Ozone depletion analysis essay

The reappearance of the ozone hole over Antarctica has been a hot topic for scientist around the world. A few of these scientists are the atmospheric physicist Richard D. McPeters and several of his colleagues at the NASA Goddard Space Flight Center in Greenbelt. The ozone hole showed up earlier than expected, and it was wider and thinner. It appeared in mid-August, about two weeks ahead of schedule, and on September 19 reached the record size of 10. 5 million square miles, more than three and a half times the area of the forty-eight contiguous United States that is a frightening statistic man. The hole actually is a thinning of the ozone layer–was also at a near-record problem. Ozone, a bluish gas whose molecules are made up of three oxygen atoms, occurs naturally in the upper atmosphere, where it acts as a kind of cosmic sun-block, protecting life on earth from the sun’s harmful ultraviolet rays. The sun’s rays destroy some ozone, but there was no real loss because ozone regenerates itself from stray oxygen atoms and molecules. At least since 1985, however, that delicate balance has been upset. An Antarctic ozone hole now forms from September to November each year, caused by man-made pollutants that destroy ozone in the atmosphere. The hole has been getting progressively larger. The culprits are chlorofluorocarbons (CFCs), once used as coolants. The chlorine atoms from CFCs react with ozone and destroy it. Sunlight splits off chlorine from CFCs, and the chlorine-ozone reaction takes place most readily on the surface of ice crystals. Thus when the sun returns in the Antarctic spring ice crystals that had formed the winter before are in place to speed the reaction. Investigators are blaming the record size of the most recent ozone hole on unusually cooler temperatures at the South Pole last year. Chemical pollutants combined with unusually low temperatures high in the atmosphere to break a record-breaking hole in Earth's protective ozone layer this year, according to measurements made in Antarctica. The stratosphere above both poles has grown colder in recent years for reasons not clear to researchers. The recent Antarctica temperatures, the lowest in 2 decades of measurements, raise concern that the ozone layer will not heal as quickly as scientists had predicted, even though nations are curbing the use of ozone-depleting chemicals. One fear among scientists is that greenhouse gases could be playing a role in lowering all stratospheric temperatures. Carbon dioxide and other forms of pollution trap heat in the lower atmosphere, but they cool off the stratosphere–the layer between 10 and 50 kilometers in altitude. The ozone hole above Antarctica starts forming in September, when springtime sunlight returns to the polar skies. The light energizes chlorine- and bromine-containing chemicals that break down ozone molecules in the stratosphere. A key part of the chemical chain reaction takes place on the surface of frozen cloud particles, so cold temperatures worsen ozone destruction. According to measurements by a NASA satellite, the ozone hole grew to 27. 3 million square kilometers on September 19, larger than the North American Continent. The biggest previous ozone hole reached 26 million k in 1996. The satellite also showed that ozone concentration in the worst section of the hole bottomed out. At only one-third of what should normally be there this time of year researchers fear now more than ever. Balloon measurements over the South Pole record a value of 92 Dobson units. The cold temperatures this year helped the ozone hole reach new heights, according to Hofmann. " We saw some ozone loss all the way up to 24 km, which is higher than usual." Normally, temperatures are too warm at that altitude to allow the formation of frozen cloud particles. Scientists tracesome of the stratospheric cooling in recent years to the loss of ozone molecules, which absorb sunlight and heat up the surrounding air. But this process cannot explain the extremely low temperatures detected in August and September above Antarctica, before much sunlight had returned to the polar skies, says William J. Randel of the National Center for Atmospheric Research in Boulder. One cause could be natural weather conditions in the lower atmosphere, which can sometimes send pressure disturbances rippling up into the stratosphere. These so-called planetary waves warm the polar stratosphere and slow ozone destruction. In recent years, however, few planetary waves have buffeted the Arctic and Antarctica during the critical season of springtime ozone loss. Earlier this year, a computer model suggested that greenhouse warming