Comparison of Air Quality in London With Other Cities Worldwide

Greater London Authority, September 2014

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Disclaimer:This presentation is based on a report prepared by AMEC Environment & Infrastructure UK Limited for the GLA and TfL

The Scope of the Report

The Scope of the Report

- A **global comparison** - air quality in London is compared with air quality in cities around the world, based on **monitored data**
- The global comparison goes beyond previous studies in terms of the breadth of cities considered, the number of pollutants included and use of recent data
- To make a **wide global comparison** (39 cities) using the available data, only **annual averages of pollution** (long term) have been used
- The ranking methodology developed could also be used to look at short term measures of pollutions for those cities with suitable data

The Ranking Method

The Ranking Method

- A **multi-pollutant weighted index of annual average concentrations**
- Concentrations are **normalised** with respect to an annual average value such as the EU limit value
- The index used has a pollutant mixture and weighting suitable for a mixture of traffic, industrial and fossil-fuelled heating sources
  - Citywide - general - NO_2: 0.3; PM_{10}: 0.3; SO_2:0.3; $PM_{2.5}$: 0.1;
- **Sensitivity tests** considered a weighting scheme suitable for cities with traffic as the dominant source and a weighting that reflects the relative health impacts of different pollutants:
  - Citywide/Traffic Focussed - NO_2: 0.4; PM_{10}: 0.4; $PM_{2.5}$: 0.2;
  - Health Impacts - NO_2: 0.02; SO_2:0.03; PM_{10}: 0.71; $PM_{2.5}$: 0.24.

City Rankings

Citywide Index - Ranking

City	Rank	City	Rank
Vancouver	1 (best)	Tokyo	19
Sydney	2	Warsaw	20
Stockholm	3	Rome	21
Vienna	4	Munich	22
Berlin	5	Sao Paulo	23
Amsterdam	6	Moscow	24
Chicago	7	Bucharest	25
Singapore	8	Stuttgart	26
Prague	9	Rio de Janeiro	27
Frankfurt	10	Milan	28
Brussels	11	Istanbul	29
Paris	12	Hong Kong	30
Budapest	13	Mexico city	31
Los Angeles	14	Jakarta	32
London	**15**	Mumbai	33
Barcelona	16	Shanghai	34
New York	17	Beijing	35
Madrid	18	Cairo	36 (worst)

Citywide/Traffic Focused Index - Ranking

City	Rank	City	Rank
Vancouver	1 (best)	Barcelona	19
Sydney	2	Los Angeles	20
Singapore	3	Sao Paulo	21
Stockholm	4	Jakarta	22
Chicago	5	Munich	23
Vienna	6	Bucharest	24
New York	7	Rome	25
Prague	8	Stuttgart	26
Berlin	9	Tokyo	27
Amsterdam	10	Milan	28
Moscow	11	Rio de Janeiro	29
Madrid	12	Hong Kong	30
Frankfurt	13	Istanbul	31
Brussels	14	Shanghai	32
Budapest	15	Mexico city	33
Warsaw	16	Beijing	34
London	**17**	Cairo	35
Paris	18	Mumbai	36 (Worst)

Health Impacts Index - Ranking

City	Rank	City	Rank
Vancouver	1 (best)	Stuttgart	19
Sydney	2	Paris	20
New York	3	Rome	21
Stockholm	4	Budapest	22
Chicago	5	Sao Paulo	23
Madrid	6	Los Angeles	24
Tokyo	7	Warsaw	25
Frankfurt	8	Bucharest	26
London	**9**	Milan	27
Moscow	10	Hong Kong	28
Amsterdam	11	Mexico city	29
Prague	12	Istanbul	30
Vienna	13	Rio de Janeiro	31
Singapore	14	Jakarta	32
Munich	15	Shanghai	33
Berlin	16	Mumbai	34
Brussels	17	Beijing	35
Barcelona	18	Cairo	36 (worst)

