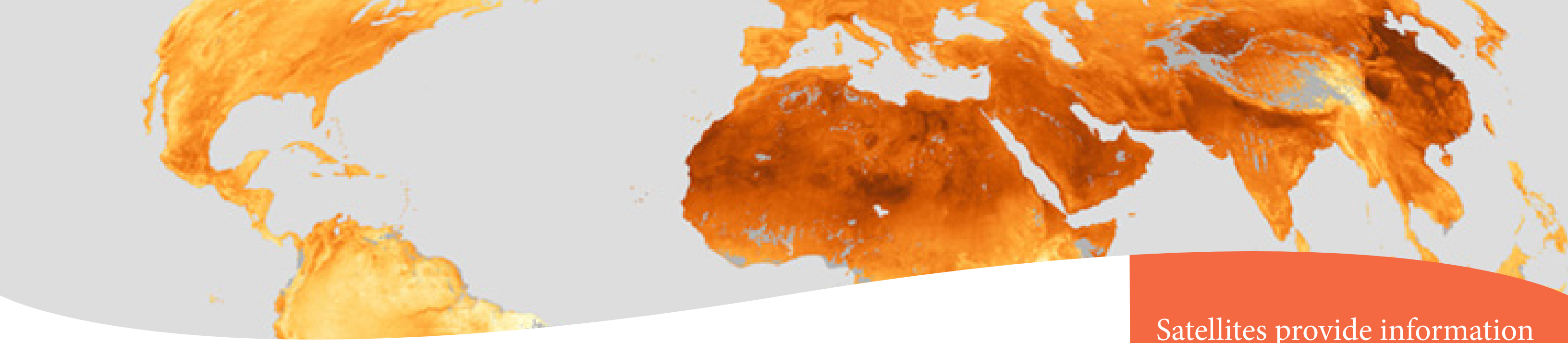
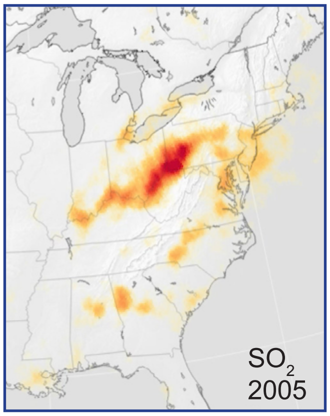


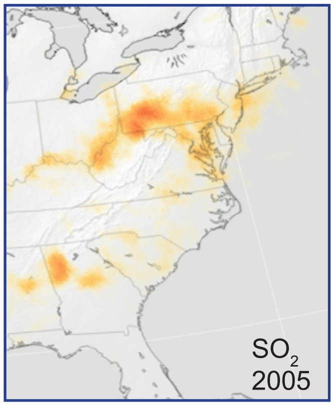
NASA Satellite Data Improves Spatial Coverage of Air Pollutants

Satellite data complement existing air quality research and provide additional information that ground-level research cannot itself provide; by detecting air pollutants from above, satellites can determine air quality over a broader scope and with increased confidence. Such information can provide evidence to support air quality legislation and decrease air-induced mortality.

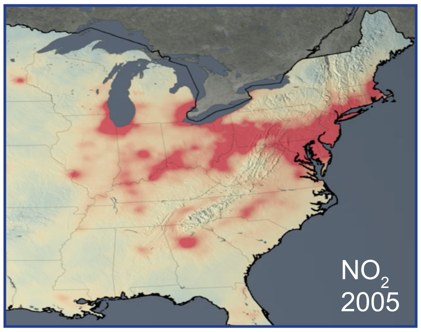


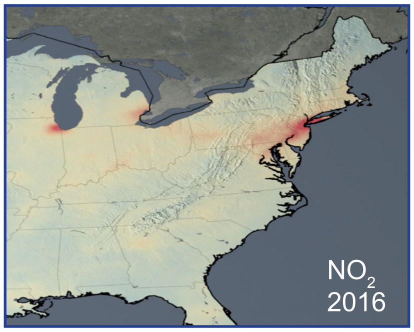
Methods

First used to detect air pollutants in 2004, NASA's Aura satellite now provides daily collections of quality, reliable data and modeling systems at a temporal-spatial level that can assist with decision-making. The spatial coverage afforded by satellite data offers increased statistical power that strengthens inference of the relation between pollutants and health outcomes.



In addition to detecting directly emitted pollutants, such as sulfur dioxide (SO2), satellites can estimate levels of tropospheric ozone forming in the atmosphere. While OMI was not designed to study ground-level ozone, it provides scientists with a global view of a key piece of the equation--nitrogen dioxide (NO2)--a component of nitrogen oxides (NOx). Because nitrogen oxides are a precursor ingredient to ozone, concentrations of NO2 can indicate where high levels of ozone could possibly form. When OMI detects the presence of nitrogen dioxide in the atmosphere, scientists can identify and monitor its sources.





