

Providing Open and Universal Access to Global Air Quality Data



openaq.org • explore.openaq.org

Chris Hagerbaumer, OpenAQ

chris@openaq.org

HAQAST Utah

“Multiple Pollutant Sources & Other
Environmental Exposures” panel

October 19, 2023



About OpenAQ

“By providing universal access to air quality data, OpenAQ empowers a global community of changemakers to solve air inequality.”



Chris Hagerbaumer, MPP
Executive Director



Russ Biggs
Director of Technology



Colleen Marciel F. Rosales, Ph.D.
*Strategic Partnerships
Director*



Gabe Fosse
*Data Analyst and
Developer*

- Founded in 2015 by Christa Hasenkopf, Atmospheric Chemist, and Joe Flasher, Software Engineer
- U.S. 501(c)(3) non-profit organization as of 2018

Read the origin story: bit.ly/OpenAQ-Origin





The OpenAQ Platform

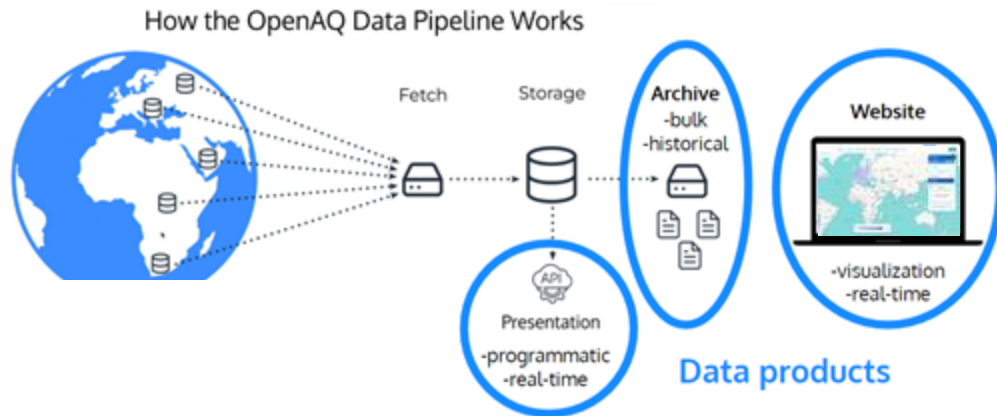
The world's largest **open-source** real-time air quality data platform
openaq.org • explore.openaq.org



explore.openaq.org

43 billion data points
56,000 locations
153 countries

- PM_{2.5}
- PM₁₀
- Sulfur Dioxide (SO₂)
- Nitrogen Dioxide (NO₂)
- Carbon Monoxide (CO)
- Black Carbon (BC)
- Ozone (O₃)



Data Sources (instruments)

1. Reference monitors
2. Air sensors (“low-cost” sensors)

Data Problems

- Disparate formats
 - JSON
 - FTP
 - Web pages
 - XML
- Some data exists only temporarily
- Not designed to be globally (or even nationally) interoperable
- Typically not fully accessible to the public