Comparison of London with Other Cities

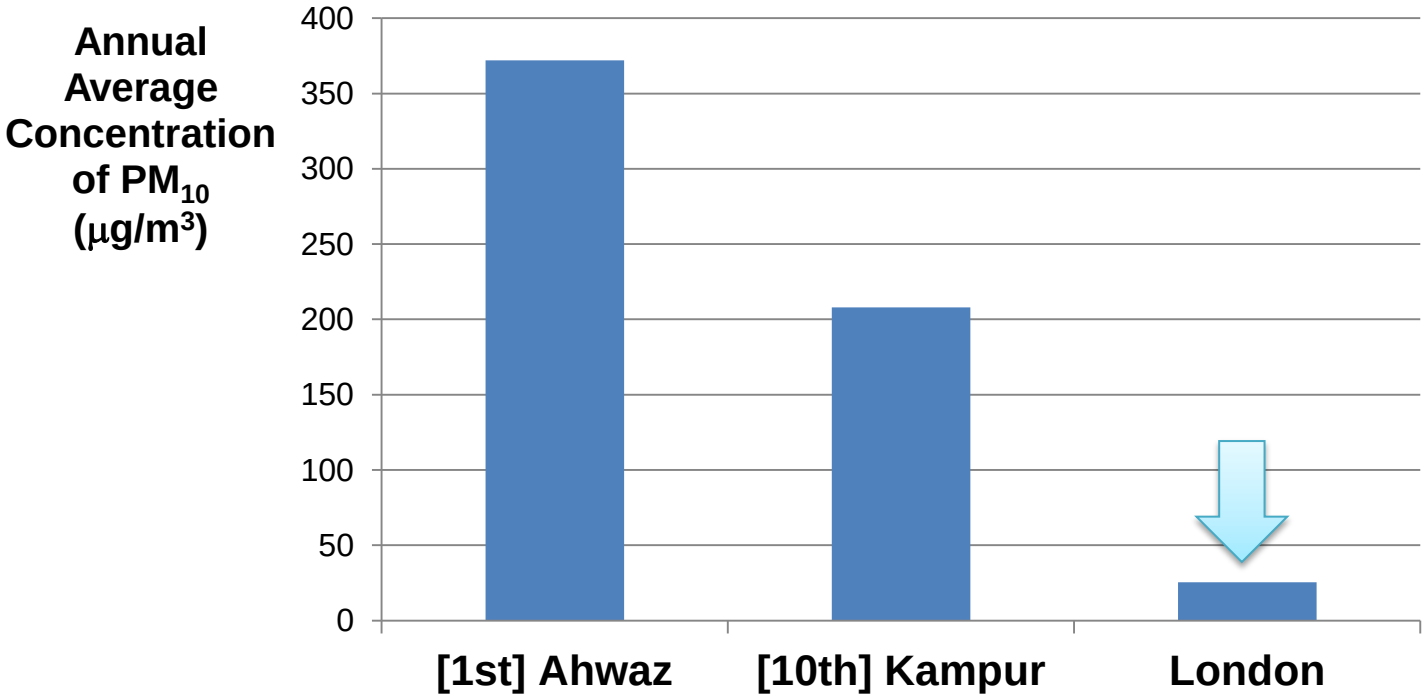
The world's most polluted cities (PM_{10})

October 2013, Quartz using WHO data on PM_{10}

- 1. Ahwaz, Iran
- 2. Ulaanbaatar, Mongolia
- 3. Sanandaj, Iran
- 4. Ludhiana, India
- 5. Quetta, Pakistan
- 6. Kermanshah, Iran
- 7. Peshawar, Pakistan
- 8. Gaborone, Botswana
- 9. Yasouj, Iran
- 10. Kanpur, India

http://science.time.com/2013/10/18/the-10-most-polluted-cities-in-the-world/

The world's most polluted cities (PM_{10})



http://science.time.com/2013/10/18/the-10-most-polluted-cities-in-the-world/

Comparison for PM_{10}

Average of 5 years annual averages (2008-2012)

