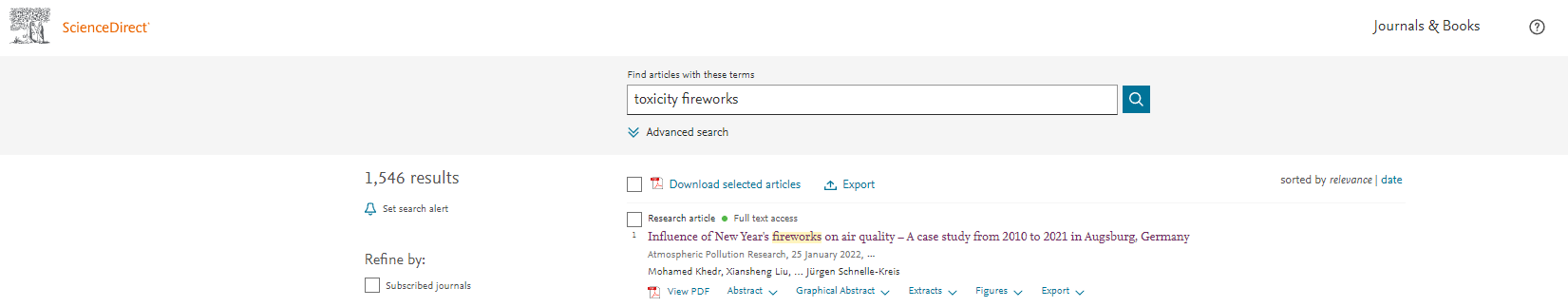
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**DŮLEŽITÉ INFORMACE**

**Effect of fireworks events on urban background trace metal aerosol concentrations: Is the cocktail worth the show?** (2010)

<https://doi.org/10.1016/j.jhazmat.2010.07.082>

We report on the effect of a major firework event on urban background atmospheric [PM](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/particulate-matter)2.5 chemistry, using 24-h data collected over 8 weeks at two sites in Girona, Spain. The firework pollution episode (Sant Joan fiesta on 23rd June 2008) measured in city centre parkland increased local background PM2.5 concentrations as follows: Sr (x86), K (x26), Ba (x11), Co (x9), Pb (x7), Cu (x5), Zn (x4), Bi (x4), Mg (x4), Rb (x4), Sb (x3), P (x3), Ga (x2), Mn (x2), As (x2), Ti (x2) and SO42− (x2). Marked increases in these elements were also measured outside the park as the pollution cloud drifted over the city centre, and levels of some metals remained elevated above background for days after the event as a reservoir of metalliferous dust persisted within the urban area. Transient high-PM pollution episodes are a proven health hazard, made worse in the case of firework combustion because many of the elements released are both toxic and finely respirable, and because displays commonly take place in an already polluted urban atmosphere.

**Influence of New Year's fireworks on air quality – A case study from 2010 to 2021 in Augsburg, Germany** (2022)

<https://doi.org/10.1016/j.apr.2022.101341>

Fireworks have been shown to contribute short-term but potent source of ambient [particulate matter](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/particulate-matter" \o "Learn more about particulate matter from ScienceDirect's AI-generated Topic Pages) (PM). Here we present a source apportionment-based approach to estimate the quantitative contributions of fireworks in releasing black carbon (eBC), polycyclic aromatic hydrocarbons (PAHs) and metals into urban ambient air on six New Year's Day fireworks events from the period 2010 to 2021. Simplified PMF analyses were performed to assign PAHs, eBCs, and metals to major contributors (building heating, traffic, and fireworks) of ambient PM. The trends of PM10 and PM2.5 concentrations clearly showed the drastic increase of the concentrations on New Year's Days. The PMF analyses showed that, on average, about 35% (20–80% for individual years) of the PAHs and about 45% of eBC (10–100%) were associated with the fireworks. Metals presented in high concentrations in pyrotechnic sets, namely Ba, Cu, K, Mg, and Sr were attributed to fireworks about 90%, while Al was attributed to fireworks by 86%. Other metals (Ca, Cr, Fe, Na, Pb, Ti, and Zn) were attributed to fireworks by variable proportions averaging at 67%, 77%, 44%, 59%, 64%, 75%, and 33%, respectively. Overall, these findings complement future monitoring programs and regulations for fireworks emissions.

