Ozone threat from climate change

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UD's Cristina Archer is a professor in the College of Earth, Ocean and Environment, with a joint appointment between the Physical Ocean Science and Engineering (POSE) program of the School of Marine Science and Policy and the Department of Geography. Credit: University of Delaware

Increasing temperatures due to climate change will shift climatic conditions, resulting in worse air quality by increasing the number of

days with high concentrations of ozone, according to a new journal article on air quality throughout the Mid-Atlantic region from researchers at the University of Delaware's College of Earth, Ocean and Environment(CEOE).

Cristina Archer led a team from CEOE as the members compiled nearly 50 years' worth of data from Delaware Department of Natural Resources and Environmental Control (DNREC) air monitoring and climate models to analyze climatic trends. They found that rising temperatures will increase the number of days in a year where ozone levels in Earth's lower atmosphere become dangerous.

Archer said DNREC, which funded her study, is concerned with near-ground ozone levels for two main reasons: impacts on human health and compliance with federal and state regulations limiting high-ozone concentrations.

"Ozone has large negative impacts on health, especially affecting the cardiopulmonary and respiratory systems," Archer said. "It is especially bad if you already have a respiratory condition, asthma, for example, or an infection. In Delaware, we are barely in attainment or slightly in non-attainment (of ozone regulations). When we are not in attainment, the Environmental Protection Agency has to act. That is the relevance. That is why we need to know now there is a problem, so we can act on it."

The study, titled "Global Warming Will Aggravate Ozone Pollution in the U.S. Mid-Atlantic," was recently published in the *Journal of Applied Meteorology and Climatology*.

Archer is a professor in CEOE with a joint appointment between the Physical Ocean Science and Engineering (POSE) program of the School of Marine Science and Policy and the Department of Geography. Collaborators in the research and writing were Sara Rauscher, an

associate professor in the Department of Geography, and Joseph Brodie, a former graduate student and postdoctoral researcher at CEOE who is currently director of atmospheric research at the Rutgers University Center for Ocean Observing Leadership.

Ozone in the upper atmosphere is beneficial for blocking harmful ultraviolet (UV) rays from the sun. However, ozone closer to the surface of the Earth—the focus of the study—can lead to pulmonary complications among the population. Near-ground ozone can lead to coughing, irritation of the throat and chest, exacerbation of asthma, inflammation of lung cells, aggravation of chronic lung diseases, and ozone even reduces the disease-fighting capabilities of the immune system. On days where ozone levels are high enough, prolonged exposure can even lead to permanent lung damage. Ozone is regulated as a pollutant by the EPA because of ozone's hazardous nature.

Near-ground ozone forms as a result of photochemical reactions between nitrogen oxides (NOx) and volatile organic compounds (VOCs). Intense UV rays from the sun are the catalyst for the reactions between NOx emissions and the VOCs. NOx emissions occur when cars or power plants burn fossil fuels such as coal and gasoline. VOCs are also man-made and derive from a variety of sources, including cars and gasoline-burning engines, paints, insecticides, cleaners, industrial solvents, and chemical manufacturing.

According to Archer, limiting ozone is difficult because it is a secondary pollutant.

"There are primary pollutants that are emitted and there are secondary pollutants that form in the air," said Archer. "Ozone is one of these [secondary pollutants]. You can't go to a smokestack and measure the ozone coming out. You'll get precursors or other compounds that form it but never ozone itself."

Most of the time, near-ground ozone is not an issue for Delaware. As outlined in Archer's paper, during the 1980s the average number of high-ozone days in Delaware was about 75, whereas by 2015 it was less than 20, decreasing by about two days every year due to stricter air quality regulations.

However, the team of researchers found that increasing temperatures due to climate change are threatening to reverse the decrease in near-ground ozone pollution and increase the number of days where surface ozone levels become dangerous.

Conditions that lead to high-ozone days are typical of hot summer days.

As global temperatures increase, summers will continue to get hotter and will lead to more days with high ozone concentrations. Archer also stated that more high-ozone days could also occur during the fall and spring, since increasing global temperatures will make those seasons warmer on average. According to the Intergovernmental Panel for Climate Change, global temperatures have increased by one degree Celsius as of 2019 and will increase by another one degree Celsius by the end of the 21st century. Archer also said high-ozone days themselves may become more intense due to increased ozone concentrations.

The increase in the number and intensity of high-ozone days is troubling because the adverse health effects impact anyone who spends ample time outdoors, including children and people who exercise outside. More people go outside more often during the summer, potentially increasing human exposure to dangerous levels of near-ground ozone.

In the article, Archer said that a "business as usual" approach will inevitably lead to a dangerous increase in high-ozone days. Archer said that the country needs stricter regulations if it is to limit the number of high-ozone days.

More information: Cristina L. Archer et al. Global Warming Will Aggravate Ozone Pollution in the U.S. Mid-Atlantic, *Journal of Applied Meteorology and Climatology* (2019). DOI: 10.1175/JAMC-D-18-0263.1

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