# Survey of open burning around Bangkok using satellite images analysis

## GCOM C Satellite Image Analysis

Tiny solid and liquid particles suspended in the atmosphere are called aerosols. These aerosols can be added to the atmosphere due anthropogenic and natural activities. Aerosols has good and bad impact to the atmosphere and monitoring aerosol is a vital task. Now a day's satellite remote sensing plays a major role in monitoring aerosols in atmosphere. In this study, for the aerosol monitoring, GCOM C aerosol products were used.

### 1. GCOM C aerosol products

GCOM-C conducts long-term and continuous global observation and data collection to contribute to surface and atmospheric measurements related to the climate change with emphasis on the carbon cycle and the radiation budget. Aerosol optical thickness is one its product to identify the atmospheric changes in terms of aerosols.

Aerosol Optical Depth (AOD) is the measure of aerosols (e.g., urban haze, smoke particles, desert dust, sea salt) distributed within a column of air from the instrument (Earth's surface) to the top of the atmosphere. GCOM C Aerosol optical thickness product (polarized observation and non-polarized observation) comes in L2 and L3(statistics) levels. Level 2 aerosol by polarization (ARPL) products were used here for the visualization.

| Data Level | Data Type | Description | Region | Temoral statistics | | | Resolution |
|---|---|---|---|---|---|---|---|
| | | | | 01D | 08D | 01M | |
| L2 | ARNP | Aerosol by non polarization | tile | | | | 1 km |
| L2 | ARPL | Aerosol by polarization | tile | | | | 1 km |
| L2 | ARNP | Aerosol by non polarization | Global | | | | 1/24 deg |
| L2 | ARPL | Aerosol by polarization | Global | | | | 1/24 deg |
| L3 | AOTO | Aerosol over ocean optical thickness ) | Global | | | | 1/12 deg |
| L3 | AOTL | Land aerosol optical thickness (near UV) | Global | | | | 1/12 deg |
| L3 | AAEO | Aerosol over ocean angstrom exponent | Global | | | | 1/12 deg |
| L3 | AAEL | Land aerosol angstrom exponent (near UV) | Global | | | | 1/12 deg |
| L3 | AOTP | Land aerosol optical thickness (polarized) | Global | | | | 1/12 deg |
| L3 | AAEP | Land aerosol angstrom exponent (polarized) | Global | | | | 1/12 deg |
| L3 | ASSA | Land aerosol single scattering albedo (polarized) | Global | | | | 1/12 deg |

*Table 1 GCOM C Aerosol data products*

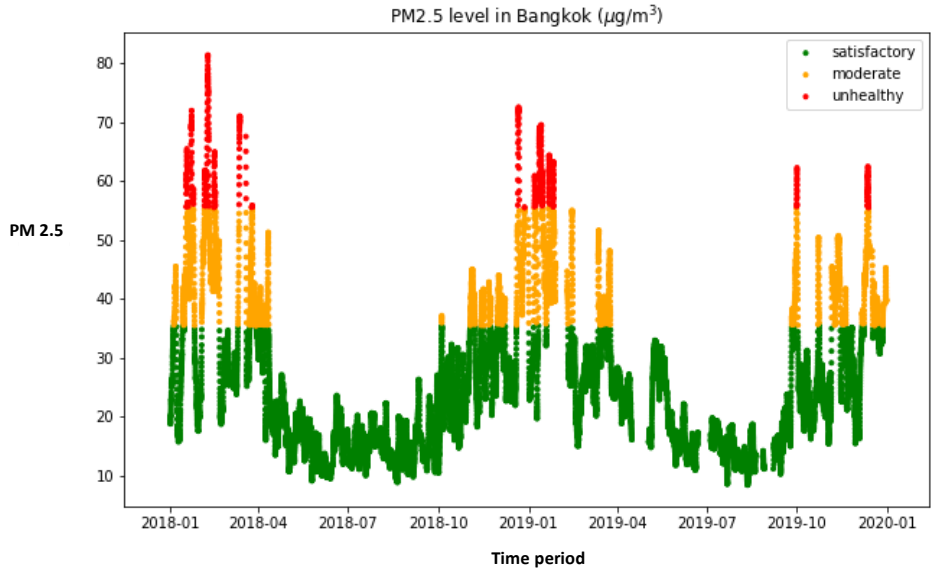
### 2. PM 2.5 and Aerosol Optical Thickness (AOT) data visualization

Before visualizing the data, the relationship between aerosols and agricultural burning should be identified. Since Aerosols and PM 2.5 have a good correlation, effects of agricultural burning for the atmosphere in term of aerosols can be assessed with the PM 2.5 values.