Satellites provide information that ground-level research cannot, including:

- Short-term as well as long-term data,
- Equal and consistent across the U.S. and the world, and
- Tracking of air pollutants as they move from one location to another.

NASA satellite data affirm that harmful atmospheric pollutants in the U.S. have decreased from 2005-2017. During this time period:

- NO_2 has decreased by 40-60%,
- Surface $PM_{2.5}$ has decreased by 30-40%, and
- SO_2 has decreased by as much as 90% over power plants.

Satellite data can be used to:

- Make predictions on future air pollutant concentrations and their locations,
- Determine which regions and communities are in the most need of cleaner air, and
- Understand how past legislation has or has not been successful in improving air quality.

Practical Uses

Data on air pollutant concentrations and movements can help to guide further research and U.S. policies.

Previous studies have utilized satellite data to :

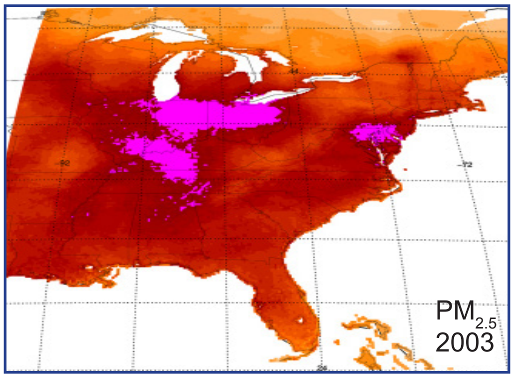
- Constrain the magnitude of air pollutant concentrations and monitor trends regarding the intercontinental transport of pollutants (West et al., 2016),
- Determine levels of PM2.5 exposure for the Global Burden of Disease in 2013 and compare to trends since 1990 at a country level (Brauer et al., 2013), and
- Define correlations with ground-sensing AERONET data and investigate the link between premature mortality and emissions sources in urban and rural environments (Lelieveld et al., 2015).

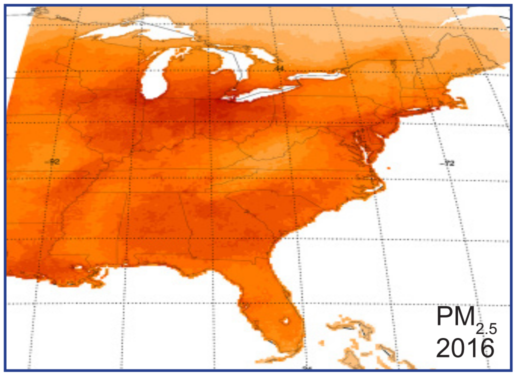
Federal agencies have also begun to incorporate satellite data into standards and recommendations. The EPA has incorporated Aura's OMI data into its National Ambient Air Quality Standards to determine which pollutants are considered harmful to the environment, and the CDC has incorporated the data in order to release recommendations for best health practices given county-level UV exposure information.

Health Impacts

Using satellite data can improve our knowledge of air quality and its associated adverse health impacts. Ambient air quality is still a critical threat to public health worldwide. Pollution is linked to 1 out of every 9 deaths globally, making it a larger environmental health risk than AIDS, tuberculosis, and malaria combined (Landrigan et al., 2017). In the U.S., ambient PM2.5 remains the fifth highest mortality risk factor; just in 2015, it resulted in roughly 88,400 deaths (Cohen et al., 2017).

Economically, the benefits of air pollution mitigation and subsequent public health improvement more than 30 times exceed the associated costs; while the U.S. dedicates roughly $65 billion annually to improve air quality, there is a resulting $2 trillion in benefits from economic production due to reduced premature mortality (US EPA, 2011).





Past studies have incorporated satellite data in order to determine health vulnerabilities within regions of the U.S. One such study detected NO2 exposure in order to assist policy-makers in determining which regions and communities of the U.S. are suffering from the greatest environmental inequalities, ultimately finding that reducing the nitrogen dioxide exposure of minorities to that of white Americans would reduce mortality from coronary heart disease by roughly 7,000 deaths each year (Clark et al., 2014). OMI also tracks formaldehyde (HCHO), allowing researchers to estimate that 6,600-12,500 Americans develop cancer due to outdoor HCHO (Zhu et al., 2017).

Improving air quality can have beneficial results for human health, food security, and the U.S. economy. By utilizing satellite data to monitor and locate air pollutant concentrations, researchers can learn how to improve air quality and provide evidence-based support for air quality improvement policies.
U.S. research and subsequent legislation on air quality have led to improvements in air quality. However, air pollutants are still concentrated enough to harm human health; further emissions reduction policies, as well as increased funding for air quality research, are necessary to ensure well-being and sustainability.