\*\*\*DEBRIS DA\*\*\* 2

\*\*\*NEG\*\*\* 3

1NC Debris Disad 3

2NC Uniqueness 7

Link – SPS Specific 8

2NC Link & i/L – Generic 9

2NC Impact – Communication/Heg 11

MISC. 13

\*\*\*OZONE DA\*\*\* 15

\*\*\*NEG\*\*\* 16

1NC Ozone Disad 16

2NC Uniqueness 19

2NC Link 23

SPS: 28

2NC Impact – Cancer/Cataracts 29

2NC Ozone → UV Rays 30

2NC Impact – Phytoplankton/Marine Life 31

2NC Impact –Plants 35

2NC Impact – Plankton 36

2NC Impact: Ozone Good 38

2NC Impact – Health 41

2NC Impact - Food 43

AT: Ozone DA 44

\*\*\*Aff Arguments\*\*\* 44

Non-Unique 45

No Link 46

No Impact 50

Impact Turns 51

AT: Pollution DA\*\*\* 52

Link Turn 53

\*\*\*\*AT: Space Debris DA 56

AT: Debris = Risk 57

No Link 58

Link Turn 59

2AC: Non-unique 60

Aircraft Alt-Cause 62

Aff—Nitrous Oxides o/w 63

Uniqueness Overwhelms the Link 65

Impact Turn 69

No Link 73

\*\*\*DEBRIS DA\*\*\*

\*\*\*NEG\*\*\*

1NC Debris Disad

1. Space debris collisions are extremely unlikely in the status quo.

Swiss Reinsurance Company 11 (Leading insurer for functioning satelites, March 24, 2011, “Space debris; on collision course for insurers?, http://media.swissre.com/documents/Publ11\_Space+debris.pdf)

Much has been written about the collision risk in Leo and the results are well documented. For example, in sun-synchronous orbit within LEO, the annual probability of collision of a 1 cm size debris with a 10 meter squared satellite exceeds 0.8%. This is the largest debris hazard anywhere in Earth Orbit

2. If spacecrafts continue to be launched, space debris collisions will become more probable and have a larger impact. If this trench continues, then collisions will continue to occur for 200 years.

Senechal, Thierry. Degree in economics and finance from Harvard University, London Business School, and Columbia University. 2007. “Space Debris Pollution: A Convention Proposal.” http://www.pon.org/downloads/ien16.2.Senechal.pdf

Collisions at orbital velocities can be highly damaging to functioning satellites and space manned missions. At orbital velocities of more than 28,000 km/h (17,500 mph), an object as small as 1 cm in diameter has enough kinetic energy to disable an average-size spacecraft. Objects as small as 1 mm can damage sensitive portions of spacecraft, but these particles are not tracked.8 At a typical impact velocity of 10 km/s, a 1 cm liquid sodium-potassium droplet would have the destructive power of an exploding hand grenade. A fragment that is 10 cm long is roughly comparable to 25 sticks of dynamite. The chance of a collision and substantial damage is not insignificant. The Space Shuttle has maneuvered to avoid collisions with other objects on several occasions. Regarding satellite constellations, if a potential collision will lead to the creation of a debris cloud that may result in damage to other constellation members, it may be worthwhile to perform a collision avoidance maneuver. Large particles obviously cause serious damage when they hit something. Part of a defunct satellite or any large debris resulting from a space launch would almost certainly destroy a satellite or kill a space explorer on impact. A source of risk is found in the likelihood of a chain of collisions in the coming years. Under such a scenario, space debris would grow exponentially as they start to collide. As a result, collisions would become the most dominant debris-generating mechanism in the future. Several studies demonstrated, with assumed future launch rates, the production rate of new debris due to collisions exceeds the loss of objects due to orbital decay. As a result, in some low Earth orbit (LEO) altitude regimes, where the density of objects is above a critical spatial density, more debris would be created. The growth of future debris populations is shown in the following two graphs (See Figure 2-2). They show the effective number of LEO objects, 10 cm and larger, from the LEGEND simulation. . A detailed analysis conducted by NASA specialists J. C. Liou and N. L. Johnson (2006) indicates that the predicted catastrophic collisions and the resulting population increase are nonuniform throughout LEO. They conclude that it is probable that about 60% of all catastrophic collisions will occur between 900 and 1000 km altitudes, with the number of objects 10 cm and larger tripling in 200 years, leading to a factor of 10 increase in collisional probabilities among objects in this region. They argue: ―Even without new launches, collisions will continue to occur in the LEO environment over the next 200 years, primarily driven by the high collision activities in the region between 900- and 1000-km altitudes, and will force the debris population to increase. In reality, the situation will undoubtedly be worse because spacecraft and their orbital stages will continue to be launched.

**3. Space debris collisions could spark accidental US-Russia nuclear war.**

Jeffrey Lewis, fellow in the Advanced Methods of Cooperative Security Program at the Center for International and Security Studies at the University of Maryland School of Public Policy (CISSM). Graduaged *magma cum laude* from Augustana College with degrees in Philosophy and Political Science “What if Space Were Weaponized? Possible Consequences for Crisis Scenarios” Center for Defense Information. July, 2004, http://www.cdi.org/PDFs/scenarios.pdf

This is the second of two scenarios that consider how U.S. space weapons might create incentives for America’s opponents to behave in dangerous ways. The previous scenario looked at the systemic risk of accidents that could arise from keeping nuclear weapons on high alert to guard against a space weapons attack. This section focuses on the risk that a single accident in space, such as a piece of space debris striking a Russian early-warning satellite, might be the catalyst for an accidental nuclear war. As we have noted in an earlier section, the United States canceled its own ASAT program in the 1980s over concerns that the deployment of these weapons might be deeply destabilizing. For all the talk about a “new relationship” between the United States and Russia, both sides retain thousands of nuclear forces on alert and conﬁgured to ﬁght a nuclear war. When briefed about the size and status of U.S. nuclear forces, President George W. Bush reportedly asked “What do we need all these weapons for?” 43 The answer, as it was during the Cold War, is

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1NC Debris Disad

that the forces remain on alert to conduct a number of possible contingencies, including a nuclear strike against Russia. This fact, of course, is not lost on the Russian leadership, which has been increasing its reliance on nuclear weapons to compensate for the country’s declining military might. In the mid-1990s, Russia dropped its pledge to refrain from the “ﬁrst use” of nuclear weapons and conducted a series of exercises in which Russian nuclear forces prepared to use nuclear weapons to repel a NATO invasion. In October 2003, Russian Defense Minister Sergei Ivanov reiterated that Moscow might use nuclear weapons “preemptively” in any number of contingencies, including a NATO attack. 44 So, it remains business as usual with U.S. and Russian nuclear forces. And business as usual includes the occasional false alarm of a nuclear attack. There have been several of these incidents over the years. In September 1983, as a relatively new Soviet early-warning satellite moved into position to monitor U.S. missile ﬁelds in North Dakota, the sun lined up in just such a way as to fool the Russian satellite into reporting that half a dozen U.S. missiles had been launched at the Soviet Union. Perhaps mindful that a brand new satellite might malfunction, the ofﬁcer in charge of the command center that monitored data from the early-warning satellites refused to pass the alert to his superiors. He reportedly explained his caution by saying: “When people start a war, they don’t start it with only ﬁve missiles. You can do little damage with just ﬁve missiles.” 45 In January 1995, Norwegian scientists launched a sounding rocket on a trajectory similar to one that a U.S. Trident missile might take if it were launched to blind Russian radars with a high altitude nuclear detonation. The incident was apparently serious enough that, the next day, Russian President Boris Yeltsin stated that he had activated his “nuclear football” – a device that allows the Russian president to communicate with his military advisors and review his options for launching his arsenal. In this case, the Russian early-warning satellites could clearly see that no attack was under way and the crisis passed without incident. 46 In both cases, Russian observers were conﬁ- dent that what appeared to be a “small” attack was not a fragmentary picture of a much larger one. In the case of the Norwegian sounding rocket, space-based sensors played a crucial role in assuring the Russian leadership that it was not under attack. The Russian command system, however, is no longer able to provide such reliable, early warning. The dissolution of the Soviet Union cost Moscow several radar stations in newly independent states, creating “attack corridors” through which Moscow could not see an attack launched by U.S. nuclear submarines. 47 Further, Russia’s constellation of early-warning satellites has been allowed to decline – only one or two of the six satellites remain operational, leaving Russia with early warning for only six hours a day. Russia is attempting to reconstitute its constellation of early-warning satellites, with several launches planned in the next few years. But Russia will still have limited warning and will depend heavily on its space-based systems to provide warning of an American attack. 48 As the previous section explained, the Pentagon is contemplating military missions in space that will improve U.S. ability to cripple Russian nuclear forces in a crisis before they can execute an attack on the United States. Anti-satellite weapons, in this scenario, would blind Russian reconnaissance and warning satellites and knock out communications satellites. Such strikes might be the prelude to a full-scale attack, or a limited effort, as attempted in a war game at Schriever Air Force Base, to conduct “early deterrence strikes” to signal U.S. resolve and control escalation. 49 By 2010, the United States may, in fact, have an arsenal of ASATs (perhaps even on orbit 24/7) ready to conduct these kinds of missions – to coerce opponents and, if necessary, support preemptive attacks. Moscow would certainly have to worry that these ASATs could be used in conjunction with other space-enabled systems – for example, long-range strike systems that could attack targets in less than 90 minutes – to disable Russia’s nuclear deterrent before the Russian leadership understood what was going on. What would happen if a piece of space debris were to disable a Russian early-warning satellite under these conditions? Could the Russian military distinguish between an accident in space and the ﬁrst phase of a U.S. attack? Most Russian early-warning satellites are in elliptical Molniya orbits (a few are in GEO) and thus difﬁcult to attack from the ground or air. At a minimum, Moscow would probably have some tactical warning of such a suspicious launch, but given the sorry state of Russia’s warning, optical imaging and signals intelligence satellites there is reason to ask the question. Further, the advent of U.S. on-orbit ASATs, as now envisioned 50 could make both the more difﬁcult orbital plane and any warning systems moot. The unpleasant truth is that the Russians likely would have to make a judgment call. No state has the ability to deﬁnitively determine the cause of the satellite’s failure. Even the United States does not maintain (nor is it likely to have in place by 2010) a sophisticated space surveillance system that would allow it to distinguish between a satellite malfunction, a debris strike or a deliberate attack – and Russian space surveillance capabilities are much more limited by comparison. Even the risk assessments for collision with debris are speculative, particularly for the unique orbits in which Russian early-warning satellites operate. During peacetime, it is easy to imagine that the Russians would conclude that the loss of a satellite was either a malfunction or a debris strike. But how conﬁdent could U.S. planners be that the Russians would be so calm if the accident in space occurred in tandem with a second false alarm, or occurred during the middle of a crisis? What might happen if the debris strike occurred shortly after a false alarm showing a missile launch? False alarms are appallingly common – according to information obtained under the Freedom of Information Act, the U.S.-Canadian North American Aerospace Defense Command (NORAD) experienced 1,172 “moderately serious” false alarms between 1977 and 1983 – an average of almost three false alarms per week. Comparable information is not available about the Russian system, but there is no reason to believe that it is any more reliable. 51 Assessing the likelihood of these sorts of coincidences is difﬁcult because Russia has never provided data about the frequency or duration of false alarms; nor indicated how seriously earlywarning data is taken by Russian leaders. Moreover, there is no reliable estimate of the debris risk for Russian satellites in highly elliptical orbits. 52 The important

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1NC Debris Disad

point, however, is that such a coincidence would only appear suspicious if the United States were in the business of disabling satellites – in other words, there is much less risk if Washington does not develop ASATs. The loss of an early-warning satellite could look rather ominous if it occurred during a period of major tension in the relationship. While NATO no longer sees Russia as much of a threat, the same cannot be said of the converse. Despite the warm talk, Russian leaders remain wary of NATO expansion, particularly the effect expansion may have on the Baltic port of Kaliningrad. Although part of Russia, Kaliningrad is separated from the rest of Russia by Lithuania and Poland. Russia has already complained about its decreasing lack of access to the port, particularly the uncooperative attitude of the Lithuanian government. 53 News reports suggest that an edgy Russia may have moved tactical nuclear weapons into the enclave. 54 If the Lithuanian government were to close access to Kaliningrad in a ﬁt of pique, this would trigger a major crisis between NATO and Russia. Under these circumstances, the loss of an early-warning satellite would be extremely suspicious. It is any military’s nature during a crisis to interpret events in their worst-case light. For example, consider the coincidences that occurred in early September 1956, during the extraordinarily tense period in international relations marked by the Suez Crisis and Hungarian uprising. 55 On one evening the White House received messages indicating: 1. the Turkish Air Force had gone on alert in response to unidentiﬁed aircraft penetrating its airspace; 2. one hundred Soviet MiG-15s were ﬂying over Syria; 3. a British Canberra bomber had been shot down over Syria, most likely by a MiG; and 4. The Russian ﬂeet was moving through the Dardanelles. Gen. Andrew Goodpaster was reported to have worried that the conﬂuence of events “might trigger off … the NATO operations plan” that called for a nuclear strike on the Soviet Union. Yet, all of these reports were false. The “jets” over Turkey were a ﬂock of swans; the Soviet MiGs over Syria were a smaller, routine escort returning the president from a state visit to Moscow; the bomber crashed due to mechanical difﬁculties; and the Soviet ﬂeet was beginning long-scheduled exercises. In an important sense, these were not “coincidences” but rather different manifestations of a common failure – human error resulting from extreme tension of an international crisis. As one author noted, “The detection and misinterpretation of these events, against the context of world tensions from Hungary and Suez, was the ﬁrst major example of how the size and complexity of worldwide electronic warning systems could, at certain critical times, create momentum of its own.” Perhaps most worrisome, the United States might be blithely unaware of the degree to which the Russians were concerned about its actions and inadvertently escalate a crisis. During the early 1980s, the Soviet Union suffered a major “war scare” during which time its leadership concluded that bilateral relations were rapidly declining. This war scare was driven in part by the rhetoric of the Reagan administration, fortiﬁed by the selective reading of intelligence. During this period, NATO conducted a major command post exercise, Able Archer, that caused some elements of the Soviet military to raise their alert status. American ofﬁcials were stunned to learn, after the fact, that the Kremlin had been acutely nervous about an American ﬁrst strike during this period. 56 All of these incidents have a common theme – that conﬁdence is often the difference between war and peace. In times of crisis, false alarms can have a momentum of their own. As in the second scenario in this monograph, the lesson is that commanders rely on the steady ﬂow of reliable information. When that information ﬂow is disrupted – whether by a deliberate attack or an accident – conﬁdence collapses and the result is panic and escalation. Introducing ASAT weapons into this mix is all the more dangerous, because such weapons target the elements of the command system that keep leaders aware, informed and in control. As a result, the mere presence of such weapons is corrosive to the conﬁdence that allows national nuclear forces to operate safely.

1NC Debris Disad

4. A war with Russia would mean certain and immediate extinction

Steven Starr -- director of the University of Missouri's Clinical Laboratory Science Program, senior scientist at the Physicians for Social Responsibility, worked with the United Nations to eliminate thousands of high-alert, launch-ready U.S. and Russian nuclear weapons, (Nuclear Darkness, 3/12/2010, “The climatic consequences of nuclear war,”, http://www.thebulletin.org/web-edition/op-eds/the-climatic-consequences-of-nuclear-war

Although the ongoing Nuclear Posture Review is supposed to include all aspects of the strategy and doctrine that govern the use of U.S. nuclear weapons, it once again will not consider one crucial question: What would be the long-term consequences to Earth's environment if the U.S. nuclear arsenal were detonated during a conflict? This isn't a question to be avoided. [Recent scientific studies](http://climate.envsci.rutgers.edu/pdf/ToonRobockTurcoPhysicsToday.pdf) PDF have found that a war fought with the deployed U.S. and Russian nuclear arsenals would leave Earth virtually uninhabitable. In fact, NASA computer models have shown that even a "successful" first strike by Washington or Moscow would inflict catastrophic environmental damage that would make agriculture impossible and cause mass starvation. Similarly, in the January *Scientific American*, Alan Robock and Brian Toon, the foremost experts on the climatic impact of nuclear war, warn that the environmental consequences of a "regional" nuclear war would cause a global famine that could kill one billion people. Their article, ["Local Nuclear War: Global Suffering,"](http://climate.envsci.rutgers.edu/pdf/RobockToonSciAmJan2010.pdf) predicts that the detonation of 100 15-kiloton nuclear weapons in Indian and Pakistani megacities would create urban firestorms that would [loft](http://www.nucleardarkness.org/warconsequences/fivemilliontonsofsmoke/) 5 million tons of thick, black smoke above cloud level. (This smoke would engulf the entire planet within 10 days.) Because the smoke couldn't be rained out, it would remain in the stratosphere for at least a decade and have profoundly disruptive effects. Specifically, the smoke layer would block sunlight, heat the upper atmosphere, and cause massive destruction of protective stratospheric ozone. A [2008 study](http://climate.envsci.rutgers.edu/pdf/MillsPNAS.pdf) calculated ozone losses (after the described conflict) of 25-45 percent above mid-latitudes and 50-70 percent above northern high latitudes persisting for five years, with substantial losses continuing for another five years. Such severe ozone depletion would allow intense levels of harmful ultraviolet light to reach Earth's surface--even with the stratospheric smoke layer in place. Beneath the smoke, the loss of warming sunlight would produce average surface temperatures colder than any experienced in the last 1,000 years. There would be a corresponding shortening of growing seasons by up to 30 days and significant reductions in average rainfall in many areas, with a 40-percent decrease of precipitation in the Asian monsoon region. Basically, the Earth's surface would become cold, dark, and dry. Humans have had some experience with this sort of deadly global climate change. In 1815, the largest volcanic eruption in recorded history took place in Indonesia. Mount Tambora exploded and created a stratospheric layer of sulfuric acid droplets that blocked sunlight from reaching Earth. During the following year, which was known as "The Year without Summer," the northeastern United States experienced snowstorms in June and debilitating frosts every month of the year. In an [earlier study](http://climate.envsci.rutgers.edu/pdf/acp-7-2003-2007.pdf), Robock, Toon, and their colleagues predicted that the decreases in average surface temperatures following the nuclear conflict described above would be 2-3 times colder than those experienced in 1816 and that the black soot produced by subsequent nuclear firestorms would remain in the stratosphere five times longer than the acid clouds from volcanic eruptions. In other words, 10 years after a regional nuclear war, Earth's average surface temperatures would still be as cold, or colder, than they were in 1816. Most likely, the long-lived smoke layer would produce a "decade without a summer." Here it's important to point out that the 100 Hiroshima-size weapons detonated in Robock and Toon's regional war scenario contain less than 1 percent of the combined explosive power in the 7,000 or so operational and deployed nuclear weapons the United States and Russia possess. If even one-half of these weapons were detonated in urban areas, Robock and Toon have predicted that the resulting [nuclear darkness](http://www.nucleardarkness.org/index2.php) would cause daily minimum temperatures to fall below freezing in the largest agricultural areas of the Northern Hemisphere for a period of between one to three years. Meanwhile, average global surface temperatures would become colder than those experienced 18,000 years ago at the height of the last Ice Age. Amazingly, however, no follow-up studies have been initiated to further evaluate the decreases in temperature, precipitation, or ozone depletion predicted to arise from either regional or strategic nuclear war. Large studies were conducted in the 1980s on "nuclear winter" by the U.S. [National Academy of Sciences](http://books.nap.edu/openbook.php?record_id=540&page=R1), the World Meteorological Organization, and the International Council for Science's Scientific Committee on Problems of the Environment. But given that Robock and Toon's new research has found that these early studies significantly underestimated the climatic and environmental consequences of nuclear war, wouldn't it make sense for such groups to now revisit the subject? At the very least, Washington and Moscow, with 95 percent of the world's nuclear weapons, should be required to investigate the environmental and climatic consequences from a nuclear war created by their nuclear arsenals. Moreover, in the United States, there appears to be a legal basis to force the Defense Department to evaluate the likely consequences of its nuclear arsenal. According to the EPA's [website](http://www.epa.gov/compliance/nepa/), "The National Environmental Policy Act [NEPA] requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet NEPA requirements, federal agencies [must] prepare a detailed statement known as an Environmental Impact Statement." If that's the case, why not require Defense to create an Environmental Impact Statement for the more than 1,000 U.S. strategic nuclear weapons now on high-alert? To date, the discussion of a nuclear-weapons-free world has included no mention of the environmental consequences of nuclear war. I fear that without such a dialogue, the debate lacks the sense of urgency required to change the nuclear status quo. That's why I believe that a wake-up call from the scientific community is seriously needed. Regardless of how "safe from use" U.S. and Russian nuclear weapons are considered to be, they still could wipe out humanity. Thus, the recognition by Washington that its nuclear arsenal, if used in conflict, will make the whole world--including all of its territory--uninhabitable, is long overdue.

2NC Uniqueness

We are on the brink – an increased frequency in space launches will create a permanent cloud of debris that will threaten all future space activities and cause problems between major powers.

Senechal, Thierry. Degree in economics and finance from Harvard University, London Business School, and Columbia University. 2007. “Space Debris Pollution: A Convention Proposal.” http://www.pon.org/downloads/ien16.2.Senechal.pdf

The time is right for addressing the problem posed by orbital debris and realizing that, if we fail to do so, there will be an increasing risk to continued reliable use of space-based services and operations as well as to the safety of persons and property in space. We have reached a critical threshold at which the density of debris at certain altitudes is high enough to guarantee collisions, thus resulting in increased fragments. In a scenario in which space launches are more frequent, it is likely that we will create a self-sustaining, semi-permanent cloud of orbital ―pollution that threatens all future commercial and exploration activities within certain altitude ranges. The debris and the liability it may cause may also poison relations between major powers. Because space debris is a global challenge that may impact any country deciding to develop space activities, the issue cannot be resolved among a few countries. This is why I am advocating that a global convention on space debris is a requirement for preserving this special environment for future generations. Following the logic of the Brundland Report, we need development that ―meets the needs of the present without compromising the ability of future generations to meet their own needs.

Space debris collisions are extremely unlikely in the status quo.

Swiss Reinsurance Company 11 (Leading insurer for functioning satelites, March 24, 2011, “Space debris; on collision course for insurers?, http://media.swissre.com/documents/Publ11\_Space+debris.pdf)

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Link – SPS Specific

SPS requires 40,000 times as many launches as the Apollo era to solove

David R. Criswell, “Solar Power via the Moon”, April/May 2002, http://www.aip.org/tip/INPHFA/vol-8/iss-2/p12.pdf

Several types of solar-power satellites have been proposed. They are projected, over 30 years, to deliver approximately 10,000 kW•h of electric energy to Earth for each kilogram of mass in orbit around the planet. To sell electric energy at $0.01/ kW•h, less than $60 could be expended per kilogram to buy the components of the power satellites, ship them into space, assemble and maintain them, decommission the satellites, and finance all aspects of the space operations. To achieve this margin, launch and fabrication costs would have to be lowered by a factor of 10,000. Power prosperity would require a fleet of approximately 6,000 huge, solar-power satellites. The fleet would have more than 330,000 km2 of solar arrays on-orbit and a mass exceeding 300 million tonnes. By comparison, the satellite payloads and rocket bodies now in Earth geosynchronous orbit have a collective surface area of about 0.1 km2. The mass launch rate for a fleet of power satellites would have to be 40,000 times that achieved during the Apollo era by both the United States and the Soviet Union. A many-decade development program would be required before commercial development could be considered.

2NC Link & i/L – Generic

The main source of space debris is the launch of satellites – either their deterioration or fragmentation collisions.

Kennewell, John. 2010. The Australian Space Weather Agency. “Overview of Orbital Space Debris.” <http://www.ips.gov.au/Educational/4/2/1>

The initial and continuing source of space debris is the launch of satellites. Not only the satellites themselves add to the population of orbiting space objects, but often the last stages of the rockets that are used to place them in orbit also remain aloft for many years. As satellites get old they deteriorate under the influence of the space environment. Outgassing can not only release gases, but may also take other materials with them, as the gas beneath a surface slowly makes it way into the surrounding environment. The strong solar UV in space can cause the deterioration of many materials. Paint and other surface materials may be expelled in flakes. More catastrophic than age related deterioration are satellite fragmentation events. These may result from collisions with other (external) objects, or they may be explosive, as when remnant fuel in an old spacecraft undergoes an exothermic reaction (ignites). Both of these type of events can produce an astounding number of small fragments that become a new source of space debris.

If spacecrafts continue to be launched, space debris collisions will become more probable and have a larger impact – even if all launches are stopped right now, collisions will continue to occur for another 200 years.

Senechal, Thierry. Degree in economics and finance from Harvard University, London Business School, and Columbia University. 2007. “Space Debris Pollution: A Convention Proposal.” http://www.pon.org/downloads/ien16.2.Senechal.pdf

Collisions at orbital velocities can be highly damaging to functioning satellites and space manned missions. At orbital velocities of more than 28,000 km/h (17,500 mph), an object as small as 1 cm in diameter has enough kinetic energy to disable an average-size spacecraft. Objects as small as 1 mm can damage sensitive portions of spacecraft, but these particles are not tracked.8 At a typical impact velocity of 10 km/s, a 1 cm liquid sodium-potassium droplet would have the destructive power of an exploding hand grenade. A fragment that is 10 cm long is roughly comparable to 25 sticks of dynamite. The chance of a collision and substantial damage is not insignificant. The Space Shuttle has maneuvered to avoid collisions with other objects on several occasions. Regarding satellite constellations, if a potential collision will lead to the creation of a debris cloud that may result in damage to other constellation members, it may be worthwhile to perform a collision avoidance maneuver. Large particles obviously cause serious damage when they hit something. Part of a defunct satellite or any large debris resulting from a space launch would almost certainly destroy a satellite or kill a space explorer on impact. A source of risk is found in the likelihood of a chain of collisions in the coming years. Under such a scenario, space debris would grow exponentially as they start to collide. As a result, collisions would become the most dominant debris-generating mechanism in the future. Several studies demonstrated, with assumed future launch rates, the production rate of new debris due to collisions exceeds the loss of objects due to orbital decay. As a result, in some low Earth orbit (LEO) altitude regimes, where the density of objects is above a critical spatial density, more debris would be created. The growth of future debris populations is shown in the following two graphs (See Figure 2-2). They show the effective number of LEO objects, 10 cm and larger, from the LEGEND simulation. A detailed analysis conducted by NASA specialists J. C. Liou and N. L. Johnson (2006) indicates that the predicted catastrophic collisions and the resulting population increase are nonuniform throughout LEO. They conclude that it is probable that about 60% of all catastrophic collisions will occur between 900 and 1000 km altitudes, with the number of objects 10 cm and larger tripling in 200 years, leading to a factor of 10 increase in collisional probabilities among objects in this region. They argue: ―Even without new launches, collisions will continue to occur in the LEO environment over the next 200 years, primarily driven by the high collision activities in the region between 900- and 1000-km altitudes, and will force the debris population to increase. In reality, the situation will undoubtedly be worse because spacecraft and their orbital stages will continue to be launched.