PM2.5 refers to atmospheric particulate matter (PM) that have a diameter of less than 2.5 micrometers. These PM 2.5 data can be obtained through freely available resources and it can be visualized in order to identify the relationship. Many factors can affect to this PM 2.5 scenario and it is a challenging task to identify the amount each factor contributes. Here simply the relation between agricultural burning and the PM 2.5 value was tested.

First the PM 2.5 data were taken from the Berkleyearth website (http://berkeleyearth.org/) for Bangkok (Bangkok station) for 2018 to 2020 march. Then the variation of the daily average PM2.5 value was plotted with time. Fig 1 shows the plotted graph and it can be clearly seen that the peak PM 2.5 values can be ranged from November to March.

To identify the impact from agricultural burning, active fire hotspot data from MODIS satellite (1km)was obtained from the NASA Fire Information for Resource Management System website (https://firms.modaps.eosdis.nasa.gov/ ) for the same time period of the PM 2.5 data. These data were taken within a buffer zone of 250 km from the Bangkok station.




*Fiaure 1 PM 2.5 level variation in Banakok 2018 to 2020 March*

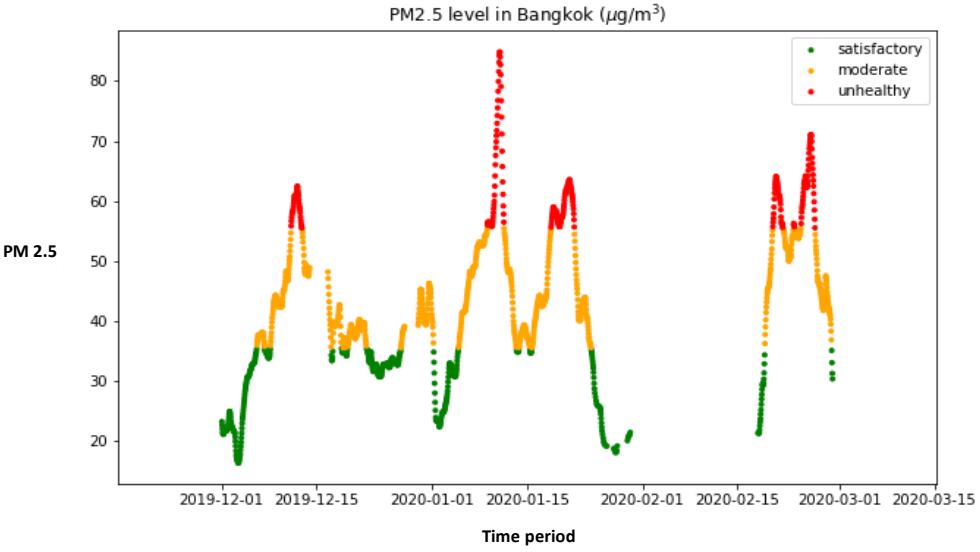



*Figure 2 PM 2.5 variation in Bangkok for field survey period*

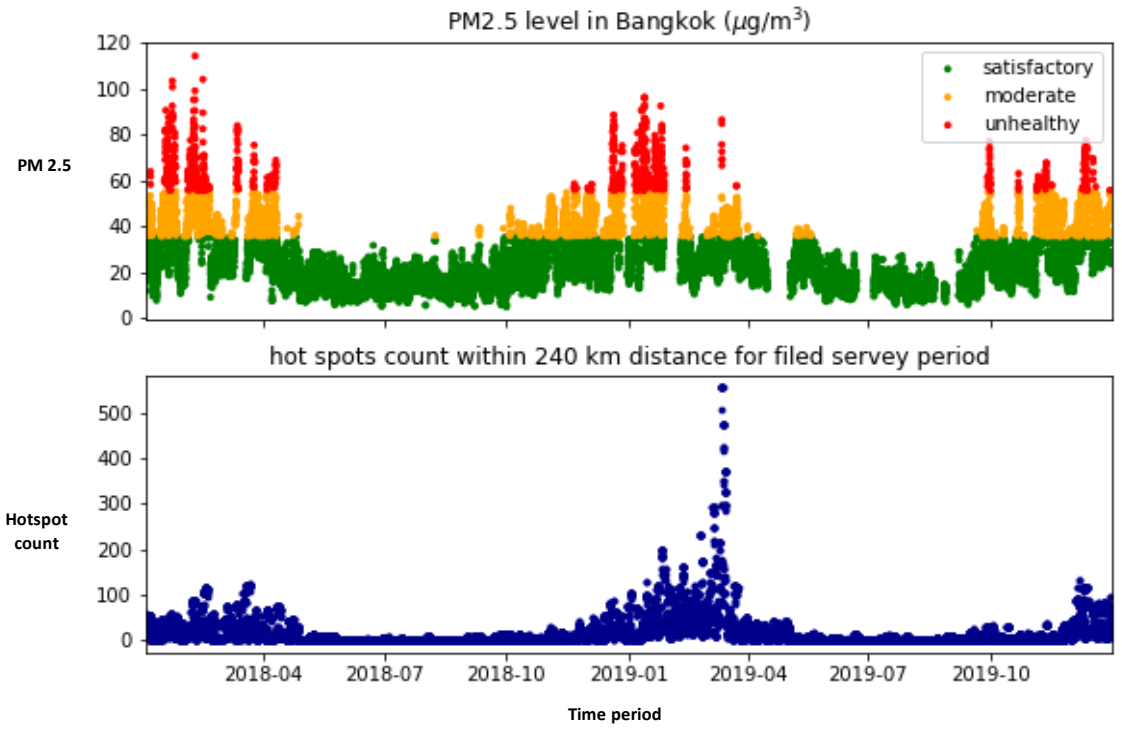



*Figure 3 Variation of hots spot and PM 2.5 value with the time*

Above figure shows the increase pattern of the PM 2.5 values with the respect to the active number of hotspots detected. Both PM 2.5 and hotspot count has highest peak values at the same time periods. Fig 4 shows the daily average PM 2.5 values over the last two years. This is also verifying the pattern of high PM 2.5 values in November to March while white patches indicate the no data values.

