Vigyan Samachar: MoES News
25/06/2020

IITM study to help understanding complex role of aerosols in global climate and local weather

Keywords: Aerosol, global warming, atmospheric cooling, aerosol-cloud condensation nucleation, CCN, IITM, global climate

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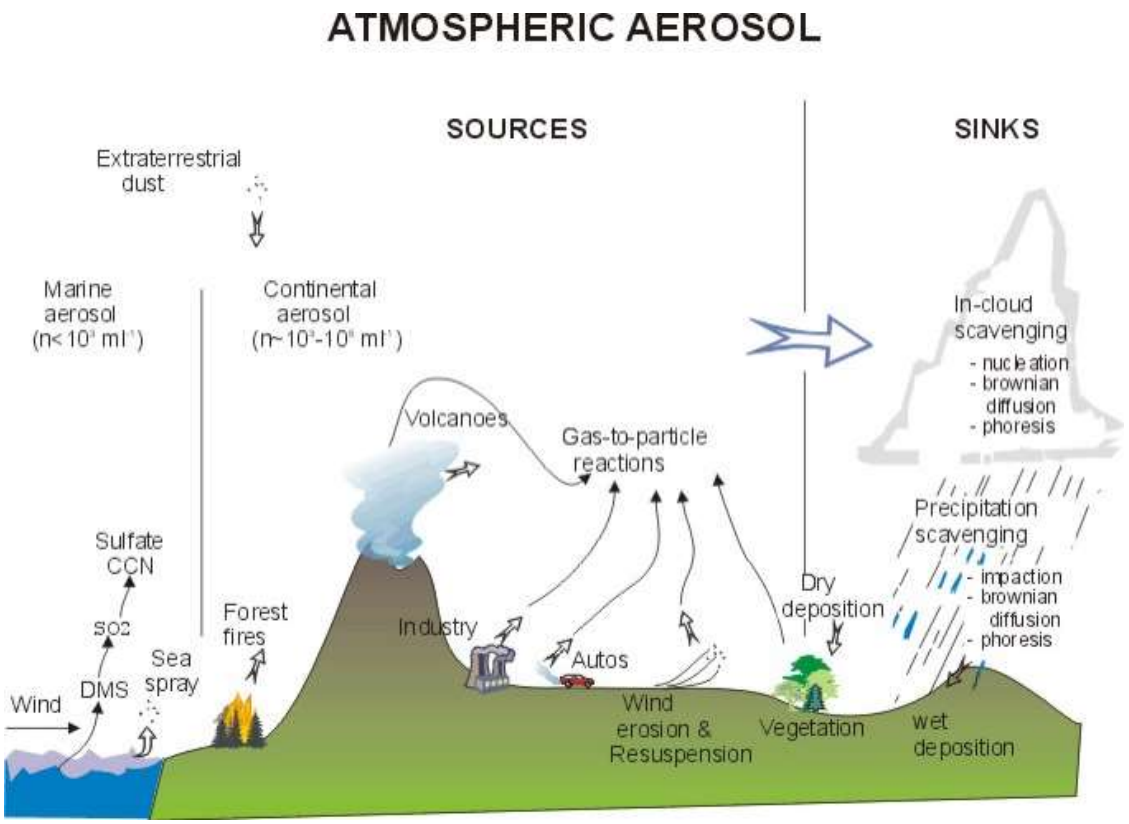
Aerosols play an important role in cooling and heating of the Earth's climate. Atmospheric aerosol, also known as particulate matter (PM), is a suspension of fine solid particles or liquid droplets in the air. A new study conducted by atmospheric researchers at the Indian Institute of Tropical Meteorology (IITM), Pune would now provide better insights into the processes involved in the formation and aging of aerosol, which would also help better understanding of the aerosol-cloud condensation nucleation (CCN) activation properties and cloud formation processes. The CCN is a subset of hygroscopic aerosol particles that nucleate water drops at supersaturations less than 1 percent.



Complexity of Atmospheric Aerosol in Global Climate and Local Weather

Image courtesy: http://butane.chem.uiuc.edu/pshapley/environmental/l12/4.html

Common perception about aerosols is that these are produced from hairspray or deodorant. Aerosols however can be any microscopic particles suspended in the atmosphere. They can be man-made, like from burning fossil fuels and sulfate emissions, or naturally occurring from sources such as volcanic eruptions, bushfires, and sea spray. They can be solids such as smoke and sea salt, liquids such as water, or gases such as Sulphur dioxide (SO_2). Without aerosols in the atmosphere, the Earth will heat up very fast. Interaction of the submicron aerosol particles with clouds help reflecting more of the Sun's energy into space meaning that their overall role is to cool the Earth. But this cooling effect of aerosols is made ineffective to a great extent due to the warming effect of increased greenhouse gases. This is one of the reasons that the Earth is heating up more rapidly.

A new study on aerosol variability, its formation, and ageing in relation to different meteorological parameters at a high altitude location in South-West India (Mahabaleshwar) was conducted by IITM. The study found that with the increase in Relative Humidity (RH) during the summer as well as winter season, there was also an increase in mass concentration and fraction of aerosol components such as organic, sulfate, nitrate and chloride. IITM study revealed that high RH condition is mostly associated with the lower temperature condition which sets up the environment for the gas phase nitrate to be partitioned into the particle phase. While there is more increase in concentration of chloride, organic compound and sulfate due to anthropogenic (manmade pollutant) emission at high RH condition.

It was also found during the study that when the atmospheric temperature increases by a fraction of 17 to 24 degrees Celsius, there was an increase of concentration of sulfate by 88%. This is indicative of the dominance of photochemical ageing processes during high-temperature conditions. The extent of photochemical ageing was found to be higher during the summer season (mean temperature ~25.4 ± 2.6 degrees Celsius) as compared to winter season (mean temperature ~20.5 ± 2.6 degrees Celsius). Thus the overall atmospheric aerosol condition is related to high-temperature conditions as high temperature results in higher photochemical oxidation.

A technique used during this study, which is known as the nonparametric wind regression analysis revealed that the mass concentration of aerosol components during winter was majorly contributed by distant sources from northeast direction of Mahabaleshwar while during summer the local sources were more dominant.

This study was conducted to understand the influence of aerosols in global climate as well as their role in the daily local weather. Different environmental variables and aerosol properties can have positive as well as negative effects and thus result in uncertainties in the external forcing of the climate system.

Led by Subrata Mukherjee, the research team comprised of Vyoma Singla, Guman Singh Meena, Mohammad Yusuf Aslam, Pramod Digambar Safai, Pallavi Buchunde, Anil Kumar Vasudevan, Chinmay Kumar Jena, Sachin Dinkar Ghude, Kundan Dani and, Govindan Pandithurai of IITM, Ministry of Earth Sciences, Pune, The research paper is published in the Journal of Environmental Pollution (available online from 15 June 2020).