Why Air Quality Matters

Understanding Particulate Pollution

Why Is Air Quality Important?

The quality of ambient air impacts every member of society, and measuring air quality has caught the interest of researchers and citizens alike for decades. As a result, plentiful evidence has been gathered showing the negative impacts of air pollution on public health and the cost those impacts have on society. While local air pollution sources are undoubtedly important, air pollution can spread around the globe, impacting people thousands of miles away from the point of emission.

Which Pollutants Are Most Important?

Air quality describes the degree to which the ambient air is polluted. This is assessed by measuring at least one – but often, several – types of pollution. In general, pollutants can be classified as either gaseous or particulate matter. For each of these two categories, the most commonly measured pollutants are listed below:

Gaseous Pollutants

- Ozone (O_3)
- Sulfur dioxide (SO_2)
- Oxides of nitrogen (NOx)
- Carbon monoxide (CO)
- Volatile organic compounds (VOC)

Particulate Pollutants

- Carbonaceous particles
- Non-carbonaceous particles
- Particulate Matter (PM1, PM2.5, PM10)
- Ultrafine particles

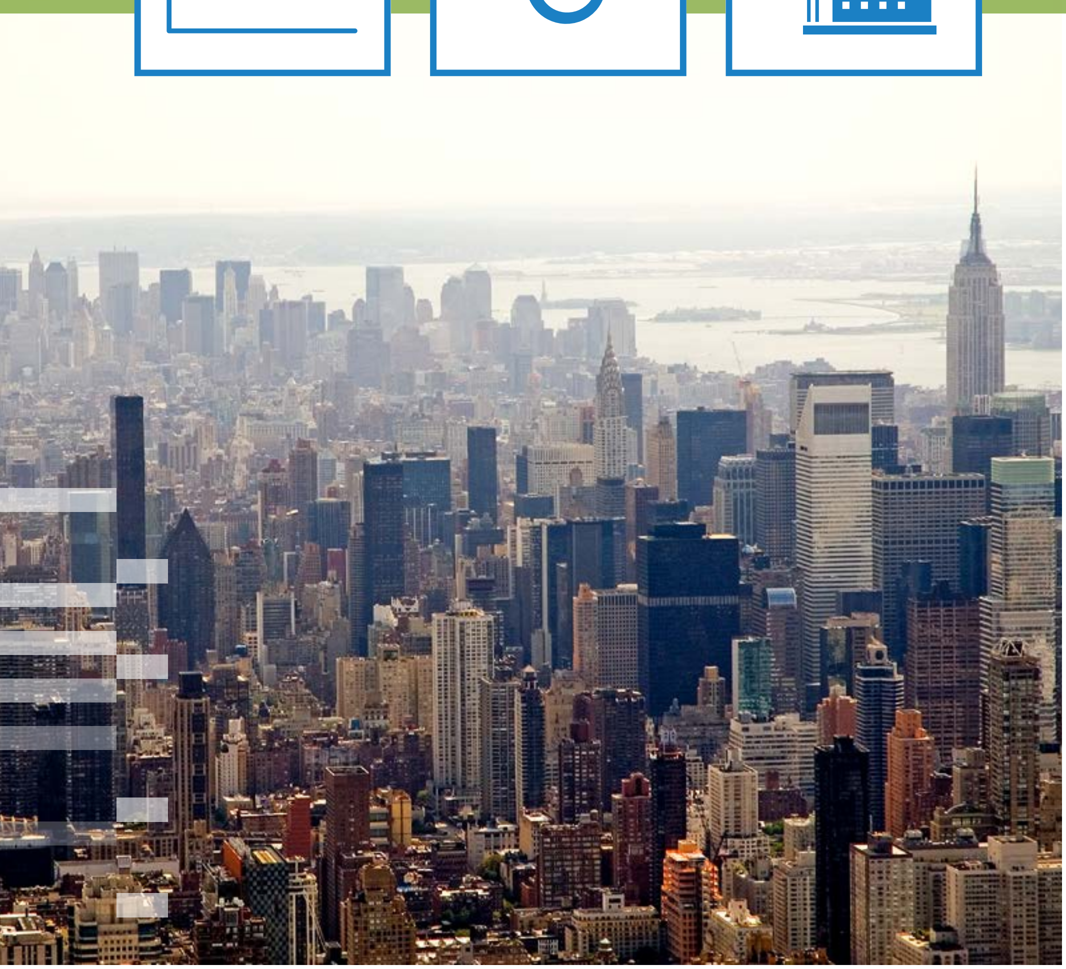
Global View

While all of the gases and particulates previously listed are known to be types of air pollution, different regions of the world prioritize some of these over others. To give a few examples:

- The World Health Organization has suggested guiding values ([1,2]) for fine dust, ozone, and NO_2.
- The EPA (Environmental Protection Agency) in the United States calculates the Air Quality Index (AQI) for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide.
- In China, the National Ambient Air Quality Standard described in GB3095-2012 includes particulate matter (PM2.5, PM10), carbon monoxide, sulfur dioxide, nitrogen dioxide, and ozone.