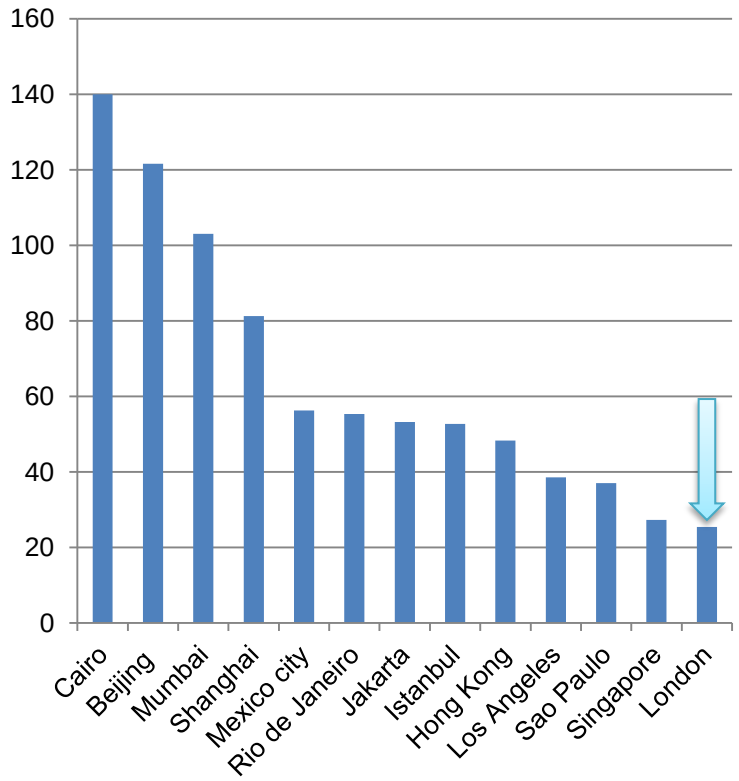
Non-EU City	PM_{10} ($\mu g/m^3$)
Cairo	140
Beijing	122
Mumbai	103
Shanghai	81
Mexico City	56
Rio de Janeiro	55
Jakarta	53
Istanbul	53
Hong Kong	48
Los Angeles	39
Sao Paulo	37
Singapore	27
London	**25**

EU City	PM_{10} ($\mu g/m^3$)
Milan	44
Bucharest	40
Warsaw	36
Budapest	33
Rome	32
Paris	32
Stuttgart	30
Barcelona	30
Brussels	28
Munich	28
Prague	27
Berlin	27
Vienna	27
Amsterdam	26
London	**25**

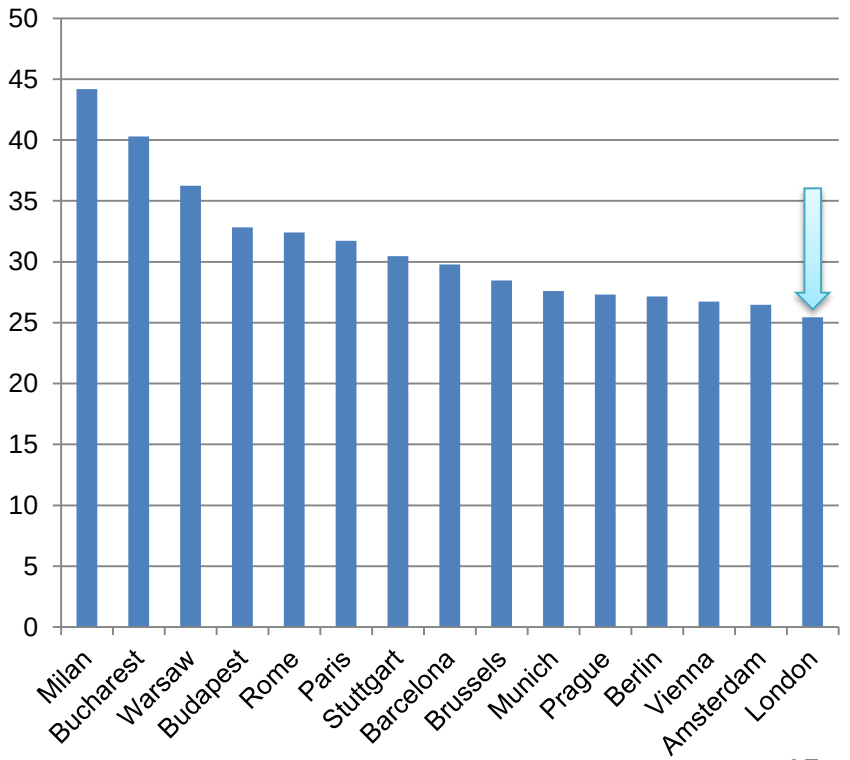
Comparison for PM_{10}

Average of 5 years annual averages (2008-2012)

