Genesis of Aerosol in Air Quality Assurance; A meta-analysis on Climate Change

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Abstract - Purpose: The purpose of this paper is to focus on the role of Aerosols in the climatic variations and the in turn assessment in health hazards of certain hotspot regions of India specific to regionally important. Therefore, an investigation has been performed on the role of Aerosols on the climatic variations and thereafter leads change in the pattern of lively hood.

Design: The research work is designed and structured into varying segments as: analysing, monitoring and interpreting the Aerosols constituents over the geographical regions by earth observing system, Moderate Resolution Imaging Spectroradiometer (MODIS) in order to estimate and justifying how far the anthropogenic biomass burning and windblown dust emissions extends to the ecosystem.

Originality: The studies on Atmospheric Aerosol are highlighting a new insight for the depth and dimensions of the aerosol emissions are two folded by the past several years. A model study will be generated and a gas phase species and predicting their outcomes will identify and the predictions improvements will record for the future work horizons. A preliminary experiment has been done in the four states of the country. The obtained data are modelled and simulated through the and MODIS and appropriate software tools. Aerosol Chemistry is of great concern over the current period owing to their manifold contribution in various scientific disciplines akin to biogeochemistry, physics, earth sciences, meteorology, public health etc. Therefore, new sophisticated techniques and technologies are developed in the new scientific era for Air Quality (AQ) monitoring, estimating and finally their effective assessment in each country. Hence worldwide both ground and satellite monitoring approach have come up in a more scientific and systematic manner. This review articles attempts to represent a brief outline on the characteristic properties of the aerosol constituents, their varying sizes, health impacts and monitoring strategies.

Keywords - Aerosol, Air Quality (AQ) monitoring, Green House Gases (GHGs), MODIS, Health impacts.

I. INTRODUCTION

Worldwide, the scientific community has agreed and concluded that anthropogenic activities are altering the Earth's climate pattern by changing the overall infrared radiation flux in the troposphere and will continue in an upheaval level in the coming years. The input of atmospheric trace gases including Green House Gases (GHGs) such as carbon dioxide(CO_2), methane (CH_4), nitrous oxide (N_2O) etc. are formed by means of natural ways and human activities (IPCC, 2007) would results a continuous rise in the Earth's average temperature. Both at national and regional levels, climate change (CC) is having disproportionate adverse effects specifically on minorities, old people and children etc (Pandey et al., 2002; Barnett et al., 2005; Kaushik et al., 2006; Gayathree et al., 2016). CC has developed a pathetic situation to poverty reduction. In association with the atmospheric temperatures, both physical and biological impacts are coupled and are being noticed day by day in the whole ecosystem. Among them, owing to the dynamic and physically diversified nature, coastal zones have become the most conducive attractive economic zone throughout the world. These highly productive and assorted characters supply a broad spectrum of basic amenities of changeable lively hoods for mankind (Nair et al., 2008; Sundaresan, 2011; Gayathree, 2016). Enough number of environmental consequences have experienced such as in the profile of sea level rise, increased surface temperatures which has in turn shaped a variation in precipitation, intensity in rain fall lead into land erosion, storms, flood and drought etc (Mukhopadhyay & Kreycik, 2008). The dramatic alteration increased the

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frequency in weather magnitude events geographically and resulted a drastic change in the life expectancy of the coastal inhabitants.

II. Atmospheric Aerosols

The mounting evidence proven that the atmospheric aerosol (AA) distribution and their constituent is having a strong influence on the radiative forcing character for climate by reflecting sunlight back to space (Penner et al., 2001; Kiehl, 1999) and its effect on cloud microphysics and albedo (Twomey, 1977; Coakley et al., 1987; Kaufman & Fraser, 1983). Uncertainties are found for modelling these climate forcers. The aerosol forcing is showing a reverse trend in the magnitude of the green house gases (GHGs) and thereafter observed a different spatial coverage, their diurnal cycle and finally a complex climate pattern is breed out (IPCC, 1995).The primary pollutants are generated through biomass burning, traffic and industrial emissions, the photochemical reactive moieties of biogenic organic volatiles etc (Kuo et al., 2011; Tsai & Kuo, 2013; Tsai et al., 2012 and 2015, Chuang et al., 2013). Of the secondary organic and inorganic particulates (Samy et al., 2010; Fu et al., 2012), the Organic Aerosols (OA) are derived from biomass burning, contributing a profound effect on regional air quality and visibility, ecological systems, human health and global radiation balance leading to climate (Hsieh & Liao, 2013; Silva et al., 2010; Caseiro et al., 2009). Mineral dust particles as the dominant atmospheric aerosol component contains iron, phosphrous and other productivity inducing micronutrients and ultimately modifies the atmospheric ocean cycles (Jickells et al., 2005). Through the direct and indirect effects, it alters the marine biogeochemistry and rephrase in the climate profile.