would reduce the number of planetary waves hitting the Arctic and Antarctica (SN: 4/11/98, p. 228). Other computer models have come to the opposite conclusion, raising questions about the validity of this prediction, says Newman. The recent cooling, he says, " increases our worry about this potential problem. But we certainly can't say that this is evidence for it." Polar stratospheric clouds look lovely, glowing in streaks of spring Antarctic or Arctic sunrise. Yet the wispy wonders, around 20 kilometers up, are causing concern below. They create conditions that permit chlorine in the atmosphere to ravage the Earth's protective ozone layer. This week at the spring meeting of the American Geophysical Union in Washington, D. C., scientists announced that more polar stratospheric clouds formed in Arctic skies last winter than had ever been recorded previously and that the clouds lasted longer. Meanwhile, researchers say, they observed significant ozone loss. Polar stratospheric clouds hit the ozone layer with two punches. " These are the culprits in ozone loss," says NASA's

Michael J. Kurylo of Washington, D. C., who is a leader of the project known as the SAGE III Ozone Loss and Validation Experiment (SOLVE). On the surfaces of particles within the clouds, inactive chlorine compounds derived from humanmade chlorofluorocarbons convert into a reactive form that destroys ozone. If they linger, the clouds also drip nitric acid, lowering the nitrogen concentration in the stratosphere. Nitrogen mitigates chlorine’s power to destroy ozone, and nitrogen loss–a process called denitrification–leaves chlorine free to attack ozone. At the meeting this week, one international group of researchers reported preliminary results from last winter indicating more and longer-lived polar stratospheric clouds in the Arctic than they had expected. The data, obtained between December 1999 and March 2000, came from SOLVE instruments on aircraft. “ We did see patchy, severe denitrification,” says SOLVE team member Eric J. Jensen of NASA’s Ames Research Center in Moffett Field, Calif. However, he adds, the team must analyze more data before speculating on how widespread the phenomenon was and whether it might have contributed to the ozone losses observed last winter. Computer models suggest that even without denitrification, other processes can cause the lower stratosphere to lose 40 to 50 percent of its ozone, says Katja Drdla of Ames. With severe denitrification, she says, the loss can total 60 to 80 percent. Also at the meeting, Azadeh Tabazadeh of Ames presented independent satellite measurements from the latest Arctic winter. Her group found that polar stratospheric clouds persisted 1. 2 to 1. 5 times as long as they did during the coldest winters of the 1990s. Her team reports signs of denitrification, “ but it’s not severe,” Tabazadeh says. She adds, “ Most of the ozone loss actually during this winter I don’t believe was due to denitrification.” The reports follow a study by Tabazadeh and her colleagues in the May 26 SCIENCE thatwarned of unusually long-lived polar stratospheric clouds in the Arctic. They examined satellite measurements from a typical Antarctic winter in the 1990s and the two coldest Arctic winters of the decade. Tabazadeh's group found that polar stratospheric clouds lasted half as long in the Arctic as in Antarctica. Mathematical modeling by Tabazadeh's group suggests that if Arctic stratospheric cooling continues at 2 degrees C per decade, such clouds could last twice as long in the Arctic during the coldest winters of the decade that will begin in 2010. The date could slip to the 2030s if cooling slows to 1 degrees C each decade. Severe denitrification could increase Arctic ozone loss by 30 percent once polar stratospheric clouds become twice as persistent, Tabazadeh's team speculates. " I think the study she's done is really good," says Drew T. Shindell of NASA's Goddard Institute for Space Studies in New York. Aircraft studies and ground-based measurements depict localized conditions, he says, " but things change from region to region, so it's nice to have these global data sets from satellites." " It's important to realize that the question is very closely connected to the bigger picture of carbon dioxide increases and human-caused climate change," adds Michael J. Newchurch of the University of Alabama at Huntsville. Earth's stratosphere cools as its surface warms. Still, Tabazadeh suspects that the Arctic will not continue its cooling trend or produce annual ozone holes rivaling Antarctica's. " I don't think it can keep cooling and cooling…. It should either slow down very much or even reverse." Bibliography: