2 = 0.41); air pressure and relative humidity in winter (R^2 = 0.38); cloud cover and temperature in summer(R^2 = 0.37); air pressure and temperature in winter (R^2 = 0.32); air pressure and temperature in summer (R^2 = 0.49). (Fig. 2a,b,d,f,g,n,j,k)

The regressions of cloud cover and relative humidity in summer (R^2 = 0.16); air pressure and relative humidity in summer (R^2 =0.08); air pressure and relative humidity in rainy season (R^2 = 0.01); cloud cover and temperature in rainy season (R^2 = 0.11); air pressure and temperature in rainy season (R^2 = 0.01); cloud cover and temperature in winter (R^2 = 0.01) have small value of R^2 indicating that these two factors have no correlation. (Fig. 2e,h,i,o,l,m)

a)

SUMMARY OUTPUT

Temperature (w)

Regression Statistics	
Multiple R	0.416258586
R Square	0.173271211
Standard Error	1.765369174
Observations	32

	Coefficients	*andard Err*	*t Stat*	*P-value*
Intercept	32.80145	2.754968	11.90629	2.97E-12
doud level (x)	0.91466	0.550555	1.661342	0.108214
doud type (z)	0.148707	0.271896	0.546927	0.588921
Relative Humidity(y)	-0.01878	0.041407	-0.4536	0.653744
Cloud cover (v)	-0.02333	0.023215	-1.00517	0.323741

w= 0.915x+0.149z–0.0188y-0.0233v+32.801

b)

SUMMARY OUTPUT

Relative Humidity (y)

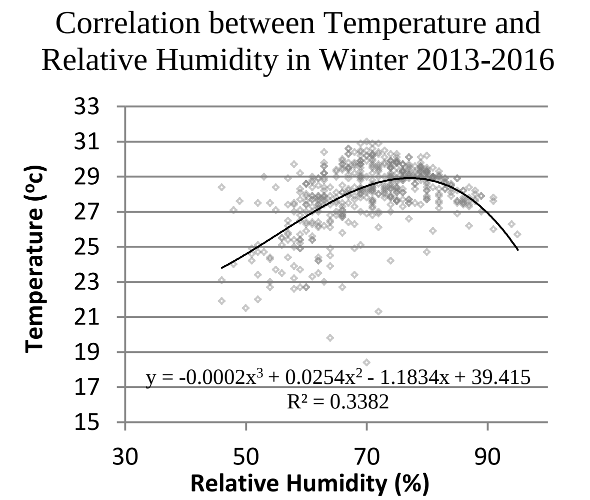
Regression Statistics	
Multiple R	0.383348901
R Square	0.14695638
Standard Error	8.173855672
Observations	32

	Coefficients	*andard Err*	*t Stat*	*P-value*
Intercept	56.74101	29.96261	1.893727	0.069023
doud level(x)	-2.39374	2.636304	-0.90799	0.371917
doud type(z)	-0.67567	1.259169	-0.5366	0.595938
temperature(w)	-0.40265	0.887689	-0.4536	0.653744
Cloud cover(v)	0.158987	0.105116	1.512487	0.142028

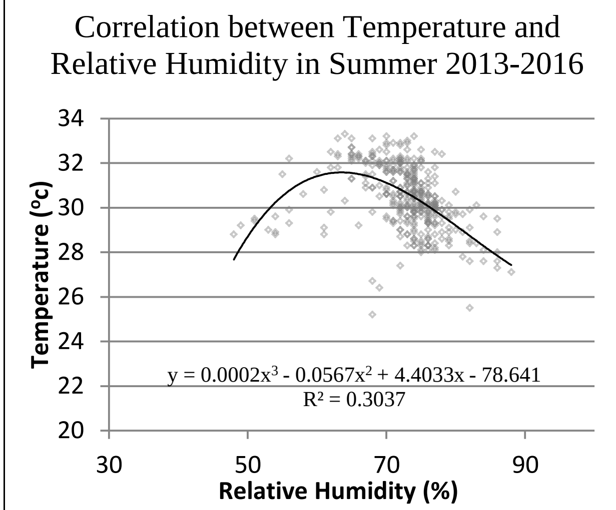
y=-2.294x-0.676z-0.403w+0.159v+56.741

Figure 1: Summary output of regression analysis and forecasting equation: temperature as dependent variable (a) and relative humidity as dependent variable (b)