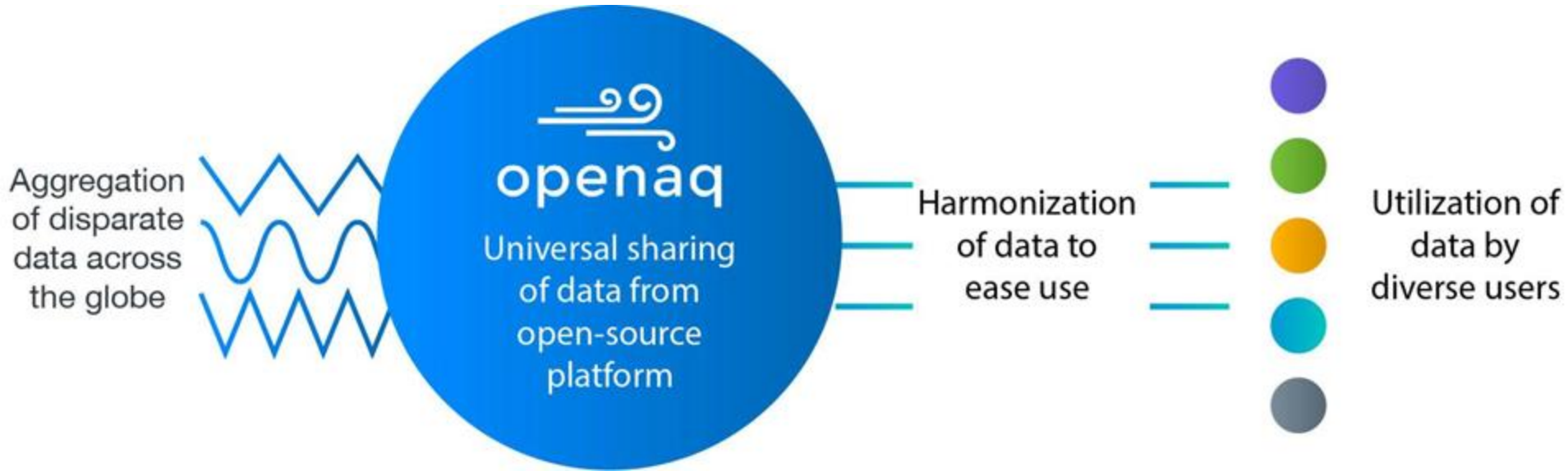
Central Scotland						
Latest measured levels						
Monitoring site	Running & Raining 8 hour mean (µg/l)	Steady Raining 8 hour mean (µg/l)	Max 10 min mean (µg/l)	Running 15 min mean (µg/l)	Running 14 hour mean (µg/l)	Last updated
Northumbria Road Dumfries, Dumfries	45 (1 Low)	-	5/75	0 (1 Low)	0 (1 Low)	23/06/2015 21:00:00
Bush Estate Dumfries, Dumfries	51 (1 Low)	0 (1 Low)	5/75	5/75	5/75	24/06/2015 21:00:00
Northumbria Road Dumfries, Dumfries	7/75	0 (1 Low)	5/75	5/75	5/75	19/06/2015 21:00:00
Edinburgh St Dumfries, Dumfries	29 (1 Low)	25 (1 Low)	0 (1 Low)	0 (1 Low)	0 (1 Low)	21/06/2015 21:00:00
George Grant Dumfries, Dumfries	5/75	19 (1 Low)	5/75	5/75	5/75	19/06/2015 21:00:00



Patients	Quasi CO	Deceit CO	Microsat CO	Multiple CO	Carbon CO	Buffy CO	Penicillin CO	Penicillin PA	PA
Average Parity	1.5-hour average	1-hour average	1.5-hour average	1.5-hour average	1-hour average	1-hour average	1-hour average	1-hour average	1-hour average
Sydney East									
Bentley	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Rear	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Lynch	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sydney North-west									
Bentley	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Rear	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Sydney South-west									
Bentley	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Rear	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Compass Rose	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Compass	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Stevens	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
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Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
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Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Wentworth									



OpenAQ harmonizes air quality data from disparate sources into one single format so that the public can more fully maximize the uses—and ultimate impact—of the data



Who makes use of the data in OpenAQ?



- Air quality & climate change researchers/analysts at universities, think tanks, governments, multilateral orgs
- Governments producing & sharing AQ data
- Public health entities
- Non-governmental organizations (NGOs) & community-based organizations (CBOs)
- Journalists and storytellers
- App developers and tech companies
- Data enthusiasts that need a big dataset for data science studies
- Anyone who cares about air quality!

Global COVID-19 Impacts

pnas.org/content/117/32/18984

PNAS

Proceedings of the
National Academy of Sciences
of the United States of America



Zander et al. (PNAS, 2020) accessed ground monitoring data from OpenAQ and satellite data from TROPOMI to analyze the immediate impact of COVID Lockdowns on AQ for 34 countries.

