***Logbook***

Name: Tvara Parikh

Topic: Geo-engineering

Feb 1:

**Time table:**

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| --- | --- |
| Date | What should be done |
| Feb 2-Feb 7 | Understanding the basics of geoengineering, find some sources, making a list of topics I need to further research |
| Feb 8- March 8 | Research the topics, through a variety of different resources. Copies paste all the information that might help me and then later I will change it later. |
| March 8-March 14 | Make a Skelton for the research, turn all the notes into a research paper, make a video, and finishing all the other categories |
| March 15- March 19  | Finishing touches. |

**A brief description of the project:**

My project: I wish to analyze the effects of geoengineering on climate change.

The proposed project will be divided into four parts.

1. Problems and contradictions in climate change-related to geoengineering
2. Geoengineering methods and the effects of implementing them in the real world
3. Ethics of geoengineering in terms of climate change
4. Sustainable methods in geoengineering

I was inclined to pursue this project because our situation regarding global warming is worse than ever, and the discussions, meetings and treaties signing has done nothing to stop it. Data collected by scientists has shown that geoengineering can contradict climate change with minimal side effects. Making it a very useful resource.  Therefore humans will be left with no choice but to turn to geoengineering, and when we do, we all should be aware and educated on the topic.

**Problem:**

How can geoengineering affect climate change?

**Hypothesis/Predicted Outcome:**

Geoengineering is a very effective method, and if it is used correctly according to scientists' suggestion, there will be very minimal, controllable side effects if there are any at all. In *Geoengineering the climate*: *History and prospect* states that two geoengineers Govindasamy & Caldeira, tested the effects of albedo geoengineering using a high-quality model known to do a good job of simulating the global radiative balance. Both the models had two times the carbon dioxide, but one also had a uniform modification of planetary albedo accomplished using scattering systems. Comparing the two models, they concluded that the Geoengineering model's temperature rose only 15% compared to 97% for the other  model. Contrary to expectations, there was very little change in the diurnal and seasonal cycles' amplitude in the geoengineering case. Other techniques such as sulphur injection in the stratosphere to increase the albedo (which had two main problems: hurting the ozone layer and the whitening of the sky) have been rethought and improved. Scientists Teller et al, suggest adding alumina particles could minimize the impact on ozone chemistry. This technique also decreases the mass needed to be sprayed. Two configurations of metallic scatterers were analyzed: mesh microstructures and micro-balloons, and both of these techniques work very effectively. Techniques, experiments and data like these prove that geoengineering is a sustainable and reliable method.

**Materials required**:

* Journal articles
* Textbooks
* Report
* Interview with a geoengineer to understand the current methods and practices used in geoengineering
* Interview with a climate change specialist to understand what preventative measures are being taken towards the issue of climate change

**Background research:**

Feb 2

Today I read a report called Geoengineering the climate: History and Prospect

Notes:

* The possibility of using geoengineering—the deliberate manipulation of the planetary environment—to counteract anthropogenic climate change is deeply controversial.
* The evolving status of geoengineering as a response to anthropogenic climate change is examined through a review of U.S. climate assessments and the IPCC assessment reports.
* In this review, geoengineering is defined as intentional large-scale manipulation of the environment. Scale and intent play central roles in the definition. Second, scale without intent: The modification of global climate owing to increasing atmospheric CO2 has a global effect, yet it is not geoengineering because it is a side effect resulting from the combustion of fossil fuels with the aim of providing energy services.

There was a section on history in the report which I skipped since I knew I dint’ want the history of geoengineering in my research.

* Albedo is the amount of light reflected back into space
* Govindaswamy & Caldeira tested the effects of albedo geoengineering using a high-quality model known to do a good job of simulating the global radiative balance. They compared a control case with two test cases, one with 2 CO2 and the other a «geoengineering» case with 2 CO2 and a reduction of a solar constant by 1.8%. By design, the geoengineering case had the same mean surface temperature as the control. Surprisingly, the spatial pattern of surface temperature showed little change despite the changed vertical and latitudinal distributions of atmospheric heating. As with other geoengineering proposals, deliberate and inadvertent climate modification are closely linked: Anthropogenic sulphate aerosols in the troposphere currently influence the global radiation budget by ∼1 Wm−2 —enough to counter much of the effect of current anthropogenic CO2.
* The addition of aerosol to the stratosphere could have serious impacts, most notably, the depletion of stratospheric ozone. Recent polar ozone depletion has clearly demonstrated the complexity of chemical dynamics in the stratosphere and the resulting susceptibility of ozone concentrations to aerosols. Although the possibility of this side effect has long been noted, no serious analysis has been published.
* 105 t of such mesh structures are required to achieve the benchmark 1% albedo increase. The proposed metal balloons have diameters of 4 mm, are hydrogen-filled, and are designed to float at altitudes of 25 km. The required mass is 106 t. Because of the much longer stratospheric residence time of the balloon system, the mass flux required to sustain the two systems is comparable. Finally, Teller et al show that either system, if fabricated with aluminum, can be designed to have long stratospheric lifetimes, yet oxidize rapidly in the troposphere, ensuring that few particles are deposited on the surface. Proposals to modify the climate using space-based technology reflect an extreme of confidence in human technological prowess.

Feb 4:

The report I read on Feb 2 was a little hard for me to understand since I have no past knowledge, so I started reading another report called Geoengineering for climate stabilization:

Notes:

* ‘Solar radiation management’ or SRM targets an increase in the amount of solar energy radiated back into space, effectively dimming the Sun. The necessary albedo enhancement is envisioned for deserts, oceans, mountains, clouds, and also manmade objects like roofs or roads.
* Carbon Dioxide removal or CDR are techniques to pull out carbon di-oxide form the air

Global Dimming

* Global dimming is an aspect that could be exploited for climate engineering. Monoterpenes from boreal forests were found to contribute to global dimming, apart from being a CO2 sink, so tree planting would be a working biogeoengineering approach. Global dimming, generally, is caused by an increase in particulates such as sulfate aerosols in the atmosphere due to human action.
* The effect of anthropogenic global dimming has interfered with the hydrological cycle by reducing evaporation and so may have reduced rainfall in some areas. Global dimming also creates a cooling effect that may have partially counteracted the effect of greenhouse gases on global warming. Arctic geoengineering focuses geographically on the Arctic, which plays a key role in maintaining current climate due to its albedo and stored methane.