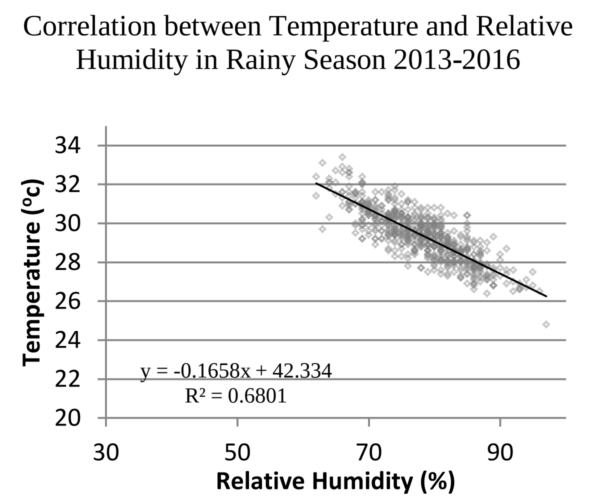
a)


Correlation between Temperature and Relative Humidity in Winter 2013-2016
Temperature (ºc)
Relative Humidity (%)
y = -0.0002x³ + 0.0254x² - 1.1834x + 39.415
R² = 0.3382
33
31
29
27
25
23
21
19
17
15
30
50
70
90

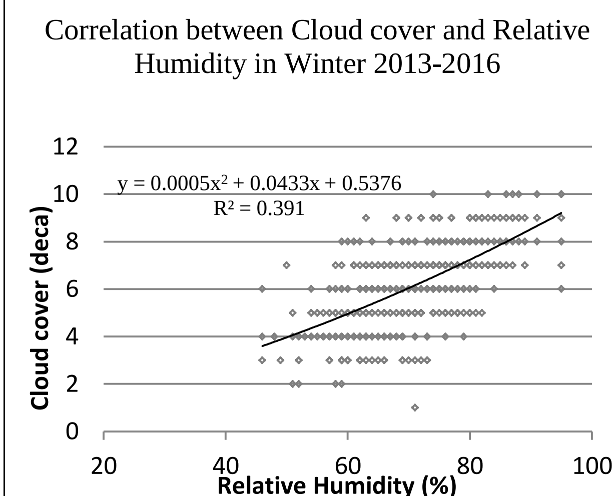
b)


Correlation between Temperature and Relative Humidity in Summer 2013-2016
Temperature (ºc)
Relative Humidity (%)
y = 0.0002x³ - 0.0567x² + 4.4033x - 78.641
R² = 0.3037
34
32
30
28
26
24
22
20
30
50
70
90

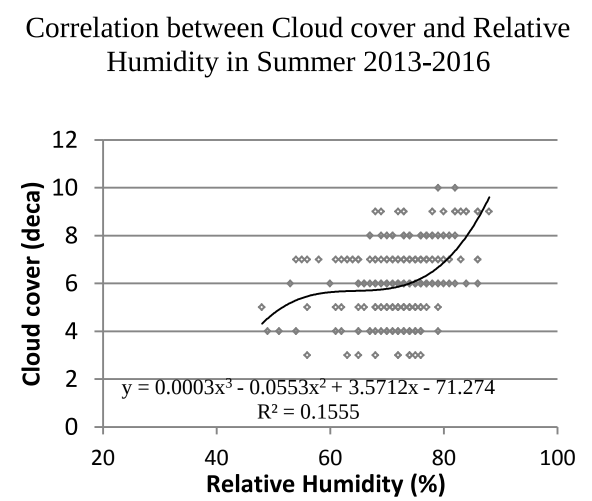
c)


Correlation between Temperature and Relative Humidity in Rainy Season 2013-2016
Temperature (ºc)
Relative Humidity (%)
y = -0.1658x + 42.334
R² = 0.6801
34
32
30
28
26
24
22
20
30
50
70
90

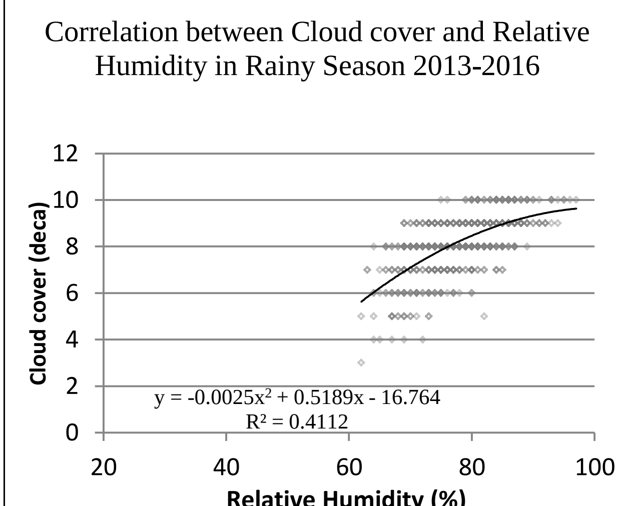
d)