2NC Link & i/L – Generic

More space debris is added with every launch, only further damaging the environment for the future of space.

Scott 10 (Mr. Scott is a former Rocky Mountain bureau chief for AVIATION WEEK magazine. Previously, he also served as senior national editor, avionics editor and senior engineering editor. He is a co-author of three books: Counterspace: The Next Hours of World War III; Space Wars: The First Six Hours of World War III, and Inside the Stealth Bomber: The B-2 Story. In 12 years of military and civilian flight testing, plus evaluating aircraft for AVIATION WEEK, he has logged approximately 2,000 flight hours on 80 aircraft types. Scott earned a Bachelor of Science degree in electrical engineering from California State University, Sacramento. Space Foundation, May 2010, <http://newsletters.spacefoundation.org/spacewatch/articles/id/479>)

Perhaps the most worrisome aspect of the increasing utilization - and globalization - of space is a simple question: "what's up there?" The Critical Issues - Space Situational Awareness & Space Debris panel at the 26th National Space Symposium examinedtwo different, but related, issues: the challenge of keeping abreast of what is taking place in near-Earth space, and the proliferation of space debris. Presented in association with the AMOS Conference, a Project of the Maui Economic Development Board, Inc. (MEDB), the panel featured a special introduction by Sandy Ryan, AMOS Conference Director, MEDB, and was moderated by space author William B. Scott. Panelists included: Lt. Gen. Brian A. Arnold, USAF (Retired), vice president for space strategy, Raytheon Space and Airborne Systems Roger L. Hall, ST, deputy director, Tactical Technology Office, Defense Advanced Research Projects Agency (DARPA) Houston T. Hawkins, senior fellow, Los Alamos National Laboratory, and chief scientist, Principal Associate Directorate for Global Security Maj. Gen. Susan J. Helms, USAF, director of Plans and Policy, U.S. Strategic Command Nicholas L. Johnson, chief scientist for orbital debris, NASA Joseph Sheehan, president, Analytical Graphics, Inc. (AGI) Arnold laid out the issues, saying, "Awareness of our space environment has never been more important," but that most of the space tracking radars are located in the northern hemisphere, "making continuous coverage impossible." He also noted that every time we send something to orbit, we contribute to the debris. "We need to preserve the environment for the future of space by looking at methods to mitigate space debris - environmental cleaning of space," he said.

We are on the brink – if launch rates experience a step increase it will cause debris to grow exponentially.

Klinkrad et al. ESA study manager. July, 2002 “Update of the ESA Space Debris Mitigation Handbook Executive Summary”

The long-term evolution of the orbital debris environment is predicted to be highly sensitive to variations in future traffic (launches, explosions and SRM firings). Particularly, if the future traffic rates were to experience a step increase by a factor of two or more, then (without mitigation) the lethal centimetre-sized debris population levels in LEO are predicted to undergo significant exponential growth by an order of magnitude or more over the next century. Such a significant rise in future traffic might be caused by a technology breakthrough such as highly reuseable launch vehicles making frequent low-cost flights to LEO.

Debris impacts degrade the efficiency and subsequently destroy satellites and solar panels.

Verker et al. Space Environment Division. Department of Solid Mechanics, Materials and Systems, Tel Aviv University. 2006. Ground simulation of hypervelocity space debris impacts on polymers.

Spacecraft debris impact damages can degrade the performance of exposed spacecraft materials and, in some cases, destroy a satellite’s ability to perform or complete its mission.3 The Hubble space telescope solar array, for example, suffered impacts at ultrahigh velocities ranging from 2.9 to 11.5 km/s from particles 7-98 μm in diameter.7 Particles traveling at ultrahigh velocities generate temperatures in the range of 5000 K and pressures of several mega-Bars when they collide with a surface.8 Accumulation of impacts over the large surface area of solar panels leads, in some cases, to degradation in efficiency.9 Impacts into metals form craters, which have diameters averaging about 5 times the impact diameter. These craters are of concern because they can prevent impacted components from operating. In the case of composites, if a complete penetration occurs, this can lead to further breakdown of the composite during subsequent exposure to AO or VUV. Debris impacts into polymer films occurs quite often, since they are used extensively onboard spacecrafts, mainly as thermal blankets. Mostly, these materials are thin laminated layers; thus, the impacts cause delamination of these layers into many times the diameter of the crater.3

2NC Impact – Communication/Heg

Debris causes damage to spacecraft in orbit, has potential to danger people on the ground, and interferes with astronomical observations, including military efforts at space surveillance, by creating light pollution.

Hitchens, Theresa. Director of the Center of Defense Information (CDI). Former editor of Defense News. 2004. “Chapter 5: Space Debris: Next Steps.” http://www.unidir.org/pdf/articles/pdf-art2378.pdf

Space debris is dangerous because of its potential to collide with and damage satellites and/or spacecraft. Even tiny pieces

of debris such as paint flecks measured in millimetres can cause destruction. Debris is so dangerous because objects in orbit move at extremely high speeds—about 10km per second in LEO6—thus relative velocities and the energy generated at impact can be very high. In fact, NASA must replace one or two Space Shuttle windows after each mission as a result of damage by small pieces of debris.7 “We get hit regularly on the shuttle”, Joseph Loftus, then assistant director of engineering for NASA’s Space and Life Science Directorate, as quoted by space.com in September 2000, noting that, as of that time, more than 80 shuttle windows had been replaced because of debris impacts.

Debris can also be a danger to people and things on the ground, as some space junk in LEO will eventually de-orbit, pass through the atmosphere and land. Although such landfalls are rare, they do happen when very large space objects de-orbit. For example, large pieces of Skylab fell over Western Australia in July 1979; in April 2000, pieces of a Delta 2 second stage rocket fell over Cape Town, South Africa.9 Debris—as well as the ever-increasing population of active spacecraft and satellites—can further interfere with astronomical observations by creating a form of light pollution (just like satellites or spacecraft, debris pieces can reflect sunlight and clutter efforts at sky mapping). Light pollution is not only a problem for civil astronomy, but also for military efforts at space surveillance, since tracking and monitoring space objects relies in large part on optical telescopes.

The destruction of a single satellite by space debris could cut off all communication services in North America.

The United Nations. 2008. “Space Debris: Orbiting Debris Threatens Sustainable use of Outer Space.” http://www.un.org/en/events/tenstories/08/spacedebris.shtml

Far above the earth, orbiting satellites play a crucial role in our everyday lives – powering countless services ranging from cell phones to banking, weather reports and navigation. Taken largely for granted, these modern conveniences are actually in constant peril, due to potential collisions with accumulating outer space debris left by defunct satellites and other spacecraft. In 2008, countries at the UN adopted space debris mitigation guidelines to curb the pollution of outer space and promote international consensus on acceptable spacecraft operations so that outer space may be used in a sustainable way. Some one thousand operational satellites, belonging to more than 40 countries, are now in orbit around the earth, providing weather, mapping, communications and other basic services that are vital to our way of life. But just as human activities on earth generate mountains of waste, the increasing traffic of satellites in outer space has created growing amounts of debris that are in constant danger of colliding and disrupting these services. In May 1998, the malfunctioning of a single satellite abruptly cut off communications services in North America, silencing about 40 million pagers, blocking automated teller machines and credit card payments, and forcing radio and television networks off the air.

2NC Impact – Communication/Heg

Even the smallest fragment of space debris can have a catastrophic effect if a collision occurs.

Hitchens 05 (Editor of Defense News from 1998 to 2000, Hitchens has had a long career in journalism, with a focus on military, defense industry and NATO affairs. Her time at Defense News included five years as the newspaper's first Brussels bureau chief, from 1989 to 1993. From 1983 to 1988, she worked at Inside Washington Publishers on the group's environmental and defense-related newsletters, covering issues from nuclear waste to electronic warfare to military space, United Nations Institute for Disarmament Research (UNIDIR), 2005, <http://www.unidir.org/pdf/articles/pdf-art2378.pdf>)

Space debris is dangerous because of its potential to collide with and damage satellites and/or spacecraft. Even tiny pieces of debris such as paint flecks measured in millimetres can cause destruction. Debris is so dangerous because objects in orbit move at extremely high speeds—about 10km per second in LEO6—thus relative velocities and the energy generated at impact can be very high. In fact, NASA must replace one or two Space Shuttle windows after each mission as a result of damage by small pieces of debris. 7 “We get hit regularly on the shuttle”, Joseph Loftus, then assistant director of engineering for NASA’s Space and Life Science Directorate, as quoted by space.com in September 2000, noting that, as of that time, more than 80 shuttle windows had been replaced because of debris impacts. 8 Debris can also be a danger to people and things on the ground, as some space junk in LEO will eventually de-orbit, pass through the atmosphere and land. Although such landfalls are rare, they do happen when very large space objects de-orbit. For example, large pieces of Skylab fell over Western Australia in July 1979; in April 2000, pieces of a Delta 2 second stage rocket fell over Cape Town, South Africa. 9 Debris—as well as the ever-increasing population of active spacecraft and satellites—can further interfere with astronomical observations by creating a form of light pollution (just like satellites or spacecraft, debris pieces can reflect sunlight and clutter efforts at sky mapping). Light pollution is not only a problem for civil astronomy, but also for military efforts at space surveillance, since tracking and monitoring space objects relies in large part on optical telescopes.

More debris causes spaces collisions and Kessler Syndrome

Klinkrad 09 (Heiner Klinkrad Head of ESA Space Debris Office, OPS-GR, at ESOC, European Space Agency, February 20, 2009, “Space Debris Environment” http://www.esa.int/esaMI/Space\_Debris/SEMQQ8VPXPF\_0.html)

As a consequence of the rising object count, the probability for catastrophic collisions will also grow in a progressive manner (doubling the number of objects will increase the collision risk approximately four-fold). As the debris population grows, first collisions will occur. In a 'business-as-usual' scenario, such collisions will start prevailing over the now-dominating explosions within a few decades from now. Ultimately, collision fragments will collide with collision fragments, until the entire population is ground to sub-critical sizes. This self-sustained process, which is particularly critical for the LEO region, is known as the 'Kessler syndrome'. It is a scenario that must be avoided by the timely application of space debris mitigation and remediation measures on an international scale.

Space debris causes problems with and outside of the Earth’s mesosphere—this includes future spaceflights.

Atkinson 08 (Nancy Atkinson is the Senior Editor for Universe Today, producer for Astronomy Cast, and project manager for 365 Days of Astronomy podcast. Also, I'm a NASA/JPL Solar System Ambassador, Universe Today, April 11, 2008, http://www.universetoday.com/13587/space-debris-illustrated-the-problem-in-pictures/)

Space junk, space debris, space waste — call it what you want, but just as junk and waste cause problems here on Earth, in space spent booster stages, nuts and bolts from ISS construction, various accidental discards such as spacesuit gloves and cameras, and fragments from exploded spacecraft could turn into a **serious problem for the future of spaceflight** if actions to mitigate the threat are not taken now. The European Space Operations Centre has put together some startling images highlighting this issue. Above is a depiction of the trackable objects in orbit around Earth in low Earth orbit (LEO–the fuzzy cloud around Earth), geostationary Earth orbit (GEO — farther out, approximately 35,786 km (22,240 miles) above Earth) and all points in between

MISC.

## Space debris colliding creates more debris

**Guterl**, 8-17-**09** (Fred Fred Guterl is a Senior Editor at Newsweek International and directs the magazine’s coverage of science, technology, health, medicine and the environment., Newsweek, August 17, 2009, “Space Junk: Earth is being engulfed in a dense cloud of hazardous debris that won't stop growing,” Newsweek, p. lexis, accessed June 29, 2011)

The consequences go far beyond merely the loss of two pieces of property. Each satellite weighed more than half a metric ton and was moving at 7.5 kilometers per second. The resulting explosion was catastrophic, generating a massive cloud of cosmic debris--perhaps 100,000 pieces of junk bigger than one centimeter in diameter, estimates David Wright, a space expert at the Union of Concerned Scientists. In one stroke, the accident increased by nearly a third the number of stray objects in the crucial 700-to-900-kilometer band known as low Earth orbit (LEO). The junk cloud will eventually disperse around the entire planet, like a shroud.

Space debris is a growing problem that will have serious consequences in the future.

Senechal, Thierry. Degree in economics and finance from Harvard University, London Business School, and Columbia University. 2007. “Space Debris Pollution: A Convention Proposal.” http://www.pon.org/downloads/ien16.2.Senechal.pdf

The problem we face is complex and serious; the danger posed by the human-made debris to operational spacecraft (pilotless or piloted) is a growing concern. Because debris remains in orbit for long period of time, they tend to accumulate, particularly in the low earth orbit. What is certain today is that the current debris population in the Low Earth Orbit (LEO) region has reached the point where the environment is unstable and collisions will become the most dominant debris-generating mechanism in the future. The tremendous increase in the probability of collision exists in the near future (about 10 to 50 years). Some collisions will lead to breakups and will sow fragments all over the geosynchronous area, making it simply uninhabitable and unreliable for scientific and commercial purposes. In the early years of the space era, mankind was concerned primarily with conquering space. The process of placing an aircraft in Earth‘s orbit and targeting the moon was such a challenge that little thought was given to the consequences that might arise from these actions. Space debris has thus been created at the time of the cold war, when the military and space race between the two great powers of the time was at its peak. Not much can be done to change what has been done during the last decades of the 20th Century. As with many aspects of Earth-bound pollution, it is taking time to recognize the damaging effects of what we call now ―space junk or space pollution. Space debris is a source of increasing concern. The scientific and engineering communities have studied the problem of space debris for decades and warned of the dangers. Large space debris has been tracked and catalogued. The increased pace of small debris has also been studied using sophisticated models. Although space debris has been extensively studied by public and private research institutions around the world since the 1980s, its implications have only been discussed in narrow circles of specialists at international conferences.

56% of all objects orbiting the earth are space debris – fragmentations from explosions of spacecrafts caused by deterioration in the mechanics.

ESA, European Space Agency. February 20th, 2009. Space Debris: “History and Background.” http://www.esa.int/esaMI/Space\_Debris/SEMQQ8VPXPF\_1.html

In almost 50 years of space activities, more than 4800 launches have placed some 6000 satellites into orbit, of which only a minor fraction - about 800 - are still operational today. Besides this large amount of intact space hardware, with a total mass of about 5500 tonnes, several additional objects are known to orbit the Earth. More than 12 000 in total are regularly tracked by the US Space Surveillance Network and maintained in their catalogue, which covers objects larger than approximately 5 to 10cm in low Earth orbit (LEO) and 30cm to 1m at geostationary altitudes (GEO).   Only 6 percent of the catalogued orbit population are operational spacecraft, while 38 percent can be attributed to decommissioned satellites, spent upper stages and mission-related objects (launch adaptors, lens covers, etc.). The remaining 56 percent originates from more than 200 in-orbit fragmentations which have been recorded since 1961. Except for a few collisions (less than 10 accidental and intentional events), the majority of the 200 break-ups were explosions of spacecraft and upper stages.   These are assumed to have generated a population of objects larger than 1 cm on the order of 600,000. Only near sizes of 0.1 mm to 1mm may the sporadic flux from meteoroids prevail over man-made debris. The main cause of in-orbit explosions is related to residual fuel that remains in tanks or fuel lines once a rocket stage or satellite is discarded in Earth orbit. Over time, the harsh space environment can deteriorate the mechanical integrity of external and internal parts, leading to leaks and/or mixing of fuel components, which could trigger self-ignition.

MISC.

Debris large enough to be tracked makes up 94% of objects in orbit – but there are trillions of other pieces too small to be tracked.

Hitchens, Theresa. Director of the Center of Defense Information (CDI). Former editor of Defense News. 2004. “Chapter 5: Space Debris: Next Steps.” http://www.unidir.org/pdf/articles/pdf-art2378.pdf

The official catalogue of space objects kept by the US Air Force’s Space Surveillance Network (SSN) contains about 9,000 objects, but the Air Force also tracks approximately 4,000 other objects whose origins and exact orbits are not yet confirmed. Although there is no unclassified, publicly available data on exactly how many operational satellites are orbiting at any one time, US officials say that only about 6% of those 13,000 objects being watched are working satellites or spacecraft, such as the International Space Station. The rest is debris.

Worse yet, the debris now tracked represents only a small fraction of the junk in orbit. Most space debris is smaller than 10cm—too small to be verifiably detected and followed with current technology.4 Space scientists estimate that there are more than 100,000 objects between 1cm and 10cm in size—that is, larger than a marble—and perhaps trillions of pieces that are smaller yet.5 Space debris is concentrated in the two orbits that are most useful for human space operations: Low Earth Orbit (LEO) is defined as between the ceiling of the Earth’s atmosphere from around 100km to 1,000–2,000km in altitude; Geosynchronous Orbit (GEO) is roughly 36,000km above the Earth and where satellites essentially remain stationary over one spot on the ground.

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1NC Ozone Disad

1. The ozone layer is recovering from abuse

Climate and Pollution Agency, 9/17/2010, Ozone layer, www.environment.no, http://www.miljostatus.no/en/Topics/Climate/Ozone-layer/#A

The ozone layer is found in the stratosphere, 15-35 km above the surface of the earth. Ninety per cent of the ozone (O3) present in the atmosphere is concentrated here. Ozone is continually generated and broken down through natural processes in the stratosphere. Anthropogenic emissions of ozone-depleting substances have disturbed the balance in the stratosphere.

The ozone layer expected to recover significantly by 2050-2070

The amount of most of the ozone-depleting substances in the troposphere is now declining slowly. The ozone layer is expected to recover significantly by 2060-2075 above Antarctica and around 2050 elsewhere.

Recent global ozone data indicate that there might be signs of ozone recovery from mid 1990s in most of the world. However this is uncertain, particularly at high latitudes and in the Arctic region. The uncertainty is caused by the high natural variability in these regions, and the influence of factors like decreasing temperatures in the stratosphere, which is partly due to the increase of greenhouse gases in the troposphere.

2. Rocket launches kill the ozone- one radical destroys 10,000 ozone molecules

Nancy Atkinson, science journalist who writes about space exploration and astronomy, Senior Editor and writer for Universe Today, project manager for 365 Days of Astronomy podcast, part of the production team for Astronomy Cast and has articles published on Wired.com, Space.com, NASA’s Astrobiology   Magazine, Space Times Magazine, and several newspapers in the Midwest.  April 2, 2009 Will Rocket Launches Deplete the Ozone? Universe Today, http://www.universetoday.com/28412/will-rocket-launches-deplete-the-ozone/

A new study predicts that Earth’s stratospheric ozone layer will suffer significant damage from future unregulated rocket launches. The study provides a market analysis for estimating future ozone layer depletion based on the expected growth of the space industry and known impacts of rocket launches. The increase in launches could cause ozone depletion that eventually could exceed ozone losses from CFCs (chlorofluorocarbons) which were banned in the 1980′s. “As the rocket launch market grows, so will ozone-destroying rocket emissions,” said Professor Darin Toohey of CU-Boulder’s atmospheric and oceanic sciences department, a member of the study. “If left unregulated, rocket launches by the year 2050 could result in more ozone destruction than was ever realized by CFCs.” The study says more research should be done on how different rockets affect the ozone before imposing stricter regulations on chemicals used in rocket fuels. Current global rocket launches deplete the ozone layer by no more than a few hundredths of 1 percent annually, said Toohey. But as the space industry grows and other ozone-depleting chemicals decline in the Earth’s stratosphere, the issue of ozone depletion from rocket launches is expected to move to the forefront. Rockets around the world use a variety of propellants, including solids, liquids and hybrids. Martin Ross, lead author of the study from The Aerospace Corporation Ross said while little is currently known about how they compare to each other with respect to the ozone loss they cause, new studies are needed to provide the parameters required to guide possible regulation of both commercial and government rocket launches in the future. Since some proposed space efforts would require frequent launches of large rockets over extended periods, the new study was designed to bring attention to the issue in hopes of sparking additional research, said Ross. “In the policy world, uncertainty often leads to unnecessary regulation,” he said. “We are suggesting this could be avoided with a more robust understanding of how rockets affect the ozone layer.” “Twenty years may seem like a long way off, but space system development often takes a decade or longer and involves large capital investments,” Ross continued. “We want to reduce the risk that unpredictable and more strict ozone regulations would be a hindrance to space access by measuring and modeling exactly how different rocket types affect the ozone layer.” Highly reactive trace-gas molecules known as radicals dominate stratospheric ozone destruction, and a single radical in the stratosphere can destroy up to 10,000 ozone molecules before being deactivated and removed from the stratosphere. Microscopic particles, including soot and aluminum oxide particles emitted by rocket engines, provide chemically active surface areas that increase the rate such radicals “leak” from their reservoirs and contribute to ozone destruction, said Toohey. In addition, every type of rocket engine causes some ozone loss, and rocket combustion products are the only human sources of ozone-destroying compounds injected directly into the middle and upper stratosphere where the ozone layer resides, he said.

1NC Ozone Disad

3. Depleted Ozone harms marine life- plankton won’t survive

The Ozone Hole, 06/26/2011, Ozone Hole Consequences, http://www.theozonehole.com/consequences.htm

Less phytoplankton means less food for these animals to eat. It is estimated that a 16 % ozone depletion could result in further losses in Phytoplankton, which would lead to a loss of about 7 million tons of fish per year. With the human food supply already strained due to demands of an ever-increasing population, small reductions resulting from UV damage may be disastrous to many people, especially the poor and indigenous people. **UV Rays enter the** **human body** Researchers say it's clear that UV-B harms Antarctic microbes. Dr Patrick Neale, of the Smithsonian Environmental Research Center, has predicted that phytoplankton photosynthesis declines by as much as 8.5 per cent under the worst conditions. It also damages the DNA of marine bacteria and the larvae of starfish and urchins, they say. And it even alters ocean chemistry, creating potentially dangerous substances in the water itself. "This refers to the fact that UV radiation is involved in a number of photochemical reactions in seawater (including the hydrolysis/splitting of water molecules) that produce radicals (hydroxyl, peroxide, superoxide, etc.). These radicals are very reactive and can cause biological damage by oxidizing biological molecules. It's really dramatic what the changes in ozone levels will do to rates of DNA damage and inhibited development," says biologist Deneb Karentz of the University of San Francisco. "If you have a 30 per cent decline in ozone, that doesn't mean a 30 per cent decline in a given biological process - it could be a lot more than that". Experts predict that an estimated 10 % reduction in the ozone layer will result in a 25 % increase in non-melanoma skin cancer rates for temperate latitudes by the year 2050.

4. Ozone depletion causes adverse effects on marine life, specifically to phytoplankton-a key organism in the marine life food chain.

Jenkins 06 (Rod Jenkinsworked for NASA Marshall Space Flight Center during the Apollo launches; EPA in Washington D.C. from the Nixon Watergate era through the early Reagan years, 2006, <http://www.ozonedepletion.info/index.html>)

Impact on the Biosphere (of ozone depletion)1. Marine Ecosystems . The effects on aquatic ecosystems, especially on phytoplankton and larvae of higher organisms, are of particular concern. Marine phytoplankton play a fundamental role both in the food chain as well as the oceanic carbon cycle by which atmospheric carbon dioxide is converted into oxygen. See Figure 13. Approximately 30 percent of the world’s animal protein for human consumption comes from the sea The tendency toward a more westerly (counterclockwise, or cyclonic) circulation within and around the polar cap region may be contributing to the recent retreat of the Arctic pack ice during summertime as well as the thinning of the perennial pack ice ([86](http://www.pnas.org/content/97/4/1412.full#ref-86)–[89](http://www.pnas.org/content/97/4/1412.full#ref-89)). A more cyclonic wind stress, as occurs in the high index polarity of the NAM, favors divergence of ice and surface water out of the Arctic, opening up leads, and thinning the layer of cold, fresh water that insulates the pack ice from the warmer, saltier waters underneath ([22](http://www.pnas.org/content/97/4/1412.full#ref-22)). Another possible complicating factor is the oceanic thermohaline circulation, whose sinking branch lies along the edge of the pack ice in the far reaches of the North Atlantic. In recent years, the conditions that favor bottom water formation (i.e., strong outflows of cold, dry air across the ice edge) have been observed less frequently over the Greenland Sea and more frequently over the Labrador Sea, suggesting that bottom water formation has been occurring farther westward ([90](http://www.pnas.org/content/97/4/1412.full#ref-90), [91](http://www.pnas.org/content/97/4/1412.full#ref-91)). Whether such a shift will, in time, serve to change the intensity or basic character of the thermohaline circulation has yet to be determined. There are indications that the latitude of the north wall of the Gulf Stream has shifted northward slightly in recent decades in response to the trend in the NAM ([92](http://www.pnas.org/content/97/4/1412.full#ref-92)). A continued northward shift would favor additional warming over Eurasia and the Arctic, above and beyond that associated with the trend in the NAM itself. Coupled interactions such as these could conceivably give rise to NAM-related variability on time scales much longer than the historical record.