Impacts of Climate Engineering

* The targeted impact of climate engineering is to bring down global air and surface temperatures. Several researchers have run computer models to investigate the effect of blocking part of the solar radiation. Sun would, according to the models, reduce the global temperatures, but also lead to profound changes to precipitation patterns including disrupting the Indian Monsoon. Anthropogenic SO2 in the stratosphere at a level necessary to counteract the radiative forcing of human CO2 and CH4 could cut rainfall in the tropics by 30 % .

The Geoengineering Model Inter comparison Project around Ben Kravitz assesses the projected impacts of geoengineering by different climate models, focusing on SRM. In 2013, 12 climate models simulating quadrupled atmospheric carbon dioxide levels and a corresponding reduction in solar radiation were compared.

Feb 5:

Today I finished reading the report form yesterday:

Moral and Social Issues

* While anthropogenic greenhouse gas emissions are an unwanted side effect, climate engineering constitutes a large-scale, intentional effort to alter the climate. Responsibilities and global political governance are not clear. It is conceivable that different governments have different targets for global temperatures. So actions by one country to alter the climate, motivated by expected local benefits, might result in war.

Carbon Di-oxide removal concepts

* Use of biomass as carbon sinks. Protection of and creation of terrestrial carbon sinks such as grasslands. Enhancement of oceanic uptake of CO2, for example, by fertilization of the oceans with naturally scarce nutrients such as iron or by changing ocean currents. It can be mixed with soil to create terra preta, a carbon sink.
* There are numerous other concepts, such as removing vegetation from the mountain tops or changing the composition of ship and aircraft exhaust. This chemical approach to geoengineering involves land- or ocean-based techniques. Examples of land-based enhanced weathering techniques are in situ carbonation of silicates such as ultramafic rocks. Ocean-based techniques involve alkalinity enhancement of the sea, by grinding, dispersing, and dissolving olivine, limestone, silicates, or calcium hydroxide against ocean acidification and for CO2 sequestration.
* BECS is a hybrid approach in which bioenergy crops are grown and used as fuel, and the CO2 emissions are captured and stored . Biochar and BECS could together contribute a carbon sink of 14 GtC/year by 2100. 100 tC are bound as coarse wood carbon from a typical mid-latitude forest area of 1 km2 in 1 year. However, there is the potential for counterproductive emissions of methane from anaerobic decomposition of the buried wood.

Solar Radiation Management

* The second set of techniques for climate engineering is the SRM category.
* SO2 is known to cause global dimming, as it leads to aerosol formation, and the aerosols reflect sunlight. The mechanism is that SO2 is oxidized to sulfuric acid, which is hygroscopic, has a low vapor pressure, and hence forms aerosols . It was suggested to inject sulfur into the stratosphere as SO2, sulfuric acid, or hydrogen sulfide by artillery, aircraft, and balloons . According to estimates by the Council on Foreign Relations, one kilogram of well placed sulfur in the stratosphere would roughly offset the warming effect of several hundred thousand kilograms of carbon dioxide.
* Space-based concepts aim at transforming the solar constant into a controlled solar variable . Concepts of giant lenses , dust rings, and sunshades to block part of the Sun’s incoming radiation using the effects of reflection, absorption, and diffraction were worked out.
* Dust Clouds of extraterrestrial dust placed in the vicinity of the L1 point are an alternative concept to thin-film reflectors, aiming at significantly reducing the manufacturing efforts.

Conclusion:

* At the present time, the consequences of such measures, and even the magnitude of their very effect, are hard if not impossible to predict, possibly generating huge risks from irreversibly messing up the complex climate system of our Earth for centuries, altering rainfall patterns, and provoking severe military activities, to name but a few possible side effects.
* Yet, climate engineering poses an option to deal with the impending aggravation of climate change, and once scientists know more about the various options, one or the other of them might in fact become a viable support in global climate change mitigation and adaptation measures to bring the anthropogenic impacts back under control.

Feb 9:

I started reading a book called Hacking Planet Earth, today I read the first three chapters:

Chapter one: Thor’s hammer

* Spraying clouds with silver iodide, for example, is a common practice that is used to make it rain artificially. The chemicals are drooped by plane or launched by rockets; then they spread in the clouds, and water binds to them, making the cloud heavier. When the clouds become too heavy, its predicates. The problem is cloud seeding is that it doesn't always work. For example, in 1950, a secret British military cloud seeding operation called Cumulus drenched the English countryside, causing flash floods that killed 35 people. pg13
* Sky river: The Tibetan plateau, sometimes called the world's roof, may become Earth's largest weather testing station. China has placed thousands of burning chambers, which contain solid fuel and realize silver iodine. Rocket technology developed by China has allowed these burning chambers to burn and high altitudes even when the oxygen is thin. The chambers only work when the wind is just right, blowing into the mountains and creating an updraft. The iodine chemicals hitch a ride on that wind current and rise high into clouds. Silver iodide has a similar molecular structure to ice- so similar that ice already formed within a cloud is tricked and bonds to it. When enough particles form they become heavy ad fall as precipitation to Earth.

Chapter 2: A Parasol for the Planet

* Dr.Angel, a professor of astronomy and optical sciences at the University for Arizona started working on a project for spaced based geoengineering. The parasols would be made in space, in free orbiting factories near the Lagrange point. Glass would be delivered from the moon, we invision the constellation as being like a large shoal of fish or flocks of birds, with station keeping control largely by autonomous computer in each unit to prevent collision or self shadowing. A local positioning system like the GPS would be used as well. The shield would three major high tech elements that would likely be manufactured and lunched from the Earth. The first would be the package to enable material production and launch on the moon. This would include the robot, electronics, solar cells, wire, bearings, motors and high temperature ceramic for the lunar manufacturing and for the rail gun to lunch the manufactured items back of the moon. It would also include the pilot facilities on the moon to bootstrap and local manufacture of structural elements used in the full scale lunar operations. Eventually, Angle says, he realized the project had some practical challenges so he developed another nitration own his own. This was would b a “sunshade cloud” of tiny spacecraft. The meter sized flyers would be assembled complete before launch, avoiding any need of construction or unfolding in space, and they would weigh about a gram year. The project would take 25 years, and a few trillion dollars.
* The BBC reported about one idea; to explode hydrogen bombs in space and jolt us far enough away from the sun to cool the planet. Carful analysis shows that wouldn’t work, the earth is too big and traveling to fast for any significant distance to be made by even a million nuclear bombs exploding in space.
* First, engineers would hijack a comet or asteroid and direct it closes enough to earth so that it speeds past but send some of its gravitational energy to us. The asteroid or comet would then be slung to the outer reach for the solar system, where it would pick up more energy and essentially boomerang back toward earth repeating the process. After enough passes earth would move to higher orbit away from the sun.