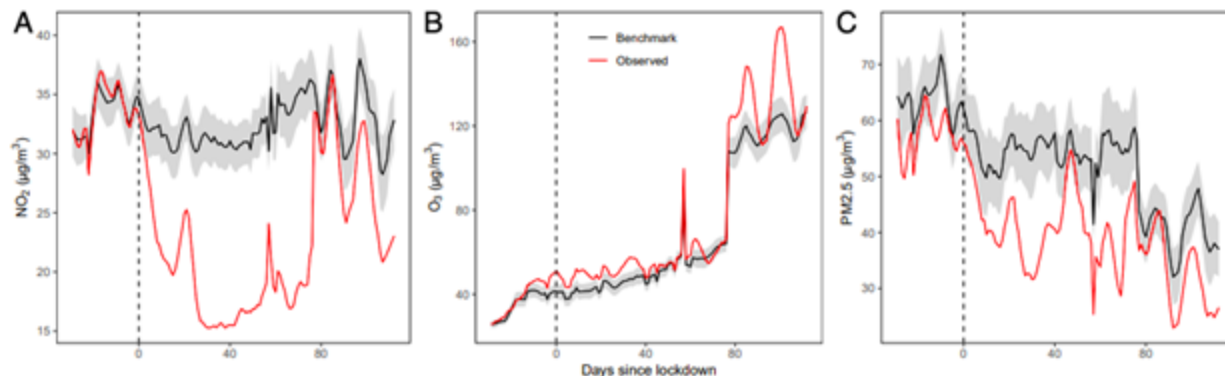


Fig. 2. Lockdown ground-level air pollution anomalies relative to weather benchmarks for NO_2 (A), O_3 (B), and $\text{PM}_{2.5}$ (C). The daily population-weighted average ($n = 34$ countries) ambient pollutant concentrations observed 1 mo before and up to 15 May after lockdowns are plotted in red. Benchmark levels which represent expected concentrations considering time of year and prevailing weather are plotted in black with 95% CIs.



Machine Learning + Air Quality Data



AQAI

Machine learning-powered predictive model for monitoring air quality
(Belize, Latin America)

UNICEF Venture-fund backed



airquality.lacity.org

Predicting What We Breathe

Los Angeles+CSULA+OpenAQ w/ NASA funding. Forecasting algorithm for air pollution events developed based on time-series measurements of satellite & ground data + machine learning (accuracy = 80-94%, compared to ground data alone). Used to inform citywide air quality policies.

New NASA grant → Integration of Earth observations and socioeconomic data to ensure decision-making processes enhance environmental justice.

Shoot I smoke

shootismoke.app



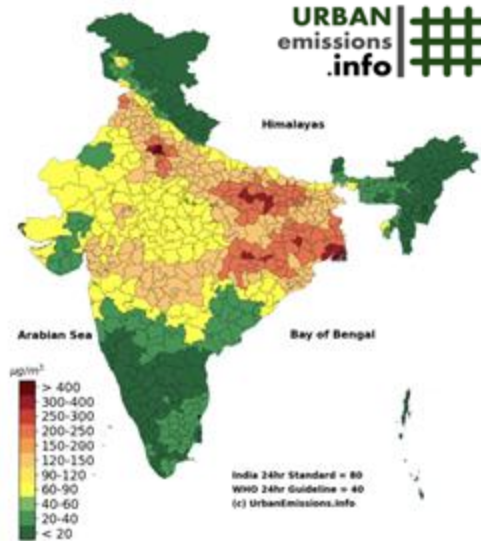
- Correlates breathing air in a city to the equivalent amount of cigarettes smoked
- Free, open-source tool based on data from OpenAQ and WAQI

All India Air Quality Forecast System

urbanemissions.info



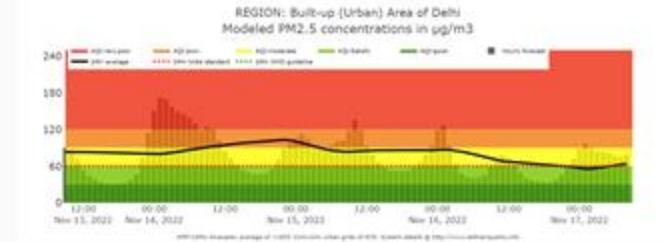
India Air Quality Information: 3-day forecasts
Particulate Matter (PM_{2.5})
24hr Average for 14Dec2021 Tuesday



- Visualize trends on effects of high pollution events (ex: dust storms, Diwali)
- Long-term air quality management plans
- Public health alert systems

