Updates from the World Meteorological Organization

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World Meteorological Organization
Organisation météorologique mondiale

Lorenzo Labrador, World Meteorological Organization

Forty-third session of the LRTAP's Executive Body
Geneva, 11-14 December 2023

2023 WMO Air Quality and Climate Bulletin

- First edition in 2021

- Born of the collaboration of the GAW Scientific Advisory Groups on Aerosol, Reactive Gases, and Total Atmospheric Deposition

- Message: air quality and climate cannot be treated as separate subjects

- Launched with a WMO press conference to coincide with the UN-sanctioned “Clean Air for Blue Skies”

- One of WMO’s flagship publications

WMO Air Quality and Climate Bulletin 2023

WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

GLOBAL ATMOSPHERE WATCH

No. 3 – SEPTEMBER 2023

WMO AIR QUALITY AND CLIMATE BULLETIN

Introduction

Ongoing climate change, caused by the accumulation of greenhouse gases in the atmosphere, is happening on a timescale of decades to centuries and is driving environmental changes worldwide. In contrast, the air pollution that occurs near the Earth's surface happens on a timescale of days to weeks, and across spatial scales that range from local (for example, urban centres) to regional (such as the eastern United States of America, northern India or the Amazon). Despite these wide-ranging differences, air quality and climate change are strongly interconnected. The *WMO Air Quality and Climate Bulletin* reports annually on the state of air quality and its connections to climate change, reflecting on the geographical distribution of and changes in the levels of traditional pollutants.

Traditional pollutants include short-lived reactive gases such as ozone – a trace gas that is both a common air pollutant and a greenhouse gas that warms the atmosphere – and particulate matter (PM) – a wide range of tiny particles suspended in the atmosphere (commonly referred to as aerosols), which are detrimental to human health and which, due to their complex characteristics, can either cool or warm the atmosphere.

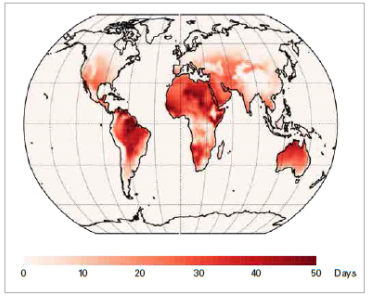

Figure 1. Change in the number of days per year with daily maximum surface temperatures above 35 °C, relative to an 1850–1900 baseline, as predicted by 27 numerical models, in a world that will have experienced 1.5 °C warming (based on the Shared Socioeconomic Pathway SSP5-8.5), globally averaged

Source: Figure produced using data from the IPCC Working Group I Interactive Atlas: https://interactive-atlas.ipcc.ch/

Air quality and climate are interconnected because the chemical species that affect both are linked, and because changes in one inevitably cause changes in the other. Human activities that release long-lived greenhouse gases into the atmosphere also lead to the enhancement of concentrations of shorter-lived ozone and PM in the atmosphere. For example, the combustion of fossil fuels (a major source of carbon dioxide (CO_2)) also emits nitrogen oxide (NO) into the atmosphere, which can lead to the formation of ozone and nitrate aerosols. Similarly, some agricultural activities (which are major sources of the greenhouse gas methane) emit ammonia, which then forms ammonium aerosols. Air quality in turn affects ecosystem health via atmospheric deposition (the process by which air pollutants settle from the atmosphere onto the Earth's surface), which therefore also links air quality to climate. Deposition of nitrogen, sulfur and ozone can negatively affect the services provided by natural ecosystems such as clean water, biodiversity and carbon storage, and can impact crop yields in agricultural systems.

The present edition of the *WMO Air Quality and Climate Bulletin* provides an update on the global distribution of PM for 2022 and explores avenues through which heatwaves affect atmospheric composition. Heatwaves are expected to worsen with climate change (Figure 1), and several notable heatwaves occurred in 2022. Two case studies further examine the interconnections between PM, climate and air quality. Increased severity of wildfires in heatwave-stricken areas can produce more aerosol pollution, such as occurred over western North America in August–September 2022, while the intrusion of a desert air mass over Europe from North Africa brought both heatwave conditions and desert dust in August 2022. Furthermore, the present edition of the Bulletin explores how the persistent heatwave that impacted Europe in June–August 2022 influenced concentrations of ground-level ozone. New findings elucidating the role that wildfires play in driving nitrogen deposition, which can negatively affect ecosystems, are summarized, and the numerous and complex interactions between agriculture and air quality are outlined. Finally, the Bulletin concludes by exploring how elevated temperatures may be exacerbated in cities via the Urban Heat Island effect and how the presence of parks can benefit urban centres by cooling the surrounding air and absorbing CO_2.

