**Supplemental Material**

Aerosol climatology characterization over Bangladesh using ground-based and remotely sensed satellite measurements

Short title: Aerosol climatology over Bangladesh

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Table S1. Observation sites and the total number of datasets at each AERONET site. AAE = Absorption angstrom exponent; AE = Angstrom exponent; EAE= Extinction angstrom exponent; FMF = Fine mode fraction; RRI = Real refractive index; SSA = Single scattering albedo

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| --- | --- | --- | --- | --- |
| Sites | Time period | Total | | Elevation |
| Direct products (FMF, AE) | Inversion products (AAE, EAE, SSA, RRI) |
| Dhaka | Jun, 2012- Jun, 2019 | 1294, 1223 | 609 | 34 m |
| Bhola | Jan, 2013 - Jun,2019 | 1028, 994 | 585 | 7 m |

Table S2: 95% confidence interval for the aerosol optical parameters using Bootstrap method for Bhola and Dhaka. AAE = Absorption angstrom exponent; AE = Angstrom exponent; EAE= Extinction angstrom exponent; FMF = Fine mode fraction; RRI = Real refractive index; SSA = Single scattering albedo

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| --- | --- | --- | --- | --- |
| Aerosol optical parameters | Observation sites | 95% Lower confidence interval | Mean | 95% Upper confidence interval |
| AAE | Bhola | 1.228 | 1.257 | 1.285 |
| Dhaka | 1.281 | 1.311 | 1.34 |
| EAE | Bhola | 1.228 | 1.242 | 1.255 |
| Dhaka | 1.182 | 1.197 | 1.211 |
| SSA | Bhola | 0.909 | 0.912 | 0.915 |
| Dhaka | 0.889 | 0.891 | 0.894 |
| AE | Bhola | 1.253 | 1.27 | 1.286 |
| Dhaka | 1.178 | 1.195 | 1.211 |
| RRI | Bhola | 1.461 | 1.465 | 1.468 |
| Dhaka | 1.455 | 1.459 | 1.463 |
| FMF | Bhola | 0.843 | 0.855 | 0.866 |
| Dhaka | 0.847 | 0.858 | 0.869 |

Table S3: Overall statistics of Kruskal-Wallis rank sum test for Dhaka and Bhola. AAE = Absorption angstrom exponent; AE = Angstrom exponent; EAE= Extinction angstrom exponent; FMF = Fine mode fraction; RRI = Real refractive index; SSA = Single scattering albedo

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| --- | --- | --- | --- | --- |
| Aerosol optical parameters | Observation sites | Kruskal-Wallis rank sum test statistics | | |
| Chi squared | Degrees of freedom (df) | p-value |
| AAE | Dhaka | 26.9 | 3 | 6.214E-06 |
| Bhola | 40.2 | 3 | 9.868E-09 |
| EAE | Dhaka | 63.1 | 3 | 1.279E-13 |
| Bhola | 25.4 | 3 | 1.268E-05 |
| RRI | Dhaka | 33.9 | 3 | 1.998E-07 |
| Bhola | 9.5 | 3 | 2.29E-02 |
| SSA | Dhaka | 58.1 | 3 | 1.494E-12 |
| Bhola | 121.3 | 3 | 2.2E-16 |
| FMF | Dhaka | 244.8 | 3 | 2.2E-16 |
| Bhola | 271.9 | 3 | 2.2E-16 |
| AE | Dhaka | 23.1 | 3 | 3.879E-05 |
| Bhola | 40.9 | 3 | 7.011E-09 |