Chapter 3: Carbon Vampires:

* In theory, the more trees planted the more carbon that is absorbed. Yet even the process is slow. It takes an average tree 40 hears to absorb just one ton of carbon. Remember tens of billions of tons of carbon is realized through human activity just in one year. The amount of land needed would equally three Indians in some estimates. That’s why Klaus Lanker decided to make a different kind of tree. Lanker, It’s a metallic apparatus whose leaf is a carbon capturing membrane, when air passes over the membrane carbon-dioxide is trapped and then funneled away and stored. Normal leaves also work like this, they just store carbon in stem, branches and roots rather than metallic tank. Lanker’s tree send carbon to stainless steel storage tank. Lancker’s tree at a height of about 12 feet looks like a football goal post. Between the upright is the membrane which is designed in accordion like fashion. When the membrane is starched out as a virtual sail, it catches air and the carbon molecules in it. When it contracts it squeeze out the carbon and funneling it into the tank.

Feb 10: I read the next three chapters

Chapter 4: Dessert Reflectors

In April 1958 nosebleed local area and into the atmosphere causing scores of death injury cancer and environmental destruction. The incident disturbed 49-year-old German particle physicists, Gerhard Knies, so much that he began to look for a safer alternative form of energy for which he could ply his trade. Dr. Knies made a calculation that would come to change his life; within six hours the world dessert received more energy from the sun than humankind consumes in a year. That remarkable tidbit of information sent him on a mission to developed dessert energy. It manifested into what he called desertic, a big idea to cover with solar panel every inch of desert area on the planet.

The wind generators look like giants baseball bats standing on their handles. They are forty-one foot cylinders oscillating when the wind blows and generates electricity via an alternator. The technology works off the concept of vortices. Interestingly it is not so much the win itself per se that powers the turbines but the vibration created by the wind’ energy.

Some floating ocean-thermal-energy platform look like man-made octopus pipe float down from the body of the platform where the heat exchanger and other mechanics are housed. Several companies have begun operating ocean thermal plants. The world’s largest plant, developed

Chapter 5: Cools roofs and roads

* We are effectively recovering the surface areas of streets and roofs, says Jonathan Parfrey, who helped pioneer a city wide initiative known as cool roof law. The idea is to recoat black surface, playgrounds, parking lot, alleyways, and roof tops to make them more reflective thereby cooling the temperature. Parfrey is executive director of the LA nonprofit climate resolve, which looks to foster local solutions for climate change in the hopes they will catch on in other cities across the globe.
* Most houses have steep sloped roofs whereas commercial buildings typically have c-surface roofs. In general, a v surface is more presupposed to attract and absorb more heat, but reflectivity all depends on the geography and the angle of the sun. Builder and roof workers have to take all of these in not considerations into account to best cool a roof. And they do. And they are cooling them.
* In the cool city, gardens grow on top of white roof tops. Bicycle glide on grey streets. The air cleaner and cooler, even on a 80 degree day people can enjoy a walk and picnic outside.
* The city with dark roof and black roads, experience intense heat car emitting pollution, people sweltering, inside building, air condition is blasting in the building that have it. Coal plants are on over drive to produce electricity. The message is clear.

Chapter 6:

* At this rate of degradation all the world’s topsoil will be gone and it takes 1000 for 3 centimeters to form naturally..
* Smart soils are compounded to create ideal growth environments for crops. This entails rotating vegetation, managing irrigation, composting using cover crops as fertilizers and minimizing oil disturbance.
* Smart soils crack the code of traditional farming and crows sources the best practice farmer can use to yield the most of whichever crop they grow.

Feb 12

I read the next three chapters:

Chapter 7

* Marine clouds are different clouds on land; they are lower and reflect 10% less light. Marine cloud carries bigger size water droplets than continual clouds as well. Smaller water droplet are more reflective because of sometime called the Twomey’s effect, which explains that more concentrated amount of water droplet form a virtual shield and shine bright. The effect is facilitated by aerosols or pollution.
* Lantham’s big idea was to replace these phenomena, replacing the sulphur emission of the ships engines which salt water, which similar bring about the Twomeny effect. One huge scale the result would be to effect global cooling but in addition to global cooling, Latham discovered marine cloud brightening can accomplish more localized task like saving the carol reefs, preventing ice from melting, or reducing the strength of hurricanes.

Chapter 8

* Dead zones around the road are increasing and it take ocean thousands of years to recover from depleting oxygen like the one in Gulf of Mexico.
* Phytoplankton are small celled organisms that float near the surface and are important to life everywhere.
* They are the first link every food chain
* When they die they drift When plankton die the skink to the bottom of the seafloor and create a massive carbon storage layer. If an organism eats the plankton then it gets transferred on in the food chain, and the carbon is processed through the organism’s waste or when it dies.
* The less carbon stored the less there is on the surface the more the ocean can absorb, the cooler the world gets.
* The problem is there are only 40% of the original phytoplankton left
* Whale feces and Sarah dessert have a lot of iron which helps phytoplankton grow. African storms from the Sarah dump a lot of sand into the Atlantic helping phytoplankton grow there.

Chapter 9: Dutch Sea Level Defense

* Flood comes in different types. River floods are easily caused by excessive rain snow melt or ice jams that back up running water and causes it to over flow. A coastal flood is cause by higher than average tides and wind that blow water on shore. Storm search produced by low pressure system can also cause cost to flood. In land flooding happens with intense rains- when land can absorb water fast enough. Flash floods can happen in minutes whereas other flood cans gestate over days. No place is really safe from floods. Except for perhaps the McMurdo, dry valleys in entire Antarctic that reported haven’t seen rains in a million years.
* The Tide City is inspired by the powerful dynamics of the current and the tides, the town would float on the water like a piece of flexible seaweed. It would be composed of large, medium and small pontoons linked by tentacle to the central square. A long bridge would connect the square to the main land and ensure that the structure can move up and down. Tide City would generate a very location specific experience with a constantly changing view above all; it would provide a safe place to live with opportunity for land reclamation and energy generation. That is how Van Boxel and Corman described the project that to date exist only in the model stage. But it turns out its serves another purpose. The Tide City the ground work for the Delta 3000 project
* Delta 3000 scheme ambiguously calls for low lying areas throughout the country to be cover in sand, and manmade hills to be added to the landscape. Covering the countries in sand would prevent flooding, produce fresh water and create natural sustaining ecosystem.

