Aerosols

Why in news?

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Contrary to the general notion that pre-monsoon aerosol loading results in decrease in seasonal rainfall, a long-term (2002-2013) satellite observational study and model-based analysis by IIT Kanpur has found that **higher aerosol loading results in delayed but more rainfall** over Central and Northern India.

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What is an Aerosol?

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- Aerosols are minute particles suspended in the atmosphere.
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- 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.
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- Aerosols are **short-lived,** unlike greenhouse gases that persist and accumulate in the atmosphere for longer period.
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- The bulk of aerosols—**about 90% by mass—have natural origins.** Volcanoes, for example, eject huge columns of ash into the air, as well as sulfur dioxide and other gases, yielding sulfates.
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- The remaining 10% of aerosols are considered anthropogenic, or human-made, and they come from a variety of sources.
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- **Automobiles, incinerators, smelters, and power plants** are prolific producers of sulfates, nitrates, black carbon, and other particles.
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- Deforestation, overgrazing, drought, and excessive irrigation can alter the land surface, increasing the rate at which dust aerosols enter the atmosphere. Even indoors, cigarettes, cooking stoves, fireplaces, and candles are sources of aerosols.
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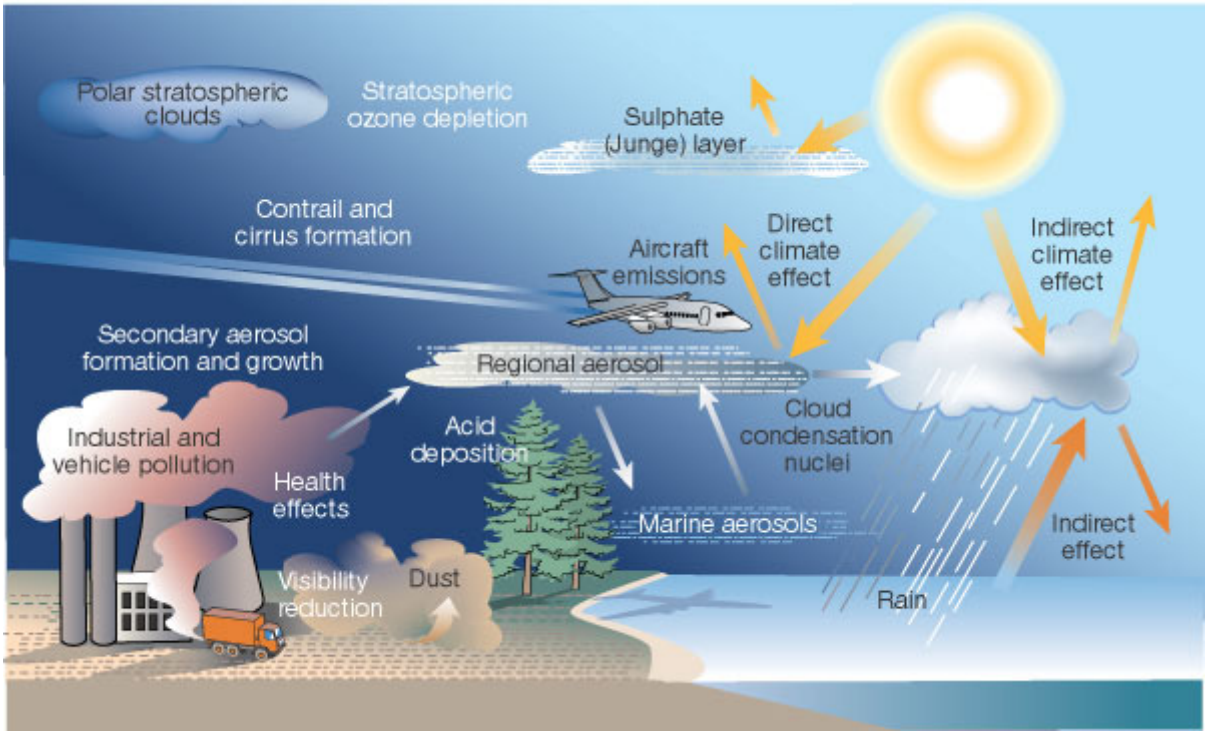

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What are the direct effects of Aerosols?

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- Aerosols interact both directly and indirectly with the Earth's radiation budget and climate.
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- Different aerosols scatter or **absorb sunlight to varying degrees**, depending on their physical properties. Although most aerosols reflect sunlight, some also absorb it.
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- An aerosol’s effect on light depends primarily on the composition and color of the particles.
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- **Pure sulfates and nitrates** reflect nearly all radiation they encounter, cooling the atmosphere. **Black carbon,** in contrast, absorbs radiation readily, warming the atmosphere but also shading the surface.
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- **Brown carbon** or organic matter, has a warming influence on the atmosphere depending on the brightness of the underlying ground. **Salt** particles tend to reflect all the sunlight they encounter.
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- In addition to scattering or absorbing radiation, **aerosols can alter the**

reflectivity, or albedo, of the planet.
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- In the Arctic, aerosols from wildfires and industrial pollution are likely **hastening the melting of ice.**
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What are the indirect effects of Aerosols?

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- 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.
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- Aerosols also can act as sites for chemical reactions to take place.
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- The most significant of these reactions are those that **lead to the destruction of stratospheric ozone.**
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- On a global scale, these aerosol “indirect effects” typically work in opposition to greenhouse gases and cause cooling.
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- Broadly speaking, aerosols are thought to suppress precipitation because the particles decrease the size of water droplets in clouds.
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What did the IIT Kanpur study say?

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- It said Satellite data showed that **clouds are getting taller and wider under high aerosol loading.**
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- As the height of clouds increases, the ice particles generated at top of the cloud come in contact with numerous water and ice particles and become bigger in size.
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- This results in more ice mass in the cloud and **eventually more rainfall** when the ice particles fall down due to gravity.
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- In the absence of cloud, aerosol particles tend to absorb solar radiation and this leads to warming or less decrease in temperature with height.

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- As a result, there is suppression of convection leading to further suppression of cloud formation.
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- Till now scientists have shown that presence of more aerosol in pre-monsoon season may lead to reduction in total monsoon rainfall due to aerosol-solar radiation interactions.
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- But in the recent study revealed that higher aerosol loading can enhance the strength of convective rainfall and increase the frequency and intensity of extreme rainfall during Indian summer monsoon.
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Source: The Hindu

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