Researchers find link between climate change, ozone loss and possible increase in skin cancer incidence

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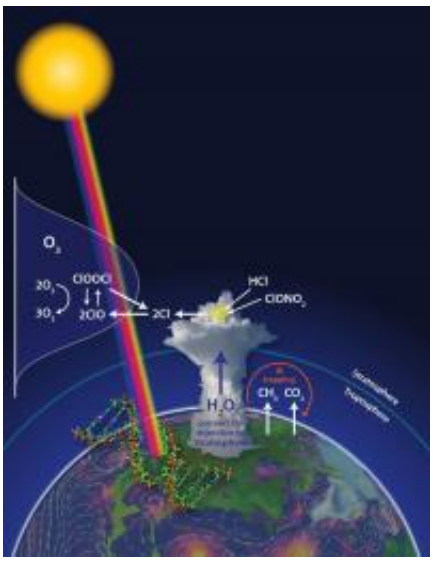

Graphical depiction of the photochemical reactions linking the convective injection of water vapor into the summer lower stratosphere over the United States to the catalytic removal of ozone. Ozone absorbs UV radiation from the sun that damages the structure of DNA. Image courtesy of Robert Stanhope, Anderson group, Harvard University

For decades, scientists have known that the effects of global climate change could have a potentially devastating impact across the globe, but Harvard researchers say there is now evidence that it may also have a dramatic impact on public health.

As reported in a paper published in the July 27 issue of *Science*, a team of researchers led by James G. Anderson, the Philip S. Weld Professor of Atmospheric Chemistry, are warning that a newly-discovered connection between climate change and depletion of the ozone layer over the U.S. could allow more damaging ultraviolet (UV) radiation to reach the Earth's surface, leading to increased incidence of skin cancer.

In the system described by Anderson and his team, water vapor injected into the stratosphere by powerful thunderstorms converts stable forms of chlorine and bromine into free radicals capable of transforming ozone molecules into oxygen. Recent studies have suggested that the number and intensity of such storms are linked to climate changes, Anderson said, which could in turn lead to increased ozone loss and greater levels of harmful UV radiation reaching the Earth's surface, and potentially higher rates of skin cancer.

"If you were to ask me where this fits into the spectrum of things I worry about, right now it's at the top of the list," Anderson said. "What this research does is connect, for the first time, climate change with ozone depletion, and ozone loss is directly tied to increases in skin cancer incidence, because more ultraviolet radiation is penetrating the atmosphere."

Unfortunately, Anderson said, we don't know how this process will evolve over time.

"We don't know what the development of this has been – we don't have measurements of this deep convective injection of water into the stratosphere that go back in time," Anderson said.

"But the best guide for the evolution of this is to look at the research that connects climate change with severe storm intensity and frequency, and it's clear that there is a developing scientific case that the addition of

carbon dioxide to the atmosphere is increasing climate change, and in turn driving severe storm intensity and frequency."

While it's impossible to know how many skin cancer cases may be related to ozone depletion over the U.S., the link between ozone loss and increased incidence of the disease has been extensively studied, Anderson said.

"There has been a major effort by the medical community to define the relationship between decreases in ozone and the subsequent increases in skin cancer," he said. "The answer is quite clear – if you multiply the fractional decrease in ozone protection by about three, you get the increase in skin cancer incidence. There are 1 million new skin cancer cases in the U.S. annually – it's the most common form of cancer, and it's one that's increasing in spite of all the medical research devoted to it."

But it isn't only humans who have to worry about the effects of increased UV radiation.

Many crops, particularly staple crops grown for human consumption – such as wheat, soybeans and corn – could suffer damage to their DNA, Anderson said.

Ironically, Anderson said, the discovery that climate change might be driving ozone loss happened virtually by accident.

Though they had worked since the mid-1980s to investigate ozone depletion in the Arctic and Antarctic, by the early-2000s, Anderson's team had turned their attention to climate studies. In particular, they were working to understand how the convective clouds – updrafts that cause storms to build high into the sky – contribute to the creation of cirrus clouds.

"It was in the process of looking at that mechanism that we came to this unexpected observation – that the convective clouds in these storm systems over the U.S. are reaching far deeper into the stratosphere that we ever expected," Anderson said.

While earlier tests performed in the Arctic had demonstrated that water vapor was a key component in creating the "free-radical" compounds that break down ozone, Anderson said the latest finding is much more troubling, because it suggests the process can happen at much higher temperatures than initially suspected.

"The bottom line is that if you increase the water vapor concentration, you actually increase the threshold temperature for executing this chemical conversion – from the stable forms of chlorine to the free radical form," Anderson said. "If the amount of water vapor and the temperature over the U.S. satisfies the conditions for rapid conversion of inorganic chlorine to this free-radical form, we've got a real problem, because the chemistry is identical to what we previously demonstrated is taking place over the Arctic."

Also surprising, he added, was the realization that, to throw water vapor high into the atmosphere, storms needn't be unusually large.

"We have hundreds of measurements world-wide addressing the photochemical structure controlling ozone, but only a limited number of flights over the U.S. in summer," he said. "The flights were studying average storms over the middle-west, and of the 20 observations we made over the U.S., about half demonstrated significant penetration into the stratosphere," he said.

The next step in the research, Anderson said, is to conduct a series of tests to confirm whether the free-radical form of chlorine and bromine are present in the stratosphere at significantly elevated levels in the

presence of convectively-injected water vapor.

"In my mind, this is not just a broad public health issue," Anderson said. "This is about actually being able to step out into the sunlight – it's about your children and your children's health. Of course, we don't know how rapidly the frequency and intensity of these storms will increase, so we can't place a time scale on this problem, but the core issue here is quite straightforward and simple, because we understand this chemistry."

More information: "UV Dosage Levels in Summer: Increased Risk of Ozone Loss From Convectively Injected Water Vapor," by J.G. Anderson, *Science*, 2012.

Provided by Harvard University