Feb 13:

I read the next three chapters:

Chapter 10

* Greenland, more than three time the size of Texas, the world’s largest island. Ice covers 80% of it, and in some of the areas that ice is as much as 2 miles thick. All told the ice on Greenland measures large than Arctic Ocean it’s self. If Greenland’s ice were to all thaw completely it would cause global sea levels to rise by 24 feet. And its thawing fast
* The arctic is warming twice as fast as the res to the planet. Every foot of sea level rise causes 100 feet of coastal erosion. The melt puts at risk major cities such as London and Miami to be completely spewed.
* The concern begins with the Svartisen glacier in Norway. The Svartisen which comprise of 150 miles squared.
* Fresh snow rifts 95% of the sun rays back, whereas snow covered make such a difference is because they are dark materials and absorb the heat coming from sunlight causing ice and snow to melt more quickly. More heat trapped equals warming global temperature.
* There are three way to preserve glaciers:
* One: By blocking warm water from reaching eyes, melting would slow more ice would form, and iceberg would launch. This would be done by dredging along continental shelves to create artificial embankments.
* Another solution would be to artificially prop up ocean shelves. This would be accomplished by pinning the ice shelves in front of the glaciers to the see floors. By erecting men made islands, warm water would be blocked from Encroaching on the glacier.
* The third idea is to dry out sub glacier streams. Sub =glaciers stream are fast sliding ice streams with supply 90% of ice entering the sea. As the ice slides over the glacier friction, hear generate. More heat creates more water which intern creates more heat. By draining the stream the flow slows down and allows enough time for the ice to thicken.

As I started reading I didn’t find the methods, practically or efficient and there was no point of adding them into my research. I also felt as though they violated the definition of geoengineering.

So I deiced to move on to Humans V Future. The first chapter was bout self driving car, which again in my onion is not geoengineering

Chapter 16

* Masdar is the name of a company. It is a subsidiary of the Abu Dhabi’s government Mubadala Investment Company. Masdar was begun in 2006, to advance clean energy, innovation in Abu Dhabi and around the world. It is an important link for UAE, the petroleum state to diversify beyond its vast reserve, of oil, which one day will run out, if “peak oil” observes are to be believed, or if the world weans itself off fossil fuels.
* Masdar city begun as a physical test center and a green print for sustainability. The mission has been and continuous to be demonstrate the commercial viability of renewable
* Air, water, energy and food have all be manipulated to make life more comfortable. Buildings are strategically positioned in harmony with the sun, to keep them temperate.
* Smart window capture energy and funnel it to storage cells in basements. Air duct re-direct wind and cool rooms.
* There are no power switches.
* Skylight provide natural light
* Motion detector turn on LED light whenever they are needed
* Water pours from recycle system
* There are agriculture land and test labs of vertical farms to produce local food products
* The entire city is connected to the internet
* Autonomous electric shutters get people around

Green Park abound.

Research

Feb 15- Into

Problems we have caused

Burning of fossil fuels has led to an increased amount of carbon di-oxide in our atmosphere. Excess carbon means higher temperatures. The carbon cycle, the backbone to all living things on earth, is also getting disrupted due to the excess carbon. As of 2018 the annual number of extreme meteorological events has doubled since 1980. Just because of the global temperatures rising by one degree has caused December in California to be smoky because of the forest fires. Brutal autumn, a wayward hurricane in Ireland. Puerto Rico’s grid lashed by winds means no electricity. While the polar jets split and warps, shoving cold air into the middle of the United States. Not to mention the droughts in Europe during the summer.

The excess carbon has also made our oceans more acidic. Oceans are the largest carbon-sinks, absorbing ¼ of all carbon we emit. Although this is great, the ocean is absorbing way too much carbon, resulting in the temperature increasing by 0.13 degrees Celsius. Life in the oceans is not very good at adapting. In the Great Barrier Reef 29 percent of the reefs have been bleached. Bleaching has also occurred in the Indian Ocean and Seychelles killing 69 to 99 in the Indian Ocean and 50 percent in the Seychelles. (https://coast.noaa.gov/states/fast-facts/coral-reefs.html)The bleaching of Coral Reefs and  loss of life, is caused due to the rise of ocean acidity by 0.1 pH or 30% more increase in hydrogen ions concentration.

At this rate temperatures will rise to 5.4 degrees Celsius by the middle of the century. The consequences of this are more extreme temperatures, higher sea levels, endangered food supplies. The heat might also completely destroy the rainforest known as the Earth’s “lungs” because of all the carbon it takes from the atmosphere and stores. If the Amazon goes, climate change effects will multiply exponentially. No serious actions are being taken, to slow down climate change. All the discussions, treaties and handshaking by the world government is a lousy excuse for trying. Therefore scientists and politicians turn to the quickest way we can change our paths; geoengineering. I decided to do this project, in order to inform people, on the truth of what exactly is geoengineering. So if the time comes that we need to voice our thoughts on geoengineering we can make educated decisions based on facts, not lies.

Feb 19- Basic geoengineering information

Geoengineering:

Geoengineering is defined as intentional large-scale manipulation of the environment. Scale and intent play central roles in the definition. For an action to be geoengineering, the environmental change must be the primary goal rather then a side effect and the intent and effect of the manipulation must be large in scale, e.g. continental to global

Geoengineering  can mainly be divided into two parts:

SRM

Solar Radiation Management or SRM is a very big part of geoengineering. SRM technologies aim to reflect a certain amount of sunlight back out into space, which would result in a cooler planet. Greenhouse gasses trap the sunlight, just like how your body heat is trapped inside a blanket, so if less sunlight is absorbed the less will be trapped, decreasing the temperature. This is currently being done by nature, clouds, oceans, ice and mountains reflect 30% of the sunlight that reaches the other back into space.

The fraction of sunlight that is reflected back into space is known as the ‘planetary albedo’. SRM techniques can be implemented faster that carbon di-oxide removal  and the techniques are cheaper than carbon di-oxide removal ; but they have their drawbacks:

* If the systems shut down for whatever reasons the temperature will more very quickly
* SRM may alter precipitation pattern
* Ozone depletion

Carbon dioxide removal (carbon di-oxide removal ) -200

Like discussed above, carbon dioxide leads to the heating of the planet. Carbon dioxide removal (carbon di-oxide removal ) aims to remove the carbon from the atmosphere, which would decrease the heat captured. This is done by either physical, chemical or biological methods such as afforestation, ocean fertilization, weathering or certain sedimentary rocks, or combining carbon capture and storage technology, with the production of biofuels, among other approaches.

