Recent Advances in Understanding Ozone Pollution Near Large Water Bodies

The four studies highlighted in this issue of *EM* exemplify inter-agency and inter-state cooperative efforts to advance scientific understanding of air pollution near the land–water interface.
The interplay between emissions and meteorology near large water bodies requires in-depth technical analysis. Research has shown that high ozone (O$_3$) concentrations can form over water and affect both nearby and more distant coastal areas, and that high-resolution air quality models are needed to represent local conditions more accurately.$^{1,2}$ Though major regional and local reductions in O$_3$ precursors have significantly improved air quality in the eastern United States, episodic high O$_3$ events persist, particularly over large bodies of water and adjacent coastal areas, contributing to violations of the federal O$_3$ standard. Motivating the four studies described in this issue were questions about the relative importance of emissions from nearby industrial or urban centers versus more distant sources of air pollution, the potential to use advanced monitoring techniques to better understand pollution episodes, and the importance of improving the ability of air quality models to simulate the fine-scale dynamics of the land–water interface. Scientists continue to stress the importance of measuring O$_3$ aloft (as was done in studies described here) to help resolve questions about local and long-distance transport of O$_3$ and precursor pollutants.$^3$

The U.S. Environmental Protection Agency (EPA) has recognized the value of short-term special studies, such as those described in this issue. When EPA adopted the 70 parts per billion (ppb) 8-hr O$_3$ National Ambient Air Quality Standard (NAAQS) in 2015, the agency also substantially revised the requirements for enhanced monitoring plans for O$_3$ and its precursors. To help states develop plans to comply with new monitoring requirements, in 2017 EPA published a “Technical Note”$^4$ describing optional long-term monitoring methods, but also encouraging states to work collaboratively with other agencies to conduct short-term intensive monitoring campaigns if needed to help understand the formation of ozone in their particular areas. The results of special studies like these, along with other analytical techniques and information, can help air quality managers develop effective pollution control measures.

The first study included in this issue focuses on the complex atmospheric chemistry and physics of Long Island Sound. High amounts of O$_3$ precursors from the New York City metropolitan area and areas upwind are transported over the Sound, where weak mixing allows intense O$_3$ concentrations to form. Then, an afternoon sea breeze transports the high O$_3$ onshore in coastal Connecticut. As a result, the highest O$_3$ levels in the region consistently are not seen in New York City itself, but downwind along coastal Connecticut. Alexandra Karambelas’s article describes the context for the 2018 Long Island Sound Tropospheric Ozone Study (LISTOS). She also looks ahead to how these data will be used in modeling to better understand and develop controls to reduce O$_3$ pollution.

The next article focuses on the Baltimore area, which has made steady progress toward attaining the EPA O$_3$ standards in part due to targeted regional emissions reductions efforts such as the oxides of nitrogen (NO$_x$) SIP Call and also due to Maryland regulations and the state’s Healthy Air Act. However, episodes of high O$_3$ over and near the Chesapeake Bay have kept the Baltimore area from attaining the 2015 ozone standard. Sites northeast of Baltimore and adjacent to the northern coast of the Chesapeake Bay continue to be the highest reading O$_3$ monitors in the area, despite improvements in other parts of the region. NASA’s Ozone Water–Land Environmental Transition Study (OWLETS) intensive monitoring programs focused on the Chesapeake Bay region, integrating in-situ and remotely sensed data from ground, water, air, and satellite platforms. The article in this issue by John T. Sullivan and colleagues describes the 2018 OWLETS-2 campaign. The highlights

**Figure 1.** Long Island Sound (July 28, 2019). Strong temperature gradients between the land and water on July 28, 2019, force a line of clouds along Long Island, while keeping the Long Island and Connecticut coastlines along the Long Island Sound cloud free. Every single coastal Connecticut O$_3$ monitor exceeded 70 ppb on this day, along with a New York monitor on the northern coast of Long Island.

*Source: True color imagery from VIIRS instrument on the Suomi NPP satellite. NOAA JSTAR Mapper (https://www.star.nesdis.noaa.gov/jpss/mapper).*
presented in this article exemplify a special study integrated into an Enhanced Monitoring Program implemented by the state to assess the formation and transport of pollution over and near the Chesapeake Bay.

Next, the article by Zac Adelman and colleagues describes the 2017 Lake Michigan Ozone Study (LMOS), an important addition to ongoing efforts to better understand the formation and transport of \( \text{O}_3 \) across and along Lake Michigan. Despite many years of air quality improvements, persistent air quality problems in meeting newer NAAQS remain. The questions addressed in this study included the relative importance of local and interstate pollution sources, the importance of \( \text{NO}_X \) and volatile organic compound (VOC) precursors, and how well air quality models represented atmospheric chemistry in the Lake Michigan region. Contributions to \( \text{O}_3 \) problems were traced to both anthropogenic and natural sources, and the study documented how and when the importance of VOC and \( \text{NO}_X \) sources varied.

Finally, the article by Anne M. Thompson and colleagues takes us to the Gulf of Mexico where NASA and the Bureau of Ocean Energy Management conducted the Satellite Coastal and Oceanic Atmospheric Pollution Experiment (SCOAPE) to assess the utility of satellite data to help assess the impact of expanded offshore oil and gas development. Satellite measurements of total column pollutants were compared to surface measurements taken at oil and gas platforms and onboard the University of Southern Mississippi’s Research Vessel.

In next month’s issue...

**Background Ozone**

Air pollution regulators use “background ozone” to describe ozone originating from sources outside of their control. In the United States, background ozone has been defined as originating from transport of ozone from the stratosphere, ozone formed from natural precursor sources (lightning, fires, biogenic sources, etc.), and ozone formed from international anthropogenic precursors. Quantifying background ozone is complicated by the fact that many emissions sources are impacted by both anthropogenic and natural processes. The November issue explores the current state of understanding regarding background ozone.
The conditions of their May 2019 sampling, O₃ levels were higher closer to shore, influenced by the New Orleans–Baton Rouge region, than over the Gulf.

Each of these multi-agency collaborative studies yielded information about micro meteorology, pollution transport, and the impacts of local and distant sources on air quality above and near large bodies of water.

References


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