Pollution cools monsoon days: study

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Highlights

- Increased emissions of aerosols into the atmosphere due to pollution are beginning to have a definite cooling effect of 1 degree C during the Indian summer monsoon period, a study has found.
- The increased cooling is seen during the day, while the night time temperature is increasing, thus shrinking the diurnal temperature difference.
- The diurnal temperature difference is what drives the convection process (where water evaporates and reaches the atmosphere as water vapour), and development of clouds.

Shape, characteristics

- As diurnal temperature difference decreases, the lower layer of the atmosphere will reduce in height and come closer to the earth's surface.
- This will cause more aerosols to get into the atmosphere, thus impacting the lower atmospheric turbulence, which may eventually affect the distribution of moisture and rainfall.
- The increased concentration of aerosols in the atmosphere also tends to change the shape and characteristics of rain-bearing clouds, leading to extreme rainfall events but weakened monsoon rainfall.

Striking similarity

- The study by a team of researchers from the University of Hyderabad, found striking similarity between satellite data (2002-2016) and a global reanalysis modelled data that showed cloud structure being modified with increased aerosol emission.
- Rain-bearing clouds were found to increase in number and height when aerosol emission is higher.
- The clouds also tend to have a far higher number of ice particles that are smaller in size when aerosol loading is higher, thus reducing the efficiency of water droplet growth.
- When aerosol loading is higher, the anvil (cloud top) contains more number of smaller ice particles, which tend to reflect the shortwave radiation from the top of the cloud, leading to increased cooling of the earth's surface.
- Cooling by shortwave radiation surpasses warming by longwave radiation, leading to net reduction in daytime temperature during the summer monsoon.

Additional Info:

Aerosols are minute particles suspended in the atmosphere. Aerosols can be natural or anthropogenic.Examples of natural aerosols are fog, dust, forest exudates and geyser steam.

Examples of anthropogenic aerosols are haze, particulate air pollutants and smoke.

Effect on Sunlight

- When these particles are sufficiently large, we notice their presence as they scatter and absorb sunlight.
- Their scattering of sunlight can reduce visibility (haze) and redden sunrises and sunsets.
- Aerosols interact both directly and indirectly with the Earth's radiation budget and climate.
- As a direct effect, the aerosols scatter sunlight directly back into space.

Effect on Atmosphere

- As an indirect effect, aerosols in the lower atmosphere can modify the size of cloud particles, changing how the clouds reflect and absorb sunlight, thereby affecting the Earth's energy budget.
- Aerosols also can act as sites for chemical reactions to take place (heterogeneous chemistry).
- The most significant of these reactions are those that lead to the destruction of stratospheric ozone.
- During winter in the polar regions, aerosols grow to form polar stratospheric clouds.
- The large surface areas of these cloud particles provide sites for chemical reactions to take place.
- These reactions lead to the formation of large amounts of reactive chlorine and, ultimately, to the destruction of ozone in the stratosphere.
- Evidence now exists that shows similar changes in stratospheric ozone concentrations occur after major volcanic eruptions, like Mt. Pinatubo in 1991, where tons of volcanic aerosols are blown into the atmosphere

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