# 1AC v. Mary Wash

## Contention One is Warming

#### It’s happening and is anthropogenic---reject negative evidence

**Prothero 12** [Donald R. Prothero, Professor of Geology at Occidental College and Lecturer in Geobiology at the California Institute of Technology, 3-1-2012, "How We Know Global Warming is Real and Human Caused," Skeptic, 17.2, EBSCO]

How do we know that global warming is real and primarily human caused? There are numerous lines of evidence that converge toward this conclusion. 1. Carbon Dioxide Increase Carbon dioxide in our atmosphere has increased at an unprecedented rate in the past 200 years. Not one data set collected over a long enough span of time shows otherwise. Mann et al. (1999) compiled the past 900 years' worth of temperature data from tree rings, ice cores, corals, and direct measurements in the past few centuries, and the sudden increase of temperature of the past century stands out like a sore thumb. This famous graph is now known as the "hockey stick" because it is long and straight through most of its length, then bends sharply upward at the end like the blade of a hockey stick. Other graphs show that climate was very stable within a narrow range of variation through the past 1000, 2000, or even 10,000 years since the end of the last Ice Age. There were minor warming events during the Climatic Optimum about 7000 years ago, the Medieval Warm Period, and the slight cooling of the Litde Ice Age in the 1700s and 1800s. But the magnitude and rapidity of the warming represented by the last 200 years is simply unmatched in all of human history. More revealing, the timing of this warming coincides with the Industrial Revolution, when humans first began massive deforestation and released carbon dioxide into the atmosphere by burning an unprecedented amount of coal, gas, and oil. 2. Melting Polar Ice Caps The polar icecaps are thinning and breaking up at an alarming rate. In 2000, my former graduate advisor Malcolm McKenna was one of the first humans to fly over the North Pole in summer time and see no ice, just open water. The Arctic ice cap has been frozen solid for at least the past 3 million years (and maybe longer),[ 4] but now the entire ice sheet is breaking up so fast that by 2030 (and possibly sooner) less than half of the Arctic will be ice covered in the summer.[ 5] As one can see from watching the news, this is an ecological disaster for everything that lives up there, from the polar bears to the seals and walruses to the animals they feed upon, to the 4 million people whose world is melting beneath their feet. The Antarctic is thawing even faster. In February-March 2002, the Larsen B ice shelf -- over 3000 square km (the size of Rhode Island) and 220 m (700 feet) thick -- broke up in just a few months, a story -typical of nearly all the ice shelves in Antarctica. The Larsen B shelf had survived all the previous ice ages and interglacial warming episodes over the past 3 million years, and even the warmest periods of the last 10,000 years -- yet it and nearly all the other thick ice sheets on the Arctic, Greenland, and Antarctic are vanishing at a rate never before seen in geologic history. 3. Melting Glaciers Glaciers are all retreating at the highest rates ever documented. Many of those glaciers, along with snow melt, especially in the Himalayas, Andes, Alps, and Sierras, provide most of the freshwater that the populations below the mountains depend upon -- yet this fresh water supply is vanishing. Just think about the percentage of world's population in southern Asia (especially India) that depend on Himalayan snowmelt for their fresh water. The implications are staggering. The permafrost that once remained solidly frozen even in the summer has now thawed, damaging the Inuit villages on the Arctic coast and threatening all our pipelines to the North Slope of Alaska. This is catastrophic not only for life on the permafrost, but as it thaws, the permafrost releases huge amounts of greenhouse gases which are one of the major contributors to global warming. Not only is the ice vanishing, but we have seen record heat waves over and over again, killing thousands of people, as each year joins the list of the hottest years on record. (2010 just topped that list as the hottest year, surpassing the previous record in 2009, and we shall know about 2011 soon enough). Natural animal and plant populations are being devastated all over the globe as their environments change.[ 6] Many animals respond by moving their ranges to formerly cold climates, so now places that once did not have to worry about disease-bearing mosquitoes are infested as the climate warms and allows them to breed further north. 4. Sea Level Rise All that melted ice eventually ends up in the ocean, causing sea levels to rise, as it has many times in the geologic past. At present, the sea level is rising about 3-4 mm per year, more than ten times the rate of 0.1-0.2 mm/year that has occurred over the past 3000 years. Geological data show that the sea level was virtually unchanged over the past 10,000 years since the present interglacial began. A few mm here or there doesn't impress people, until you consider that the rate is accelerating and that most scientists predict sea levels will rise 80-130 cm in just the next century. A sea level rise of 1.3 m (almost 4 feet) would drown many of the world's low-elevation cities, such as Venice and New Orleans, and low-lying countries such as the Netherlands or Bangladesh. A number of tiny island nations such as Vanuatu and the Maldives, which barely poke out above the ocean now, are already vanishing beneath the waves. Eventually their entire population will have to move someplace else.[ 7] Even a small sea level rise might not drown all these areas, but they are much more vulnerable to the large waves of a storm surge (as happened with Hurricane Katrina), which could do much more damage than sea level rise alone. If sea level rose by 6 m (20 feet), most of the world's coastal plains and low-lying areas (such as the Louisiana bayous, Florida, and most of the world's river deltas) would be drowned. Most of the world's population lives in low-elevation coastal cities such as New York, Boston, Philadelphia, Baltimore, Washington, D.C., Miami, and Shanghai. All of those cities would be partially or completely under water with such a sea level rise. If all the glacial ice caps melted completely (as they have several times before during past greenhouse episodes in the geologic past), sea level would rise by 65 m (215 feet)! The entire Mississippi Valley would flood, so you could dock an ocean liner in Cairo, Illinois. Such a sea level rise would drown nearly every coastal region under hundreds of feet of water, and inundate New York City, London and Paris. All that would remain would be the tall landmarks such as the Empire State Building, Big Ben, and the Eiffel Tower. You could tie your boats to these pinnacles, but the rest of these drowned cities would lie deep underwater. Climate Change Critic's Arguments and Scientists' Rebuttals Despite the overwhelming evidence there are many people who remain skeptical. One reason is that they have been fed distortions and misstatements by the global warming denialists who cloud or confuse the issue. Let's examine some of these claims in detail: \* "It's just natural climatic variability." No, it is not. As I detailed in my 2009 book, Greenhouse of the Dinosaurs, geologists and paleoclimatologists know a lot about past greenhouse worlds, and the icehouse planet that has existed for the past 33 million years. We have a good understanding of how and why the Antarctic ice sheet first appeared at that time, and how the Arctic froze over about 3.5 million years ago, beginning the 24 glacial and interglacial episodes of the "Ice Ages" that have occurred since then. We know how variations in the earth's orbit (the Milankovitch cycles) controls the amount of solar radiation the earth receives, triggering the shifts between glacial and interglacial periods. Our current warm interglacial has already lasted 10,000 years, the duration of most previous interglacials, so if it were not for global warming, we would be headed into the next glacial in the next 1000 years or so. Instead, our pumping greenhouse gases into our atmosphere after they were long trapped in the earth's crust has pushed the planet into a "super-interglacial," already warmer than any previous warming period. We can see the "big picture" of climate variability most clearly in ice cores from the EPICA (European Project for Ice Coring in Antarctica), which show the details of the last 650,000 years of glacial-inters glacial cycles (Fig. 2). At no time during any previous interglacial did the carbon dioxide levels exceed 300 ppm, even at their very warmest. Our atmospheric carbon dioxide levels are already close to 400 ppm today. The atmosphere is headed to 600 ppm within a few decades, even if we stopped releasing greenhouse gases immediately. This is decidedly not within the normal range of "climatic variability," but clearly unprecedented in human history. Anyone who says this is "normal variability" has never seen the huge amount of paleoclimatic data that show otherwise. \* "It's just another warming episode, like the Medieval Warm Period, or the Holocene Climatic Optimum or the end of the Little Ice Age." Untrue. There were numerous small fluctuations of warming and cooling over the last 10,000 years of the Holocene. But in the case of the Medieval Warm Period (about 950-1250 A.D.), the temperatures increased only 1°C, much less than we have seen in the current episode of global warming (Fig. 1). This episode was also only a local warming in the North Atlantic and northern Europe. Global temperatures over this interval did not warm at all, and actually cooled by more than 1°C. Likewise, the warmest period of the last 10,000 years was the Holocene Climatic Optimum ( 5,000-9,000 B.C.E.) when warmer and wetter conditions in Eurasia contributed to the rise of the first great civilizations in Egypt, Mesopotamia, the Indus Valley, and China. This was largely a Northern Hemisphere-Eurasian phenomenon, with 2-3°C warming in the Arctic and northern Europe. But there was almost no warming in the tropics, and cooling or no change in the Southern Hemisphere.[ 8] From a Eurocentric viewpoint, these warming events seemed important, but on a global scale the effect was negligible. In addition, neither of these warming episodes is related to increasing greenhouse gases. The Holocene Climatic Optimum, in fact, is predicted by the Milankovitch cycles, since at that time the axial tilt of the earth was 24°, its steepest value, meaning the Northern Hemisphere got more solar radiation than normal -- but the Southern Hemisphere less, so the two balanced. By contrast, not only is the warming observed in the last 200 years much greater than during these previous episodes, but it is also global and bipolar, so it is not a purely local effect. The warming that ended the Little Ice Age (from the mid-1700s to the late 1800s) was due to increased solar radiation prior to 1940. Since 1940, however, the amount of solar radiation has been dropping, so the only candidate remaining for the post-1940 warming is carbon dioxide.[ 9] "It's just the sun, or cosmic rays, or volcanic activity or methane." Nope, sorry. The amount of heat that the sun provides has been decreasing since 1940,[ 10] just the opposite of the critics' claims (Fig. 3). There is no evidence of an increase in cosmic ray particles during the past century.[ 11] Nor is there any clear evidence that large-scale volcanic events (such as the 1815 eruption of Tambora in Indonesia, which changed global climate for about a year) have any long-term effects that would explain 200 years of warming and carbon dioxide increase. Volcanoes erupt only 0.3 billion tonnes of carbon dioxide each year, but humans emit over 29 billion tonnes a year,[ 12] roughly 100 times as much. Clearly, we have a bigger effect. Methane is a more powerful greenhouse gas, but there is 200 times more carbon dioxide than methane, so carbon dioxide is still the most important agent.[ 13] Every other alternative has been looked at and can be ruled out. The only clear-cut relationship is between human-caused carbon dioxide increase and global warming. \* "The climate records since 1995 (or 1998) show cooling." That's simply untrue. The only way to support this argument is to cherry-pick the data.[ 14] Over the short term, there was a slight cooling trend from 1998-2000, but only because 1998 was a record-breaking El Nino year, so the next few years look cooler by comparison (Fig. 4). But since 2002, the overall long-term trend of warming is unequivocal. All of the 16 hottest years ever recorded on a global scale have occurred in the last 20 years. They are (in order of hottest first): 2010, 2009, 1998, 2005, 2003, 2002, 2004, 2006, 2007, 2001, 1997, 2008, 1995, 1999, 1990, and 2000.[ 15] In other words, every year since 2000 has been on the Top Ten hottest years list. The rest of the top 16 include 1995, 1997, 1998, 1999, and 2000. Only 1996 failed to make the list (because of the short-term cooling mentioned already). \* "We had record snows in the winter of 2009-2010, and also in 2010-2011." So what? This is nothing more than the difference between weather (short-term seasonal changes) and climate (the long-term average of weather over decades and centuries and longer). Our local weather tells us nothing about another continent, or the global average; it is only a local effect, determined by short-term atmospheric and oceano-graphic conditions.[ 16] In fact, warmer global temperatures mean more moisture in the atmosphere, which increases the intensity of normal winter snowstorms. In this particular case, the climate change critics forget that the early winter of November-December 2009 was actually very mild and warm, and then only later in January and February did it get cold and snow heavily. That warm spell in early winter helped bring more moisture into the system, so that when cold weather occurred, the snows were worse. In addition, the snows were unusually heavy only in North America; the rest of the world had different weather, and the global climate was warmer than average. Also, the summer of 2010 was the hottest on record, breaking the previous record set in 2009. \* "Carbon dioxide is good for plants, so the world will be better off." Who do they think they're kidding? The Competitive Enterprise Institute (funded by oil and coal companies and conservative foundations[ 17]) has run a series of shockingly stupid ads concluding with the tag line "Carbon dioxide: they call it pollution, we call it life." Anyone who knows the basic science of earth's atmosphere can spot the gross inaccuracies in this ad.[ 18] True, plants take in carbon dioxide that animals exhale, as they have for millions of years. But the whole point of the global warming evidence (as shown from ice cores) is that the delicate natural balance of carbon dioxide has been thrown off balance by our production of too much of it, way in excess of what plants or the oceans can handle. As a consequence, the oceans are warming[ 19, 20] and absorbing excess carbon dioxide making them more acidic. Already we are seeing a shocking decline in coral reefs ("bleaching") and extinctions in many marine ecosystems that can't handle too much of a good thing. Meanwhile, humans are busy cutting down huge areas of temperate and tropical forests, which not only means there are fewer plants to absorb the gas, but the slash and burn practices are releasing more carbon dioxide than plants can keep up with. There is much debate as to whether increased carbon dioxide might help agriculture in some parts of the world, but that has to be measured against the fact that other traditional "breadbasket" regions (such as the American Great Plains) are expected to get too hot to be as productive as they are today. The latest research[ 21] actually shows that increased carbon dioxide inhibits the absorption of nitrogen into plants, so plants (at least those that we depend upon today) are not going to flourish in a greenhouse world. It is difficult to know if those who tell the public otherwise are ignorant of basic atmospheric science and global geochemistry, or if they are being cynically disingenuous. \* "I agree that climate is changing, but I'm skeptical that humans are the main cause, so we shouldn't do anything." This is just fence sitting. A lot of reasonable skeptics deplore the right wing's rejection of the reality of climate change, but still want to be skeptical about the cause. If they want proof, they can examine the huge array of data that points directly to human caused global warming.[ 22] We can directly measure the amount of carbon dioxide humans are producing, and it tracks exactly with the amount of increase in atmospheric carbon dioxide. Through carbon isotope analysis, we can show that this carbon dioxide in the atmosphere is coming directly from our burning of fossil fuels, not from natural sources. We can also measure the drop in oxygen as it combines with the increased carbon levels to produce carbon dioxide. We have satellites in space that are measuring the heat released from the planet and can actually see the atmosphere getting warmer. The most crucial evidence emerged only within the past few years: climate models of the greenhouse effect predict that there should be cooling in the stratosphere (the upper layer of the atmosphere above 10 km or 6 miles in elevation), but warming in the troposphere (the bottom layer below 10 km or 6 miles), and that's exactly what our space probes have measured. Finally, we can rule out any other suspects (see above): solar heat is decreasing since 1940, not increasing, and there are no measurable increases in cosmic rays, methane, volcanic gases, or any other potential cause. Face it -- it's our problem. Why Do People Continue to Question the Reality of Climate Change? Thanks to all the noise and confusion over climate change, the general public has only a vague idea of what the debate is really about, and only about half of Americans think global warming is real or that we are to blame.[ 23] As in the evolution/creationism debate, the scientific community is virtually unanimous on what the data demonstrate about anthropogenic global warming. This has been true for over a decade. When science historian Naomi Oreskes[ 24] surveyed all peer-reviewed papers on climate change published between 1993 and 2003 in the world's leading scientific journal, Science, she found that there were 980 supporting the idea of human-induced global warming and none opposing it. In 2009, Doran and Kendall Zimmerman[ 25] surveyed all the climate scientists who were familiar with the data. They found that 95-99% agreed that global warming is real and human caused. In 2010, the prestigious Proceedings of the National Academy of Sciences published a study that showed that 98% of the scientists who actually do research in climate change are in agreement over anthropogenic global warming.[ 26] Every major scientific organization in the world has endorsed the conclusion of anthropogenic climate change as well. This is a rare degree of agreement within such an independent and cantankerous group as the world's top scientists. This is the same degree of scientific consensus that scientists have achieved over most major ideas, including gravity, evolution, and relativity. These and only a few other topics in science can claim this degree of agreement among nearly all the world's leading scientists, especially among everyone who is close to the scientific data and knows the problem intimately. If it were not such a controversial topic politically, there would be almost no interest in debating it since the evidence is so clear-cut. If the climate science community speaks with one voice (as in the 2007 IPCC report, and every report since then), why is there still any debate at all? The answer has been revealed by a number of investigations by diligent reporters who got past the PR machinery denying global warming, and uncovered the money trail. Originally, there were no real "dissenters" to the idea of global warming by scientists who are actually involved with climate research. Instead, the forces with vested interests in denying global climate change (the energy companies, and the "free-market" advocates) followed the strategy of tobacco companies: create a smokescreen of confusion and prevent the American public from recognizing scientific consensus. As the famous memo[ 27] from the tobacco lobbyists said "Doubt is our product." The denialists generated an anti-science movement entirely out of thin air and PR. The evidence for this PR conspiracy has been well documented in numerous sources. For example, Oreskes and Conway revealed from memos leaked to the press that in April 1998 the right-wing Marshall Institute, SEPP (Fred Seitz's lobby that aids tobacco companies and polluters), and ExxonMobil, met in secret at the American Petroleum Institute's headquarters in Washington, D.C. There they planned a $20 million campaign to get "respected scientists" to cast doubt on climate change, get major PR efforts going, and lobby Congress that global warming isn't real and is not a threat. The right-wing institutes and the energy lobby beat the bushes to find scientists -- any scientists -- who might disagree with the scientific consensus. As investigative journalists and scientists have documented over and over again,[ 28] the denialist conspiracy essentially paid for the testimony of anyone who could be useful to them. The day that the 2007 IPCC report was released (Feb. 2, 2007), the British newspaper The Guardian reported that the conservative American Enterprise Institute (funded largely by oil companies and conservative think tanks) had offered $10,000 plus travel expenses to scientists who would write negatively about the IPCC report.[ 29] In February 2012, leaks of documents from the denialist Heartland Institute revealed that they were trying to influence science education, suppress the work of scientists, and had paid off many prominent climate deniers, such as Anthony Watts, all in an effort to circumvent the scientific consensus by doing an "end run" of PR and political pressure. Other leaks have shown 9 out of 10 major climate deniers are paid by ExxonMobil.[ 30] We are accustomed to hired-gun "experts" paid by lawyers to muddy up the evidence in the case they are fighting, but this is extraordinary -- buying scientists outright to act as shills for organizations trying to deny scientific reality. With this kind of money, however, you can always find a fringe scientist or crank or someone with no relevant credentials who will do what they're paid to do. Fishing around to find anyone with some science background who will agree with you and dispute a scientific consensus is a tactic employed by the creationists to sound "scientific". The NCSE created a satirical "Project Steve,"[ 31] which demonstrated that there were more scientists who accept evolution named "Steve" than the total number of "scientists who dispute evolution". It may generate lots of PR and a smokescreen to confuse the public, but it doesn't change the fact that scientists who actually do research in climate change are unanimous in their insistence that anthropogenic global warming is a real threat. Most scientists I know and respect work very hard for little pay, yet they still cannot be paid to endorse some scientific idea they know to be false. The climate deniers have a lot of other things in common with creationists and other anti-science movements. They too like to quote someone out of context ("quote mining"), finding a short phrase in the work of legitimate scientists that seems to support their position. But when you read the full quote in context, it is obvious that they have used the quote inappropriately. The original author meant something that does not support their goals. The "Climategate scandal" is a classic case of this. It started with a few stolen emails from the Climate Research Unit of the University of East Anglia. If you read the complete text of the actual emails[ 32] and comprehend the scientific shorthand of climate scientists who are talking casually to each other, it is clear that there was no great "conspiracy" or that they were faking data. All six subsequent investigations have cleared Philip Jones and the other scientists of the University of East Anglia of any wrongdoing or conspiracy.[ 33] Even if there had been some conspiracy on the part of these few scientists, there is no reason to believe that the entire climate science community is secretly working together to generate false information and mislead the public. If there's one thing that is clear about science, it's about competition and criticism, not conspiracy and collusion. Most labs are competing with each other, not conspiring together. If one lab publishes a result that is not clearly defensible, other labs will quickly correct it. As James Lawrence Powell wrote: Scientists…show no evidence of being more interested in politics or ideology than the average American. Does it make sense to believe that tens of thousands of scientists would be so deeply and secretly committed to bringing down capitalism and the American way of life that they would spend years beyond their undergraduate degrees working to receive master's and Ph.D. degrees, then go to work in a government laboratory or university, plying the deep oceans, forbidding deserts, icy poles, and torrid jungles, all for far less money than they could have made in industry, all the while biding their time like a Russian sleeper agent in an old spy novel? Scientists tend to be independent and resist authority. That is why you are apt to find them in the laboratory or in the field, as far as possible from the prying eyes of a supervisor. Anyone who believes he could organize thousands of scientists into a conspiracy has never attended a single faculty meeting.[ 34] There are many more traits that the climate deniers share with the creationists and Holocaust deniers and others who distort the truth. They pick on small disagreements between different labs as if scientists can't get their story straight, when in reality there is always a fair amount of give and take between competing labs as they try to get the answer right before the other lab can do so. The key point here is that when all these competing labs around the world have reached a consensus and get the same answer, there is no longer any reason to doubt their common conclusion. The anti-scientists of climate denialism will also point to small errors by individuals in an effort to argue that the entire enterprise cannot be trusted. It is true that scientists are human, and do make mistakes, but the great power of the scientific method is that peer review weeds these out, so that when scientists speak with consensus, there is no doubt that their data are checked carefully Finally, a powerful line of evidence that this is a purely political controversy, rather than a scientific debate, is that the membership lists of the creationists and the climate deniers are highly overlapping. Both anti-scientific dogmas are fed to their overlapping audiences through right-wing media such as Fox News, Glenn Beck, and Rush Limbaugh. Just take a look at the "intelligent-design" cre-ationism website for the Discovery Institute. Most of the daily news items lately have nothing to do with creationism at all, but are focused on climate denial and other right-wing causes.[ 35] If the data about global climate change are indeed valid and robust, any qualified scientist should be able to look at them and see if the prevailing scientific interpretation holds up. Indeed, such a test took place. Starting in 2010, a group led by U.C. Berkeley physicist Richard Muller re-examined all the temperature data from the NOAA, East Anglia Hadley Climate Research Unit, and the Goddard Institute of Space Science sources. Even though Muller started out as a skeptic of the temperature data, and was funded by the Koch brothers and other oil company sources, he carefully checked and re-checked the research himself. When the GOP leaders called him to testify before the House Science and Technology Committee in spring 2011, they were expecting him to discredit the temperature data. Instead, Muller shocked his GOP sponsors by demonstrating his scientific integrity and telling the truth: the temperature increase is real, and the scientists who have demonstrated that the climate is changing are right (Fig. 5). In the fall of 2011, his study was published, and the conclusions were clear: global warming is real, even to a right-wing skeptical scientist. Unlike the hired-gun scientists who play political games, Muller did what a true scientist should do: if the data go against your biases and preconceptions, then do the right thing and admit it -- even if you've been paid by sponsors who want to discredit global warming. Muller is a shining example of a scientist whose integrity and honesty came first, and did not sell out to the highest bidder.[ 36] \* Science and Anti-Science The conclusion is clear: there's science, and then there's the anti-science of global warming denial. As we have seen, there is a nearly unanimous consensus among climate scientists that anthropogenic global warming is real and that we must do something about it. Yet the smokescreen, bluster and lies of the deniers has created enough doubt so that only half of the American public is convinced the problem requires action. Ironically, the U.S. is almost alone in questioning its scientific reality. International polls taken of 33,000 people in 33 nations in 2006 and 2007 show that 90% of their citizens regard climate change as a serious problem[ 37] and 80% realize that humans are the cause of it.[ 38] Just as in the case of creationism, the U.S. is out of step with much of the rest of the world in accepting scientific reality. It is not just the liberals and environmentalists who are taking climate change seriously. Historically conservative institutions (big corporations such as General Electric and many others such as insurance companies and the military) are already planning on how to deal with global warming. Many of my friends high in the oil companies tell me of the efforts by those companies to get into other forms of energy, because they know that cheap oil will be running out soon and that the effects of burning oil will make their business less popular. BP officially stands for "British Petroleum," but in one of their ad campaigns about 5 years ago, it stood for "Beyond Petroleum."[ 39] Although they still spend relatively little of their total budgets on alternative forms of energy, the oil companies still see the handwriting on the wall about the eventual exhaustion of oil -- and they are acting like any company that wants to survive by getting into a new business when the old one is dying. The Pentagon (normally not a left-wing institution) is also making contingency plans for how to fight wars in an era of global climate change, and analyzing what kinds of strategic threats might occur when climate change alters the kinds of enemies we might be fighting, and water becomes a scarce commodity. The New York Times reported[ 40] that in December 2008, the National Defense University outlined plans for military strategy in a greenhouse world. To the Pentagon, the big issue is global chaos and the potential of even nuclear conflict. The world must "prepare for the inevitable effects of abrupt climate change -- which will likely come [the only question is when] regardless of human activity." Insurance companies have no political axe to grind. If anything, they tend to be on the conservative side. They are simply in the business of assessing risk in a realistic fashion so they can accurately gauge their future insurance policies and what to charge for them. Yet they are all investing heavily in research on the disasters and risks posed by climatic change. In 2005, a study commissioned by the re-insurer Swiss Re said, "Climate change will significantly affect the health of humans and ecosystems and these impacts will have economic consequences."[ 41] Some people may still try to deny scientific reality, but big businesses like oil and insurance and conservative institutions like the military cannot afford to be blinded or deluded by ideology. They must plan for the real world that we will be seeing in the next few decades. They do not want to be caught unprepared and harmed by global climatic change when it threatens their survival. Neither can we as a society.

