AEROSOL PARAMETERS DURING WINTER AND SUMMER SEASONS AND METEOROLOGICAL IMPLICATIONS

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ABSTRACT

The MICROTOPS II aerosol optical depth (AOD) and Moderate Resolution Imaging Spectroradiometer (MODIS) Aqua AOD and angstrom exponent (AE) were collected during December 2016 to May 2017. Higher AOD values were recorded during winter (December - February) and summer (March - May) Months. These values were observed by MICROTOPS II (0.35 - 1.279) and MODIS (0.222 - 1.904) during winter season. During summer AOD values were recorded by MICROTOPS II (0.272 – 1.744) and MODIS (0.227 – 1.33). Whereas MODIS AE (0.218 – 1.799) values were found high during winter season indicates about the dominance of fine particulates. During summer months MODIS AE (.001 – 1.648) values are indicating about the mixing of the aerosol particles. The relative humidity values during December and January months were found to be high, while its values were found decreasing during late February due to transition phase. Relative humidity values were recorded low during summer (36 – 86%) months in compare to the winter (50 - 100%) months.

1. INTRODUCTION

The continuously increasing air pollutant concentrations are not only an environmental issue within the cities, while it has also regional and global environmental effects [1, 2]. The rapidly increasing population, vehicles, industrial developments and the resulting anthropogenic activities are the major concerns for the air, water and land pollution in most of the developing Asian countries [1-6]. So, it becomes very essential to the management of near surface air quality due to its possible implications for the human health, visibility, precipitation and agricultural crop yield [7-9]. Indo Gangetic Plain (IGP) in India, experiences a very high aerosol loading with a strong intra-seasonal to inter-annual variability [10]. IGP region traversed by the Ganga river and its tributaries is one of the largest, densely populated, industrialized and developing region of the world where aerosol not only affect the Indian monsoon but also the global climate system [11]. The high mortality estimates from satellite observations in comparison to the ground-based databases were found by [8]. All the anthropogenic activity, including various festivals, affects the environment especially in India.

2. METHODOLOGY

2.1 Study area and sampling

Samples were collected in Varanasi (25.2677° N, and 82.9913° E) over the middle IGP during December 2016 – May 2017. The AOD (550 nm) samples were collected on daily basis using MICROTOPS II Sunphotometer. MODIS Aqua AOD (550 nm) and AE (412 – 470 nm) were collected from NASA Giovanni website (http://giovanni.gsfc.nasa.gov/giovanni/). The meteorological parameter (relative humidity) data was collected from the India Meteorological Department (IMD) established center at Banaras Hindu University (BHU), Varanasi.

3. RESULTS

3.1 AOD and AE for the atmospheric aerosols during winter season

During winter months AOD values were in the ranges (0.35 - 1.279) collected by MICROTOPS II. The maximum limit is not very large because the AOD data by MICROTOPS II was available from late January 2017 to February 2017. The AOD values were found very high during December month, can be clearly seen from the MODIS collected AOD (0.222 - 1.904) data. The temporal variation of MODIS aqua AOD and AE, MICROTOPS II AOD and relative humidity are shown in Figure 1. The decreasing trend of AOD was observed from December 2016 to February 2017. AE values were found high during December and January months while its values were observed decreasing at the late February month. The AE>1 values are indicating about the dominance of fine particles during winter season. During winter season the aerosols were originated from biomass/biofuel burning and due to vehicular pollution over the site [12].

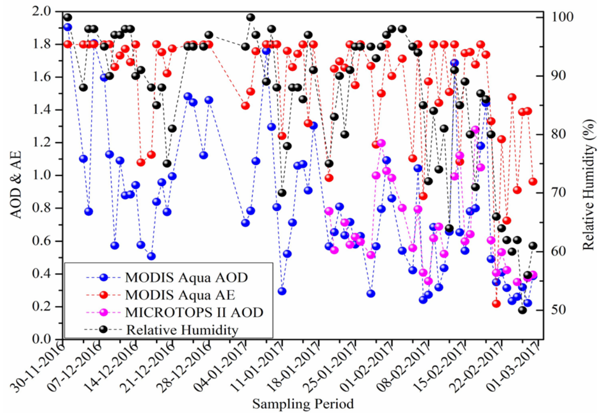

Figure 1: Temporal variation of MICROTOPS II AOD, MODIS Aqua AOD and AE and relative humidity during winter season.