* Afforestation
* Enchanted Weathering: Carbon dioxide is naturally removed from the atmosphere slowly through weathering- a process that breaks down rocks of silicate and carbonate rocks. Speeding up this weathering process could remove a large amount of CO2 from the atmosphere. One proposed method is to speed crushed olivine, a type of silicate rock, on agricultural and forested adns to sequester CO2 and improve soil quality. However, this technique would require the rock to be mined, ground and transported. Weather or not this technique will benefit us has not yet been calculated.

All the techniques discussed in this paper can be classified into these two categories. Since these categories are so broad I decided to further split them into which part of the planet they would be implemented in, to make it easier for me and the reader. This layout was inspired from a book I read while doing my research called “Hacking planet Earth”

Feb 20- Cloud seeding:

China has placed a burning chamber on the Tibetan Plateau. Rocket technology developed by China allows these chambers to burn at high altitudes, even if the oxygen is thin. These strategically placed chambers are called the sky river. They looked like a tall chimney, an outdoor stove with a tall cylinder vent on top. Each costs about eight thousand dollars and can operate for years. The way they work is that they realize silver iodine, and when the wind is just right, they hitch a ride and rise high into the clouds. Silver iodine exists in nature and is known to have harmful effects on life. Now silver iodine has a molecular structure very similar to that of ice. Ice tricks into thinking that the silver iodide is condensed ice and bonds to it, making the clouds heavier, thus making it rain. This technique is most commonly known as cloud seeding.  This is not only done in China but many other places such as Australia, UAE. There are a great many benefits of cloud seeding. For example, in a study site in the Snowy Mountains of New South Wales, Australia, a five-year cloud seeding project designed by DRI resulted in a 14 percent increase in snowfall across the project area. Other uses for cloud seeding are:

* For hydroelectric companies, it snows more than there will be more runoff in the spring, therefore more electricity will be generated.
* Cloud seeding can also clear away the fog by turning it into precipitation. This helps increases visibility around airports
* Hail is a big issue in Alberta. Cloud seeding is used to manage this. Silver Iodine increases the number of ice pellets in hail-producing clouds, but also decreases the size, which reduces damage.

But projects like Sky River will take years to implement, and the side effect is unknown. Some scientists believe that causing rainfall in one place is likely to cause a drought in another place. Research on this topic is still being done. It can also cause health problems, as we start to use this method more and more, we will consume more and more silver iodine. This can cause a disease called argyria, which is the graying or bluing of the skin, however there are no other effects of this disease. A laser treatment is being developed, and is showing promising results.

Feb 22- SAI

Stratospheric aerosol injections

The technique that has received the most attention so far is called stratospheric aerosol injection. Aerosols are tiny solid or liquid particles in the atmosphere that reflect or absorb light. Whether or not a type of aerosol absorbs or reflects light depends on the color and composition. Broadly speaking, bright-colored or translucent particles tend to reflect radiation in all directions and back towards space. Darker aerosols can absorb significant amounts of light. Pure sulfates and nitrates reflect nearly all radiation they encounter, cooling the atmosphere. Black carbon, in contrast, absorbs radiation readily, warming the atmosphere but also shading the surface. This method was inspired by nature. In 1991 Mt.Pinatubo exploded; this was the second-largest explosion of the 20th century. As tragic as this event was, it injected 20 million tons of sulfur dioxide into the air, this gas reacts with other gases to form sulfate aerosol. These particles don’t wash out with precipitation; they only settle after a few years.

The after-effects of the explosion were that the global temperature went down by 0.5 degrees Celsius. What scientists propose is that via some other delivery system inject reflective particles, such as sulfates, into the stratosphere.  The following system has been chosen. A modified aircraft is designed to meet the assumed requirements. The aircraft will be carrying a 25-ton payload 20 km high. With the help of several of the aerospace and engine companies, a team of engineers have successfully modified a normal aircraft to an aircraft which can carry out the task we require. In order to sustain flight in thin air, the wingspan has nearly been doubled. The aircraft would have 4

wing-mounted low-bypass engines, modified for high-altitude operations with an aggregate take-off.  Combustion, a simple reaction that will be ongoing when the aircraft is in the air. So Smith proposes that the aircraft should be filled with S a substance much less dangerous than SO2 on the ground. Through combustion, the S will convert to SO2 which can be captured and then could be released into the atmosphere.

Adding aerosol into the atmosphere might not only reduce the temperature but do many other things. A team of scientists made the Norwegian Earth system model, and they found that when they added stratospheric aerosol injections   the ocean began to take up more carbon. If used aggressively the ocean and sequester more than 10% more carbon than with stratospheric aerosol injections  .

Obviously adding gas in such quantity can't come without side effects. Some negative effects of stratospheric aerosol injections   are that it increases the burden of stratospheric aerosol and thus the surface area available for heterogeneous reactions.

The heterogeneous directions on H2SO4 aerosol are well characterized, and this activity can be used as a baseline for assessing the ozone-depleting impacts of other aerosol types. Also, there is no guarantee that the planet will cool equally, making some countries more sustainable for living than others causing political tension.

Once we start injecting aerosol into our environment, we might never be able to stop. A termination shock is a substantial rise in global temperature due to the sudden stop in stratospheric aerosol injections   or if SRM deployment would have to be exerting a substantial cooling or disruption to SRM deployment would have to persist for many months or longer. Many models have studied that stopping not only stratospheric aerosol injections   but other SRM techniques could offset the warming effects of many decades of greenhouse gases, making it impossible for so many species, including humans, to adapt. This does not mean that stratospheric aerosol injections   could never be stopped, if done over a period of time, there would be no termination shock.

Feb 23- Marine Cloud Brightening

Since we are already talking about how we can use the clouds in our battle against our own demons, another way is to brighten the clouds. Think of it this way; if we have two jars of marble that are the same colour but just different sizes, it will seem like one jar holds marble darker than the marble in the second jar. The jar with smaller marbles has more surface area; therefore, they reflect more light, making it seem lighter. Clouds work in the same way. A cloud with larger droplets will have less surface area than a cloud with the same amount of water but smaller droplets. Now the question is who we can promote smaller droplets to form?

