The importance of anthropogenic vapors on haze pollution over Hong Kong and mainland China's megacities

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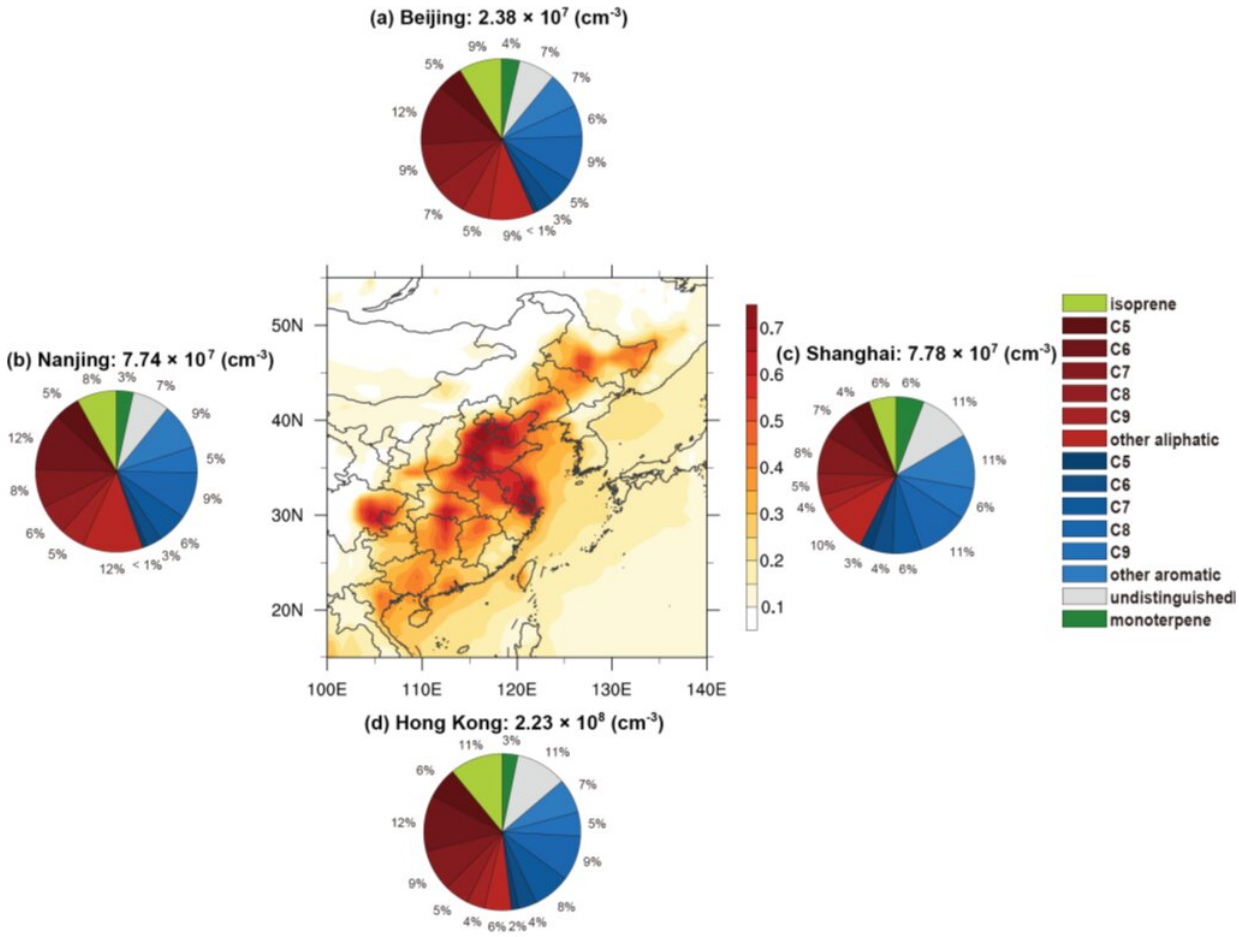

The figure shows a strong homogeneity in the distribution and formation pathways of OOMs across China's megacities including Hong Kong, Beijing, Nanjing, and Shanghai. Credit: HKUST

Prof. Wang Zhe, assistant professor at the Hong Kong University of Science and Technology (HKUST)'s Division of Environment and Sustainability, has collaborated with international scientists to reveal the significant roles of anthropogenic low-volatility organic vapors on the secondary organic aerosol (SOA) formation in four megacities in China, providing new insights for effectively mitigating the urban air pollution issues.

Air pollution kills around 7 million people worldwide each year, and is the largest environmental health risk. Air pollutants could be directly emitted or formed via complex atmospheric reactions of precursors both from natural (e.g., plants) and anthropogenic sources (e.g., traffic, coal combustion, etc.). Pollution measures are effective in controlling primary pollutants, but it has been very challenging to mitigate secondary pollutants because of the large knowledge gaps in the underlying formation mechanisms.

SOA contributes a significant fraction to the particulate haze pollution in many urbanized regions, with profound impacts on climate and human health. The knowledge gaps in the sources and relevant chemical processes of SOA formation are the bottleneck for implementing effective measures to mitigate haze pollution. This joint research confirmed the dominant roles of anthropogenic low-volatility organic vapors as critical intermediates connecting the oxidation of volatile organic compounds (VOCs) to SOA and haze pollution in urban environments.

The team used state-of-the-art mass spectrometers to conduct comprehensive atmospheric field study. Credit: HKUST

The HKUST researchers conducted a comprehensive field study in Hong

Kong, and during the same period, coordinated studies were concurrently carried out in three other Chinese megacities by mainland and international researchers in Beijing, Nanjing, and Shanghai. For the first time, the joint research characterized plenty of highly reactive oxygenated organic molecules (OOMs) in different urban environments, and developed a novel classification framework to trace the measured OOMs and formed SOA to different precursors.

The results showed that oxidation of anthropogenic VOCs dominates OOMs formation in the urban atmosphere, with approximately 40% contribution from aromatics and another 40% contribution from aliphatic hydrocarbons, a previously under-accounted class of VOCs. The study unveiled that multi-step oxidation and auto-oxidation processes play key roles in OOMs formation, and nitrogen oxides (NO_x) significantly affect the VOCs oxidation process, producing a considerable fraction of nitrogen-containing organic compounds. The irreversible condensation of these anthropogenic OOMs is a dominant source of SOA, even under severe haze conditions.

The study showed a strong homogeneity in the distribution and formation pathways of OOMs across China's three most urbanized regions, where more than 800 million people live and suffer from air pollution. It implies a possibility of solving air pollution issues with a uniform and effective mitigation strategy across these highly populated city clusters.

The study findings were recently published in *Nature Geoscience*.

More information: Wei Nie et al, Secondary organic aerosol formed by condensing anthropogenic vapours over China's megacities, *Nature Geoscience* (2022). DOI: 10.1038/s41561-022-00922-5