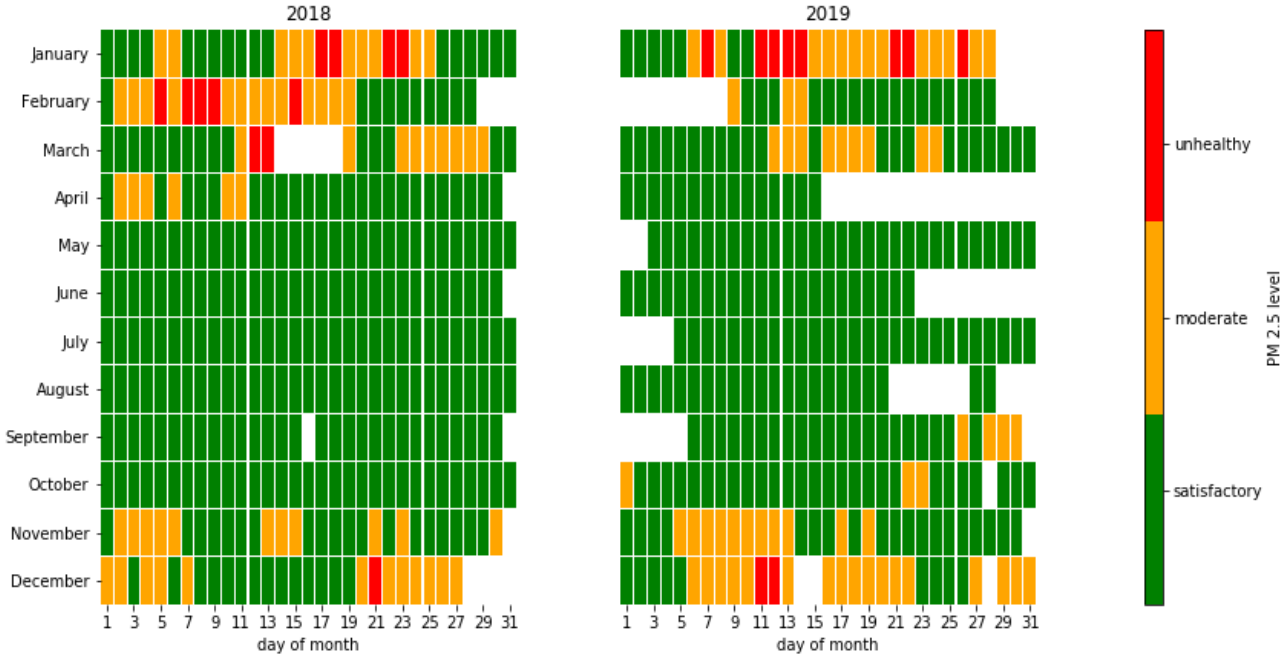



*Figure 4 Daily average PM 2.5 values in 2018 and 2019*

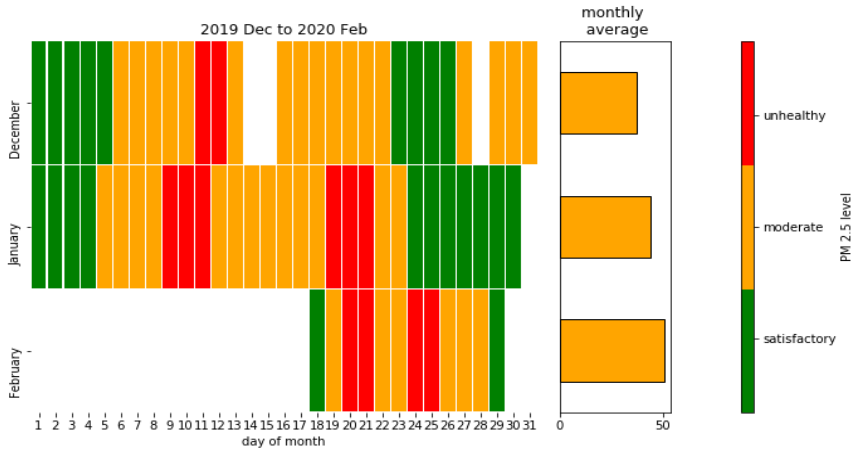



*Figure 5 Daily average PM 2.5 values during the survey period*

This above plot shows high PM 2.5 value in January 8 -12 for the Bangkok region. GCOM C ARPL products available for these time periods were processed and observed for a wide area. 2020 January 4 image shows less aerosol optical thickness (AOT) over Bangkok and other areas. When it is compared with January 8 and 12 images, it is clearly shown in Fig 7,8 has overall high AOT over the region. Both detected active fire hotspots for each relevant day, also overlaid with these images and it shows some detectable relationship with the AOT distribution over the region. Which is Higher the number of hotspots, higher the distribution of aerosols and thickness over the region.

