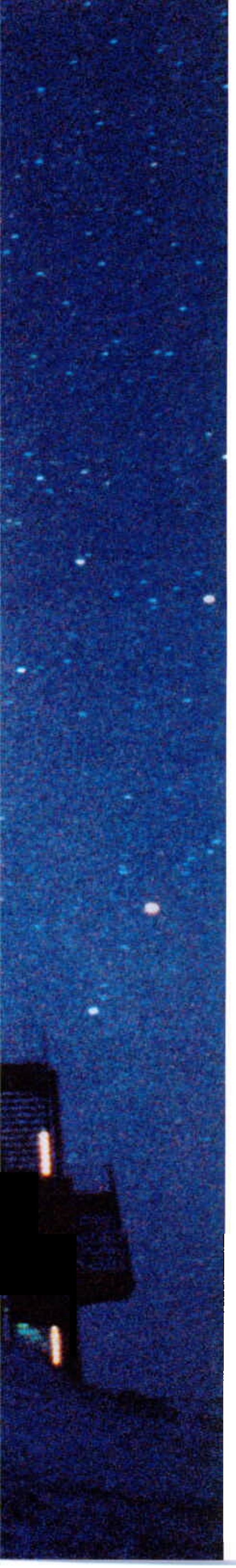
OZONE

Research in the High Arctic: *the Hole Story*

By Matt Bassford

Lidar & Aurora over the Arctic Stratospheric Ozone Observatory, Eureka, Nunavut.



It sometimes seems as if Mother Nature is losing her marbles. While Arctic ice caps are melting at an alarming rate, there was summertime snow in Calgary and Vancouver is partway through its wettest year on record. And then there are all those worrying news stories reporting that man-made pollution is making Swiss cheese of the ozone layer. Is our climate really changing or is all the fuss just a storm in a teacup? It is in an attempt to answer this question that roving research scientists visit Eureka, Nunavut, high above the Arctic Circle.

On top of a mountain ridge near Slidre Fjord on Ellesmere Island sits a squat red building loaded with state-of-the-art equipment developed to monitor atmospheric gases. This building is the Arctic Stratospheric Ozone Observatory (ASTRO). ASTRO was built by Environment Canada in response to concerns that the fragile ozone layer above the Canadian Arctic was in jeopardy. Ozone is naturally present in our atmosphere - mostly at altitudes between 20 and 25 km - and protects us from harmful solar rays like a giant sunshade. Although the ozone layer is very thin (a flimsy 3 mm if concentrated in a single band at ground level), it is very effective at filtering out this dangerous radiation. If our ozone shield is depleted, then damaging rays from the sun can reach the Earth's surface, causing skin cancer in humans and threatening sensitive eco-systems. The prime culprits for ozone destruction are a group of ozone-eating gases called CFCs (chlorofluorocarbons to give them their full name). To limit damage to our natural sunshade, the manufacture of CFCs was capped in the late 1980s. In developed countries like Europe and North America, CFC production was banned in 1996, although they continue to escape into the atmosphere from leaky air-conditioners and refrigerators.

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I asked Dr. Hans Fast of Environment Canada what kind of shape the ozone layer is in. Unfortunately, his diagnosis was not good news. Dr. Fast (who manages the ASTRO research station at Eureka) told me that over the last ten years, the overall amount of ozone over Canada's Arctic region has decreased by about 10 %, with short-term losses as large as 45 % occurring at specific times and locations. He then explained the rationale behind the research at Eureka. "Ozone, and the gases that control its concentration are important to measure" elucidated Dr. Fast "in order to determine how well we understand what is happening in the atmosphere. We need to check the accuracy of the complex computer simulations that are used to predict the degree and extent of ozone depletion. Only by continuing to monitor ozone and these other gases will it be possible to assess the effectiveness of the worldwide bans on ozone-destroying substances." In other words, we need to figure out just what is happening 22 km above our heads, and whether the health of the ozone layer is going to improve or get worse.

As a research scientist working at the University of Toronto, one of the most interesting and challenging parts of my job is the chance to travel to Eureka and join the investigation into ozone destruction. I made the long journey north last March, flying from Toronto via Ottawa and onto Resolute before boarding a Twin-Otter aircraft for the final leg. Amongst the mail, food and other supplies for those people hardy enough to work at Eureka, I found space to sit on the plane dubbed the 'workhorse of the Arctic'. I then came to a dawning realization that maybe that last cup of coffee in Resolute had not been such a good idea. My first experience of flying on an airplane with no washroom. My next important lesson in Arctic life came two and a half hours later, shortly after I leapt off the plane and onto the snowy airstrip at Eureka. Never stand still outdoors or your extremities begin to freeze up! I vividly remember just standing there awestruck at the landscape that greeted me on Ellesmere Island. There were craggy mountains on three sides of me and frozen into the ocean inlet that faced me were an assortment of ghostly looking icebergs. At that moment it was difficult to believe that man-made pollution was damaging the atmosphere high above such a pristine environment and endangering one of Earth's last wildernesses.