Table S4: Pair-Wise Wilcox test summary (p-values) for Dhaka and Bhola. The parameters are statistically different if p<5.00E-02. Statistically different values are marked as bold. AAE = Absorption angstrom exponent; AE = Angstrom exponent; EAE= Extinction angstrom exponent; FMF = Fine mode fraction; RRI = Real refractive index; SSA = Single scattering albedo.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Dhaka | | | | | Bhola | | | | |
| Parameters | Seasons | Monsoon | Post-monsoon | Pre-monsoon | Parameters | Seasons | Monsoon | Post-monsoon | Pre-monsoon |
| AAE | Post-monsoon | 6.40E-01 | NA | NA | AAE | Post-monsoon | 8.63E-02 | NA | NA |
| Pre-monsoon | 4.85E-01 | **1.17E-02** | NA | Pre-monsoon | **1.79E-02** | **6.00E-06** | NA |
| Winter | 4.85E-01 | 2.28E-01 | **1.50E-06** | Winter | **4.30E-02** | 6.68E-02 | **5.96E-06** |
| EAE | Post-monsoon | **4.43E-05** | NA | NA | EAE | Post-monsoon | **3.44E-02** | NA | NA |
| Pre-monsoon | 1.09E-01 | **3.57E-09** | NA | Pre-monsoon | 7.87E-02 | **1.64E-04** | NA |
| Winter | 5.59E-02 | **1.98E-12** | 6.46E-01 | Winter | **3.76E-02** | **8.43E-04** | **3.44E-02** |
| RRI | Post-monsoon | **2.10E-03** | NA | NA | RRI | Post-monsoon | 2.65E-01 | NA | NA |
| Pre-monsoon | 1.20E-01 | **4.06E-05** | NA | Pre-monsoon | 6.10E-01 | **2.01E-02** | NA |
| Winter | **2.10E-03** | 2.89E-01 | **3.62E-05** | Winter | 6.10E-01 | **2.01E-02** | 8.44E-01 |
| SSA | Post-monsoon | **9.06E-07** | NA | NA | SSA | Post-monsoon | **1.56E-02** | NA | NA |
| Pre-monsoon | **3.35E-04** | **3.50E-07** | NA | Pre-monsoon | 6.15E-01 | **9.13E-10** | NA |
| Winter | **9.06E-07** | **3.35E-04** | **1.08E-04** | Winter | **9.64E-03** | 8.20E-01 | **6.55E-25** |
| FMF | Post-monsoon | **2.35E-09** | NA | NA | FMF | Post-monsoon | **1.56E-02** | NA | NA |
| Pre-monsoon | 2.72E-01 | **1.02E-34** | NA | Pre-monsoon | 6.15E-01 | **9.13E-10** | NA |
| Winter | **3.46E-09** | 1.04E-01 | **4.42E-42** | Winter | **9.64E-03** | 8.20E-01 | **6.55E-25** |
| AE | Post-monsoon | **3.88E-05** | NA | NA | AE | Post-monsoon | **1.05E-03** | NA | NA |
| Pre-monsoon | **4.76E-05** | 7.11E-01 | NA | Pre-monsoon | **8.21E-05** | **2.00E-03** | NA |
| Winter | **6.13E-04** | 6.42E-02 | 7.48E-02 | Winter | **6.23E-05** | **2.97E-02** | **1.10E-04** |

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| (b)  (a) |  |

Figure S1. Scatterplot between AERONET-AAOD and OMI-AAOD over Bangladesh for time period of 2012-2019 (a) Dhaka, (b) Bhola. AERONET= Aerosol robotic network, OMI= Ozone monitoring instrument, AAOD= Aerosol absorption optical depth.

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| (a) | (b) |
| C:\Users\SARK\Desktop\v50_BC_2015.png | |
| (c) | |

Figure S2. Temporal emission profiles of black carbon and PM2.5 over Bangladesh using EDGAR (Emission database for global atmospheric research) version 5.0 data for 2000-2015. (a) Black carbon, (b) PM2.5, (c) Annual grid map of BC during 2015.