A book called “How to cool the planet,” the author meets Salter, a scientist. He proposed that we build a ship that is 50 feet long and weighs 300 tons. Instead of sails, there would be three 60 feet high tubes with regularly spaced ribs on them. These tubes would still function as sails but also have smokestacks for saltwater. The idea is that the 300 boats would set sail and pump seawater into the low-hanging clouds right above the ocean. The presence of salt makes it harder for water molecules to bond to the ice structure because ice naturally repels salt molecules. So in a sense, the salt gets in the way of water molecules, blocking them from joining the ice. According to Anthony Slingo, in a British climate, brighter clouds reflect more sunlight and thus have a cooling effect on the climate. Slingo argued that by increasing the brightness of low-hanging clouds by 20%, you could offset the heat trapped by the doubling of carbon dioxide emission. However, as the droplets get smaller they can easily evaporate leading to a change in precipitation patterns.  Model studies have shown suppression of evaporation and reduced precipitation over low-latitude oceans and vice-versa over low-latitude land regions due to marine cloud brightening . Some studies also show a reduction in mean

precipitation over the Amazon rainforest area due to marine cloud brightening . However, there are some studies showing the possible usefulness of localized impacts of marine cloud brightening . For example, John examines the potential efficiency of marine cloud brightening  to cool the ocean surface over hurricane regions to weaken the hurricane development. Similarly, Latham examines the application of marine cloud brightening  in cooling the ocean surface over coral reef regions to reduce the coral bleaching caused by increased sea surface temperatures. Results suggest coral bleaching is eliminated with the implementation of marine cloud brightening  over the coral reef regions. Termination shock that is explained in the stratospheric aerosol injections   section also holds true for marine cloud brightening . A sudden stop will result in a rapid increase in temperatures.

Feb 26- Spaced Based Geoengineering

Another idea that scientists have taken a serious look at is space based geoengineering schemes. Basically, the concept centre on fabricating and deploying a large occulting disc or many smaller ones to reduce the amount of solar insolation. Less solar insolation leads to mitigating increased temperatures. The disc or discs would weigh a total of 10^7-10^8 tonnes, and the disc or discs would be positioned at the L1 point in the Earth-Moon triangular Lagrange. A problem with this idea is that the orbiting discs could cause significant orbital debris hazard. The way to reduce the damage is to use multiple discs instead of one large one

Dr. Roger Angel, a professor of astronomy and optical science at the university of arizona has a parasol to develop the concept for a giant space parasol, 1000 miles across. The parasol will be made up of many smaller free-flying parasols of “gossamer thin, lunar-made glass”. His plan included three major high tech elements; first would be the package to enable material production and launch on the moon.

 Angel relied that this plan had some practical challenges so he revised it. He developed a ‘sunshade cloud’. To avoid any assembly in space Angel proposed that all of it was done on Earth, each ‘flyer’ would weigh about 1 gram and the project would be ready in less that 25 years costing a few trillion dollars.

Dan lunt  professor of climate science at the University of Bristol in England. He made a model to try Angel’s idea out. His models reveal that the sunshade works to lower the global temperatures. He tried out three different models and in all three the solar constant; or the amount of solar radiation the Earth receives deceased, eventually Lunt was able to achieve air temperature like they were as in pre-industrial times. However the cooling is not consistent throughout the planet, and this could cause some grave ramification for life. However there was a big difference between a model with the sunshade and a preindustrial model, the hydrological cycle with a sunshade world would generally be drier than the preindustrial.

Another idea is to use clouds made of dust grain. About 2\*10^11 tonnes of lunar or commentary dust are creating clouds at the L4 and L5 points in the Earth-Moon triangular Lagrange. These clouds reflect sunlight back to space. However, since each cloud only reduces solar insolation for a relatively short period each month, when the cloud is between the Earth and the Sun, significant mass is required to ensure a large optical depth and so useful cooling on average.

Lunt concludes that geoengineering space is ‘a crazy idea’ and will lead to many complications. But plans to geoengineering in space are going on with full speed, the Made In Space, a california company, is exploring new ways of designing materials using ‘the unique traits of space environment’.

Feb 27- Glaciers

The Arctic is warming twice as fast as the rest of the planet. As the ice on the land melts it expands taking extra space and making the sea level rise. Every foot of sea level rise quotes to 100 feet of coastal erosion, putting about a billion people at risk, causing major cities to become swaps and the extinction of many species. The Svarstein glacier is forged between two rocks, leading to crevasses stacked above each other, giving the glacier blue-colored ice. The view around the glacier is breath-taking, surrounded by a mountain range and landscapes. Unfortunately this beauty won’t be there for our future generation to look at. The glacier when seen at first looks solid but it's retreating at an alarming rate skirting to a size not seen since the Little Ice Age. Not only is it the Svartisen glacier but 198,000 glaciers all over the world which are retreating fast. There are many consequences to retreating glaciers, one of them being the earth’s albedo. Fresh snow reflects 95% of the sun’s rays back into outer space, water, on the other hand, only 10%. Soot and dust also play a factor here, they tend to absorb the sun rays as they are dark materials. The heat that is absorbed melts the snow faster.

John Moore, a professor of climate science and his colleague Michael Wolovick, a researcher at Beijing Normal University, propose building underwater sills. When warm water comes in contact with a glacier it melts it. A barrier like and weather dam built for ocean floor material could blacok that warm water. It could provide glaciers more time to accumulate again. Another idea that they have is to dry out the subglacial stream. Friction is generated when ice slips over the glacier bed, fiction generates heat at the base of the ice streams. The water acts as a lubricant speeding up the flow, which in turn generates more heat and creates more water slippage. To stop this vicious cycle some glaciologists have drilled a tunnel in the bedrock of Svartisen to drain it. The water that leaves the tunnel powers a hydroplanet and provides valuable information.

Another scientist working on saving the glacier is Leslie Field a A chemical engineer and lecturer at Stanford. After seeing the ‘An inconvenient truth’ she felt as though she needed to do something about the problem of climate change. Her idea is to distribute silica beads on the Arctic Ice. Silica is a safe material that occurs naturally and is highly reflective. The technology is ecotoxicology and field testing. The results are positive and no adverse ecological effects.

Feb 28- Fertilizing oceans

Colorful coral reefs, beautiful fish and crystal clear water. The oceans are extremely beautiful, but also very useful. Phytoplankton  are small,single-celled organisms which float near the top of the surface of the water. They are the oxygen producers for marine life, but for humans as well, in fact half of the oxygen in our atmosphere is created by marine plants. When plankton die the skink to the bottom of the seafloor and create a massive carbon storage layer. If an organism eats the plankton then it gets transferred on in the food chain, and the carbon is processed through the organism’s waste or when it dies. This is vital because the less carbon our oceans store the more there is up here and the warmer the planet gets. In 1950 40% of the plankton died, and since they are so down in the food chain this disappearance affects all sorts of life forms.

Whale poop and the Sahara desert are the solution to our dying phytoplankton. The curious connection between whale feces and desserts is that they both contain high amounts of iron which is beneficial for phytoplankton’s growth. A dead zone is an hypoxic area where no life can sustain. Naturally there are 4 dead zones: the eastern North Pacifc of the coast of Guatemala, the south pacific near Australia,  the bay of bengal and one in the Arbian sea. Due to human activities other dead zones are occuring, like the one in the Gulf of Mexico and in the northeast pacific’s subarctic oceans.