„Among other components, the metals used for coloring the fireworks (e.g., red: Sr and Ca, green: Ba and Cu, blue: Cu, white or silver: Mg, Al, and Ti, and gold: Fe) are released in large quantities during firework's set off. The contribution of fireworks in elevating the concentrations of many metals and sulfate on New Year's Day has been confirmed in numerous studies in several countries, such as Auckland, New Zeland, Manila, Philippines, Mexico City, Mexico, and Rotterdam, The Netherlands ([Lorenzo et al., 2021](https://www.sciencedirect.com/science/article/pii/S1309104222000289?via%3Dihub" \l "bib28); [Retama et al., 2019](https://www.sciencedirect.com/science/article/pii/S1309104222000289?via%3Dihub" \l "bib40); [Rindelaub et al., 2021](https://www.sciencedirect.com/science/article/pii/S1309104222000289?via%3Dihub" \l "bib41), [ten Brink et al., 2019](https://www.sciencedirect.com/science/article/pii/S1309104222000289?via%3Dihub" \l "bib50)).“

„For example, [Pongpiachan et al. (2017)](https://www.sciencedirect.com/science/article/pii/S1309104222000289?via%3Dihub" \l "bib38) found an increase >150% in total PAHs concentrations during the fireworks period in Bangkok, Thailand.“

„Taken together, these findings call for future monitoring programs and regulations for fireworks emissions.“

**Air quality during and after festivals: Aerosol concentrations, composition and health effects** (2019)

<https://doi.org/10.1016/j.atmosres.2019.05.012>

Ambient [particulate matter](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/particulate-matter" \o "Learn more about particulate matter from ScienceDirect's AI-generated Topic Pages) (PM) continues to be among the top environmental health concerns globally; in 2017, nearly 3 million deaths were attributed to exposure to PM2.5 around the world ([HEI, 2019](https://www.sciencedirect.com/science/article/pii/S0169809518307270" \l "bb0235)). While much attention is paid towards point and mobile sources of PM (e.g., power plants, vehicles), episodic/periodic events such as dust storms, use of fireworks etc. can also increase ambient PM levels and lead to adverse effects on air quality, visibility, and human health, albeit in the short-term. Fireworks and bonfires are commonly used during religious and cultural festivals including Diwali (India), Lunar New Year (China), Bastille Day (France), Guy Fawkes Night (UK), Australia Day (Australia), Fourth of July/Independence Day (USA), New Year's Eve (worldwide) as well as large sporting and other events. During these events, use of fireworks results in smoke plumes which can raise the PM concentration levels for short periods of time. This review article summarizes the current body of literature on the role of fireworks use (and bonfires) on air quality, visibility, and human health. A summary of distinct type of fireworks and existing legislations/laws in different countries is also presented. Overall, there is clear evidence that such events produce exceptionally high level of pollutants, and as a result there can be intense exposures to a multipollutant mixture. In particular, the sharpest spikes are found in [pollutant concentrations](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/pollutant-concentration" \o "Learn more about pollutant concentrations from ScienceDirect's AI-generated Topic Pages) (such as PM2.5, PM10, and NOx) during and immediately after the firework event, followed by a decrease in the concentrations back to background levels, typically within 24 h. Peak concentrations of pollutants during firework events can exceed ambient levels by 2–8 times. As a result, overall visibility also decreases significantly, and in some cases, by as much as 92% during fireworks events. Moreover, significant health risks due to fireworks activities are also reported, although limited research has been conducted on this type of rapid air pollution exposure. The review concludes with a list of suggested future research priorities required to better understand the impacts of fireworks and bonfires on human and environmental health.

„These studies have reported several-fold increase in concentrations of pollutants including PM10 (PM with aerodynamic diameter < 10 μm), PM2.5 (PM with aerodynamic diameter < 2.5 μm), and NOx during fireworks events across the world ([Barman et al., 2008](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0045); [Kong et al., 2015a](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0300); [Seidel and Birnbaum, 2015](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0505)).“

„Exposure to air pollution in the short-term has been linked to several health effects ([Brunekreef and Holgate, 2002](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0095); [Nhung et al., 2017](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0415); [Shah et al., 2015](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0510); [Shang et al., 2013](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0520); [Wu et al., 2016](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0715)). „

„Exposure to air pollutants including PM and gases has been found to trigger specific health effects including respiratory and cardiovascular diseases ([Brook, 2008](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0085); [Brook et al., 2010](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0090); [Franklin and Brook, 2015](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0165); [Laumbach and Kipen, 2012](https://www.sciencedirect.com/science/article/pii/S0169809518307270?via%3Dihub" \l "bb0330)).“

„In conclusion, wider regulations on the use of fireworks will help in reducing exposure to fireworks-related air pollution.“

