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CONTENT ANALYSIS OF GLOBAL WARMING SKEPTICS

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by

Andrew S. Carruth

Michael P. Gorse

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Approved:

Professor Stephen W. Pierson, Major Advisor

Professor Wesley V. Jamison, co-advisor

1

Abstract

Many scientists believe global warming (GW) to be one of the most serious problems facing the world today and that it demands immediate action. However, many people, called skeptics, advocate for various reasons that action should not be taken at this time. We performed a content analysis of their literature to quantitatively analyze their arguments to help counteract them. We found that the most common argument dealt with the lack of evidence that GW was happening, followed by arguments that GW would be too expensive to counteract or that GW would not be harmful.

Contents

Chapter 1

Introduction

For the past century, the developed world has been relying primarily on the burning of fossil fuels for its energy. Burning of these fuels puts greenhouse gases such as carbon dioxide (or CO_2) into the atmosphere, leading to a higher concentration of these gases now than prior to the industrial revolution. Since greenhouse gases are thought to trap heat in the atmosphere, their increased concentrations are believed to be causing the Earth to warm.

Many scientists have predicted that rapid warming of the Earth could have severe consequences, such as proliferation of tropical diseases and destruction of human settlements in coastal areas through rising sea levels. Because the effects of rapid changes in the Earth's temperature are not well understood and potentially harmful to the ecosystem, some people believe that taking action now to reduce global warming is preferable to not taking action and risking damage to the ecosystem. Since the burning of fossil fuels adds CO_2 into the atmosphere, many people therefore view their burning as an important cause of global warming. For this

reason, some scientists maintain the position that, although the evidence will never be entirely conclusive, we should take steps to reduce mankind's dependency on fossil fuels.

Not everyone agrees with the majority viewpoint, however. Although many scientists believe that global warming is occurring and that it may have harmful effects on the Earth's ecosystem, there is genuine scientific debate about the issue. The existence of global warming, its impact on the climate, whether or not it is feasible or even possible to halt the buildup of greenhouse gases in Earth's atmosphere, and, if so, what method would work best are all subjects of debate among various scientific and economic communities. The people who are against the majority of the scientific community on this issue (referred to as the consensus by global warming advocates) are termed "skeptics" since they are skeptical of the viewpoint that global warming is occurring and is harmful. Skepticism is a valuable and necessary part of the scientific process since, throughout history, important discoveries have often come from theories that have gone against the scientific consensus of the time.

However, some groups, in an effort to get their viewpoint across more forcefully, have resorted to using a type of research called "junk science". Junk science is literature that purports to be scientific research but which falls outside the rigor of the scientific method and peer review process.[1] Junk science is problematic because science must be the basis for sound policy decisions. Junk science interferes with this process by resembling legitimate science and fooling people into passing laws based on itself rather than real research.

Because of the corporate interest involved, there has been some concern that

some skeptic groups on the global warming issue are junk science groups. Various corporations are interested in the issue because reduced consumption of coal and oil would affect the fossil fuel industry. It is therefore possible that they would go to great lengths to prevent the implementation of measures that would reduce consumption of these fuels, possibly by funding junk science or other skeptic groups. We feel that this is a serious issue since the arguments of these groups are, in some cases, preventing action on global warming from being taken. Therefore, the purpose of our project is to do a quantitative assessment of the arguments being used to support such views and to explain the motives of groups for using these arguments so that future arguments can be predicted.

Our goals are similar to a project done by a group last year which set out to find the causes of junk science and create a strategy for preventing its existence.[2] This group, whose work will be discussed in more detail in the next chapter, performed case studies and interviews with members of various organizations to determine the methods that they used to spread their message. However, the research done by this project group did not assess the types of arguments or the frequencies of arguments made by skeptic groups against the theory that global warming is harmful and that reduction of CO_2 emissions is necessary. We feel that a quantitative study of these arguments will be useful to gain a greater understanding of the overall message of skeptic groups, which will be helpful in countering their arguments.

We have performed such a quantitative study of the arguments of skeptic groups using a technique called content analysis. Content analysis, which will be described more fully in chapter 3, is a technique of counting certain features within a group

of literature to look for patterns. Our content analysis has helped us to understand the message of skeptic groups by showing us the predominant arguments that existed in the literature we reviewed. Having completed this project, we have found ways for skeptic arguments to be countered more effectively and gained an understanding of the effects that global warming skeptics can have on environmental policy.

Chapter 2

Literature Review

The issue of global warming is complicated from a scientific standpoint because of debate about whether global warming is occurring and what contribution various human activities have in the global warming process. There are also economic factors involved. For example, a near phase-out of the fossil fuel industry would ultimately be required to reduce greenhouse gas emissions and therefore the stakes for them are high as well. Because of the scientific and economic complexity of global warming, many different organizations that have positions on the issue have formed. We felt that it would be beneficial to understand the reasons why people join these organizations because we reasoned it would help us to understand what actions these groups will take and why. We also felt that in order to perform our analysis of skeptic groups properly, we needed to gain an understanding of the issues relating to global warming that are being debated.

In this chapter, we will begin with background on the different positions that organizations have on the issue of global warming. We will then discuss in greater

detail the arguments of the activists and the skeptics. We will then discuss some theory on why people join different types of organizations and conclude this review with a summary of the results from a previous project that studied global warming skeptic groups and explain how it relates to our project.

2.1 Background

Since global warming is a complicated issue with much at stake, many types of groups with varying interests have positions on the matter. These include advocacy groups maintaining the position that global warming is a threat and that the buildup of greenhouse gases in the atmosphere should be halted, skeptic groups that argue for various reasons that action should not be taken to halt global warming, and research groups that research the evidence without a particular bias. In this section, we will discuss the outlook held by these various groups on the issue of global warming and their views on potential consequences of increased CO_2 concentrations in the atmosphere.

2.1.1 The concerns of the advocates

Supporters of regulations on CO_2 emissions, such as Greenpeace and the Sierra Club, maintain that humans have likely been contributing to global warming by emitting CO_2 from the burning of fossil fuels. They also believe that global warming could have harmful effects on the ecosystem. Since no known technology exists to efficiently remove carbon dioxide from the air, these people feel that action should therefore be taken to reduce the consumption of fossil fuels and consequently

limit the spread of global warming. They also claim that there are methods of reducing CO_2 emissions that will save money and should therefore be implemented regardless of the threat to the climate. We will discuss these arguments separately.

CO_2 emissions are causing global warming

According to Darren Goetze, historical records indicate that, in the 20th century, the global mean surface temperature has increased by 0.3 - 0.6 C, the 10 warmest years since 1860 have all been after 1980, and sea level has risen 10 - 25 cm. Pattern-based studies have linked warming in the 20th century with increased concentrations of greenhouse gases, the climactic changes being inconsistent with patterns produced by solar and volcanic activity. Further studies have shown models of climactic change produced by increased levels of CO_2, aerosols, and O_3 (which are all greenhouse gasses), in the atmosphere to be very similar to the changes observed from 1963 to 1987.[3] Many scientists have interpreted this evidence as suggesting that more greenhouse gases cause global warming.

Global warming is harmful to humans

The consensus of scientists worry that by the next century, if current trends continue, the average global temperature could rise by three to four degrees Celsius (six to eight degrees Fahrenheit), or an increase roughly equal in magnitude of the change between the temperatures of today and the temperatures of the last ice age.[4] Such an increase in temperature could cause an increase in desertification including droughts in agricultural areas, flooding of coastal areas which may even be sufficient to submerge some island nations[5], and in increase in infectious dis-

eases due to a better climate for producing disease and an increase in the mosquito populations that help spread them.

The effects of global warming on humans could include such things as an increase in disease, flooding of coastal communities, and droughts.[6] Heat waves in cities have been known to cause hundreds of heat related deaths in the past and would be more frequent and pronounced under global warming. It is thought that insurance rates would increase due to more erratic weather patterns associated with global warming. There is also the possibility of an abrupt "snap" in global climate patterns.[7] If the temperature on Earth changed dramatically in a short period of time, then local ecosystems might not have the ability to adapt fast enough. Thus large populations of people and animals could be affected.

According to an economic study by William Cline, damages due to a 2.5 degree Celsius increase in global temperatures could result in losses to the US economy of sixty billion dollars (1 percent of Gross Domestic Product, GDP) if one considers only material things such as the costs associated with losses of lumber, reduced runoff, and losses to other businesses such as the ski industry. If one considers other factors such as intangible losses due to species extinction, the overall damages in the US could rise to as much as 2 percent of GDP. This again assumes only a 2.5 degree warming by the year 2050.[8]

Under Cline's models, however, the total overall warming may be much greater if one looks beyond the arbitrarily set date of 2050 to determine the full consequences of global warming. Under this line of thinking, the temperature of the Earth would still be increasing until the year 2300 when deep ocean mixing would partially reverse the increase in CO_2 concentrations. Under this model, a ten de-

gree Celsius increase in temperature is expected. Even if the damage done by this amount of warming is linear, the cost is likely to be six percent of GDP in the US. If greater warming is occurring, however, or if the damage done is non-linear with temperature increase, then the costs could reach as high as 20 percent of GDP.[9]

Low cost efforts to reduce CO_2 emissions

Because of the seriousness of the global warming problem, scientists and engineers have been doing studies to find ways that will not only reduce CO_2 emissions but will also conserve energy and save money. These are called "no regrets policies" because even if global warming turns out to be less of a threat then scientists believe, the money and energy saved on these measures will still have made them worth while.

For instance, Nissani states that the United States, which emits more greenhouse gases than any other country, is not as energy-efficient as some other developed countries such as Sweden or Japan. It has been estimated that adding triple pane windows to existing buildings and improving the design of hot water tanks could save the United States $56 billion while reducing its CO_2 emissions by 18 percent. Also, replacing 75-watt incandescent light bulbs with equally bright 15-watt fluorescent bulbs would further reduce consumption of fossil fuels, as would manufacturing automobiles with more efficiently-designed engines.[10] As an example of the above, in 1993, Greenpeace took a Renalds Twingo and cut its fuel emissions in half by using a more efficient engine, reducing its weight, and using low resistance tires. These modifications did not compromise the degree of safety of the vehicle as verified by independent sources[11].

11

2.1.2 The research of the IPCC

Since there is much debate on the existence of global warming and effects of increased CO_2 concentrations, and since these effects could have disasterous implications for life on Earth, impartial research groups have been created to study the problem. One such group is the Intergovernmental Panel on Climate Change (IPCC). Established in 1988, the IPCC was formed by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) to investigate information relevant to the risk of climate change caused by humans. The IPCC attempts to remain unbiased and is composed of the leading 2,500 relevant scientists comprised by delegates from many different countries.[12] It tries to research the scientific evidence relating to climate change without a bias towards one side of the debate or the other. It is divided into three working groups; Working Group I reviews the progress of scientific research on climate change, Working Group II studies the effects that climate change will have on ecosystems and what methods might be used to adapt to that climate change, and Working Group III analyzes the economic feasibility of reversing or at least slowing global warming.