Non-EU Cities, PM_{10} ($\mu g/m^3$)



EU Cities, PM_{10} ($\mu g/m^3$)



Comparison for $PM_{2.5}$

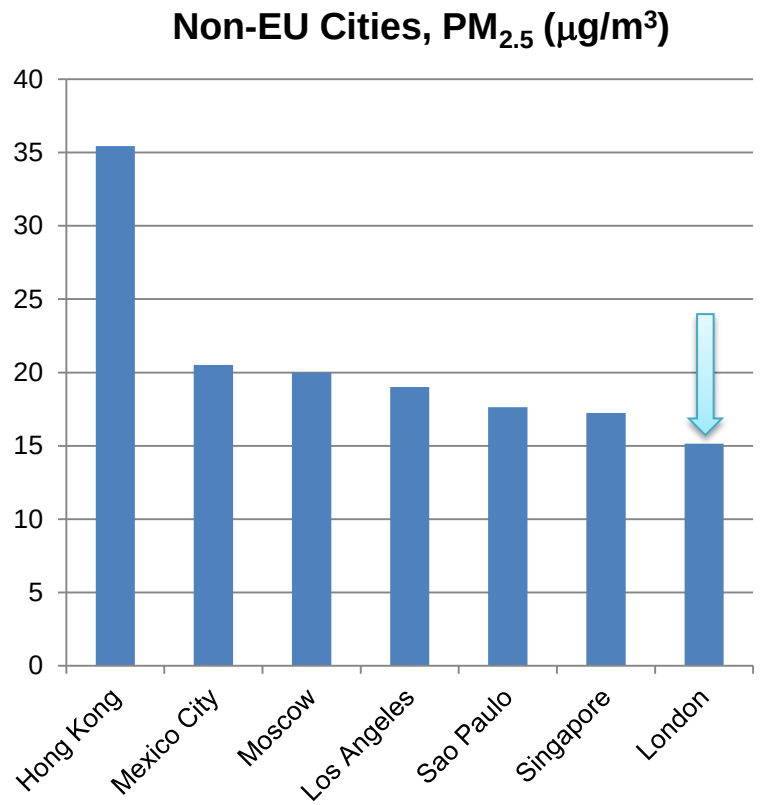
Average of 5 years annual averages (2008-2012)

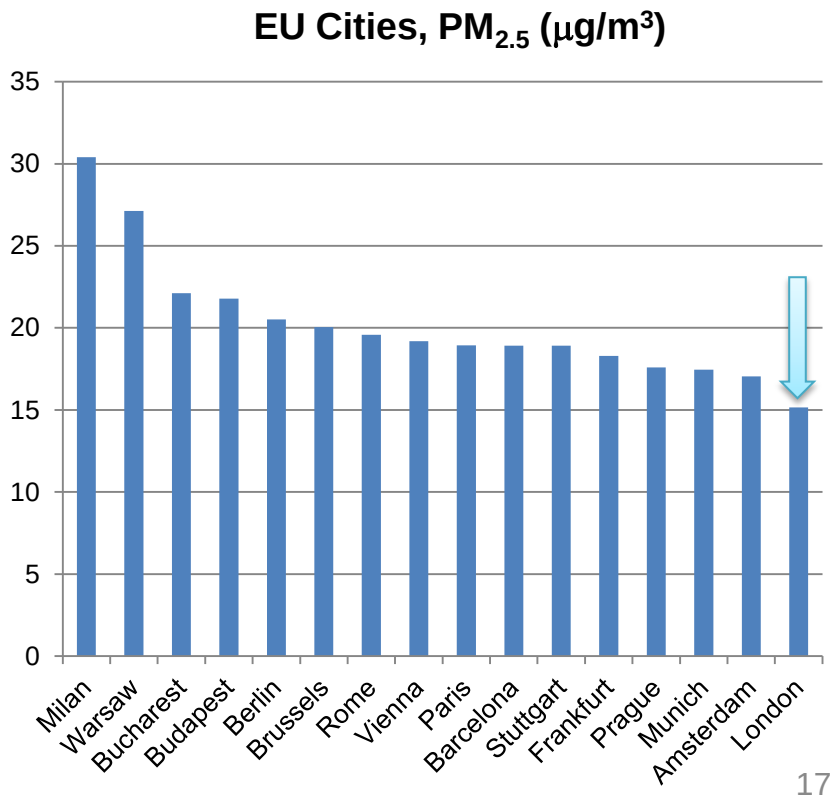
Non-EU City	$PM_{2.5}$ ($\mu g/m^3$)
Cairo	140
Beijing	122
Mumbai	103
Shanghai	81
Mexico City	56
Rio de Janeiro	55
Jakarta	53
Istanbul	53
Hong Kong	48
Los Angeles	39
Sao Paulo	37
Singapore	27
London	**25**