1NC Ozone Disad

5. Decline in phytoplankton causes warming, they’re the largest internal link to marine health and they’re key to human life

Steve Connor, Science Editor, “Global warming blamed for 40 per cent decline in the ocean's phytoplankton”, The Independent, London, First Edition, page 4, 7/29/10, Lexis Nexis

THE MICROSCOPIC plants that support all life in the oceans are dying off at a dramatic rate, according to a study that has documented for the first time a disturbing and unprecedented change at the base of the marine food web. Scientists have discovered that the phytoplankton of the oceans has declined by about 40 per cent over the past century, with much of the loss occurring since the 1950s. They believe the change is linked with rising sea temperatures and global warming. If the findings are confirmed by further studies it will represent the single biggest change to the global biosphere in modern times, even bigger than the destruction of the tropical rainforests and coral reefs, the scientists said yesterday. Phytoplankton are microscopic marine organisms capable of photosynthesis, just like terrestrial plants. They float in the upper layers of the oceans, provide much of the oxygen we breathe and account for about half of the total organic matter on Earth. A 40 per cent decline would represent a massive change to the global biosphere. "If this holds up, something really serious is underway and has been underway for decades. I've been trying to think of a biological change that's bigger than this and I can't think of one," said marine biologist Boris Worm of Canada's Dalhousie University in Halifax, Nova Scotia. He said: "If real, it means that the marine ecosystem today looks very different to what it was a few decades ago and a lot of this change is happening way out in the open, blue ocean where we cannot see it. I'm concerned about this finding." The researchers studied phytoplankton records going back to 1899 when the measure of how much of the green chlorophyll pigment of phytoplankton was present in the upper ocean was monitored regularly. The scientists analysed about half a million measurements taken over the past century in 10 ocean regions, as well as measurements recorded by satellite. They found that phytoplankton had declined significantly in all but two of the ocean regions at an average global rate of about 1 per cent per year, most of which since the mid 20th Century. They found that this decline correlated with a corresponding rise in sea-surface temperatures - although they cannot prove that warmer oceans caused the decline. The study, published in the journal Nature, is the first analysis of its kind and deliberately used data gathered over such a long period of time to eliminate the sort of natural fluctuations in phytoplankton that are known to occur from one decade to the next due to normal oscillations in ocean temperatures, Dr Worm said. "Phytoplankton are a critical part of our planetary life support system. They produce half of the oxygen we breathe, draw down surface CO2 and ultimately support all of our fishes." he said. But some scientists have warned that the Dalhousie University study may not present a realistic picture of the true state of marine plantlife given that phytoplankton is subject to wide, natural fluctuations. "Its an important observation and it's consistent with other observations, but the overall trend can be overinterpreted because of the masking effect of natural variations," said Manuel Barange of the Plymouth Marine Laboratory and a phytoplankton expert. However, the Dalhousie scientists behind the three-year study said they have taken the natural oscillations of ocean temperatures into account and the overall conclusion of a 40 per cent decline in phytoplankton over the past century still holds true. "Phytoplankton are the basis of life in the oceans and are essential in maintaining the health of the oceans so we should be concerned about its decline. "It's a very robust finding and we're very confident of it," said Daniel Boyce, the lead author of the study. "Phytoplankton is the fuel on which marine ecosystems run. A decline of phytoplankton affects everything up the food chain, including humans," Dr Boyce said. Phytoplankton is affected by the amount of nutrients the well up from the bottom of the oceans. In the North Atlantic phytoplankton "blooms" naturally in spring and autumn when ocean storms bring nutrients to the surface. One effect of rising sea temperatures has been to make the water column of some regions nearer the equator more stratified, with warmer water sitting on colder layers of water, making it more difficult for nutrients to reach the phytoplankton at the sea surface. Warmer seas in tropical regions are also known to have a direct effect on limiting the growth of phytoplankton.

2NC Uniqueness

A growing private sector space industry will place more demand on rockets—they destroy the ozone layer.

SD, Science Daily, “ Rocket Launches May Need Regulation To Prevent Ozone Depletion, Says Study”, 4/1/09, http://www.sciencedaily.com/releases/2009/03/090331153014.htm

The global market for rocket launches may require more stringent regulation in order to prevent significant damage to Earth's stratospheric ozone layer in the decades to come, according to a new study by researchers in California and Colorado. Future ozone losses from unregulated rocket launches will eventually exceed ozone losses due to chlorofluorocarbons, or CFCs, which stimulated the 1987 Montreal Protocol banning ozone-depleting chemicals, said Martin Ross, chief study author from The Aerospace Corporation in Los Angeles. The study, which includes the University of Colorado at Boulder and Embry-Riddle Aeronautical University, provides a market analysis for estimating future ozone layer depletion based on the expected growth of the space industry and known impacts of rocket launches. "As the rocket launch market grows, so will ozone-destroying rocket emissions," said Professor Darin Toohey of CU-Boulder's atmospheric and oceanic sciences department. "If left unregulated, rocket launches by the year 2050 could result in more ozone destruction than was ever realized by CFCs." A paper on the subject by Ross and Manfred Peinemann of The Aerospace Corporation, CU-Boulder's Toohey and Embry-Riddle Aeronautical University's Patrick Ross appeared online in March in the journal Astropolitics. Since some proposed space efforts would require frequent launches of large rockets over extended periods, the new study was designed to bring attention to the issue in hopes of sparking additional research, said Ross. "In the policy world uncertainty often leads to unnecessary regulation," he said. "We are suggesting this could be avoided with a more robust understanding of how rockets affect the ozone layer." Current global rocket launches deplete the ozone layer by no more than a few hundredths of 1 percent annually, said Toohey. But as the space industry grows and other ozone-depleting chemicals decline in the Earth's stratosphere, the issue of ozone depletion from rocket launches is expected to move to the forefront. Today, just a handful of NASA space shuttle launches release more ozone-depleting substances in the stratosphere than the entire annual use of CFC-based medical inhalers used to treat asthma and other diseases in the United States and which are now banned, said Toohey. "The Montreal Protocol has left out the space industry, which could have been included." Highly reactive trace-gas molecules known as radicals dominate stratospheric ozone destruction, and a single radical in the stratosphere can destroy up to 10,000 ozone molecules before being deactivated and removed from the stratosphere. Microscopic particles, including soot and aluminum oxide particles emitted by rocket engines, provide chemically active surface areas that increase the rate such radicals "leak" from their reservoirs and contribute to ozone destruction, said Toohey. In addition, every type of rocket engine causes some ozone loss, and rocket combustion products are the only human sources of ozone-destroying compounds injected directly into the middle and upper stratosphere where the ozone layer resides, he said. Although U.S. science agencies spent millions of dollars to assess the ozone loss potential from a hypothetical fleet of 500 supersonic aircraft -- a fleet that never materialized -- much less research has been done to understand the potential range of effects the existing global fleet of rockets might have on the ozone layer, said Ross. Since 1987 CFCs have been banned from use in aerosol cans, freezer refrigerants and air conditioners. Many scientists expect the stratospheric ozone layer -- which absorbs more than 90 percent of harmful ultraviolet radiation that can harm humans and ecosystems -- to return to levels that existed prior to the use of ozone-depleting chemicals by the year 2040. Rockets around the world use a variety of propellants, including solids, liquids and hybrids. Ross said while little is currently known about how they compare to each other with respect to the ozone loss they cause, new studies are needed to provide the parameters required to guide possible regulation of both commercial and government rocket launches in the future. "Twenty years may seem like a long way off, but space system development often takes a decade or longer and involves large capital investments," said Ross. "We want to reduce the risk that unpredictable and more strict ozone regulations would be a hindrance to space access by measuring and modeling exactly how different rocket types affect the ozone layer." The research team is optimistic that a solution to the problem exists. "We have the resources, we have the expertise, and we now have the regulatory history to address this issue in a very powerful way," said Toohey. "I am optimistic that we are going to solve this problem, but we are not going to solve it by doing nothing." The research was funded by the National Science Foundation, NASA and The Aerospace Corporation.

2NC Uniqueness

The ozone is recovering on its own already.

Martin Dameris, Professor at Institute of Atmospheric Physics (IPA), German Aerospace Center, Angiewandte Chemie, “Climate Change and Atmospheric Chemistry: How Will the Stratospheric Ozone Layer Develop?” 4 OCT 2010

The ozone layer, including the polar regions, is expected to make a full recovery by the middle of the century. Owing to climate change, it seems plausible that the thickness of the ozone layer will actually exceed that of earlier years from then on (see Figure 7). The results of many numerical simulations with different coupled CCMs are in agreement in this conclusion, even if the time that this “over-recovery” of the ozone layer will take place is forecast differently by the various atmospheric models.23 The results of CCM E39C-A from the German Aerospace Center (DLR), for example, show that climate-change-related processes will result in an accelerated recovery of the ozone layer overall.24 Ozone values of a magnitude similar to those measured in the 1960s are predicted to occur even before the middle of the century. Towards the end of its simulation period (2040–2050), the model clearly shows that the thickness of the ozone layer will be greater than that measured in the period of 1960–1970, a time when the massive stratospheric ozone depletion owing to CFCs had not yet shown a significant impact. However, Figure 7 also shows that natural processes, such as the eleven-year solar activity cycle and large volcanic eruptions (Agung 1963, El Chichon 1982, Pinatubo 1991) result in a clear change in the thickness of the stratospheric ozone layer. The close similarity between the changes in the thickness of the ozone layer derived from observations and actual observations shows the high quality of the numerical simulations (see Figure 3). The model system used obviously takes the key factors influencing the stratospheric ozone layer into account. For this reason, within the limits of the above-mentioned uncertainties, predictions on future ozone-layer developments are reliable.

Status quo levels of rocket launches won’t threaten the ozone, but increased space exploration <or development/SBSP/etc> would change this.

Martin Ross, the Aerospace Corporation; and Darin Toohey, University of Colorado; Manfred Peinemann, the Aerospace Corporation; Patrick Ross, Embry-Riddle Aeronautical University, “Limits on the Space Launch Market Related to Stratospheric Ozone Depletion”, Astropolitics, 7:1, 50-82, 2009, http://www.tandfonline.com/doi/abs/10.1080/14777620902768867

Cicerone and Stedman2 first considered rocket emissions as a source of ozone depletion. Subsequent studies have shown consistently that at current launch rates, ozone depletion from rocket exhaust is insignificant compared to other sources of ozone loss.3 If launch rates and ozone depletion from other sources remain at current levels, this assessment will not change. The potential exists that the demand for launch services could increase significantly in the future.4 Large (factors of ten or more) increases in launch demand could come about for a variety of reasons, including national decisions regarding security, enhanced space exploration, market forces associated with significant reductions in launch costs, or the emergence of new markets such as space tourism, manufacturing, or solar power. Analysts generally assume that if the cost of access to orbit is reduced sufficiently, then large, new markets will emerge for space industry and the launch market. This development **would be considered revolutionary**, and it is not clear when or if, this might occur. Nevertheless, if space transport follows the ‘‘normal’’ development path of transportation technology enters a period of continual expansion, it would be necessary to reconsider **the environmental consequences of large rockets, launched often**. In this paper, we consider the implication of such significant increase in demand for orbital launches on the global ozone layer. We do not consider greenhouse gas emissions from rockets. Climate change is to some extent a separable problem from ozone depletion. While rocket engines emit gases identified as contributing to climate change, the amount emitted globally is trivial compared to other sources and is likely to remain so. Annual CO2 emissions from rockets, for example, are about several kilotons (kt) compared to emissions of several hundred kt from aircraft which, in turn, is only a few percent from all CO2 sources.5 Space launch emissions, even for the large growth scenarios discussed here, will not likely be significant in future greenhouse gas regulatory schemes. As a cautionary tale, we point out that even though aircraft are responsible for a few percent of all CO2 emissions, the airline industry must contend with considerable attention and likely regulation or carbon taxation.6 The message to the space industry should be clear: policy and media attention on high visibility propulsion emissions are often framed in ways that overemphasize the relative contribution.7 If rockets are a minuscule contributor to the problem of climate change, they do have a significant potential to become a significant contributor to the problem of stratospheric ozone depletion. This follows from three unique characteristics of rocket emissions: 1. Rocket combustion products are the only human-produced source of ozone-destroying compounds injected directly into the middle and upper stratosphere. The stratosphere is relatively isolated from the troposphere so that emissions from individual launches accumulate in the stratosphere. 8 Ozone loss caused by rockets should be considered as the cumulative effect of

several years of all launches, from all space organizations across the planet. 2. Stratospheric ozone levels are controlled by catalytic chemical reactions driven by only trace amounts of reactive gases and particles.9 Stratospheric concentrations of

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2NC Uniqueness

these reactive compounds are typically about one-thousandth that of ozone. Deposition of relatively small absolute amounts of these reactive compounds can significantly modify ozone levels. 3. Rocket engines are known to emit many of the reactive gases and particles that drive ozone destroying catalytic reactions.10 This is true for all propellant types. Even water vapor emissions, widely considered inert, contribute to ozone depletion. Rocket engines cause more or less ozone loss according to propellant type, but every type of rocket engine causes some loss; no rocket engine is perfectly ‘‘green’’ in this sense. Since 1987, the ozone layer has been protected by international agreements11 that limit the production and use of substances that have been determined to cause ozone depletion. The Montreal Protocol on Substances That Deplete the Ozone Layer (and subsequent amendments), regulates the worldwide production and use of ozone depleting substances (ODSs), including the well-known chlorofluorocarbons (CFCs) and other halogen gases. The Montreal Protocol is widely considered a significant success and the global phase out of ODSs mandated by the Protocol is expected to allow the ozone layer to recover to pre-ODS levels by about 2040. In support of the Montreal Protocol, the stratospheric science community issues a quadrennial summary, the Scientific Assessment of Ozone Depletion,12 describing the state of knowledge of stratospheric composition, the factors causing ozone depletion, and projections of the future ozone layer. The Quadrennial Ozone Assessments have occasionally addressed ozone depletion caused by rocket emissions and have determined that the current loss is ‘‘small’’ in comparison to other sources of ozone loss so that rocket emissions are not a part of the regulatory framework that protects the ozone layer. Later we discuss the threshold level of ozone loss that might be considered ‘‘not small,’’ as well as the level that might be considered ‘‘too large.’’ The recovery of the ozone layer,13 while a favorable development, is motivation to be concerned about ozone depletion caused by rocket emissions over the next several decades. The eventual elimination of the major sources of ozone loss (that is, ODSs) raises the question: Will sources of ozone loss currently considered small, such as rocket emissions, eventually be scrutinized more closely by the stratospheric protection community?14 This would particularly apply to rocket emissions if demand for launch services increases in coming decades, just as other sources of ozone loss decrease due to the success of the Montreal Protocol. In addition, revisions in our understanding of emissions, stratospheric processes, or the introduction of new propellants on a large scale (hybrid rockets, for example) may cause changes in the estimated ozone loss for a given launch rate. In this paper, we examine the problem of rockets and ozone depletion from several new points of view. For the first time, we consider the problem in a long-term context that includes significant, sustainable,15 growth in the space industry and evolving regulatory actions associated with the recovery of the ozone layer from past pollution. We apply the first plausible estimates of ozone loss caused by liquid propellant rockets, which will certainly play the major role in a significant expansion of the launch industry. We develop a parameterization of the steady-state global ozone loss caused by solid and liquid propellant rocket emissions and relate the ozone loss to amount of payload delivered to Low Earth Orbit (LEO). The model is limited by uncertainties in the actual composition of rocket emissions, and the stratospheric processes that bring about the ozone loss; and it can only be used to draw conclusions of an order of magnitude. Nevertheless, the model is useful to examine long-term trends and investigate rocket emission ozone loss within the context of scenarios of large increases in launch rates, the recovery of the ozone layer, and conceptual analysis of the econometric effect of caps on rocket emissions that might be enacted to protect the ozone layer. We draw a number of conclusions for the global launch industry that have implications for policymakers for both strategic space transport planning and future protection of the ozone layer. Finally, we also identify the most important areas where new research could reduce the model uncertainties and so increase the ability to reliably plan for future space systems development. STRATOSPHERIC OZONE AND REGULATORY PROTECTION Ozone Chemistry A detailed account of stratospheric chemistry is beyond the scope of this paper however, a few critical concepts need to be explained in order to justify our parameterization of rocket ozone loss. The stratospheric ozone (O3) layer generally resides between 20–30km altitudes, absorbing harmful solar ultraviolet radiation before it reaches the Earth’s surface. Chemical and dynamical processes that are well understood determine the vertical and horizontal distributions of stratospheric ozone. The ozone layer results from a long-term balance between the vertical profile of ozone production, the vertical profile of ozone destruction, and the global circulation of stratospheric air. The ozone destruction side of the balance is dominated by reactive trace gases known as radicals. The highly reactive radicals—oxides of nitrogen, hydrogen, bromine, and chlorine referred to as NOx, HOx, BrOx, and ClOx—control global ozone levels by tilting the long-term balance between ozone production and destruction in favor of the latter. Moreover, because the radical reactions are catalytic, only trace amounts, a few parts per billion, are able to control much greater amounts of stratospheric ozone. A single radical molecule emitted into the stratosphere, for example, can destroy up to 105 ozone molecules before being deactivated and transported out of the stratosphere. Radicals react with ozone on very short time scales, minutes to hours, so that direct injection into the stratosphere over a limited area (a rocket plume, for example) will cause a prompt, localized, ozone ‘‘hole.’’ 16 Particles also play an important role in ozone destruction. Chemical reactions particle surfaces activate radicals from their reservoirs, shifting the balance toward lower ozone levels. The strong potential for particles to reduce ozone is demonstrated in the springtime south polar stratosphere, where photochemical reactions on ice particles efficiently liberate ClOx from reservoirs17 and so play a role in the formation of the infamous ‘‘Ozone Hole.’’ Such reactions are known occur on the surface of alumina and, possibly, soot particles.18 Particles with diameter less than about 1 micron (mm) remain suspended in the stratosphere for several years19 and become mixed globally by the stratospheric circulation. This means that repeated injections of submicron particles into the stratosphere, as from global (weekly) rocket launches for example, result in an accumulation of particles. The accumulated particle surfaces increase the rates that radicals ‘‘leak’’ from their reservoirs and so reduce ozone levels globally. NOx, HOx, BrOx, and ClOx radicals are produced from source gases and reservoir gases. The sources and reservoirs can be thought of as a sort of chemical storage for the radicals, which leak photochemically from storage into the stratosphere, increasing the rate of ozone destruction. The concentrations of the sources and particularly reservoirs are determined by a steady state between fluxes across the tropopause, production from radical-radical reactions, loss from photolysis and radical-reservoir reactions, and direct injection from rocket engine emissions. H2O, emitted by all rocket engines, is one of the most critical source gases.20 H2O is the source gas for HOx radicals but also contributes to the formation of the ice particles that cause the polar ozone hole. Small changes in middle atmosphere water vapor and temperature can cause large changes in stratospheric cloudiness. Ozone loss from water vapor emissions is highly nonlinear and difficult to predict. As a foundation for further discussion, we proceed with the understanding that all types of rocket engines, solid rocket motors (SRMs) and liquid rocket engines (LREs), emit compounds that are known to reduce ozone to various degrees, depending on their various compositions. Rockets engines inject all of the types of compounds mentioned above associated with ozone loss—radicals, their sources and reservoirs, and reactive particles—throughout all levels of the stratosphere. They are the only ozone destroying, human-produced, compounds that are emitted into the stratosphere this way. OZONE

2NC Uniqueness

The ozone layer is recovering from abuse

Climate and Pollution Agency, 9/17/2010, Ozone layer, www.environment.no, http://www.miljostatus.no/en/Topics/Climate/Ozone-layer/#A

The ozone layer is found in the stratosphere, 15-35 km above the surface of the earth. Ninety per cent of the ozone (O3) present in the atmosphere is concentrated here. Ozone is continually generated and broken down through natural processes in the stratosphere. Anthropogenic emissions of ozone-depleting substances have disturbed the balance in the stratosphere.

The ozone layer expected to recover significantly by 2050-2070

The amount of most of the ozone-depleting substances in the troposphere is now declining slowly. The ozone layer is expected to recover significantly by 2060-2075 above Antarctica and around 2050 elsewhere.

Recent global ozone data indicate that there might be signs of ozone recovery from mid 1990s in most of the world. However this is uncertain, particularly at high latitudes and in the Arctic region. The uncertainty is caused by the high natural variability in these regions, and the influence of factors like decreasing temperatures in the stratosphere, which is partly due to the increase of greenhouse gases in the troposphere.

Ending use of CFC’s has allowed ozone recovery

NOAA NEWS onlineNovember 13, 2008***,*** Scientific Assessment Presents Status, Expectations for Ozone Layer, National Oceanic and Atmospheric Administration

The numbers reflect a decline of 97-98 percent in the U.S. production of the ozone-damaging chemicals since the late 1980s. U.S. actions have aided international efforts to achieve a recovery of the ozone layer, which is expected to occur about mid-century for most regions of the globe. Ozone depletion is not worsening, and in some regions the ozone layer is now showing early signs of recovery.

The ozone layer is recovering largely because of the actions taken by the international community to limit ozone-depleting substances, such as chlorofluorocarbons, or CFCs, that were used as coolants in refrigerators and air conditioning systems. The Montreal Protocol and its subsequent amendments established limits and eventual phase-outs for production and consumption of several ozone-depleting substances.

Human action has depleted ozone layer- CFCs kill stratosphere

Guy Clavel, Concordia Base (AFP) Antarctica, Feb 15, 2007 Scientists Diagnose Ozone Layer Status OZONE NEWS http://www.terradaily.com/reports/Scientists\_Diagnose\_Ozone\_Layer\_Status\_999.html

The collective diagnosis is unambiguous: the stratospheric blanket of oxygen molecules, some 15-35 kilometers (nine-21 miles) above Earth's surface, which protects human skin and eyes and plant DNA from dangerous ultraviolet light is ulcerated.

It is being split apart by a hole that gapes open and narrows with the seasons.

In October 2006 the ozone layer's wound spanned a record 29.5 million square kilometers (10.81 million square miles) and showed a loss of 40 million tonnes, exceeding the previous record of 39 million tonnes set in 2000, according to the European Space Agency (ESA).

The primary cause of illness is known too.

Over the second half of the 20th century, human activity excreted a corrosive soup of man-made chemicals -- especially chlorine and chlorofluorocarbons (CFCs) -- that breaks down the oxygen molecules in the stratosphere.

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Rocket launches cause catalytic destruction of stratospheric ozone

Smith et al., Tyrell W. Smith, Jr., Ph.D, TRW Space & Electronics Group; John R. Edwards, Daniel Pilson, Environmental Management Branch “Summary of the Impact of Launch Vehicle Exhaust and Deorbiting Space and Meteorite Debris on Stratospheric Ozone”, Prepared for: U.S. Air Force Space and Missile Systems Center Environmental Management Branch, 9/30/1999, http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA414306

Rocket launches can affect the atmosphere both in an immediate, episodic manner, and in a long-term, cumulative manner. The stratosphere is affected immediately after launch along the flight trajectory of the launch vehicle (LV) for about 60 to 120 seconds, the time required for the LV to pass through the stratosphere. Formed either directly or indirectly from rocket exhaust, radicals, such as Cl, ClO, H, OH, HO2, NO, and NO2, can cause the catalytic destruction of stratospheric ozone. Other exhaust compounds that presumably could lead to ozone destruction either by direct reaction with ozone or by providing a surface for heterogeneous processes include Al2O3 and ice (Hanning-Lee et al., [1996]). While no experimental evidence exists and no work to date has been performed, Lohn et al., [1999] has suggested that soot may contribute to catalytic ozone destruction in rocket plumes. The emissions from some types of launch vehicles significantly perturb the atmosphere along the launch trajectory at a range of a kilometer or less from the rocket passage. Ozone is temporarily reduced, an aerosol plume may be produced, and combustion products such as NOx, chlorinated compounds, and reactive radicals can temporarily change the normal chemistry along the vehicle path. The stratosphere exchanges mass with the troposphere beneath it at a relatively low rate. With no rainout or other removal mechanisms, the rocket combustion products can build up in the stratosphere over time if there is a sufficient launch rate. When deposited into the stratosphere, ideally sized particulate (0.15 to 0.4 microns in size) such as alumina aerosols can persist for months and circle the globe. Aerosols that exist in the stratosphere can assist in catalyzing the destruction of ozone. The stratospheric chemistry of alumina surfaces under stratospheric conditions has also been studied (Meads et al., [1994]). The results of this study indicated that the reaction probabilities for critical chlorine reactions are typically an order of magnitude less than for ice and water-rich nitrate aerosols. However, the alumina surfaces are considerably more reactive than the sulfuric acid aerosols found in the lower stratosphere in mid-latitudes. As a result, for regions where PSCs and water or ice aerosols are rare, such as in the tropical and mid-latitudes, the alumina aerosol surfaces may play an important role in expediting ozone destruction by halogen species if a sufficient atmospheric loading occurs. However, compared with the sulfate aerosol loading, the alumina loading from rocket launches is less than 1 percent of the sulfate aerosol even when there have not been any recent volcanic eruptions (Beiting [1997b]).

Rocket launches kill the ozone with chlorine oxides

Anne Minard, a scientific journalist who has published in National Geographic News, The New York Times, the Los Angles Times, Science, Scientific American and High Country News, awarded first place in environmental reporting from the Arizona Associated Press Managing Editor's Association, April 14, 2009, Rocket Launches Damage Ozone Layer, Study Says, National Geographic News http://news.nationalgeographic.com/news/2009/04/090414-rockets-ozone.html

But when solid-fuel rockets launch, they release chlorine gas directly into the stratosphere, where the chlorine reacts with oxygen to form ozone-destroying chlorine oxides.