In light of the evidence it reviewed, the IPCC's second assessment report stated that warming in the 20th century "is unlikely to be entirely natural in origin" and that "the balance of evidence ... suggests a discernible human influence on global climate."[13] The original proposal for the summary for policy makers of the SAR was subject to hundreds of amendments, many of them from petroleum-exporting countries and industry. For example, the sentence, "The balance of evidence suggests that there is a discernible human influence on global climate"

initially read, "The weight of evidence indicates a significant human influence in global climate change."[14]

The IPCC's Second Assessment Report states, among other things, that global warming will cause prospects for more severe droughts and/or floods in some places and less severe droughts and/or floods in other places.[15] Global warming is expected to have many effects; it may improve agricultural productivity in some places while reducing productivity in others. Also, many ecosystems could be affected if temperatures and sea levels rise, as many scientists predict that they will. Some species of coral reefs may bleach more often and be less capable of reproducing because of the warmer temperatures, and human settlements in coastal areas may be put at risk.[16]

Thus the IPCC agrees with the views of the global warming advocates that something should be done to reduce CO_2 emmissions. The assessments and recomendations of the IPCC were supposed to be used by every country in their efforts to reduce their greenhouse gas emissions.[17]

There is currently an international treaty that will adress the concerns of the IPCC. It is called the Kyoto Protocall, and it sets greenhouse gas emission reduction targets for most of the world's developed countries. However, only the countries that sign the treaty are bound by its reduction targets, and some of the world's larger developing nations such as China and India have refused to sign it.

2.1.3 The skeptics

Despite the IPCC report, not all scientists agree that global warming is occurring and is caused by human activity, or even that it will have harmful effects if it is occurring. These people are called the skeptics. Skeptics also point out the lack of consensus among scientists. For these reasons, these scientists believe that we should not implement policies to reduce fossil fuel consumption.

Some, but not all, of these groups are associated, directly or indirectly, with industries that could be affected by evidence linking the use of fossil fuels to global warming. The Western Fuels Association (WFA) and the American Petroleum Institute (API) are examples of such skeptic groups; the WFA distributes coal to companies to generate power, and the API is a trade organization representing the petroleum industry. These groups both argue that there is still too much uncertainty to warrent any action at this time. But because they are composed of industries that would be affected by reductions in fuel usage some people have questioned their motives claiming that they are more concerned with making profit then the fact that it may be harming the planet in the process. In this section, we will describe the arguments of the skeptics.

Skeptic views of the IPCC

Because the IPCC report was produced by a large body of scientists studying a topic with many uncertainties, it is often very vague, and some parts of it may be interpreted by both advocates and skeptics as supporting their cause. For example, in its statement on global warming, the American Petroleum Institute (API) cites

the statement "The balance of evidence suggests that there is a discernible human influence on global climate" from the IPCC's Second Assessment Report. The API holds that, since humans are likely to influence climate in many ways such as deforestation and agriculture, (which can contribute directly or indirectly to greenhouse gas emissions), this statement does not imply that CO_2 emissions from fossil fuels are warming the Earth.[18]

Economics

Those who oppose taking action to reduce CO_2 emissions, as proposed by the Kyoto Protocol for example, often cite economics, saying that reducing CO_2 emissions would be expensive and would be a severe strain on the U.S. economy. William Cline of the Institute for International Economics has estimated that the cost of cutting CO_2 emissions by one-third by 2040 would be 3.5 percent of world gross product, or $900 billion annually in terms of estimated world output in 1992.[19] Moore argues that this would hurt the world economy, the money being better spent on investments in developing countries. (It is interesting to note that William Cline in the publication cited by Moore, "Global Warming the Economic Stakes," was actually arguing for reducing carbon dioxide emissions to avoid much greater "costs" associated with global warming in the long term.) The API's web site discusses a study released by WEFA, an economic forecasting firm, that states that the regulations of the Kyoto Protocol jeopardize 2.4 million American jobs in mining, energy, manufacturing, agriculture, and service industries, and predicts an impact of $2700 to the average American family as prices rise. Economists at Charles River Associates have made similar findings, using a model used by the

U. S. administration and modifying some assumptions, attempting to make them more realistic.[20]

The U.S. cannot do anything about it

Some groups have also argued that proposed regulations will not be useful, even if global warming proves to be a threat. For example, the American Petroleum Institute argues that the Kyoto Protocol will be ineffective since developing countries will not be required to participate and they will become increasingly large emitters of green-house gases. They also state that there is research that shows that the Kyoto targets will only lower global temperatures by 1/20 of a degree Centigrade by the year 2050.[21]

Lack of evidence

In a review of issues involving global warming, the Oregon Institute of Science and Medicine argues that climatological data has not supported the hypothesis that increased CO_2 emissions cause global warming. Siting measurements from weather balloons and satellites that show trends from 1979 to 1996 of -0.60 and -0.45 C per decade, respectively, the article states that temperatures have actually been cooling slightly in the past two decades. It argues that temperatures had been increasing from 1900 to 1940, but this could be explained as part of a warming trend that had been going on for three centuries following the "little ice age", and temperatures have not been increasing over the past half century, when CO_2 emissions have been increasing.[22] Although this petition was never peer-reviewed, it was widely distributed and signed by thousands of people.[23] Climate is a complex

16

issue they argue; natural variation will occur, and temperature can change as a result of factors other than human influence, such as an increase in solar radiation.

Effects

Some of the arguments concerning global warming suggest that the Earth's warming and/or heightened levels of CO_2 in the atmosphere will have effects that are mostly beneficial to humans. Thomas Gayle Moore, for example, states that the Earth's temperature has fluctuated naturally over the last 10000 years and gives examples of success of humans over the past few millennia coinciding with warming of the Earth. He states that South America and Australia were believed to be both warmer and wetter during the climate optimum between 4000 and 2000 B.C., deserts in Australia and many other areas having expanded when this epoch ended and temperatures cooled. He also correlates famine in Europe and Asia and slowing of population growth with a rapid decline in temperatures between 1200 and 1400 A.D.[24]

Other groups, such as the Greening Earth Society (GES), maintain that increased CO_2 emissions will benefit the Earth because plants will grow better in the increased carbon dioxide concentrations. Since plants need to absorb CO_2 to produce the sugars that they use to store energy, GES maintains that more CO_2 in the atmosphere will make it even easier for them to produce these sugars which will help them grow.

Summary

Arguments have been made by skeptics on several fronts. While these arguments differ, all of them imply that it is unwise to take action to limit CO_2 emissions.

2.1.4 The overall effects

Skeptics often use areas of legitimate scientific debate to reinforce their claims that action should not be taken yet. However, predictions of future effects of global warming carry a great deal of uncertainty, so effects may be more severe than what is predicted as well as less severe. Because scientists have acknowledged that the uncertainty could work both ways, it should not be used as a reason for inaction.[25]

The validity of skeptic research is also sometimes questionable because of the industrial interests that skeptics often represent. It may be worth noting, for example, that API's arguments suggesting that reducing energy consumption would be prohibitively expensive do not address possible methods of using energy more efficiently without sacrificing comfort or productivity, or the potential costs needed to adapt to warmer temperatures. It is unclear whether the models that the API refers to take these into account, but we have no evidence to suggest that they do. This possible omission raises questions about the validity of their claims relating to the costs of adhering to the Kyoto Protocol.

However, skeptic groups have been effective at raising doubt about taking action. For example, the Clinton Administration still has not submitted the Kyoto Protocall to the Senate for ratification because there is overwhelming support

18

against it. In spite of the recommendations of the IPCC that global warming is a real problem and that something should be done to deal with it, the Senate will still not sign an international treaty that will do just that because many sentaors still doubt that there is a problem because of skeptic literature.

2.1.5 Summary

It is because skeptics can have such a large effect on public policy that we feel that their arguments need to be studied in greater detail. Before we could study their arguments however, we wanted to learn more about what types of organizations they might be. In the next section we discuss a model that can be used to categorize various organizations based on the types of incentives they offer.

2.2 Types of organizations

Skeptic groups are composed of people who all have various motives for joining these organizations. Therefore, an understanding of the motivations of people who join interest groups is important to our understanding of skeptic groups. An analysis of some of the reasons why people join voluntary organizations was made by James Q. Wilson in his classic book Political Organizations. According to Wilson people join an organization because they hope to acquire some benefit from it. There are three main types of benefits that people hope to acquire which are material, purposive, and solidary benefits. Each of the main types of groups also has associated sub-categories.[26]

Wilson emphasized that his analysis was intended to be applied only to volun-

tary organizations which means that it would not be appropriate as such to apply his models to a corporation where workers are paid for doing their jobs. However, groups of corporations that band together in a coalition, such as petroleum companies have done in the API, can be studied since the members of the American Petrolium Institute (which are all fossil fuel companies instead of people), are in the organization by choice.

Acording to Wilson, material benefits are monetary benefits or benefits that are easily converted into some amount of money such as access to various goods and services. Material benefits can further be classified according to exclusive benefits and individual benefits.[27] An example of material benefits as it relates to this particular project on global warming can be found by examining the API. The API works to sell more oil to people thereby increasing the profits of its members. By its efforts to block legislation that would reduce the consumption of fossil fuels they are working indirectly toward their goal of selling more oil. This means more profits for all of the companies involved.

Exclusive benefits are benefits that are only available to the members of an organization, but they are available to all of the members. The above example of the API is an exclusive material benefit. Another example of an exclusive benefit would be a group of hypothetical Solar Panel Companies testifying before Congress that the Earth has only five years to live unless huge subsidies are made to their industries and unless everyone buys a solar panel. Since this would increase their profits it is a material benefit. Individual benefits are benefits that are only given to a specific person. An example of this would be a hypothetical Scientist S who downplays the effects that greenhouse gasses have on the biosphere in order to

get a job with a hypothetical Petrolium Company P. The benefit of a job that Petrolium Company P bestows is on Scientist S alone. Individual benefits are not used frequently as it tend to undermine notions of equality within the organization.

According to Wilson, a purposive benefit is emotional satisfaction that a member gets from contributing to a specific cause.[28] They often benefit other people as well as the membership of the organization. For instance, a purposive group might be dedicated to saving a patch of rain-forest. Perhaps none of the members own a part of the rain-forest but they are dedicated to saving it for reasons such as the fact that they like forests, they feel that biodiversity is important and saving the forest will help preserve biodiversity, or they just like the idea that the forest is around. Wilson reasoned that since saving the forest will not only benefit the members of the group but also other people who are not members. Since everyone benefits from their efforts, then if such a group is succesful, then it may not matter if a particular person joined or not since they still get the benefits of the rain forests that the members do. Unless the group is very small such that each member's efforts are directly noticable, it is also unlikely that the action or inaction of any one person will make a difference. Therefore, the only benefit that some members might get from such a group is emotional satisfaction from "doing their part" to help save the rainforest.