**REFERENCES TO FIREWORKS TOXICITY**

Chen, S., Jiang, L., Liu, W., & Song, H. (2022). Fireworks regulation, air pollution, and public health: Evidence from China. *Regional Science and Urban Economics*, *92*, 103722. https://doi.org/https://doi.org/10.1016/j.regsciurbeco.2021.103722

Coghlan, A. (2008). Great fireworks, shame about the toxic fallout. *New Scientist*, *200*(2687), 12. https://doi.org/https://doi.org/10.1016/S0262-4079(08)63193-0

Devereux, R., Westhead, E. K., Jayaratne, R., & Newport, D. (2022). Microplastic abundance in the Thames River during the New Year period. *Marine Pollution Bulletin*, *177*, 113534. https://doi.org/https://doi.org/10.1016/j.marpolbul.2022.113534

Fleischer, O., Wichmann, H., & Lorenz, W. (1999). Release of polychlorinated dibenzo-p-dioxins and dibenzofurans by setting off fireworks. *Chemosphere*, *39*(6), 925–932. https://doi.org/https://doi.org/10.1016/S0045-6535(99)00019-3

Hickey, C., Gordon, C., Galdanes, K., Blaustein, M., Horton, L., Chillrud, S., Ross, J., Yinon, L., Chen, L. C., & Gordon, T. (2020). Toxicity of particles emitted by fireworks. *Particle and Fibre Toxicology*, *17*(1), 28. https://doi.org/10.1186/s12989-020-00360-4

Isobe, T., Ogawa, S. P., Sugimoto, R., Ramu, K., Sudaryanto, A., Malarvannan, G., Devanathan, G., Ramaswamy, B. R., Munuswamy, N., Ganesh, D. S., Sivakumar, J., Sethuraman, A., Parthasarathy, V., Subramanian, A., Field, J., & Tanabe, S. (2013). Perchlorate contamination of groundwater from fireworks manufacturing area in South India. *Environmental Monitoring and Assessment*, *185*(7), 5627–5637. https://doi.org/10.1007/s10661-012-2972-7

Joly, A., Smargiassi, A., Kosatsky, T., Fournier, M., Dabek-Zlotorzynska, E., Celo, V., Mathieu, D., Servranckx, R., D’amours, R., Malo, A., & Brook, J. (2010). Characterisation of particulate exposure during fireworks displays. *Atmospheric Environment*, *44*(34), 4325–4329. https://doi.org/https://doi.org/10.1016/j.atmosenv.2009.12.010

Khedr, M., Liu, X., Hadiatullah, H., Orasche, J., Zhang, X., Cyrys, J., Michalke, B., Zimmermann, R., & Schnelle-Kreis, J. (2022). Influence of New Year’s fireworks on air quality – A case study from 2010 to 2021 in Augsburg, Germany. *Atmospheric Pollution Research*, *13*(3), 101341. https://doi.org/https://doi.org/10.1016/j.apr.2022.101341

Liu, Y., Ma, W., Yin, S., Li, C., Xu, K., Zhang, C., Zhang, W., Xue, Z., Sun, Y., Ji, D., Li, J., Chen, J., Tian, H., & Liu, X. (2022). Quantification of enhanced VOC emissions from fireworks. *Environmental Pollution*, *315*, 120389. https://doi.org/https://doi.org/10.1016/j.envpol.2022.120389

Mahilang, M., Deb, M. K., Nirmalkar, J., & Pervez, S. (2020). Influence of fireworks emission on aerosol aging process at lower troposphere and associated health risks in an urban region of eastern central India. *Atmospheric Pollution Research*, *11*(7), 1127–1141. https://doi.org/https://doi.org/10.1016/j.apr.2020.04.009

Manchanda, C., Kumar, M., Singh, V., Hazarika, N., Faisal, M., Lalchandani, V., Shukla, A., Dave, J., Rastogi, N., & Tripathi, S. N. (2022). Chemical speciation and source apportionment of ambient PM2.5 in New Delhi before, during, and after the Diwali fireworks. *Atmospheric Pollution Research*, *13*(6), 101428. https://doi.org/https://doi.org/10.1016/j.apr.2022.101428

Mandal, J., Chanda, A., & Samanta, S. (2022). Air pollution in three megacities of India during the Diwali festival amidst COVID-19 pandemic. *Sustainable Cities and Society*, *76*, 103504. https://doi.org/https://doi.org/10.1016/j.scs.2021.103504