Delhi – Air Quality Forecasts

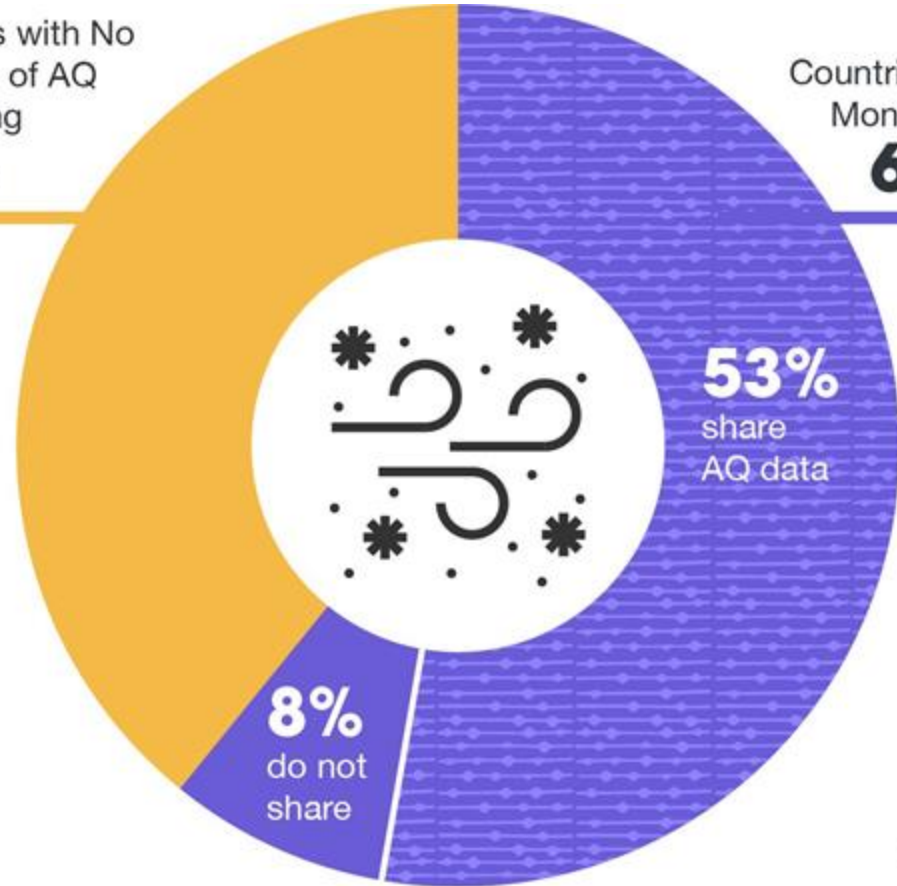
To support Delhi's air pollution management, we forecast ambient concentrations for all the criteria pollutants for the next 72 hours. The modeling domain covering [Delhi](#) and [its satellite cities](#), extends 80 km in North to South and 80 km West to East, with a spatial resolution of 0.01 degrees (~1 km) and a temporal resolution of 1 hour. The modeled meteorology and concentration data fields are updated everyday at ~7:00 PM (IST).





