AQAST members use satellite data to tease out ozone patterns in Wisconsin

By Olivia Sanderfoot and Ben Kaldunski
November 25, 2015

Sheboygan County, Wisconsin, shown in red.
Credit: Wikimedia Commons.

If you are looking for your next vacation spot, consider Sheboygan, Wisconsin. This picturesque town, located right on the shore of Lake Michigan, boasts four-star hotels, beautiful beaches, outstanding sailing and fishing, over thirty parks, and a quaint, historic downtown district with many shops and restaurants. Surprisingly, the small, mostly rural county is also the site of one of the state's biggest air quality concerns: ozone pollution.

Ground-level ozone is a serious air pollutant regulated by the U.S. Environmental Protection Agency (EPA). The chemical compound forms when ozone precursors — nitrogen oxides and volatile organic compounds — react in sunlight. High atmospheric concentrations of ozone harm human health by causing respiratory damage and have been linked to premature mortality.

State agencies have the responsibility of designing programs to bring counties into compliance with air quality standards set by the EPA. Ozone formation is affected by numerous factors, including the source of ozone precursors, wind patterns, weather, and climate. Sheboygan County, for example, is subject to emissions transport from upwind sources including those in Chicago and the Ohio River Valley. Ozone concentrations can be especially high right along the Lake Michigan shoreline due to a phenomenon referred to in the air quality community as "the lake breeze effect." Given this complexity, pinpointing which emission reduction strategies will lower ambient ozone concentrations can be challenging.

"There is a need for better understanding of ozone chemistry," says Dr. Angela Dickens, an air policy analyst with the Wisconsin Department of Natural Resources (DNR) and Lake Michigan Air Directors Consortium (LADCO). Dickens points out that this is especially important following the EPA's revision of the ozone National Ambient Air Quality Standard (NAAQS) on October 1st, 2015. The EPA lowered the daily maximum 8-hour ozone concentration from 75 parts per billion to 70 parts per billion. As a result of this amendment, more counties are likely to be classified as non-attainment, challenging environmental managers to come up with new strategies for controlling emissions of ozone precursors.

Dickens is working with members of the National Aeronautics and Space Administration (NASA) Air Quality Applied Sciences Team (AQAST) to tease out ozone patterns in Wisconsin. She is especially interested in analyzing the persistently high levels of ozone in Sheboygan County.

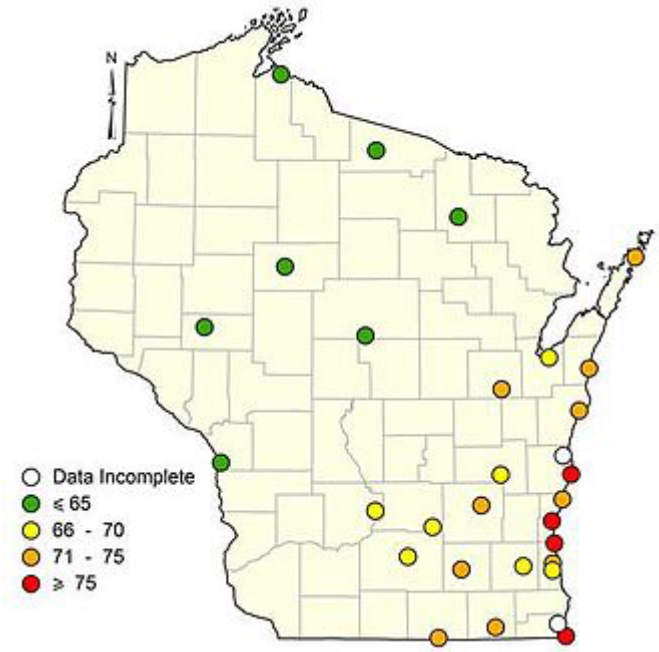
AQAST researchers have employed satellite data to study the sources, sinks, and transport of ozone in Sheboygan and throughout the state of Wisconsin. AQAST member Brad Pierce, from the National Oceanic and Atmospheric Administration (NOAA), has improved modeling of the lake breeze effect over Lake Michigan, which Dickens says is the root cause of many of Wisconsin's worst ozone episodes. A study conducted by AQAST member Arlene Fiore, a professor at Columbia University, also confirmed that more ozone is transported to Wisconsin from other U.S. states than is produced from in-state emissions. Dickens says the DNR may be able to use that information to demonstrate how emissions transport is preventing parts of Wisconsin, such as Sheboygan County, from complying with the ozone standard. Wisconsin DNR and LADCO modelers are currently working with researchers to develop improved, fine-resolution modeling of ambient ozone concentrations in Wisconsin to gain further insight into air quality trends along the eastern edge of the state.

Dickens says that working with AQAST researchers to tackle Wisconsin's ozone problem has been incredibly helpful. "With limited resources, it has been great to have access to AQAST," she says. "It's very useful to be able to pick the brain of someone working in a different area of expertise."

Wisconsin's effective engagement with AQAST is not surprising. AQAST member and deputy leader Dr. Tracey Holloway, a professor at the University of Wisconsin–Madison, has worked with the Wisconsin DNR since the launch of AQAST, and Bart Sponseller, Deputy Administrator of the DNR's Environmental Management Division, is a co-investigator on Holloway's AQAST research grant.

Someday, Dickens would like to see satellite data used in a regulatory context. She says that given the limited number of monitors for ozone precursors in Wisconsin, satellite data could prove to be an efficient and cost-effective way to measure ground-level air pollutant concentrations. “The vertical resolution isn’t quite fine enough for us to use right now,” she says, but new analysis techniques and next-generation satellites could open the door for broader use of space-based data. Holloway hopes that by the time better data are available, there will be a regulatory framework in place to allow the DNR to use those tools.

Holloway believes AQAST’s work will help the Wisconsin DNR and other state agencies use satellite data to improve air quality management, especially in communities like Sheboygan, Wisconsin that suffer disproportionately from air pollution. AQAST researchers have already used satellite data to help DNR air policy analysts like Dr. Angela Dickens prove that high levels of ozone in Sheboygan County are not due to high emissions within its borders, but rather the result of interstate ozone transport coupled with complex atmospheric processes. This is an important step toward improving air quality in the region while supporting the businesses, shops, and restaurants that make Sheboygan such a wonderful lakeside vacation spot.



This map shows counties in the state of Wisconsin that are at risk of failing the ozone NAAQS based on 2012-2014 “design values.” These values are compared to the NAAQS to determine whether or not a county is in compliance with the standard. Ozone design values are calculated by averaging the fourth highest daily maximum 8-hour ozone concentration over three years. Each color in the key represents a range of design values, measured in parts per billion. Counties shown in red are most likely to fall out of attainment. Credit: Angela Dickens.