According to Wilson, the three types of purposive benefits are goal-oriented, ideological, and redemptive.[29] Goal-oriented organizations have a single specific goal they are trying to achieve. An example of a group that seems to be goal-oriented is the Greening Earth Society. Their members believe that more CO_2 in the atmosphere will allow plants to grow faster. If they succeed in getting people

to use more fossil fuels and their belief is correct, then everyone will benefit from the increase in plant growth. A goal oriented group may also have a specific set of purposes with respect to a particular part of society. An example of this would be hypothetical group SUV, USA! which promotes SUV ownership. Their goals would be ongoing and related to SUV use and therefore such a group would be opposed to regulations that would restrict ownership of fuel inefficient vehicles.

Ideological groups as defined by Wilson are groups that have "a systemic set of assumptions, theories, and values that offer an interpretation of, and program for, man in all aspects of his life or society as a whole." The main purpose of such groups is to convert others to their beliefs.[30] An example would be Mysterious Environmental Cult M which tries to convince people that the end of the world is "near" and that you can only be "saved" by abstaining from eating meat, (because meat farming is wastefull of food and resources), living a simple lifestyle, (so as not to overburden the planet's resources), by obeying the Cult leader's every command, (because of his wisdom in environmental matters), and by collecting "donations" for the organization, (which will be used to help save the planet of course). Mysterious Environmental Cult M has theories about the world, advocates a characteristic lifestyle and is therefore an ideological organization, albeit an extreme example of one. (Author's note: any group that has a single letter in its name, such as the letter "M" in the previous example, is only a ficticious group we are using to illistrate an example.)

The finaal type of purpose group is a redemptive organization. These organizations work by setting an example for others to follow and strictly adhering to their principles. For example, a ficticious group, "The inhabitants of Solar City",

live in a commune and only use solar electricity and drive solar cars. Such a group would be redemptive since it attempts to set an example for others to follow by only using solar-powered items.

Solidary benefits are defined by Wilson as being "intangible rewards arising out of the act of associating ... with people."[31] Such rewards can include a feeling of belonging within the organization and a certain distinction with associating with that organization. These are called general benefits. They can also include the benefit of holding a title or office within the organization. These are called specific benefits and can only be given out to a limited number of people to be meaningful. (Or else if many positions or offices are given out within the organization the importance of such positions must be ranked somehow so that some offices or positions are better or higher then others.) Often the awarding of specific solidary benefits is a source of dispute within the organization.[32]

An example of a general solidary benefit would be the hypothetical group "Club Siera." Although they do some environmental protection work it is mostly an exclusive organization that only invites top environmentalists to join. As a result of its exclusiveness, all of its members feel priveleged to join and to remain members because of the status that they get from being associated with the group. An example of a specific solidary benefit is the case of Lumberjack Mac who really only joined it because he hopes to be its president someday.

Although all types of incentives are usually important in maintaining membership in an organization, the most important incentives seem to be material. Groups that give out mainly material benefits tend to have a more stable membership as opposed to purposive groups that retain their membership only as long

as they can keep people dedicated to their cause.[33]

Our original hypothesis was that skeptic groups tend to be composed of or funded by fossil fuel companies. Since companies exist primarily to make money, it is reasonable to expect that many of the arguments coming from these groups will reflect economic concerns and will tend to downplay the effects of global warming. For this reason, a content analysis of these groups should probably focus on looking for these themes.

2.3   Previous work on skeptic groups

We have only found one prior study done on junk science in global warming. This study was done as an IQP by Jon Kennedy and William Kennerly.

Kennedy and Kennerly set out to create a strategy for dealing with junk science and analyzed the problem through a case study and interviews. They studied the Alar controversy to gain an understanding of the way junk science may influence policy and interviewed representatives of various groups that publish information on global warming to determine the methods that they use for spreading their message. They found that the skeptic groups who they contacted for interviews were more responsive than the "supporter" groups and suggested that the UCS should be responsive to people requesting interviews and try to better educate the public on scientific procedure.

This project had similar objectives to ours since we were studying similar issues, but it used different methodology. We feel that our approach of using content analysis has been more objective and has allowed us to expand on the work done

by the last group.

Chapter 3

Methodology

We have already demonstrated how global warming and greenhouse gasses are considered to be a major problem by many of the world's scientists. However, the high stakes involved for the fossil fuel companies has caused groups associated with them to use uncertainty about various aspects of the science to delay action to reduce the amounts of greenhouse gasses emitted. We felt that it would help advocacy groups to counteract these skeptic messages if an analysis of the types of arguments they used was performed. We therefore decided to use a technique called content analysis to determine what types of arguments the skeptic groups were using.

In this chapter, we will explain our methods for doing our content analysis. We begin by defining content analysis, discussing different methods of analyzing text, and explaining the advantages of using the technique of content analysis in our project. We then discuss what we counted and how we selected samples.

3.1 Definition of content analysis

Our project involved doing content analysis of skeptic groups. As defined by Berg, content analysis is "any technique for making inferences by systematically and objectively identifying special characteristics of messages."[34] This means that we look for repeated ideas in the messages that skeptic groups are giving. Messages can be any type of publication or statement by an organization or individual. Pamphlets, videos, web sites, lectures, books and any other product that communicates with an audience that is produced by the organization or person in question contains a message.

In our content analysis, we dealt only with the original sources of these skeptic messages, such as newsletters and papers produced directly by skeptic groups. News articles or radio and TV broadcasts stating the position of the person or organization are also publications, but it is less desirable to analyze any source that is second hand information and has already been interpreted by someone else. This is because meanings can sometimes be lost or added in the rewriting process because of the point of view or the interpretation of the reporter or journalist. Since this can add information that the original source never intended, it is best not to use these types of sources.

Berg defined these special characteristics of the message as key words and ideas that the researcher is looking for that relate to the topic of interest. They can be in one of seven forms which are words or terms, themes, characters (people) paragraphs, items, concepts, or semantics.

The first form, words, are the smallest unit that can be counted. For example,

one can count the frequency of certain words in a document. Words that are used more often are more important to the organization. For instance if the most common word a skeptic group uses in a particular brochure is "cost then one can conclude that they are most interested in cost issues.

Themes can be sentences or groups of words that have meaning to the analysis. Themes can be located anywhere inside the text so it is necessary to specify where one will look for them in advance. Characters are people one is studying. In this type of analysis, one would look for all references to that specific person or type of character within a text. Paragraphs can be counted according to their theme, but this is seldom done because there are often several different themes inside the same paragraph. Items are entire messages that are categorized according to their general message. Items can be books, papers, speeches, TV shows, or any other whole communication.

Concepts are entire groups of words. One looks for a particular word and then looks at the other words associated with it. For example if one is studying the attitude of people towards sea level rise then one might search for the term "sea level rise" in certain types of literature. One may find positive terms associated with this word such as "beach party" or "all year surfing" or one may find negative terms such as "flooding" or "completely submerged." By identifying and classifying these words one can determine a range of attitudes toward the subject. Semantics analyzes the "strength" or "weakness" of a word within a sentence.

Messages may also have what is called "latent" or "manifest" meaning. Manifest meaning is what is directly stated within the text. Word counts or character counts for instance are generally concerned with manifest meanings. Latent

meaning is the implied meaning within a text. Counts of concepts are generally concerned with latent meanings. It is generally best to look for both because it gives a broader range of information. If one looks only for manifest meaning then one may miss a variety of useful information that is in a text but not directly stated. If one looks only at latent meaning then one misses out on a large volume of information inside the text.

One must specify in advance which one of the seven types of analysis listed above are being conducted, what words or concepts are being counted, and whether one is concerned with identifying latent or manifest meanings. One also needs to specify what types of publications one is looking for. For instance, one would need to specify what group or groups one is analyzing publications from. One would need to specify the time frame that one is interested in, and whether this includes all publications or only certain ones. If there is a large body of information to analyze then one must also specify whether only a sample is going to be analyzed and if so how the sample groups were selected.

There are several advantages to performing a content analysis to gather information about our topic. First of all, it provides a non-intrusive means of researching the organizations one is interested in. Whereas an interview would be intrusive because the organization would be aware of the fact that it is being analyzed and what the analysis is about, a content analysis analyzes things that have already been produced. The organizations in question may therefore have no knowledge that an analysis of their publications is underway.

Another advantage is that publications can be analyzed over a long period of time. If a writing exists it can be analyzed. For example, if one wants to perform

a content analysis of thirteenth century English literature then one can do so if one can find the literature. The fact that writings can be analyzed over time also means that one can see how the position of a group has changed within a certain time frame, whereas an interview can generally only obtain information about current attitudes toward a topic.

A final advantage is that it is cost effective. The materials needed to perform a content analysis are generally only a series of publications (which may be freely available). One can also use computer programs to perform a content analysis and although these have a certain cost they are usually insignificant compared to the cost of conducting a large scale survey.

3.2 Our methods of content analysis

In order to determine the message of junk science groups using content analysis, we must have some kind of identifiable unit that we will search for within the items that we analyze. We define these units in this section and discuss how they will be used in our analysis.

The object of our content analysis was to determine the message of skeptic groups, or the set of ideas that they are trying to convey to the public on global warming and/or greenhouse gas emissions. In order to do this we had to break down the messages in their writings into specific units that we could count. In our review of literature items published by these groups, we noticed certain themes emerging within the messages of the groups that we analyzed. Even though all messages were different the arguments all fall into certain categories. We therefore

decided to use themes as the basic unit we would count. A theme, for our purposes, is a group of phrases that, taken together, oppose action to reduce global warming or emissions in greenhouse gases. We are looking for this type of theme because this is what the UCS and we are interested in. We identified four distinct themes: (1) there are economic reasons not to act, (2) the evidence does not support taking action, (3) there is no point in taking action, and (4) global warming and greenhouse gases are not cause for concern. These themes will be described in more detail below.

Within each theme used by junk science groups there are also several subcategories that we call arguments. Each argument is a more specific version of the original theme. They relate directly to one theme and to no other. Also, each argument within a theme must be identifiably different from all of the others within that theme.

Even the themes themselves had some variation within them. Within each theme, we have identified several sub-categories, or arguments. For example, within theme four we have identified two arguments. One argument (four A) states that global warming or increased greenhouse gas concentrations are not harmful. This relates to the general intent of the theme which is that global warming and greenhouse gases are not cause for concern. However, it is more specific because the argument directly states that they aren't harmful or not that harmful while the theme only states that they are not cause for concern. The other argument within this theme states that greenhouse gases and global warming are a good thing. This relates to the original theme because clearly something that is good is also not cause for concern. It is also different from the previous argument because

it says that these are good things while the first only states that CO2 and global warming are not a threat.

Within our four themes, we have identified a total of 18 different arguments. We tried to make these arguments specific enough to be useful, but general enough so that we didnt get lost in unessicary detail. Other researchers who analyze this same topic may therefore create different arguments or themes from our own. If an argument that a junk science group made could logically fit into one of our existing arguments, then we counted it as such. However, as with the themes, we added new arguments where we found something that could not be fit into the existing arguments.

The following section is a list of all of the themes and arguments that we identified.

1. **There are economic reasons not to require reductions in greenhouse gas emissions or the green-house effect.** This includes all arguments that relate to economics; groups that we've found generally argue that reducing CO_2 emissions would harm the U.S. and other world economies.