Countries with No
Evidence of AQ
Monitoring
39%

Countries that
Monitor AQ
61%



N=197

Open Air Quality Data: The Global Landscape
December 2022

bit.ly/OpenAQ2022Report





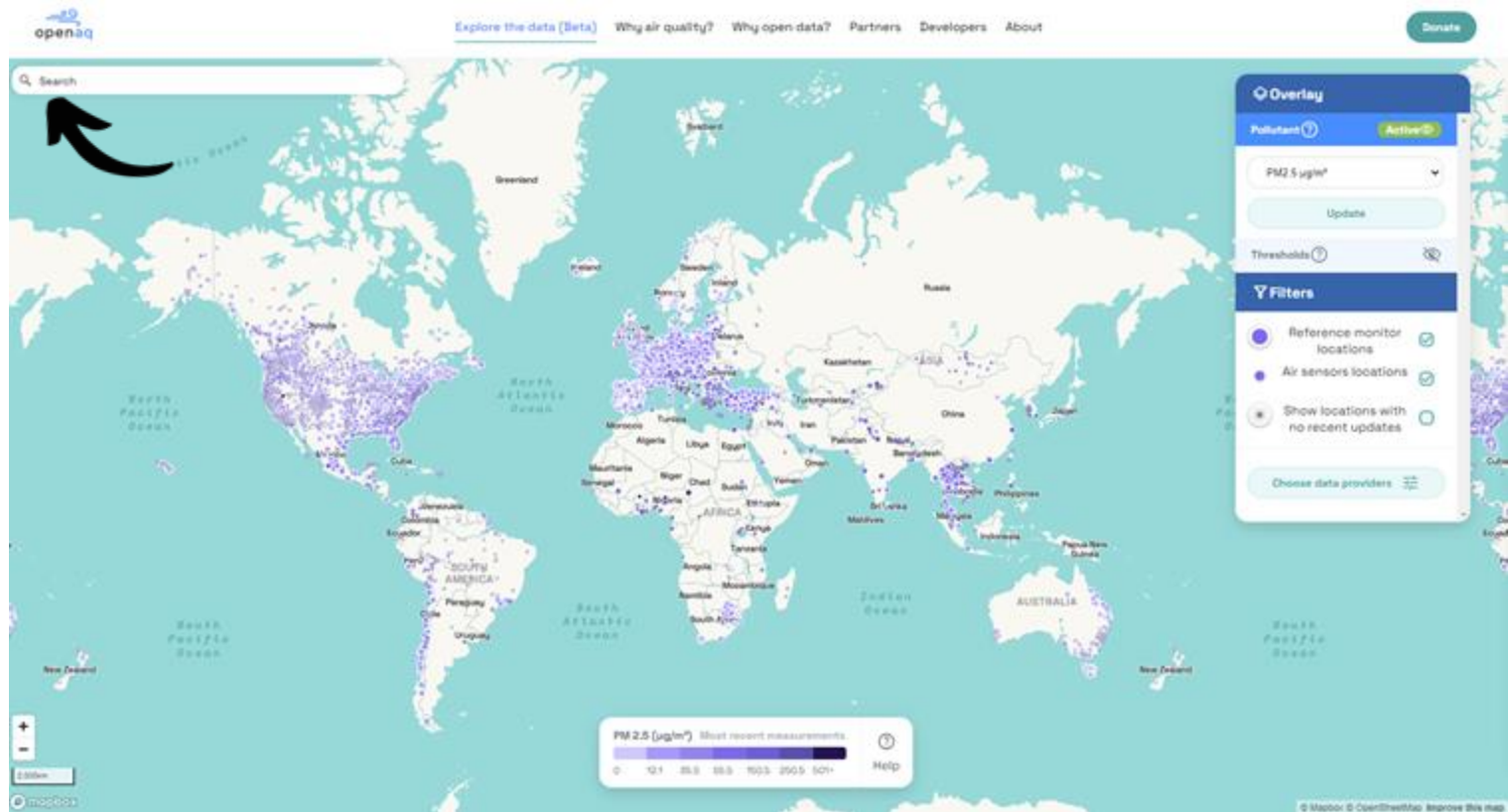
2023 OpenAQ Community Ambassador Program

Global leadership program targeted to AQ advocates in LMICs that are committed to utilizing open data to spur clean air action in their communities

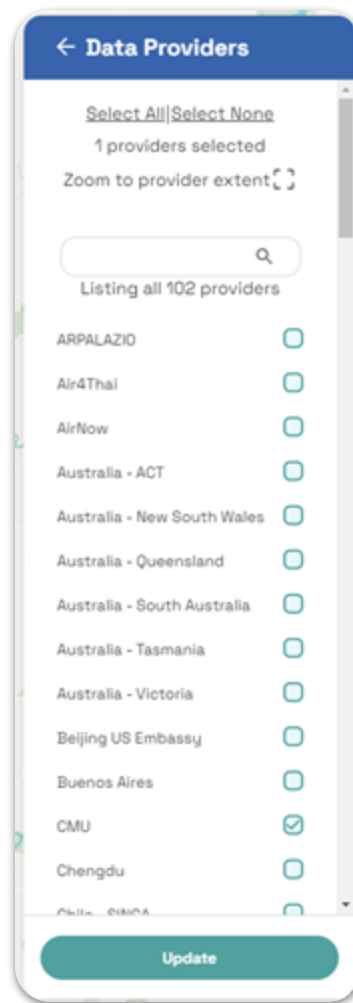
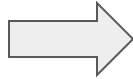
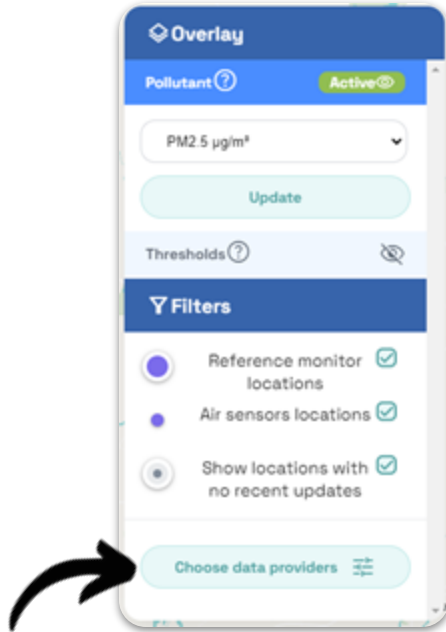


