Weather patterns as a major contributing factor to complex air pollution

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"Complex pollution" usually refers to the environmental pollution phenomenon formed by the simultaneous presence of multiple pollutants in the same environment. In China, the issue of controlling the complex air pollution of fine particulate matter ($PM_{2.5}$) and ozone (O_3) poses a serious challenge, at present and in the future.

Thoroughly analyzing the underlying causes of atmospheric complex pollution is essential for devising effective strategies aimed at continuously improving air quality. Recently, a research team led by Prof. Hong Li from the Chinese Research Academy of Environmental Sciences published a paper on this topic in *Atmospheric and Oceanic Science Letters*.

Taking Dongying, a typical petrochemical city located in the Bohai Rim region of China as an example, this paper elucidates the significant influence of weather patterns on $PM_{2.5}$ and O_3 complex pollution from a meteorological perspective, and discusses the implications of the research findings for local management and control of air pollution.

Differences were found in the atmospheric circulation conditions that were prone to triggering "$PM_{2.5}$-only pollution," "O_3-only pollution," and "co-occurring $PM_{2.5}$ and O_3 pollution" in Dongying from 2017 to 2022.

From January to April and from October to December, $PM_{2.5}$-only pollution was more likely to occur under "high-pressure top front," "offshore high-pressure rear," and "high-pressure inside" weather

patterns. From April to September, O_3-only pollution was more likely to occur under "offshore high-pressure rear," "subtropical high," and "high and low systems" patterns.

In March, April, June, and October, co-occurring $PM_{2.5}$ and O_3 pollution was more likely to occur under "offshore high-pressure rear" and "high-pressure inside" patterns. And lastly, the non-occurrence of $PM_{2.5}$ or O_3 pollution was found to be related to precipitation and strong northerly winds.

"The variation in dominant synoptic patterns is a crucial factor that leads to changes in the frequency of $PM_{2.5}$-only pollution, O_3-only pollution, and co-occurring $PM_{2.5}$ and O_3 pollution," Prof. LI explains.

From January to April and from October to December, one of the meteorological reasons for the alleviation in $PM_{2.5}$-only pollution in Dongying between 2017 and 2022 was the decrease in the frequency of high-pressure controlling patterns. Furthermore, an increase in the frequency of the "offshore high-pressure rear" and "subtropical high" patterns from April to September has contributed to the aggravation of O_3-only pollution in Dongying in recent years.

Moreover, an overall decrease in the frequency of the "high-pressure inside" pattern was found to have contributed to an overall decline in co-occurring $PM_{2.5}$ and O_3 pollution, whereas the greater likelihood of co-occurring $PM_{2.5}$ and O_3 pollution in October in Dongying is attributable to the increased occurrence of this particular synoptic pattern during that month.

"For Dongying, strengthening the control of local air pollution will promote the synergistic control of $PM_{2.5}$ and O_3 under favorable meteorological conditions, including synoptic patterns controlled by high pressure with strong northerly winds, or subtropical high and inverted

trough synoptic patterns with strong precipitation.

"Whereas, under weather patterns that are prone to triggering pollution, it is possible to modify local meteorological conditions by employing strategies such as artificial cloud seeding to enhance precipitation, thereby reducing the occurrence of $PM_{2.5}$ and O_3 pollution," Prof. Li concludes.

More information: Yongxin Yan et al, Clarifying the relationship between PM2.5 and ozone complex pollution and synoptic patterns in a typical petrochemical city in the Bohai Rim region of China: Implications for air pollution forecasting and control, *Atmospheric and Oceanic Science Letters* (2024). DOI: 10.1016/j.aosl.2024.100539

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