#### Reducing emissions now prevents extinction---it’s not too late to solve

Nuccitelli 12 – Dana, environmental scientist at a private environmental consulting firm in Sacramento and has a Bachelor's Degree in astrophysics from the University of California at Berkeley, and a Master's Degree in physics from the University of California at Davis, 2012, “Realistically What Might The Future Climate Look Like?”, http://thinkprogress.org/climate/2012/09/01/784931/realistically-what-might-the-future-climate-look-like/

This is Why Reducing Emissions is Critical¶ We’re not yet committed to surpassing 2°C global warming, but as Watson noted, we are quickly running out of time to realistically give ourselves a chance to stay below that ‘danger limit’. However, 2°C is not a do-or-die threshold. Every bit of CO2 emissions we can reduce means that much avoided future warming, which means that much avoided climate change impacts. As Lonnie Thompson noted, the more global warming we manage to mitigate, the less adaption and suffering we will be forced to cope with in the future.¶ Realistically, based on the current political climate (which we will explore in another post next week), limiting global warming to 2°C is probably the best we can do. However, there is a big difference between 2°C and 3°C, between 3°C and 4°C, and anything greater than 4°C can probably accurately be described as catastrophic, since various tipping points are expected to be triggered at this level. Right now, we are on track for the catastrophic consequences (widespread coral mortality, mass extinctions, hundreds of millions of people adversely impacted by droughts, floods, heat waves, etc.). But we’re not stuck on that track just yet, and we need to move ourselves as far off of it as possible by reducing our greenhouse gas emissions as soon and as much as possible.¶ There are of course many people who believe that the planet will not warm as much, or that the impacts of the associated climate change will be as bad as the body of scientific evidence suggests. That is certainly a possiblity, and we very much hope that their optimistic view is correct. However, what we have presented here is the best summary of scientific evidence available, and it paints a very bleak picture if we fail to rapidly reduce our greenhouse gas emissions.¶ If we continue forward on our current path, catastrophe is not just a possible outcome, it is the most probable outcome. And an intelligent risk management approach would involve taking steps to prevent a catastrophic scenario if it were a mere possibility, let alone the most probable outcome. This is especially true since the most important component of the solution – carbon pricing – can be implemented at a relatively low cost, and a far lower cost than trying to adapt to the climate change consequences we have discussed here (Figure 4).¶ Climate contrarians will often mock ‘CAGW’ (catastrophic anthropogenic global warming), but the sad reality is that CAGW is looking more and more likely every day. But it’s critical that we don’t give up, that we keep doing everything we can do to reduce our emissions as much as possible in order to avoid as many catastrophic consequences as possible, for the sake of future generations and all species on Earth. The future climate will probably be much more challenging for life on Earth than today’s, but we still can and must limit the damage.