The OpenAQ Explorer

 explore.openaq.org



Data Providers



Try these providers:

- Air4Thai
- PurpleAir
- Rwanda REMA
- StateAir_Bamako

Try “Nairobi”

<https://explore.openaq.org/locations/352507>

Latest Readings



Latest Readings ⓘ



Time series

- Hourly average shown (end of hour- ceiling)
- Finer averages are downloadable

- Linear and logarithmic y-scale
- Breaks are shown when data are not available
- Point only appears if $\geq 75\%$ complete

Patterns

Patterns

O₂ (ppm)

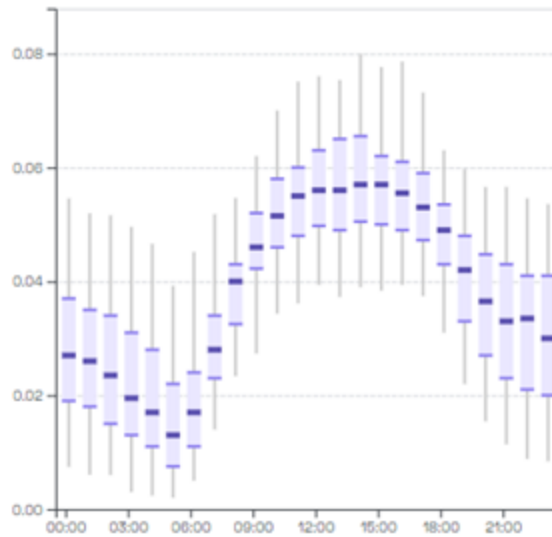


All time

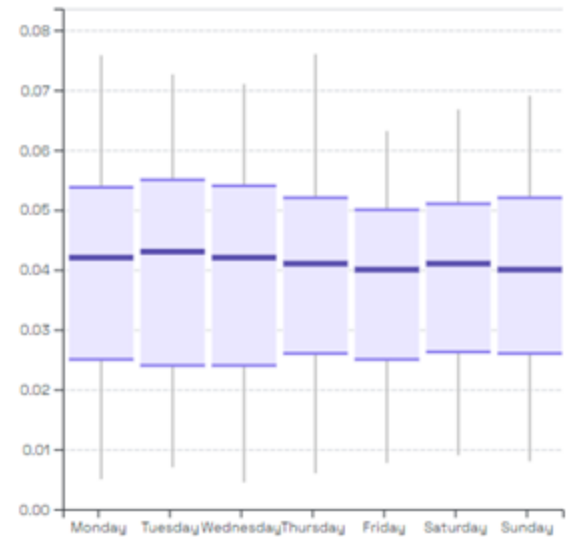


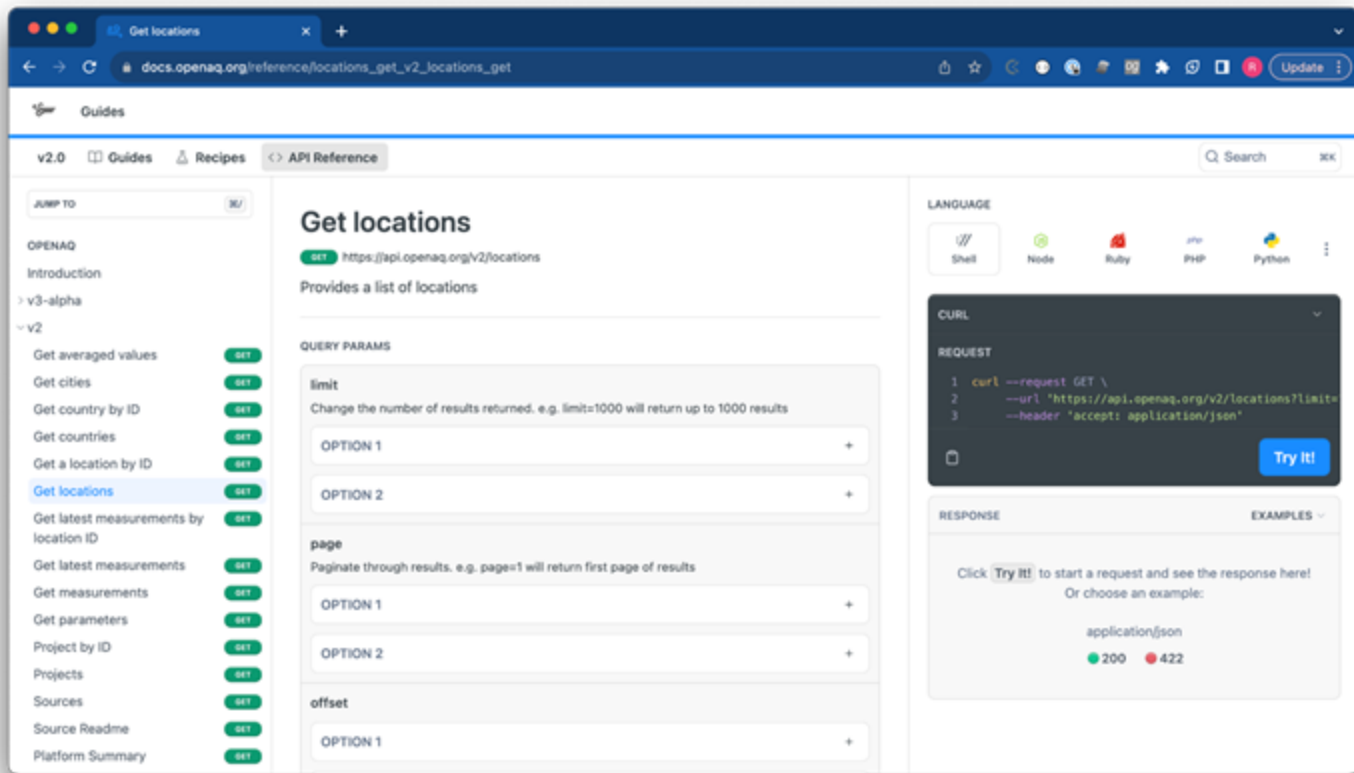
Update

Hour of day



Day of week





The screenshot shows a web browser displaying the OpenAQ API documentation for the 'Get locations' endpoint. The browser's address bar shows the URL `docs.openaq.org/reference/locations_get_v2_locations_get`. The page has a dark blue header with a search bar and navigation links for 'v2.0', 'Guides', 'Recipes', and 'API Reference'. A left sidebar lists various API endpoints, with 'Get locations' highlighted. The main content area is titled 'Get locations' and shows the endpoint `https://api.openaq.org/v2/locations` with a 'GET' method. It describes the endpoint as 'Provides a list of locations'. Below this, there are sections for 'QUERY PARAMS' including 