   (a) Acting will hurt the US economy. Reductions in greenhouse gas concentrations cannot come without harm to the US economy.

   (b) Acting will hurt the world economy.

   (c) Acting would cost money or jobs; Anything that suggests a cost, that does not fall into category 1d.

   (d) Acting would cost too much money or too many jobs; This will include arguments that suggest that the costs are too high. e) The US should

not reduce its emissions because developing countries will have a competitive advantage because they don't pay for their emissions; Some groups maintain that this will hurt the US economy because it will move jobs outside the United States.

2. **The scientific evidence does not support legislation by world governments to require reduction of greenhouse gases or global warming.** This theme deals partly with differences in interpretation of data and partly with the uncertainty of the science itself. Junk science groups that use this theme always claim one of two things. One claim they make is that no definite conclusions about global warming or greenhouse gas build-up can be drawn from scientific data that has been collected so far on the subject. For whatever reason they feel that the research that has been done isn't yet sufficient and that additional research is needed to confirm the presence of the greenhouse effect and what ecological impact it might have. The other claim they make is that the current data does indeed suggest a definite pattern: namely that they are correct in their belief that global warming is not a reality! They feel that all the results are in, that the whole thing is a misguided attempt by a few scientists to scare the public with threats about planetary destruction so that they can receive research grants and that there never will be a global warming threat.

Some arguments also have what we call a "junk science equivalent" argument. Originally we were looking for these arguments to tell us if the literature we reviewed was junk science or not. Although we decided not to use the term

"junk science" to describe the material we reviewed we are including these arguments here to demonstrate the thought process we went through. Eight separate junk science equivalent arguments were identified as being slightly different variations of the original and these are summarized below. Any item that has a junk science indicator was considered by us to be junk science. Science depends on ideas that can be supported or refuted with replicable experiments, based on logical reasoning, that consist of quantifiable data. Any argument that violates any part of this reasoning, (for instance, if it gives absolute answers that can't be refuted), is junk science by our definition. If a junk science argument is identified then a "-J" will be put next to it and in frequency counts it will be recorded in the same place as the other non-junk science arguments.

(a) Climate change or the buildup of CO_2 concentrations occurs naturally. It is caused, at least in part, by natural phenomenon such as solar activity and is not necessarily caused by any other human activities; there is no debate here that something is happening to make the Earth warm. However the geological record shows us that our planet has warmed and cooled many times over its long history. Perhaps this is all just a passing phase caused by increased solar radiation or the Earth being a little closer to the Sun. Since the warming trend is being brought about predominantly by natural events and only partly by human activities, reducing greenhouse gas emissions won't help and therefore we have no reason to act. This argument can refer to instances

34

where historical records have been cited to support claims that climate change is natural. It can not refer to historical records that have been cited to show that global warming is not harmful since it has happened before.

Junk science equivalent: Climate change occurs naturally. It is caused, by natural phenomenon such as solar activity and is not caused by any other human activities.

(b) Humans contribute to the problem in many different ways such as deforestation so it is unclear what role greenhouse gasses play; Again no debate that global warming is happening. They even agree that humans are the cause. However they draw the line at blaming the whole problem on greenhouse gas emissions. They argue that besides greenhouse gasses other activities such as deforestation, and the heat trapping ability of asphalt roads (called the "urban island effect") are contributing to global warming as well. How can the extent of greenhouse gas concentration on global warming be calculated when there are so many other factors involved they argue? Since it is difficult to calculate the effects of greenhouse gasses in the atmosphere we don't know if they're the main source of the problem or not. This argument is used by such groups as the fossil fuel industry when they don't want to disagree with the idea of global warming but they want to protect their own interests by! shifting the blame from their actions to the actions of all mankind. Junk science equivalent: Human activities that don't involve greenhouse

gas emissions, such as deforestation, cause global warming. Greenhouse gasses play no significant role.

(c) There is no evidence to link concentrations of CO_2 in the atmosphere with global warming; This argument disputes the effects from CO_2 concentration in the atmosphere on global warming. It is not concerned with the possible effects from deforestation, the urban island effect, or other causes and therefore it never mentions them.

Junk science equivalent: Evidence to link concentrations of CO_2 in the atmosphere with global warming can not be obtained.

(d) Because non-CO_2 emissions, such as NO_X or water vapor, play a much greater role in global warming; This argument is in some ways the opposite of the last one. The last argument said that there is no evidence to link CO_2 with global warming. This argument almost admits that CO_2 is a greenhouse gas and is therefore capable of causing global warming. However it states that the other greenhouse gasses, (especially water vapor), also cause global warming and that the effect from all of these is greater then the effect from CO_2 emissions. It would therefore be pointless, they reason, to reduce emissions of CO_2 when they play such a small role in the problem.

Junk science equivalent: Because non-CO_2 emissions, such as NO_X or water vapor, are the cause of global warming. CO_2 emissions play little or no part.

(e) There is no hard evidence that global warming is even occurring; We see

36

a break here from the other types of arguments mentioned above. All of the previous arguments did not dispute the existence of global warming. This argument does. This argument only disputes the possibility that the Earth's climate is warming and does not refer to any other effect (such as greenhouse gas concentration).

Also any statement worded to the effect that "The evidence that we currently have does not yet show that global warming is occurring. would fall into this category. The key words though are 'evidence that we currently have,' and 'yet.' This type of statement that is saying that the evidence gathered so far does not show any global warming trend. It does not explicitly rule out the possibility of the existence of global warming and it implies that future evidence gathered on the subject might more convincingly demonstrate the existence of global warming. If any similar argument, ("The evidence that we currently have does not yet show that global warming is occurring."), then goes on to rule out the possibility that global warming is occurring, it will be placed in 2f-J. If it implies that no future evidence can demonstrate the existence of global warming, then if will be placed in our next category (category 2e-j).

Arguments to the effect that "the Earth is only warming slightly or that the Earth is warming less than what has been predicted, as well as arguments that state that the data is not statistically significant, will be placed into this category.

Junk science equivalent: No hard evidence that global warming is even occurring can be gathered.

(f) There is hard evidence to show that global warming is probably not occurring; Not only does this argument dispute the possibility that global warming is occurring, it all but refutes it. It is much more skeptical of the possibility of global warming then 2e. Also, any arguments, which state that the Earth has been cooling, will be placed into this category.

Junk science equivalent: There is hard evidence to show that global warming is not occurring

(g) There is evidence to say that CO_2 emissions probably do not cause global warming; This sounds much like 2c. (There is no evidence to link concentrations of CO_2 with global warming.) However this argument is far more skeptical of the link between CO_2 and global warming. This argument does not deal with the question about whether global warming is occurring.

Junk science equivalent: There is evidence to say that CO_2 emissions do not cause global warming.

(h) There isn't sufficient scientific consensus on the issue. Scientists do not understand all of the issues related to climate change and more research is needed; This argument basically states that scientists don't agree on the meaning of the data that has been obtained. It claims that there is no scientific consensus on the issue and that more research should be performed before any policies are enacted.

Junk science equivalent: There will never be sufficient scientific consensus on the issue. Scientists will never understand all of the issues related to climate change and more research is unnecessary for this reason. -This last junk science equivalent does not represent science that is being conducted in a bad way since the theory that there will never be a sufficient scientific consensus on the issue is science as such. This equivalent is listed here merely as one of the indicators.

3. **There is no point in trying to reduce greenhouse gas emissions or global warming, even if they are harmful.** This theme includes all arguments that suggest that action will be ineffective, for reasons other than a lack of evidence to suggest that global warming is happening.

   (a) Reducing emissions/fuel consumption in the US would not halt global warming or the build-up of CO2 because developing countries would continue to pollute; Many of these countries are vary populous and will be the main producers of CO_2 in the future.

   (b) It is too late to prevent CO2 build-up or global warming; we have already put a large amount of CO2 in the atmosphere, and reducing emissions will not help much.

   (c) Delaying a decade or two would not cause any significant harm, so we can wait until we know more about the science before committing to reductions on CO2 emissions and/or global warming.

4. **Global warming or increased CO_2 emissions might not be cause for**

concern. This includes any arguments that suggest that they would not be a problem (as opposed to theme 2, which states that global warming is not occurring).

(a) Global warming or increased CO2 emissions are not harmful or not very harmful.

(b) Global warming or increased CO2 emissions are beneficial; Global warming would do more good than harm, and experiments show that plants will grow faster with increased levels of CO_2 in the atmosphere.

When reading documents, we marked each occurrence of an argument. We later counted the number of times each argument occurred in the document.

We have found some topics which may not appear to relate directly to global warming but which we feel relate indirectly to the global warming debate in such a way that they need to be counted. These topics include computer-based climate models (models used to predict warming of the Earth caused by greenhouse gases), the Kyoto Protocol, and oceanic warming (warming of the ocean caused by warming of the atmosphere). We considered the question of whether these should not be counted because they deal with consequences of global warming rather than directly with the subject. Also, a group may, for example, support taking action to reduce global warming but oppose the Kyoto Protocol.

However, we have found that these topics are used, in certain circumstances, as indirect arguments against taking action. (The word argument as used here should not be confused with the subcategory of a theme as discussed earlier.) By attacking the credibility of the Kyoto Protocol or computer models, or showing

that the ocean is not warming, a group may be indirectly arguing against measures in general to reduce emissions of greenhouse gases or global warming. We will count these topics if they are used by a group that is primarily opposed to taking action against global warming. We feel that, in such cases, the group is more interested in the issue of global warming than in the topic of the indirect argument. If the indirect argument is made in conjunction with direct arguments, then we will assume that the group is interested in the issues of global warming and greenhouse gases, so we will count the argument.

3.3 General procedures

We analyzed material from groups that the UCS has identified as publishing junk science that are skeptical of global warming. These groups included the American Petroleum Institute (API), the Global Climate Coalition (GCC), the Greening Earth Society (GES), the Competitive Enterprise Institute (CEI), the Heartland Institute, the Marshall Institute, the Oregon Institute of Science and Medicine (OISM), and the Science and Environmental Policy Project (SEPP). Material that we analyze was taken from the organizationsweb pages and any booklets, brochures, and video cassettes we were able to obtain from the organizations. In this section we will discuss what we were looking for in a particular item, and why we decided to exclude certain other items.

3.3.1 Identifying junk science literature

Before a content analysis could be conducted, we needed to identify as many sources of junk science literature as possible that were relevant to our investigation. We chose only groups that are skeptical of the occurrence of global warming or of the benefits of abating greenhouse gas emissions. While there may be junk science groups that advocate halting the spread of global warming (non-skeptic groups), the purpose of this project was to come up with a recommendation about skeptic groups only.