#### Scientific consensus proves warming is real, anthropogenic, and causes extinction – SPS solves

Flournoy 12 –Dan Flournoy, PhD and MA from the University of Texas, Former Dean of the University College at Ohio University, Former Associate Dean at State University of New York and Case Institute of Technology, Project Manager for University/Industry Experiments for the NASA ACTS Satellite, Currently Professor of Telecommunications at Scripps College of Communications @ Ohio University, January 2012, "Solar Power Satellites," Springer Briefs in Space Development

In the Online Journal of Space Communication , Dr. Feng Hsu, a NASA scientist at Goddard Space Flight Center, a research center in the forefront of science of space and Earth, writes, “The **evidence of global warming is alarming**,” noting the potential for a catastrophic planetary climate change is real and troubling (Hsu 2010 ) . Hsu and his NASA colleagues were engaged in monitoring and analyzing climate changes on a global scale, through which they received first-hand scientific information and data relating to global warming issues, including the dynamics of polar ice cap melting. After discussing this research with colleagues who were world experts on the subject, he wrote: I now have no doubt global temperatures are rising, and that global warming is a serious problem confronting all of humanity. No matter whether these trends are due to human interference or to the cosmic cycling of our solar system, there are two basic facts that are crystal clear: (a) there is overwhelming scientific evidence showing **positive correlations between the level of CO2 concentrations** in Earth’s atmosphere **with respect to** the historical **fluctuations of global temperature** changes; and (b) the overwhelming majority of the world’s scientific community is in agreement about the risks of a potential catastrophic global climate change. That is, if we humans continue to ignore this problem and do nothing, if we continue dumping huge quantities of greenhouse gases into Earth’s biosphere, humanity will be at dire risk (Hsu 2010 ) . As a technology risk assessment expert, Hsu says he can show with some confidence that the planet will face more risk doing nothing to curb its fossil-based energy addictions than it will in making a fundamental shift in its energy supply. “This,” he writes, “is because the risks of a catastrophic anthropogenic climate change can be potentially the **extinction of human species**, a risk that is simply too high for us to take any chances” (Hsu 2010 ) . It was this NASA scientist’s conclusion that humankind must now embark on the next era of “sustainable energy consumption and re-supply, the most obvious source of which is the mighty energy resource of our Sun” (Hsu 2010 ) (Fig . 2.1 ).

#### CO2 emissions will destroy the ocean - causes extinction

Sify, Citing Professors @ University of Queensland and North Carolina, 10 (Sify News, Citing Ove Hoegh-Gulberg, Professor @ University of Queensland and Director of the Global Change Institute AND Citing John Bruno, Associate Professor of Marine Science @ UNC, “Could unbridled climate changes lead to human extinction?,” June 19th, <http://www.sify.com/news/could-unbridled-climate-changes-lead-to-human-extinction-news-international-kgtrOhdaahc.html>)

Sydney: Scientists have sounded alarm bells about how **growing concentrations of greenhouse gases are driving irreversible and dramatic changes in the** way the **oceans** function, **providing evidence that humankind could well be on the way to** the next great **extinction**. **The findings** of the comprehensive report: 'The impact of climate change on the world's marine ecosystems' **emerged from a synthesis of recent research** on the world's oceans, **carried out by** two of **the world's leading marine scientists.**  One of the authors of the report is Ove Hoegh-Guldberg, professor at The University of Queensland and the director of its Global Change Institute (GCI). '**We may see sudden, unexpected changes that have serious ramifications for** the overall well-being of humans, including **the capacity of the planet to support people**. This is further evidence that **we are well on the way to the next great extinction event**,' says Hoegh-Guldberg. 'The findings have enormous implications for mankind, particularly **if the trend continues**. The earth's ocean, which produces half of the oxygen we breathe and absorbs 30 per cent of human-generated carbon dioxide, is equivalent to its heart and lungs. This study shows worrying signs of ill-health. It's as if the earth has been smoking two packs of cigarettes a day!,' he added. 'We are entering a period in which **the ocean services upon which humanity depends are** undergoing massive change and in some cases **beginning to fail**', he added.

#### Warming magnifies all impacts and makes global conflicts inevitable

Ginsborg et al. 12 – Mikkel Funder, Signe Marie Cold-Ravnkilde and Ida Peters Ginsborg - in collaboration with Nanna Callisen Bang, Denmark Institute for International Studies, 2012, "ADDRESSING CLIMATE CHANGE AND CONFLICT IN DEVELOPMENT COOPERATION EXPERIENCES FROM NATURAL RESOURCE MANAGEMENT" www.diis.dk/graphics/Publications/Reports2012/RP2012-04-Addressing-climate-change\_web.jpg.pdf

2.2 Climate change as a conﬂict multiplier¶ Climate change is therefore best seen as a conﬂict multiplier, rather than as a major direct cause of conﬂict in itself. **Climate change may aggravate and extend the scope of existing conﬂicts, or trigger underlying and latent conﬂicts to break out into the open**. ¶ Previous studies have identiﬁed a number of areas in which **climate change may contribute to a worsening of conﬂicts** (Brown & Crawford 2009). These include:¶ • Land and water access. Access and use rights to land are a key feature in most situations where climate change has contributed to natural resource conﬂicts so far. Climate change can **intensify existing conﬂicts over land**, as land becomes less fertile or is ﬂooded, or if existing resource sharing arrangements between diﬀerent users and land use practices are disrupted. **In some parts of Africa, climate change may lead to a decline in available water resources of some 10–20% by the end of the century** (op cit.). This may **intensify existing competition** for access to water at intra-state and/or subnational levels. ¶ • Food security. Reduced rainfall and rising sea levels may lead to a decline in agricultural production and a substantial loss of arable land in some parts of Africa. Reduced yields for own consumption and increasing domestic food prices may in some cases lead to **civil unrest, and competition over access to land may intensify**.¶ • Migration and displacement. In some cases, increased scarcity of and competition over access to water and arable land may contribute to internal or regional migration, and disasters such as ﬂoods may lead to temporary or long-term local displacement. This may in turn **strengthen conﬂicts between host societies/communities and migrants** looking for access to new land and resources. ¶ • Increasing inequality and injustice. Through processes such as the above, some population groups may be particularly hard hit, leading to increased inequality and a sense of injustice. This may **intensify existing grievances and disputes** between natural resource users and/or between resource users and outside actors such as governments – thereby increasing the risk and intensity of conﬂict.

#### Warming causes African instability

Fuerth 8 – Fuerth, Research Professor of International Affairs at George Washington University, former National Security Advisor to VP Al Gore, 2008, Leon, Severe Climate Change over the Next Thirty Years, In Climatic Cataclysm, p. 142

In sub-Saharan Africa, hundreds of millions of already vulnerable persons will be exposed to intensified threat of death by disease, malnutrition, and strife. Natural causes such as long-term drought will play a major role, but political factors either will exacerbate these disasters or may even precipitate them as the result of a mix of mismanagement and miscalculated policy. Such was the case in Ethiopia during the rule of Colonel Mengistu Haile Mariam. The ongoing genocide in Darfur may have begun as a consequence of water scarcity, as noted elsewhere in this report.¶ Under conditions of severe global climate change environmental factors will push already failed states deeper into the abyss, **while driving other states toward the brink**. The stronger regional states, such as South Africa, will be affected not only by internal social and economic stress related to changing climatic patterns but also by southward flows of refugees hoping for rescue and safety.¶ Contemporary Africa aspires to be a unified system but falls far short. Severe climate change would, in a grim way, provide for the first time the missing element of connectivity. **From one end of the African continent to the other**, severe climate change will become the common denominator of turbulence and destruction.

#### Great power nuclear war

Glick 7 Caroline Glick 7, deputy managing editor of The Jerusalem Post, Senior Fellow for Middle East Affairs of the Center for Security Policy, “Condi's African holiday”, December 11, http://www.rightsidenews.com/20071211309/editorial/us-opinion-and-editorial/our-world-condis-african-holiday.html

The Horn of Africa is a dangerous and strategically vital place. Small wars, which rage continuously, can easily escalate into big wars. Local conflicts have regional and global aspects. All of the conflicts in this tinderbox, which controls shipping lanes from the Indian Ocean into the Red Sea, can potentially give rise to regional, and indeed global conflagrations between competing regional actors and global powers.

#### SPS facilitates a complete transition away from conventional energy

Flournoy 12 – Don Flournoy, PhD and MA from the University of Texas, Former Dean of the University College at Ohio University, Former Associate Dean at State University of New York and Case Institute of Technology, Project Manager for University/Industry Experiments for the NASA ACTS Satellite, Currently Professor of Telecommunications at Scripps College of Communications at Ohio University, "Solar Power Satellites," January, Springer Briefs in Space Development, Book

One of the obvious opportunities for solar power satellites is to become an **on-demand source of electric power for terrestrial utilities.** Once Sunsat providers can demonstrate the capability to direct continuous radio or light frequency power beams to production sites, the owners of coal-fired generation stations will quickly discover the value of this service. The same will also be true of **nuclear, gas-fired, biomass** and other such plants. With electrical power production ratings of 1 gw or more, solar satellite systems can be designed to meet the short- and long-term **needs of the terrestrial power plants at their** existing locations, at first to complement but eventually to replace their current fuel feedstocks. An attractive feature of this approach for space solar power investors is that the utilities have a predictable need for energy in great quantities. Since the power utilities are already connected to an electrical power grid, often covering regions larger than a single state or nation, the Sunsat people won’t have to also be in the terrestrial distribution business. Whether producing power from coal, nuclear, gas, biomass or other sources, **power utilities can be expected to step forward as early users** of this new space asset to begin reducing their mining and transportation costs. The use of scrubbers and filters will be greatly reduced, if needed at all. Problems related to spent fuel disposal and toxic waste management should be fewer. But mainly the utilities will become clients (and possibly investors) in the Sunsat business to guarantee a **sustainable night-and-day fuel source.**

#### SPS overcomes the flaws of other energy sources – terrestrial alternatives fail

Flournoy 12 – Don Flournoy, PhD and MA from the University of Texas, Former Dean of the University College at Ohio University, Former Associate Dean at State University of New York and Case Institute of Technology, Project Manager for University/Industry Experiments for the NASA ACTS Satellite, Currently Professor of Telecommunications at Scripps College of Communications at Ohio University, "Solar Power Satellites," January, Springer Briefs in Space Development, Book

Alternative terrestrial energy is not the complete answer, either. According to Woodcock, the limitation of Earth-based renewable energy sources is that they are not “demand” sources; that is, **they are only intermittently available.** Terrestrial solar power works when the Sun shines. Terrestrial wind power works when the wind blows. Terrestrial hydroelectric power is a way of storing water energy until users demand it. This process can include hydroelectric pumped storage, which is the lifting of water uphill where it is held until released to create electricity as it flows through turbines. But there is little capacity remaining on the planet for hydroelectric installations. Geothermal energy is also way to tap stored energy in the Earth itself. Batteries, water electrolysis and hydrogen storage in fuel cells are other ways to provide storage. But to run a **modern power grid** exclusively (or even largely) on terrestrial renewable energy, he says, would **require enormous amounts of storage**, and **storage is expensive**. Woodcock concludes that [SPS] solar power satellites are a potential solution because they can be positioned in space over a particular location to which they can stream continuous sunlight. Supplying power around the clock, such an energy system can serve as a demand source with very little storage required. He also suggests, given constant solar pointing, the photovoltaic area could probably be reduced by a factor of 10–100 by using concentrators. Land designated for receiving sites might also serve dual or multiple purposes. The National Space Society (NSS) hosts annual conferences that include sessions on space solar power. The organization’s website includes one of the most complete archives on space solar research. It also has taken positions of advocacy, stating that “all viable energy options should be pursued with vigor, [but that] Sun/ Sat power (**SSP) has a number of** substantial advantages over other energy sources.” The NSS lists several of these advantages: • Unlike oil, gas, ethanol and coal, SSP does not emit greenhouse gases. • Unlike nuclear power plants, SSP does not **produce hazardous waste** that needs to be stored and guarded for hundreds of years. • **Unlike terrestrial solar and wind** power plants, **SSP can be available in huge quantities 24-hours-a-day, 7 days a week. It produces regardless of cloud cover, daylight, or wind speed.** • Unlike coal and nuclear fuels, SSP does not require environmentally problematic mining operations. • Unlike nuclear power plants, SSP doesnot **provide** potential **targets for terrorists** (National Space Society 2008 ).

#### The US is key---US action sends a signal that revitalizes international cooperation on warming even before the energy created

Ritter 11-24 – Karl Ritter, reporter for the Huffington Post, November 24th, 2012, "U.N. Climate Talks: Will U.S. Take More Central Role After Bout Of Extreme Weather?" [www.huffingtonpost.com/2012/11/24/un-climate-un-qatar-united-states\_n\_2184357.html?view=print&comm\_ref=false](http://www.huffingtonpost.com/2012/11/24/un-climate-un-qatar-united-states_n_2184357.html?view=print&comm_ref=false)

"I think there will be expectations from countries to hear a new voice from the United States," said Jennifer Morgan, director of the climate and energy program at the World Resources Institute in Washington.¶ The climate officials and environment ministers meeting in the Qatari capital of Doha will not come up with an answer to the global temperature rise that is already melting Arctic sea ice and permafrost, raising and acidifying the seas, and shifting rainfall patterns, which has an impact on floods and droughts.¶ They will focus on side issues, like extending the Kyoto protocol – an expiring emissions pact with a dwindling number of members – and ramping up climate financing for poor nations.¶ **They will also try to structure the talks for a new global climate deal that is supposed to be adopted in 2015, a process in which American leadership is considered crucial**.¶ Many were disappointed that Obama didn't put more emphasis on climate change during his first term. He took some steps to rein in emissions of heat-trapping gases, such as sharply increasing fuel efficiency standards for cars and trucks. But a climate bill that would have capped U.S. emissions stalled in the Senate.¶ "We need the U.S. to engage even more," European Union Climate Commissioner Connie Hedegaard told The Associated Press. "Because that can change the dynamic of the talks."¶ The world tried to move forward without the U.S. after the Bush Administration abandoned the Kyoto Protocol, a 1997 pact limiting greenhouse emissions from industrialized nations. As that agreement expires this year, the climate curves are still pointing in the wrong direction.¶ The concentration of heat-trapping gases like carbon dioxide has jumped 20 percent since 2000, primarily from the burning of fossil fuels like coal and oil, according to a U.N. report released this week. And each year, the gap between what researchers say must be done to reverse this trend, and what's actually being done, gets wider.¶ Bridging that gap, through clean technology and renewable energy, is not just up to the U.S., but to countries like India and China, whose carbon emissions are growing the fastest as their economies expand.¶ But Obama raised hopes of a more robust U.S. role in the talks when he called for a national "conversation" on climate change after winning re-election. The issue had been virtually absent in the presidential campaigning until Hurricane Sandy slammed into the East Coast.¶ **The president still faces domestic political constraints**, and there's little hope of the U.S. increasing its voluntary pledge in the U.N. talks of cutting emissions by 17 percent by 2020, compared to 2005 levels.¶ Still, just a signal that Washington has faith in the international process would go a long way, analysts said.¶ "**The** perception **of many negotiators and countries is that the U.S. is not really interested in increasing action on climate change** in general," said Bill Hare, senior scientist at Climate Analytics, a non-profit organization based in Berlin.