EU City	$PM_{2.5}$ ($\mu g/m^3$)
Milan	44
Bucharest	40
Warsaw	36
Budapest	33
Rome	32
Paris	32
Stuttgart	30
Barcelona	30
Brussels	28
Munich	28
Prague	27
Berlin	27
Vienna	27
Amsterdam	26
London	**25**

Comparison for $PM_{2.5}$

Average of 5 years annual averages (2008-2012)





Comparison for SO_2

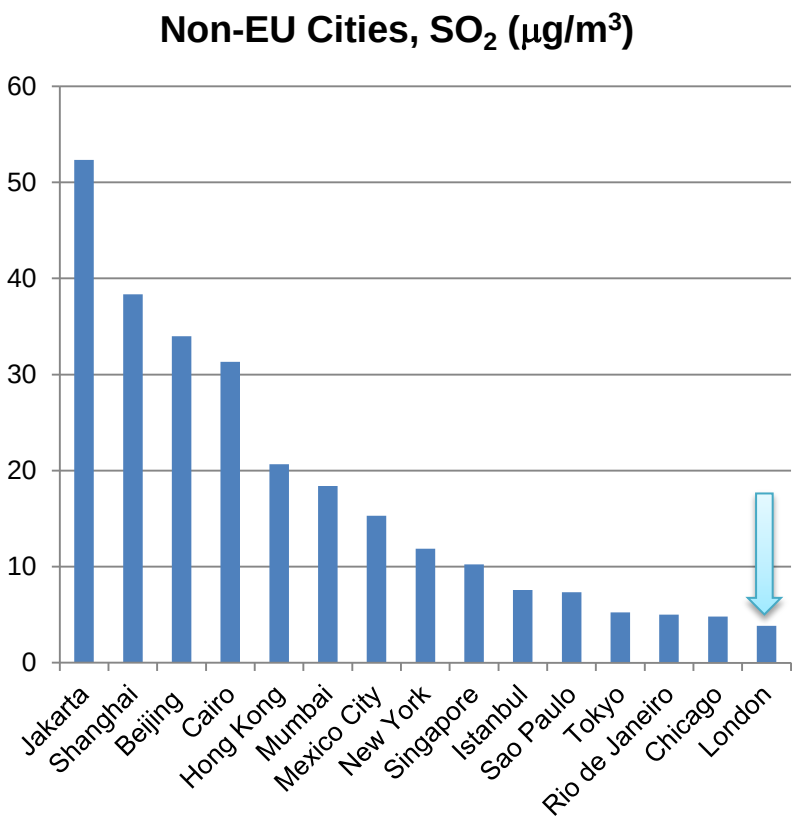
Average of 5 years annual averages (2008-2012)