Correlation between Cloud cover and Relative Humidity in Winter 2013-2016
Cloud cover (deca)
Relative Humidity (%)
y = 0.0005x² + 0.0433x + 0.5376
R² = 0.391
12
10
8
6
4
2
0
20
40
60
80
100

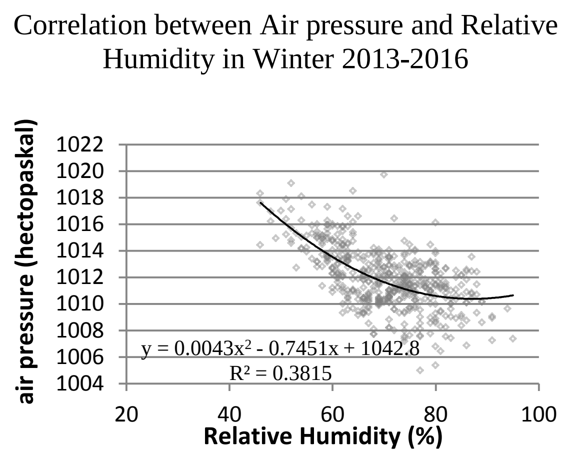
e)


Correlation between Cloud cover and Relative Humidity in Summer 2013-2016
Cloud cover (deca)
Relative Humidity (%)
y = 0.0003x³ - 0.0553x² + 3.5712x - 71.274
R² = 0.1555
12
10
8
6
4
2
0
20
40
60
80
100

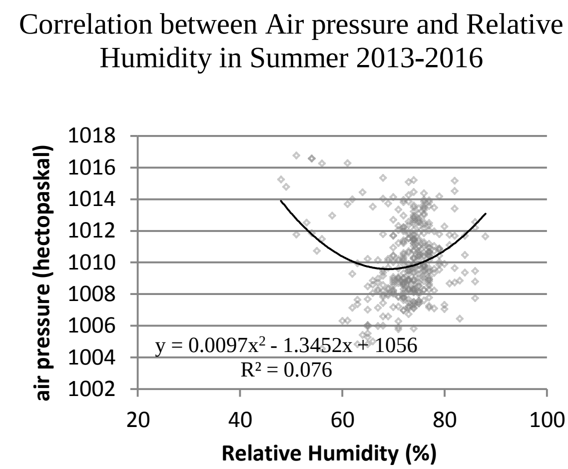
f)


Correlation between Cloud cover and Relative Humidity in Rainy Season 2013-2016
Cloud cover (deca)
Relative Humidity (%)
y = -0.0025x² + 0.5189x - 16.764
R² = 0.4112
12
10
8
6
4
2
0
20
40
60
80
100

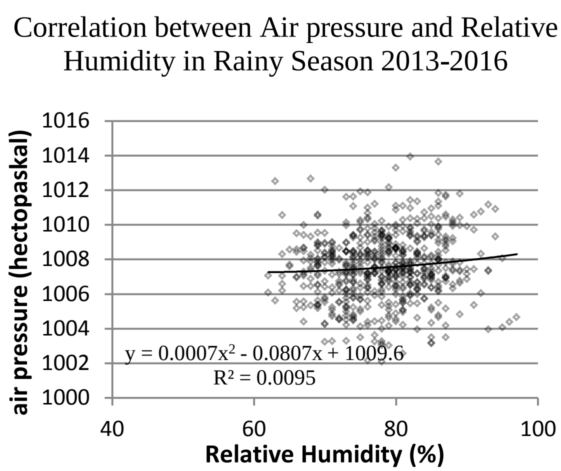
g)


Correlation between Air pressure and Relative Humidity in Winter 2013-2016
air pressure (hectopaskal)
1022
1020
1018
1016
1014
1012
1010
1008
1006
1004
20
40
60
80
100
Relative Humidity (%)
y = 0.0043x² - 0.7451x + 1042.8
R² = 0.3815