III. Size, Distribution and Composition of Atmospheric Aerosols

The concentration, size, distribution and composition of AA particles are spatio-temporarily highly distinctive and variable. According to the properties of different types of atmospheric model aerosols, their characteristics are expressed in terms of fine and coarse fractions. These freshly formed fine fraction constitute very small particles (diameter <0.01 μm) and also called the “ultrafine”. The coarse particles or the “giant” one are generally larger than about 1 micron or having an aerodynamic diameter of 2.5 μm. Generally several key AAs exists and are originated from urban, marine, rural, remote continental, free atmosphere, polar and desert. These fine and coarse particles are having different composition (Seinfeld & Pandis, 1998). The formation pathway of fine particles is due to the process of chemical reactions, nucleation condensation, coagulation, cloud/fog formation. They constitutes sulphate , nitrate, ammonium, hydrogen ion, elemental carbon, organic compounds, metals (Pb, Cd, V, Ni, Cu, Zn, Mn, Fe etc) which are largely soluble and are hygroscopic (Rastogi & Sarin, 2009).

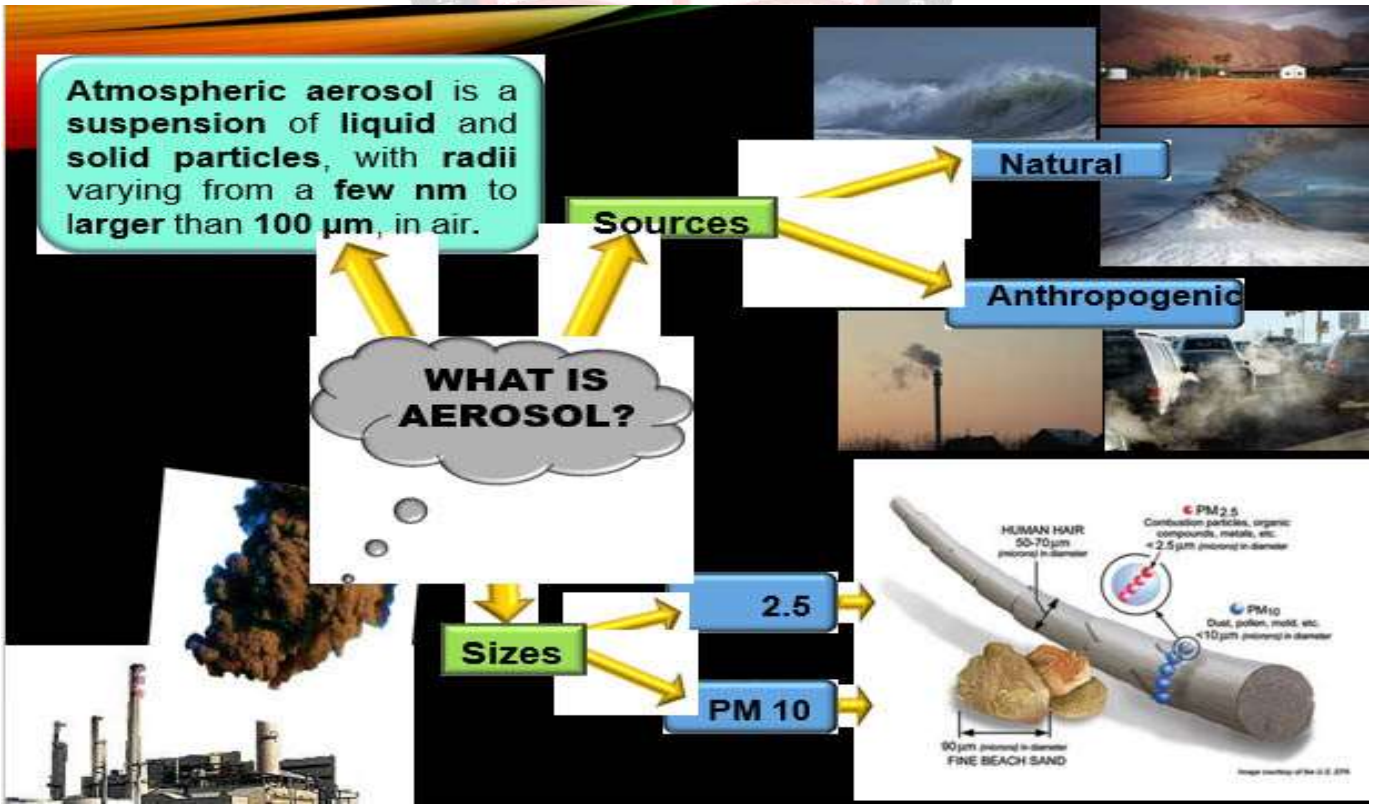

Fig 1. Aerosol Components

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IV. Interrelation between Aerosol and Climate

Subdividing the causes of climate change, the reasons chiefly represent physical and chemical factors. The foremost physical factors are temperature, cloud condensation nuclei, rain fall intensity, natural hazards etc. Other than the temperature differences, changes are being occurred in the rainfall patterns and natural hazards similar to earthquakes, tsunami and floods which are equally fetching destructions of the ecosystem. The cloud condensation nuclei (CCNs) also known as "cloud seeds" are small particle of the range 0.2µm, or 1/100th the size of a cloud droplet on which water vapor condenses. As water vapor is an effective green house gas, this is also an important reason for changing or regulating climate. The atmospheric trace gases together with the Green House Gases (GHGs), the anthropogenic derived constituents like volatile organics, black carbon along with the important cooling gases