The subarctic oceans should not, technically be a dead zone. Upwelling, when micronutrients from the  bottom of the ocean go to the surface and feed the plantokon, occurs there a lot. This really bothered a scientist named John Martin. In January 1988 John Martin found out that the amount of iron in the water the more phytoplankton there will be.  Whereas a colleague of John Martin conducted a test, where fewer phytoplankton were produced and they absorbed less carbon. Moreover, his tests even showed that a type of phytoplankton called the ‘red tide’ was created due to iron dusting. These phytoplankton produce toxins perilous to fish and can make people sick if they consume shellfish.

  A large scale experiment of iron dusting was done by Russ George. In 2012 George trucked one hundred tons of iron dust to the coast of British Columbia, loaded it up on a fishing boat and dumped the lot into the Pacific Ocean, about two hundred miles from the shore. He faced much criticism, environmentalists accused George of illegal dumping, violating United Nations covenants on geoengineering and other international protocols.  Illegal or not, his actions brought life back into a zone that was dead. That fall of 2013, Alaska caught 50 to 52 million fish, they had to stop at 226 million because there was no longer any place to store them.

Another way to bring back life is to skim the wastewater from a dead zone and put it in a tank. Bacteria would break down the waste turning it into ammonia.

Weathering:

“Weathering” is the breaking down of rock. This process needs carbon di-oxide and removes it from the atmosphere for thousands of years. Whereas in the oceans the same process occurs with powered minerals. Such reactions can form sediments and settle on the seafloor, however the process is very slow. One geoengineering proposal is to accelerate this process by adding powdered minerals to the oceans to increase the rate of carbon di-oxide removed from the atmosphere. This could also counteract ocean acidification from elevated atmospheric concentration of carbon di-oxide

Kelp farming

Another way is to cultivate kelp or seaweed, which would remove carbon di-oxide through the process of photosynthesis. Eventually the kelp balded biome to heavy and the blades fall on the ocean floor. Where they sediment and create a carbon storage.  Companies like the Ridding Tide are already working on this project. Enhancing the growth of kep won’t only sequester carbon but also restore our food chain, (more kelp, more fish) and restore our coast because 90% of the kelp forest have disappeared and bringing them back will help stabilize our environment.

Ocean Welling:

Large vertical pipes will bring nutrient rich water from deep down to the surface. This is a substitute for ocean fertilization. Siloam pipes could also be used to enhance the down welling of carbon rich cold water for storage in the deep ocean.

Ocean alkalization for coral reef recovery/restoration

Ocean acidification damages reefs. Neutralization is the process of  mixing a base and acid till there is no excess of hydrogen or hydroxide ions present in the solution.

Micro bubble to enhance ocean albedo:

Micro bubbles are bubbles smaller than one hundredth of a millimeter in diameter, but larger than one micrometer. Just like cloud brightening, micro bubbles have the same effect. There are three ways of generating micro-bubbles. The most common way is dissolving air into some sort of liquid and then releasing it through a specially designed nozzle system, to create micro bubbles. The second way is to create micro bubbles through ultrasound. power ultrasound to induce cavitations locally at points of extreme rarefaction in the standing ultrasonic waves. The third way is to use an air stream which would be delivered under low offset pressure, the air would break off due to mechanical vibration, or flow focusing, or fluidic oscillation, creating bubbles. Forming small bubbles might seem easy, but that is far from the truth. The first reason is that when a bubble is formed from a single aperture, the liquid attached to the perimeter of the aperture serves as an “anchor” as the wetting force attaches the growing bubble to the solid surface. Unless this anchoring force is disrupted, the bubble will grow until the buoyant force on the bubble (which is proportional to its volume) exceeds the anchoring restraint on the bubble (typically proportional to its contact perimeter), and therefore breaks off. In this low pressure offset scenario, the force balance usually breaks off the bubble at a size an order of magnitude larger than the diameter of the aperture.A second reason for forming larger bubbles from small apertures is polydispersity of bubble sizes and irregularity of the spacing between bubbles leading to quick coalescence of the bubble cloud. Even if small bubbles are formed, then coalescence can rapidly reduce the benefit. The third reason for not forming small bubbles from small apertures is channeling in a nozzle bank of pores or through a porous ceramic material. This is described in Figure 1. The largest bubble that forms then provides the path of least resistance, preferentially growing against all other bubbles in the parallel percolation process in a nozzle bank or porous ceramic material.

A side effect of this, is that sufficient sunlight might not reach the life below. The micro bubbles approach would also reduce oxygen in the upper layers of the ocean, where most fish and other species live. The effects of bubble clouds on oceanic life, both in terms of temperature and sunlight changes, are unknown. A cooler ocean will also absorb CO2 more efficiently, enhancing ocean acidification. Bubble clouds would change oceanic circulation and cause unexpected or unusual evaporation, which would in turn affect atmospheric heating and circulation. This would also raise questions about the possibility of regional climate control, with potential unilateral deployment and even using the technology as a weapon.5

The potential impacts of microbubbles on human society was highlighted by research conducted by the Integrated Assessment of Geoengineering Proposals. Through modelling exercises, it found that geoengineering with ocean microbubbles could affect 2 billion people through regional weather changes and extreme events such as floods and droughts.

March 1- Artificial trees

An average tree takes about 40 years to absorb  one ton of carbon, and tens of billions of carbon is emitted each year. So it makes sense that we should end deforestation and restore our forest. Other benefits include prevention of erosion, recreational value, natural habitats and production of forest foods, also large scale afforestation can modify local climates by increasing humidity, and reduce wind speeds however the process of growing trees is slow and ineffective and we are running out of time. Also in tropical forests, increases in tree growth may lead to an increase in evaporation that can warm the atmosphere through the greenhouse effect. In boreal regions, planting trees on open land that is often covered by snow in wintertime decreases surface albedo, resulting in surface warming. Also it is hard to practice this method. Landowners will not be too happy to grow trees on private land and using farm land is not an option ,since we don't’ have enough food to feed the people right now.  Most afforestation projects occur on marginal croplands. Certain models estimate 60 million to 65 million U.S agricultural land could be converted to woodlands by 2050. The cost of a project can range from $65 to $200 per acre depending on the species and the condition of the land before.

Therefore as natural and safe afforestation is, it is not the best option.