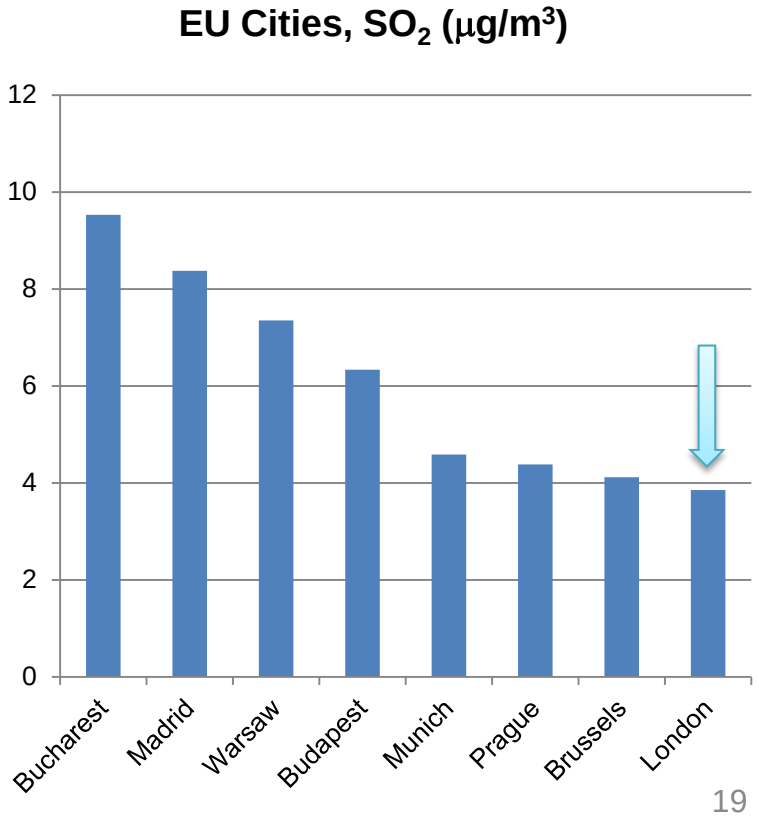
Non-EU City	SO_2 (μg/m³)
Jakarta	52
Shanghai	38
Beijing	34
Cairo	31
Hong Kong	21
Mumbai	18
Mexico City	15
New York	12
Singapore	10
Istanbul	8
Sao Paulo	7
Tokyo	5
Rio de Janeiro	5
Chicago	5
London	**4**

EU City	SO_2 (μg/m³)
Bucharest	10
Madrid	8
Warsaw	7
Budapest	6
Munich	5
Prague	4
Brussels	4
London	**4**

Comparison for SO_2

Average of 5 years annual averages (2008-2012)





About the Air Quality Limits

Limits for annual average NO_2 across the world

- EU: **40** μg/m^3
- US: **101** μg/m^3 (53ppb)

http://www.epa.gov/air/criteria.html

- Chinese API based on daily averages
  - Excellent: up to **80** μg/m^3
  - Good: **81-120** μg/m^3

http://www.mep.gov.cn/

Comparison for NO_2

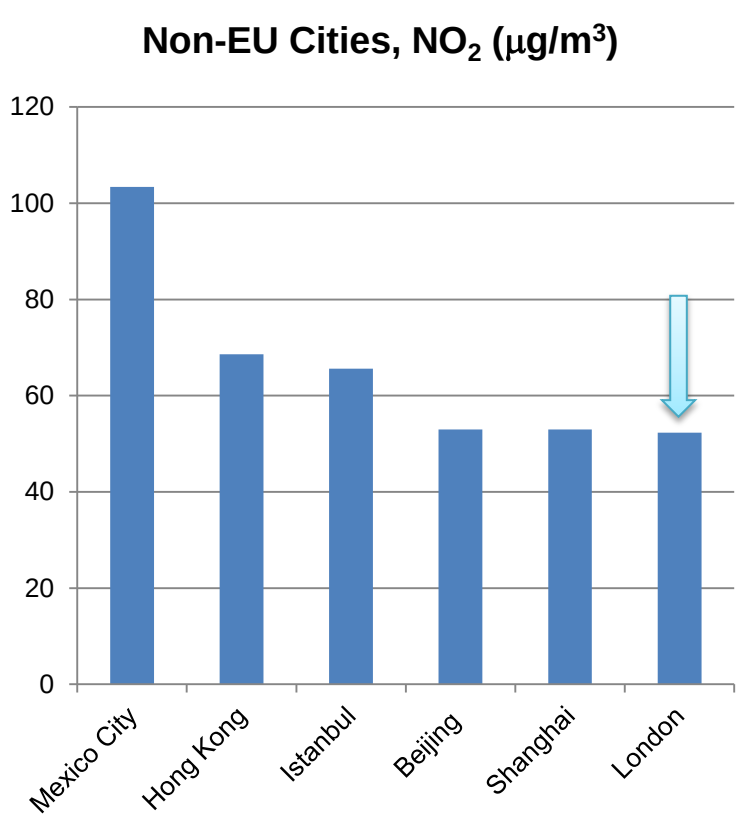
Average of 5 years annual averages (2008-2012)

