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WHEN NORTHERN INDIA'S SMOG TRAVELS SOUTH: HOW AEROSOLS WORSEN CHENNAI'S AIR

-Dr. Vivek Panwar,
Department of Physics,
Sri Venkateswara College, University of Delhi

A hidden journey in the sky

Every winter, a strange and invisible journey takes place in India's skies. Massive swirls of air currents lift microscopic particles soot, dust, sulfates, and smoke from the fields and cities of northern India and sweep them thousands of kilometers away. Where do they go? Scientists from IIT Madras and SRM Institute of Science and Technology have now shown that a surprising destination is the southeastern coast of India, including Chennai, one of the country's busiest megacities.

The study reveals that these long-distance travelers called aerosols play a crucial role in degrading air quality over Chennai. Their arrival reduces the atmosphere's capacity to disperse pollutants, traps fine particulate matter close to the ground, and leaves millions exposed to unhealthy air. What was once thought to be a "local" pollution problem turns out to have deep roots in India's interconnected atmospheric systems.

What exactly are aerosols?

In simple terms, aerosols are tiny particles or droplets suspended in the air. Some come from natural sources like sea spray or dust storms. But in India, a huge fraction originates from human activities, burning coal and biomass, vehicle emissions, stubble burning in Punjab and Haryana, and urban-industrial growth in the Indo-Gangetic Plain (IGP).

During winter, the IGP becomes a hotspot of pollution, with heavy smog often blanketing cities like Delhi and Lucknow. Until recently, the assumption was that such pollution stayed relatively local. However, winds and circulation patterns can pick up these aerosols and carry them hundreds to thousands of kilometers away a process called regional transport.

The IIT Madras–SRM discovery

The research team, led by Dr. Chandan Sarangi (IIT Madras), Dr. Saleem Ali (Amal College, Kerala), and Dr. Sanjay Mehta (SRM Institute, Chennai), combined satellite data, ground-based weather instruments, and advanced modeling to trace these invisible movements.

They found that during the winter months (December–March), anticyclonic circulation a clockwise swirl of winds over India acts like a conveyor belt. It pulls polluted air from the north,

funnels it into the Bay of Bengal, and then curves it back toward the southeastern coastline. The result is a steady stream of haze that can linger over Chennai for 2–4 days at a time, sometimes even longer.

What happens when this haze arrives in Chennai?

The study paints a striking picture of what these aerosol transport episodes (RTEs) do to Chennai's air and climate:

- Aerosol layers form at 1–3 km altitude: These "invisible blankets" absorb sunlight and heat the air above, while simultaneously cooling the surface below.
- Boundary layer shrinks: Mixing height drops from ~2–2.5 km on clear days to <1 km during RTEs, trapping pollutants.
- ·PM2.5 levels spike by 50–60%: With the mixing suppressed, fine particulate matter accumulates near the surface. Residents breathe air that is significantly dirtier than on haze-free days.
- Persistent episodes last up to a week: Some winters, these hazy conditions cover 10–15% of the season, and the trend has been rising over the last decade.

Why does this matter?

Chennai often thinks of its air pollution as a local issue caused by traffic congestion, industrial clusters, or construction dust. But this study shows that the city's air is also at the mercy of distant fires and emissions from the north.

This raises several important concerns:

- Public health: Fine particulate matter (PM2.5) is linked to asthma, cardiovascular diseases, and premature deaths. If regional transport increases PM2.5 levels by more than 50%, millions face elevated risks.
- Climate effects: Aerosols alter radiation balance cooling the surface and warming the lower atmosphere. This can disrupt weather patterns and even influence rainfall.
- Policy blind spots: Air quality management in India has often been city-centric. But if pollution in Chennai partly originates in Punjab's stubble fires or Uttar Pradesh's factories, local measures alone will not suffice.

Chennai's vulnerability

Being a coastal megacity, it already experiences complex meteorology. Sea breezes interact with land heating, creating fluctuations in how air circulates vertically. When an external blanket of aerosols arrives, it amplifies this instability, making dispersion even harder.

Moreover, the city's population of more than 11 million is already grappling with urban expansion, heat stress, and flooding risks. Poor air quality adds yet another burden, particularly on children, the elderly, and those with pre-existing respiratory problems.

A national and regional problem

This study suggests that pollution is a national issue, and actions taken by one state can affect citizens living thousands of kilometers away. For example, farm fires in Punjab can worsen air quality in Chennai, while industrial clusters in the Indo-Gangetic Plain may indirectly impact the respiratory health of people in Tamil Nadu. This highlights the need for coordinated interstate action, going beyond city-level efforts like the NCAP.

The road ahead

The IIT Madras–SRM study is only a starting point. More observations, advanced models, and ground networks are needed to understand aerosol transport. Still, the findings highlight urgent actions:

- Interstate cooperation – Pollution crosses borders, so states must work together.
- Early warning systems – Predicting transport episodes can help cities like Chennai issue health advisories.
- Source reduction – Lasting improvement requires cutting emissions in the Indo-Gangetic Plain through cleaner fuels, stricter norms, and alternatives to crop burning.

A warning from the skies

The study shows that Chennai's air quality and public health depend on choices made far away. Northern India's haze worsens southern India's air, reminding us that pollution is shared, and so must be the solutions.