Global particulate matter concentrations in 2022 recorded by the Copernicus Atmosphere Monitoring Service

Johannes Flemming, Vincent-Henri Peuch

Inhaling PM smaller than 2.5 micrometres ($PM_{2.5}$) over long periods is a severe health hazard (WHO, 2021). Human and natural sources contribute to $PM_{2.5}$ pollution in varying proportions at the global scale, and include emissions from fossil fuel combustion, wildfires and wind-blown desert dust. Figure 2(b), produced from the $PM_{2.5}$ data from the Copernicus Atmosphere Monitoring Service (CAMS) reanalysis, shows the average $PM_{2.5}$ surface concentrations for 2003–2022 and the anomalies (absolute differences) in 2022 compared with the mean values for 2003–2022 (Figure 2(a)).

The 2022 $PM_{2.5}$ anomalies were much less impacted by large fire events compared to 2021 (*WMO Air Quality and Climate Bulletin, No. 2*). Rather, the trends of anthropogenic emissions and annual variability of the desert dust emissions played a larger role in controlling surface $PM_{2.5}$. Fire-driven positive $PM_{2.5}$ anomalies occurred in parts of the Amazon basin and Alaska because of an active fire season in July and August 2022, and over South Africa because of fire activity in July to September. Dust storm activity was, in general, lower than usual over most of the Sahara Desert except over its north-west fringe, while the Taklimakan Desert and most of the Arabian Peninsula experienced a higher than usual amount of dust which contributed to the increased $PM_{2.5}$ levels. As was the case in 2021, the positive $PM_{2.5}$ anomaly over India and the negative anomalies over China, Europe and the eastern United States in 2022 were mainly manifestations of increased or decreased anthropogenic emissions in the respective regions (Figure 2(a)). Overall, the 2022 $PM_{2.5}$ anomalies were consistent with the long-term trends, with decreases across East Asia and Europe, and increases across South Asia (Figure 3).

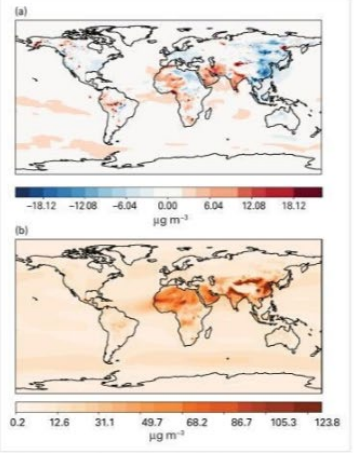

Figure 2. (a) Anomaly (absolute difference) of the mean $PM_{2.5}$ surface concentrations ($\mu g\,m^{-3}$) in 2022 compared to (b) the average for the period 2003–2022, as produced by the CAMS reanalysis. Low concentrations across the oceans are largely due to naturally occurring sea salt particles. The CAMS reanalysis system assimilated satellite-detected aerosol optical depth (AOD) retrievals from the Moderate Resolution Imaging Spectroradiometer (MODIS) and Advanced Along-Track Scanning Radiometer (AATSR) instruments. The Global Fire Assimilation System (GFAS) wildfire emissions data set was also used.

Source: European Centre for Medium-Range Weather Forecasts (ECMWF)/CAMS

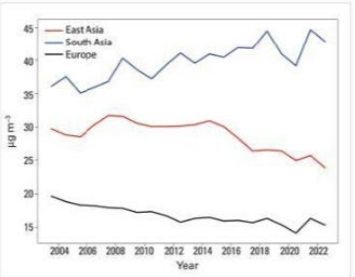

Figure 3. 2003–2022 time series of annual mean $PM_{2.5}$ surface concentrations ($\mu g\,m^{-3}$) for different regions: East Asia (red), South Asia (blue) and Europe (black)

Source: ECMWF/CAMS

Mechanisms linking heatwaves and particulate matter: Wildfires and desert dust intrusions

Peter Colarco, Lucia Mona

While large fires and dust storm activity were generally less frequent in 2022, as mentioned in the previous section, notable events of this kind still occurred. Their linkages to heatwaves, high levels of aerosols and poor air quality are explored in the following paragraphs in