#### SPS solves for global emissions

Kammen 7 – Professor of Public Policy @ UC Berkeley (Daniel, "Green Jobs Created by Global Warming Initiative," September 25th, http://www.unep.org/civil\_society/GCSF9/pdfs/karmen-senate.pdf)

In addition to supporting domestic job creation, clean energy is an important and fastest growing international sector, and one where overseas policy can be used to support poor developing regions – such as Africa (Jacobsen and Kammen, 2007) and Central America – as well as regaining market share in solar, fuel cell and wind technologies, where European nations and Japan have invested heavily and are reaping the benefits of month to year backlogs in clean energy orders. Some of those orders are for U. S. installations, but many more could be if we choose to make clean and green energy a national priority for both domestic installation and overseas export. Technology exports have impacts well beyond domestic job creation. In fact, if properly managed, the development of a thriving ‘cleantech’ sector can address a vital global issues, namely the emissions trajectories of major developing nations. China and India are often singled out for attention as major, emerging global emitters. China, in fact, will become the world’s largest greenhouse emitter in the near future, if it has not already. This fact, is often used – mistakenly in my view – to argue against unilateral climate protection efforts by nations such as the United States.  This view is shortsighted in two vital respects. First, China is demonstrably already suffering from the impacts of fossil fuel use. Crop yields in many parts of China are significantly lower than they would be without the significant sulfur and particulate burden that results from domestic coal combustion. (In fact, coal combustions emissions from China have significant air quality impacts on Japan, and can be measured in the U. S. as well.) Crop losses of over 20% have been reported in part of China, with the decrease unambiguously linked to air pollution. China also experiences significant human health impacts from this pollution burden as well. Second, China has committed, on paper, to a ‘circular economy’ where waste is reduced and overall productivity is enhanced. If the United States were to become a major exporter, or even a partner, in the production of low-emissions technologies – from truly carbon-capture coal-fired power plants, to increased numbers of solar, wind, and biofuel technologies – China would be an eager trading partner, so that they could install increasing numbers of low-emissions technologies. This would directly help the Chinese economy and their environmental and public health situation**.** On both of these grounds, U. S. domestic expansion of the clean energy sector will likely positively impact the ability and the actions of a number of emerging economies to ‘go green’.

#### Fossil fuel dependence is unsustainable – only SPS-ALPHA solves world energy needs and can be exported globally

Dvorsky 11-28 – George Dvorsky, writer for Io9, a daily science and technology publication, November 28th, 2012, "How space-based solar power will solve all our energy needs" io9.com/5963955/how-space+based-solar-power-will-solve-all-our-energy-needs

Humanity's demand for energy is growing at an astonishing rate. Combine this with an ever-dwindling supply of fossil fuels, and it becomes painfully clear that something innovative and powerful is required. There's one high-tech proposal that holds tremendous promise — an idea that has been around since the late 1960s. Here's how space-based solar power will **eventually** solve all our energy needs.¶ Humans needs more power¶ Assuming that economic progress and globalization continues at its current pace, **we'll need to produce twice the amount of energy that's consumed today by the 2030s — what will reach a monumental 220 trillion kiloWatt hours per year. And by the end of the century, we'll need four times the current rate of consumption.**¶ **Just as importantly, we're also going to have to kick the fossil fuel habit — and not only because** it'll eventually run out**. Rising CO2 emissions are wreaking havoc on the Earth's atmosphere, what's creating environmentally deleterious side-effects at a rate faster than expected.**¶ Moreover, if greenhouse gases are to be brought under control over the course of the next several decades, we'll need to get upwards of 90% of all our energy from either renewable or nuclear sources.¶ While there are a number of proposals on the table for how we might be able to meet these challenges, **none** really **appear to be truly viable**.¶ Except for solar powered satellites.¶ Obvious benefits¶ A closer look at a space-based solution yields a lengthy list of advantages.¶ Solar powered satellites **don't produce any greenhouse gases**, nor do they take up valuable real estate on Earth. Once the initial costs are met, they would be relatively cheap to maintain; the solar modules used for generating solar energy have a long service life, not to mention the astounding ROI that would come from a virtually unlimited energy source.¶ Additionally, they're not constrained by night/day cycles, the weather, or the changing seasons. And indeed, they would be much more efficient than any kind of ground-based station. The collection of solar energy in space is seven times greater per unit area than on the surface of the planet. Moreover, **the amount of solar energy available up there is staggering — on the order of** billions **of times greater than what we draw today; the Earth receives only one part in 2.3 billion of the Sun's output**. The potential for scalability is enormous, to say the least.¶ Solar powered satellites won't be prone to terrorist attacks and they'll **reduce geopolitical pressure for oil.** According to futurist Keith Henson, space-based solar could be used to power vehicles, like electric cars, or by enabling the production of synthetic fuels — which at a penny per kiloWatt hour would result in gasoline that costs one dollar a gallon.¶ At the same time, space-based solar would provide true energy independence for those nations who choose to implement it. And on top of that, the energy could be exported to virtually anywhere in the world; it would be especially valuable for isolated areas of the globe, including Africa and India.¶ Lastly, **space-based solar power would also yield** tremendous benefits to human and robotic space exploration**, including the powering of off-planet colonies on the Moon, Mars, and space stations.** It could also serve as the first seed in the development of a Dyson Sphere — a massive array of solar collectors that would completely envelope the sun at a distance of about 1 AU.¶ How it's going to work¶ Back in the late 1960s, Peter Glaser proposed the idea of solar powered satellites (SPS), what he envisioned as space-based photovoltaics that could transfer energy wirelessly back down to Earth. His design called for a large platform positioned in space in a high Earth orbit that would continuously collect and convert solar energy into electricity. In turn, that power would be used to drive a wireless power transmission (WPT) that beams the solar energy to receiving stations on Earth — what would be comprised of massive receiving dishes.¶ A number of visionaries have updated Glaser's vision to include the use of a microwave wireless power transmitter. This would involve large discrete structures (like a solar array and transmitter) that would have to be assembled in space. SPS systems could also include a modular electric/diode array laser WPT concept, involving self-assembling solar power-laser-thermal modules. Other designs call for an extremely modular microwave WPT SPS "sandwich structure" concept, requiring a significant number of small solar power-microwave-thermal modules that would be robotically assembled on orbit.¶ But to make it happen, we'll need to develop low-cost, environmentally-friendly launch vehicles. Eventually we'll send the materials up in a space elevator, but until then we'll have to come up with something more efficient. Thankfully, SpaceX and other private firms are already working on more efficient launch solutions.¶ Additionally, we'll require large scale construction and operations stations in orbit — space-based workplaces that would be more complex, larger, and more energy-demanding than the ISS. They would allow for the production of large, simple panels, that are easy to assemble and consist of many identical parts. Eventually, it may be possible to construct an entire flotilla of these solar collectors using materials extracted from asteroids.¶ Design proposals¶ As word gets out about the potential for SPS, and as the technology catches up to the idea, a number of design proposals have been put forth; this isn't just idle speculation anymore — it's something that's just about ready for prime-time.¶ For example, there's SPS-ALPHA (Solar Power Satellite via Arbitrarily Large PHased Array) which is being developed by NASA's John Mankins. Using a "biomimetic" approach, the project calls for huge platforms constructed from tens of thousands of small elements that could deliver tens to thousands of megawatts via wireless power transmission.¶ It would do this by using a large array of individually controlled thin-film mirrors outfitted on the curved surface of a satellite. These adjustable mirrors would intercept and redirect incoming sunlight toward photovoltaic cells affixed to the backside of the solar power satellite's large array. The Earth-pointing side of the array would be tiled with a collection of microwave-power transmission panels that generate the coherent, low-intensity beam of radio frequency energy and transmits that energy to Earth.¶ And what's particularly cool about this concept is that **it would enable the construction of a solar-power satellite that can be assembled entirely from individual system elements that weigh no more than 110 to 440 pounds (**50 **to 200** kilograms**), allowing all pieces to be** mass produced at low cost.

## Contention Two is…

#### **SPS is key to bistatic radar – this is key to countering stealth radar**

Johnson et al. 9 – W. Neil Johnson, Naval Research Laboratory, High-energy Space Environment Branch, Space Science Division, AND\*\*\* Keith Atkins, James Armstrong, Kwok Cheung, Glen Henshaw, Steven Huynh, Paul Jaffe, Matthew Long, Michael Mook, Michael Osborn, Robert Skalitzky, and Frederick Tasker, Spacecraft Engineering Department, AND\*\*\* Jill Dahlburg and Michael N. Lovelette, Space Science Division, AND\*\*\* Robert Bartolo and Keith Williams, optical sciences division, AND\*\*\* Mark Dorsey, radar division, AND\*\*\* Donald Gubser, Materials Science and Technology Division, October 23rd, 2009, "Space-based Solar Power: Possible Defense Applications and Opportunities for NRL Contributions" [www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA513123](http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA513123)

Bistatic radar systems are generally well-suited to several specific applications where they outperform conventional monostatic radars, especially in real-world tactical scenarios. Notably, bistatic radars are of particular value in countering anti-radiation missile (ARM) threats, retro-directive radar jammers, and stealth radar technologies. They are inherently capable of implementing some processes, notably cluttertuning, that are impossible for monostatic radars [2]. Any SBSP satellite delivering RF energy to the surface can be used in a “hitchhiker” configuration, where the same RF downlink used to provide power to ground users can also be used as a coherent source of that RF energy for bistatic radar implementations. ¶ SBSP satellites used as RF sources for **bistatic radar applications possess advantages** over and above those afforded by more traditional satellites (e.g., GEO communication satellites, and GPS). Initially, SBSP bistatic systems will be able to operate at much higher effective isotropic radiated power (EIRP) than other spaceborne sources, providing orders of magnitude higher illumination of the surface, resulting in much higher signal to noise ratio (SNR), which allows detection of targets with much lower radar cross sections and minimizes an already lower threat from surface jammers. Instead of relying on coincidental illumination from more traditional spaceborne sources, SBSP RF illumination can be **directed to specific tactical areas** of interest, providing an **“on-demand” capability** as an adjunct **to the SBSP’s** primary **power transmission mission.**

#### **Existing Monostatic radar fails at addressing security threats**

Baker & Griffiths 5 – C J Baker, AND\*\*\* H D Griffiths, University College London Department of Electrical and Electronic Engineering, 2005, "Bistatic and Multistatic Radar Sensors for Homeland Security," [www.prometheus-inc.com/asi/sensors2005/papers/baker.pdf](http://www.prometheus-inc.com/asi/sensors2005/papers/baker.pdf)

Radar has long been used in a variety of military and civilian applications and has become an essential component of current defensive systems. The chief reason for this is an ability to survey wide areas rapidly during the day or at night and in all weather conditions. It is2 the only sensor able to do this. Many countries have a network of civil aviation radars that often form a part of a wider air defence capability that is able to detect aircraft out to ranges of hundreds of km. These networks are speciﬁcally designed to ensure early warning against potentially hostile threat targets. In a similar manner coastal shorelines are monitored also using a combination of civilian coastguard and military maritime systems.¶ However, **the range and nature of potential threat targets is becoming ever more diverse. For example targets are becoming faster, more agile, stealthier and can occur in many guises.** The tragic events of 9/11 are of course but one example of how the meaning of legitimate ‘targets’ has changed irrevocably. Others might include missile attack, uavs (including micro-lights), small high speed boats (including jetskis). In fact **the potential range of threat targets is almost unlimited. This means that the source of attack can emanate in a much wider variety of new and diﬀerent forms.** These are not necessarily well dealt with by current conventional radar systems and alternatives merit evaluation.

#### Bistatic radar prevents cruise missile proliferation

Tanks 2k – David Tanks, analyst at the Institute for Foreign Policy Analysis, 2000, "Assessing the Cruise Missile Puzzle: How great a defense challenge?" [www.ifpa.org/pdf/CM200/CM\_Report.pdf](http://www.ifpa.org/pdf/CM200/CM_Report.pdf)

As was noted in the Introduction, it is not expected that other states will produce cruise missiles with the same degree of sophistication the U.S. is capable of producing. However, it is clear that future systems will pose a greater challenge than has been the case heretofor**.** The evolving cruise-missile threat will require a new approach to target detection and tracking.¶ **Since the curvature of the earth prevents low-flying cruise missiles or aircraft from being detected by a surface-based radar until it closes on the radar’s location, any system designed to counter a cruise missile threat must use elevated sensors capable of seeing beyond the earth’s local horizon**. The systems must also incorporate advanced radar detection technologies capable of processing and interpreting very faint signal returns.¶ Theoretical approaches to reduced-signature object detection. No object can become entirely invisible to detection. The simple passage of an object through the atmosphere displaces air molecules and disturbs the electromagnetic spectrum. The key to detecting reduced-signature objects is to focus collection efforts against those disturbances that cannot be shielded. While it is much more difficult to detect objects that incorporate signature reduction technologies, it is not impossible. Bistatic radar provides a potential means for detecting objects with a very small RCS.¶ Bistatic means that the radar’s transmitter is separate from the receiver. To put the system in perspective, all early radar sets were bistatic since the switching between transmit and receive in the same antenna was not fast enough—the pulse got back to the antenna before the radar could switch to the receive mode. By necessity, the radio signal had to be broadcasted by a stand-alone transmitter; the return pulse was recorded and processed by a separate receiver. As technology advanced the two functions were combined into a single equipment set that used a common antenna. ¶ Almost all modern radar sets combine the transmit/receive functions in a single equipment set. However, the need to detect reduced-signature objects is creating renewed interest in the development of networked radar sets that can receive and process the echoes of signals transmitted by other radio sources. In essence, the situation resembles a baseball game. Until now, all of the individual games being played involved only a pitcher and a batter. The batter always bunted the ball back to the pitcher. (See figure 13, p. 22)¶ **The emergence of aircraft and cruise missiles with smaller RCSs are creating a requirement to field more players on the team, all of whom can be kept aware of the common situation and all of whom are capable of catching a ball regardless of where it is hit (the echoed signal).** Likewise, it is clear that **future detection challenges will require the use of bistatic radar techniques**, networked into a system of systems to detect targets that are difficult to sense naturally or that incorporate signature reduction technologies. (Figure 14, p. 23) (Note: technically, situations involving multiple receivers and a common transmission source are called multistatic.)