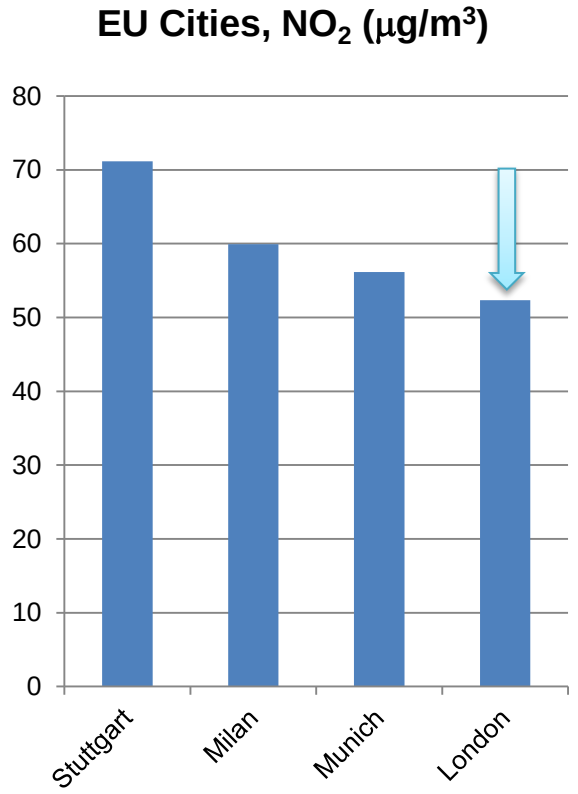
Non-EU City	NO_2 ($\mu g/m^3$)
Mexico City	103
Hong Kong	69
Istanbul	66
Beijing	53
Shanghai	53
London	**52**

EU City	NO_2 ($\mu g/m^3$)
Stuttgart	71
Milan	60
Munich	56
London	**52**

Comparison for NO_2

Average of 5 years annual averages (2008-2012)

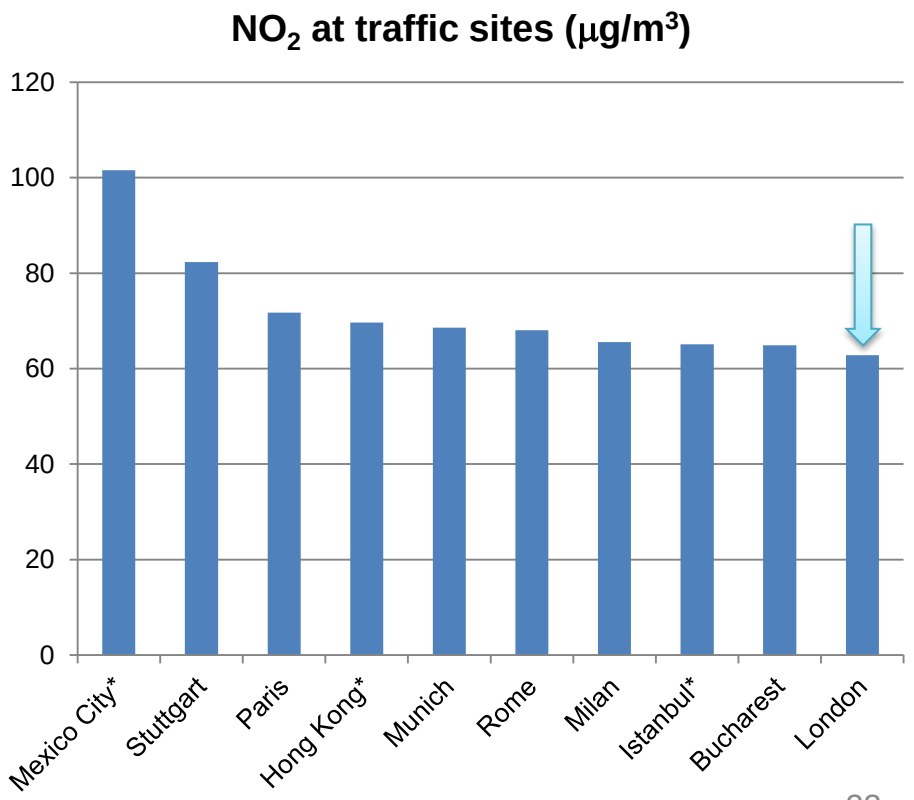




Comparison of London with traffic sites only

Average of 5 years annual averages (2008-2012)