WMO OMM

The Telegraph online

Friday, 08 September 2023

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Home / World / Intense, frequent heatwaves measurably worsening air quality: World Meteorological Organization

Intense, frequent heatwaves measurably worsening air quality: World Meteorological Organization

Heatwaves and dry conditions are also conducive to wildfires, which, once started, propagate rapidly upon encountering dry, easily combustible vegetation, further adding to aerosol emissions

PTI | New Delhi | Published 07.09.23, 02:06 PM

CHINADAILY.COM.CN 中国日报网 | Global Edition | Sept 7, 2023

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• Europe

Air quality impacted by changing climate

By JONATHAN POWELL in London | China Daily Global | Updated: 2023-09-07 09:15

People wait to dive in the water at a beach in Saint-Malo, France, on Tuesday, as a heat wave hit the country. REUTERS

A new report from the World Meteorological Organization, or WMO, reveals that climate change is significantly impacting air quality, human health, and the environment by heightening the intensity and frequency of heat waves, and exacerbating wildfires and desert dust.

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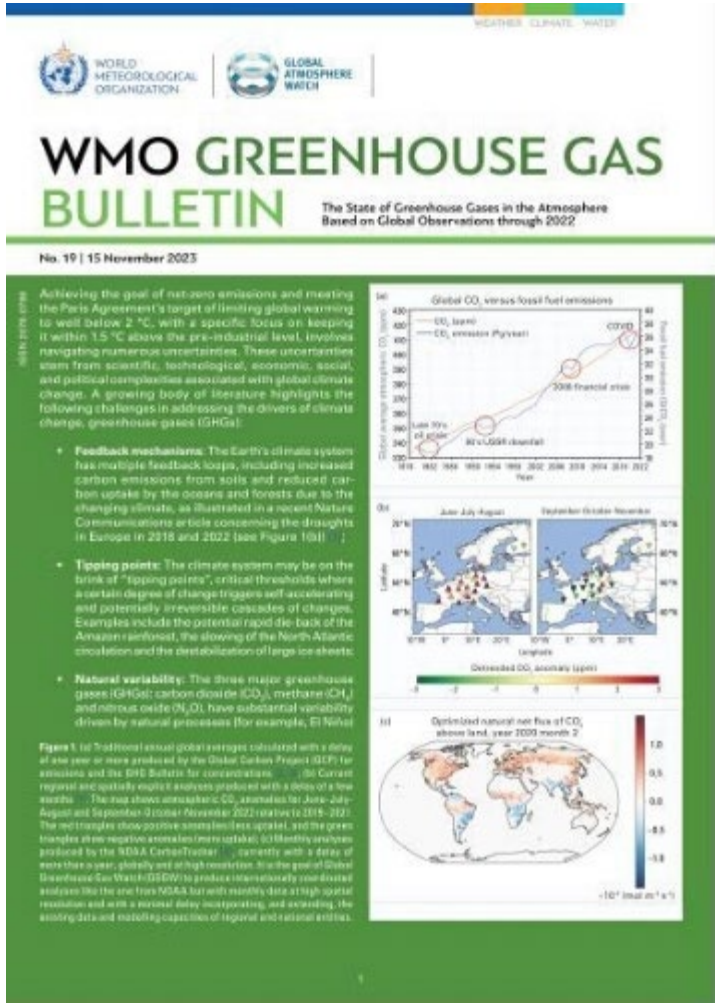
'Climate breakdown' alert as air quality dips during heatwaves: UN chief

2023 WMO Greenhouse Bulletin

Key messages:

- Record levels of heat-trapping gases mean further temperature increase
- Carbon budget is shrinking fast
- Climate change impacts include more extreme weather, sea level rise
- **Global Greenhouse Gas Watch** will support climate action

