World Health Organization

# FIRST WHO GLOBAL CONFERENCE ON AIR POLLUTION AND HEALTH

IMPROVING AIR QUALITY, COMBATTING CLIMATE CHANGE – SAVING LIVES

# Ambient air quality monitoring, modelling and forecasting

BREATHE LIFE

## Key messages

- Air quality monitoring in low- and middle-income countries (LMICs) needs to be strengthened, especially in areas close to sensitive groups (hospitals, schools, workplaces).
- Low-cost sensors (LCS) and other new technologies can expand air quality monitoring and forecasting to areas that are currently underserved.
- New protocols and standards are needed to guide the effective use and interpretation of data produced by LCS in citizen science and other applications.

UN environment United Nations Environment Programme | WMO | CLIMATE & CLEAN AIR COALITION TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS | UNECE | THE WORLD BANK IBRD • IDA | WORLD BANK GROUP

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## Introduction

Air quality monitoring, modelling and forecasting is an essential element of the global effort to assess and develop appropriate policy responses to reduce the immense damage to human health caused by air pollution.

Air pollution is high on the global agenda, as reflected in the Sustainable Development Goals (SDGs), which include three indicators – related to energy access in the homes, air quality in cities and mortality from air pollution – for which the World Health Organization (WHO) is custodial agency.

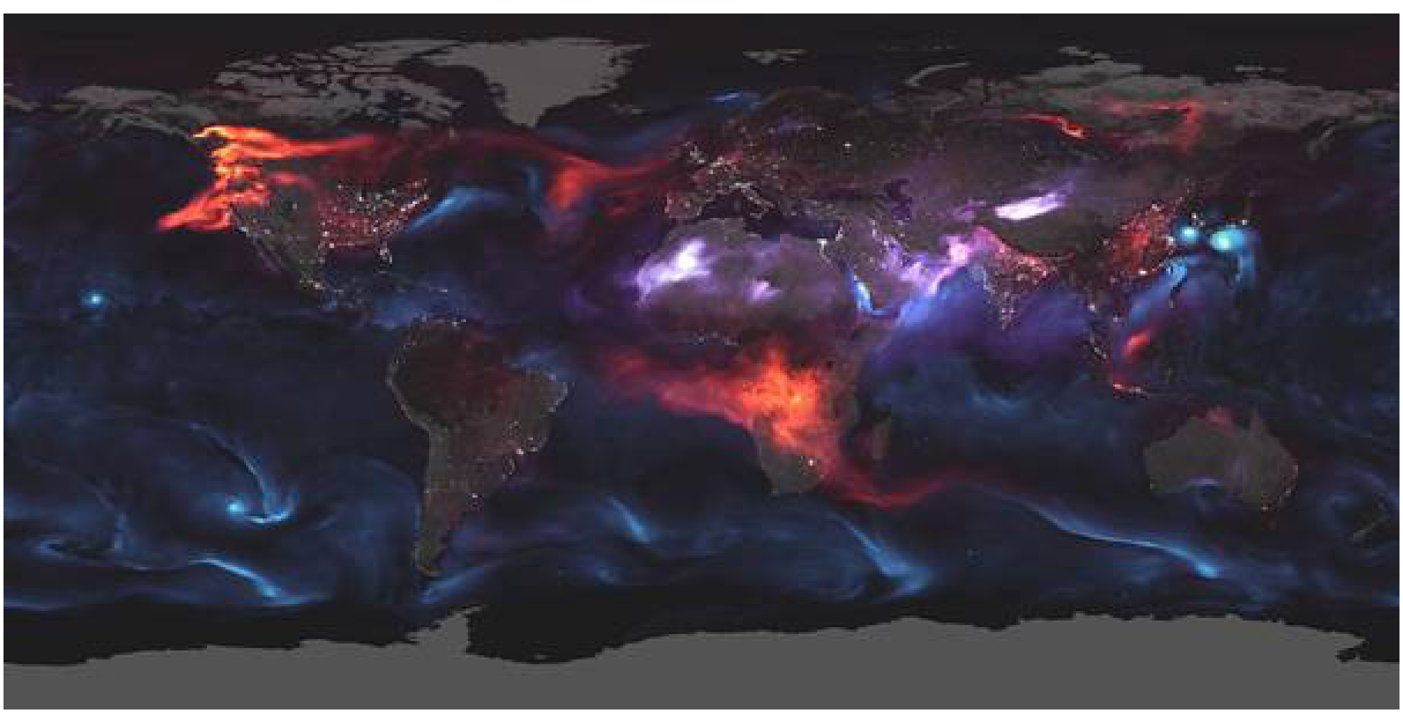
In May 2018, WHO released information that revealed the alarming toll of air pollution: 7 million deaths caused by exposure to ambient and household air pollution each year. It noted that over 90% of the world's population lived in areas where air pollution exceeds WHO limits.

> Estimates of exposure and burden of disease– at the country, regional and global levels – are critically important for guiding decision-making on ways to improve air quality and protect public health.

A powerful example is the recent comprehensive assessment by the Global Burden of Disease from Major Air Pollution Sources (GBD MAPS) project of the current and predicted burdens of disease attributable to major sources of particulate matter (PM2.5) in India and China. These are the world's most populous countries, and the two countries with the largest share of the burden of disease from air pollution. Coal burning, especially by industry, was found to be the largest contributor to the disease burden from air pollution in China. In India, residential biomass combustion was a major source. In both countries, modelling of future emissions scenarios indicated increases in future attributable deaths for all scenarios, due to ageing and growing populations. In both countries, increasing numbers of deaths could be avoided with increasingly stringent emissions reductions scenarios.