We also felt that not all literature that uses junk science should be used in our analysis. While all junk science is harmful to the scientific method, we feel that it is not all equally harmful because some people just use it thinking that it is science and some people produce it without following the scientific method. A reporter who asks a junk science group for their opinion so that she can present a non-bias story, or a high school kid who uses junk science to write a report for some school science project are not nearly as harmful as a petroleum company that spends millions of dollars on an add campaign to convince people that the economy will be in shambles if a 25 cent gas tax is implemented. There is a difference between using a bad source of information because you don't know any better and writing a bad source of information because you hope to confuse people with it. While the purpose of every junk science group might not be to confuse the public about global warming, we will never the less concentrate on the source groups who are putting out the original material and hope that by killing the roots of the problem we can kill the whole weed.

This project therefore focused only on groups that talk about themselves and their positions on global warming. All reviews of information from junk science literature done by others were not used as part of our analysis. This is so that we could cut to the source of the junk science problem without having to worry about the effects that this source has on others. The groups that we included in our study cited either "prime resource" articles (peer reviewed or not) on the issue of global warming, or they cited the opinions or positions of people or organizations on the subject of global warming, both for the purpose of backing up their position. An example of this is the way that OISM cites articles from Nature and Science magazines to support its position. We thus excluded items written by people which are intended to be reviews of certain groups or literature, or people who cite junk science in an attempt to present non-partisan views of an issue, (as a news article would do).

We would also use literature that states anything to the effect of reducing greenhouse gas emissions is impractical because it would cost too much, if it doesnt analyze the benefits. We would not use literature that states anything to the effect that "there will be a large cost to mitigating the greenhouse effect" or peer reviewed literature that weighs the benefits of reducing CO_2 emissions against the costs, even if its conclusion goes against the consensus.

As an example of a literature item that would be considered in our analysis, consider economist E. Economist E has done research that indicates that the only way to reverse the greenhouse effect is to invest ten trillion dollars in alternative energy sources. He therefore argues that this is too expensive for the world economy and that efforts to reduce the greenhouse effect should not be made. Economist E

would be included in our analysis because he has failed to mention that there are also effects from contributing to the greenhouse effect such as rising sea levels and loss of species habitat. He is therefore ignoring the larger issue. If he had done an analysis of the "costs" of loosing these intangible benefits and compared this with the cost to loss of productivity to the world from its developing nations, then he would not be used in our analysis. Under these conditions, he would be looking at the big picture.

An example of an item that we would not include would be literature from petroleum company P saying that implementing greenhouse gas reduction measures would cost the average family an additional \$20 per month in fuel consumption charges at current energy consumption levels. Petroleum company P would not be used in our analysis because, although they may be ignoring certain considerations in their calculations, (such as the fact that increased prices on gas will lead to increased efficiency in gas use which may cancel out their projected price increase), they are not making any argument that CO_2 levels should not be reduced. P is using propaganda techniques to try and halt passage of legislation on the global warming issue, and is also doing general complaining about this bill for reasons that are not obvious to us since P will be making more money by its own arguments. Both are interesting topics of research, but our analysis focused only on junk science related to globa! l warming, or, more specifically, people who are against halting the buildup of CO_2 in the atmosphere. P would have been included if they had used this argument as evidence that it would not be best to cut CO_2 emissions.

Another example of literature that would not have been used in our analysis is

a paper by Economist $ whose analysis shows that the benefits of reducing greenhouse gases would be twenty trillion dollars but that the costs of such emission reduction would be thirty trillion dollars. Economist $ argues that it is therefore not worth it to reduce emissions because the costs are greater then the benefits. As long as this item had been peer reviewed, it would not be included because economist $ is inviting debate on the subject. He has considered all of the arguments (hopefully) and has published a statement saying that he doesn't agree with reducing greenhouse gas emissions. Even though he doesn't agree with the consensus as long as his analysis is done properly his work can not be called junk science. If his article had not been peer reviewed then it would be covered under our analysis. In general, any peer reviewed article will not be used in our analysis even if it goes agai! nst the consensus.

3.3.2   Finding literature

To locate junk science literature, we conducted searches for organizations on the web using information about such groups from the UCS web site. We also contacted several groups to obtain additional information on global warming and their position on the issue.

Items were only reviewed if they have been recently published. This is so that we could get an idea of what these groups are saying now as opposed to what was said in the past. Our cutoff dates were October 1, 1997 to October 1, 1999. These dates were arbitrarily established. The lower limit from 1997 is because our group does not consider anything published prior to that date to be current information.

The upper date was established because it will be difficult to always review any "up to the minute" changes that may take place. Any brochures that are received will be considered "current" even if their last copyright date outside of our range. This is because the groups that sent them to us would not be doing so if the brochure did not conform to its current attitudes. Web sites that were created or last modified prior to October 1, 1997 will also be used if they are referred to by an organization whose web site was created or modified during these time limits. The logic is the same as before: if a new organization wants to cite an old piece of literature to support its argument, then this says something about the current attitude of the new group. In both cases, however, the thing that would be reviewed in our analysis is the position of the group that sent out/ maintains the information and not the position of the old information.

As an example of the above, let us pretend that junk science group B published a pamphlet in 1995 about the benefits to plant life of increased CO_2 concentration in the atmosphere. Wandering around in the library in 1999, our group stumbles across a copy of it. We would not include it in our analysis since it was published outside of our time limit. However, if we called junk science group B and they sent us the same pamphlet today then we would include it in our analysis since they are basically saying that this pamphlet conforms to their current ideas. If we also went to the home page of Back to the Land Group Y and found an old copy of this pamphlet that they had scanned in, as evidence that supported their position, then we would also read the pamphlet because it supports their current position. However, in this case we would then talk about the position of back to the land group Y on the global warming issue and not about the content of B's

brochure since Y would be using it to express their position.

3.3.3 Selecting literature

We began by finding as many items as we can from each of the groups that met our selection criteria. We then analyzed a subset of these items. We sorted the items into groups depending on which organization they came from and select one item from each group to analyze. This method allowed us to learn what each group thinks about the issue of global warming. This is called a stratified selection process. After we had analyzed one selection from each group, we analyzed additional items from some groups to gain a somewhat better sample.

When looking at web sites, we counted a home page and all linked pages that are on the site as one item. Links recommended on the page that are off-site would be counted as separate items. If a home page had information from a source other than the maintainer of the site, (as, for example, a scanned in brochure), we would search for the original source of the information. If it could be found elsewhere, then we would consider it representative of the views of the maintainer of the original web page if it was endorsed by that site. Otherwise we would consider it a part of the original home page rather than a separate item. (Endorsed by the original site means that the group says something like "to better understand our views read this pamphlet that we scanned in." An example of a non-endorsed item is if the site recommends "for further information/reading on the subject please see the following links" since they may only be about the subject in general or they may have c! hanged since the group was there last.)

If an organization sent several pieces of information in response to an inquiry, each document would be counted as a separate item. We assumed that information meant to be counted as one item will be counted together. If we got the same piece of information from two different sources, such as from a web site and from a pamphlet or from two different web sites, it would only be counted once.

After selecting our items, we began the coding process looking for the four types of arguments that we discussed in our section on methods of content analysis. If an argument was made several times in an item, we counted it multiple times, considering it an indication of the importance of the argument to that group. If the same argument occurred in non-consecutive sentences, then we would counted as a separate instance of the same argument. If an item contained two variations of an argument of the same category type, (ex: more CO_2 makes plants grow faster, more CO_2 makes more plants grow, therefore more CO_2 is better) then they will be counted as separate arguments and therefore two separate countings of the same type of theme.

3.3.4 Analysis of data

After the coding process was complete, we proceeded to analyze our data and sort it in various ways according to the number of groups, number of items, and frequency of each argument. From this sorting method, we were able to learn what type of argument is the most important to a particular group, and which types of arguments are most prevalent among a particular type of group.

3.4 Determining types of groups

Since our analysis involved determining which category each group belonged to (i.e., material, purposive, or solidary), we needed a way to categorize the groups. We did this, for the purpose of our report, by searching their web page for a mission statement or a description of the group's purpose. If its purpose indicated that its purpose involved material benefits, then we classified the group as material. On the other hand, we classified groups as purposive if they described themselves as having been founded for the purpose of doing scientific research or participating in the global warming debate. This method of classification caused some groups, such as GCC and GES, to be classified as purposive, even if they acted on the behalf of material groups.

Chapter 4

Results and analysis

According to the findings of many scientists, global warming has the potential to be one of the greatest threats to the environment of all time. However, legitimate scientific uncertainty on the issue has given rise to various skeptic groups who doubt the existence or the extent of these problems. Various groups, sometimes pursuing special interests relating to the fossil fuel industry, have used this uncertainty to delay or obstruct efforts to stem the tide of this potential catastrophe. In an effort to combat a growing scientific consensus, some groups may even resort to confusing the public with improperly conducted research called junk science. In order to better understand the message of such groups, so that it can be more effectively counteracted, we conducted an analysis of their literature using a technique called content analysis. In our content analysis, we reviewed some of the available publications of such groups, on the issue of global warming, and counted ho! w often certain themes were used. We will now present our findings from our analysis of the various groups. We will first give our data and explain which

arguments were used most often. We will then turn to discussing the link between these arguments and the types of groups making them.

It may be worth noting that we did not make any attempt to address the issue of whether our literature should be considered "junk science", so we are not using that term. For this reason, our results should be considered representative of the literature put out by skeptic groups rather than a representation of junk science. We will discuss this more fully in the next chapter.

4.1 Summary of content analysis results

In all, eight groups were analyzed which were the American Petroleum Institute (API), the Competitive Enterprise Institute (CEI), the Global Climate Coalition (GCC), the Greening Earth Society (GES), the Heartland Institute (abbreviated HI below), the Marshall Institute (abbreviated MI below), the Oregon Institute of Science and Medicine (OISM), and the Science and Environmental Policy Project (SEPP). A total of 428 separate arguments were found. As previously explained, we found eighteen different types of arguments, which we had divided into four themes, in our initial content analysis. We will first discuss our findings as related to themes. We will then discuss the arguments more specifically.

4.1.1 Results by Theme

Although we counted the occurrences of each argument separately within our themes, we felt that it would be useful to look at the results in terms of the themes first to give an overall picture of what is happening. As discussed earlier,

we have identified four themes; (1) there are economic reasons not to act, (2) the evidence does not support taking action, (3) action will not be effective even if global warming will be harmful, and (4) global warming or increased atmospheric CO_2 concentrations are not very harmful. Contrary to our initial expectation that most groups would use the economic-based theme (theme 1) most frequently, theme 2 was by far the most widely used theme. We will now discuss in greater detail the frequencies of themes for the groups we researched.

After performing our content analysis, we counted the number of times each group used each particular theme. Our results are summarized in the table below (Table 4.1). The names of the themes on the left side column are merely reminders and are not full descriptions of each theme. For such a description see chapter three "Methodology."

Table 4.1

	API	CEI	GCC	GES	HI	MI	OISM	SEPP	Total
Economic (1)	26	18	8	2	22	3	1	10	91
Evidenciary (2)	32	20	17	21	9	21	39	58	219
Does not matter (3)	7	4	3	1	2	7	0	5	32
Benefits (4)	4	19	3	13	1	3	24	25	96
Total	69	61	31	37	34	34	64	98	428

Table 4.1: Number of occurrences of each theme for all groups.