Moreno, T., Querol, X., Alastuey, A., Amato, F., Pey, J., Pandolfi, M., Kuenzli, N., Bouso, L., Rivera, M., & Gibbons, W. (2010). Effect of fireworks events on urban background trace metal aerosol concentrations: Is the cocktail worth the show? *Journal of Hazardous Materials*, *183*(1), 945–949. https://doi.org/https://doi.org/10.1016/j.jhazmat.2010.07.082

Moreno, T., Querol, X., Alastuey, A., Cruz Minguillón, M., Pey, J., Rodriguez, S., Vicente Miró, J., Felis, C., & Gibbons, W. (2007). Recreational atmospheric pollution episodes: Inhalable metalliferous particles from firework displays. *Atmospheric Environment*, *41*(5), 913–922. https://doi.org/https://doi.org/10.1016/j.atmosenv.2006.09.019

Nishanth, T., Praseed, K. M., Rathnakaran, K., Satheesh Kumar, M. K., Ravi Krishna, R., & Valsaraj, K. T. (2012). Atmospheric pollution in a semi-urban, coastal region in India following festival seasons. *Atmospheric Environment*, *47*, 295–306. https://doi.org/https://doi.org/10.1016/j.atmosenv.2011.10.062

Pang, N., Gao, J., Zhao, P., Wang, Y., Xu, Z., & Chai, F. (2021). The impact of fireworks control on air quality in four Northern Chinese cities during the Spring Festival. *Atmospheric Environment*, *244*, 117958. https://doi.org/https://doi.org/10.1016/j.atmosenv.2020.117958

Ravindra, K., Kumar, S., & Mor, S. (2022). Long term assessment of firework emissions and air quality during Diwali festival and impact of 2020 fireworks ban on air quality over the states of Indo Gangetic Plains airshed in India. *Atmospheric Environment*, *285*, 119223. https://doi.org/https://doi.org/10.1016/j.atmosenv.2022.119223

Retama, A., Neria-Hernández, A., Jaimes-Palomera, M., Rivera-Hernández, O., Sánchez-Rodríguez, M., López-Medina, A., & Velasco, E. (2019). Fireworks: A major source of inorganic and organic aerosols during Christmas and New Year in Mexico city. *Atmospheric Environment: X*, *2*, 100013. https://doi.org/https://doi.org/10.1016/j.aeaoa.2019.100013

Singh, A., Pant, P., & Pope, F. D. (2019). Air quality during and after festivals: Aerosol concentrations, composition and health effects. *Atmospheric Research*, *227*, 220–232. https://doi.org/https://doi.org/10.1016/j.atmosres.2019.05.012

Steinhauser, G., Sterba, J. H., Foster, M., Grass, F., & Bichler, M. (2008). Heavy metals from pyrotechnics in New Years Eve snow. *Atmospheric Environment*, *42*(37), 8616–8622. https://doi.org/https://doi.org/10.1016/j.atmosenv.2008.08.023

Tsai, H.-H., Chien, L.-H., Yuan, C.-S., Lin, Y.-C., Jen, Y.-H., & Ie, I.-R. (2012). Influences of fireworks on chemical characteristics of atmospheric fine and coarse particles during Taiwan’s Lantern Festival. *Atmospheric Environment*, *62*, 256–264. https://doi.org/https://doi.org/10.1016/j.atmosenv.2012.08.012

Wang, Y., Zhuang, G., Xu, C., & An, Z. (2007). The air pollution caused by the burning of fireworks during the lantern festival in Beijing. *Atmospheric Environment*, *41*(2), 417–431. https://doi.org/https://doi.org/10.1016/j.atmosenv.2006.07.043

**INTERNETOVÉ DENÍKY:**

https://www.epa.gov/sites/default/files/2017-07/documents/fireworks-brochure\_final.pdf

<https://www.forbes.com/sites/grrlscientist/2019/12/31/festive-fireworks-create-harmful-pall-of-pollution/?sh=6f6836e42853>

<https://www.publichealth.columbia.edu/research/niehs-center-environmental-health-northern-manhattan/toxicity-fireworks-particles>

<https://moffitt.org/taking-care-of-your-health/taking-care-of-your-health-story-archive/the-toxic-beauty-of-fireworks/>

<https://www.dw.com/en/germanys-new-years-eve-fireworks-ruining-air-quality/a-46894887>

<https://www.dw.com/en/new-years-eve-are-fireworks-harming-the-environment/a-41957523>

<https://scitechdaily.com/common-fireworks-emit-toxic-metals-into-the-air-damage-human-cells-and-animal-lungs/>

https://www.breeze-technologies.de/blog/how-disneyland-reduced-emissions-from-their-fireworks/