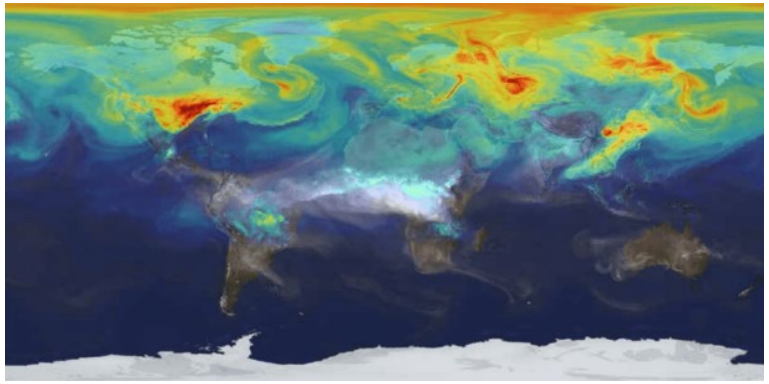


WMO Global Greenhouse Gas Watch (GGGW)

A WMO-coordinated global Greenhouse Gas Monitoring Infrastructure

Concept:

- To provide sustained, routine global monitoring of greenhouse gas concentrations and fluxes required to better understand climate change, and provide support to mitigation action taken by the Parties to the UNFCCC and the Paris Agreement.
- Born of the need to increase focus on the role of GHGs as a driver of climate change and the need to strengthen the GHG information basis for decisions on climate mitigation efforts
- GGGW leverages expertise of the Global Atmosphere Watch's community.
- Concept Note approved at 2023 WMO Congress, Implementation plan currently being drafted.



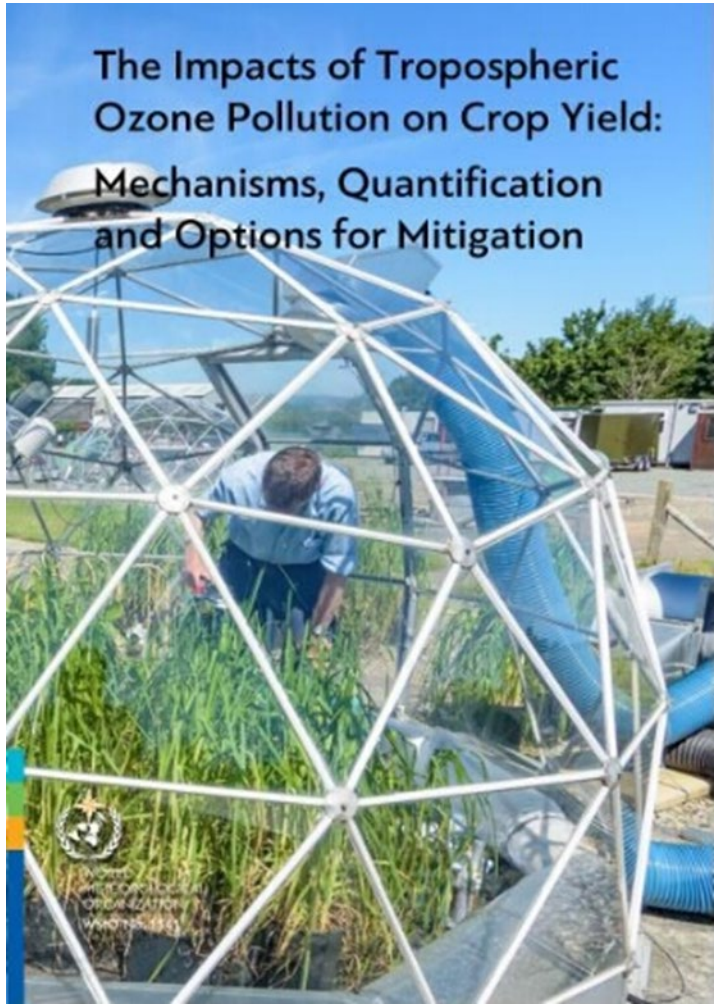
A Year In The Life Of Earth's CO_2, **NASA Goddard Institute for Space Studies**

WMO reports on the effects of air pollution on agriculture

Quantifying the impacts of tropospheric ozone on crop yield: mechanisms, quantification and options for mitigation

- A synthesis of current knowledge
- **Aim:** to document the current knowledge of the damaging effects

of tropospheric (ground-level) ozone pollution on food crops around the world and to discuss ways of mitigating these effects.



- Makes the case for the inclusion of ozone in future crop yield predictions and recommends that management practices being developed to cope with climate change take the effects of ozone into account.
- First of two guidance documents commissioned by the WMO Expert Team on Agrometeorological Sciences.