Modelling and forecasting are also essential tools for assessment of air quality. They support the public health community by informing estimates of exposure and health impacts, and help guide preventive action by decision-makers.

Critical gaps in coverage exist, however, which hamper efforts to address the health risks of air pollution. This is especially so in low- and middle-income countries (LMICs), where the vast majority of the burden of disease occurs.



## Why it matters

**Monitoring**: Collecting information about the amount and type of pollutants in the air is an essential step in protecting people from the health impacts of being exposed to those pollutants. Ground monitoring networks are the primary source of data for informing estimates of population-level exposures to air pollution, which in turn is essential for estimating the total burden of disease. Armed with reliable information provided by air quality monitoring programmes, decision-makers can devise more effective policies to clean up the air and reduce exposures. Investing in air quality measurement is a smart investment in public health. Yet, many countries around the world do not gather data on ambient air quality – including some places that are expected to be among the most heavily polluted.

The updated version of the WHO ambient air quality database – which compiles ground measurements of annual mean concentrations of particulate matter (PM10 and PM2.5) mainly from national monitoring networks – showed that information on air quality was available for 4,300 human settlements (mostly cities) from 108 countries. The number of settlements increased by almost 50%, in terms of data availability, since 2016. But air quality monitoring in LMICs still needs to be strengthened.

**Modelling**: Air quality modelling is an essential tool in air quality management. One of its important applications is providing estimates of the contribution of specific sources and sectors to air pollution surface concentrations, which are used to estimate exposure and to assess health effects. Simulations of various emission reduction options provide insights to decision-makers developing mitigation strategies.

**Forecasting**: Air quality forecasting is another important application to help reduce the health impacts of air pollution. Predictions of air quality over the next several days can be used to reduce exposure to air pollution. They can support efforts by local health and air managers to issue advisories (e.g. to reduce outdoor activities) and contribute to actual reductions of ambient pollutant levels by mandating temporary emissions control measures (e.g. traffic restrictions, fuel switching, bans on wood-burning for heating).

## New advances in methods and tools

A new generation of monitoring and modelling tools is now available to assess and forecast air pollution trends, and to help in designing the most effective strategies to improve air quality. These monitoring tools (in-situ networks, Earth observations, low-cost sensors, emission inventories, and air pollution models) enable better analyses of air quality and its driving factors in various parts of the world.

The rapid development of new technologies is lowering the cost and advancing the field of air quality monitoring. Stationary and dynamic networks of low-cost sensors (LCS) for air pollution monitoring are being established. Sensors for air pollution monitoring are being deployed on mobile phones, drones and retrofitted cars that serve as mobile monitoring stations. New, lower-cost sensors are becoming more widely available as commercial products, presenting new opportunities for innovative applications and broader participation in air quality monitoring and management by communities, citizens, and companies. This should lead to more dense monitoring networks that complement regulatory monitoring, and to better identification of pollution hot spots and specific sources.

In recent years, advances in satellite data retrieval and analysis have also contributed to important progress in air quality assessment. Information gathered by satellites is essential to generating estimates of air pollution exposures around the world. Ground monitoring of fine particulate air pollution is supplemented with information from remote-sensing satellites and other sources to produce high-resolution estimates of concentrations for every country. These estimates form the basis of the calculations of country-level, regional and global, burden of disease.

## Challenges and gaps

Data on air quality in sub-Saharan Africa, and LMICs of the Western Pacific and the Eastern Mediterranean regions remains scarce. There is an urgent need to enhance air quality monitoring in LMICs, through expansion of ground-based monitoring in regions with sparse data and through methods than can enhance calibration and validation of remote sensing and modelling approaches.

With regard to new low-cost sensors and related technologies, questions must be addressed about their quality, performance (accuracy, precision, drift with time or robustness) and standardization. Common protocols and guidelines for their production, use and minimum performance requirements need to be developed. Ways of integrating information generated by low-cost sensors (e.g. through citizen science) in WHO databases must also be explored.

The general trajectory for LCS is one of ever-improving capability. But researchers must use great care in understanding the data that LCS produce. Users of LCS need to have a clearly defined application scope and set of questions they wish to address prior to selecting a sensor approach. Real-world conditions, where sensors are most often used, are often not captured in preliminary calibration and validation efforts. This leads to additional uncertainty in LCS results.

## The way forward

WHO is working closely with the World Meteorological Organization (WMO) Global Atmosphere Watch programme to improve the integration of locally and regionally available chemical transport models, remote sensing and ground monitoring data into global assessments to improve estimates of air pollution exposure. A particular area of focus is integrating products from the Copernicus Atmosphere Monitoring Service (CAMS) – which provides state-of-the-art estimates with high temporal and spatial resolution of PM2.5. and other pollutants – into DIMAQ.

Building the capacity of professionals working on air quality monitoring and health impact assessment in LMICs is another key priority. An example of a promising partnership is the GEOHealth Hub, a research and training centre focused on environmental and occupational health in eastern Africa (see below).

**WHO is leading a Global Platform on Air Quality and Health** in partnership with international and national organizations, to address the rising health toll of air pollution. The Global Platform brings together international and national experts, scientists and policy actors to strengthen ways to track and report progress on air pollution. A key element of the platform's work is developing a data clearinghouse to help countries and cities reduce exposure to air pollution, its associated burden of disease and more effectively tackle the sources of health-damaging air pollution. One of the Global Platform's current areas of focus is improving methods to integrate air pollution data from satellite, ground monitoring and chemical models, and to better characterize air pollution sources (such as transport, industry and agriculture).