This raw data is not that useful for doing comparisons because our analysis gave us more arguments from some groups than from other groups. Therefore, to make sense of the above data, we converted all of our numbers into percentages as listed in Table 4.2 below. The percentage is just the number of times a particular group uses a particular theme, divided by the total number of arguments it uses in all themes, times one hundred percent.

Table 4.2

	API	CEI	GCC	GES	HI	MI	OISM	SEPP
Economic (1)	37.7	29.5	25.8	5.4	64.7	8.8	1.6	10.2
Evidenciary (2)	46.4	32.8	54.8	56.8	26.5	61.8	60.9	59.2
Does not matter (3)	10.1	6.6	9.7	2.7	5.9	20.6	0	5.1
Benefits (4)	5.8	31.2	9.7	35.1	2.9	8.8	37.5	25.5

Table 4.2: Occurrences of each theme by percentage for all groups.

Although these numbers make a little more sense, we wanted to find the average percent occurrence of a particular theme across all groups. To determine the average percentage of each theme, we used two different methods. The first method was a common sense method where we added up the number of times a particular theme occurred among all of the groups and divided by the total number of themes occurring in all of the groups in all of the analysis. For example, from Table 4.1, the total number of all arguments (1A to 4B) occurring in all groups (API to SEPP) was 428. (We are using the term arguments in describing this calculation because they are the smallest unit that we counted. All of our themes are made up of groups of arguments. This is why we are using them to calculate our percentage of themes.) The total number of times that theme 4 occurred in all groups (API to SEPP) was 96. Dividing 96 into 428 and taking the percentage we find that theme 4 was used 22.4% of the! time. This "total average" method is probably the best way to analyze our findings given the assumption that people who review skeptic literature read from many different sources.

The previous method contains a possible flaw. The problem is that groups who have a high frequency of argument usage under our analysis will contribute a greater amount to the final percentage then groups that have a lower frequency of

arguments. For instance, GCC used a total of only 31 arguments while SEPP used a total of 98 arguments. Since some groups used a greater percentage of certain arguments then others we were concerned that groups where more arguments were found would "drown" out groups with fewer arguments. To compensate for this effect we did a second calculation where we averaged the percentage values of all themes (found in table 4.2) from all eight groups. For example, CEI had a total of 61 arguments. Nineteen of those were from theme 4, so 31.2% of their arguments were of this category. For the other seven groups the percentage of theme 4 used was 5.8, 9.7, 35.1, 2.9, 8.8, 37.5, and 25.5. Adding all of these percentages and dividing by 8 gives us an! average percentage of 19.6%. This "group weighted" method is probably the best way to analyze our findings given the assumption that people are only reading from only one or two sources.

Table 4.3 shows the results of our calculation of the percentage of each theme among all groups using the "total average" and "group weighted" calculation methods described above. Even though the two calculations used entirely different methods to arrive at a percentage value, the results are similar, not varying by more than 2.8%. Therefore, since the results of our calculations are not very different, we can conclude that our analysis of the results is valid.

Table 4.3

	Total average	Group weighted
Economic (1)	21.3	23.0
Evidenciary (2)	51.2	49.9
Does not matter (3)	7.5	7.6
Benefits (4)	22.4	19.6

Table 4.3: Comparison of occurrences of themes by percentages using both methods of calculation as discussed in the text.

By far the most common theme that emerged from our study was the theme stating that the scientific evidence does not support taking action to reduce greenhouse gas emissions (Theme 2), accounting for about 50% of all arguments as shown by the above table. Next most common were the themes stating that there are economic reasons not to reduce emissions (Theme 1), and that global warming or greenhouse gases might not be that harmful (Theme 4) accounting for about 22% and 21% of the themes, respectively. The last theme (Theme 3) which stated that there is no point in taking action, even if global warming is harmful accounted for only about 7% of the arguments. These results are contrary to our initial expectation that most groups would rely heavily on economic themes. We will discuss this unusual finding in section 4.2.

4.1.2 Frequencies of argument usage

In order to look at our findings in more detail, we will now examine the frequencies of each argument used. Our results indicate that, in general, the arguments in the literature we analyzed were primarily concerned with debunking the theory of global warming. The other frequently-used arguments state that global warming will cost too much to stop or could be beneficial. These results are also contrary to our initial expectations since only one economic argument (1c) made it to the top five.

Our raw data of the number of times each particular argument was used within each group are shown below (Table 4.4). Again the titles given are just reminders and not descriptions of each argument. (See explanation from Table 4.1.)

Table 4.4

	API	CEI	GCC	GES	HI	MI	OISM	SEPP
Hurt US economy (1a)	6	3	2	2	8	2	0	1
Hurt world econ. (1b)	0	1	1	0	0	1	1	5
Big cost (1c)	18	12	3	0	11	0	0	4
Costs too much (1d)	2	1	0	0	0	0	0	0
Jobs go overseas (1e)	0	1	2	0	3	0	0	0
GW is natural (2a)	10	4	4	6	1	2	6	1
Other human causes (2b)	0	0	0	0	0	0	0	5
No CO_2-GW link (2c)	0	1	2	0	0	4	2	1
Other GHGs worse (2d)	0	0	0	0	0	0	1	1
Possibly no warming (2e)	2	4	5	6	3	5	5	11
Probably no warming (2f)	0	0	2	8	2	3	17	7
Probably not CO_2 (2g)	0	0	0	0	1	0	4	0
Science uncertain (2h)	20	11	4	1	2	7	4	20
US would be alone (3a)	5	1	1	0	2	1	0	3
It's too late(3b)	1	2	0	0	0	0	0	0
It can wait (3c)	1	1	2	1	0	6	0	2
CO_2 not bad (4a)	2	10	0	3	1	2	6	7
CO_2 is good (4b)	2	9	3	10	0	1	18	18
Total	69	61	31	37	34	34	64	98

Table 4.4: List of the number of arguments used by each group. Under argument 2c the initials "GW" stand for global warming, and under 2d the initials "GHGs" stand for green house gases.

To calculate the percentage of times that a group used a particular argument we used the same method as described above from Table 4.2. (The number of times a particular class of argument, such as 2a, was used in a group divided by the total number of arguments within the group times one hundred percent.) The results are shown below in Table 4.5. To convert these figures to a single average percentage the total average and group weighted methods described above were used. The results of that calculation are shown below in Table 4.6.

In spite of using two different methods to calculate the argument percentages,

56

Table 4.5

	API	CEI	GCC	GES	HI	MI	OISM	SEPP
Hurt US economy (1a)	8.7	4.9	6.4	5.4	23.5	5.9	0	1.0
Hurt world econ. (1b)	0	1.6	3.2	0	0	2.9	1.6	5.1
Big cost (1c)	26.1	19.7	9.7	0	32.4	0	0	4.1
Costs too much (1d)	2.9	1.6	0	0	0	0	0	0
Jobs go overseas (1e)	0	1.6	6.4	0	8.8	0	0	0
GW is natural (2a)	14.5	6.6	12.9	16.2	2.9	5.9	9.4	13.3
Other human causes (2b)	0	0	0	0	0	0	0	5.1
No CO_2-GW link (2c)	0	1.6	6.25	0	0	11.8	3.1	1.0
Other GHGs worse (2d)	0	0	0	0	0	0	1.6	1.0
Possibly no warming (2e)	2.9	6.6	16.1	16.2	8.8	14.7	7.8	11.2
Probably no warming (2f)	0	0	6.4	21.6	5.9	8.8	26.6	7.1
Probably not CO_2 (2g)	0	0	0	0	2.9	0	6.2	0
Science uncertain (2h)	29.0	18	12.9	2.7	5.9	20.6	6.2	20.4
US would be alone (3a)	7.2	1.6	3.2	0	5.9	2.9	0	3.1
It's too late(3b)	1.4	3.3	0	0	0	0	0	0
It can wait (3c)	1.4	1.6	6.4	2.7	0	17.6	0	2.0
CO_2 not bad (4a)	2.9	16.4	0	8.1	2.9	5.9	9.4	7.1
CO_2 is good (4b)	2.9	14.8	9.7	27.0	0	2.9	28.1	18.4

Table 4.5: Frequency of each argument by percentage for all groups.

these two sets of values are also similar to each other, with the largest variation being 1.6% between the two sets of calculations. Out of the five arguments used most frequently, three were evidenciary (Theme 2). The most widely-used argument was of this theme and dealt with a lack of scientific consensus on the issue of global warming (argument 2h). The arguments stating that climate change occurs naturally (2a), and that there is no hard evidence that global warming is occurring (2e) were also in the top five. The second most popular argument was that global warming or CO_2 emissions are beneficial. (4b), and the third most popular was that there will be a large cost associated with trying to convert to less CO_2

Table 4.6

	Total average	Group weighted
Hurt US economy (1a)	7.0	5.6
Hurt world econ. (1b)	1.8	2.1
Big cost (1c)	11.5	11.2
Costs too much (1d)	0.6	0.7
Jobs go overseas (1e)	2.1	1.4
GW is natural (2a)	10.2	10.7
Other human causes (2b)	0.6	1.2
No CO_2-GW link (2c)	3.0	2.3
Other GHGs worse (2d)	0.3	0.5
Possibly no warming (2e)	10.5	9.6
Probably no warming (2f)	9.6	9.1
Probably not CO_2 (2g)	1.1	1.2
Science uncertain (2h)	14.5	16.1
US would be alone (3a)	3.0	3.0
It's too late(3b)	0.6	0.7
It can wait (3c)	4.0	3.0
CO_2 not bad (4a)	6.6	7.2
CO_2 is good (4b)	13.0	14.2

Table 4.6: Frequency of arguments in each group by percentage using both calculation methods as described in the text.

intensive fuels (1c).

The least frequently used argument we found was that greenhouse gases other than CO_2 play a much greater role in global warming (2d). The arguments that humans contribute to the problem of global warming in many different ways aside from greenhouse gas emissions (2b), that reducing CO_2 emissions would cost too much money or too many jobs (1d), that it is too late to prevent the build-up of CO_2 (3b), and that CO_2 emissions probably do not cause global warming (2g), were also used infrequently.

4.2 Analysis

Before we began our content analysis, we hypothesized that the arguments that a group made were determined by the type of group it was and that most groups that we found would be material in nature. If these hypotheses were correct, then most of the arguments we found would have been economic. However, as shown in the previous section, this was not the case. In this section, we will offer a possible explanation of our results. We will first show that most of our groups should be considered purposive, addressing the issue of whether all of our groups can be categorized using Wilson's method. We will then discuss the lack of a complete correlation between the kind of arguments that a group uses and the kind of group that it is. Finally, we will offer an explanation for the large amount of variation seen in the frequencies of argument and theme usage between groups.

4.2.1 Group types

In our literature review, we discussed Wilson's methods for categorizing groups based on the incentives they offer to their members. Wilson places incentives into three categories: material, purposive, and solidary. In this section, we will discuss the types of incentives offered by the groups. We will then address the issue of applying Wilson's criteria to "think-tank" groups, as they may appear to be different from the types of groups that he discusses.