Increased international space launches and the potential commercial space travel boom could mean that rockets will soon emerge as the worst offenders in terms of ozone depletion, according to the study, published in the March issue of the journal *Astropolitics.*

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Rocket fuel destroys ozone in the stratosphere

Martin Ross, the Aerospace Corporation; and Darin Toohey, University of Colorado; Manfred Peinemann, the Aerospace Corporation; Patrick Ross, Embry-Riddle Aeronautical University, “Limits on the Space Launch Market Related to Stratospheric Ozone Depletion”, Astropolitics, 7:1, 50-82, 2009, http://www.tandfonline.com/doi/abs/10.1080/14777620902768867

STRATOSPHERIC IMPACT OF ROCKET EXHAUST Overview and Methodology A full description of the complex processes that mix, transport, and chemically process rocket emissions into the global stratosphere is beyond the scope of this work However, it is of interest to briefly review the available information on rocket emissions and how the ozone layer is affected. With this background, we present approximate descriptions of the global ozone loss DO3 for rocket emissions based on available data and models. The available information is sparse and approximate; so our analysis must be considered in the context of large uncertainties. This is particularly so for liquid propellant engines. The alternative to our work is to make no progress at all. Accordingly, in addition to our conclusions, we highlight the many areas where further research is required. To first order, rocket engine exhaust consists of chemically inert compounds (N2 and CO2), radicals (NO, OH, Cl), radical sources and reservoirs (HCl, H2O), intermediate underoxidized compounds (H2, CO) and alumina or soot. The relative combinations of these compounds in the exhaust depend on propellant type; four main propellant types are in wide use, one solid, and three liquid. We must distinguish between rocket exhaust (hot gases and particles at the nozzle exit) and rocket emissions (the cold plume wake that mixes into the stratosphere). In the lower stratosphere, fuel rich rocket exhaust is modified in the hot plume by intense secondary combustion reactions driven by atmospheric oxygen mixing into the plume. This ‘‘afterburning’’ governs the conversion of H2 to H2O, CO, and soot to CO2, and net production of ozone destroying radicals.28 Afterburning is vigorous in the lower stratosphere, lessens with altitude, and stops in the upper stratosphere and so rocket emissions are highly variable with altitude. Afterburning is not well understood—especially with respect to the minor components that most affect ozone. Table 1 shows the first order emission compositions for the four main propellant types. Parentheses show the common names for the different propellant types. Table 1 acknowledges afterburning by reporting H2 and CO in the exhaust as converted to H2O and CO2, respectively, and net production of radicals. We emphasize that plume models have never been validated with respect to the net emission of radicals, soot, or the details of the alumina particles sizes. One recent measurement suggests that the models in fact underestimate the production of NO in the Space Shuttle SRMs or LREs. The emissions presented in Table 1 cause prompt and deep ozone loss (approaching 100%) in the immediate plume wake, caused by the radical emissions, over areas of hundreds of square miles lasting several days after launch. These stratospheric ‘‘ozone mini-holes’’ have been well observed in situ by high altitude aircraft plume sampling campaigns. It is not known if the cumulative effect of the small ‘‘ozone holes’’ is significant compared to the global steady-state chemical effects of the emissions. Beyond the prompt plume wake ozone destruction, second order processing of rocket combustion products occurs during the weeks and months after launch. The plumes are transported and mixed into the global stratosphere and lose their identity as distinct air masses. This intermediate mesoscale phase would be characterized by complex plume-atmosphere interactions among radicals, reservoirs, and sinks. Significant influences from alumina or soot particles are expected, possibly involving the creation of new H2O related particles. The details of this processing will be highly variable according to altitude and even time of day of launch and certainly has a large influence on the steady-state global ozone loss. A few chance observations of aged plumes confirm the importance of the mesoscale processing. No studies have been done on this aspect of rocket emissions.

Rocket launches kill the ozone with chlorine oxides

Anne Minard, a scientific journalist who has published in National Geographic News, The New York Times, the Los Angles Times, Science, Scientific American and High Country News, awarded first place in environmental reporting from the Arizona Associated Press Managing Editor's Association, April 14, 2009, Rocket Launches Damage Ozone Layer, Study Says, National Geographic News http://news.nationalgeographic.com/news/2009/04/090414-rockets-ozone.html

But when solid-fuel rockets launch, they release chlorine gas directly into the stratosphere, where the chlorine reacts with oxygen to form ozone-destroying chlorine oxides.

Increased international space launches and the potential commercial space travel boom could mean that rockets will soon emerge as the worst offenders in terms of ozone depletion, according to the study, published in the March issue of the journal *Astropolitics.*

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Rocket launches kill ozone- one radical destroys 10,000 ozone molecules

Nancy Atkinson, science journalist who writes about space exploration and astronomy, Senior Editor and writer for Universe Today, project manager for 365 Days of Astronomy podcast, part of the production team for Astronomy Cast and has articles published on Wired.com, Space.com, NASA’s Astrobiology   Magazine, Space Times Magazine, and several newspapers in the Midwest.  April 2, 2009 Will Rocket Launches Deplete the Ozone? Universe Today, http://www.universetoday.com/28412/will-rocket-launches-deplete-the-ozone/

A new study predicts that Earth’s stratospheric ozone layer will suffer significant damage from future unregulated rocket launches. The study provides a market analysis for estimating future ozone layer depletion based on the expected growth of the space industry and known impacts of rocket launches. The increase in launches could cause ozone depletion that eventually could exceed ozone losses from CFCs (chlorofluorocarbons) which were banned in the 1980′s. “As the rocket launch market grows, so will ozone-destroying rocket emissions,” said Professor Darin Toohey of CU-Boulder’s atmospheric and oceanic sciences department, a member of the study. “If left unregulated, rocket launches by the year 2050 could result in more ozone destruction than was ever realized by CFCs.” The study says more research should be done on how different rockets affect the ozone before imposing stricter regulations on chemicals used in rocket fuels.  
Current global rocket launches deplete the ozone layer by no more than a few hundredths of 1 percent annually, said Toohey. But as the space industry grows and other ozone-depleting chemicals decline in the Earth’s stratosphere, the issue of ozone depletion from rocket launches is expected to move to the forefront.

Rockets around the world use a variety of propellants, including solids, liquids and hybrids. Martin Ross, lead author of the study from The Aerospace Corporation Ross said while little is currently known about how they compare to each other with respect to the ozone loss they cause, new studies are needed to provide the parameters required to guide possible regulation of both commercial and government rocket launches in the future.

Since some proposed space efforts would require frequent launches of large rockets over extended periods, the new study was designed to bring attention to the issue in hopes of sparking additional research, said Ross. “In the policy world, uncertainty often leads to unnecessary regulation,” he said. “We are suggesting this could be avoided with a more robust understanding of how rockets affect the ozone layer.”

“Twenty years may seem like a long way off, but space system development often takes a decade or longer and involves large capital investments,” Ross continued. “We want to reduce the risk that unpredictable and more strict ozone regulations would be a hindrance to space access by measuring and modeling exactly how different rocket types affect the ozone layer.”

Highly reactive trace-gas molecules known as radicals dominate stratospheric ozone destruction, and a single radical in the stratosphere can destroy up to 10,000 ozone molecules before being deactivated and removed from the stratosphere. Microscopic particles, including soot and aluminum oxide particles emitted by rocket engines, provide chemically active surface areas that increase the rate such radicals “leak” from their reservoirs and contribute to ozone destruction, said Toohey.

In addition, every type of rocket engine causes some ozone loss, and rocket combustion products are the only human sources of ozone-destroying compounds injected directly into the middle and upper stratosphere where the ozone layer resides, he said.

Regulations needed on Rockets- ozone destruction growing

Environmental News Service- April 1, 2009, Scientists: Regulate Rocket Launches to Safeguard Ozone Layer http://www.ens-newswire.com/ens/apr2009/2009-04-01-091.html

Future stratospheric ozone losses from unregulated rocket launches will exceed ozone losses from fluorinated gases, finds a new study by researchers in California and Colorado. Stricter regulation of launches will be needed to prevent damage to Earth's stratospheric ozone layer, the scientists advise.

"As the rocket launch market grows, so will ozone-destroying rocket emissions," said Professor Darin Toohey of the Atmospheric and Oceanic Sciences Department at the University of Colorado, Boulder. "If left unregulated, rocket launches by the year 2050 could result in more ozone destruction than was ever realized by CFCs."

Future ozone losses from unregulated rocket launches will eventually exceed ozone losses due to chlorofluorocarbons, or CFCs, which stimulated the 1987 Montreal Protocol banning ozone-depleting chemicals, said Martin Ross, chief study author from The Aerospace Corporation in Los Angeles.

Proposed space activities would require frequent launches of large rockets over extended periods ot time, so the new study was designed to bring attention to the issue in hopes of triggering additional research, said Ross.

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Rocket launches deplete ozone

Martin Ross, director of research at the Aerospace Corp., “OpEd: Time to Get Serious About Rocket Emissions”, 6/16/09, http://www.spacenews.com/archive/archive09/rossoped\_0608.html

The twin problems of stabilizing Earth's climate and maintaining the stratospheric ozone layer will likely emerge as the most urgent ecological concerns of the 21st century. A cooperative global regime to limit greenhouse gas emissions and mitigate the effects of climate change will emerge only after years of difficult diplomatic and research initiatives. The good news is that the international community has a working model for global cooperation in the Montreal Protocol, a global treaty protecting the ozone layer that came into force in 1989. The landmark Montreal Protocol established a legal framework to phase out the production and use of substances that deplete the ozone layer, mainly chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). The tremendous success of the Montreal Protocol is due, in part, to unambiguous metrics, regular scientific review, a provision for treaty modifications to respond to new scientific data and technological developments, and strict adherence to the concept that once an ozone-depleting substance is identified, all applications are phased out, no matter how small. Recognizing the success of the Montreal Protocol and the coupled natures of the climate and ozone problems, proposals have been made to use the Protocol to limit hydrofluorocarbons (HFCs) — gases that have no ozone depletion potential but large global warming potential. However the Protocol evolves, the number and types of banned substances can be expected to grow as legacy ozone depleters from the past century — CFCs and their substitutes — disappear from the atmosphere as planned. So how do space systems fit into this fast-changing global regulatory situation? Rocket engines emit reactive gases and particles of various types depending on propellant type and engine details. During entry, vaporizing spacecraft and debris generate a very wide variety of gases and particles that are deposited into the upper stratosphere. Space systems are the only direct pollution sources above about 20 kilometers. As to climate change, rocket engine carbon dioxide emissions are fairly well-known and by almost any metric, space travel's carbon footprint is insignificant compared with other forms of transportation. New and unexpected data could change this view. For example, it was only recently discovered that water emissions from supposedly "green" cryogenic engines cause mesospheric cloud formations thousands of kilometers away from launch sites. Nevertheless, space systems are not likely a significant contributor to climate change, even with a much larger space industry. Continual vigilance seems prudent, however. The situation with regard to ozone depletion is completely different. The minor rocket engine gas and particle emissions that affect ozone are more difficult to model and measure than carbon dioxide and water vapor. Currently, space systems are responsible for at most a few percent of all ozone depletion. That sounds insignificant. Consider, however, that aircraft emissions are responsible for a comparably small percentage of all global warming and yet the air transport industry is under tremendous pressure to limit combustion emissions. The lesson is that being a small part of a big problem is no cause for indifference or automatic exemption from international environmental regulation. In fact, there are several specific reasons that the potential for ozone depletion-related regulation poses a risk to space systems development and operations: ▪ First, space systems emissions are a growing part of the global ozone depletion picture**.** Atmospheric concentrations of CFCs and related gases are rapidly decreasing and since space transport is growing (even if only slowly right now), the space industry's relative impact is increasing and could possibly emerge as the largest contributor to ozone depletion within several decades. In this situation, it is certain that at some point space system emissions will be subject to increased scrutiny under the Montreal Protocol. ▪ Second, there are very large gaps in our understanding of aerospace propulsion emissions and how they affect the middle atmosphere. We do not have reliable emission models, validated by in situ plume wake data, for all of the different rocket propellant types. We do not have good models of the ozone loss caused by specific launch vehicles or the impact of different combined fleets of launch vehicles. We have not developed standard scenarios for future emissions as the air transport industry has done. In short, we do not have the tools that are needed to understand and predict how current or future space architecture will affect the stratosphere. ▪ Third, very significant investments are being made in new launch and orbital systems without any regard to how they affect ozone. Hybrid propellant rockets and hypersonic scramjets are far into development and testing under the assumption of unlimited future use. But we have nil understanding of how hybrid or hypersonic systems affect the ozone layer. Investments are also being made in space-based solar power but we have no estimates of how transport to orbit of such large payloads would affect ozone. All of these new systems require high launch rates — and therefore vastly increased stratospheric emissions — to justify the current investments. Is the expectation of very high flight rates consistent with the evolving ozone protection regime? It is clear that the risk of regulation that would cap or even tax space systems according to the amount of ozone depletion they cause is small, but it is real. And the risk is almost certain to increase. This risk increases uncertainties in all areas of space industry development from capital investments in new propulsion systems, to the economic assumptions behind the push to reduce launch costs using high flight-rate systems, to assumptions regarding assured access to space.

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Hasty shuttle launches leads to radioactive pollution in atmosphere.

Vasiliy Kharkov, Commentary by Aleksandr Druzhinin, BBC Summary of World Broadcasts, “Cause of Challenger Disaster Was ''Haste in Carrying out Shuttle Programme'', June 12, 1986

NASA's negligence and mistakes cost seven astronauts their lives. Now, what would be the price humanity would have to pay in the event of a catastrophe in a militarised space? This seems to be the question Washington politicians must ask themselves after the Challenger tragedy. But they haven't. Moreover, the Washington administration has boosted its plans for turning space into a military testing range. The US Assistant Defence Secretary, Richard Perle, said recently that the first components of space weapons would be deployed in space in a few years time. Washington has failed to derive any lessons from the Challenger tragedy. It stubbornly continues along the way leading to ''Star War'' madness. (ii) Text of commentary: And now some facts about the launching of American spaceships. At the begining of 1967 Japanese dosiometric stations panicked. The level of radiation in the country had risen for unknown reasons. The rise was caused by the explosion of a Transit spy satellite of the US Navy. The satellite carried a nuclear reactor. As a result of the explosion a considerable amount of plutonium-238 spread in the atmosphere but, at the time, Washington managed to conceal the truth about the disaster. Foreign news agencies and press report other facts as well. An oxygen tank exploded during the flight to the moon of Apollo-13 in April, 1970. The spaceship had to return to Earth hastily and on the way back the unnecessary landing module, with a nuclear reactor and a cargo of plutonium on board, was dropped into the Pacific near Australia. It's still on the ocean bed contaminating the atmosphere. Last May, Washington intended to take two unmanned stations with nuclear reactors and 30 kilos of radioactive plutonium into space on a shuttle. The launching was postponed following the explosion of Challenger last January. Besides Challenger, Titan and Delta booster rockets have exploded this year alone during takeoff, but the Pentagon is opposed to stopping the use of radioactive fuel on American spaceships because, first of all, nuclear reactors are installed on military satellites to [word indistinct] the spying equipment and combat devices on them. [Note: In a round-up for Tass of Western press comment on the findings of the presidential commission, Vasiliy Kharkov said (in English 1444 gmt 10 Jun 86) that faults on the shuttle had been known ''for many years''. ''The question of what necessitated such a busy schedule is passed over in silence in the report,'' he said. ''And the American press is hushing up that matter too.'' In an interview for the British ITV company, he said, Roy Gibson, Director of the British National Space Centre, had said that Britain, which had always oriented itself towards the US space programme, should not gear itself to that programme and should have other options.]

SPS:

SPS requires 40,000 times as many launches as the Apollo era to solove

David R. Criswell, “Solar Power via the Moon”, April/May 2002, http://www.aip.org/tip/INPHFA/vol-8/iss-2/p12.pdf

Several types of solar-power satellites have been proposed. They are projected, over 30 years, to deliver approximately 10,000 kW•h of electric energy to Earth for each kilogram of mass in orbit around the planet. To sell electric energy at $0.01/ kW•h, less than $60 could be expended per kilogram to buy the components of the power satellites, ship them into space, assemble and maintain them, decommission the satellites, and finance all aspects of the space operations. To achieve this margin, launch and fabrication costs would have to be lowered by a factor of 10,000. Power prosperity would require a fleet of approximately 6,000 huge, solar-power satellites. The fleet would have more than 330,000 km2 of solar arrays on-orbit and a mass exceeding 300 million tonnes. By comparison, the satellite payloads and rocket bodies now in Earth geosynchronous orbit have a collective surface area of about 0.1 km2. The mass launch rate for a fleet of power satellites would have to be 40,000 times that achieved during the Apollo era by both the United States and the Soviet Union. A many-decade development program would be required before commercial development could be considered.

2NC Impact – Cancer/Cataracts

Ozone depletion is directly correlated with increase in skin cancer and cataracts.

EPA, U.S. Environmental Protection Agency. 2011. Ozone Layer Protection – Science. Health and Environmental Effects of Ozone Layer Depletion http://www.epa.gov/ozone/science/effects/

Reductions in stratospheric ozone levels will lead to higher levels of [UVB](http://www.epa.gov/ozone/defns.html#uvb) reaching the Earth's surface. The sun's output of UVB does not change; rather, less ozone means less protection, and hence more UVB reaches the Earth. Studies have shown that in the Antarctic, the amount of UVB measured at the surface can double during the annual ozone hole. Another study confirmed the relationship between reduced ozone and increased UVB levels in Canada during the past several years. Laboratory and epidemiological studies demonstrate that UVB causes nonmelanoma skin cancer and plays a major role in malignant melanoma development. In addition, UVB has been linked to cataracts -- a clouding of the eye’s lens. All sunlight contains some UVB, even with normal stratospheric ozone levels. It is always important to [protect your skin and eyes from the sun](http://www.epa.gov/sunwise). Ozone layer depletion increases the amount of UVB and the risk of health effects.

Exposure to UV radiation has implications on the human body, including cataracts and skin cancer, as well as on ecosystems.

UNEP. United Nations Environment Program. 2005. “Protecting the Ozone Layer.” http://www.uneptie.org/ozonaction/information/mmcfiles/2333-e.pdf

The ozone layer is important because it absorbs certain wavelengths of ultraviolet (UV) radiation from the Sun, reducing their intensity at the Earth’s surface. High doses of UV radiation at these wavelengths can damage eyes and cause skin cancer, reduce the efficiency of the body’s immune system, reduce plant growth rates, upset the balance of terrestrial and marine ecosystems, and accelerate degradation of some plastics and other materials.

An increase in UV radiation leads to an increased risk of cancer.

Olivier Boucher, Dr. Olivier Boucher, Head Climate, Chemistry and Ecosystems, Met Office Hadley Centre, Weather, “Stratospheric ozone, ultraviolet radiation and climate change”, March 29, 2010

Overexposure to ultraviolet (UV) radiation can lead to damage to the eyes and skin (WHO, 2006; Norval et al., 2007). Skin cancer in particular is a major health concern. The three most common types of skin cancer are melanoma (the most dangerous but least frequent of the three), squamous cell carcinoma (which can develop quickly and deep in the skin), and the basal cell carcinoma (the least dangerous but most common). A skin condition known as actinic keratosis consists of pre-cancer lesions and has also been associated with UV radiation.

2NC Ozone → UV Rays

Ozone depletion leads to an increase in surface UV radiation.

Olivier Boucher, Dr. Olivier Boucher, Head Climate, Chemistry and Ecosystems, Met Office Hadley Centre, Weather, “Stratospheric ozone, ultraviolet radiation and climate change”, March 29, 2010

For instance we know relatively well how surface UV radiation varies with stratospheric ozone, which is the main parameter determining surface UV radiation in the absence of clouds. Figure 4 shows that every 1% reduction in stratospheric ozone column increases surface UV radiation by 1.1% in clear sky (Madronich et al., 1998). This is critical in the context of stratospheric ozone depletion which has been observed in the Antarctic but also the Arctic polar region. Ozone depletion in the stratosphere is largely due to catalytic destruction cycles of ozone by atomic chlorine and bromine originating from the photodissociation of chlorofluorocarbon (CFC) compounds emitted at the surface.

The healing of ozone hole directly corresponds with increased global warming

SoftPedia January 26th, 2010 Global Warming Promoted by Ozone-Layer Healing, http://news.softpedia.com/news/Global-Warming-Promotes-by-Ozone-Layer-Healing-133172.shtml

Researchers have recently determined that one of the factors promoting [global warming](http://news.softpedia.com/news/Global-Warming-Promotes-by-Ozone-Layer-Healing-133172.shtml) today is the healing of the ozone layers. Its effects are most dominantly felt in the Southern Hemisphere, as the hole first formed over Antarctica. The original damage was done through the excessive use of chlorofluorocarbons (CFC), chemicals that endured in the atmosphere, and prevented ozone from being replenished and protecting our planet from dangerous ultraviolet (UV) rays from the Sun. In the new investigation it became apparent that, while the ozone layer indeed let UV radiation slip through, it also generated a feedback mechanism of sorts, which protected the areas underneath from excessive warming. A direct consequence of the hole were higher speed winds, which in turn promoted the formation of larger amounts of high-altitude clouds above Antarctica. These clouds were directly responsible for reflecting a lot of sunlight back into space, protecting the Southern continent from being warmed up, and melting.   
“These clouds have acted like a mirror to the Sun's rays, reflecting the Sun's heat away from the [surface](http://news.softpedia.com/news/Global-Warming-Promotes-by-Ozone-Layer-Healing-133172.shtml) to the extent that warming from rising carbon emissions has effectively been canceled out in this region during the summertime. If, as seems likely, these winds die down, rising CO2 emissions could then cause the warming of the southern hemisphere to accelerate, which would have an impact on future climate predictions,” the coauthor of the investigation, University of Leeds Professor Ken Carslaw, explains. Details of this work will appear tomorrow, in the January 26 issue of the respected scientific journal Geophysical Research Letters.  
As the hole is currently beginning to heal, thanks to international agreements banning the use of CFC, the amount of clouds that form underneath could decrease, or the clouds themselves could become less bright and reflective. This would translate into an accelerating global effect in Antarctica, which could result in global sea-level rises. “Our research highlights the value of today's state-of-the-art models and long-term datasets that enable such unexpected and complex climate feedbacks to be detected and accounted for in our future predictions,” Carlsaw reports.

Increased UV poses a major threat to human kind- increases disease and mutations

The Ozone Hole, 06/26/2011, Ozone Hole Consequences, http://www.theozonehole.com/consequences.htm

The burning goes deeper however, than sunburn, skin cancers, and cataracts. Wearing certain sunglasses may enhance exposure of the lens and retina to harmful UV rays, because the iris opens wider to compensate for the reduced visible light and then more penetration of UV can reach the retina. Through other similar mechanisms, UV rays can suppress the human immune system leaving the body vulnerable to many diseases caused by bacteria and viruses entering through or affecting the skin. While darker skinned individuals are less likely to contract a skin cancer from sun exposure, dark skin is not a protection against immune suppression by UV. But dark skin does require a greater dosage of UV than white skin to initiate immune suppression.Increased exposure to UV rays in animals and humans has been linked to elevated risk from the following diseases: the herpes viruses, the human immunodeficiency virus HIV- 1, a variety of papilloma viruses, leishmaniasis, malaria, forms of tuberculosis, leprosy, lupus erthematodes, dermatitis, E. coli, and Staphylococcus aureus. Since UV rays readily damage DNA in all cells, it is not unrealistic to hypothesize that this will play an additional role in the mutation of existing disease bacteria and viruses and may produce totally new strains of pathogens. Physicians are finding that infection and disease is a greater global challenge than cancer, as people of all skin pigmentation are at equal risk from the effects of immuno-suppression. Geographic areas of poor public health are at even greater risk.

2NC Impact – Phytoplankton/Marine Life

Ozone depletion decreases survival rates of phytoplankton, the foundation of aquatic food webs.

EPA,U.S. Environmental Protection Agency. 2011. Ozone Layer Protection – Science. Health and Environmental Effects of Ozone Layer Depletion http://www.epa.gov/ozone/science/effects/

Phytoplankton form the foundation of aquatic food webs. Phytoplankton productivity is limited to the euphotic zone, the upper layer of the water column in which there is sufficient sunlight to support net productivity. The position of the organisms in the euphotic zone is influenced by the action of wind and waves. In addition, many phytoplankton are capable of active movements that enhance their productivity and, therefore, their survival. Exposure to solar UVB radiation has been shown to affect both orientation mechanisms and motility in phytoplankton, resulting in reduced survival rates for these organisms. Scientists have demonstrated a direct reduction in phytoplankton production due to ozone depletion-related increases in UVB. One study has indicated a 6-12% reduction in the marginal ice zone. Solar UVB radiation has been found to cause damage to early developmental stages of fish, shrimp, crab, amphibians and other animals. The most severe effects are decreased reproductive capacity and impaired larval development. Even at current levels, solar UVB radiation is a limiting factor, and small increases in UVB exposure could result in significant reduction in the size of the population of animals that eat these smaller creatures.

Depleted Ozone harms marine life- plankton won’t survive

The Ozone Hole, 06/26/2011, Ozone Hole Consequences, http://www.theozonehole.com/consequences.htm

Less phytoplankton means less food for these animals to eat. It is estimated that a 16 % ozone depletion could result in further losses in Phytoplankton, which would lead to a loss of about 7 million tons of fish per year. With the human food supply already strained due to demands of an ever-increasing population, small reductions resulting from UV damage may be disastrous to many people, especially the poor and indigenous people.

**UV Rays enter the** **human body**

Researchers say it's clear that UV-B harms Antarctic microbes. Dr Patrick Neale, of the Smithsonian Environmental Research Center, has predicted that phytoplankton photosynthesis declines by as much as 8.5 per cent under the worst conditions.

It also damages the DNA of marine bacteria and the larvae of starfish and urchins, they say. And it even alters ocean chemistry, creating potentially dangerous substances in the water itself.

"This refers to the fact that UV radiation is involved in a number of photochemical reactions in seawater (including the hydrolysis/splitting of water molecules) that produce radicals (hydroxyl, peroxide, superoxide, etc.). These radicals are very reactive and can cause biological damage by oxidizing biological molecules. It's really dramatic what the changes in ozone levels will do to rates of DNA damage and inhibited development," says biologist Deneb Karentz of the University of San Francisco. "If you have a 30 per cent decline in ozone, that doesn't mean a 30 per cent decline in a given biological process - it could be a lot more than that". Experts predict that an estimated 10 % reduction in the ozone layer will result in a 25 % increase in non-melanoma skin cancer rates for temperate latitudes by the year 2050.

