# **Collection of AOD (Aerosol Optical Depth) 550 nm from Aqua Satellite**

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 Earth’s surface to the top of the atmosphere. The used AOD 550 nm is the dust aerosol optical thickness at 550 nanometers (nm). The satellite AOD (Aerosol Optical Depth) 550 nm data were collected using NASA Giovanni data visualization platform. The available AOD 550 nm product was preprocessed from MODIS (Moderate Resolution Imaging Spectroradiometer) instrument aboard the Aqua Satellite, which passes from South to North poles of the earth. The obtained AOD 550 nm product is basically the level-3 atmosphere daily global product (MYD08\_D3), which are derived from four leve-2 MODIS AQUA atmosphere products MYD04\_L2, MYD05\_L2, MYD06\_L2, and MYD07\_L2. It contains daily 1 x 1 degree grid average values of atmospheric parameters related to atmospheric aerosol particle properties, total ozone burden, atmospheric water vapor, cloud optical and physical properties, and atmospheric stability indices. The selected shape of the data was Bangladesh, which means obtained AOD 550 nm product were collected and preprocessed by the AQUA satellite using the MODIS instrument while orbiting above Bangladesh. The collected data timeframe was from 2021-03-01 to 2021-03-31. The obtained AOD 550 nm is the mean AOD 550 nm for each day processed by the AQUA MODIS. **DATA SOURCE: https://giovanni.gsfc.nasa.gov/giovanni/**

# **Collection of ground station PM2.5 data**

PM2.5 refers to a category of particulate matter or pollutants that is 2.5 micrometers or smaller in size. The data of PM2.5 raw concentration was obtained from AirNow. AirNow is a partnership of the U.S EPA (Environmental Protection Agency), National Oceanic and Atmospheric Administration (NOAA), National Park Service, NASA, Centers for Disease Control, and tribal, state, and local air quality agencies. The extracted data from AirNow represents the data of Raw concentration of PM2.5 as a unit of μg/m3 for Dhaka and the timeframe was from 2021-03-01 to 2021-03-31. The initial data was of the mean raw concentration of PM2.5 per hour for 24 hours of each day, later it was converted to mean concentration of PM2.5 per day to fit with the AOD 550 nm product data obtained from the AQUA MODIS. DATA SOURCE: **AirNow.gov**

# **Converting AOD 550 nm to PM2.5**

The required data to obtained estimated PM2.5 from Aqua satellite are:

* PM2.5 mass concentration from ground monitors
* Satellite derived Aerosol Optical Depth

PM2.5 can be estimated from satellite AOD using multiple methods, among them the mostly used methods are Two-Variable Method (TVM), Multivariable Method, Artificial Intelligence, and Model Scaling (MSC). The Two-Variable Method (TVM) or Simple Linear Regression Model is used here to estimate the PM2.5 from the satellite AOD. Firstly, the AQUA MODIS AOD at 550 nm were correlated with the ground station PM2.5 which shows the R2 of (0.1202) with a slope of (-52.077) and intercept of (196.31) as shown in figure (1). The slope and intercept were used to estimate the PM 2.5 at ground level with the help of AQUA MODIS 550 at nm measurements.

**Figure 1: Scatter plot of AQUA MODIS AOD at 550 nm against Ground Station PM2.5 measurements.**

The estimated PM2.5 was derived using TVM or simple linear regression model, where the slope and intercepting point were obtained from the correlations of AQUA MODIS AOD at 550 nm and Ground Station PM2.5 Mass Concentration. The equation  **– Eq:01** was derived from the correlation and was used to obtain the estimated PM2.5. For each AOD at 550 nm provided a estimated PM2.5.

**Figure 2: Scatter plot between Estimated and Ground Station PM2.5 Mass Concentration from AOD model**

Later, the correlation of estimated PM2.5 which was measured by the AQUA MODIS AOD with the ground station PM2.5 which shows the R2 of (0.1202) with a slope of (0.1202) and intercept of (127.78) as shown in figure (2). Here, a low R2 value indicates that the independent variable (Ground Station PM2.5 Mass Concentration) is not much effective in the variation of the dependent variable (Estimated PM2.5 Mass Concentration) from which we can interpret that there might be more independent variables affecting the dependent variable.

# **Calculating AQI from PM2.5 Mass Concentration**

For each PM2.5 Mass Concentration a AQI was obtained using the AQI equation:

**– Eq:02**

These variables are the following:

***CP*:** The concentration of pollutant *P*.

***C*low, *C*high:** The low/high concentration breakpoints that contain *CP*. These breakpoints are defined by the EPA in the figure (3).