But what about  a forest of artificial trees? Klaus Lancker, the director of the Center for Negative Carbon Emissions and a professor at Arizona State University, came up with a more efficient tree. His trees can absorb as much as one ton of carbon di-oxide per day. Lancker’s tree, about 12 feet tall, look like small-foot goal post. The trees have “leaves”, which capture carbon di-oxide as air passes through, just like normal leaves, and then send it to a stainless-steel storage tank. Trees use sunlight to power the transformation of carbon di-oxide Lancker’s tree uses water. When moisture in the air is captured and dries, it acts like a fuel and powers the storage process. The problem is political will and money. Each tree cost twenty thousand to thirty thousand dollars to make, which is not cheap.

March 3- Cover crops

Another problem, that is causing climate change, is agricultural. As our population grows, we clear more and more land, in order to feed people. As we farm, soils lose their original organic carbon, many cultivated soils have lost 50-70%. Cover crops  are plants that are planted to cover the soil rather than for the purpose of being harvested. Cover crops manage soil erosion, soil fertility, soil quality, water, weeds, pests, diseases, biodiversity and wildlife in an agro ecosystem. They are often in leguminous crops such as bean, lentil, and alfalfa. Cover crops have been found to increase soil carbon sequestration, decrease emissions of nitrous oxide and leaching losses of soil nitrate. Farmers are adapting to no or low tillage, which is essentially trying to plant seeds and using fertilizer or manure with minimal soil disturbance which results in net soil carbon sequestration that averages 1.2 tCO2 per hectare per year.

March 4- Writing about future

Usually at the end of research papers like this one, the author would let the reader know how bright the future's of whatever topic they are writing about, and the wonderful development that will be coming our way. I may be the first, that is hoping that this hopefully never happens. Like I said before, geoengineering is like chemo, it does cure cancer, but the best course of action is not to consume alcohol in the first place. Everyone that is working on developing geoengineering hopes that they never have to use it. However expecting humanity to cut emissions as fast as we need them to, seems impossible.

So as we move forward more people, politics and government are considering geoengineering, lifting the taboo that was on it. Now the theoretical proposals are being implemented. For example, Harvard now has a Solar Geoengineering Research Program, intatied by David Keith.  They are planning to conduct a field experiment, where they inject sulfur dioxide, alumina, or calcium carbonate into the stratosphere. They would then employ sensors to measure the reflectivity of the particles, the degree to which they disperse, and how they interact with other compounds. Initial test flights could occur as early as next year. More and more tests like these once are being allowed, and the more data we are gaining.

As we start to experiment more laws will be developed in order to ensure our safety.

For carbon di-oxide removal  the laws will be made on the local or state level, since most of the methods only have a

March 7- Conclusion:

When Edward Jenner in 1796 developed the first human vaccine for smallpox many people refused to take it because they feared injury or death, and this was true long after the vaccine was proven to be safe. We are petrified of the uncertain, but then once in a while these people come along and they change our life. Yes those people are smart and born with talent, but then so are we. The difference is that they are willing to take the risk to jump even if they don’t know here they are going to land.

The purpose of this paper was not to promote geoengineering. The Energy and Climate: Studies in Geophysics Report published by the U.S. National Academy of Science in 1977, barely talked about cutting emissions, but it mentioned geoengineering as the sole answer to our problem. Governments are starting to consider this, and in my opion when geoengineering is exactly what politicians want, a way to satisfy scientists and environmentalists and not ruin their precious economy. So if they want to start implementing these techniques, they will show the most peachest side of geoengineering without mentioning the side effects. I want to inform people about the truth of geoengineering. Full transparency.

I try my best not to influence my readers in supporting or being against of geoengineering. I hope that you have understood the techniques of geoengineering and based an opinion on the facts provided , and your experience and belifis. Since it is the end of the paper I would like to share by view. The Paris Agreement, one of the biggest agreements for climate change, had everyone so hopeful. The aim of the Paris Agreement was to keep the global temperatures from increasing more than 2 degree Celsius  and maybe even 1.5 degree Celsius. Most countries are barely following the plan. Talking, meeting, signing, does nothing to help our problem. But we can’t put all the blame on the governments. Mating a temperature requires us to cut emissions and that means, at least in Alberta, that so many people have to lose their jobs, and the economy crashes. Leaders need to make sure that their people don’t suffer. For these reasons I believe that geoengineering seems like our only option. Yes, there might be side effects, but if we don’t do anything, we will die anyway, just a little later and it will probably be more gruesome. In fact many scientists still believe that we have gone past the point of no return. Even if we magically stop emitting greenhouse gases, we have emitted enough to doom us. So we will have to use carbon di-oide removal methods

Another reason why I believe that geoengineering is safe, is that the ideas are mostly based on natural processes, the techniques just enhance them. For example, like I mentioned before, stratospheric aerosol injection is based on volcanoes. Volcanoes erupt all the time,and it definitely does not have any side effects, and if we start stratospheric aerosol injection we will start with so much less aerosol than a volcano put in our atmosphere.

I really like the end of a book called “Hacking planet Earth”. It says that “The quicker we admit the Earth-our common Mother- is sick and can no longer care for herself, the sooner we can intervene and help her heal. Natural remedies aren’t working. Medical vaccines have saved humans from dying off in droves. Geoengineering and environmental technologies are the vaccines. I believe we need to cure the plaent’sill. It's time to take our shots.”

Recommendations:

I feel like my topic was to broad. So that means I talked about to many methods but not really in-depth, if I could do this project again I would narrow it down.

Another reason I think I used Hacking Planet Earth just a little bit too much, I feel like relying on one topic to much might influence my research.

The last thing I might change, is my way of doing research, I tend not to stick to the plans I make and then end up cramming, so I would want to stick to my timeline next time

March 10- Script making

Today I wrote my script for my video. I practiced it a couple times, but I feel like I will need to have the paper with me in the videos.

The way I am going to film is get some pictures for each category and then paste then on a paper and then use those picture to help explain the different techniques.

I also added a little bit more information in the smaller techniques under the categories called “Ocean Fertilization”

I also got my pictures

March 13- Filming

I finished filming today, I took it all in one take so I didn’t need to do much editing.

March 15- Everything else

So today I filled in my problem, method, citation acknowledgements, and added all the attachments required in the presentation sections. I couldn’t add the data; I will ask my teacher tomorrow.

March 16

So I read it over a I found it fine I made a few change here and there but nothing to big, my parent were busy so they will read it over tomorrow.

March 17- Finishing everything of

My parents said it was okay to, nothing but a few grammatical errors. I formatted it, adding some color, and looked over everything making sure it was fine.

WE ARE DONE