Emissions of volatile organic compounds higher than previously assumed

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Thomas Karl from Department of Atmospheric and Cryospheric Sciences at the University of Innsbruck Credit: Uni Innsbruck

In the scientific journal *PNAS*, researchers from Innsbruck, Austria, present the world's first chemical fingerprint of urban emission sources

of volatile organic compounds (VOCs). Accordingly, the abatement strategy for organic solvents is having an effect in Europe. At the same time, the data suggest that the total amount of man-made VOCs globally is likely to be significantly higher than previously assumed.

In the northern hemisphere, about half of the volatile organic compounds (VOCs) originate from both man-made and natural sources. In cities, the share of emissions from transport, restaurants, solvents and smoking is significantly higher. So far, however, quantitative statements about their level have been rather vague. Using a sophisticated measurement method, researchers led by Thomas Karl and Georg Wohlfahrt at the University of Innsbruck have now produced a chemical fingerprint of urban VOC emission sources for the first time. From July to October 2015, scientists measured a large number of volatile organic compounds at the Campus near Innsbruck's city center. Using statistical methods, they were able to draw conclusions about individual emission sources from the measurement data. This was possible because the so-called eddy-covariance method is used to determine the concentration of trace gases depending on the direction of air flow. A special proton-transfer-reaction-mass spectrometer developed by the university spin-off Ionicon Analytics was used as an electronic detector, which can sniff out trace gases at very low concentrations.

Significantly more VOCs than expected

For about 15 years, the EU has been regulating volatile organic compounds from organic solvents in paints and varnishes by means of legal measures. Many of these toxic solvents have since been replaced by more environmentally friendly, water-soluble substances. This change can now also be seen in the data measured in Innsbruck. "We find smaller amounts of compounds such as benzene or toluene," says researcher Thomas Karl from the Department of Atmospheric and Cryospheric Sciences. "On the other hand, water-soluble substances are

much more ubiquitous. These are less reactive, which can have a positive effect on the formation of ground-level ozone." However, some of these oxygenated components can form secondary organic aerosols and thus contribute to the formation of particulate matter. At this point however, it is not clear how this amount compares to primary urban aerosol sources. The Innsbruck data also show that, due to the very high proportion of oxygen-containing compounds, the total global amount of urban emissions is significantly underestimated. "If the figure calculated for Innsbruck is also representative of Asian cities—which is rather optimistic—then this would at least double the number globally," emphasizes Thomas Karl. Since this would also result in more particulate matter entering the atmosphere which in turn has an influence on cloud formation, regional and global climate models might have to be adapted accordingly.

Cosmetics leave their scent in the air

The researchers measured a broad range of compounds at very low quantities and were able to determine the fingerprint of VOC emission sources within a radius of about one kilometer. Since many of the trace gases are odorous, these data reflect the characteristic scent of a city. "In this respect Innsbruck is a quite ordinary city," says Thomas Karl. "We find mainly traces of food preparation—from coffee roasting to frying—and solvents that humans associate with the particular smell of a city. The sources of emissions range from bakeries to the regional hospital." The scientists were also amazed to find compounds associated with cosmetics and detergents in the air. "In our data, we found clear evidence of silicone oils contained in many cosmetic and cleaning products," says Thomas Karl. "We were surprised that these compounds leave such a characteristic fingerprint in urban air."

More information: Urban flux measurements reveal a large pool of oxygenated volatile organic compound emissions. T. Karl, M. Striednig,

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M. Graus, A. Hammerle, and G. Wohlfahrt. Proc. Natl. Acad. Sci. 2018,
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