***I*low, *I*high:** The low/high index range associated with concentration breakpoints for *CP*.

Example: For PM2.5 mass concentration of 89.7 µg/m3 average pollution over a 24-hour period, then this reading falls in the 55.5--150.4 range for PM2.5 concentrations, associated with the 151--200 index range (this is in the row of the table labeled "Unhealthy"). Thus, the AQI formula for this pollutant becomes:

|  |  |  |
| --- | --- | --- |
| **Category** | AQI | **PM2.5 (µg/m3) 24hr avg** |
| Good | 0--50 | 0--12.0 |
| Moderate | 51--100 | 12.1--35.4 |
| Unhealthy for Sensitive Groups | 101--150 | 35.5--55.4 |
| Unhealthy | 151--200 | 55.5--150.4 |
| Very Unhealthy | 201--300 | 150.5--250.4 |
| Hazardous | 301--500 | 250.5--500.4 |

**Figure 3: AQI Breakpoint Table**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Date | AQUA MODIS AOD 550 nm | Ground PM2.5 | AQI Ground | AQI Category | Estimated PM2.5 | Estimated AQI | Estimated AQI Category |
| 3/1/2021 | 0.621923075 | 89.7 | 169 | Unhealthy | 163.9 | 214 | Very Unhealthy |
| 3/2/2021 | 0.44706523 | 102.4 | 175 | Unhealthy | 173 | 223 | Very Unhealthy |
| 3/3/2021 | 0.479187056 | 126.1 | 187 | Unhealthy | 171.3 | 222 | Very Unhealthy |
| 3/4/2021 | 0.576767895 | 142.3 | 196 | Unhealthy | 166.2 | 217 | Very Unhealthy |
| 3/5/2021 | 0.855233195 | 115.6 | 182 | Unhealthy | 151.7 | 202 | Very Unhealthy |
| 3/6/2021 | 0.825564444 | 77.5 | 162 | Unhealthy | 153.3 | 204 | Very Unhealthy |
| 3/7/2021 | 1.25258258 | 90.9 | 169 | Unhealthy | 131 | 190 | Unhealthy |
| 3/8/2021 | 1.16718272 | 130.6 | 190 | Unhealthy | 135.5 | 192 | Unhealthy |
| 3/9/2021 | 1.91480311 | 79.1 | 163 | Unhealthy | 96.5 | 172 | Unhealthy |
| 3/10/2021 | 1.47957444 | 62.6 | 155 | Unhealthy | 119.2 | 184 | Unhealthy |
| 3/11/2021 | 1.16871349 | 96.5 | 172 | Unhealthy | 135.4 | 192 | Unhealthy |
| 3/12/2021 | 1.1684171 | 154.6 | 205 | Very Unhealthy | 135.4 | 192 | Unhealthy |
| 3/13/2021 | 1.62215327 | 149.2 | 199 | Unhealthy | 111.8 | 180 | Unhealthy |
| 3/14/2021 | 0.828912805 | 95.7 | 172 | Unhealthy | 153.1 | 204 | Very Unhealthy |
| 3/15/2021 | 0.656754169 | 153.6 | 204 | Very Unhealthy | 162.1 | 212 | Very Unhealthy |
| 3/16/2021 | 0.488711245 | 320.3 | 370 | Hazardous | 170.8 | 221 | Very Unhealthy |
| 3/17/2021 | 0.54776322 | 152.6 | 203 | Very Unhealthy | 167.7 | 218 | Very Unhealthy |
| 3/18/2021 | 0.652457109 | 232.2 | 282 | Very Unhealthy | 162.3 | 213 | Very Unhealthy |
| 3/19/2021 | 0.705899459 | 245.8 | 295 | Very Unhealthy | 159.5 | 210 | Very Unhealthy |
| 3/20/2021 | 1.33915197 | 215.6 | 266 | Very Unhealthy | 126.5 | 188 | Unhealthy |
| 3/21/2021 | 0.751072169 | 318.4 | 368 | Hazardous | 157.1 | 208 | Very Unhealthy |
| 3/22/2021 | 0.694079068 | 188.1 | 238 | Very Unhealthy | 160.1 | 211 | Very Unhealthy |
| 3/23/2021 | 1.07608067 | 87.6 | 168 | Unhealthy | 140.2 | 195 | Unhealthy |
| 3/24/2021 | 1.2399527 | 195.7 | 246 | Very Unhealthy | 131.7 | 190 | Unhealthy |
| 3/25/2021 | 0.508000238 | 127 | 188 | Unhealthy | 169.8 | 220 | Very Unhealthy |
| 3/26/2021 | 0.657984872 | 147.3 | 198 | Unhealthy | 162 | 212 | Very Unhealthy |
| 3/27/2021 | 0.646923759 | 149 | 199 | Unhealthy | 162.6 | 212 | Very Unhealthy |
| 3/28/2021 | 0.975679124 | 146.4 | 198 | Unhealthy | 145.4 | 197 | Unhealthy |
| 3/29/2021 | 1.65575138 | 157.6 | 208 | Very Unhealthy | 110 | 179 | Unhealthy |
| 3/30/2021 | 2.04113359 | 74.7 | 161 | Unhealthy | 90 | 169 | Unhealthy |
| 3/31/2021 | 1.35735422 | 76.1 | 162 | Unhealthy | 125.6 | 187 | Unhealthy |

**Figure 4: Data Table for Aqua MODIS AOD 550 nm, raw and estimated PM2.5 mass concentration, and AQI.**

The data table in figure (4) shows the AQUA MODIS AOD at 550 nm and Ground PM.25 data which is derived to obtain the estimated PM2.5 using **Eq:01** and AQI Ground and Estimated AQI is obtained using **Eq:02**, the AQI Category is determined according to figure (3).

The conversion methods were gathered from the below sources:

* Atmospheric Chemistry and Physics Journal (Q1)
* Journal of Geophysical Research Journal (Q1)
* NASA Applied Remote Sensing Training Program