The Five days back trajectories using HYSPLIT model over Varanasi for 6 January 2017 with huge aerosol loading is shown in Figure 2.

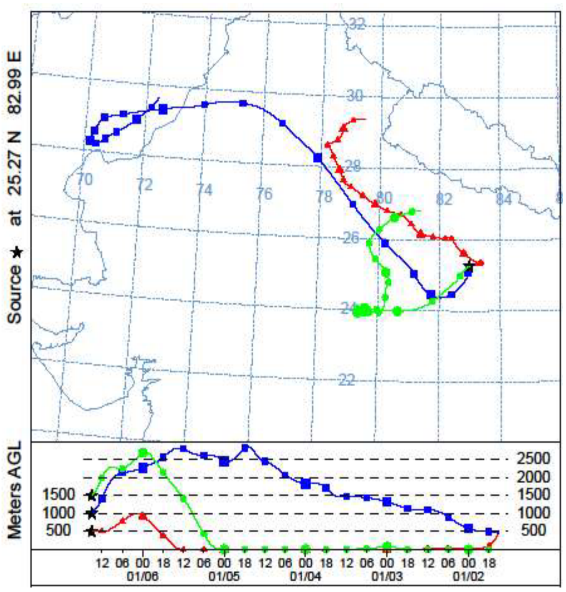

Figure 2: The Five days back trajectories using HYSPLIT model over Varanasi for 6 January 2017 with huge aerosol loading.

During 6 January 2017 it was observed that some of the aerosols are coming from Pakistan country. However mostly aerosols are arising from the states of Uttarakhand, Uttar Pradesh and Madhya Pradesh.

3.2 AOD and AE for the atmospheric aerosols during summer season

The AOD values varies in the different ranges during summer months by MODIS (0.227 – 1.33) and MICROTOP II (0.272 – 1.744). Good agreement between MODIS and MICROTOPS II AOD was observed. The agreement can clearly be seen by Figure 3.

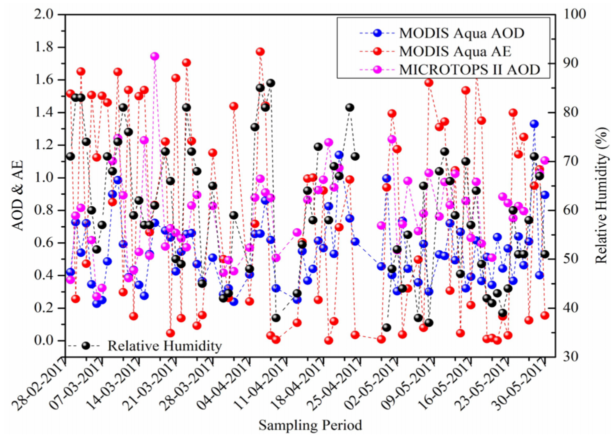

Figure 3: Temporal variation of MICROTOPS II AOD, MODIS Aqua AOD and AE and relative humidity during summer season.

While larger range of AE (.001 – 1.648) values are indicating about the mixing of the different size particles. Some of the AE values were observed very low while some were very high. For the most of the cases the AE<1 values during summer months is the indication of the dominance of the coarser particles. Long range transportation of the mineral dust during summer months are the major concern for the dominance of coarser particles. The coarse-mode aerosol concentrations were enhanced because of IGP is strongly affected by frequent and intense dust storms through long-range transport from Arabian Sea, southwest Asia, and the Thar Desert [13]. The Five days back trajectories using HYSPLIT model over Varanasi for 12 May 2017 with huge aerosol loading is shown in Figure 4.