So here's the rub. CFCs were developed to be extremely safe, non-toxic and stable gases for use in everyday appliances like refrigerators and air-conditioners. In fact, their maverick inventor Thomas Midgely (who was also responsible for leaded gasoline) used to inhale CFCs at public lectures to demonstrate their inertness. When released from appliances on the Earth's surface, CFCs drift slowly upwards until they reach high altitudes. That means they can be blown around the globe from heavily populated source-regions and reach remote locations like the Arctic. High in the atmosphere, CFCs are broken up by intense sunlight that releases active chlorine, which then begins to chew up ozone molecules. The now infamous polar ozone hole appears in early spring over Antarctica because during the long, cold winter night air is blown around the pole by strong winds and becomes isolated from warmer air. Extremely cold temperatures can also be reached in the Arctic ozone layer (- 85°C and lower) which spawn the formation of ice clouds. The ice crystals also contain nitric acid and sulphuric acid and lead to subtle - but important - changes in the blend of gases that affect ozone levels. When the sun finally reappears, sunlight triggers a chain of chemical reactions; "ideal conditions for ozone depletion" according to Dr. Fast. He continued "Eureka was chosen [as a good site] for monitoring ozone loss since for most of the winter it is situated under the cold polar air mass - what scientists call the polar vortex".

In Eureka, the sun normally rises for the first time after the polar night around February 20. I arrived there at the start of March, the time of year when the sun struggles into the sky before skimming across the horizon and disappearing again in a spectacular sunset. The white snow was reflecting a mixture of purples, oranges and reds that blurred the distinction between land and sky as I set to work atop the Eureka Observatory. After shovelling snow from the roof and off the side of the building to the ground 25 feet below, I began installing the ozone-measuring equipment I had shipped up from Toronto. 'Forty minutes work up here on the roof', I thought, 'and then I can go get some dinner'. A couple of hours later and I was still up there, frustrated and hungry. I was struggling to connect two frozen cables together but wearing thick mitts on my hands meant that any kind of dexterity was nigh on impossible. Imagine trying to thread a needle while wearing hockey gloves! I had taken to working in stints, a quarter of an hour outdoors then a spell indoors, frosting up then thawing out. I eventually finished setting up my ozone monitor and it was with an amalgam of relish and relief that I finally cranked on the power and started up the instrument.

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Getting sensitive scientific equipment to work in the harsh conditions of the High Arctic is the kind of challenge that can make Eureka an unwelcoming place to carry out research. Most of the scientists who visit Eureka thrive on overcoming the obstacles that routinely crop up though, and appear to savour their visits there. There is another common theme that emerges when talking to people who have been to Ellesmere Island - its natural inhabitants. Dr. Fast recalled his first Arctic trip to me. "I was amazed by the large abundance of wildlife, more than a hundred hares at Eureka with only sparse vegetation to sustain them, as well as herds of muskoxen." In addition to hares and muskoxen I felt truly privileged to see a pair of wolves, dozens of Arctic foxes and a herd of white caribou during my northern posting. Paradoxically, the ecological equilibrium of the seemingly unpolluted Arctic is one of the environments most at risk from decreasing ozone levels. The organisms that constitute the delicate marine ecosystem are particularly threatened.

And what of our ozone layer? What is the prognosis for the new millenium - are we destined to fry or can the ozone layer somehow heal itself? Well, current evidence suggests that both are possible scenarios. Computer models of the atmosphere predict that ozone losses will worsen, rather than improve, over the next 10 to 20 years. There is some cause for optimism though, if we are successful in ridding the atmosphere of ozone-eating gases, ozone levels should eventually recover. It may just turn out that measurements made at Eureka over the next five years will hold the key to unlocking the future of the ozone layer and minimizing further human impact.

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View from the Ozone Observatory across Slidre Fjord joining Eureka Sound.

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Dr. Matt Bassford is a scientist working in the Physics Department at the University of Toronto. His Arctic research work is primarily funded by the Natural Sciences and Engineering Research Council of Canada. For details on atmospheric research at the University of Toronto visit: www.atmosp.physics.utoronto.ca

More information about research at the Eureka Observatory can be found at the Environment Canada web site:
http://exp-studies.tor.ec.gc.ca/eureka/eureka.htm