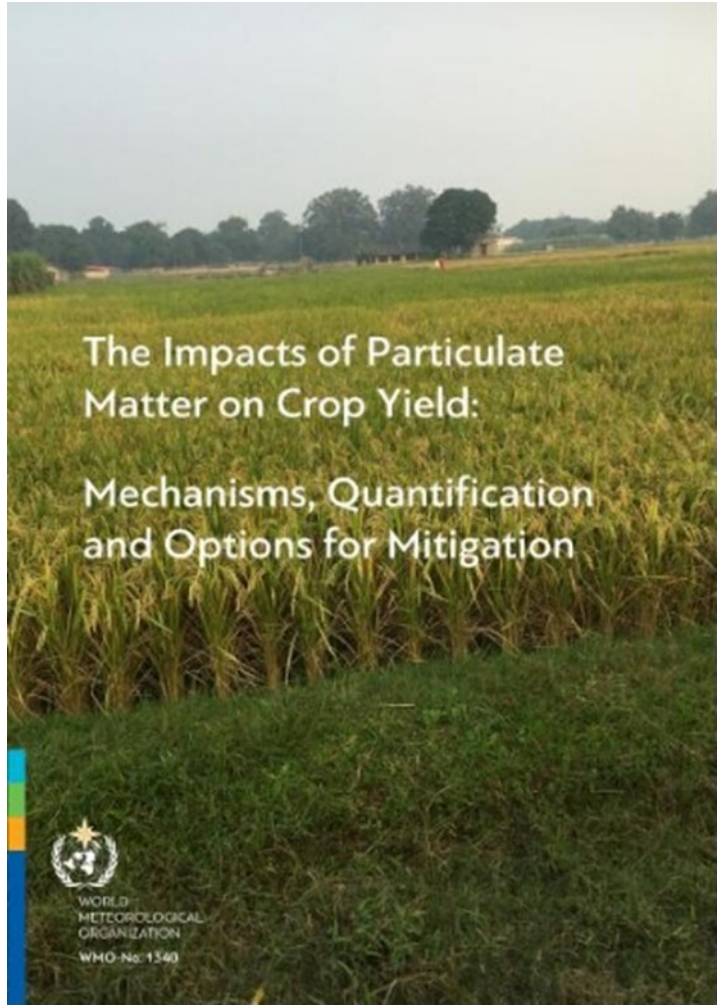
https://library.wmo.int/records/item/68654-the-impacts-of-tropospheric-ozone-pollution-on-crop-yield-mechanisms-quantification-and-options-for-mitigation

WMO reports on the effects of air pollution on agriculture

The impacts of particulate matter on crop yield:

mechanisms, quantification and options for mitigation

- **Aim:** to provide an evidence-based assessment of current knowledge, in one easily accessible document, on the impacts of particulate matter pollution on the growth, productivity, yield quantity and quality of crops.
- Second of a series of two guidance documents commissioned by the Expert Team on Agrometeorological Sciences as a contribution to the Standing Committee on Services for Agriculture of the WMO Commission for Weather, Climate, Hydrological, Marine and Related Environmental Services and Applications (SERCOM).



https://library.wmo.int/records/item/68653-quantifying-the-impacts-of-particulate-matter-on-crop-yield-a-synthesis-of-current-knowledge

Chacaltaya Global GAW Station

GAW Global stations:

- Situated in remote regions with very low background levels of air pollutants and no anthropogenic influence. Critical in tracking well-mixed greenhouse gases.
- Have a large area of representativeness and measure a broad range of atmospheric pollutants over long periods.
- Have a measurement programme in at least three of the six GAW focal areas.

Cahacaltaya GAW Global Station, Bolivia is the newest member of the family of Global stations, bringing the total to 31

Chacaltaya Global GAW Station

Contribution to the Climate and Clean Air Coalition's Clean Air Flagship 2024-2026

- CCAC Partners requested a new effort to achieve clean air across the world at the Climate and Clean Air Ministerial 2022
- At the Climate and Clean Air Ministerial 2023, the CCAC launched the "Clean Air Flagship" to mobilize the partnership and 'move the needle' on this important topic.

Aims:

- Saving lives: Supporting governments to achieve cleaner air as quickly as possible, consistent with improved WHO air quality interim targets
- Slowing climate change: Taking full advantage of win-win opportunities to reduce the emissions of short-lived climate pollutants simultaneously with other harmful pollutants
- Maximizing co-benefits: Improving agricultural productivity, economic development and the overall quality of life

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Thank you for your attention

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