As stated earlier, we began the analysis expecting to find a good number of economic arguments. We did find that one group, the American Petroleum Institute (API), used a large number of economic arguments. Based on their web page which

says that they allow companies to "leverage resources and obtain needed services cost-effectively"[35], we have concluded that they exist to benefit the petroleum industry monetarily and that they are therefore a material group. So it logically follows that they will use a large number of economic arguments.

Most groups, however, used few economic arguments, instead predominantly using themes that questioned the state of the science (2) and the harm of global warming or increased CO_2 (4). This discrepancy may be explained by the types of groups in question. From the results of our content analysis, it would seem that most groups are purposive rather then material. Looking at their mission statements, we have partially confirmed this finding. For example, the Greening Earth Society describes itself as "a not for profit grassroots organization created by the Western Fuels Association to promote the viewpoint that human-kind is a part of nature, rather than apart from nature."[36] Although this statement indicates that GES has ties to the Western Fuels Association (a material group), its focus is on emphasizing the ties between man and nature. Its mission statement, and it's not-for-profit stat! us, allow us to categorize it as a purposive group. Another group by the name of the Science and Environmental Policy Project (SEPP) is another example of a purposive group focusing on scientific research, which was founded as "a non-profit, 501(c)3 educational group ... to clarify the diverse problems facing the planet and, where necessary, arrive at effective, cost-conscious solutions."[37] Some of its research may involve cost-conscious issues, but it exists mainly as an educational group and is thus purposive. Although many of the other groups may have ties to material groups, their focus appears to be purposive and not economic.

Since most of the groups we analyzed such as SEPP, the Heartland Institute, and the Marshall Institute are "think-tanks", one may ask whether our negative result can be explained by the hypothesis that think-tank groups cannot be classified according to Wilson's categories of material, purposive and solidary groups. Think-tanks seem to have a different organizational structure than the types of groups that Wilson talks about in his book. The groups that Wilson talks about are mostly "grassroots" organizations. Essentially anyone can join these organizations, contribute to them, and can rise through the ranks, given enough time and influence, to achieve any position within the organization. think-tanks are different in the sense that not anyone who wants to join can do so. They have a certain number of staff and a certain number of research associates but no members as such beyond these people. One could almost describe think-tanks as "elitist" groups as compared to! the grassroots organizations that occupy most of the discussion in Political Organizations. Therefore, one way to explain our results is to say that think-tanks operate by a set of rules outside the model that we initially used.

However, although think-tanks may not have any members as such, they do have what they call "sponsors." The sponsors are either individuals, foundations, or corporations that donate money to the think-tank, sometimes as little as $20, but occasionally over $10,000. In exchange for their contribution, the sponsors get a variety of different things in return depending on the level of their contribution and the think-tank. Some of the types of things that sponsors get are newsletters, research that the think-tank produces, books, tapes, and even invitations to retreats that the group sponsors. Although the think-tanks may not regard their sponsors as official members, they offer them incentives similar to the kinds that

61

members in a grassroots organization might receive. Therefore, for our purposes, their sponsors can be thought of as members.

One may then wonder if an elitist group can be thought of in terms of Wilson's models. Because of their restricted membership and the fact that much of their funding may come from only a few wealthy contributors, it is reasonable to look at think-tanks as being somewhat elitist. However, there are some examples of groups that exclude certain people from joining that are essentially purposive. Mensa, for example, will only accept members above a certain IQ rating, but they are not out to make a profit. The Boy Scouts of America exclude certain people from their membership (you have to be below a certain age to be a "scout") but they are also a purposive group. Furthermore, Wilson does not specifically exclude elitist groups from his categories. We therefore don not see that elitist has anything to do with applying Wilson's models to this situation.

The difference between grassroots organizations and think-tanks can almost be thought of as the difference between a democracy and a (benevolent) dictatorship. One has a more grassroots structure that relies heavily on input from the masses in order to run. It is funded primarily by large numbers of small donations. The other is more of an elitist structure that depends more heavily on input from only a few people. It is funded primarily by small numbers of large donations. Yet although a democracy and a dictatorship are both very different types of governments, they can both be very effective, very powerful governments. We feel that although a think-tank may be a different type of group than the Sierra Club, for example, Wilson's models are still applicable. We therefore do not see any reason why Wilson's models should not be applied to think-tanks. Consequently, we feel that

they can be thought of as purposive groups.

So why are there so many purposive groups instead of material groups? We believe that fuel companies want to be involved with the scientific debate on global warming but that they can not do it directly for two reasons. The first reason is that they don not want to appear to be selfish. If a company is producing a product that some people think is unsafe then this will lead to public pressure on the company to change their product or even to stop producing it. However, the product may be extremely profitable for the company or be the company's only product, so it may not wish to stop making it. (Or it may really feel that the science is not advanced enough to definitively tell if its product is harmful or not.) But if it tries to disagree openly with the research then there will be people who will question it's motives. So smart companies will find or create separate organizations to advocate their viewpoint for them. An example of this is the Greening Earth Society, which was created by the Western Fuels Association. The public is much more likely to believe a purposive society that says that CO_2 is good for the Earth then they would a company who produces carbon products that says the same thing.

The other reason that fuel companies can not get directly involved in the scientific climate debate is that it would be contrary to the purpose of their organization. A company exists to make profit. Its stockholders, board members, CEO, management, and all of its employees are only interested in making money. In the case of oil and coal companies, this involves making money by selling oil and coal. These same oil and coal companies are not particularly interested in exploring issues related to the radiative feedback of clouds, the reasons why icebergs melt, the

sunspot cycle of the sun, or any other climate change phenomena in general since they do not have anything to do with fossil fuels directly and are not profitable. They therefore have no desire to become involved in the climate change debate personally. However the climate change debate is important to them in the sense that it could have an impact on their business. They could always hire their own climate change scientists to give them an independent analysis. However the company probably does not want to hear that they will need to stop producing fossil fuels so they probably will not hire any scientists that will advocate this position. They could hire scientists that would all support their point of view but then they would run into the problem mentioned before that the public would accuse them of pursuing selfish special interests. So once again they will fund or form an interest group to advocate their position for them. We believe that this is why there are so many purposive groups out there. Obviously not all of them were formed by coal and oil interests, but many continue to exist today from funds that may come at least partly from the fossil fuel industry.

Our hypothesis does not preclude material groups from forming and participating in the climate change debate. Indeed, API is a material group, and the Competitive Enterprise Institute (CEI) is possibly another. But such groups are less common than purposive groups for the reasons mentioned before.

4.2.2 Theme variations

We also feel that we need to explain another potentially confusing aspect of our results, which was that a particular type of group did not always use the cor-

responding argument all of the time. For instance, although we did find that groups with material incentives tended to use a higher proportion of economic arguments than groups whose incentives were more purposive, no material group used a majority of economic arguments. Even API, which used a higher percentage of economic arguments than any other group, used about as many evidenciary arguments as economic arguments. Also, many purposive groups, in addition to their own purposive arguments, also used economic arguments ones. This may seem to be counterintuitive based on the assumption that a group will always make the same type of arguments as the type of group that it is.

However, we feel that the variation exists because a group needs to make a variety of different arguments in order to make a stronger case to support its views. For example, although API's primary goals are to benefit its members materially, it may not make sense for it to argue against global warming solely on economic grounds. A good argument for not reducing greenhouse gas emissions is that it may prove to be expensive. But it may be necessary to reduce emissions, in spite of the expense, if not doing so will have disastrous consequences for the environment. Therefore, questioning the evidence along with using economic arguments allows API to make the argument that reducing greenhouse gas emissions would not only be expensive but would also be unjustified based on the current state of knowledge. Such a combined message is much stronger than one which merely points out the costs of taking action. Even though API is a material group, it can not ignore non-economic lines of reasoning.

A similar thing happens with the purposive groups. Even though a think-tank may want to exclusively use purposive arguments, its case is strengthened by

adding some economic ones as well. For instance, a think-tank may do a good job of arguing in an article that global warming is probably not happening. However, someone reading the article may still feel that we should try to stop greenhouse gas buildup anyway because there is still the chance that something bad could happen as a result of global warming. If the think-tank had tried to demonstrate in that article that acting to stop global warming would cost that person an extra 10% more a year in taxes then the person would be far less likely to advocate reducing emissions. With only the purposive argument they might have responded less to the article, taking a "better safe then sorry" attitude towards climate changeii since they may feel that they do not have much to lose by acting and something bad might happen to the Earth's climate if they do not act. But if they had read a material argument as well, then they might want to wait until they see more proof that global warming could be damaging, because acting now would cost them money for something that they are unsure is a problem. Therefore, all groups will make some of both types of arguments to make a stronger case.

Also, a group may make several different kinds of arguments to appeal to a wider range of interests. Although the group may only be material, for example, they realize that the public has purposive interests as well. Similarly a purposive group may realize that most people have economic interests as well as purposive ones. By combining both economic and material arguments, they are therefore giving out something to everyone and appealing to a wider audience.

4.2.3 Variations among groups

Since most groups were purposive and primarily used themes that questioned the state of the science (2) and the harm of global warming or increased CO_2 (4), one might expect the amounts of arguments used by each group to be similar. However, we found some variation in the frequencies of each argument used. We will discuss these variations below.

The argument that global warming or increased CO_2 emissions may be beneficial (4b) is an example of an argument which shows variation between groups. For instance, from Table 4.5 , 27% of GES's arguments are type 4b, as are 28% of OISM's arguments, 18% of SEPP's, and 15% of CEI's, but other groups did not use this argument more than 10% of the time. The argument that delaying action by a few years will have little effect (3c) is another argument which shows variation, accounting for 17% of the arguments from the Marshall Institute and 6% of the arguments from the GCC but not more than 5% for any other group.

We can see from Table 4.5 that, even if two groups are both purposive, they will not necessarily use the same arguments with the same frequency. It is our hypothesis that this represents a variety of interests on the skeptic side of the global warming debate. There are many groups that each offer a somewhat different appeal, thus recruiting somewhat different groups of members with differing interests. These groups are each pursuing their interest of debunking the theory of global warming in slightly different ways, which is what we think produces the variation.

4.3   Conclusion

In this chapter, we have shown that groups tend to use several themes regardless of their apparent purpose. We are hypothesizing that groups do this out of a necessity to use arguments that, taken together, are most persuasive and thus most effective in allowing the group to reach its goal. The most important themes by far are evidenciary themes with arguments questioning the state of the science or whether global warming or increased CO_2 concentrations would not be harmful. However, from our results, it would appear that groups with material interests may, in general, use more economic arguments than groups without economic motives. We feel that the abundance of purposive groups is because they are being funded by an industry that does not want to openly advocate these issues because it would look selfish in doing so. We have also discussed that we think each group is a little bit different because they were created separately and appeal to different groups in society. In the next chapter we will discuss our conclusions from our content analysis and our recommendations to the UCS on how to better counteract the message of skeptic groups.