EU City	NO_2 (µg/m³)
Mexico City*	102
Stuttgart	82
Paris	72
Hong Kong*	70
Munich	69
Rome	68
Milan	66
Istanbul*	65
Bucharest	65
London	**63**



*all monitoring stations, not just traffic sites

About the Monitoring Data

About the Monitoring Data: Type

- Monitoring sites can be classified as: Traffic/ Urban Background/Suburban/Rural/Industrial
- **Classifications can vary**, in some cities traffic monitoring sites are at least 10m from the kerb
- Not all countries/cities report the type of the monitoring sites
- Amongst cities reporting site type, London has a high proportion of traffic sites, as do Brussels, Milan, Munich and Stuttgart (but London has by far the greatest number of sites)

About the Monitoring Data: Siting Requirements

- **EU Directive – European Cities Monitoring Programmes**
  - Responsibility of the Member State
  - Purpose is for judging compliance – sites must be representative
- **UK Local Air Quality Management (LAQM)**
  - Responsibility of local government
  - Purpose – can vary, may investigate **hot spots**

About the Monitoring Data: Siting Requirements

- **EU Directive – European Cities Monitoring Programmes**
  - "*Sampling points shall in general be sited in such a way as to avoid measuring very small micro-environments in their immediate vicinity, which means that a sampling point must be sited in such a way that the air sampled is* ***representative of air quality for a street segment no less than 100 m length*** *at traffic-orientated sites*";
  - *"The inlet probe shall not be positioned in the immediate vicinity of sources in order to avoid the direct intake of emissions unmixed with ambient air".*
- **UK Local Air Quality Management (LAQM)**
  - "*The site should not be close to local or point emissions sources, unless these have been specifically targeted for investigation*";
  - "*Try to site the monitors as* ***near to the point of public exposure as possible***".

About the Monitoring Data: Number of Sites

- London has a very large number of automatic monitoring sites: 157
- By comparison, Paris has 32 year-round sites
- In EU cities, there tend to be few monitoring sites other than the official sites for EU reporting – except in London
- In London there are 17 official sites for EU reporting, the remainder (139) have been located by local government
- London has almost 2 monitoring stations per 100,000 habitants, bettered only by Amsterdam and Vancouver
- London has 1 monitoring site per 0.1km^2, bettered only by Barcelona, Brussels and Vancouver

Considering individual sites reported to the EU for compliance

- In 2010 the highest NO_2 concentration was recorded in Florence, followed by a site in Stuttgart, then Munich, then Marylebone Road in London
- In 2011, the sites in Florence and Stuttgart recorded higher concentrations than Marylebone Road.
- In 2013, one site in Paris recorded higher concentrations than Marylebone Road

Concentrations at Marylebone Road have fallen each year from 2009: 107.0 $\mu g/m^3$ >> 98.3 $\mu g/m^3$ >> 97.2 $\mu g/m^3$ >> 94.0 $\mu g/m^3$ >> 80.6 $\mu g/m^3$

Summary

Summary

- It is alleged that London has the worst air quality in the world
  - This is to ignore the many cities with exceedingly high levels of particulate pollution
  - Considering the pollutants of concern in the EU, London has low levels of PM_{10}, $PM_{2.5}$ and SO_2
  - On a citywide basis the NO_2 concentration in London is lower than that in Stuttgart, Milan and Munich (and cities outside the EU)
  - Considering traffic sites only, the NO_2 concentration in London is lower than that in Stuttgart, Paris, Munich, Rome, Milan, Bucharest (and cities outside the EU).
  - London has many more automatic monitoring sites than other EU cities with high quality data and easy, transparent access
  - Many of the monitoring sites have been sited by local government investigating hot spots rather than by Member States looking for representative locations. Note that in some (non-EU) cities traffic sites are at least 10m from the kerb.