#### Cruise missile proliferation causes nuclear war

Telegraph 11 – Missile Technology Control Regime (MTCR) Reinforced Point Of Contact (RPOC) Meeting, April 10, 2008, “Wikileaks Transcript Classified by ISN/MTR Director Pam Durham”

21. (C) Additionally, many countries are pursuing cruise missile programs as alternatives or supplements to their ballistic missile capabilities. Like ballistic missiles, cruise missiles can be a platform for WMD delivery and provide a more effective vehicle for biological and chemical weapons distribution than ballistic missiles. These trends are especially evident in the key regions of tension, the Middle East and Persian Gulf, Northeast Asia, and South Asia. 22. (C) Ballistic and cruise missile programs in these regions are evolving in different ways. While nearly all ultimately seek to obtain indigenous production capabilities, some rely primarily on direct missile purchases from countries such as North Korea, while others solicit extensive foreign assistance in missile design, development, and/or production. In other cases, more limited, specialized assistance is sought from foreign sources to sustain domestic design efforts and overcome technological impediments that prevent self-sufficiency in a state's missile program. 23. (C) The procurement efforts required to support missile development are global in scope, utilizing the territories and economies of a wide range of countries as sources of equipment and technology, as re-export/transit cutouts, and as brokering and finance centers. Many of these countries, including MTCR Partner countries, are not aware that their entities are inadvertently assisting ballistic missile proliferation. 24. (C) In several cases, broad international consensus has been reached that certain national missile programs constitute a threat to international peace and security. With respect to Iran, UNSCRs including 1696, 1737, and 1747, and 1803, prohibit technological transfers and other assistance by all states to Iran's missile programs. UNSCRs 1695 and 1718 require similar actions regarding ballistic missile programs in North Korea. These UNSCRs reflect the fact that ongoing nuclear tensions in the Persian Gulf and Northeast Asia threaten the viability of the global nonproliferation and security system. These tensions are aggravated and made more real and widespread by the open development and testing of ballistic missiles capable of delivering WMD. 25. (S/REL MTCR) For example, Iran has publicly revealed it had conducted some tests related to solid-propellant missile technology and implied that it was working on a design for a two-stage, 2,000 km-range system. Iran has also worked to improve the capabilities of its liquid propellant missile systems, claiming that a variant of the Shahab-3 missile has a 2,000 km-range and improved accuracy. Not only would missile-delivered WMD in Northeast Asia or the Middle East have the potential to cripple the global economy, the development of longer-range ballistic missiles carries with it the ability to deliver WMD to other regions. 26. (C) There are similar implications related to missile proliferation in South Asia, where a nuclear and missile arms race has the direct potential to lead to nuclear war in the world's most densely populated area and a region of increasing global economic significance. As we have already seen in South Asia in the nuclear area, the possession and development of missile technology there also carries with it the risk that this technology will spread to other regions. 27. (C) In an increasingly interdependent world, missile programs for WMD delivery in regions of tension threaten stability -- not just in those regions, but globally. Moreover, the challenge posed by these programs is growing as they improve qualitatively and quantitatively, often by drawing on all of us for various forms of facilitation.

#### Bistatic radar is key to prevent drug trafficking

Martin et al. 6 – Andreas Arnold-Bos, Arnaud Martin, Ali Khenchaf, members of the Institute of Electrical and Electronics Engineers and analysts at Ecole Nationale Superieure des Ingenieurs des Etudes et Techniques de l'Armement (ENSIETA), a French laboratory, 2006, "A Versatile Bistatic & Polarimetric Marine Radar Simulator" [www.arnaud.martin.free.fr/publi/ARNOLD\_06a.pdf](http://www.arnaud.martin.free.fr/publi/ARNOLD_06a.pdf)

On an average day, more than a hundred and ﬁfty ships transit through the English Channel. Among them, about eight **ships carry dangerous goods and could** potentially **be responsible for ecological disasters** similar as the sinking of Amoco Cadiz ´ (1978) or more recently, Erika (1999) and Prestige (2002). Drug smuggling**, illegal immigration, or piracy are yet other rampant problems that marine authorities have to face.** To improve safety along coasts, especially in zones where intense ship trafﬁc occurs, **detection and tracking algorithms for radar-based surveillance systems must be continuously improved**. Doing so requires an important insight in the physical phenomena that occur during the acquisition of the data. The problem is that real data with extensive ground truth are barely available today, especially with uncommon, yet promising, conﬁgurations such as bistatic radar.

#### Drug trafficking crushes Amazon biodiversity

Barraca 10—Sara, Dialogo News, Drug Trafficking Damaging Amazon Basin, Diálogo is a professional military magazine published quarterly by the Commander of the United States Southern Command as an international forum for military personnel in Latin America, 3/12, [www.dialogo-americas.com/en\_GB/articles/rmisa/features/regional\_news/2010/12/03/feature-01](http://www.dialogo-americas.com/en_GB/articles/rmisa/features/regional_news/2010/12/03/feature-01)

Drug trafficking organizations are causing significant damage to the Amazon rain forest and watershed in Colombia, Peru, Ecuador and Venezuela, endangering the region’s diverse flora and fauna and threatening the planet’s “green lungs.”¶ In addition, the production of staple crops such as potatoes and corn has suffered as farmers have been forced to grow coca plants.¶ Dialogo recently interviewed environmental officials in some of the affected countries about the damage caused by illicit drug production.¶ Colombia¶ “Illicit crop growers have started to develop mechanisms to avoid the state’s eradication efforts," said Víctor Nieto, a researcher for Colombia’s National Forest Research and Development Corporation (CONIF).¶ "Initially, this type of crop grew in open fields, so they were easily identifiable on satellite images, and police planes could fumigate and eliminate those crops," he said. Illicit crop growers attempted strong counter-measures, Nieto said. "They sought ways to halt the advance of crop dusters and even went so far as to string high-tension aerial cables from one hill to another, so the planes would run into them and crash."¶ But eventually farmers settled on a different approach: cutting back natural forests, and leaving only trees that provided greater aerial coverage.¶ "This allowed the crops to blend in with the tree canopy, making the crops more difficult to eradicate by crop dusting from the air," Nieto said. "The success of this approach encouraged the clearing of natural forests in patches or lots resulting in serious loss of forested areas, a decline in the quality of remaining forests, and interference with flora and fauna naturally found in ecological corridors associated with these forests."¶ "Needless to say, the waste created by the processing camps – residue from chemicals used to extract the active drug components – is dumped into streams and rivers in the heart of the rain forest. The cans, plastic containers and other waste are randomly discarded in rain forest.”¶ “It is very difficult for other crops to compete against a business as profitable as coca production, so the community devotes is time to that," he said.¶ Market pressures tend to foster dependence on illicit farming once it has begun, Nieto said.¶ "Everything is affected by the market. Profitable crops increase the value of consumer products in the region and, therefore, the community near the production area has no choice but to enter the supply chain or be left out of the consumer market.”¶ "In 2009, at the Climate Change Summit in Copenhagen in 2009, then-president of Colombia Álvaro Uribe called on participating countries to strengthen their commitment against the production, consumption and trafficking of narcotics. That commitment could involve even more meetings than were originally contemplated," Nieto said.¶ Illegal armed groups have taken a financial stake in illicit crops, Nieto said, complicated the issue even further.¶ "Years ago, guerrilla groups like the FARC and ELN were destroying oil pipelines as a tactic to attack the government and the interests of multinational capitalists," Nieto said, and "recent governments have invested heavily in the elimination of armed groups."¶ A few years ago, the guerrillas undertook “visibility” projects, he said. Their goal was to create instability and unrest with actions such as destroying pipelines.¶ "These ideas are no longer used, and today the armed groups only seek economic benefits for financing the war (or leaders). This, for the community, seems to be the current lesson.”¶ The international community has responded to the environmental hazards of illicit farming with programs like the UN's "Familias Guardabosques," Nieto said. The UN program develops sources of income for rural communities as an alternative to cultivating narcotics.¶ "Then, the question was one of sustainability from a financial standpoint," he said. "It was argued that once the financial resources ran out, families would return to non-legal businesses. State resources were dedicated to the program, along with international cooperation."¶ A new approach has gained support, Nieto said: paying communities for preserving forestland the same amount that they would gain for cutting it down.¶ "It started with the analysis of how much money communities near forests could be earning if they harvested timber from the forests, and the data showed that after felling, removing and selling the timber, the profits were not worth the effort put into it, or the value of the existing forests," he said.¶ The idea has been successful and implemented with great transparency, Nieto said.¶ "Continual monitoring, which allows for assurance of conservation and new bids for mitigation of climate change and reducing emissions from deforestation and degradation, seems to be the way to create sustainability of the project over time. The plan is still new and in a transitional phase, but is an excellent way to simultaneously solve several of the community’s problems.”¶ All of these programs are only playing environmental defense, however, and none have found a way to restore the damage already done according to Nieto.¶ "There are no serious forest restoration or recovery programs, and we can only possible eradicate [illegal] crops and wait for nature to do the rest. The forest is not capable of quickly rebuilding its forest cover; all of this will require many years of work," he said.¶ "In the end, the real loser is mankind," Nieto said. "We will lose forests that capture carbon, and we will then experience the effects of climate change."¶ "Frequent reference is made to Colombia having been declared one of the most biodiverse countries in the world, a national point of pride. It has been our country’s goal to attain this recognition, and hopefully it might help to garner support for conservation. In any event, a country like ours needs support in order to realize characterization and conservation. Biodiversity characterization and conservation should be tools for social development, and this is not always the case," he said.¶ Ecuador¶ Ecuador faces different challenges, engineer Sonia Díaz from the National Council for the Control of Narcotic Drugs and Psychotropic Substances (CONSEP) said.¶ “Ecuador is not a country of drug growers. Rather, it is considered a transit country, and the greatest ecological damage in the world occurs on our northern border with Colombia because of the crop dusting that has been done since 1997. You can see how this has adversely affected rivers, biodiversity of native species, and the populations in that area," she said.¶ Dr. Aguilar Alfaro from the Center for Biology at Universidad de Central de Ecuador agreed.¶ “The damage to the ecosystem, extinction of species, contamination of water, soil, plants and air, not to mention damage to large areas of fertile ground, has affected the production of crops such as potatoes and corn.”¶ Peru¶ Drug trafficking is a threat to the environment in Peru as well, said César A. Ipenza Peralta, advisor to Peru’s Ministry of the Environment.¶ "It is obvious that drug trafficking has one of the greatest impacts on the Amazon, leading to severe deforestation of tropical forests and contamination of the watershed."¶ Chemicals used during the three stages of the cocaine refining process sometimes produces over two metric tons of waste per hectare of coca, he said – and the local impact of the drug trade on soil, hydrology and biodiversity are often devastating.¶ Farmers use large quantities of toxic pesticides are used to help clear new land and to control weeds and insects.¶ Piles of processed coca leaves dumped near streams can cause further environmental problems, he said.¶ "The leaves are saturated with toxic chemicals and, as they decay, they become the main source of pollution for any nearby water source since they add a huge amount of organic matter to the water. This increases oxygen demand and can severely affect a waterway for a long stretch," Peralta said.¶ "The environmental damage to the country caused by drug trafficking includes deforestation, loss of species and biodiversity, pollution of rivers and water sources and loss of aquatic resources (fish)," he said.

#### Loss of Amazon biodiversity causes extinction

Takacs 96—Takacs, David, 1996 Philosophies of Paradise, The Johns Hopkins Univ. Pr., Baltimore.

"Habitat destruction and conversion are eliminating species at such a frightening pace that extinction of many contemporary species and the systems they live in and support ... may lead to ecological disaster and severe alteration of the evolutionary process," Terry Erwin writes." And E. 0. Wilson notes: "The question I am asked most frequently about the diversity of life: if enough species are extinguished, will the ecosystem collapse, and will the extinction of most other species follow soon afterward? The only answer anyone can give is: possibly. By the time we find out, however, it might be too late. One planet, one experiment."" So biodiversity keeps the world running. It has value in and for itself, as well as for us. Raven, Erwin, and Wilson oblige us to think about the value of biodiversity for our own lives. The Ehrlichs' rivet-popper trope makes this same point; by eliminating rivets, we play Russian roulette with global ecology and human futures: "It is likely that destruction of the rich complex of species in the **Amazon basin could trigger rapid changes** in global climate patterns. Agriculture remains heavily dependent on **stable climate**, and human beings remain heavily dependent on food. By the end of the century the **extinction** of perhaps a million species in the Amazon basin could have entrained famines in which a billion human beings perished. And if our species is very unlucky, the famines could **lead to a** thermonuclear war, which could **extinguish civilization.""**

#### Conclusive evidence proves biodiversity is key to prevent extinction

**Science Daily 11** (Citing Prof Michel Loreau, PhD Ecologist, and Prof Michael Scherer-Lorenzen, PhD and Professor @ University of Freiburg, " Biodiversity Key to Earth's Life-Support Functions in a Changing World," Aug 11, http://www.sciencedaily.com/releases/2011/08/110811084513.htm)

ScienceDaily (Aug. 11, 2011) — The biological diversity of organisms on Earth is not just something we enjoy when taking a walk through a blossoming meadow in spring; it is also the basis for countless products and services provided by nature, including food, building materials, and medicines as well as the self-purifying qualities of water and protection against erosion. These so-called ecosystem services are what makes Earth inhabitable for humans. They are based on ecological processes, such as photosynthesis, the production of biomass, or nutrient cycles. Since biodiversity is on the decline, both on a global and a local scale, researchers are asking the question as to what role the diversity of organisms plays in maintaining these ecological processes and thus in providing the ecosystem's vital products and services. In an international research group led by Prof. Dr. Michel Loreau from Canada, ecologists from ten different universities and research institutes, including Prof. Dr. Michael Scherer-Lorenzen from the University of Freiburg, compiled findings from numerous biodiversity experiments and reanalyzed them. These experiments simulated the loss of plant species and attempted to determine the consequences for the functioning of ecosystems, most of them coming to the conclusion that a higher level of biodiversity is accompanied by an increase in ecosystem processes. However, the findings were always only valid for a certain combination of environmental conditions present at the locations at which the experiments were conducted and for a limited range of ecosystem processes. In a study published in the current issue of the journal Nature, the research group investigated the extent to which the positive effects of diversity still apply under changing environmental conditions and when a multitude of processes are taken into account. They found that 84 percent of the 147 plant species included in the experiments promoted ecological processes in at least one case. The more years, locations, ecosystem processes, and scenarios of global change -- such as global warming or land use intensity -- the experiments took into account, the more plant species were necessary to guarantee the functioning of the ecosystems. Moreover, other species were always necessary to keep the ecosystem processes running under the different combinations of influencing factors. These findings indicate that much more biodiversity is necessary to keep ecosystems functioning in a world that is changing ever faster. The protection of diversity is thus a crucial factor in maintaining Earth's life-support functions.