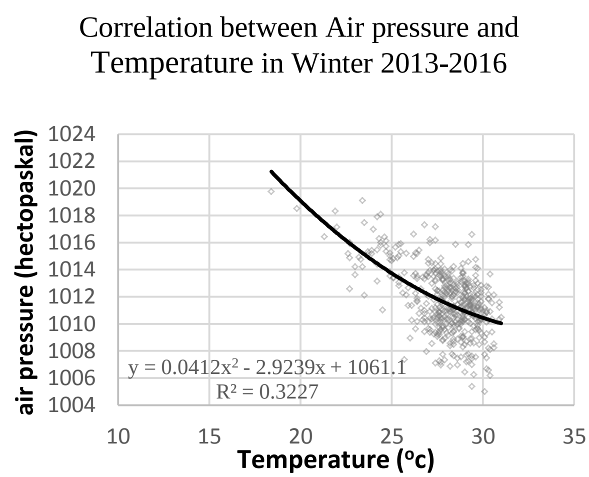
h)


Correlation between Air pressure and Relative Humidity in Summer 2013-2016
air pressure (hectopaskal)
1018
1016
1014
1012
1010
1008
1006
1004
1002
20
40
60
80
100
Relative Humidity (%)
y = 0.0097x² - 1.3452x + 1056
R² = 0.076

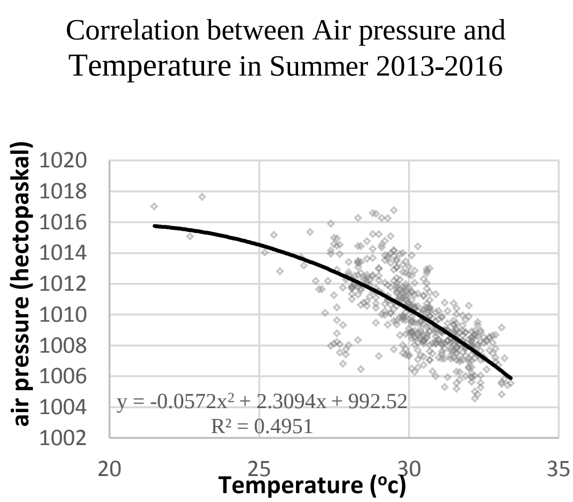
i)


Correlation between Air pressure and Relative Humidity in Rainy Season 2013-2016
air pressure (hectopaskal)
1016
1014
1012
1010
1008
1006
1004
1002
1000
40
60
80
100
Relative Humidity (%)
y = 0.0007x² - 0.0807x + 1009.6
R² = 0.0095

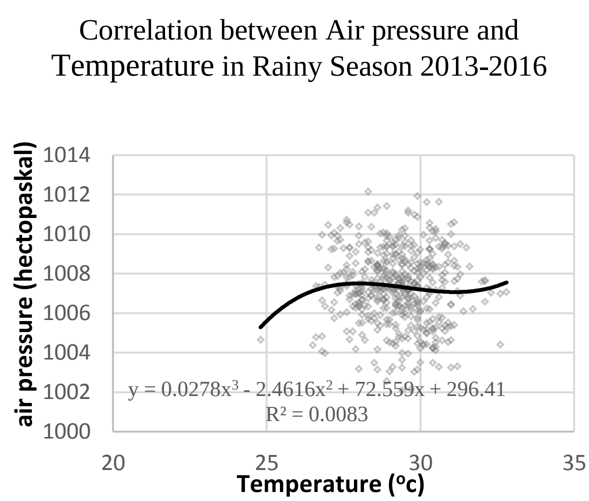
j)


Correlation between Air pressure and Temperature in Winter 2013-2016
air pressure (hectopaskal)
1024
1022
1020
1018
1016
1014
1012
1010
1008
1006
1004
10
15
20
25
30
35
Temperature (°c)
y = 0.0412x² - 2.9239x + 1061.1
R² = 0.3227

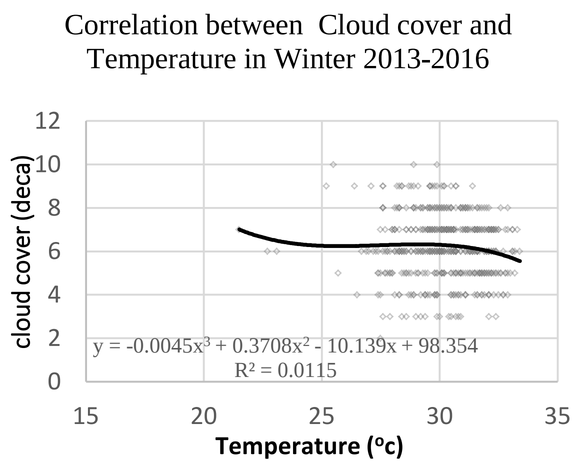
k)