2NC Impact – Phytoplankton/Marine Life

Increased radiation due to ozone depletion damages various forms of sea life

DENEB KARENTZ, University of San Fransisco Department of Biology, AND ISIDRO BOSCH, State University of New York Department of Biology, “Influence of Ozone-Related Increases in Ultraviolet Radiation on Antarctic Marine Organisms”, AMER. ZOOL., 41:3–16 (2001) http://icb.oxfordjournals.org/content/41/1/3.full.pdf+html

Observations in temperate freshwater communities have underscored the importance of understanding the direct effects of UV on consumer populations (Bothwell et al., 1994), but little research has been conducted on the UV-photobiology of Antarctic zooplankton. A limited amount of information is available for Euphausia superba (krill). E. superba contains all seven MAAs that have been identified from Antarctic organisms (Karentz et al., 1991b), suggesting at least a minimum capacity for UV shading of vital cellular targets. Euphausia superba DNA has a very low (32%) guanine-cytosine base composition (Jarman et al., 1999). Since UV-induced DNA damage is predominantly comprised of adducts formed between adjacent thymine residues (e.g., cyclobutane dimers and pyrimidine-pyrimidone 6–4 photoproducts), the high adenine-thymine complement may predispose krill to higher concentrations of DNA damage than occur in other organisms. Malloy et al. (1997) have observed relatively high levels of DNA repair in E. superba under laboratory conditions; however, ambient levels of DNA damage are not known. Examination of historical data on krill ozone levels over a 20-yr period (1977– 1997) provides the first connection between ozone depletion and variability in krill populations along the Antarctic Peninsula (Naganobu et al., 1999). Correlations are evident between E. superba abundance and ozone levels and the areal extent of ozone depletion. Krill recruitment is not closely correlated to ozone levels, but appears to be affected by sea level pressure (fluctuations in westerly winds). The large annual variability in the estimates of krill abundance and the two-year period required for sexual maturity contribute to the complexity of evaluating the biological impact of large scale environmental variables. Studies from other latitudes provide evidence of higher sensitivity to UVB in early developmental stages of marine invertebrates than in adults (e.g., Damkaer et al., 1981; Giese, 1939). Similar observations have been reported for fish larvae (Hunter et al., 1981; Vetter et al., 1999). The accelerated developmental activity and minimal morphological complexity of embryos and larvae make them more vulnerable than adult animals. UV exposure during early stages of development can cause developmental delays and/or lethality that will affect recruitment to adult populations. Many of the most common benthic macroinvertebrate species in the Antarctic reproduce with a planktonic stage during the austral spring when the greatest deterioration of ozone occurs (Bosch et al., 1987; Pearse et al., 1991). These include the sea star Odontaster validus, the sea urchin Sterechinus neumayeri and the ribbon worm Parborlasia corrugatus; all of which produce eggs ,0.2 mm diameter and have planktotrophic larval development (Bosch et al., 1987; Pearse et al., 1991; StanwellSmith and Peck, 1998). Embryos and larvae of some of these species (e.g., Sterechinus) contain MAAs. MAAs provide a protective sun screening function for urchin embryos in temperate species (Adams and Shick, 1996) and similar observations have been made for Sterechinus neumayeri (DK/ IB, unpublished data). However, MAA concentrations are not sufficient to prevent excessive damage to embryos that inhabit shallow surface waters (,5–10 m) (Fig. 7). The early development of the Antarctic sea urchin Sterechinus neumayeri has proved to be a reliable model for the study of UV effects on early invertebrate development. In situ measurements of DNA damage, abnormality in development and lethality show that incident UVB is detrimental to development without ozone depletion, and that increased exposure under ozone-depleted conditions exacerbates responses (Fig. 7). UV effects on embryos are generally not observed at incubation depths below 5 m, suggesting that only individuals drifting very near the surface for prolonged periods of time would be adversely affected by UV exposure. Embryos and larvae of Sterechinus and other benthic invertebrates have been found in surface waters (Bosch et al., 1987; Stanwell-Smith et al., 1999); however, because residence times and mixing rates are not known, it is not possible to assess the vulnerability of these species to ozone-related changes in UV. The effects of ultraviolet light on the embryos and larvae of the sea star Psilaster charcoti have also been studied. This species represents a second major type of invertebrate developmental strategy with the production of large (0.7 mm diameter) yolk-laden eggs and free-swimming nonfeeding larvae (Pearse et al., 1991). Although MAAs are lacking in P. charcoti, the relatively large size and high amounts of carotenoids in eggs and embryos might be expected to provide effective protection against UVB exposure. However, when zygotes and early cleavage embryos are incubated in situ, both UVB and UVA cause considerable damage to embryonic development under ‘‘normal’’ and depleted ozone columns (Fig. 8). The degree of damage and the maximum depth of the UVB effect are comparable to those observed in S. neumayeri; but the implications of these results are quite different. Eggs released by P. charcoti float upwards at rates of 1.5– 2.0 m/hr in situ, a velocity that would allow them to move from depths occupied by adults to depths at which they are vulnerable to UV damage in less than 1 day or before the third embryonic cleavage is completed.

2NC Impact – Phytoplankton/Marine Life

Ozone depletion wrecks phytoplankton—UVB radiation exposure damages them faster than they can recover

John J. Cullen and Patrick J. Neale, “ Ultraviolet radiation, ozone depletion, and marine photosynthesis”, Biomedical and Life Science Volume 39 No. 3, Kluwer Academic Publishers, accepted in revised form 29 September 1993, http://www.springerlink.com/content/n0pk34t544078026/

Concerns about stratospheric ozone depletion have stimulated interest in the effects of UVB radiation (280-320 nm) on marine phytoplankton. Research has shown that phytoplankton photosynthesis can be severely inhibited by surface irradiance and that much of the effect is due to UV radiation. Quantitative generalization of these results requires a biological weighting function (BWF) to quantify UV exposure appropriately. Different methods have been employed to infer the general shape of the BWF for photoinhibition in natural phytoplankton, and recently, detailed BWFs have been determined for phytoplankton cultures and natural samples. Results show that although UVB photons are more damaging than UVA (320-400 nm), the greater fluxes of UVA in the ocean cause more UV inhibition. Models can be used to analyze the sensitivity of water column productivity to UVB and ozone depletion. Assumptions about linearity and time-dependence strongly influence the extrapolation of results. Laboratory measurements suggest that UV inhibition can reach a steady-state consistent with a balance between damage and recovery processes, leading to a non-linear relationship between weighted fluence rate and inhibition. More testing for natural phytoplankton is required, however. The relationship between photoinhibition of photosynthesis and decreases in growth rate is poorly understood, so long-term effects of ozone depletion are hard to predict. However, the wide variety of sensitivities between species suggests that some changes in species composition are likely. Predicted effects of ozone depletion on marine photosynthesis cannot be equated to changes in carbon flux between the atmosphere and ocean. Nonetheless, properly designed studies on the effects of UVB can help identify which physiological and ecological processes are most likely to dominate the responses of marine ecosystems to ozone depletion.

2NC Impact – Phytoplankton/Marine Life

UVB radiation harms biological processes of many life forms—this is especially true of phytoplankton

John J. Cullen and Patrick J. Neale, “ Ultraviolet radiation, ozone depletion, and marine photosynthesis”, Biomedical and Life Science Volume 39 No. 3, Kluwer Academic Publishers, accepted in revised form 29 September 1993, http://www.springerlink.com/content/n0pk34t544078026/

1. Introduction Depletion of stratospheric ozone, particularly in the Antarctic, has stimulated concerted efforts to predict the effects of increased ultraviolet radiation on biological systems. The justification for heightened interest is clear: continuing reduction of stratospheric ozone can permit more middle ultraviolet radiation (UVB1; 280-320nm) to reach the earth's surface, and UVB is known to harm many biological processes. A great deal has been learned about biological effects of UVB, and aspects of the subject have been regularly reviewed (e.g., Smith and Baker 1989, H/ider and Worrest 1991, United Nations Environment Programme 1991, Vincent and Roy 1993). Let us consider here the possible influence of UVB and ozone depletion on marine primary production and biogeochemical cycling. This entails discussing the spectral dependence and kinetics of photosynthesis and photoinhibition, the contribution of UVB-induced photoinhibition to reduced phytoplankton growth rates relative to other UVB-sensitive physiological processes, and the degree to which reduced phytoplankton growth rates near the surface might alter the fluxes of carbon in the ocean. Damage by UVB and protection from that damage are described at the molecular level by Strid and Anderson (1994). The focus here is on the difficult oceanographic problem of quantifying the net effects of UVB on phytoplankton in the natural environment. Characterization of photosynthetic responses is of central importance. Uncertainties include: 1. the magnitude of photoinhibition of photosynthesis in situ, and how much worse it would be under ozone depletion; 2. the adaptability of individual phytoplankton to enhanced UVB fluence and the extent to which UVB-induced damage can be prevented or repaired; 3. the relative sensitivities of different phytoplankton taxa to UVB, and the degree to which ozone depletion might alter planktonic community structure; and 4. the quantitative relationship between reduced photosynthesis near the sea-surface and the fluxes of carbon in the ocean. The objectives of this review are to describe different methods for assessing the effects of UVB on marine photosynthesis, to examine critical assumptions that strongly influence quantitative predictions, and to suggest what else should be considered when the results of shortterm experiments are used to predict long-term and large-scale changes in marine systems. 2. Effects of UV on the photosynthesis of natural phytoplankton Neither the complex variability of spectral irradiance and other environmental factors in the upper water column, nor the genetic diversity of natural phytoplankton communities can be reproduced in the laboratory. Thus, direct measurements on natural phytoplankton will always be essential to estimating marine photosynthesis and how it might change under the influence of ozone depletion. Experimental measurements require unnatural confinement of phytoplankton, however, and it is sometimes difficult to relate measured rates to the actual rates in situ (Harris 1978, Marra 1978, Cullen and Neale 1993). It is therefore useful to consider the influence of UVB on the measurement of primary production prior to discussing the effects of UVB on primary production in situ. Other biological effects of UV will be discussed after photosynthesis is examined in detail. UV and the measurement of primary productivity The uptake of carbon by marine phytoplankton is commonly estimated by putting seawater in bottles, inoculating it with 14C bicarbonate, incubating samples at the depths from which they were obtained, and measuring the incorporation of 14C into particulate matter over periods from several hours to a day. Alternatively, samples can be incubated on a ship under solar or artificial irradiance attenuated by neutral density screens, sometimes used in conjunction with colored filters (Jitts et al. 1976, Lohrenz et al. 1992). A consequence of these methods is that incubated phytoplankton are exposed to less UV radiation than is natural for the sampling depth, because conventional glass or plastic containers attenuate UV, and also because most artificial light sources are deficient in UV. Early studies, lacking detailed radiometry, showed that UV was an environmental factor that was inadequately simulated during the measurement of primary productivity: rates measured in UV-transparent containers were lower than when environmental UV was screened by glass (Steemann Nielsen 1964, Ilmavirta and Hakala 1972, Jitts et al. 1976) or Mylar (nominally opaque at <320nm; Lorenzen 1979). Smith et al. (1980) used several different manipulations of UVB during incubations of 6-12 h, for the first time supported with measurements of UV spectral irradiance, to characterize photoinhibition of natural phytoplankton as a function of quantified UV. Photoinhibition, defined as the percent decrease of pB (rate of carbon uptake normalized to Chl, g C g Ch1-1 h -1) relative to the highest rate in the water column, sometimes exceeded 80% at the surface. It was estimated that 25% of this inhibition was due to wavelengths < 340 nm, and 50% due to wavelengths < 390 nm, an assessment that was broadly consistent with earlier published results. Although there was clearly an interest in assessing the ecological consequences of UV radiation, authors were cautious, stating that their results applied to the effects of UV on the measurement of photosynthesis, not to the rate of photosynthesis in situ. Requirements for a general description of UV and photosynthesis The presentation by Smith et al. (1980; discussed further by Smith and Baker 1982) marked a turning point in the study of UVB and marine primary productivity. The fact that environmental UVB influences the measurement of primary productivity near the surface was established. However, without some quantitative way to relate biological response to UV exposure, it was not possible to generalize or to predict the variation of UV-induced photoinhibition with depth, water type, or under the influence of ozone depletion. Because Smith and colleagues had measured spectral irradiance, they were able to describe and examine a procedure for modeling the effects of UV on the measurement of marine photosynthesis.

2NC Impact –Plants

Ozone depletion harms natural processes of plants and has serious implications.

EPA,U.S. Environmental Protection Agency. 2011. Ozone Layer Protection – Science. Health and Environmental Effects of Ozone Layer Depletion http://www.epa.gov/ozone/science/effects/

Physiological and developmental processes of plants are affected by UVB radiation, even by the amount of UVB in present-day sunlight. Despite mechanisms to reduce or repair these effects and a limited ability to adapt to increased levels of UVB, plant growth can be directly affected by UVB radiation. Indirect changes caused by UVB (such as changes in plant form, how nutrients are distributed within the plant, timing of developmental phases and secondary metabolism) may be equally, or sometimes more, important than damaging effects of UVB. These changes can have important implications for plant competitive balance, herbivory, plant diseases, and biogeochemical cycles.

Phytoplankton key to health of Bering Sea

Arctic Portal, no date given, effects of arctic sea loss http://arcticportal.org/climate-and-sea/297

The seasonal expansion and melt of sea ice in the Arctic is a defining feature of the highly productive ecosystem. The timing of the phytoplankton bloom, which supplies energy to the entire ecosystem, is regulated by the timing of the ice retreat. As temperatures increase, less sea ice forms and it melts earlier in the spring, resulting in delayed spring phytoplankton bloom. Algae and tiny animals inhabit sea ice, living in and on the under surface. In the spring when sunlight is returning, ice in the Arctic melts discharging those plants and animals into the water column where they stimulate a massive phytoplankton bloom. There is more plankton present than can be consumed by the zooplankton and so most of the nutrients fall to the seafloor feeding benthic animals. The ocean bottom in many parts of the arctic are a rich living seafloor providing abundant food for diving predators including walrus, gray whales and spectacled eiders.

Warmer temperatures cause the melt to happen earlier than usual. Under this scenario, there has been less growth of ice algae and it is discharged before sufficient sunlight is present to cause the phytoplankton bloom. The bloom is then delayed until sunlight is available but without the added fuel from the ice algae. Less phytoplankton is produced and it is consumed by zooplankton before it reaches the seafloor. This scenario is considered more favorable to fish in the pelagic zone feeding on zooplankton.

The change in timing of the phytoplankton bloom affects which predators consume the phytoplankton and the effect is carried all the way up the food chain. Colder temperatures and more sea ice normally support benthic (bottom-dwelling) communities like crustaceans and in turn the marine mammals and diving sea ducks that prey on them. In contrast, warmer temperatures and reductions in sea ice result in more food available for fish in the pelagic zone (water column). Scientists are concerned that a loss of spring phytoplankton production may in turn reduce the overall productivity of the Bering Sea ecosystem

2NC Impact – Plankton

**Ozone depletion causes cancer, disease, devastates crop yields, and depletes phytoplankton.**

US Patent Application 20060048519 - Portable thermoelectric cooling and heating device Filed on September 7, 2004. Published on March 9, 2006, Inventor Childress, William H. US Classes 62/3.3, 62/3.7 Attorney, Agent or Firm Law Office of Steven B. Leavitt International Classes F25B 21/02 F25B 7/00 Issued Patent Number: 7059137, http://www.patentstorm.us/applications/20060048519/description.html

[0013] As the stratospheric ozone layer is depleted, higher UV-b levels reach the earth's surface. Increased UV-b can lead to more cases of skin cancer, cataracts, and impaired immune systems. Many of our essential crops, such as corn, barley, hops, wheat and soybeans, may become damaged, decreasing their yield. Phytoplankton, a plant in the ocean, also is affected. Depletion of this important link in the marine food chain could reduce the number of fish in the ocean. It also can increase the level of carbon dioxide in the atmosphere because phytoplankton absorbs carbon dioxide in their food and energy making processes.

Decline in phytoplankton causes warming, they’re the largest internal link to marine health and they’re key to human life

Steve Connor, Science Editor, “Global warming blamed for 40 per cent decline in the ocean's phytoplankton”, The Independent, London, First Edition, page 4, 7/29/10, Lexis Nexis

THE MICROSCOPIC plants that support all life in the oceans are dying off at a dramatic rate, according to a study that has documented for the first time a disturbing and unprecedented change at the base of the marine food web. Scientists have discovered that the phytoplankton of the oceans has declined by about 40 per cent over the past century, with much of the loss occurring since the 1950s. They believe the change is linked with rising sea temperatures and global warming. If the findings are confirmed by further studies it will represent the single biggest change to the global biosphere in modern times, even bigger than the destruction of the tropical rainforests and coral reefs, the scientists said yesterday. Phytoplankton are microscopic marine organisms capable of photosynthesis, just like terrestrial plants. They float in the upper layers of the oceans, provide much of the oxygen we breathe and account for about half of the total organic matter on Earth. A 40 per cent decline would represent a massive change to the global biosphere. "If this holds up, something really serious is underway and has been underway for decades. I've been trying to think of a biological change that's bigger than this and I can't think of one," said marine biologist Boris Worm of Canada's Dalhousie University in Halifax, Nova Scotia. He said: "If real, it means that the marine ecosystem today looks very different to what it was a few decades ago and a lot of this change is happening way out in the open, blue ocean where we cannot see it. I'm concerned about this finding." The researchers studied phytoplankton records going back to 1899 when the measure of how much of the green chlorophyll pigment of phytoplankton was present in the upper ocean was monitored regularly. The scientists analysed about half a million measurements taken over the past century in 10 ocean regions, as well as measurements recorded by satellite. They found that phytoplankton had declined significantly in all but two of the ocean regions at an average global rate of about 1 per cent per year, most of which since the mid 20th Century. They found that this decline correlated with a corresponding rise in sea-surface temperatures - although they cannot prove that warmer oceans caused the decline. The study, published in the journal Nature, is the first analysis of its kind and deliberately used data gathered over such a long period of time to eliminate the sort of natural fluctuations in phytoplankton that are known to occur from one decade to the next due to normal oscillations in ocean temperatures, Dr Worm said. "Phytoplankton are a critical part of our planetary life support system. They produce half of the oxygen we breathe, draw down surface CO2 and ultimately support all of our fishes." he said. But some scientists have warned that the Dalhousie University study may not present a realistic picture of the true state of marine plantlife given that phytoplankton is subject to wide, natural fluctuations. "Its an important observation and it's consistent with other observations, but the overall trend can be overinterpreted because of the masking effect of natural variations," said Manuel Barange of the Plymouth Marine Laboratory and a phytoplankton expert. However, the Dalhousie scientists behind the three-year study said they have taken the natural oscillations of ocean temperatures into account and the overall conclusion of a 40 per cent decline in phytoplankton over the past century still holds true. "Phytoplankton are the basis of life in the oceans and are essential in maintaining the health of the oceans so we should be concerned about its decline. "It's a very robust finding and we're very confident of it," said Daniel Boyce, the lead author of the study. "Phytoplankton is the fuel on which marine ecosystems run. A decline of phytoplankton affects everything up the food chain, including humans," Dr Boyce said. Phytoplankton is affected by the amount of nutrients the well up from the bottom of the oceans. In the North Atlantic phytoplankton "blooms" naturally in spring and autumn when ocean storms bring nutrients to the surface. One effect of rising sea temperatures has been to make the water column of some regions nearer the equator more stratified, with warmer water sitting on colder layers of water, making it more difficult for nutrients to reach the phytoplankton at the sea surface. Warmer seas in tropical regions are also known to have a direct effect on limiting the growth of phytoplankton.

2NC Impact – Plankton

Phytoplankton key to planetary life

Carmen Chai, Postmedia News, “Death of marine algae threatens Earth: study; Planetary life-supp ort system. Phytoplankton produce half the oxygen we breathe, Canadian scientist says”, The Gazette (Montreal), page A12 7/29/10, Lexis Nexis

Phytoplankton need both sunlight and nutrients to grow, but warm oceans are limiting the amount of nutrients that are delivered from deeper waters to the ocean surface. "Phytoplankton are a critical part of our planetary life-support system. They produce half the oxygen we breathe ... and ultimately support all our fisheries," he said. The species is just as valuable to survival as "all plants on land combined," he said. Tiny zooplankton, seabirds and fish are only some of the marine animals that feed on phytoplankton, and its declining population affects everything up the food chain, results from the three-year study suggested. Another Dalhousie University study reports that other marine species could potentially die because of human actions and global warming. More than 11,000 marine species live in ocean "hot spots," but these regions are most damaged by climate change, fishing and pollution.

**Healthy oceans solve extinction**

Robin Kundis Craig, Associate Professor of Law, Indiana University School of Law, 2003 34 McGeorge L. Rev. 155

Biodiversity and ecosystem function arguments for conserving marine ecosystems also exist, just as they do for terrestrial ecosystems, but these arguments have thus far rarely been raised in political debates. For example, besides significant tourism values - the most economically valuable ecosystem service coral reefs provide, worldwide - coral reefs protect against storms and dampen other environmental fluctuations, services worth more than ten times the reefs' value for food production. n856 Waste treatment is another significant, non-extractive ecosystem function that intact coral reef ecosystems provide. n857 More generally, "ocean ecosystems play a major role in the global geochemical cycling of all the elements that represent the basic building blocks of living organisms, carbon, nitrogen, oxygen, phosphorus, and sulfur, as well as other less abundant but necessary elements." n858 In a very real and direct sense, therefore, human degradation of marine ecosystems impairs the planet's ability to support life. Maintaining biodiversity is often critical to maintaining the functions of marine ecosystems. Current evidence shows that, in general, an ecosystem's ability to keep functioning in the face of disturbance is strongly dependent on its biodiversity, "indicating that more diverse ecosystems are more stable." n859 Coral reef ecosystems are particularly dependent on their biodiversity. [\*265] Most ecologists agree that the complexity of interactions and degree of interrelatedness among component species is higher on coral reefs than in any other marine environment. This implies that the ecosystem functioning that produces the most highly valued components is also complex and that many otherwise insignificant species have strong effects on sustaining the rest of the reef system. n860 Thus, maintaining and restoring the biodiversity of marine ecosystems is critical to maintaining and restoring the ecosystem services that they provide. Non-use biodiversity values for marine ecosystems have been calculated in the wake of marine disasters, like the Exxon Valdez oil spill in Alaska. n861 Similar calculations could derive preservation values for marine wilderness. However, economic value, or economic value equivalents, should not be "the sole or even primary justification for conservation of ocean ecosystems. Ethical arguments also have considerable force and merit." n862 At the forefront of such arguments should be a recognition of how little we know about the sea - and about the actual effect of human activities on marine ecosystems. The United States has traditionally failed to protect marine ecosystems because it was difficult to detect anthropogenic harm to the oceans, but we now know that such harm is occurring - even though we are not completely sure about causation or about how to fix every problem. Ecosystems like the NWHI coral reef ecosystem should inspire lawmakers and policymakers to admit that most of the time we really do not know what we are doing to the sea and hence should be preserving marine wilderness whenever we can - especially when the United States has within its territory relatively pristine marine ecosystems that may be unique in the world. We may not know much about the sea, but we do know this much: if we kill the ocean we kill ourselves, and we will take most of the biosphere with us. The Black Sea is almost dead, n863 its once-complex and productive ecosystem almost entirely replaced by a monoculture of comb jellies, "starving out fish and dolphins, emptying fishermen's nets, and converting the web of life into brainless, wraith-like blobs of jelly." n864 More importantly, the Black Sea is not necessarily unique. The Black Sea is a microcosm of what is happening to the ocean systems at large. The stresses piled up: overfishing, oil spills, industrial discharges, nutrient pollution, wetlands destruction, the introduction of an alien species. The sea weakened, slowly at first, then collapsed with [\*266] shocking suddenness. The lessons of this tragedy should not be lost to the rest of us, because much of what happened here is being repeated all over the world. The ecological stresses imposed on the Black Sea were not unique to communism. Nor, sadly, was the failure of governments to respond to the emerging crisis. n865 Oxygen-starved "dead zones" appear with increasing frequency off the coasts of major cities and major rivers, forcing marine animals to flee and killing all that cannot. n866 Ethics as well as enlightened self-interest thus suggest that the United States should protect fully-functioning marine ecosystems wherever possible - even if a few fishers go out of business as a result.

2NC Impact: Ozone Good

Without ozone layer, life on Earth is threatened.

The Environment A Global Challenge, Oracle ThinkQuest, “Ozone Depletion”, NO DATE (Website)

The ozone layer protects the Earth from the ultraviolet rays sent down by the sun. If the ozone layer is depleted by human action, the effects on the planet could be catastrophic. Ozone is present in the stratosphere. The stratosphere reaches 30 miles above the Earth, and at the very top it contains ozone. The suns rays are absorbed by the ozone in the stratosphere and thus do not reach the Earth. Ozone is a bluish gas that is formed by three atoms of oxygen. The form of oxygen that humans breathe in consists of two oxygen atoms, O2. When found on the surface of the planet, ozone is considered a dangerous pollutant and is one substance responsible for producing the greenhouse effect. The highest regions of the stratosphere contain about 90% of all ozone. In recent years, the ozone layer has been the subject of much discussion. And rightly so, because the ozone layer protects both plant and animal life on the planet. The fact that the ozone layer was being depleted was discovered in the mid-1980s. The main cause of this is the release of CFCs, chlorofluorocarbons. Antarctica was an early victim of ozone destruction. A massive hole in the ozone layer right above Antarctica now threatens not only that continent, but many others that could be the victims of Antarctica's melting icecaps. In the future, the ozone problem will have to be solved so that the protective layer can be conserved.

Ozone key to life on Earth

Greenpeace, 1995 http://archive.greenpeace.org/ozone/holes/holebg.html

The ozone layer around the Earth shields us all from harmful ultraviolet radiation from the sun. Without the ozone layer, life on earth would not exist. Exposure to increased levels of ultraviolet radiation can cause cataracts, skin cancer, and immune system suppression in humans as well as innumerable effects on other living systems. This is why Rowland's and Molina's theory was taken so seriously, so quickly - the stakes are literally the continuation of life on earth.

Without the ozone layer, skin cancer would run rampant.

NASA, National Aeronautics and Space Administration “The Good, the Bad and the Ozone”, URL:http://www.nasa.gov/missions/earth/f-ozone.html, June 4, 2004

How can solar radiation be harmful to life on Earth? Part of that radiation is ultra-violet, or UV radiation. It's an intense energy from the Sun that can cause a whole lot of damage. Skin cancer is the most dramatic result of a too much UV radiation, but there's a lot more too. Photosynthesis in plants is also affected, and that causes problems for the whole food chain. See where this is headed? We need to protect our ozone shield, and we can do so by decreasing the pollution that our industrial society puts out in large amounts every day.

Without the ozone layer, harmful UV rays will penetrate the atmosphere and harm humans.

NOAA (National Oceanic and Atmospheric Administration), Stratospheric Ozone Monitoring and Research in NOAA, “Science: Ozone Basics”, URL: http://www.ozonelayer.noaa.gov/science/basics.htm, 20 March 2008

The ozone molecules in the upper atmosphere (stratosphere) and the lower atmosphere (troposphere) are chemically identical, because they all consist of three oxygen atoms and have the chemical formula O3. However, they have very different roles in the atmosphere and very different effects on humans and other living beings. Stratospheric ozone (sometimes referred to as "good ozone") plays a beneficial role by absorbing most of the biologically damaging ultraviolet sunlight (called UV-B), allowing only a small amount to reach the Earth's surface. The absorption of ultraviolet radiation by ozone creates a source of heat, which actually forms the stratosphere itself (a region in which the temperature rises as one goes to higher altitudes). Ozone thus plays a key role in the temperature structure of the Earth's atmosphere. Without the filtering action of the ozone layer, more of the Sun's UV-B radiation would penetrate the atmosphere and would reach the Earth's surface. Many experimental studies of plants and animals and clinical studies of humans have shown the harmful effects of excessive exposure to UV-B radiation.