|  |
| --- |
| (a) |
| (b) |
| (c) |

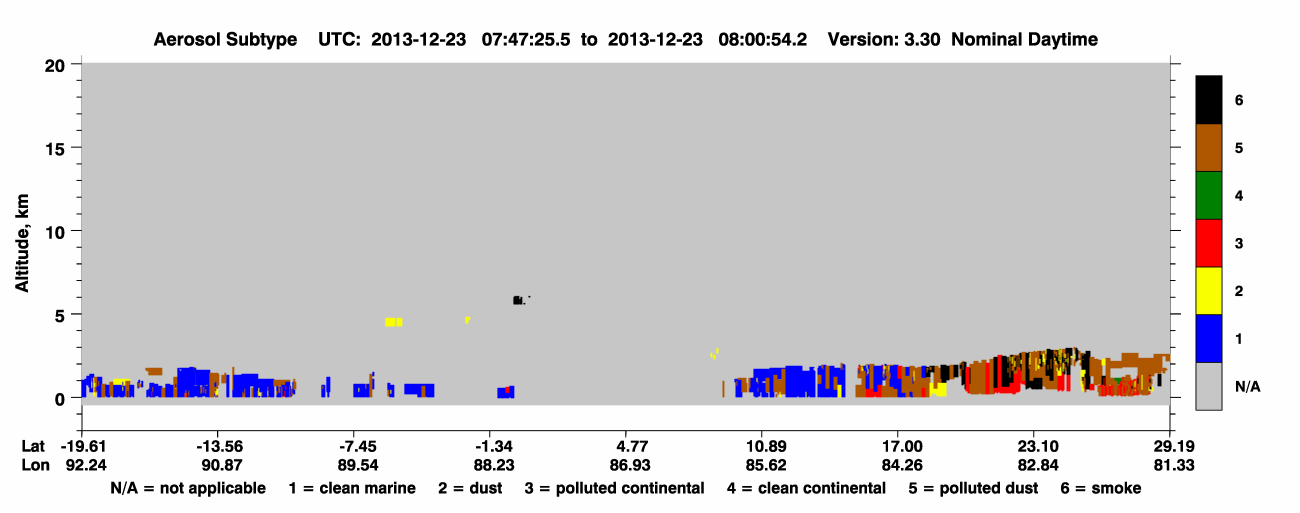


Figure S3. Aerosol subtypes from CALIPSO (version 3.30) passing over Dhaka and Bhola during selected days. (a) Pre-monsoon (2015-04-07), (b) Post-monsoon (2015-10-23), (c) Winter (2015-12-10). Red box represents the approximate coordinates of Bangladesh. N/A = not applicable, 1 = clean marine, 2 = dust, 3 = polluted continental, 4= clean continental, 5= polluted dust, 6= smoke.

**Data statement:** This refers to the second part of the supplemental materials, i.e. Excel data file.

**Sheet 1 (EAE vs AAE):** Relationship between extinction angstrom exponent (EAE) and absorption angstrom exponent (AAE)

Data source: AERONET (https://aeronet.gsfc.nasa.gov/cgi-bin/webtool\_inv\_v3)

**Sheet 2 (EAE vs RRI):** Relationship between extinction angstrom exponent (EAE) and real refractive Index (RRI)

Data source: AERONET (https://aeronet.gsfc.nasa.gov/cgi-bin/webtool\_inv\_v3)

**Sheet 3 (EAE vs SSA):** Relationship between extinction angstrom exponent (EAE) and single scattering albedo (SSA)

Data source: AERONET (https://aeronet.gsfc.nasa.gov/cgi-bin/webtool\_inv\_v3)

**Sheet 4 (FMF vs AAE):** Relationship between fine mode fraction (FMF) and absorption angstrom exponent (AAE)

Data source: AERONET (https://aeronet.gsfc.nasa.gov/cgi-bin/webtool\_inv\_v3)

**Sheet 5 (FMF vs AE):** Relationship between fine mode fraction (FMF) and angstrom exponent (AE)

Data source: AERONET (https://aeronet.gsfc.nasa.gov/cgi-bin/webtool\_inv\_v3)

**Sheet 6 (FMF vs SSA):** Relationship between fine mode fraction (FMF) and single scattering albedo (SSA)

Data source: AERONET (https://aeronet.gsfc.nasa.gov/cgi-bin/webtool\_inv\_v3)

**Sheet 7 (Seasonal variations):** Seasonal variations of the aerosol optical parameters

Data source: AERONET (https://aeronet.gsfc.nasa.gov/cgi-bin/webtool\_inv\_v3)

**Sheet 8 (MODIS fire point):** Number of MODIS fire points over Bangladesh during winter and pre-monsoon season (2018-19)

Data source: FIRMS (https://firms.modaps.eosdis.nasa.gov/country/)

**Sheet 9 (AAOD Data):** Monthly distribution of aerosol absorption optical depth (AAOD) derived from AERONET and OMI instruments

Data source: AERONET (https://aeronet.gsfc.nasa.gov/cgi-bin/webtool\_inv\_v3) and OMI (https://giovanni.gsfc.nasa.gov/giovanni/)

**Sheet 10 (EDGAR Data):** Temporal emission profiles of black carbon and PM2.5 over Bangladesh using EDGAR (Emission database for global atmospheric research) version 5.0 data for 2000-2015

Data Source: EDGAR (Emission database for global atmospheric research) version 5.0 (https://edgar.jrc.ec.europa.eu/)