Correlation between Air pressure and Temperature in Summer 2013-2016
air pressure (hectopaskal)
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
20
25
30
35
Temperature (°c)
y = -0.0572x² + 2.3094x + 992.52
R² = 0.4951

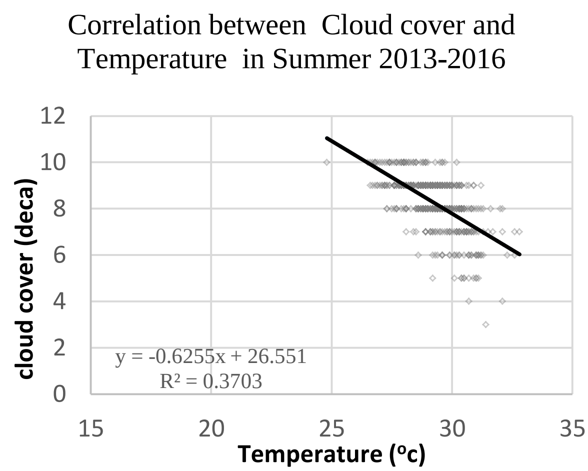
l)


Correlation between Air pressure and Temperature in Rainy Season 2013-2016
air pressure (hectopaskal)
1014
1012
1010
1008
1006
1004
1002
1000
20
25
30
35
Temperature (°c)
y = 0.0278x³ - 2.4616x² + 72.559x + 296.41
R² = 0.0083

m)



n)



o)

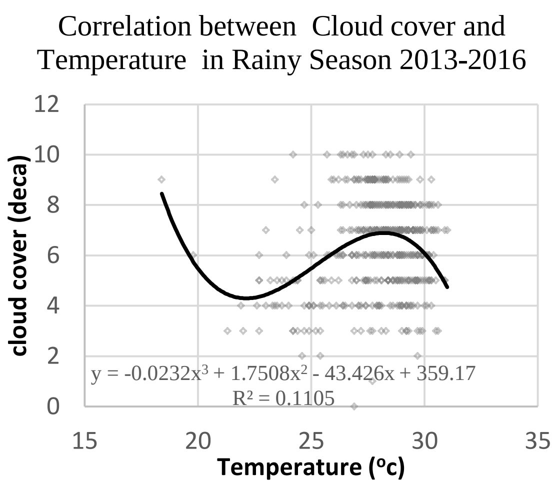


Figure 2: correlations between each climatic factor separated in three Thai seasons 2013-2016 (temperature and relative humidity (a-c); cloud cover and relative humidity (d-f); air pressure and relative humidity (g-i); air pressure and temperature (j-l); cloud cover and temperature (m-o))

4. Discussion

When analyzing the correlation of 4 variables which are temperature, relative humidity, cloud cover and cloud level over Triamudomsuksa school, Bangkok, Thailand, Multiple Regression Analysis showed that there is small correlation between temperature and others; relative humidity and others. One possible explanation is that cloud level may not clearly correlate with other climatic factors. Another is that the cloud pattern in the sky changes rapidly and continuously, so it may cause error to the analysis.

The study further demonstrates clearly that there are correlations between some climatic factors. From the graph showing the correlation between relative humidity and temperature in the rainy season, we found that the trend follows the scientific principle which is

$$\text{R.H.} = \frac{(\text{actual vapor density})}{(\text{saturation vapor density})} \times 100\ \%$$

When the temperature increases, the air expands and can hold more water vapor. So we found out that the area with high temperature has lower value of relative humidity than the area with low temperature (because of higher value of the denominator). However, the correlation between relative humidity and temperature in summer and winter doesn't follow that principle maybe because of the difference in season and other factors.

In the study, we found that if the pressure increases, the temperature will decrease in summer. But it is opposed to our general knowledge –cool air is heavier than hot air, so the cool air must have more pressure than the hot air (Pressure = Force / Area).

When consider the graph showing the correlation between relative humidity and air pressure in every season, the data points are quite scattered and these two factors have no clear and significant correlation.

From the graph showing the correlation between relative humidity and cloud cover, we found that the cloud cover tends to increase proportionally to the increase of relative humidity which is true according to Groisman et al. 2000 Journal of Climate. In the same way, from the analysis of correlation between temperature and cloud cover, temperature differently correlates with cloud cover in different seasons which is accordant to the research indicating that in the tropical regions, including Thailand, the cloud cover affects the temperature differently in different seasons (Groisman et al., 2000).

5. Acknowledgements

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