#### Countering stealth radar is key to air power

Axe 11 – David Axe, war zone reporter, June 7th, 2011, "China, Russia Could Make U.S. Stealth Tech Obsolete" [www.wired.com/dangerroom/2011/06/stealth-tech-obsolete/](http://www.wired.com/dangerroom/2011/06/stealth-tech-obsolete/)

**Stealth technology — which today gives U.S. jets the nearly unparalleled ability to slip past hostile radar — may soon be unable to keep American aircraft cloaked.** That’s the potentially startling conclusion of a new report from **Barry Watts, a former member of the Pentagon’s crystal-ball-gazing Office of Net Assessment and current analyst with the Center for Strategic and Budgetary Assessments in Washington**.¶ “The advantages of stealth … may be eroded by advances in sensors and surface-to-air missile systems, especially for manned strike platforms operating inside defended airspace,” Watts cautions in his 43-page report The Maturing Revolution in Military Affairs (.pdf), published last week.¶ That could come as a big shock to the U.S. Air Force, which has bet its future on radar-dodging technology**, to the tune of half-a-trillion dollars over the next 30** years. The Navy, on the other hand, might have reason to say, “I told you so.”¶ That is, if Watts’ prediction comes true — and that’s a big “if,” the analyst admits.¶ “In recent years there has been speculation that ongoing advances in radar detection and tracking will, in the near future, obviate the ability of all-aspect, low-observable aircraft such as the B-2, F-22 and F-35 Joint Strike Fighter, aka JSF, to survive inside denied airspace,” Watts writes, referring to America’s stealth bombers and fighter jets.¶ Stealth-killing advances include VHF and UHF radars being developed by Russia and China, and a “passive-detection” system devised by Czech researchers. The latter “uses radar, television, cellular phone and other available signals of opportunity reflected off stealthy aircraft to find and track them,” Watts explains.¶ **These new detection systems could reverse a 30-year trend that has seen the U.S. Air Force gain an increasing advantage over enemy defenses.** That phenomenon began with the introduction of the F-117 stealth fighter in the late 1980s, followed by the addition of the stealthy B-2 (pictured) in the ’90s and, more recently, the F-22.¶ So far, the Air Force has only ever fielded a few hundred stealth aircraft, requiring it to constantly upgrade some nonstealthy fighters. But the flying branch plans to purchase more than 1,700 F-35s (at more than $100 million a pop) from Lockheed Martin in coming decades, plus up to 100 new stealth bombers. In that sense, the stealth era is only now truly dawning — just as effective counter-measures are nearly ready, Watts points out.¶ In that sense, the Air Force’s stealth gamble could turn into very, very long odds.

#### Perception of credible air power is key to the global commons and independently de-escalates conflict – the alternative is regional instability and miscalculation

Eaglen & Birkey 12 – Mackenzie Eaglen is a resident fellow at the American Enterprise Institute, AND\*\*\* Douglas A. Birkey is the director for government relations at the Air Force Association, March 21st, 2012, "Nearing coffin corner: US air power on the edge" aei.org/outlook/foreign-and-defense-policy/defense/nearing-coffin-corner-us-air-power-on-the-edge/

Air power presents many opportunities for cultivating these associations. **Whether conducting training exercises, promoting regional stability through joint operations, or supporting disaster recovery and humanitarian relief efforts, American and allied airmen are uniquely situated to project smart, effective, and positive power**. This requires putting work into building enduring relationships over time, not scrambling in a crisis to create them overnight. ¶ Considering that air power can be deployed and sustained through minimal forward troop presence, such cooperative engagement has the advantage of focusing on desired regional effects without many of the liabilities associated with occupation by land forces. Also, given the scale and scope of the Asia-Pacific region, air power’s range and speed enables a discrete number of assets to engage across the theater on a sustained basis. However, these alliances will be successful only if they are built on robust policies underwritten by well-equipped forces**.** Allies’ commitment **to the United States and its interests** depends directly on their perceptions **regarding American presence,** staying power, and resolve.¶ When cooperation is not possible, **US leaders must have the capability** and capacity to discourage and ultimately deter potential adversaries from threatening American interests. Whether alone or in concert with allied partners, American air power affords many policy options through its daily missions:¶ Airlift and aerial refueling ensure regional and global mobility.¶ Intelligence, surveillance, and reconnaissance assets provide critical data to inform the decision-making process.¶ Air superiority ensures access throughout the global commons for all US forces. ¶ The ability to strike anywhere around the globe at will holds targets at risk.¶ Nuclear forces provide an umbrella of protection for allied states and US forces.¶ However, **efforts to change the calculus or behavior of potential adversaries are effective** only if they are credible. **Securing interests through peaceful influence demands robust capability and capacity, including adequate quantity of forces**. Failing to make such investments encourages regional instability that may lead to miscalculation and ultimately conflict.

#### Alaskan air power prevents Arctic conflict escalation

Schanz 8 – Mark V. Schanz, Associate Editor of Airforce Magazine, 2008, “Strategic Alaska,” http://www.airforce-magazine.com/MagazineArchive/Pages/2008/November%202008/1108alaska.aspx

**More than ever before, the Air Force is paying close attention to its force structure in Alaska.** Indeed, a major rush of events in the High North has propelled the 49th state up to the top ranks of service thinking.¶ A resurgent Russia has ramped up its long-range bomber flights nearby. A changing Arctic climate has uncorked a flurry of activity in the region as once inaccessible resources now seem ready for exploitation. Alaska’s strategic Arctic location is viewed as useful for missile defense, air defense, and force deployments to locations ranging from Europe to East Asia and beyond. And **the military training space available to USAF there is huge and varied.**¶ For these and other reasons, the Air Force has started beefing up its forces in the state. A visitor there sees that the service has been sending its newest and most advanced equipment for Alaskan service, including brand-new F-22 fighters and C-17 transports.¶ C-17s are surrounded by low clouds on the runway at Elmendorf AFB, Alaska. (USAF photo by SrA. Garrett Hothan)¶ "From an airman’s perspective, [it’s] probably the most strategic location," said Lt. Gen. Dana T. Atkins, commander of Alaskan Command and Alaskan NORAD region. **The state’s geographic location "makes it** hugely of strategic import to the United States **and** really important in a global context**."**¶ From Alaskan bases, the Air Force can gain quick access both to the Pacific and European Theaters. Transiting across the Arctic, forces could arrive in Europe faster than if flying from the East Coast of the US, Atkins pointed out. This responsive location has helped to **push Alaska to the forefront of USAF’s investment queue**.¶ The reinvigoration of Russian **bomber patrols over Arctic waters in August 2007 was an opening push of that country’s increasingly** assertive power projection efforts**. NORAD’s US and Canadian fighters have** repeatedly intercepted Russian flights skirting Alaskan airspace**.**¶ New F-22s at Elmendorf Air Force Base took center stage last fall when Raptors stepped in to fill the role of the temporarily grounded F-15 fleet to intercept Russian Tu-95 Bear bombers.¶ The Air Sovereignty Mission¶ Many of the Raptor pilots leveraged their F-15 backgrounds, and the scrambles led to the development of a new training plan for the air sovereignty mission, said Lt. Col. Orlando Sanchez, director of operations for the 525th Fighter Squadron at Elmendorf. While F-22s are no longer on alert, they may perform intercepts in the future.¶ The commander of Russia’s Air Force, Col. Gen. Alexander Zelin, said in April the country will increase its strategic patrols to as many as 30 a month.¶ "It’s been interesting in the last few years," said Gen. Carrol H. Chandler, chief of Pacific Air Forces, in September. "When I was ... Alaskan Command commander, we had one intercept in the time that I was there. The Russians have continued to put emphasis on long-range aviation; they’ve continued to put emphasis on presence in the Arctic. ... Those numbers have picked up considerably over the last three to four years."¶ Chandler suspects that a "competition for resources" will continue, and perhaps intensify, in the Arctic.¶ Last year, Russia publicized a submarine trip to the bottom of the seabed at the North Pole—where the crew deposited a titanium Russian flag, symbolically marking territory.¶ The Canadians derided the expedition as a "stunt," with Prime Minister Stephen Harper making a trip to Canada’s Arctic region to unveil several major military investments, and following with a new defense strategy, outlining new capabilities in the North**.**¶ **Russia’s focus on Arctic operations is a part of the country’s push to assert its own interests over Siberia’s extended continental shelf**—the largest and least explored so far of the world’s continental shelves, according to senior Russian military officials. Geologists believe major oil and gas deposits could potentially become available as the polar ice cap slowly recedes with warming temperatures—a fact that is the focus of increasing attention to the nations claiming Arctic waters.¶ "I don’t see that abating anytime in the near future, and **the Russians certainly have the resources at this point" to continue to push into the region**, said Chandler.¶ A Resurgent Russia¶ While Russia’s Arctic bellicosity has been on the rise, commanders in the region say the moves have to be kept in perspective.

#### Arctic conflict causes nuclear war

Wallace & Staples 10 – Michael Wallace is Professor Emeritus at the University of British Columbia; Steven Staples is President of the Rideau Institute in Ottawa, March 2010, “Ridding the Arctic of Nuclear Weapons A Task Long Overdue”, http://www.arcticsecurity.org/docs/arctic-nuclear-report-web.pdf

The fact is, the Arctic is becoming a zone of increased military competition. Russian President Medvedev has announced the creation of a special military force to defend Arctic claims. Last year Russian General Vladimir Shamanov declared that Russian troops would step up training for Arctic combat, and that Russia’s submarine fleet would increase its “operational radius.” Recently, two Russian attack submarines were spotted off the U.S. east coast for the first time in 15 years. ¶ In January 2009, on the eve of Obama’s inauguration, President Bush issued a National Security Presidential Directive on Arctic Regional Policy. It affirmed as a priority the preservation of U.S. military vessel and aircraft mobility and transit throughout the Arctic, including the Northwest Passage, and foresaw greater capabilities to protect U.S. borders in the Arctic. ¶ The Bush administration’s disastrous eight years in office, particularly its decision to withdraw from the ABM treaty and deploy missile defence interceptors and a radar station in Eastern Europe, have greatly contributed to the instability we are seeing today, even though the Obama administration has scaled back the planned deployments. **The Arctic has figured in this renewed interest in Cold War weapons systems**, particularly the upgrading of the Thule Ballistic Missile Early Warning System radar in Northern Greenland for ballistic missile defence. ¶ **The Canadian government, as well, has put forward new military capabilities to protect Canadian sovereignty claims in the Arctic**, including proposed ice-capable ships, a northern military training base and a deep-water port. Earlier this year Denmark released an all-party defence position paper that suggests the country should create a dedicated Arctic military contingent that draws on army, navy and air force assets with shipbased helicopters able to drop troops anywhere. Danish fighter planes would be tasked to patrol Greenlandic airspace. ¶ Last year Norway chose to buy 48 Lockheed Martin F-35 fighter jets, partly because of their suitability for Arctic patrols. In March, that country held a major Arctic military practice involving 7,000 soldiers from 13 countries in which a fictional country called Northland seized offshore oil rigs. ¶ The manoeuvres prompted a protest from Russia – which objected again in June after Sweden held its largest northern military exercise since the end of the Second World War. About **12,000 troops, 50 aircraft and several warships were involved**. ¶ Jayantha Dhanapala, President of Pugwash and former UN under-secretary for disarmament affairs, summarized the situation bluntly: “From those in the international peace and security sector, deep concerns are being expressed over the fact that two nuclear weapon states – the United States and the Russian Federation, which together own 95 per cent of the nuclear weapons in the world – converge on the Arctic and have competing claims. These claims, together with those of other allied NATO countries – Canada, Denmark, Iceland, and Norway – could, if unresolved, lead to conflict escalating into the threat or use of nuclear weapons.” Many will no doubt argue that this is excessively alarmist, but **no circumstance in which nuclear powers find themselves in military confrontation can be taken lightly.** ¶ The current geo-political threat level is nebulous and low – for now, according to Rob Huebert of the University of Calgary, “[**the] issue is the uncertainty** as Arctic states and non-Arctic states begin to recognize the geo-political/economic significance of the Arctic because of climate change.”

#### Airpower prevents nuclear war and bioweapons in Asia

Khalilzad & Lesser 98 – Zalmay Khalilzad, Counselor at CSIS, President of Khalilzad Associates, and Former US Ambassador to the UN AND\*\*\* Ian Lesser, PhD Senior Transatlantic Fellow @ the German Marshall Fund, 1998, "Sources of Conflict in the 21st Century," p.164-165

The first key implication derived from the analysis of trends in Asia suggests that American air and space power will continue to remain critical for conventional and unconventional deterrence in Asia. This argument is justified by the fact that several sub-regions of the continent still harbor the potential for **full-scale** conventional war. This potential is most conspicuously on the Korean peninsula and to a lesser degree, in South Asia, the Persian Gulf, and the South China Sea. In some of these areas such as Korea and the Persian Gulf, the United States has clear treaty obligations and therefore has pre-planned the use of air power should contingencies arise. U.S. Air Force assets could also be called upon for operations in some of these other areas. In almost all these cases, US **airpower would be at the forefront of an American** politico-military **response** because (a) of the vast distances on the Asian continent; (b) the diverse range of operational platforms available to the U.S. Air Force, a capability unmatched by any other country or service, (c) the possible unavailability of naval assets in close proximity, particularly in the context of surprise contingencies; and (d) the heavy payload that can be carried by U.S. Air Force platforms. These platforms can exploit speed, reach, and high operating tempos to sustain continual operations until the political objectives are secured. The entire range of warfighting capability—fighters, bombers, electronic warfare (EW), suppression of enemy air defense (SEAD), combat support platforms such as AWACS and J-STARS and tankers—are relevant in the Asia-Pacific region, because many of the regional contingencies will involve large, fairly modern, conventional forces, most of which are built around large land armies, as is the case in Korea, China-Taiwan, India-Pakistan and the Persian Gulf. In addition to conventional combat, the demands of unconventional deterrence will increasingly confront the U.S. Air Force in Asia. The Korean peninsula, China, and the Indian subcontinent are already arenas of WMD proliferation. While emergent nuclear capabilities continue to receive the most public attention, chemical and biological warfare threats will progressively become future problems. The delivery systems in the region are increasing in range and diversity. China already targets the continental United States with ballistic missiles. North Korea can threaten northeast Asia with existing Scud-class theater ballistic missiles. India will acquire the capability to produce ICBM-class delivery vehicles, and both China and India will acquire long-range cruise missiles during the time frames examined in this report. The second key implication derived from the analysis of trends in Asia suggests that airand space power **will function as a** vital rapid reaction force **in a breaking crisis**. Current guidance tasks the Air Force to prepare for two major regional conflicts that could break out in the Persian Gulf and on the Korean peninsula. In other areas of Asia, however, such as the Indian subcontinent, the South China Sea, Southeast Asia, and Myanmar, the United States has no treaty obligations requiring it to commit the use of its military forces. But as past experience has shown, American policymakers have regularly displayed the disconcerting habit of discovering strategic interests in parts of the world previously neglected after conflicts have already broken out. Mindful of this trend, it would behoove U.S. Air Force planners to prudently plan for regional contingencies in nontraditional areas of interest, because naval and air power will of necessity be the primary instruments constituting the American response.

