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Low-cost airbox network and Gaussian plume modelling to assist air quality policy-making at the local scale: Shexian County, Hebei Province, China

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High air pollution levels pose a threat to both human health and ecosystem vitality in Hebei Province, NE China. Although air quality changes are monitored hourly with high-end equipment at the provincial scale (197 stations for 187,693 km^2) it is difficult for individual counties or cities to improve local air quality based on regional-scale information. The Sino-Dutch Technology Transfer & Training Project established a monitoring network of 43 low-cost air-boxes and 11 standard meteorological stations in Shexian county, Handan city (~ 1500 km^2) to measure atmospheric concentrations of PM_{10}, $PM_{2.5}$, CO, SO_2, NO_2 and O_3 at 1-min intervals from January 2020 onwards. Data from these stations were evaluated in real time using the TNO Gaussian plume model. The model provides point emission levels of PM_{10}, $PM_{2.5}$ and CO at 10-min intervals after calibration against measured concentrations. Based on a 2019 pollution source inventory, 21 major source areas were identified and used to derive an optimized source map for model input – including a large steel company, a coal-fueled power plant, different industrial complexes (cement, coking plant for ore smelting), as well as the densely populated city centre, rural residential areas, and a busy highway. The model performs source optimization using concentration data for all 43 stations and subsequently calculates the contributions of individual sources for each monitoring station to see to what extent the source map explained observed concentrations. Full network operation started in July 2020. Based on a one-month test period (August 2020), the steel company and coking plant were estimated to contribute ~25% of the total area's PM-emissions. The central city area contributed ~10% and 17% of total PM- and CO-emissions, respectively, mostly due to construction activity and traffic. Repeating the exercise for the two provincial monitoring stations that also had high-end equipment in place in the downtown area gave inferred average urban contributions to measured concentrations as high as 60–62.5% for PM_{10} and $PM_{2.5}$ versus 48% for CO. The steel factory contributed an estimated 9–11% for PM_{10} and $PM_{2.5}$ at these locations and a cement factory 13% for CO. The combined results underline the importance of taking spatial variability of emission sources into explicit account in complex industrialized cities. Moreover, the combination of a low-cost airbox real-time monitoring network with emission apportionment modeling will allow local policy-makers to take proper actions towards reducing air pollution levels

at the local scale.