2NC Impact: Ozone Good

Without Ozone layer, many harms to Earth’s organisms.

Tyrrel W. Smith Ph.D, Jr., John R. Edwards, Daniel Pilson, Department of Chemistry, University of California, Irvine, TRW Space & Electronics Group, Environmental Management Branch, “Summary of the Impact of Launch Vehicle Exhaust and Deorbiting Space and Meteorite Debris on Stratospheric Ozone”, Prepared for U.S. Air Force Space and Missile Systems Center Environmental Management Branch, URL:http://www.globalsecurity.org/space/library/report/enviro/soilvedsmdso.pdf, 30 September 1999

The ozone layer is critical to life on Earth because it absorbs biologically damaging solar ultraviolet radiation. The amount of solar UV radiation received at any particular location on the Earth’s surface depends upon the position of the Sun above the horizon, the amount of ozone in the atmosphere, and local cloudiness and pollution. Scientists agree that, in the absence of changes in clouds or pollution, decreases in atmospheric ozone lead to increases in ground-level UV radiation (Martin [1998], WMO [1998]). Prior to the late 1980s, instruments with the necessary accuracy and stability for measurement of small long-term trends in ground-level UV-B were not available. Therefore, the data from urban locations with older, less-specialized instruments provide much less reliable information, especially since simultaneous measurements of changes in cloudiness or local pollution are not available. When high-quality measurements were made in other areas far from major cities and their associated air pollution, decreases in ozone have regularly been accompanied by increases in UV-B (WMO [1998]). Therefore, this increase in ultraviolet radiation received at the Earth's surface would likely increase the incidence of skin cancer and melanoma, as well as possibly impairing the human immune system (Kerr et al., [1993]). Damage to terrestrial and aquatic ecosystems also may occur (Martin [1998], WMO.

Ozone depletion will affect aquatic ecosystems and water supply.

Yeow Chong Soh, Felicity Roddick, John van Leeuwen, School of Civil, Environmental and Chemical Engineering, RMIT University, Y. C. Soh, F. Roddick, J. van Leeuwen Cooperative Research Centre for Water Quality and Treatment, J. van Leeuwen SA Water Centre for Water Science and Systems, University of South Australia, Adelaide, Australia Environmentalist, “The future of water in Australia: The potential effects of climate change and ozone depletion on Australian water quality, quantity and treatability”, 15 August 2007

It is hypothesised that changes in and interaction between the climate and the ozone layer will affect freshwater quantity and quality, and its treatability through conventional processes for potable use (Fig. 1). Climate change will cause a general intensiﬁcation of the hydrological cycle (Voss et al. 2002). Temperature, precipitation, evaporation and runoff are all expected to increase globally, and hydrologic extremes such as ﬂoods and droughts will probably be more common and more intense (Jackson et al. 2001). Ozone in the stratosphere is crucial for shielding the Earth from solar UV radiation, a decrease in stratospheric ozone leads to an increase in solar UVB radiation at the Earth’s surface. These changes in climate and the ozone layer will ultimately affect water resources and aquatic ecosystems by impacting on water quality, including the natural organic matter (NOM) found in most freshwater resources.

Rocket launches kill the ozone with chlorine oxides

Anne Minard, a scientific journalist who has published in National Geographic News, The New York Times, the Los Angles Times, Science, Scientific American and High Country News, awarded first place in environmental reporting from the Arizona Associated Press Managing Editor's Association, April 14, 2009, Rocket Launches Damage Ozone Layer, Study Says, National Geographic News http://news.nationalgeographic.com/news/2009/04/090414-rockets-ozone.html

But when solid-fuel rockets launch, they release chlorine gas directly into the stratosphere, where the chlorine reacts with oxygen to form ozone-destroying chlorine oxides.

Increased international space launches and the potential commercial space travel boom could mean that rockets will soon emerge as the worst offenders in terms of ozone depletion, according to the study, published in the March issue of the journal *Astropolitics.*

2NC Impact: Ozone Good

Rocket launches kill ozone- one radical destroys 10,000 ozone molecules

Nancy Atkinson, science journalist who writes about space exploration and astronomy, Senior Editor and writer for Universe Today, project manager for 365 Days of Astronomy podcast, part of the production team for Astronomy Cast and has articles published on Wired.com, Space.com, NASA’s Astrobiology   Magazine, Space Times Magazine, and several newspapers in the Midwest.  April 2, 2009 Will Rocket Launches Deplete the Ozone? Universe Today, http://www.universetoday.com/28412/will-rocket-launches-deplete-the-ozone/

A new study predicts that Earth’s stratospheric ozone layer will suffer significant damage from future unregulated rocket launches. The study provides a market analysis for estimating future ozone layer depletion based on the expected growth of the space industry and known impacts of rocket launches. The increase in launches could cause ozone depletion that eventually could exceed ozone losses from CFCs (chlorofluorocarbons) which were banned in the 1980′s. “As the rocket launch market grows, so will ozone-destroying rocket emissions,” said Professor Darin Toohey of CU-Boulder’s atmospheric and oceanic sciences department, a member of the study. “If left unregulated, rocket launches by the year 2050 could result in more ozone destruction than was ever realized by CFCs.” The study says more research should be done on how different rockets affect the ozone before imposing stricter regulations on chemicals used in rocket fuels.  
Current global rocket launches deplete the ozone layer by no more than a few hundredths of 1 percent annually, said Toohey. But as the space industry grows and other ozone-depleting chemicals decline in the Earth’s stratosphere, the issue of ozone depletion from rocket launches is expected to move to the forefront.

Rockets around the world use a variety of propellants, including solids, liquids and hybrids. Martin Ross, lead author of the study from The Aerospace Corporation Ross said while little is currently known about how they compare to each other with respect to the ozone loss they cause, new studies are needed to provide the parameters required to guide possible regulation of both commercial and government rocket launches in the future.

Since some proposed space efforts would require frequent launches of large rockets over extended periods, the new study was designed to bring attention to the issue in hopes of sparking additional research, said Ross. “In the policy world, uncertainty often leads to unnecessary regulation,” he said. “We are suggesting this could be avoided with a more robust understanding of how rockets affect the ozone layer.”

“Twenty years may seem like a long way off, but space system development often takes a decade or longer and involves large capital investments,” Ross continued. “We want to reduce the risk that unpredictable and more strict ozone regulations would be a hindrance to space access by measuring and modeling exactly how different rocket types affect the ozone layer.”

Highly reactive trace-gas molecules known as radicals dominate stratospheric ozone destruction, and a single radical in the stratosphere can destroy up to 10,000 ozone molecules before being deactivated and removed from the stratosphere. Microscopic particles, including soot and aluminum oxide particles emitted by rocket engines, provide chemically active surface areas that increase the rate such radicals “leak” from their reservoirs and contribute to ozone destruction, said Toohey.

In addition, every type of rocket engine causes some ozone loss, and rocket combustion products are the only human sources of ozone-destroying compounds injected directly into the middle and upper stratosphere where the ozone layer resides, he said.

Regulations needed on Rockets- ozone destruction growing

Environmental News Service- April 1, 2009, Scientists: Regulate Rocket Launches to Safeguard Ozone Layer http://www.ens-newswire.com/ens/apr2009/2009-04-01-091.html

Future stratospheric ozone losses from unregulated rocket launches will exceed ozone losses from fluorinated gases, finds a new study by researchers in California and Colorado. Stricter regulation of launches will be needed to prevent damage to Earth's stratospheric ozone layer, the scientists advise.

"As the rocket launch market grows, so will ozone-destroying rocket emissions," said Professor Darin Toohey of the Atmospheric and Oceanic Sciences Department at the University of Colorado, Boulder. "If left unregulated, rocket launches by the year 2050 could result in more ozone destruction than was ever realized by CFCs."

Future ozone losses from unregulated rocket launches will eventually exceed ozone losses due to chlorofluorocarbons, or CFCs, which stimulated the 1987 Montreal Protocol banning ozone-depleting chemicals, said Martin Ross, chief study author from The Aerospace Corporation in Los Angeles.

Proposed space activities would require frequent launches of large rockets over extended periods ot time, so the new study was designed to bring attention to the issue in hopes of triggering additional research, said Ross.

2NC Impact – Health

Increased UV threatens global health

World health organization, No Date Health effects of UV radiation http://www.who.int/uv/health/uv\_health2/en/index.html

Several studies have demonstrated that exposure to environmental levels of UV radiation alters the activity and distribution of some of the cells responsible for triggering immune responses in humans. Consequently, sun exposure may enhance the risk of infection with viral, bacterial, parasitic or fungal infections, which has been demonstrated in a variety of animal models. Furthermore, especially in countries of the developing world, high UV radiation levels may reduce the effectiveness of vaccines. Since many vaccine-preventable diseases are extremely infectious, any factor that results in even a small decrease in vaccine efficacy can have a major impact on public health.

Ozone key to preventing mutations

science.jrank.org 12-22-2009 Ozone Layer Depletion - The Importance Of Stratospheric Ozone http://science.jrank.org/pages/4974/Ozone-Layer-Depletion-importance-stratospheric-ozone.html

If not intercepted, ultraviolet radiation is capable of damaging genetic material. The genetic molecules [deoxyribonucleic acid (DNA)](http://science.jrank.org/pages/2007/Deoxyribonucleic-Acid-DNA.html) and [ribonucleic acid (RNA)](http://science.jrank.org/pages/5873/Ribonucleic-Acid-RNA.html) and many [proteins](http://science.jrank.org/pages/5539/Proteins.html) and other biochemicals are effective absorbers of ultraviolet radiation. DNA and RNA are especially efficient at absorbing wavelengths shorter than 320 nm, but these important chemicals are damaged by this absorption. Damages to genetic materials could result in an increased incidence of [skin cancers](http://science.jrank.org/pages/4974/Ozone-Layer-Depletion-importance-stratospheric-ozone.html). Basal carcinomas account for about 75% of human [skin](http://science.jrank.org/pages/4974/Ozone-Layer-Depletion-importance-stratospheric-ozone.html) cancers, and squamous [cell](http://science.jrank.org/pages/1319/Cell.html) carcinomas about 20%. These are both serious diseases, but they can usually be successfully treated if detected early enough. The other skin [cancer](http://science.jrank.org/pages/1166/Cancer.html) is malignant [melanoma](http://science.jrank.org/pages/4974/Ozone-Layer-Depletion-importance-stratospheric-ozone.html), a deadly [disease](http://science.jrank.org/pages/2114/Disease.html) that accounts for about 5% of total skin [carcinomas](http://science.jrank.org/pages/4974/Ozone-Layer-Depletion-importance-stratospheric-ozone.html), and which is often fatal soon after it is diagnosed.

Children are dying in Russia.

The French Press Agency, Agence France Presse, “Russian launch site said to cause sickness among local children: Nature”, January 12, 2005

Highly toxic rocket fuel, spewed out by launches at Russia's space base in Baikonur, Kazakhstan, is causing serious illness among people who live nearby, according to an unpublished study reported on Thursday in the British weekly science journal Nature. The study, which has been conducted by a team of Russian scientists but has not been published in a peer-reviewed journal, says that levels of endocrine disease and blood disorder in polluted areas are twice the regional average, the report says. The work, led by epidemiologist Sergey Zykov, focussed on children in the Altai Republic, a mountainous region on the southern fringes of Siberia. This area was chosen because of pollution from unburnt fuel, notably hydrazine, which is used to power the early stages of some Russian launchers. Zykov compared the health records of about 1,000 children in two polluted areas for 1998-2000, comparing them with 330 records from a nearby unpolluted control group. He concluded that children in the worst-affected areas were up to twice as likely to need medical attention during this time, and needed to be treated twice as long, Nature said. According to Zykov's calculations, dozens of litres (several gallons) of unburned fuel are sprayed over several square kilometers (miles) of land with every launch. "These propellants are nasty, toxic substances," Nature quoted European Space Agency (ESA) expert Fabio Caramelli as saying. "A tablespoon of hydrazine in a swimming pool would kill anyone who drank the water."

2NC Impact – Health

Millions of people suffer the effects of space exploration.

Julia Solovyova, Writer for Moscow Times, The Moscow Times, “SCIENTIST CALLS FOR CURB ON HARMFUL ROCKET LAUNCHES”, March 24, 1999

Russia and other countries that send rockets into space should protect the environment by adopting international regulations limiting the number of launches, a former presidential science adviser said Tuesday. Alexei Yablokov, head of the Center for Environmental Policy, said that pollution from rocket fuel was a major cause of damage to the earth's ozone layer, and that launches also threatened the health of people living under rocket flight paths. "In 20 or 30 years there will be a catastrophe," said Yablokov, a biologist who served as President Boris Yeltsin's science adviser from 1992-93. "We've got about three years to come up with international norms regulating the space activity. He admitted such proposals were likely to face resistance from governments and companies that depend on rocket launches for space exploration and to put commercial satellites in orbit. But something should be done, he said. Yablokov spoke at a news conference in Moscow devoted to a book co-authored by a group of independent space and environmental experts, titled "Environmental Dangers of Space Exploration." Yablokov is the editor. Chief among the dangers, Yablokov said, are the clouds of hydrogen and carbon dioxide left hanging in the atmosphere for weeks after launches. He attributed 50 percent of the shrinking of the earth's ozone layer to rocket launches. Ozone protects the earth's surface from potentially harmful radiation. In addition, toxic rocket fuel showers the earth as spent rocket stages fall in Siberian forests downrange from Russia's chief launch sites, at Plesetsk in the north and Baikonur in Kazakhstan. Russia routinely tests ballistic missiles by launching them across Siberia to Kamchatka in the Far East. Yablokov said 30 million hectares in 16 regions of Russia - about 2 percent of the country's territory - are routinely subjected to rocket fuel pollution. For people living around launch sites and under the most frequently used rocket flight paths in the Altai, Yakutia, Tuva and Arkhangelsk regions, the effects are at first invisible and cause long-term damage, much as radiation can, the environmentalists said. Even small amounts can build up in body tissues and cause long-term damage, they said. Exposure of one-third of the Altai region territory to rocket fuel pollution has lead to higher mortality rates, cancer and birth defects, said physician Vladimir Lupandin, who studied the problem for the Center for Independent Environmental Programs. Other regions are affected too, he said: "Millions of people suffer the effects of space exploration.

2NC Impact - Food

UV damages crop yield threatening global food supply

United States Environmental Protection Agency (EPA) June 23, 2011, Ozone - Good Up High Bad Nearby, http://www.epa.gov/oar/oaqps/gooduphigh/good.html#4

Ozone depletion can cause increased amounts of UV radiation to reach the Earth which can lead to more cases of skin cancer, cataracts, and impaired immune systems. Overexposure to UV is believed to be contributing to the increase in melanoma, the most fatal of all skin cancers. Since 1990, the risk of developing melanoma has more than doubled.

UV can also damage sensitive crops, such as soybeans, and reduce crop yields. Some scientists suggest that marine phytoplankton, which are the base of the ocean food chain, are already under stress from UV radiation. This stress could have adverse consequences for human food supplies from the oceans.

Decline in crop yields means World War III

William Calvin, Theoretical Neurophysiologist – U Washington, Atlantic Monthly, January 1998, Vol 281, No. 1, p. 47-64

Plummeting crop yields would cause some powerful countries to try to take over their neighbors or distant lands--if only because their armies, unpaid and lacking food, would go marauding, both at home and across the borders. The better organized countries would attempt to use their armies, before they fell apart entirely, to take over countries with significant remaining resources, driving out or starving their inhabitants if not using modern weapons to accomplish the same end: eliminating competitors for the remaining food. This would be a world-wide problem--and could lead to a Third World War.

Food access is a d-rule.

Watson, philosophy professor at Washington University, World Hunger and Moral Obligation, 1977, pp. 118-9.

One may even have to sacrifice one’s life or one’s nation to be moral in situations where practical behavior would preserve it. For example, if a prisoner of war undergoing torture is to be a (perhaps dead) patriot even when reason tells him that collaboration will hurt no one, he remains silent. Similarly, if one is to be moral, one distributes available food in equal shares even if everyone dies. That an action is necessary to save one’s life is no excuse for behaving unpatriotically or immorally if one wishes to be a patriot or moral. No principle of morality absolves one of behaving immorally simply to save one’s life or nation. There is a strict analogy here between adhering to moral principles for the sake of being moral, and adhering to Christian principles for the sake of being Christian. The moral world contains pits and lions, but one looks always to the highest light. The ultimate test always harks back to the highest principle – recant or die. The ultimate test always harks back to the highest principle – recant or die – and it is pathetic to profess morality if one quits when the going gets rough.

US agricultural production is key to leadership

Andrew Pickford, positions of Mannkal Fellow at Mannkal Economic Education Foundation and Project Consultant at the Committee for Economic Development of Australia in Western Australia, Masters of Studies in Strategic Affairs from the Australian National University, Research Manager of Future Directions International, Australia's Center for Strategic Analysis, 7/29/2008, The Rise of Agri-Powers, http://www.redorbit.com/news/business/1499253/the\_rise\_of\_agripowers/

AGRICULTURAL POWERS - those self sufficient in food, fabric, and hydrocarbon production - once were unambiguously regarded as strategic powers. This has been true throughout history: societies which were not agriculturally efficient and abundant could never long or fully sustain strategic power. Now, once again, a new set of nations is likely to emerge in the 21st Century with significant regional, if not global, influence demonstrably based on their agricultural capacity and their ability to match capital, productive land, and emerging technology on a scale which was not possible in the past. These emerging "agri-powers" are benefitting from trends making agricultural commodities more strategically important, and will gain from having a significant agricultural base. Unlike the second half of the 20th Century, the global strategic environment is set to become more fluid, and the criteria which marked "middle-power" status, such as access to sophisticated military technology, is likely to become less overwhelming in importance. Even the term itself will lose its relevancy as dozens of nations fulfil the original definition of a traditional middle- power. In this period of global turbulence, a back to basics approach, which leverages agricultural surpluses for international sale, biofuel production and potentially, through biotechnology, industrial applications, may result in nations with a substantive agricultural sector, such as Australia, having a more prominent global position. Similarly, it could make smaller

AT: Ozone DA

\*\*\*Aff Arguments\*\*\*

Non-Unique

The tipping point was in 2002, space launches now still destroy the ozone.

Julia Solovyova, “Scientist Calls for Curb on Harmful Rocket Launches, Moscow Times”, 3/24/1999, Lexis Nexis

Russia and other countries that send rockets into space should protect the environment by adopting international regulations limiting the number of launches, a former presidential science adviser said Tuesday. Alexei Yablokov, head of the Center for Environmental Policy, said that pollution from rocket fuel was a major cause of damage to the earth's ozone layer, and that launches also threatened the health of people living under rocket flight paths. "In 20 or 30 years there will be a catastrophe," said Yablokov, a biologist who served as President Boris Yeltsin's science adviser from 1992-93. "We've got about three years to come up with international norms regulating the space activity." He admitted such proposals were likely to face resistance from governments and companies that depend on rocket launches for space exploration and to put commercial satellites in orbit. But something should be done, he said.

No Link

Rockets don’t pose a threat to the ozone

Space transportation, once dominated by government, has become an important part of our commercial economy, and the business of launching payloads into orbit is expected to nearly double in the next decade. Each time a rocket is launched, combustion products are emitted into the stratosphere. CFCs and other chemicals banned by international agreement are thought to have reduced the total amount of stratospheric ozone by about 4 percent. In comparison, recent predictions about the effect on the ozone layer of solid rocket motor (SRM) emissions suggest that they reduce the total amount of stratospheric ozone by only about 0.04 percent.

Even though emissions from liquid-fueled rocket engines were not included in these predictions, it is likely that rockets do not constitute a serious threat to global stratospheric ozone at the present time. Even so, further research and testing needs to be done on emissions from rockets of all sizes and fuel system combinations to more completely understand how space transportation activities are affecting the ozone layer today and to predict how they will affect it in the future.

The ozone layer is destroyed by industry not by rockets

Dr. Joe Yoon holds degrees in physics and aerospace engineering in addition to his doctorate in electrical engineering. He spent his early career working for NASA and major aerospace companies but now operates a small private consulting firm that has been Ozone Layer Damage, aerospaceweb.org http://www.aerospaceweb.org/question/spacecraft/q0298a.shtml

The component of the Space Shuttle that environmentalists have most frequently criticized is the Solid Rocket Booster, which is also a major component of all the Project Constellation launch vehicles. One of the byproducts of the chemical reaction as the solid propellants are burned is chlorine. Large amounts of chlorine high in the stratosphere attack ozone and cause it to break down. Earth's ozone layer absorbs ultraviolet radiation from the Sun and protects life on the surface from this cancer-causing radiation. However, studies have shown that the amount of chlorine produced by the Space Shuttle and other rockets using similar solid propellants is actually quite small and has a miniscule effect on the ozone layer.

Independent atmospheric modeling studies performed by NASA and private research firms in 1990 and 1991 indicated that the vast majority of chlorine present in the stratosphere is produced by industrial or natural sources. In an average year, industry generates an estimated 300 million kilograms of stratospheric chlorine while natural sources like volcanoes produce about 75 million kilograms. Assuming nine Space Shuttle launches and six launches of Titan rockets per year results in a total of 725,000 kilograms of chlorine released into the upper atmosphere. The actual launch rate of the Shuttle has only been this high once, in 1985, and is generally much lower with an historic average of less than five launches per year.

Shuttle launches don’t deplete ozone

Robert Parson, last modified 10/22/09, http://stason.org/TULARC/science-engineering/ozone-depletion-intro/23-Do-Space-Shuttle-launches-damage-the-ozone-layer.html

23 Do Space Shuttle launches damage the ozone layer? Very little. In the early 1970's, when little was known about the role of chlorine radicals in ozone depletion, it was suggested that HCl from solid rocket motors might have a significant effect upon the ozone layer - if not globally, perhaps in the immediate vicinity of the launch. It was immediately shown that the effect was negligible, and this has been repeatedly demonstrated since. Each shuttle launch produces about 200 metric tons of chlorine as HCl, of which about one-third, or 68 tons, is injected into the stratosphere. Its residence time there is about three years. A full year's schedule of shuttle and solid rocket launches injects 725 tons of chlorine into the stratosphere. This is negligible compared to chlorine emissions in the form of CFC's and related compounds (~1 million tons/yr in the 1980's, of which ~0.3 Mt reach the stratosphere each year). It is also small in comparison to natural sources of stratospheric chlorine, which amount to about 75,000 tons per year.

No Link

Studies from the seventies don’t take into account homogenous and heterogeneous chemical reactions

Smith et al., Tyrell W. Smith, Jr., Ph.D, TRW Space & Electronics Group; John R. Edwards, Daniel Pilson, Environmental Management Branch “Summary of the Impact of Launch Vehicle Exhaust and Deorbiting Space and Meteorite Debris on Stratospheric Ozone”, Prepared for: U.S. Air Force Space and Missile Systems Center Environmental Management Branch, 9/30/1999, http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA414306

2.5.1 Impact on the Stratosphere Beginning in the early 1970s, predictions have been made that human activities will lead to a diminishing of the earth's protective ozone layer (Johnston [1971], Molina et al., [1974], Rowland et al., [1975]). Depletion of stratospheric ozone resulting from the catalytic effect of nitrogen oxides, or NOx, emitted from a proposed fleet of supersonic transports was first predicted by Johnston (Johnston [1971]). A few years later, the deleterious effects of chlorine on stratospheric ozone from chlorofluorocarbons were predicted by M. J. Molina and F. S. Rowland [Molina et al., [1974], Rowland et al., [1975]). The possible impact of the exhausts of solidfuel rockets on the ozone layer were considered in the early 1970’s as part of the Climatic Impact Assessment Program (see Hoshizaki [1975]). At that time, the effects of the Space Shuttle exhausts were considered to be small; model computations led to the conclusion that (with a launch rate of 60 Space Shuttles per year) the total ozone concentrations would be reduced by about 0.25 percent in the Northern Hemisphere and by about 0.025-0.05 percent in the Southern Hemisphere with an uncertainty factor of about three (Potter [1978]). Since that study, there has been new knowledge of the chemical reaction rates and changing perceptions of the role of homogeneous and heterogeneous chemical reactions. Accordingly, in this section more recent assessments are reviewed. 2.5.2 Launch Vehicle Emissions The major chemical emissions and afterburning products from launch vehicle (LV) activities depend on the types of propellants used. Table 2-2 provides the main emissions/afterburning products from various propellants that are currently used in space flight or are under development (AF [1990, 1991, 1994, 1996], Versar [1991], Jones [1996], NSWC [1996], WMO [1991], Lewis et al., [1994], DOT [1992]). The term hypergolic is used to characterize a propellant based on whether or not spontaneous ignition occurs when the propellants are brought into contact (this does not apply to solid propellants). A cryogenic propellant is one whose boiling point is below -130 oC. Finally, liquid propellant systems are usually categorized into the following types: monopropellant (both the oxidizer and fuel are combined into one system), bipropellant (both the oxidizer and fuel flow separately to each other), etc

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No Link

No internal link—ozone depletion won’t inhibit plant growth

Allen et al Damian J. Allen, United States Department of Agriculture/Agricultural Research Service, Photosynthesis Research Unit; Salvador Nogués, and Neil R. Baker, “Ozone depletion and increased UV-B radiation: is there a real threat to photosynthesis?”, Journal of Experimental Botany, Volume 49, Issue 328, pp. 1775-88, 1998, http://jxb.oxfordjournals.org/content/49/328/1775.short

This critical review of recent literature questions earlier predictions that photosynthetic productivity of higher plants is vulnerable to increased ultraviolet-B (UV-B) radiation as a result of stratospheric ozone (O3) depletion. Direct UV-B-induced inhibition of photosynthetic competence is observed only at high UV-B irradiances and primarily involves the loss of soluble Calvin cycle enzymes and adaxial stomatal closure in amphistomatous plants. However, even under these extreme UV-B exposures, acclimation (e.g. induction of UV-B absorbing flavonoids) can protect the photosynthetic processes. In plants irradiated with UV-B throughout development a reduction in productivity is usually associated with a reduced ability to intercept light (i.e. smaller leaf area) and not an inhibition of photosynthetic competence. Finally, a review of field experiments utilizing realistic UV-B enhancement is made to evaluate whether the mechanisms involved in UV-B-induced depressions of photosynthesis are likely to impact on the photosynthetic productivity of crops and natural vegetation in the future. Predictions of plant responses to O3 depletion are suspect from squarewave irradiance experiments in the field and controlled environments due to the increased sensitivity of plants to UV-B at relatively low photosynthetically-active photon flux densities (PPFD) and ultraviolet-A (UV-A) irradiances. Realistic modulated UV-B irradiances in the field do not appear to have any significant effects on photosynthetic competence or light-interception. It is concluded that O3 depletion and the concurrent rise in UV-B irradiance is not a direct threat to photosynthetic productivity of crops and natural vegetation.