Cities, districts, states, and countries around the world maintain air monitoring networks for various pollutants according to the pollutants they prioritize. Outside of formal monitoring networks, researchers conduct measurement efforts of their own, measuring concentrations of one or more pollutants for anywhere from a few days up to years at a time.

What Can We Learn From Air Pollution Measurements?



Regional and Long-Range Influence on Air Quality

These measurement efforts, of course, depend on measurement tools that are suited for each pollutant. As technology has advanced, techniques for measuring particulate pollution have become increasingly sophisticated, providing information that simply was not available in years past. This data on airborne particles can be used to assess many things, such as:

- Background pollutant levels for a particular area (i.e., measuring 'the status quo')
- Movement of air pollutants in and out of an area of interest
- The effectiveness of regulations on things like vehicle traffic or fuel quality in use on waterways, and the contributions of local sources such as power plants, harbors and airports

How Is Particulate Pollution Measured?

PM

Mass-Based Measurements

The traditional way of assessing particulate pollutants has been to measure the PM (Particulate Matter), which is defined as the mass concentration of particles in air.

PM is usually expressed as micrograms (of particles) per cubic meter of air. Airborne particles can vary significantly in size – from 1 nm (nanometer) up to 10 µm (micrometer) and beyond – and measurements often focus on only a portion of this range. In the interest of clarity, then, every measurement has to specify the size range to which it applies. For example, PM2.5 indicates the mass concentration of particles that are up to 2.5 µm in size, while PM10 indicates the mass concentration of particles that are up to 10 µm in size.

Mass-based measurement routines have been around for decades, and in fact many regulations across the globe are focused on mass concentrations. Mass-based measurements, however, inherently are focused on larger particles, since they have more mass. More recent research [3] has suggested, however, that exposure to very tiny particles – those which are too small to register very much in a mass measurement – may also pose health risks. Assessing this hazard requires supplementing mass-based measurements with number-based measurements.

PN

Number-Based Measurements

As mentioned previously, particulates can be measured by mass or by number. Particle number measurements count all of the particles, regardless of how big or small each of those particles are. Particle number concentration measurements have been known since the early 1900s and the first commercial continuous condensation particle counter was available in 1978. By paying attention to particle number concentrations (PN), we can gain valuable insights to the quality of ambient air, and can relate the contamination to sources emitting those particles. We can also evaluate the effectiveness of control measures undertaken by municipalities, industrial facilities, or other organizations.

PSD

Particle Size Distribution

Airborne particles are present in a wide size range (~1 nm to ~10 μm). Size distributions of particles can act somewhat like a 'fingerprint' for the source of the particles. Thus, particle size distribution measurements made in a certain location can provide insight into the sources and transport of those particles. Not only can particle size point you backward toward a potential particle source, it can point forward to the health effects of those particles: nano-scale particles are linked to different health effects than micron-scale particles. Lastly, particle size distributions provide important information for people who are designing particle removal systems (such as HVAC filters in homes, or large precipitators that are used to reduce emissions from industrial facilities), because those removal systems perform differently with particles of different sizes. So particle size is important, no matter if you are designing a filter, researching pollutant transport, or simply breathing.

Next Step
How Air Quality is Measured

If you have come to the conclusion that assessing air quality, indoor or outdoor, is a topic into which you want to dig deeper, we invite you to continue reading in our next white paper:
Understanding Particulate Pollution: How Air Quality is Measured.

Learn more at
tsi.com/ambientair

References
1) WHO Air Quality Guidelines, Global Update 2005
2) WHO Health risks of air pollution in Europe – HRAPIE project (2013)
3) Terzano et al. (2010) Air pollution ultrafine particles: Toxicity beyond the lung, European Review for Medical and Pharmacological Sciences, 14:809-821

Knowledge Beyond Measure.

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