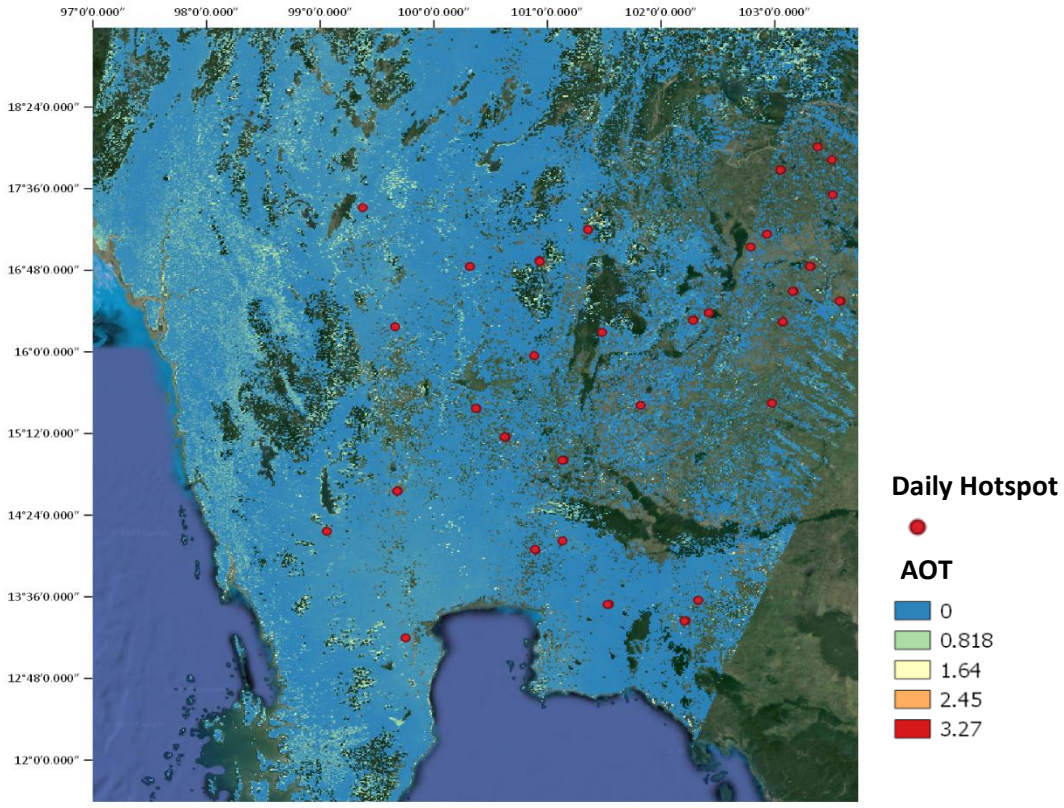



*Figure 6 Detected hot spot and aerosol optical thickness over the region interest on 2020-01-04*

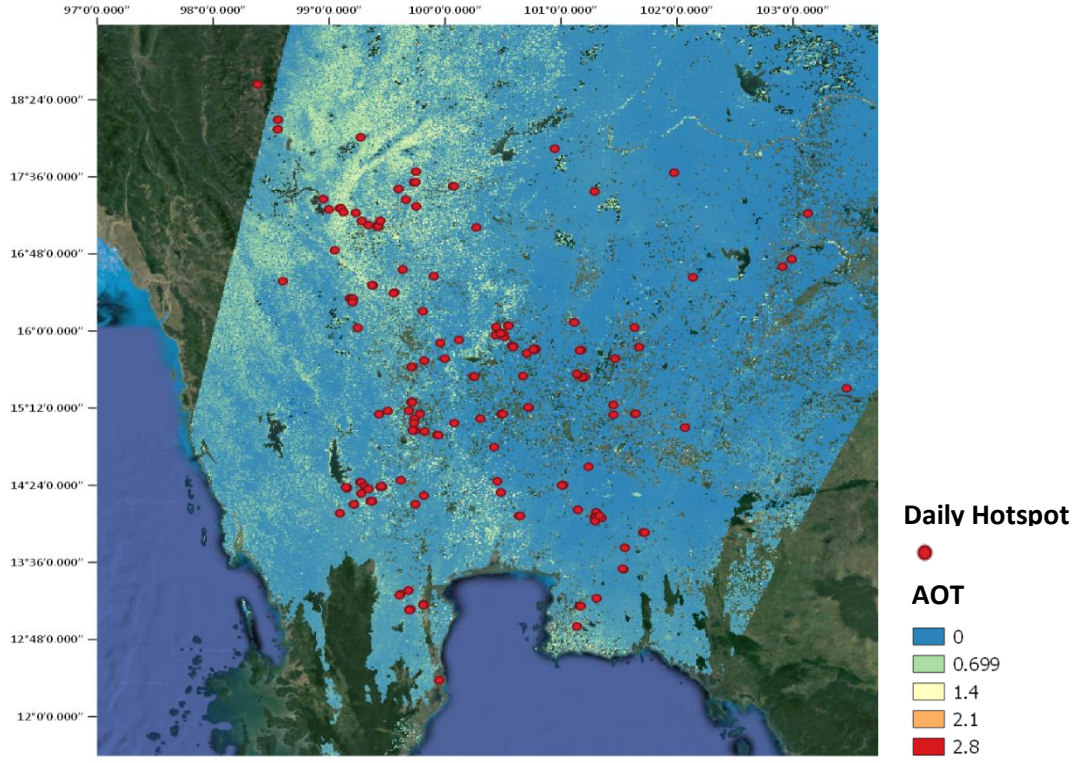



*Figure 7 Detected hot spot and aerosol optical thickness over the region interest on 2020-01-08*