'limit' (to change the number of results) and 'page' (for pagination), each with input fields and a 'Try It!' button. On the right, there's a 'LANGUAGE' section with icons for Shell, Node, Ruby, PHP, and Python. Below that is a 'CURL' section showing a request example and a 'RESPONSE' section with an example of a successful response (200 status code) and a failed one (422 status code).

Get locations

`https://api.openaq.org/v2/locations`

Provides a list of locations

QUERY PARAMS

limit

Change the number of results returned, e.g. `limit=1000` will return up to 1000 results

OPTION 1

OPTION 2

page

Paginate through results, e.g. `page=1` will return first page of results

OPTION 1

OPTION 2

offset

OPTION 1

LANGUAGE

Shell Node Ruby PHP Python

CURL

REQUEST

```
1 curl --request GET \  
2 --url 'https://api.openaq.org/v2/locations?limit=  
3 --header 'accept: application/json'
```

Try It!

RESPONSE

EXAMPLES

Click **Try It!** to start a request and see the response here!
Or choose an example:

application/json

200 422

Interacting with the OpenAQ API

OpenAQ CLI client

- OS-specific executables for Windows, Mac, and Linux
- pre-1.0.0 release
- <https://github.com/openaq/openaq-cli>





Funders supporting our vision of a world where everyone breathes healthy air, enabled by universal access to data:

