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PERSPECTIVE

The International Global Atmospheric Chemistry project comments on the revised WHO air quality guidelines

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In September 2021, the World Health Organization (WHO) announced updated global air quality guidelines providing health-based targets for six key air pollutants [1]. The annual targets for pollutant concentrations were reduced fourfold for nitrogen dioxide (NO_2) to 10 μg m^{-3} and by 50% and 25% respectively for the mass concentration of particles smaller than and equal to 2.5 μm ($PM_{2.5}$) and 10 μm (PM_{10}) to 5 μg m^{-3} and 15 μg m^{-3}. New targets were introduced for peak season ozone (O_3) at 60 μg m^{-3} and daily carbon monoxide (CO) at 4 mg m^{-3}. In contrast, the target for sulfur dioxide (SO_2) was relaxed by a factor-of-two [1] to 40 μg m^{-3}. The new guidelines also have updated interim targets.

As we show in the following paragraphs, because of atmospheric chemistry and meteorology, these new guideline values can be unattainably low for some pollutants, are too high for other pollutants, and may be jointly unattainable for a key pair of pollutants for some cities. The International Global Atmospheric Chemistry project (IGAC) [2] provides a platform through which in-country scientists can be supported to help their local air quality management agencies determine if any of these specific conditions apply and if so, how to set appropriate national standards.

Currently, it is estimated that just 0.001% of the global population breathes air that meets the new WHO guidelines for annual $PM_{2.5}$ [3]. Reaching the new WHO air quality guidelines for $PM_{2.5}$ and O_3 will be extremely challenging (or even unattainable) in many places due to natural sources and background levels [4]. Naturally occurring exposure levels (due to natural dust and fires) could exceed the annual $PM_{2.5}$ guideline for more than half of the Earth's population [3]. Similarly, background or non-locally-controllable ozone levels for some regions may be comparable to or even exceed the new guideline values for ozone [5–8].

Despite being unachievable for so many, the WHO has set their target at the lowest levels of exposure for which there is evidence of adverse health effects, without considering background levels [1]. When developing air quality standards background levels must be considered—a fact that is mentioned only in a single sentence on page 177 of the new WHO guideline report [1].

In-country scientific expertise is essential to develop and apply the evidence base such as identifying sources and quantifying background levels. In many places, the WHO interim target may be more appropriate than the final guideline value. Local air quality management agencies or available officials should be encouraged to strategize with and support scientific experts in their country on the locally relevant modifiable factors causing air pollution. Regardless of how unobtainable the WHO standards may seem, it is important to recognize that any reduction in pollution will have positive impacts on health [1, 9], especially if reductions are focused on combustion and industrial emissions that also emit carcinogenic air toxics [10].

The words 'chemistry' or 'photochemistry' appear just three times in the new 273-page WHO guideline report. However, many pollutants are co-emitted by the same source or are intertwined, necessitating a holistic, integrated approach to air quality management. NO_2 and O_3 are linked by atmospheric chemistry involving volatile organic compounds (some of which are also toxic), which means that reducing NO_2 may increase O_3 in some cities [11–14]. This could make it impossible for such cities to simultaneously achieve the new guidelines for these two critical pollutants. Confirming or rejecting this possibility requires further, localized research. It may be extremely challenging to successfully reduce O_3 and $PM_{2.5}$ without more stringent controls on SO_2 (a precursor for PM) and CO (as a proxy for combustion-produced volatile organic compounds, which are also precursors for PM) than are set under the new WHO guidelines. A lower SO_2 target may also be beneficial for human health [15]. In-country scientists should be supported to pursue research at the regional and city scales to examine atmospheric chemistry (such as any NO_2/O_3 tradeoffs) and toxic emissions in their regional context through scenario-based simulations, which can lead to appropriate recommendations for modifiable anthropogenic emissions for their local environmental agencies to consider.

In our opinion, global focus should be on improving air quality in the most polluted cities on Earth where the greatest health gains can be made, and air pollution management may be nascent or even non-existent. More than 30% of countries have not set any ambient air quality standards and over 40% have no legal definition for air pollution [16]. A significant majority of low- and middle-income countries lack monitoring networks for even the six basic air pollutants [17], with many estimated to suffer from air pollution significantly higher than even the WHO first interim target [9, 18] for $PM_{2.5}$. Furthermore, even in these regions with poor monitoring networks there is an added element of inequality where the poorest and most vulnerable are most exposed and thus most impacted [19]. We strongly encourage the establishment of basic air quality monitoring infrastructure in regions with little or no monitoring. These new networks could also include monitoring of ultrafine particles and black carbon, recommended as best practices under the WHO guidelines [1] due to emerging evidence on the health effects of PM chemical composition and particle number [20, 21]. Monitoring aerosol size distribution (made possible by aerosol size spectrometers which can also be certified for regulatory $PM_{2.5}/PM_{10}$ monitoring), PM chemical speciation, and carcinogenic air toxics will also help improve our understanding of global atmospheric chemistry while aiding air quality management. This improved understanding, led by local researchers in collaboration with policymakers and organizations such as IGAC, will provide the evidence required to set and achieve locally-relevant air quality standards for their country [22].

IGAC was formed in 1990 in recognition of the need for scientific leadership and improved collaboration in atmospheric chemistry across disciplinary and geographical boundaries towards a sustainable world [2] (see https://igacproject.org/). IGAC has regional working groups that bring together experts focusing on the air quality and atmospheric chemistry challenges specific to certain areas. Examples include the African Group on Atmospheric Sciences, the Monsoon Asian and Oceania Networking Group [23], the Americas Working Group (focused on Latin America) [24], and the Southern Hemisphere Working Group [25]. IGAC also sponsors activities such as the recent Tropospheric Ozone Assessment Report [26] and facilitates regional and international collaboration through meetings held all over the world, including a biennial IGAC science conference. As current members of the IGAC Scientific Steering Committee, we urge scientists from all countries to join our existing working groups and activities, or to propose new efforts if necessary, to address the scientific challenges your country faces in improving air quality as far as is possible towards the new WHO guidelines.

Data availability statement

No new data were created or analysed in this study.

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