Healing of ozone causes greater global warming

ScienceDaily *(Jan. 26, 20*10*)*  Ozone Hole Healing Could Cause Further Climate Warming, Science News http://www.sciencedaily.com/releases/2010/01/100125192016.htm

The hole in the ozone layer is now steadily closing, but its repair could actually increase warming in the southern hemisphere, according to scientists at the University of Leeds.

The Antarctic ozone hole was once regarded as one of the biggest environmental threats, but the discovery of a previously undiscovered feedback shows that it has instead helped to shield this region from carbon-induced warming over the past two decades.

High-speed winds in the area beneath the hole have led to the formation of brighter summertime clouds, which reflect more of the sun's powerful rays.

"These clouds have acted like a mirror to the sun's rays, reflecting the sun's heat away from the surface to the extent that warming from rising carbon emissions has effectively been cancelled out in this region during the summertime," said Professor Ken Carslaw of the University of Leeds who co-authored the research.

"If, as seems likely, these winds die down, rising CO2emissions could then cause the warming of the southern hemisphere to accelerate, which would have an impact on future climate predictions," he added.

The key to this newly-discovered feedback is aerosol -- tiny reflective particles suspended within the air that are known by experts to have a huge impact on climate.

Greenhouses gases absorb infrared radiation from the Earth and release it back into the atmosphere as heat, causing the planet to warm up over time. Aerosol works against this by reflecting heat from the sun back into space, cooling the planet as it does so.

Beneath the Antarctic ozone hole, high-speed winds whip up large amounts of sea spray, which contains millions of tiny salt particles. This spray then forms droplets and eventually clouds, and the increased spray over the last two decades has made these clouds brighter and more reflective.

As the ozone layer recovers it is believed that this feedback mechanism could decline in effectiveness, or even be reversed, leading to accelerated warming in the southern hemisphere.

No Link

The tipping point was in 2002, space launches now still destroy the ozone.

Julia Solovyova, “Scientist Calls for Curb on Harmful Rocket Launches, Moscow Times”, 3/24/1999, Lexis Nexis

Russia and other countries that send rockets into space should protect the environment by adopting international regulations limiting the number of launches, a former presidential science adviser said Tuesday. Alexei Yablokov, head of the Center for Environmental Policy, said that pollution from rocket fuel was a major cause of damage to the earth's ozone layer, and that launches also threatened the health of people living under rocket flight paths. "In 20 or 30 years there will be a catastrophe," said Yablokov, a biologist who served as President Boris Yeltsin's science adviser from 1992-93. "We've got about three years to come up with international norms regulating the space activity." He admitted such proposals were likely to face resistance from governments and companies that depend on rocket launches for space exploration and to put commercial satellites in orbit. But something should be done, he said.

No Impact

Good effects of UV balance the bad

The 2010 Assessment of the Scientific Assessment Panel**,** United Nations Environment Programme http://ozone.unep.org/Assessment\_Panels/SAP/Scientific\_Assessment\_2010/index.shtml

Changes in solar UV radiation at the surface are important due to the biological consequences—both negative and positive—for humans and for different ecosystems. The adverse effects of UV radiation on human health have dominated the public awareness during the last three decades because of ozone depletion. In recent years, though, much attention has been drawn to the benefits of solar UV radiation with respect to its involvement in the production of vitamin D, an important agent for human health (Edvardsen et al., 2007; Kazantzidis et al., 2009; McKenzie et al., 2009; Webb et al., 1988). As the spectral characteristics of solar UV radiation at the surface depend on the changes in ozone, the recovery of the stratospheric ozone layer will reduce the harmful biological doses received by humans, but will reduce also the rate of production of vitamin D, especially in the winter months at high latitudes. Ozone depletion has also influenced other communities, terrestrial and marine, as well as biological and chemical processes in the environment (UNEP, 2007). Therefore, the recovery of stratospheric ozone and the timing of this recovery are important for both. The impacts of ozone depletion and recovery, and of the resulting changes in UV radiation on the environment and the ecosystems, will be focal points for discussion in the forthcoming assessment report of the Environmental Effects Assessment Panel (EEAP) of UNEP (UNEP, 2010).

Impact Turns

Healing of ozone causes greater global warming

ScienceDaily *(Jan. 26, 20*10*)*  Ozone Hole Healing Could Cause Further Climate Warming, Science News http://www.sciencedaily.com/releases/2010/01/100125192016.htm

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As the ozone layer recovers it is believed that this feedback mechanism could decline in effectiveness, or even be reversed, leading to accelerated warming in the southern hemisphere.

AT: Pollution DA\*\*\*

Link Turn

NASA satellites to monitor and research pollution.

Warren E. Leary, New York Times Science Times Writer, The New York Times, “NASA's New Eye on Sky To Watch Earth's Ozone”, July 6, 2004

Aura will monitor the upper ozone layer, including seasonal ''holes'' that open over arctic areas, to see if the layer is recovering after a worldwide ban on ozone-depleting chemicals like chlorofluorocarbons. Studies indicate that between 1980 and 2000, stratospheric ozone decreased 3 percent globally. The craft will detect levels of ozone-eating chemicals and such byproducts as chlorine and bromine, and also help distinguish between natural and human-caused sources of destructive gases. The spacecraft's ozone monitoring instrument, which also measures trace gases and pollutants important to air quality, will help scientists determine if there is any mixing between the ''good'' ozone in the stratosphere and the pollution variety nearer the ground. In addition, readings from Aura will examine the mechanisms in the atmosphere that clean pollution. Aura's other major job will be to track atmospheric chemicals and aerosol particles, including pollutants, to see how they mix and how they are transported from one area of the world to other regions. Aerosols from human and natural sources absorb or reflect solar energy based on their size, shape, color and chemical composition, and their effect on climate is largely unknown, experts said. The spacecraft will also track greenhouse gases, like carbon dioxide and water vapor, which trap heat and contribute to global warming. In addition, it will observe heat emission from Earth's surface and atmosphere, day and night. Aura is to take on a new role later in its mission, when it becomes part of a planned fleet of Earth-observing satellites flying in a formation. Under the scheme, nicknamed the A Train because Aqua will lead the formation and Aura will bring up the rear, four other American and French satellites will fill the gap between the large spacecraft. Although on independent missions, the satellites will be positioned to pass over a region one after another, building a database of observations that should create a global picture of Earth's changing climate.

Alt Causes

New projects, if gone wrong, can pose threat to millions.

Tooker Gomberg, Environmentalist and writer for The Gazette, The Gazette Editorial Section, “Spacecraft pose catastrophic nuclear threat” December 2, 1996

Did you hear about the Russian spacecraft that was supposed to go to Mars but crashed back to Earth instead? It happened on Sunday, Nov. 17, and the official story was that there was nothing to worry about. There is, in fact lots to worry about. And the broader story is so bizarre and chilling nobody wants to come anywhere near it. Reporters tell me it's unbelievable. Friends say it's too crazy to believe. They're right. Aboard the craft, to generate a small amount of electricity, were four cannisters containing at least 200 grams of plutonium - the most toxic substance in the universe. "Named after Pluto, god of the underworld, it is so toxic that less than one-millionth of a gram, a microscopic particle, is a carcinogenic dose. One pound, if uniformly distributed, could hypothetically induce lung cancer in every person on Earth," says Helen Caldicott, founder of Physicians for Social Responsibility. Plutonium puts poison gas and arsenic to shame. Compared with this element, strychnine is candy. A few hundred grams of plutonium may not sound like much, but the carcinogenic wallop it delivers should not be ignored. Mishaps have happened before. In 1964, a U.S. satellite crashed to Earth with 2.1 pounds of plutonium on board. It disintegrated and the plutonium was dispersed through the atmosphere scattering over every continent and every latitude of the planet. Increased lung-cancer rates have been attributed to that crash. In 1978, a Soviet nuclear satellite, Cosmos 954, crashed into Canada's Arctic littering a large area with radioactive debris. Last month we were told that the cannister containing the plutonium probably remained intact, and that it probably landed somewhere in the Pacific Ocean west of Chile. Clarin, Argentinia's major newspaper, recently stated that (not 200, but) 1,200 grams of plutonium were on board, and that Chilean scientists are alarmed about the potential effect the plutonium may have on nearby rich fishing grounds if it gets into the water. Eating fish that have ingested plutonium can also cause cancer in humans, and the plutonium will remain hotly radioactive for thousands of years. The launching of rockets containing plutonium is a deadly game of Russian roulette. No less than the health of every living thing on the planet is at risk. And it's not just the Russians playing this potentially lethal game. The United States is even more enthusiastic about using plutonium in its rockets. NASA is planning to launch, next October, the Cassini mission to explore Saturn. On board would be 72.3 pounds of plutonium, more plutonium than has ever been sent into space. Cassini is slated to be launched aboard a Titan IV rocket, a rocket type that has been plagued with problems. Dr. Ernest Sternglass, professor emeritus of radiological physics at the University of Pittsburgh school of medicine, estimates that the number of deaths from a Cassini mishap could run as high as 20 to 40 million people. As if that's not enough, there are also plans afoot to use nuclear power for satellites, as well as for Star Wars. Many people think that Star Wars was shelved years ago, but it is still alive though the official name has changed from Strategic Defence Initiative to Ballistic Missile Defence. And, if a rocket or satellite mishap occurs, the American Price Anderson Act establishes upper limits of liability. Alarmingly, if there was an accident in the U.S., the limit would be $ 7.3 billion, but if there was a crash in Canada only $ 100 million could be claimed. This would let NASA or the U.S. military off the hook. "(This week's) incident is a very important wake-up call," says Karl Grossman, professor of journalism at the State University of New York. "Major accidents are inevitable if nuclear materials continue to be sent into space." He points out that solar energy could supply the electricity in space instead of plutonium. "There is absolutely no need whatsoever for this risk to life on Earth by the use of nuclear materials in space." So what actually happened to the plutonium cannisters that crashed to Earth? We may never know. But if a project like Cassini has a mishap, millions of people going about their daily lives may inhale tiny specks of plutonium. Years later, they will end up with lung cancer, thanks to some mad scientists who peer out at the universe yet forget about life here on Earth. Unless we can stop them, the unthinkable may just come to pass.

Alt Causes

Space tourism causes massive pollution.

United Press International, UPI Science News, “Study: Space tourism could pollute skies”, http://www.upi.com/Science\_News/2010/10/22/Study-Space-tourism-could-pollute-skies/UPI-67571287790772/#ixzz1Qiqfrq7C, Oct. 22, 2010

A decade of space tourism flights would cause climate change by putting as much soot into the atmosphere as current global aviation does, U.S. researchers say. A study suggests emissions from 1,000 private rocket launches a year would remain high in the stratosphere, possibly altering global atmospheric circulation and distributions of ozone, Nature.com reported Friday. "There are fundamental limits to how much material human beings can put into orbit without having a significant impact," says Martin Ross, an atmospheric scientist at the Aerospace Corp. in Los Angeles and an author of the study. In the next three years, space tourism companies say they expect to make up to two launches per day. Several private space-flight companies, such as Virgin Galactic, are contemplating using hybrid rocket engines that ignite synthetic hydrocarbon with nitrous oxide, Ross says. These hybrid engines emit more black carbon -- soot --than a normal kerosene and oxygen engine, he says. "Rain and weather wash out these particles from the atmosphere near Earth's surface, but in the stratosphere there isn't any rain and they can remain for three to 10 years," says Michael Mills, an atmospheric chemist at the National Center for Atmospheric Research in Boulder, Colo., another author of the paper.

\*\*\*\*AT: Space Debris DA

AT: Debris = Risk

Space debris can reenter Earth’s atmosphere.

GlobalCom, “Space Junk: What It Is and What Causes It”, http://www.globalcomsatphone.com/hughesnet/satellite/space\_junk.html, No Date

In general, the higher the altitude, the longer the debris will stay in space. According to the European Space Agency, there are over 7,500 pieces of orbiting space junk in space that are at least 4 inches in width. They do, however, find their way back to Earth. Although smaller debris will be burned upon entry in the Earth’s atmosphere, larger items can and have remained intact when they crashed on the ground.

No Link

Rockets don’t pose a threat to the ozone

Martin N. Ross and Paul F. Zittel, “Rockets and the Ozone Layer”, 5/16/07, http://www.aero.org/publications/crosslink/summer2000/01.html

Space transportation, once dominated by government, has become an important part of our commercial economy, and the business of launching payloads into orbit is expected to nearly double in the next decade. Each time a rocket is launched, combustion products are emitted into the stratosphere. CFCs and other chemicals banned by international agreement are thought to have reduced the total amount of stratospheric ozone by about 4 percent. In comparison, recent predictions about the effect on the ozone layer of solid rocket motor (SRM) emissions suggest that they reduce the total amount of stratospheric ozone by only about 0.04 percent. Even though emissions from liquid-fueled rocket engines were not included in these predictions, it is likely that rockets do not constitute a serious threat to global stratospheric ozone at the present time. Even so, further research and testing needs to be done on emissions from rockets of all sizes and fuel system combinations to more completely understand how space transportation activities are affecting the ozone layer today and to predict how they will affect it in the future.

Good effects of UV balance the bad

The 2010 Assessment of the Scientific Assessment Panel**,** United Nations Environment Programme, 10 http://ozone.unep.org/Assessment\_Panels/SAP/Scientific\_Assessment\_2010/index.shtml

Changes in solar UV radiation at the surface are important due to the biological consequences—both negative and positive—for humans and for different ecosystems. The adverse effects of UV radiation on human health have dominated the public awareness during the last three decades because of ozone depletion. In recent years, though, much attention has been drawn to the benefits of solar UV radiation with respect to its involvement in the production of vitamin D, an important agent for human health (Edvardsen et al., 2007; Kazantzidis et al., 2009; McKenzie et al., 2009; Webb et al., 1988). As the spectral characteristics of solar UV radiation at the surface depend on the changes in ozone, the recovery of the stratospheric ozone layer will reduce the harmful biological doses received by humans, but will reduce also the rate of production of vitamin D, especially in the winter months at high latitudes. Ozone depletion has also influenced other communities, terrestrial and marine, as well as biological and chemical processes in the environment (UNEP, 2007). Therefore, the recovery of stratospheric ozone and the timing of this recovery are important for both. The impacts of ozone depletion and recovery, and of the resulting changes in UV radiation on the environment and the ecosystems, will be focal points for discussion in the forthcoming assessment report of the Environmental Effects Assessment Panel (EEAP) of UNEP (UNEP, 2010).

Link Turn

As more space debris is created, the costs to launch space craft will outweigh the benefits.

William J. Broad, Author and a senior writer at The New York Times, 25 years as a science correspondent, he has written hundreds of front-page articles and won every major journalistic award in print and film, His reporting has explored everything from exploding stars and the lives of marine mammals to the spread of nuclear arms and the speed at which RMS Titanic sank, His journalism is featured in The Best American Science Writing, New York Times, Space and Cosmos, “Orbiting Junk, Once a Nuisance, Is Now a Threat”, February 6, 2007

Still, he warned of an economic barrier to space exploration that could arise. To fight debris, he said, designers will have to give spacecraft more and more shielding, struggling to protect the craft from destruction and making them heavier and more costly in the process. At some point, he said, perhaps centuries from now, the costs will outweigh the benefits. “It gets more and more expensive,” he said. “Sooner or later it gets too expensive to do business in space.”

2AC: Non-unique

Space debris collision is inevitable.

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Federal and private experts say that early estimates of 800 pieces of detectable debris from the shattering of the satellite will grow to nearly 1,000 as observations continue by tracking radars and space cameras. At either number, it is the worst such episode in space history. Today, next year or next decade, some piece of whirling debris will start the cascade, experts say. “It’s inevitable,” said Nicholas L. Johnson, chief scientist for orbital debris at the National Aeronautics and Space Administration. “A significant piece of debris will run into an old rocket body, and that will create more debris. It’s a bad situation.”

The ozone is not going to recover-emissions are growing

physorg.com September 16, 2010 UN scientists say ozone layer depletion has stoppedhttp://www.physorg.com/news203861925.html

Although CFCs have been phased out, they accumulated and persist in the atmosphere and the effect of the curbs takes years to filter through.

The ozone hole over the South Pole, which varies in size and is closely monitored when it appears in springtime each year, is likely to persist even longer and may even be aggravated by climate change, the report said.

Scientists are still getting to grips with the complex interaction between ozone depletion and global warming, Barrie explained.

"In the Antarctic, the impact of the ozone hole and the surface climate is becoming evident," he said.

"This leads to important changes in surface temperature and wind patterns, amongst other environmental changes," Barrie added.

CFCs are classified among greenhouse gases that cause global warming, so the phase out "provided substantial co-benefits by reducing climate change," the report found.

Barrie estimated that it had avoided about 10 gigatonnes of such emissions a year.

However, the ozone-friendly substances that have replaced CFCs in plastics or as refrigerants - hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) -- are also powerful greenhouse gases.

HFCs alone are regarded as 14,000 times more powerful than carbon dioxide (CO2), which is the focus of international efforts to tackle climate change, and HFC emissions are growing by eight percent a year, according to UN agencies.

2AC: Non-unique

Communication satellites are key to warning about, managing, and recovering from natural disasters.

GVF. Non-profit industry association created to educate governments and enterprises about satellite communications worldwide. 2010. “WHY SATELLITE COMMUNICATIONS ARE AN ESSENTIAL TOOL FOR EMERGENCY MANAGEMENT AND DISASTER RECOVERY” http://www.iaem.com/resources/links/documents/satellitewhitepaper060906.pdf

Communications provide the critical path for relief in emergency and disaster situations. Communications connect and help move logistical, rescue and first responder resources in any region of the world facing or recovering from natural or man-made disasters.

Deploying wireless communications is typically among the first priorities in any emergency response, rescue, or relief situation. However, terrestrial wireless equipment (cellular phones or land mobile radios) is only useful when communications towers and other fixed equipment are in place to connect wireless equipment to the local and global communications backbone. In the majority of emergency situations, this infrastructure has either been destroyed by the disaster (e.g. New Orleans after Hurricane Katrina) or was not available before the disaster (e.g. the earthquake in Pakistan). This reality makes it critical for local government and emergency workers to have access to a wireless communications network that is not dependant on terrestrial infrastructure.

Satellite communications provide such a solution. Satellites are the only wireless communications infrastructure that is not susceptible to damage from disasters, because the main repeaters sending and receiving signals (the satellite spacecraft) are located outside the Earth’s atmosphere.

Users today have two kinds of satellite communications networks available to support emergency response activities: geostationary satellite systems (GEO) and low Earth orbit satellites (LEO).

Geostationary (GEO) satellites are located 36,000 km above the Earth in a fixed position and provide service to a country or a region covering up to one third of the globe. They are capable of providing a full range of communications services, including voice, video and broadband data. These satellites operate with ground equipment ranging from very large fixed gateway antennas down to mobile terminals the size of a cellular phone. There are currently almost 300 commercial GEO satellites in orbit operated by global, regional and national satellite carriers.

Even before disasters strike, these networks are used in many countries to provide seismic and flood- sensing data to government agencies to enable early warning of an impending situation. Also, they broadcast disaster-warning notices and facilitate general communication and information flow between government agencies, relief organizations and the public.

LEO satellites operate in orbits between 780 km and 1,500 km (depending on the system) and provide voice and low speed data communications. These satellites can operate with handheld units about the size of a large cellular phone. As with handheld terminals that rely upon GEO satellites, the highly portable nature of LEO-based units makes them another valuable satellite solution for first responders in the field.

In order to most effectively utilize the capabilities of these systems, government agencies, relief organizations and other first responders must define as far in advance as possible what kind of terminals they will need to have in the field before and after an emergency. This planning requires an understanding of the different capabilities of the various system types outlined below.

Aircraft Alt-Cause

Aircraft emissions have less of an effect on the ozone layer than is believed.

DARIN TOOHEY, JOHN MCCONNELL, LINNEA AVALLONE, AND WAYNE EVAN, Bulletin of the American Meteorological Society, “AVIATION AND CHEMISTRY AND TRANSPORT PROCESSES IN THE UPPER TROPOSPHERE AND LOWER STRATOSPHERE”**,** 2010

It is now recognized that exhaust-influenced aerosols and heterogeneous chemistry have more important roles in UTLS chemistry. In addition, NOx sources from the PBL by convective transport are significantly larger than previously believed, suggesting that aircraft emissions could have a smaller net impact on ozone. In combination, these two new observations could act to reverse the local state of the atmosphere from a predominantly ozone-producing one (e.g., high NOx ) to one that destroys ozone (low NOx , high active chlorine). Evidence is also mounting thast abundances of inorganic bromine in the UT are significantly larger than previously believed, presumably resulting from efficient transport of short-lived bromine sources to the UT. Conversely, high abundances of NOx transported from the PBL can deactivate the inorganic halogen species.

Aircraft emissions are dangerous and potent.

ClimateLab, ClimateLab.org, Website republishing information from various sources, 1:Carbon neutral airline NatureAir joins UNEP’s Climate Initiative , Terracurve. 2Richard Miake-Lye, Aerodyne Research David Fahey,NOAA Ian Waitz,MIT Chowen Wey,NASA-Glenn Howard Wesoky,FAA, AVIATION AND THE CHANGING CLIMATE,aiaa.org 3 4:How Do Aircraft Affect Climate and Ozone? , IPCC Special Report: Aviation and the Global Atmosphere. “Airplane Emissions”, 2010

Aircraft engines produce emissions that are similar to other emissions resulting from fossil fuel combustion. However, aircraft emissions are unusual in that a significant proportion is emitted directly into the upper troposphere and lower stratosphere where they have an impact on atmospheric composition. 2This makes airplane emissions particularly potent compared to other emissions. The principal emissions of aircraft include the greenhouse gases carbon dioxide and water vapor (H2O). Other major emissions are nitric oxide (NO) and nitrogen dioxide (NO2), sulfur oxides (SOxO), and soot. According to the IPCC, because carbon dioxide has a long atmospheric residence time (ª100 years) and, as a result, becomes well mixed throughout the atmosphere, the carbon dioxide emitted from aircraft is indistinguishable from the same quantity of carbon dioxide emitted by any other source. 3 Thus, it is more difficult to quantify the climate impact of the carbon dioxide formed as a result of aviation than the emissions.

Aff—Nitrous Oxides o/w

Fossil fuels create nitrogen oxides

UCA, Union of Concerned Scientists, “The Hidden Cost of Fossil Fuels” , 10/29/02 http://www.ucsusa.org/clean\_energy/technology\_and\_impacts/impacts/the-hidden-cost-of-fossil.html

Air Pollution Clean air is essential to life and good health. Several important pollutants are produced by fossil fuel combustion: carbon monoxide, nitrogen oxides, sulfur oxides, and hydrocarbons. In addition, total suspended particulates contribute to air pollution, and nitrogen oxides and hydrocarbons can combine in the atmosphere to form tropospheric ozone, the major constituent of smog. Carbon monoxide is a gas formed as a by-product during the incomplete combustion of all fossil fuels. Exposure to carbon monoxide can cause headaches and place additional stress on people with heart disease. Cars and trucks are the primary source of carbon monoxide emissions. Two oxides of nitrogen--nitrogen dioxide and nitric oxide--are formed in combustion. Nitrogen oxides appear as yellowish-brown clouds over many city skylines. They can irritate the lungs, cause bronchitis and pneumonia, and decrease resistance to respiratory infections. They also lead to the formation of smog. The transportation sector is responsible for close to half of the US emissions of nitrogen oxides; power plants produce most of the rest. Sulfur oxides are produced by the oxidization of the available sulfur in a fuel. Utilities that use coal to generate electricity produce two-thirds of the nation's sulfur dioxide emissions. Nitrogen oxides and sulfur oxides are important constituents of acid rain. These gases combine with water vapor in clouds to form sulfuric and nitric acids, which become part of rain and snow. As the acids accumulate, lakes and rivers become too acidic for plant and animal life. Acid rain also affects crops and buildings. Hydrocarbons are a broad class of pollutants made up of hundreds of specific compounds containing carbon and hydrogen. The simplest hydrocarbon, methane, does not readily react with nitrogen oxides to form smog, but most other hydrocarbons do. Hydrocarbons are emitted from human-made sources such as auto and truck exhaust, evaporation of gasoline and solvents, and petroleum refining. The white haze that can be seen over many cities is tropospheric ozone, or smog. This gas is not emitted directly into the air; rather, it is formed when ozone precursors mainly nonmethane hydrocarbons and nitrogen oxides react in the presence of heat and sunlight. Human exposure to ozone can produce shortness of breath and, over time, permanent lung damage. Research shows that ozone may be harmful at levels even lower than the current federal air standard. In addition, it can reduce crop yields. Finally, fossil fuel use also produces particulates, including dust, soot, smoke, and other suspended matter, which are respiratory irritants. In addition, particulates may contribute to acid rain formation.

**Nitrous oxides are the largest internal link to ozone depletion**

AFP, Agence-France Presse, “Nitrous oxide is top destroyer of ozone layer: study”, 8/31/09 http://www.alternet.org/rss/breaking\_news/86746/nitrous\_oxide\_is\_top\_destroyer\_of\_ozone\_layer:\_study?page=entire

Nitrous oxide emissions caused by human activity have become the largest contributor to ozone depletion and are likely to remain so for the rest of the 21st century, a US study has concluded. "Commuters on Interstate 66 in Fairfax, Virginia, drive under a Ozone alert, in 2007. Nitrous oxide emissions caused by human activity have become the largest contributor to ozone depletion and are likely to remain so for the rest of the 21st century, a US study has concluded." The study by the National Oceanographic and Atmospheric Agency said efforts to reduce chlorofluorocarbons (CFCs) in the atmosphere over the past two decades were "an environmental success story. "But manmade nitrous oxide is now the elephant in the room among ozone-depleting substances," said A. R. Ravishankara, lead author of the study, which was published Friday in the journal Science. While nitrous oxide's role in depleting the ozone layer has been known for decades, the study marks the first time that its impact has been measured using the same methods as CFCs and other ozone depleting substances. Emissions and production of those substances are regulated under the 1987 Montreal Protocol. But the treaty excludes nitrous oxides, which are emitted by agricultural fertilizers, livestock manure, sewage treatment, combustion and certain other industrial processes. Since nitrous oxide is also a greenhouse gas, the scientists said reducing emissions from manmade sources would be good for the ozone layer and help temper climate change.