comprise in the chemical classification. Nitrogen, Oxygen, argon, carbon dioxide, also trace amounts of neon, helium, methane, krypton, hydrogen and water vapor constitute the earth's atmosphere. Any of these gases exceeding its permissible limits amounts to add air pollution and thereby cause climate changes. The changes in percentage of these gases are mainly due to vehicular and industrial emissions and also certain natural factors like volcanic eruptions.

V. Climate Forcers

5.1 Anthropogenic Aerosol Forcers

The vast and wide majority of anthropogenic gases like carbon monoxide, sulphur dioxide, carbon dioxide all that emerge from a single source human activities like combustion of fossil fuels like coal, oil, or natural gases, and from thermal power plants, industrial activities, environmental destruction like deforestation, changes in land use, soil erosion, and agriculture practices using a wide range of harmful chemicals and pesticides. SO2 is one of the priority gaseous air pollutants that have generated from various human made activities such as wood burning, vehicular transport, industrial units and power plants. The largest sources of sulphur dioxide emission are from fossil fuel combustion at power plants and other chemical industries. Smaller sources of SO2 emissions include industrial processes such as extracting metal from ore, and the burning of high sulphur containing fuels by locomotives, large ships, and non-road equipment.

Sulphur Dioxide (SO_2) - µg/m³

Date	Kerala			Karnataka		Tamil Nadu			Maharashtra		
08:30 AM - 09:30 AM	Kochi	Kannur	Kuttanadu	Shimoga	Mysore	Chennai	Tuticorin	Coimbatore	Pune	Ratnagiri	Nagpur
	9.9312° N, 76.2673° E	11.8745° N, 75.3704° E	9.3528° N, 76.4042° E	13.9299° N, 75.5681° E	15.3173° N, 75.7139° E	13.0827° N, 80.2707° E	8.7642° N, 78.1348° E	11.0168° N, 76.9558° E	18.5204° N, 73.8567° E	17.2478° N, 73.3709° E	21.1458° N, 79.0882° E
21/05/2017	3.42	1.42	3.20	0.23	0.11	7.51	27.88	1.27	1.27	0.11	3.41
22/05/2017	4.64	2.23	5.11	0.22	0.13	9.13	25.37	1.44	1.25	0.11	3.59
23/05/2017	2.74	0.88	2.87	0.22	0.14	9.03	22.37	1.50	1.18	0.12	3.72
24/05/2017	3.40	2.82	3.56	0.22	0.11	7.76	24.43	1.90	1.07	0.14	4.24
25/05/2017	3.24	1.00	2.27	0.23	0.14	7.04	19.68	1.09	1.00	0.18	3.63

Dust Extinction (DU) - T

Date	Kerala			Karnataka		Tamil Nadu			Maharashtra		
08:30 AM - 09:30 AM	Kochi	Kannur	Kuttanadu	Shimoga	Mysore	Chennai	Tuticorin	Coimbatore	Pune	Ratnagiri	Nagpur
	9.9312° N, 76.2673° E	11.8745° N, 75.3704° E	9.3528° N, 76.4042° E	13.9299° N, 75.5681° E	15.3173° N, 75.7139° E	13.0827° N, 80.2707° E	8.7642° N, 78.1348° E	11.0168° N, 76.9558° E	18.5204° N, 73.8567° E	17.2478° N, 73.3709° E	21.1458° N, 79.0882° E
21/05/2017	0.0632	0.1119	0.0739	0.1451	0.1197	0.1477	0.0738	0.0872	0.0934	0.1009	0.2378
22/05/2017	0.0818	0.1154	0.0859	0.0877	0.0983	0.1154	0.0882	0.098	0.0611	0.0746	0.1239
23/05/2017	0.0439	0.0741	0.0357	0.0722	0.0948	0.1022	0.0503	0.0597	0.1184	0.0997	0.1219
24/05/2017	0.0492	0.0611	0.0385	0.0444	0.0817	0.0832	0.0547	0.0624	0.0937	0.0909	0.2473

Table 1. Data obtained from MODIS at three different states

5.2 Aerosols and Clouds

Aerosols scatter light and thereby change the reflectivity of the Earth. The widespread distribution of aerosol particles in the earth's atmosphere subsequently forms the cloud condensation nuclei (CCN) which facilitates to develop clouds to decide the rain shower intensity profile. This climate induced changes in the content of liquid water and in turn cloud optical thickness account their change in positional structure. These greatly neither influence either as a negative result nor when comparable in size showing a positive effects.

5.3 Air Quality and Atmospheric Pollution

Time passed and years of pollution on the ecosystem as a whole have taken place paving the way towards the nastiest condition of the environment. Drastic changes in the

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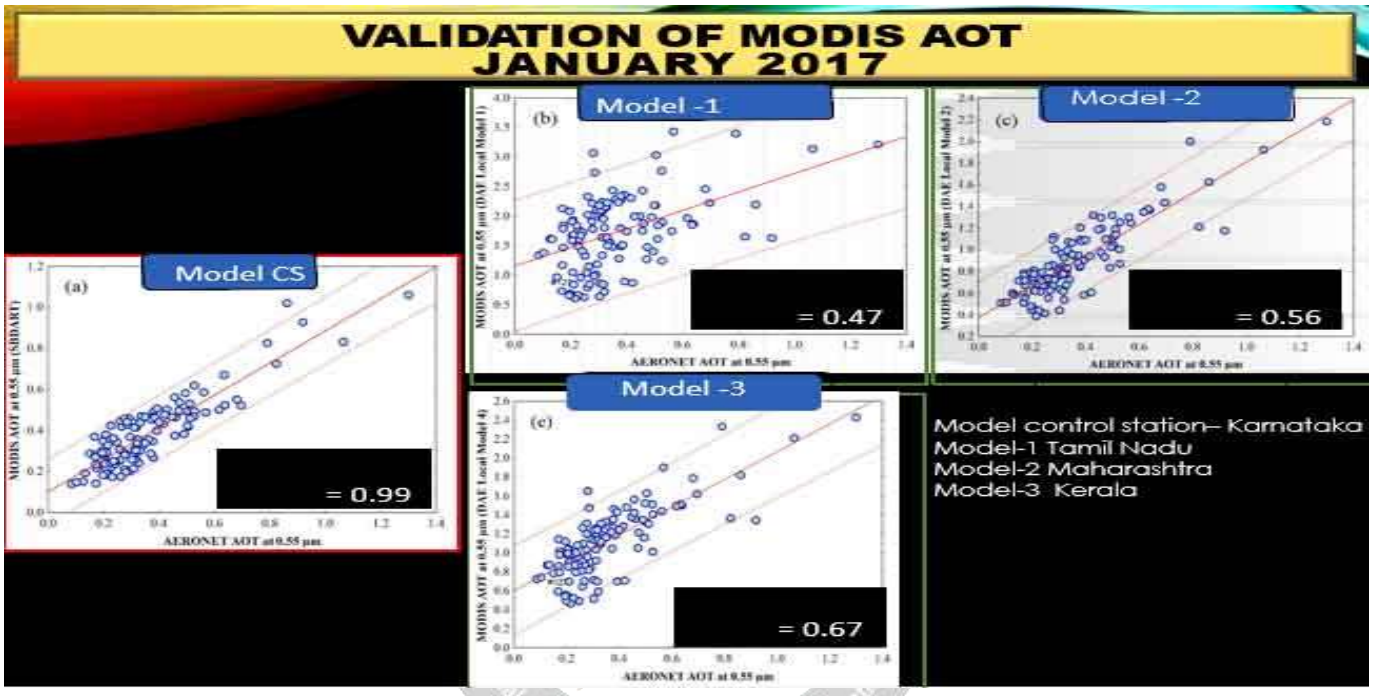
climatic pattern have happened over the years with a profusely large environmental pollution especially those from atmospheric air that we breathe even in a single minute! The pollution impacts play a pivotal negative and pathetic role for deteriorating the environment. All kinds of ill practices into the ecosystem destroys the terrains, vegetations, kills the aura, and leaves of the present environmental niche and the future generations should face with even more deadliest diseases of which many are on towards the outbreak in vanishing the fauna and flora.

5.4 Air Quality Monitoring

Climate gases are characterized by their strong absorption contributions within the infrared spectral range making them effective in the process of trapping the long wave radiation escaping to space and hence influencing the Earth radiative budget. To date, all investigations concur that the contributions of biomass burning to global modifications of the both geostationary instruments and active sensors in space within a decade. Such instruments will be flown in that time frame which depends on how well the tropospheric chemistry community can have their pleas heard that these satellites should be the highest priority for future space missions. Earlier reports discuss the remote sensing of ambient air particles by means of both ground measurement along with the data from the Moderate Resolution Imaging Spectrodiometers (MODIS) in conjunction with satellites.



Graph 1. Validation of MODIS data in selected states

5.5 Aerosol and Health

Fine particulate matter (fpm) is one of the key components influencing a health impact on humans globally. Exposure to this pollutant causes an array of adverse respiratory effects including bronchi constriction and increased asthma symptoms (USEPA, 2010). The epidemiological studies on fpm and traffic related air borne particles enhance cardiovascular and allergic diseases. The inhalation of nitrated particles triggers immune reactions; promote the genesis of skin inflammations. Airborne particulate constituents are the causative agents for reproductive and development effects such as coronary heart disease, premature mortality and other cardiovascular bronchial diseases (Brook et al., 2004; Chen et al., 2005; Dockery et al., 2013). Many efforts should be taken care for reducing the emission of particulate matter and trace gases in the atmosphere for the better sustainability of ecosystem. (Kumar et al., 2008; Liu et al., 2003).

VI. CONCLUSION

The studies on Atmospheric Aerosol are highlighting a new insight for the depth and dimensions of the aerosol emissions are two folded by the past several years. A model study will be generated and a gas phase species and predicting their outcomes will identify and the predictions improvements will record for the future work horizons. A preliminary experiment has been done in the four states of the country. The obtained data are modelled and simulated through the and MODIS and appropriate software tools. Hence intensive intergovernmental collaborative network for AQ modelling and surveillance and management system could aid to develop AQ index for specific regions in each country and recognizing that the atmospheric and oceanic realm lies in the whole universe there by conduct awareness programme with specific futuristic aim for the public to go ahead a healthy environment. This will facilitate the AQ regulation stringently for the society to lead an aesthetic life in the future.

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