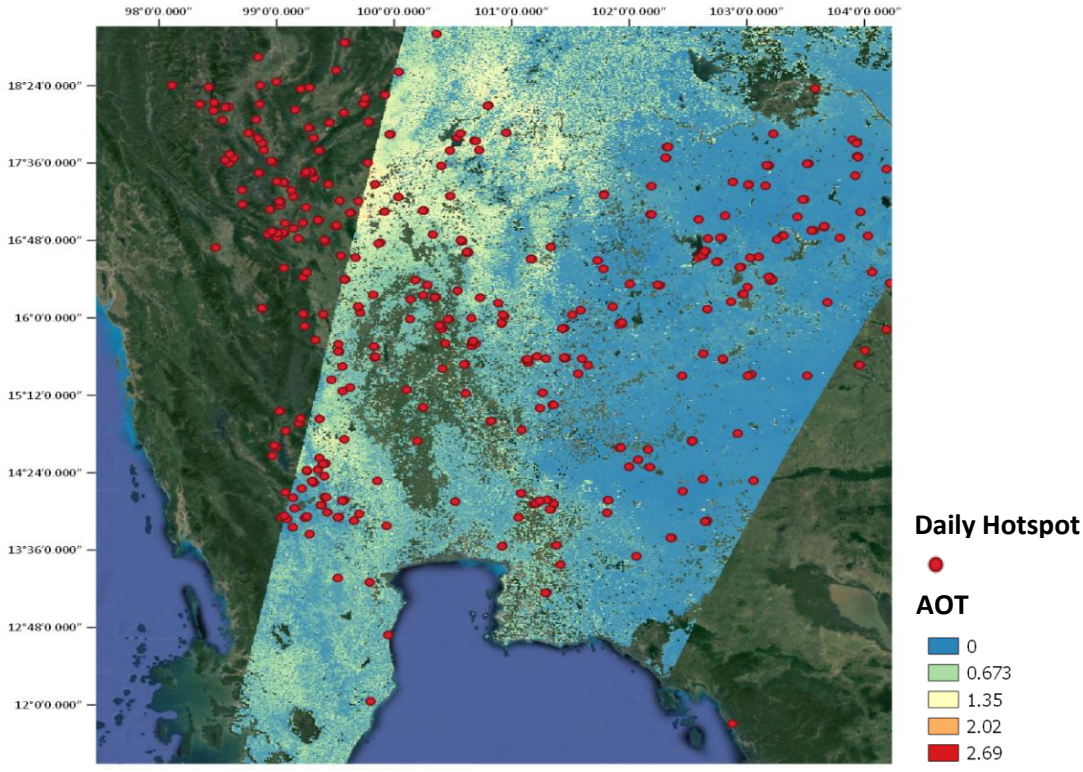
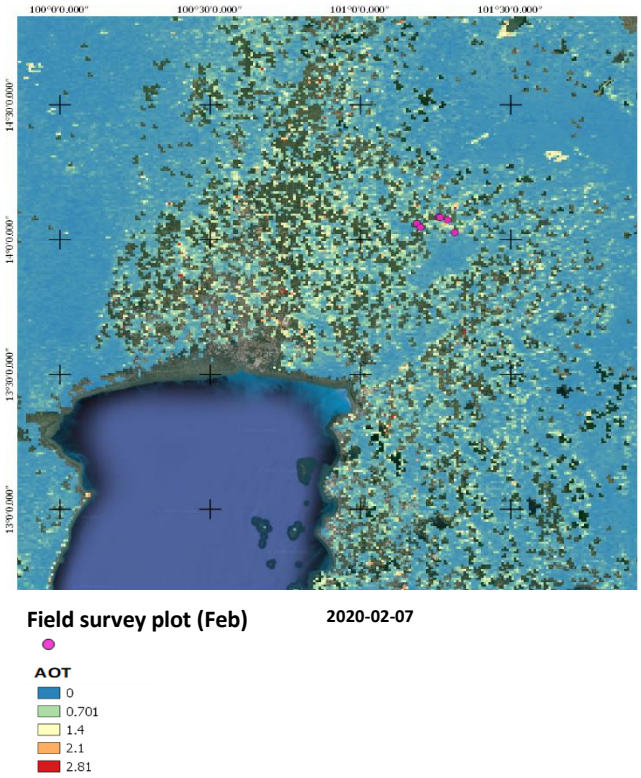
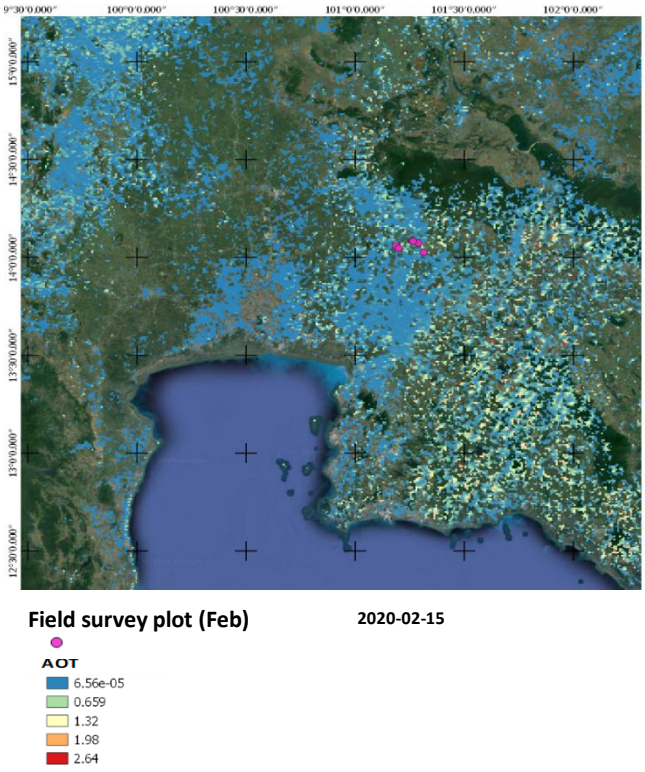



*Figure 8 Detected hot spot and aerosol optical thickness over the region interest on 2020-01-12*

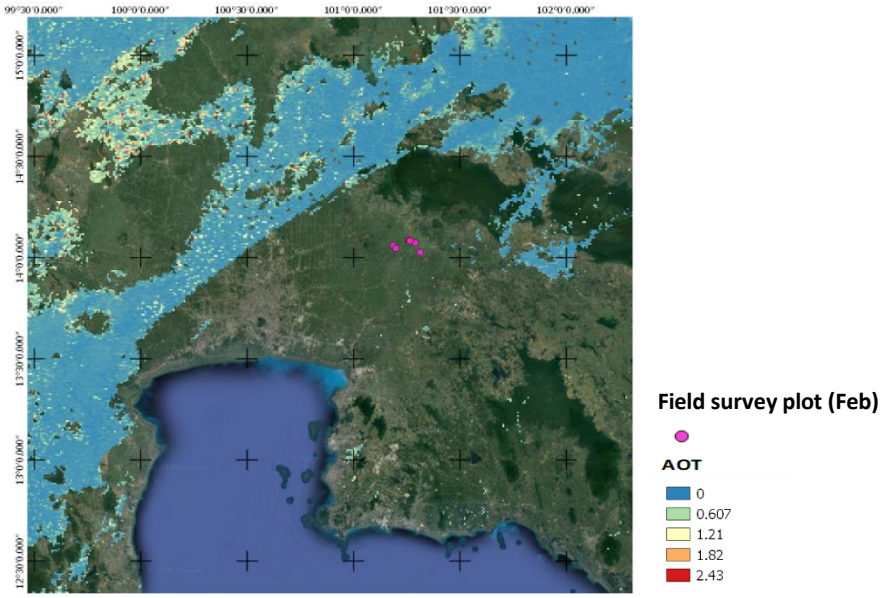
The images shown below are the GCOM C aerosol optical thickness products observed in 2020 February. (During the February field work). Some of the regions are displayed as no data values where there was no observed data and fully cloudy coverage. Field survey plot also overlaid with the AOT images and it is difficult to observe how much aerosol optical thickness change due to a small area of burning site as it can be affected by many other factors like wind and weather patterns.




2020-02-07




2020-02-15




2020-02-11

*Figure 9 Detected Aerosol optical thickness on February (a)04 (c)11 (b)15 over bangkok and other regions*

## 3. Conclusion

Active hotspot data and the PM 2.5 values shows a clear relation and it is confirmed that agricultural burning has a big impact on PM 2.5 as well as aerosol distribution in the atmosphere.

When observing the GCOM C aerosol products it is clearly shown that these products can be used for monitoring aerosol in large scale. When monitoring the aerosols there are some of pros and cons of using these GCOM C aerosol products.

Resolution of 1km of the aerosol product is one the advantages of these products when comparing with other satellite aerosol data products. Daily product availability is another advantage among them.

Even if the daily AOT product is available, the coverage is not consistent due to no data and high cloud coverage. When relating specially with agricultural burning sites, care should be taken with the time of the satellite observation as it can affect the results as well. There are also many factors that can affect the aerosol distribution, such as wind pattern, weather and contribution of vehicles, etc. These factors should also be considered when working with the satellite data.