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Uniqueness Overwhelms the Link

Space launches have a history of polluting even the space outside our mesosphere and it is still a risk to the enviroment to institute them.

Stephen Gorove, ‘72, Pollution and Outer Space: A Legal Analysis and Appraisal, <http://heinonline.org/HOL/Page?handle=hein.journals/nyuilp5&div=8&g_sent=1&collection=journals#64>

Still another form of possible contamination arising out of space activities would be nuclear explosions in space and accidents involving nuclear propelled spacecraft. Some years ago certain US and Soviet nuclear experiments were alleged to have affected the Van Allen radiation belts, jeopardizing the studies of their origins. At present, under the Nuclear Test Ban Treaty of 1963, such tests are prohibited in outer space. However, it should be noted that the ban does not relate to wartime uses of atomic energy. Also, several states, including Communist China and France, are not parties to the agreement. The possibility of accidents resulting from the use of nuclear-powered spacecraft constitutes another hazard of contamination.

Launch vehicle solid rocket’s create pollution that decompose the ozone.

M. A. Hanning et al., 1996, Lee Mechanics and Materials Technology Center, The Aerospace Corporation, Los Angeles, CA, Ozone decomposition on alumina: Implications for solid rocket motor exhaust, <http://www.agu.org/pubs/crossref/1996/96GL01808.shtml>

Rates of ozone decomposition on aluminum oxide (alumina) particles were measured in a flow tube reactor equipped with molecular beam sampling mass spectrometry and ultraviolet absorption spectroscopy, and in a static reaction cell equipped with ultraviolet absorption spectroscopy. Reaction probabilities η are reported for ozone on α‐alumina, γ‐alumina, and Chromatographic alumina (hydroxylated alumina), respectively, over the temperature range −60 to 200°C. This work addresses the potential for stratospheric ozone depletion by launch vehicle solid rocket motor exhaust. Considering best estimates of plume particle size distributions and dispersion rates, we calculate ozone depletion profiles, for direct decomposition on alumina only. The calculated ozone holes are rather narrow. In the worst case, ozone levels are within 5 × 10−5 of ambient in the center of the plume. A simple analysis of the global impact of alumina particles on ozone decomposition indicates a potential steady‐state daytime depletion of < 2.6 × 10−8 at present launch rates.

Space debris has been and still is a rather large issue, putting future space projects at jeopardy of a LEO wall of junk that could halt any sort of space r&d.

D. J Kessler, 1985, [creds], Orbital Debris Issues, http://www.sciencedirect.com/science?\_ob=MImg&\_imagekey=B6V3S-46YCW8F-1-1&\_cdi=5738&\_user=4257664&\_pii=0273117785903813&\_origin=&\_coverDate=12%2F31%2F1985&\_sk=999949997&view=c&wchp=dGLbVzW-zSkWA&md5=dbd9da091e27e358554c0406c3037608&ie=/sdarticle.pdf

Orbital debris is becoming a concern due to a combination of fundamental issues. First, the volume for Earth—orbiting objects is much smaller than that occupied by interplanetary meteoroids. Consequently, practically since the beginning of the space program, collision probabilities from payloads and rocket bodies alone have been orders of magnitude higher than collision probabilities from rneteoroids of the same size. Second, just as in the case of interplanetary meteoroids, large objects act as a source of smaller objects by frag- menting. Fragmentation of manmade satellites occurs either by accidental explosion of rocket bodies, by intentional explosion or breakup of an object, or by collision between two objects. To date, 79 satellites are known to have broken up in Earth orbit. Depending on the size distribution of fragments, the mass in a single, average manmade satellite is sufficient to cause the flux from these fragments to exceed the interplanetary meteoroid flux over the entire size spectrum of fragments and over several hundred kilometers of altitude. Finally, the large orbital inclinations coupled with the rapid precession of the ascending node produce high collision velocities in low Earth orbit. The average collision velocity between two objects in low Earth orbit is 10 km/sec. compared to an impact velocity of 15 to 20 km/sec for interplanetary meteoroids. Consequently, the damage caused by an orbital debris impact is not very different from that caused by meteoroids.

Uniqueness Overwhelms the Link

United States launches have punched holes in the ozone before using nitric oxide, which is still used in rockets today.

Peter D. Lohn and Eric Y. Wong, 1994, TRW Space and Electronics Group, The Impact of Deorbiting Space Debris on Stratospheric Ozone, http://www.globalsecurity.org/space/library/report/enviro/debrisOz.pdf

The comparison with the Steward and Gomberg measurements show the relevance and accuracy of the plume/wake dispersion-kinetics model used in this study. The calculation, however, confined attention to the effects of NO on ozone. The Titan SRM exhaust will contain chlorine as well as NO. It should be noted, however, that the NO2 photodissociation, an important reaction in the NO catalytic cycle, takes place in the solar spectrum between 200-700 nm while CI2 or CIO photodissociation takes place at 240-310 nm (Ref 5.9). The solar flux in the lower troposphere at 200-700 nm is, orders of magnitude higher than that in the 240-310 nm regime (Ref. 5.10). It is therefore anticipated that the chlorine catalytic cycle is not as important as the NO cycle in the lower troposphere. The ozone hole observed was quite likely caused by the presence of the nitric oxide in the Titan SRM exhaust. This contention should, as a follow-on activity be verified by performing a complete cold plume calculation with both chlorine and NO mechanisms included.

There is an enormous amount of space debris already circling the Earth that pose a great danger to current satellites as well as future missions, our first priority should be cleaning it up, not making more.

GREGORY E JOHNSON, February 12, 2009, Xinhua General News Service, Space debris -- man-made threat in space exploration, http://news.xinhuanet.com/english/2009-02/12/content\_10806956.htm

Last April, scientists at the American Physical Society conference in Los Angeles said there were already more than 150 million pieces, among which a large amount were junks created by astronauts. They predicted that the amount would still increase in the next 200 years. Early statistics showed that about 45 percent of space debris was produced by the United States and 48 percent by Russia or former Soviet Union. China produced only 1.2 percent. The average speed of space debris is 10 km per second and the maximum speed can be 16 km per second. Explosion or disassembly could happen if the craft is hit by a large piece of space debris. Even a 10-gram piece of debris can generate a collision force in space equaling to the crash of a car running at 100 km per hour, Du Heng, chief scientist with China's space debris action program, has said. Therefore, scientists attending last April's conference have called on the international community for joint efforts to reduce spaces debris. The threat is debris would begin slamming into other debris, creating a cascading effect called "super-criticality," they said. According to the scientists, a satellite orbiting Earth passes within 60 miles (about 96.6 km) of a piece of junk several thousand times a day and has a one percent chance each year of getting hit. On the other hand, "we are in danger of a runaway escalation of space debris," MIT physicist Geoffrey Forden said at the conference. But So far no effective way to collect space rubbish or avoid them from collision has been worked out. Satellite and spacecraft launchers can only try producing as less debris as possible while monitoring large debris and improving solidity of space vessels. According to Du, less debris is nowadays produced by the explosion of abandoned rockets with surplus fuel. Improvement in spacecraft has also been made, including strengthening solidity and designing special protection areas. The measures on the International Space Station seem effective in resisting the collision with small debris. Space powers are also trying to enhance monitoring abilities, wanting to lower the size of traceable debris to one cm. However, to avoid approaching large debris is the best way.

Uniqueness Overwhelms the Link

Space launches are damaging the ozone and cause long term health problems for the people beneath the flight paths.

Julia Solovyova, 1999, Scientist Calls for Curb on Harmful Rocket Launches, Moscow Times, <http://www.themoscowtimes.com/news/article/scientist-calls-for-curb-on-harmful-rocket-launches/279100.html>

Russia and other countries that send rockets into space should protect the environment by adopting international regulations limiting the number of launches, a former presidential science adviser said Tuesday. Alexei Yablokov, head of the Center for Environmental Policy, said that pollution from rocket fuel was a major cause of damage to the earth's ozone layer, and that launches also threatened the health of people living under rocket flight paths. "In 20 or 30 years there will be a catastrophe," said Yablokov, a biologist who served as President Boris Yeltsin's science adviser from 1992-93. "We've got about three years to come up with international norms regulating the space activity." He admitted such proposals were likely to face resistance from governments and companies that depend on rocket launches for space exploration and to put commercial satellites in orbit. But something should be done, he said. Yablokov spoke at a news conference in Moscow devoted to a book co-authored by a group of independent space and environmental experts, titled "Environmental Dangers of Space Exploration." Yablokov is the editor. Chief among the dangers, Yablokov said, are the clouds of hydrogen and carbon dioxide left hanging in the atmosphere for weeks after launches. He attributed 50 percent of the shrinking of the earth's ozone layer to rocket launches. Ozone protects the earth's surface from potentially harmful radiation. In addition, toxic rocket fuel showers the earth as spent rocket stages fall in Siberian forests downrange from Russia's chief launch sites, at Plesetsk in the north and Baikonur in Kazakhstan. Russia routinely tests ballistic missiles by launching them across Siberia to Kamchatka in the Far East. Yablokov said 30 million hectares in 16 regions of Russia - about 2 percent of the country's territory - are routinely subjected to rocket fuel pollution. For people living around launch sites and under the most frequently used rocket flight paths in the Altai, Yakutia, Tuva and Arkhangelsk regions, the effects are at first invisible and cause long-term damage, much as radiation can, the environmentalists said. Even small amounts can build up in body tissues and cause long-term damage, they said. Exposure of one-third of the Altai region territory to rocket fuel pollution has lead to higher mortality rates, cancer and birth defects, said physician Vladimir Lupandin, who studied the problem for the Center for Independent Environmental Programs. Other regions are affected too, he said: "Millions of people suffer the effects of space exploration." Yablokov and the book's authors said that spacefaring nations could agree to limit the number of total launches, to monitor pollution and clean up fuel -polluted areas at the expense of the space industry.

The ozone, despite the serious damage it has been dealt, will recover in a period of 50 years, but with dangerous biproducts.

United News of India (UNI), February 8, 2010, Depletion of Ozone levels leads to catastrophe: scientist, http://www.in.com/news/current-affairs/fullstory-depletion-of-ozone-levels-leads-to-catastrophe-scientist-12725763-in-1.html

Kakinada, Feb. 8 -- Noted environmentalist Prof Venkata R.Neralla, from 'Environment Canada', Toronto has warned that the fast depletion of Ozone layer was not arrested by all nations with concerted efforts, entire world would face a major catastrophe soon. Inaugurating a two-day international workshop on `Energy, Environment, Education, organised by the department of civil engineering JNTU college of engineering here, he said, under the Montreal Protocol 1987, a treaty signed for the protection of Ozone layer, the use of Chloro Fluoro Carbons (CFC) was to be banned by the year 2000. After this the ozone layer is expected to slowly recover over a period of 50 years. Although the use of CFCs has been reduced and now banned in most countries, other chemicals and industrial compounds such as bromine, halocarbons and nitrous oxides from fertilizers continue to affect the ozone layer. The Ozone depletion can have adverse effect on all organisms from the simplest single celled plants to insects, fish, birds and mammals alike. It can cause skin cancer, eye damage and weakening of human immune system, besides creating problems in terrestrial plants and animals. Hence, it should be the prime duty of everyone to reduce the use of hazardous chemicals and other pollutants that adversely affect the environment, he warned. Published by HT Syndication with permission from United News of India. For more information on news feed please contact Sarabjit Jagirdar at [htsyndication@hindustantimes.com](mailto:htsyndication@hindustantimes.com" \t "_blank)

Uniqueness Overwhelms the Link

There are enough contaminants in the air to severely threaten the Earth and its inhabitants, but recovery is arriving, should we be persistent in our green attitude.

Paul Fraser, 2002, CSIRO Marine and Atmospheric Research, leads CSIRO's research into the Changing Atmosphere

THE ozone hole, the man-made environmental catastrophe that changed the attitudes of Australians to their summers, to sunbathing and to aerosol sprays, should soon begin to close, according to the CSIRO. Ozone-depleting chlorine in the winds that circle the planet sourced to man-made chlorofluorocarbon gases in refrigerators, foam plastics and pre-90s aerosol sprays are declining by about 1 per cent a year, Paul Fraser, the chief research scientist with the CSIRO's atmospheric research division, said yesterday. In 50 years, nature should have restored the ozone in the stratosphere that the chlorine destroyed, and the hole will disappear. As the ozone layer in the stratosphere depleted, so did Earth's protection against ultraviolet rays and skin cancers. Dr Fraser said that in the 1950s, there had been no CFCs in the atmosphere, according to Antarctic ice samples. By 1987, when the Montreal Protocol on ozone-depleting substances was adopted, there were 1.6 parts per billion, enough to create a hole over Antarctica in the early summer. The level of CFCs peaked at 2.15ppb in 2000, but for the past two years it had declined.

Space debris is a danger to future space missions, collisions have proven to be massively destructive and to further the presence of space debris.

Space Daily, 8/25/09, Astronomy Question of the Week: Is Space Debris Dangerous, http://www.dlr.de/en/desktopdefault.aspx/tabid-1/86\_read-18916/

"There's always a first time" - for the Iridium 33 communications satellite, the first collision between two satellites in space was, however, also the last time. On 10 February of this year its flight path crossed that of the retired Russian military satellite Kosmos 2251. Both satellites were completely destroyed and about 700 pieces of debris were distributed along their paths. Such collisions cannot always be avoided and space debris has become an expensive problem. More than 600 000 objects in Earth orbit Space debris is made up of macroscopic particles near Earth. 'Macroscopic' means that the particles of space debris can be seen at close range with the naked eye. It is estimated that over 600 000 objects larger than one centimetre across orbit Earth. They include satellites that are no longer active, burnt out rocket stages or their debris, screws, wires and waste from solid fuel rocket motors. From November 2008 until 3 August 2009, when it re-entered the atmosphere, a tool bag from the Space Shuttle was orbiting Earth. Natural 'space debris' is also a risk to space flight. Micrometeoroids can collide with space vehicles. They move at speeds far in excess of 11.2 kilometres per second (Earth's surface escape speed), and so are travelling much faster than orbital debris. Space debris is not just a risk to unmanned satellites. Systems with people on board, such as the International Space Station, must be protected against small objects with deflectors and matting - and the ISS must take avoiding action for objects larger than 10 centimetres across. The lifetime of space debris depends on the height of its flight path, because the particles of scrap are slowed down by the residual atmosphere and this is denser near Earth than at greater heights. The lifetime of a particle at a height of 400 kilometres (the altitude of the ISS) is about one year, whereas at 1000 kilometres it rises to about one thousand years. Garbage avoidance Just as on Earth, the simplest way to reduce rubbish in space is to avoid it altogether - rocket stages and old satellites can be actively slowed down and made to burn up in the atmosphere. Gathering up space debris is complex and a spaceship requires a great deal of fuel for it. Other disposal concepts - such as firing laser beams at the junk - are being studied but are not yet ready for deployment.

Impact Turn

If we have no new launches satellite population will remain relatively constant and unaffected.

J.C. Lou, N.L Johnson, ESCG/ERC, Mail Code JE104, 2224 Bay Area Building, Box 7, Houston, TX 77058, USA Orbital Debris Program Office, NASA Johnson Space Center, NASA, 2101 NASA Parkway, Houston, TX 77058, USA, Advances in Space Research, “Instability of the present LEO satellite populations”, 24 April 2007

A new study has been conducted in the Orbital Debris Program Office at the NASA Lyndon B. Johnson Space Center, using higher fidelity models to evaluate the current debris environment. The study assumed no satellites were launched after December 2005. A total of 150 Monte Carlo runs were carried out and analyzed. Each Monte Carlo run simulated the current debris environment and projected it 200 years into the future. The results indicate that the LEO debris environment has reached a point such that even if no further space launches were conducted, the Earth satellite population would remain relatively constant for only the next 50 years or so. Beyond that, the debris population would begin to increase noticeably, due to the production of collisional debris. Detailed analysis shows that this growth is primarily driven by high collision activities around 900–1000 km altitude – the region which has a very high concentration of debris at present.

The risk is low now, but the more launches we have, the chances will increase.

Steve Olson, a US writer who specializes in science, mathematics, and public policy and author of two nonfiction trade books, The Atlantic Magazine, “The Danger of Space Junk”, July, 1998

Today the risk of such a disaster for a satellite or a small craft like the shuttle is relatively low, though Mir, the Russian space station, launched in 1986, has been hit by objects large enough to dent the inner wall of the crew compartment. But the International Space Station, much larger than Mir, will be a plump target for debris. Each decade that it is in orbit, according to a recent study, the station will have about a 20 percent chance of undergoing a "critical penetration" that could kill a crew member or destroy the station—and the chances will increase as more objects are launched into space. In contrast, the chances of being in a commercial-airliner accident in the United States are about one in three million.

Antarctic ozone depletion stems warming

Sindya N. Bhanoo, “ The Ozone Hole Is Mending. Now for the ‘But.’ ”, New York Times, 1/21/10, http://www.nytimes.com/2010/01/26/science/earth/26ozone.html

That the hole in Earth’s ozone layer is slowly mending is considered a big victory for environmental policy makers. But in a new report, scientists say there is a downside: its repair may contribute to global warming. It turns out that the hole led to the formation of moist, brighter-than-usual clouds that shielded the Antarctic region from the warming induced by greenhouse gas emissions over the last two decades, scientists write in Wednesday’s issue of Geophysical Research Letters. “The recovery of the hole will reverse that,” said Ken Carslaw, a professor of atmospheric science at the University of Leeds and a co-author of the paper. “Essentially, it will accelerate warming in certain parts of the Southern Hemisphere.” The hole in the layer, discovered above Antarctica in the mid-1980s, caused wide alarm because ozone plays a crucial role in protecting life on Earth from harmful ultraviolet radiation. The hole was largely attributed to the human use of chlorofluorocarbons, chemical compounds found in refrigerants and aerosol cans that dissipate ozone. Under an international protocol adopted in 1987, many countries phased out the compounds, helping the ozone to start reconstituting itself over the Antarctic. For their research, the authors of the new study relied on meteorological data recorded between 1980 and 2000, including global wind speeds recorded by the European Center for Medium-Range Weather Forecasts. The data show that the hole in the ozone layer generated high-speed winds that caused sea salt to be swept up into the atmosphere to form moist clouds. The clouds reflect more of the sun’s powerful rays and help fend off warming in the Antarctic atmosphere, the scientists write. The sea spray influx resulted in an increase in cloud droplet concentration of about 46 percent in some regions of the Southern Hemisphere, Dr. Carslaw said. But Judith Perlwitz, a University of Colorado professor and a research scientist at the National Oceanic and Atmospheric Administration, said that although the paper’s data were sound, she questioned the conclusions. Even as the ozone layer recovers, greenhouse gas emissions are expected to expand, she said. She predicted that the rise in temperatures would cause wind speeds to increase over time and have the same cloud-forming effect that the ozone hole now has. “The question is whether the wind is really going to slow down, and that I doubt,” she said. “The future is not just determined by the recovery of the ozone hole,” she said. “We’re also increasing our use of greenhouse gases, which increases the speed of the winds all year long.” Dr. Perlwitz also pointed out that the ozone hole was not expected to fully recover to pre-1980 levels until at least 2060, according to the World Meteorological Organization’s most recent report on the issue.

Impact Turn

Satellite communications are key to relief organizations.

Swanson, Gregg. Executive director of Communications for Humanitarian Aid and Relief. 2011. Disaster—Resource.com “Satellite Communications: An Essential Tool for Emergency Responders” http://www.disaster-resource.com/articles/07sat\_p12.shtml

While humanitarian managers do not measure investments in terms of financial return, they always require performance and effectiveness in the field. Increasingly, relief organizations recognize that satellite communications are not an optional enhancement, but a reliable and affordable enabling capability that makes the difference between rapid operational effectiveness and “too little, too late.”

Reliable communications should be seen as an “operational multiplier.” If deployed teams do not know where to go, what assistance is needed, or what supplies to order, they cannot do their job – they are not effective. Every hour of delay and every missed communication can result in lost opportunities to help the afflicted population.

When the first assessment team arrives at a disaster scene, they begin immediately to plan and communicate how to meet urgent requirements. They send for specialized personnel to handle the complex planning of food, water, shelter, logistics, medical care, and security. They make sure that the right supplies are on the way. And of pivotal importance, they must coordinate their actions with United Nations and government agencies, other relief organizations, and their own regional and national headquarters. If they cannot coordinate their actions, they may actually worsen, rather than improve the situation. In many cases, relief teams could put themselves at risk, in the absence of current security information.

The U.S. military depends heavily on satellite communications for operations.

Eberhardt, Maj. USAF (United States Airforce). 2004 “Satellite Communications.” Chapter 14. http://space.au.af.mil/au-18-2009/au-18\_chap14.pdf

On 19 December 1958, a recorded Christmas message from Pres. Dwight D. Eisen- hower was broadcast worldwide via shortwave radio frequency from the Army’s Signal Communications by Orbiting Relay Equipment (SCORE), which lasted for only 13 days until the battery failed. This led to the realization of British scientist Arthur C. Clarke’s vision, in 1945, for global communications via artificial satellites in 24-hour orbits stationed above the earth.1 Through countless developments since the SCORE broad- cast, the US military has become increasingly dependent on satellite communications (SATCOM) for military operations.

This chapter purposely minimizes technical jargon as much as possible and provides the war fighter and his or her staff with a basic understanding of the capabilities of primarily military, but also some commercial, SATCOM systems. Military dependency on SATCOM for bandwidth grew 30 times within the 13 years from Operation Desert Storm to Operation Iraqi Freedom (OIF).2 Furthermore, over 80 percent of SATCOM bandwidth used by the military to conduct OIF and Operation Enduring Freedom (OEF) has been commercial SATCOM. United States Strategic Command (USSTRATCOM), who forwards bandwidth requirements to the Defense Information Systems Agency (DISA), determines commercial SATCOM requirements. As the Depart- ment of Defense (DOD) designated contracting authority, DISA obtains commercial services via an existing contract vehicle or generates a new contract as necessary.3

Military SATCOM (MILSATCOM) provides minimum essential war-fighting connectivity, including systems designed to provide antijam and survivable nuclear command and control. It is unlikely (and unaffordable) that future MILSATCOM systems will fully meet rapidly expanding capacity requirements. Therefore, commercial SATCOM (COM- SATCOM) will be needed to fill the gap.

Impact Turn

Satellites are key to connecting all aspects of the military to the GIG, which allows for more universal communication.

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The dependency on radio repeaters in space (i.e., satellites) will only increase in the future because satellites are a key method of connecting the isolated war fighter to the US military’s Global Information Grid (GIG) and ultimately enabling network-centric warfare. The GIG is defined as the globally interconnected end-to-end set of information capabilities, associated processes, and personnel for collecting, processing, storing, disseminating, and managing information on demand to war fighters, policy makers, and support personnel .

All encompassing, the GIG includes all owned and leased communications, computing systems and services, software applications, system data, security, and other associated services necessary to achieve information superiority. Eventually, the GIG will connect all soldiers, weapons platforms, sensors, and command and control nodes. At its basic level, the GIG is “networks which provide voice, data, video, and facilitate more than just the passing of targeting information through sensor- to-shooter loops; such a grid also provides, for example, real-time collaboration and dynamic planning.

Satellite communications are key to relief organizations.

Swanson, Gregg. Executive director of Communications for Humanitarian Aid and Relief. 2011. Disaster—Resource.com “Satellite Communications: An Essential Tool for Emergency Responders” http://www.disaster-resource.com/articles/07sat\_p12.shtml

While humanitarian managers do not measure investments in terms of financial return, they always require performance and effectiveness in the field. Increasingly, relief organizations recognize that satellite communications are not an optional enhancement, but a reliable and affordable enabling capability that makes the difference between rapid operational effectiveness and “too little, too late.”Reliable communications should be seen as an “operational multiplier.” If deployed teams do not know where to go, what assistance is needed, or what supplies to order, they cannot do their job – they are not effective. Every hour of delay and every missed communication can result in lost opportunities to help the afflicted population. When the first assessment team arrives at a disaster scene, they begin immediately to plan and communicate how to meet urgent requirements. They send for specialized personnel to handle the complex planning of food, water, shelter, logistics, medical care, and security. They make sure that the right supplies are on the way. And of pivotal importance, they must coordinate their actions with United Nations and government agencies, other relief organizations, and their own regional and national headquarters. If they cannot coordinate their actions, they may actually worsen, rather than improve the situation. In many cases, relief teams could put themselves at risk, in the absence of current security information.

The U.S. military depends heavily on satellite communications for operations.

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No Link

Healing of ozone causes greater global warming

**ScienceDaily**(Jan. 26, 20**10**)  Ozone Hole Healing Could Cause Further Climate Warming, Science News http://www.sciencedaily.com/releases/2010/01/100125192016.htm

The hole in the ozone layer is now steadily closing, but its repair could actually increase warming in the southern hemisphere, according to scientists at the University of Leeds. The Antarctic ozone hole was once regarded as one of the biggest environmental threats, but the discovery of a previously undiscovered feedback shows that it has instead helped to shield this region from carbon-induced warming over the past two decades. High-speed winds in the area beneath the hole have led to the formation of brighter summertime clouds, which reflect more of the sun's powerful rays. "These clouds have acted like a mirror to the sun's rays, reflecting the sun's heat away from the surface to the extent that warming from rising carbon emissions has effectively been cancelled out in this region during the summertime," said Professor Ken Carslaw of the University of Leeds who co-authored the research. "If, as seems likely, these winds die down, rising CO2emissions could then cause the warming of the southern hemisphere to accelerate, which would have an impact on future climate predictions," he added. The key to this newly-discovered feedback is aerosol -- tiny reflective particles suspended within the air that are known by experts to have a huge impact on climate. Greenhouses gases absorb infrared radiation from the Earth and release it back into the atmosphere as heat, causing the planet to warm up over time. Aerosol works against this by reflecting heat from the sun back into space, cooling the planet as it does so. Beneath the Antarctic ozone hole, high-speed winds whip up large amounts of sea spray, which contains millions of tiny salt particles. This spray then forms droplets and eventually clouds, and the increased spray over the last two decades has made these clouds brighter and more reflective. As the ozone layer recovers it is believed that this feedback mechanism could decline in effectiveness, or even be reversed, leading to accelerated warming in the southern hemisphere.