Mountainous Plateau Creates Ozone Halo Around Tibet

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Not only is the air around the world's highest mountains thin, but it's thick with ozone, says a new study from University of Toronto researchers.

In fact, say the scientists, the ring of ozone that exists around the Tibetan plateau, which rises 4,000 metres above sea level and includes such famous peaks as Mount Everest and K2, is as concentrated as the ozone found in heavily polluted cities -- and may put climbers at risk. The findings are published in the journal Geophysical Research Letters.

"Around the circumference of Tibet, there's a halo of very high levels of ozone," said Professor G.W. Kent Moore, interim chair of the Department of Chemical and Physical Sciences at the University of Toronto at Mississauga and lead author of the study.

Study co-author John Semple, an associate professor of surgery and an avid mountaineer, was initially interested in how weather changes at high altitude can have a medical impact on climbers. Along with Moore, he examined earlier data and found several studies that alluded to higher ozone levels. Ozone is a highly reactive gas that can cause coughing, chest pain and damage to the lining of the lungs.

"In meteorology, it's a fairly well known phenomenon that when you get storms, quite often the tropopause -- which is the flexible boundary between the stratosphere and the troposphere -- descends," Moore says.

"Its usual height might be 12 kilometres, and it might decend to nine or 10 kilometres. If you're on Mount Everest, you're eight or nine kilometres up. It might be that you're sometimes in the stratosphere."

The stratosphere is where most of the ozone that protects the globe from the sun's ultraviolet rays can be found;for this reason stratospheric ozone is often referred to as "good" as opposed to the ground-level ozone from pollution which is referred to as "bad". When the tropopause decends, the ozone descends with it.

"Most people think about the mountains as one of the areas you can go to get clean air," said Semple, head of the Division of Plastic Surgery at Sunnybrook and Women's College Health Sciences Centre, a teaching hospital affiliated with U of T. "It may be that when you're up high in the mountains that the good ozone actually becomes bad ozone - because no matter where ozone comes from you don't want to breathe it."

Semple climbed the Yeli Pass in Bhutan in the autumn of 2004 while collecting data on weather and atmospheric changes. He measured the levels of ozone between 3,000 and 5,000 metres above sea level and discovered that instead of falling (as pollutant levels normally do with altitude), ozone levels were rising.

Moore examined satellite measurements of the ozone levels above the plateau during October and November of the years 1997 to 2004. He found that while ozone levels were low over the centre of the Tibetan plateau, high levels of the gas could be found around the periphery of the plateau -- forming a halo.

Moore believes that the halo is the result of a pattern in fluid dynamics known as a Taylor column -- a phenomenon that is normally seen underwater. When water passes around a submerged obstacle, like a seamount, the flow of water forks around the obstacle. This forked

pattern also continues above the top of the obstruction to the surface of the water, leaving a column of still water above the object.

Scientists treat air as a fluid, and Moore says that the Tibetan plateau acts like an obstacle, creating a column of stagnant air above the mountainous region. Because the plateau's influence extends into the upper troposphere and the lower stratosphere -- where the Earth's layer of UV-protectant ozone resides, Moore suggests that the plateau forms a halo of ozone-rich air in the upper-troposphere around Tibet. "As far as we know, this is the first one that's ever been found in the atmosphere," he says.

The ozone concentrations measured in this study are still considered quite low in relation to levels that are known to cause significant changes in lung function at sea level. The presence of such higher levels of ozone at extreme altitudes may add to the medical dangers faced by mountaineers.

"We can only imagine that hypoxia [lack of oxygen] and the rate of hyperventilation that people have at extreme altitudes would actually make the effects of ozone worse," Semple says. "You probably need less ozone to cause a significant change in the lungs."

Source: University of Toronto