#### Bioweapons cause extinction

Ochs 2 – Richard Ochs, former president of the Aberdeen Proving Ground Superfund Citizens Coalition, Member of the Depleted Uranium Task force of the Military Toxics Project, and M of the Chemical Weapons Working Group, June 9, 2002, “Biological Weapons Must Be Abolished Immediately,” <http://www.freefromterror.net/other_articles/abolish.html>

Of all the weapons of mass destruction, the genetically engineered biological weapons, many without a known cure or vaccine, are an extreme danger to the continued survival of life on earth. Any perceived military value or deterrence pales in comparison to the great risk these weapons pose just sitting in vials in laboratories. While a “nuclear winter,” resulting from a massive exchange of nuclear weapons, could also kill off most of life on earth and severely compromise the health of future generations, they are easier to control. Biological weapons, on the other hand, can get out of control very easily, as the recent anthrax attacks has demonstrated. There is no way to guarantee the security of these doomsday weapons because very tiny amounts can be stolen or accidentally released and then grow or be grown to horrendous proportions. The Black Death of the Middle Ages would be small in comparison to the potential damage bioweapons could cause. Abolition of chemical weapons is less of a priority because, while they can also kill millions of people outright, their persistence in the environment would be less than nuclear or biological agents or more localized. Hence, chemical weapons would have a lesser effect on future generations of innocent people and the natural environment. Like the Holocaust, once a localized chemical extermination is over, it is over. With nuclear and biological weapons, the killing will probably never end. Radioactive elements last tens of thousands of years and will keep causing cancers virtually forever. Potentially worse than that, bio-engineered agents by the hundreds with no known cure could wreck even greater calamity on the human race than could persistent radiation. AIDS and ebola viruses are just a small example of recently emerging plagues with no known cure or vaccine. Can we imagine hundreds of such plagues? HUMAN EXTINCTION IS NOW POSSIBLE. Ironically, the Bush administration has just changed the U.S. nuclear doctrine to allow nuclear retaliation against threats upon allies by conventional weapons. The past doctrine allowed such use only as a last resort when our nation’s survival was at stake. Will the new policy also allow easier use of US bioweapons? How slippery is this slope?

## Plan

#### The Department of Defense should acquire electricity from space solar power for energy production in the United States.

## Contention Three is Solvency

#### The DOD is interested in SPS – procurement rapidly accelerates commercial development

Lemonick 9 – Michael D. Lemonick is the senior writer at Climate Central, a nonpartisan organization whose mission is to communicate climate science to the public. Prior to joining Climate Central, he was a senior writer at Time magazine, where he covered science and the environment for more than 20 years. He has also written four books on astronomical topics and has taught science journalism at Princeton University for the past decade. August 31st, 2009, "Solar Power from Space: Moving Beyond Science Fiction" e360.yale.edu/feature/solar\_power\_from\_space\_moving\_beyond\_science\_fiction/2184/

But the military’s interest in SBSP could give a major boost to the technology. According to Marine Corps Lt. Col. Paul Damphousse, Chief of Advanced Concepts for the National Security Space Office, the military is interested in SBSP for two main reasons.¶ The first, he said, is that “we’re **obviously interested in energy security**, and we’re also **interested in weaning ourselves off fossil fuels** because climate change could pose national security risks.” By being an early customer, the government can rapidly accelerate development of the technology. But there would also be a **tactical advantage to space-based solar**, Damphousse noted. When the military is operating in remote regions of countries like Iraq or Afghanistan, it uses diesel generators to supply forward bases with power.¶ “We have a significant footprint getting energy in,” says Damphousse, noting the need for frequent convoys of oil tankers, the soldiers to protect them, and air support — all of which is expensive and dangerous.¶ **Being able to tap into power beamed directly down from space would clearly have a lot of appea**l, says Damphousse, even if it were relatively costly. And **it’s not just useful for the battlefield, he says, but also for areas affected by natural disasters**, such as Hurricane Katrina.¶ For those reasons, Damphousse supports the idea of coordinated studies by the Pentagon and other agencies — such as NASA and the Department of Energy — that would have a stake in space-based power.

#### Procurement makes SPS economically feasible and catalyzes investment

NSSO 7 – National Security Space Office, Report to the Director, October 10, 2007, “Space-Based Solar Power As an Opportunity for Strategic Security; Phase 0 Architecture Feasibility Study” http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf

FINDING:The SBSP Study Group found that industry has stated that the #1 driver and requirement for generating industry interest and investment in developing the initial operational SBSP systems is acquiring an anchor tenant customer, or customers, that are willing to sign contracts for high‐value SBSP services. Industry is particularly interested in the possibility that the DoD might be willing to pay for SBSP services delivered to the warfighter in forward bases in amounts of 5‐50 MWe continuous, **at a price of $1** or more per kilowatt‐hour. o Recommendation: The SBSP Study Group recommends that the DoD should immediately conduct a requirements analysis of underlying long‐term DoD demand for secure, reliable, and mobile energy delivery to the war‐fighter, what the DoD might be willing to pay for a SBSP service delivered to the warfighter and under what terms and conditions, and evaluate the appropriateness and effectiveness of various approaches to signing up as an anchor tenant customer of a commercially‐delivered service, such as the NextView acquisition approach pioneered by the National GeoSpatial‐imaging Agency. FINDING: The SBSP Study Group found that even with the DoD as an anchor tenant customer at a price of $1‐2 per kilowatt hour for 5‐50 megawatts continuous power for the warfighter, when considering the risks of implementing a new unproven space technology and other major business risks, the business case for SBSP still does not appear to close in 2007 with current capabilities (primarily launch costs). This study did not have the resources to adequately assess the economic viability of SBSP given current or projected capabilities, and this must be part of any future agenda to further develop this concept. Past investigations of the SBSP concept have indicated that the costs are dominated by costs of installation, which depend on the cost of launch (dollars per kilogram) and assembly and on how light the components can be made (kilograms per kilowatt). Existing launch infrastructure cannot close the business case, and any assessment made based upon new launch vehicles and formats are speculative. Greater clarity and resolution is required to set proper targets for technology development and private capital engagement. Ideally SBSP would want to be cost‐competitive with other baseload suppliers in developing markets which cannot afford to spend a huge portion of their GDP on energy (4c/kWh), and these requirements are extremely stringent, but other niche export markets may provide more relaxed criteria (35c/kWh), and **some customers, such as DoD, appear to be** spend**ing more than $1/kWh in forward deployed locations**. It would be helpful to develop a series of curves which examine technology targets for various markets, in addition to the sensitivities and opportunities for development. Some work by the European Space Agency (ESA) has suggested that in an “apples‐to‐apples” comparison, **SBSP may already be competitive with large‐scale terrestrial solar baseload power**. A great range of opinions were expressed during the study regarding the near‐term profitability. It is instructive to note that that there are American companies that have or are actively marketed SBSP at home and abroad, while another group feels the technology is sufficiently mature to create a dedicated public‐private partnership based upon the COMSAT model and has authored draft legislation to that effect. • **The business case is much more likely to close in the near future if the U.S. Government agrees to: o** Sign up as an anchor tenant customer, and o Make appropriate technology investment and risk‐reduction efforts by the U.S. Government, and o Provide appropriate financial incentives to the SBSP industry that are similar to the significant incentives that Federal and State Governments are providing for private industry investments in other clean and renewable power sources. • The business case may close in the near future with appropriate technology investment and risk‐reduction efforts by the U.S. Government, and with appropriate financial incentives to industry. Federal and State Governments are providing significant financial incentives for private industry investments in other clean and renewable power sources. o Recommendation: The SBSP Study Group recommends that in order to reduce risk and to promote development of SBSP, the U.S. Government should increase and accelerate its investments in the development and demonstration of key component, subsystem, and system level technologies that will be required for the creation of operational and scalable SBSP systems. Finding: The SBSP Study Group found that **a small amount of entry capital by the US Government is likely to** catalyze substantially more investment by the private sector**.** This opinion was expressed many times over from energy and aerospace companies alike. Indeed, there is anecdotal evidence that even the activity of this intermim study has already provoked significant activity by at least three major aerospace companies. Should the United States put some dollars in for a study or demonstration, it is likely to catalyze significant amounts of internal research and development. Study leaders likewise heard that the DoD could have a catalytic role by sponsoring prizes or signaling its willingness to become the anchor customer for the product.

#### **SPS-Alpha can be up and running in a few years with only a few billion dollars – new tech ensures feasibility and low costs**

Mankins 12 – John C. Mankins, President of Artemis Innovation Management Solutions LLC is an internationally recognized leader in space systems and technology innovation, spent 25 years at NASA and CalTech's Jet Propulsion Laboratory. He holds undergraduate (Harvey Mudd College) and graduate (UCLA) degrees in Physics and an MBA in Public Policy Analysis (The Drucker School at Claremont Graduate University). Mr. Mankins is a member of the International Academy of Astronautics (IAA) and Chair of the Academy Commission III (Space Systems and Technology Development); and a member of the International Astronautical Federation (IAF), the American Institute of Aeronautics and Astronautics (AIAA), and the Sigma Xi Research Society. Editor/Authors are :Brian Wang, Director of Research. Sander Olson, Interviews and other articles Phil Wolff, Communications and social technologist. Alvin Wang. Computer, technology, social networking, and social media expert. June 7th, 2012, "A New Paradigm for Space-Based Solar Power," nextbigfuture.com/2012/06/new-paradigm-for-space-based-solar.html

Question: How exactly has the technology evolved since the 1970s? ¶ There have been a number of improvements. The **efficiency of solar photovoltaics has improved** from less than 10% efficiency to more than 30% efficiency now. I'm confident that within the next decade, solar photovoltaics could achieve efficiencies of up to 50%. There have also been **substantial improvements in key electronic components**, such as solid-state power amplifiers. The efficiencies have gone from 15% in the 1970s to **70% now**. With focused investments, we should be able to get devices with efficiencies approaching 80% by 2020. This will further increase the viability of space-based solar power. A wide range of other technologies have also improved dramatically, including **light-weight and high-strength materials, robotics, in-space propulsion and others.** ¶ Question: You are the chief architect behind the SPS-ALPHA design. What are the central aspects of this new paradigm? ¶ The SPS-ALPHA concept facilitates the design and development of a very large solar power satellite out of a large number of very small pieces. Each piece weighs perhaps 25-100 kilograms, but there are tens of thousands of pieces in the final product. **The beauty of this system is that all of the parts of the design can be manufactured readily in a standard factory – resulting in very low costs for the system hardware.** ¶ Question: So the power satellite would be composed of vast numbers of identical modules? ¶ Yes, the modules would be stackable – like pizza boxes – for ease of transportation to space, and then unstacked and assembled once they reach the operational orbit for the satellite. There might be about 6 or 8 different types of modular elements, and each type would be mass produced with from hundreds to tens of thousands of copies. They would initially be launched into a low Earth orbit, and from there transferred to a higher orbit for integration into the SPS platform. We are looking at using robotic systems to assemble the panels. ¶ Question: So your plan employs robots for most of the construction? ¶ Yes. The SPS-ALPHA architecture would only employ people on the ground to supervise the robots operating in space. The goal would be to assume the intervention of astronauts only in the event of a problem that could not be resolved using robots. As a rule of thumb, we expect that it may cost from 100-times to 1000-times more to have a suited astronaut perform a task in a high Earth orbit than to have a remotely-supervised robot do it. This field of technology has advanced rapidly in the past decade, and so we plan to employ robots extensively. ¶ Question: How long would it take to get a prototype system up and running? ¶ With sufficient funding, we could have a ground based, rudimentary prototype up and running by 2014. **An early prototype in orbit could be** built by 2017-2018. And in about a decade, a larger pilot plant could be in geosynchronous Earth orbit, generating 10 megawatts. The total cost for this roadmap could be several billion dollars, with most of the cost coming in the last few years. As a point of comparison, the pilot plant would be approximately the same size as the International Space Station, which cost $100 billion to manufacture, launch into space and assemble. **The cost savings would result from using standard, mass-produced pieces, standard launch systems and robotic assembly in space.**

#### Recent studies prove that SPS tech exists now – terrestrial solar fails

Garretson 12 – Lt Col Peter Garretson is an airpower strategist currently serving on the CSAF’s Strategic Studies Group (HAF/CK). His previous assignment was at the Institute for Defence Studies and Analyses in New Delhi as an Air Force Fellow examining Indo–US long-term space collaboration under the sponsorship of the Council on Foreign Relations. Prior to that he was the chief of future science and technology exploration for the HQ USAF Directorate of Strategic Planning (AF/A8XC), Spring 2012, "Solar Power in Space?" Strategic Studies Quarterly Spring, <http://www.au.af.mil/au/ssq/2012/spring/garretson.pdf>