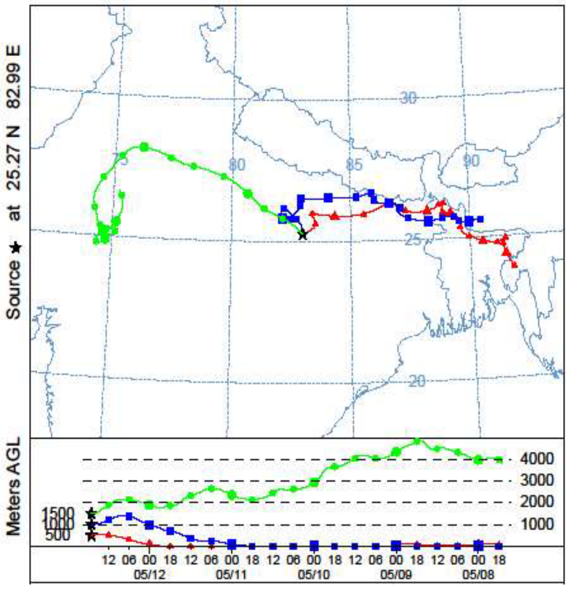

Figure 4: The Five days back trajectories using HYSPLIT model over Varanasi for 12 May 2017 with huge aerosol loading.

During 12 May 2017 it was observed that some of the aerosols are coming from Bangladesh country. However some of the aerosols are coming from Rajasthan and North Eastern states over the site of Varanasi.

3.3 Meteorological implication over the site

Meteorological parameters play a crucial role during observation of aerosol particles and its parameters. During winter months relative humidity was observed very high. While relative humidity values were found to be decreasing in the late February due to transition phase. It's ranging between (50 - 100%) during winter months. The exponential increase in AOD in highly humid condition (relative humidity>85%) is mostly attributed to the hygroscopic growth of fine particulates over the region [14]. During summer months relative humidity ranges between (36 – 86%) indicating about the dominance of the coarser particles. Lower values of relative humidity were observed during summer months in compare to the winter months.

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REFERENCES

[1] A. Choudhary, et al. Variability in emission rate of Auto-Rickshaw based on real world driving profile: A case study in Guwahati city. 2019 URSI Asia-Pacific Radio Science Conference (AP-RASC). IEEE, (2019)

[2] A. Choudhary, et al. Urban mobility associated ambient air quality and policies for Environmental implication. Atmospheric Pollution and their complications: From regional to global scale. Cambridge Scholars Publishing 2019 (In Press)

[3] S. Menon, et al. Climate effects of black carbon aerosols in China and India. Science 297:2250–2253 (2002)

[4] H. Akimoto, Global air quality and pollution. Science 302:1716–1719 (2003)

[5] Prasad et al. Seasonal climatology of aerosol optical depth over Indian subcontinent: trend and departures in recent years. International Journal of Remote Sensing 27:2323–2329 (2006)

[6] S. Tiwari et al. Identification of aerosol types over Indo-Gangetic Basin: implications to optical properties and associated radiative forcing. Environmental Science and Pollution Research 22:12246–12260 (2015)

[7] S. Han et al. Effect of aerosols on visibility and radiation in spring 2009 in Tianjin, China. Aerosol and Air Quality Research 12, 211–217 (2012)

[8] J. Evans et al. Estimates of global mortality attributable to particulate air pollution using satellite imagery. Environmental Research 120:33–42 (2013)

[9] A. Mhawish, Remote sensing of aerosols from space: retrieval of properties and applications. In: Remote Sensing of Aerosols, Clouds, and Precipitation. Elsevier Inc, pp. 1–38. http://dx.doi.org/10.1016/B978-0-12-810437-8.00003-7 (2018)

[10] R. P. Singh et al. Variability of aerosol parameters over Kanpur, Northern India. Journal of Geophysical Research109: D23206,doi:10.1029/2004JD004966 (2004)

[11] S. K. Guttikunda et al. The contribution of mega cities to regional sulphur pollution in Asia. Atmospheric Environment, 37(1): 11-22 (2003)

[12] P. Kumar, et al. Temporal variation of atmospheric aerosols and associated optical and metrological parameters. 2019 URSI Asia-Pacific Radio Science Conference (AP-RASC). IEEE, 2019

[13] P. Kumar, et al. Atmospheric aerosols over Indo Gangetic Plain: characteristics, sources and climate

implications. Atmospheric Pollution and their complications: From regional to global scale. Cambridge Scholars Publishing (2019) (In Press).

[14] O. Altaratz et al. Relative humidity and its effect on aerosol optical depth in the vicinity of convective clouds. Environmental Research Letters 8 (3) 034025 (2013)