As of 2010, the fundamental research to achieve technical feasibility for the SPS [solar-power satellites] was already accomplished. Whether it requires 5–10 years or 20–30 years to mature the technologies for economically viable SPS now depends more on the development of appropriate platform systems concepts and the availability of adequate budgets. —International Academy of Astronautics (IAA), 2011 The world needs a constant supply of uninterrupted electrical power to enable and sustain economic growth; power its cities, factories, and vehicles; and provide energy for heating, cooling, lighting, cooking, and desalination. Long term, it is desirable to transition from an energy system based on fossil fuels—an exhaustible resource which alters the composition of our atmosphere with unknown long-term effects on our climate— to a system based upon renewable sources. Many see solar power as the answer, because the resource is so vast and available. However, traditional solar power has limitations that make it less than a perfect match for our society. It is highly intermittent (only a 20-percent duty cycle) due to weather effects (clouds, rain, dust), and its low density requires vast tracks of land. Worst of all, it is not available at night, requiring vast storage or nonrenewable backup systems. Space-based solar is an innovation designed to retain[s] the advantages of traditional solar power while sidestepping the disadvantages. The basics of the idea are quite simple. Rather than cope with the unpredictability and intermittency of solar power on the ground, go where the sun always shines. In geostationary orbit (GEO), the sun shines constantly and is 36 percent stronger, allowing a solar array to collect almost 10 times the amount of energy as the same array installed at mid latitude on the ground (see fig.1). Power can then be transferred (beamed) directly to where it is needed. The technologies to do this are not magic or unfamiliar—they are the same elements used every day to emplace, power, and communicate with every existing satellite. Building the SBSP system would rely on the same familiar solar cells, radio transceivers, and rockets to propel them to GEO, only assembled on a grand different scale. In a mature system-of-systems, multiple solar-power satellites would reside in geostationary orbit, each collecting vast amounts of power and transmitting it through active electronic beam steering, like routers in a vast orbiting power internet. While appearing to hover above a particular location, each SPS could service multiple markets, providing power on demand to urban centers or remote locations. For example, a single satellite south of Baja California could service markets across most of North and South America; a satellite over the Indian Ocean could service markets as far apart as Africa and Indonesia, and from Diego Garcia to as far north as Russia. 1 Power in this system-of-systems would be transmitted using a technique called retrodirective phased array, where an encrypted pilot signal from the ground handshakes with the satellite’s active electronic beam-steering system to link transmitter and receiver. The beam itself would be in the ISM band (typically 2.45 or 5.8 GHz), so that it passes nearly full strength through the atmosphere, clouds, and rain. Because of low atmospheric losses (<2 percent), extremely efficient reconversion (>80 percent), and most of all, constant illumination, the beam can be safely kept at an amazingly low intensity (only one-sixth the intensity of sunlight) and yet be significantly more energy productive than a comparably sized terrestrial solar plant. The location and diameter of the beam are predictable and well confined. Unlike communications satellites—which, because of their small-aperture antennas, cast continent-sized footprints and must be separated by degrees (and thousands of miles) on orbit to deconflict signals—SPSs have very large apertures and therefore can send very narrow beams, allowing them to be spaced much closer together. The beam itself terminates on a receiver called a rectenna, with peak intensity in its center and tapering to nearly nothing at the periphery. The rectenna, about the size of a municipal airport, is a mesh of dipole antennas that capture all the incident energy from the beam. It is nevertheless 80 percent transparent to sunlight, allowing the land beneath to remain available for agricultural uses.

#### SPS is resilient, cost-effective, and efficient

Reed & Willenberg 4 – Head of the Welsom Space Consortium, and Harvey, PhD, Independent Review Team Leader for Space Power Research for NASA, Former Chief Scientist of the ISS (Kevin and Harvey, , "Early commercial demonstration of space solar power using ultra-lightweight arrays,” Acta Astronautica, Volume 65, Issues 9-10, accessed on Science Direct)

Future systems will be even more sensitive to specific power. A number of conceptual design architecture studies have been performed that offer promise for terrestrial electrical power generation by [SSP] space solar power, i.e. a constellation of large Earth-orbiting spacecraft that collect solar power, convert it to laser or microwave beams, and beam that power to terrestrial collectors that, in turn, convert that power to electricity.[1-3] To make this concept economically attractive, they must compete with current large power plants by economically generating Gigawatts (GW) of power. At 100 W/kg, such a power station must weigh 2-5 ∙ 107 kg or more – a tall order for launch vehicles that currently place no more than 2-3 ∙ 103 kg into geosynchronous orbit. Recent technology advances in the area of thin film photovoltaic arrays offer a solution to the mass limitations of high power arrays. Thin film arrays, while the efficiency is only around 9-12%, are so lightweight that they offer specific powers in excess of 1,000 W/kg - a factor of ten or more above the current state of the art. Since these arrays are deployable, they can be packaged with minimum mass and volume, and readily deployed in space with **near-term demonstrable technologies**. This section provides an introduction to this possibility. The next section will discuss the specific advantages of lightweight arrays. Section 3 will describe near-term applications in the 50-500 kWe power range, both in space and in the high altitude atmosphere, as well as future directions for space power satellites and high-power electric thrusters. Section 4 discusses recent and ongoing plans for prototype testing of thin-film arrays in civil and military applications as well as commercial "NewSpace" applications. In Section 5, we discuss some key process steps required for commercial development of space solar power and wireless power transmission, with specific focus on the development pathway for these solar arrays. A development Roadmap is described in Section 6. A short summary is presented in Section 7, followed by references. 2. ADVANTAGES OF ULTRALIGHTWEIGHT ARRAYS Since the beginning of Earth-orbiting satellites, solar array technology has gone through two or three generations, and is on the verge of a new generation. Most early satellites were powered with crystalline silicon arrays, with power levels generally below about 6 kilowatts (kWe). These silicon arrays were heavy and operated at low efficiency, i.e. the amount of power produced per unit area of solar array started around 10-12% at beginning of life. These crystalline silicon arrays also degraded rapidly, dropping to 8-10% efficiencies after several years in space, as a result of radiation-induced degradation of the photovoltaic silicon and atomic oxygen-induced discoloration of the cover glass which protects the silicon from these environmental factors. In the 1990s, the technology for many, if not most, satellite solar arrays converted from these original silicon arrays to compound semiconductors, which generally used gallium arsenide plus a second or third semiconductor to capture a greater share of the solar spectrum and convert it to electricity. These compound dual-junction and triple-junction semiconductors are much more resistant to radiation and more efficient, with efficiencies of 20-24%. More recently, the ability to separate different wavelengths of the solar spectrum and tailor the incident light onto a stretched lens of selected semiconductors (separating red, yellow, green, and blue wavelengths) has shown indications of efficiencies as high as 40-50%.[4-5] Yet even at this nearly theoretical limit of efficiency, the power density level will reach only 300 W/kg. Until recently, the focus of most solar array technology development has been toward more efficient, more radiation-resistant arrays. This focus has been driven primarily by the challenge of deployment of large arrays. This challenge has limited the total array area that can be launched into space, and therefore the way to higher power arrays has been higher efficiencies. These rigid, higher efficiency solar arrays come at the cost, however, of relatively high mass - with the best rigid arrays able to produce about 80-100 Watts per kilogram (W/kg) at 30% efficiency, and the stretched lens arrays promising about 150 W/kg but limited to a total of around 10 kW by deployment considerations. Two dominant performance metrics in the selection of solar array technologies are this power/mass ratio (i.e. the amount of power that can be produced for each kilogram of total mass) and the volume of the stowed array as it is launched. These are important because of the mass and volume limitations on the launch vehicle that places the array into space, and the high cost of launching this limited mass and volume. Using launch vehicles available today, these limit the total power available to satellites in geostationary orbit to about 18 kWe. Higher powers will be highly desirable as the user demands for communications services continue to increase. Recent advances in the ability to place photovoltaic materials on very thin film substrates have produced a new generation of solar arrays. These advances allow arrays to be stowed in the launch vehicle in very compact configurations, and easily deployed to much larger arrays than have heretofore been achievable. These new, thin film arrays are much lighter - around 1200 W/kg, including the deployment systems. Laboratory test cells have been produced by Institut de Microtechnique at the University of Neuchatel, Switzerland using LaRCTM-CP1 thin-film substrates produced by SRS Technologies in Huntsville, AL that have the highest power/mass ratio on record - 4300 W/kg![6] These thin film arrays can be stowed in a rolled or folded configuration in the launch vehicle and deployed in space by simple boom extension or roller mechanisms. A well-designed 50 kW space solar array and deployment system using rolled mechanisms with this specific power would weigh 32 kg with a payload volume the size of a suitcase. This low mass and payload volume, combined with high power density, can provide 50 kW+ space solar arrays at 25% of the cost of current rigid solar arrays. There are two approaches to thin film arrays: amorphous silicon (a-Si:H) and polycrystalline Cu(Ga,In)Se2 (CIGS). The Neuchatel partners have developed an array configuration that deposits amorphous silicon on SRS 6 µm-thick CP1TM polymer films, referred to as CP1/a-Si:H arrays. CIGS cells are generally deposited on 30 µm-thick metal foil substrates, a fact that assures that CIGS cells will be heavier than CP1/a-Si:H cells. Some basic comparisons between these solar arrays are summarized in Table 1. Using deployable thin-film arrays with specific powers in excess of 1,000 W/kg opens opportunities for large power levels in space. With current launch vehicles, this means that communications satellites can have 200 kWe or more in geosynchronous orbit, or that commercial platforms such as manufacturing sites or tourist destinations, can approach a MWe. With such possibilities, **this technology might drive the economics of [SSP] space solar power satellites into the profitable arena**, thereby contributing greatly to a non-petroleum-based worldwide electrical power grid. 3. APPLICATIONS Deployable thin-film arrays would have immediate applications with communications satellites and with high altitude aircraft. A 60 kWe array which can be rolled out in 20 kWe segments would greatly extend the useful lifetime of communications satellites – essentially tripling the array lifetime by rolling out 20 kWe of beginning-of-life (BOL) arrays at the end of the array's useful lifetime. An alternative application would be for much higher-power communications satellites, from 50 to 200 kWe, for higher data rates or power. A unique application may also be realized for recharging mobile batteries. Such an orbiting power platform may provide a source of electrical power for very distributed demands, such as for cellular phones and laptop computers. A 200 kWe solar array would have a mass of less than 200 kg. This would make a thin-film array attractive for still higher-power commercial applications, such as orbiting hotels – with expected demands in the 250 kWe to 1 MWe – and manufacturing sites. The latter would be either for sites for in-space construction of larger platforms, or for processing of materials in the microgravity environment of space. As the technology matures to the megawatt range, additional applications appear promising. For example, electric thrusters in the megawatt range would be attractive for human transportation to Mars and its moons. This technology can be developed in stages, perhaps using high altitude airships as platforms to demonstrate megawatt arrays. As the technology for high power thin film arrays matures, the logical next step would be solar power satellites. With a launch vehicle capable of placing 50,000 kg to geosynchronous orbit, 50 MWe platforms can be considered as building blocks for the GWe stations that would be required to provide a primary source of power for the electrical power grid. 4. DEVELOPMENT OF ULTRALIGHTWEIGHT ARRAYS Recent advances in the ability to place photovoltaic materials on very thin film substrates have produced a new generation of solar arrays. These advances allow arrays to be stowed in the launch vehicle in very compact configurations and easily deployed to much larger arrays than have heretofore been achievable. These new, thin film arrays are much lighter - around 1200 W/kg, including the deployment systems. Problematic to most thin-film solar arrays are radiation and atomic oxygen erosion. Test solar cells are made on CP1TM polyimide that is space-rated for 10 years in Geosynchronous Earth Orbit ( GEO), or SRS CORIN which is the only transparent uncoated commercial polyimide that will not erode in LEO. These flexible, 6 micron thick, thin film arrays, can be rolled or folded into a very low stowed volume in the launch vehicle configuration, and then deployed in space by simple boom extension or roller mechanisms. Such a typical 50 kW space solar array and deployment system would weigh 32 kg with a payload volume the size of a suitcase. This low mass and payload volume, combined with high power density, can provide 50 kW+ space solar arrays at 25% of the cost of current rigid solar arrays. The key technologies are ultra-thin, deployable arrays that generate power at acceptable efficiencies with high power density, and are resistant to atomic oxygen and radiation in the operational space environment.

#### SPS is key to air power – perception of federal pursuit solves

Garretson 12 – Lt Col Peter Garretson is an airpower strategist currently serving on the CSAF’s Strategic Studies Group (HAF/CK). His previous assignment was at the Institute for Defence Studies and Analyses in New Delhi as an Air Force Fellow examining Indo–US long-term space collaboration under the sponsorship of the Council on Foreign Relations. Prior to that he was the chief of future science and technology exploration for the HQ USAF Directorate of Strategic Planning (AF/A8XC), Spring 2012, "Solar Power in Space?" Strategic Studies Quarterly Spring, <http://www.au.af.mil/au/ssq/2012/spring/garretson.pdf>

But so far at least, the reaction seems more consistent with the worry expressed by Friedman that the United States, as compared to China, had lost its “can-do” spirit in the early twenty-first century.29 Airmen, as stewards of America’s aerospace power, should not be so complacent. Understanding the critical link between dual-use infrastructure that contributes to access and on-orbit capabilities, an Air Force strategist might then take a much less complacent view of international competition. There are no battles in this strategy; each side is merely trying to outdo in performance the equipment of the other. . . . Its tactics are industrial, technical, and financial. . . . A silent and apparently peaceful war is therefore in progress, but it could well be a war which of itself could be decisive. —General d’Armee Andre Beaufre For years **the Air Force has kept the** United States **out of** a **major war and kept the world from another** global conflict **by maintaining technological preeminence** and overmatch, practicing what a Cold War textbook called a “Strategy of Technology”: The Technological War is the decisive struggle in the Protracted Conflict. Victory in the Technological War **gives supremacy in all other phases of the conflict**. . . . The Technological War creates the resources to be employed in all other parts of the Protracted Conflict. It governs the range of strategies that can be adapted in actual or hot war. . . . Military superiority or even supremacy is not permanent, and never ends the conflict unless it is used. The United States considers the Technological War as an infinite game: one which is not played out to a decisive victory. We are committed to a grand strategy of defense, and will never employ a decisive advantage to end the conflict by destroying our enemies. Consequently, we must maintain not only military superiority but [also] technological supremacy. The race is an alternative to destructive war, not the cause of military conflict. . . . The United States is dedicated to a strategy of stability. We are a stabilizing rather than a disturbing power, and our goal is preserving the status quo and the balance of power rather than seeking conquest and the final solution to the problems of international conflict through occupation or extermination of all opponents. In a word, the U.S. sees the Technological War as an infinite game, one played for the sake of continuing to play, rather than for the sake of “victory” in the narrow sense. 30 That is not to imply that Airmen should recommend a zero-sum orientation toward SBSP competition, only that America should get its head in this game. Because it is the policy of the United States to pursue international cooperation in space and take the lead in multilateral efforts which enhance stability and transparency in space, Airmen must consider not only the threat of losing an important technical competition but also the opportunity international cooperation could provide to advance US interests through partnerships in the domains under their stewardship. Aerospace competition is not only technical; it also has an aspirational moral dimension, as nations are measured, admired, and respected not only by their accomplishments but also by their ambitions. Former USAF strategist Col John Boyd made clear the strategic value of vision: “What is needed is a vision rooted in human nature so noble, so attractive that it not only **attracts the uncommitted and magnifies** the spirit and **strength of** its **adherents, but also undermines** the dedication and **determination of any** competitors and **adversaries.**” 31