Chapter 5

Conclusions and

recommendations

In the last chapter, we determined that the arguments used by the groups we studied were mostly evidenciary and that the organizations themselves were mostly purposive. Although this may seem unusual considering the amount of corporate interest on the subject, we have found two reasons why the arguments are purposive instead of material. The first reason is that if there are any material groups that want to join in the global warming debate they must use arguments that wont give the impression to the general public that they are being selfish. These types of arguments tend to be purposive rather than material. The second reason is that a company is generally more concerned with making money then following scientific and philosophical debates. Since they want policy decisions to be reached in their favor, they may fund someone else to look into issues that concern them and advocate their side of the argument. These people that they fund are very often

purposive groups and make purposive types of arguments. In this chapter, we will discuss the implications of this finding as we see them. Finally, we will conclude the report by giving some recommendations for policy and future research.

5.1 The obvious implications

As previously stated, our results show that evidenciary arguments are used more commonly than any other type. We feel that one reason for this is that there are a large number of purposive organizations that exist that refute evidence of global warming.

5.1.1 Counteracting skeptics in general

Our results show different arguments are used in different frequencies by different skeptic groups. However, certain arguments were used with greater frequency then others overall. Therefore if one wanted to counteract global warming skeptic groups in general, then it would be best to focus on only these few arguments.

For instance, the most common argument was the one dealing with the uncertainty of climate science (argument 2h). The next most common argument stated that CO_2 was a good thing (4b) followed by the argument that switching from fossil fuels would cost a lot of money (1c). In spite of variations between the groups we studied, all three of these arguments show up commonly in the materials we analyzed. Therefore, by focusing on counter-arguments to these three points, one could deal effectively with a large amount of skeptic literature.

5.1.2 The counter-argument must fit the group

As we have shown, there is a great deal of variation among the types of arguments that groups will use. Although some arguments will be more prevalent then others in general, certain groups may use a certain argument more frequently. Therefore, if one is trying to counteract the arguments of a specific group then one general set of counter-arguments may not be as effective as a set created specifically for that group.

For example, our research has indicated that material groups may use a large number of economic arguments. Therefore, it follows that in order to counter economically based groups, it would be prudent to use many arguments that show that reducing CO_2 emissions will not cause significant economic harm, possibly by analyzing the costs of renewable energy. However, most groups were purposive and did not use a large number of economic arguments, instead relying mostly on various types of evidenciary arguments. Therefore, when one is dealing with these types of groups it may be best to concentrate most effort into showing that the balance of evidence supports the theory that humans are warming the Earth.

Even among purposive groups however, there is variation in the types of arguments used most often. For example one purposive group, the Marshall Institute, focuses mostly on the uncertainty of the science (Theme 2) and the costs to the US economy (Argument 1a). When debating specifically against this group, one should therefore use counter-arguments that address these two areas specifically. But when debating with another purposive group, one might need to focus on a different set of issues. The Greening Earth Society (GES), for instance, primar-

ily uses arguments that demonstrate that increased CO_2 concentrations may be beneficial (argument 4b) and arguments that question whether climate change is occurring (arguments 2e and 2f). One cant use the same set of counter-arguments that one did with the Marshall Institute because GES is talking about different things. Therefore a separate set of counter-arguments for each group will probably be necessary.

5.2   Our other recommendations

Although we studied the problem of global warming specifically, we feel that some of our findings may be applicable to a wider range of issues. We will discuss our reasoning below.

We have demonstrated that, in the area of global warming, companies do not usually get directly involved in the debate, preferring instead to create or fund a purposive group to argue their position for them. This is because they don't want the public to think they are being selfishly concerned with their own profit margin at the expense of public safety, and because the people within the company are more directly concerned with profit making issues rather then abstract debates. We have seen that the results of this are that there are usually a number of arguments that look at the logical practical reasons in favor of doing or not doing something, rather then a number of arguments that deal directly with profit making issues.

However, there is no reason to suppose that this type of behavior is unique to the climate change environment. Therefore we feel that whenever an industry is concerned with a particular issue they will behave in this way. If a company was

making a product that had some sort of down side to it, they would find some organization that was willing to argue for their side of the story, if not their specific point of view, and fund them. For example, if the nuclear power industry sensed that it was coming under fire because of the unsafe nature of uranium, it might well fund an organization that was arguing for continued use of nuclear power. However, that organization might be arguing for nuclear power on the grounds of national sovereignty instead of economics. In other words, the organization may be more concerned with reducing our dependence on foreign oil imports then it is with the costs or savings associated with nuclear power. Therefore, most of their arguments could be expected to be purposive instead of material.

Based on this, we feel that it may be more effective to address skeptics on any issue by analyzing purposive arguments rather then material ones. Although material arguments are still a good thing to look at, it is more likely that, if an industry is involved, it is backing some other group that is making non-material arguments. Therefore, by our reasoning, the purposive arguments should be more common most of the time. Research into this theory should determine whether or not we are correct.

5.3   Concluding remarks

> If you know the enemy and know yourself, you need not fear the result
> of a hundred battles. If you know yourself but not the enemy, for every
> victory gained you will also suffer a defeat. If you know neither the
> enemy nor yourself, you will succumb in every battle.[38]

The above quote is a famous saying from a Chinese general named Sun Tzu who lived 2500 years ago. Although Sun Tzu was only talking about the wars and the warriors of his time, his sayings apply to a number of situations today and are still used. We feel that the above saying, in particular, applies to this project since advocacy groups and skeptic groups are, in a sense, at war with one another over the issue of global warming, and the side that understands itself as well as the other side will probably have a significant advantage. In this last section, we wanted to provide a few concluding remarks about this project. Our original goal was to understand skeptic literature as well as possible so that this information could be used by the Union of Concerned Scientists, (UCS), in its seemingly never-ending struggle with skeptic groups. Over the course of several months we got to know those groups very well however, through our reviews of skeptic literature, and the better we knew them the more we started to doubt a few of our ideas. We had originally thought that global warming was occurring because of increased amounts of CO_2 being pumped into the atmosphere. Anyone who was trying to oppose this idea was probably doing so for his or her own benefit. However, we can't say that we believe that with certainty anymore. Although we do not agree with all arguments made by the skeptics, we feel that some of the arguments that we found in our literature may possibly have some scientific merit and that the groups that use them may not all be junk science groups.

We realize that we have mostly been reading only one side of the story, so there may be views that we missed among the advocacy groups. We also realize that it does serve some corporate interests for us to doubt the existence of global warming. In effect we may have partially succumbed to the very problem we are trying to

help avoid. However, among the advocacy literature that we read, we cannot easily find answers to all of the skeptics' arguments. Although counter-arguments to skeptic claims may exist, we had trouble finding them on the web page of the UCS and among other materials we reviewed, and the counter-arguments we did find did not include references to peer-reviewed literature. Because of this, we have no way of knowing which side is correct and cannot state that either side is using "junk science".

This uncertainty, combined with lack of a good working definition of "junk science" was the reason that we stopped using this term to describe the skeptic groups we researched. Junk science has a very negative connotation associated with it. It implies that the research being done by a group is somehow sub-standard or just plain wrong. Since we don't know that much about the science involved ourselves, we felt that it would be best not to call any of the groups we reviewed "junk science" groups since we don't know if any of their arguments were valid. This is not to say that any of these groups are not junk science groups because, as far as we know, every one of their arguments could be wrong too. All that we're sure of is that we cannot answer that question either way so we feel it's best if we do not.

We think that if any advocacy group uses the words junk science to describe their opponents or their arguments, then that advocacy group should be sure that they are right and should also be able to prove it. It can be easy to assume that someone who disagrees is wrong. If there are good counter-arguments to all of the points that the skeptics address, then we would be willing to accept that the skeptic groups that use them are practicing junk science and that the arguments

themselves are junk science. But if some of the skeptic arguments don't have answers then we would be hesitant to write them off as coming from a junk science group. This is only in the interest of scientific fairness since, according to the UCS itself, challenges to the consensus are sometimes needed to " advance our understanding of key scientific questions."[39] And if it turns out that some of the concerns of the skeptics are legitimate then opposing their arguments is a whole different story. This is simply because if an argument that the skeptics use is found to be a legitimate scientific concern then it can not simply be dismissed as "junk".

An advocacy group may still wish to oppose a particular argument anyway, such as an argument, for example, that advocates delaying any action to reduce CO_2 emissions. However the argument that one is concerned with will probably be better counteracted if one treats it as what it really is, either as a legitimate argument from a legitimate skeptic group or as a junk argument from a junk science group, rather than simply assuming it to be a junk science group. If care is not taken in this regard then, as Sun Tzu pointed out, for every victory gained one may also suffer a defeat. For example, if an advocacy group treats a real scientific argument as junk then people may be less likely to believe other things that group says since they may assume that they are trying to overlook legitimate research simply to support their own agenda. Conversely, if an advocacy group treats a junk argument as real science, then people may take that group less seriously since they will assume that group is not smart enough to know what it is talking about. Responding to an argument the wrong way can therefore lessen the respect that others have towards the respondent. It is therefore important to know exactly which type of argument one is dealing with and respond appropriately.

Of course, it is also important to know oneself. For instance, it may be necessary for a group to perform content analysis on its own literature from time to time to see if the group is really saying all that it wants to say and thinks it is saying. If one wants to be certain of using specific counter-arguments then one may have to analyze what one has written to make sure that this argument is actually being used. But, beyond that, it is important for a group to know what type of organization it is; (either a skeptic, advocacy, junk science, or independent research group) and what type of arguments it is using. For example, the name "Union of Concerned Scientists" implies an impartial research group. However, from the types of arguments that it makes and the type of activities that it does, we have concluded that the UCS is a purposive advocacy group. Much of the material on its web site is dedicated to the message that global warming is a threat which must be stopped. It even discusses ways that its readers can help prevent global warming. These are all of the hallmarks of an advocacy group. It is also our feeling that a non-bias research group would do more to explain to its readers where the limits of the research are on the subject. In other words, it is our belief that if uncertainty on a particular issue related to global warming exists then a non-bias group will point out this uncertainty and try and explain what it means. Instead of doing this, however, the UCS advocates that uncertainty should not be used as a reason not to act now to stop global warming.

The fact that UCS is an advocacy group is important because it means that the UCS is already bias toward a particular side of the debate and it may therefore be more difficult for it to distinguish real science groups and arguments within the realm of the skeptics from all of the junk out there. It is therefore possible

that if the debate turns against the UCS's favor, then it may find itself using advocacy arguments anyway because that is what it is used to doing. Under these circumstances the UCS would become a junk science group itself simply because it would be trying to adhere to its advocacy aspect instead of its scientific aspect.

We are not trying to imply that anything of this sort would happen to the UCS or that the UCS doesn't carefully consider all points of view. Although some have worried in the past that scientific "orthodoxy" may get in the way of new discoveries, a good scientist will always consider all possibilities carefully and therefore does not run much risk of letting his or her personal feelings and biases cloud his or her judgment. All that we are trying to suggest is that it is important not only to know your opponent but also to know yourself. Otherwise you will succumb to your enemy in every battle.

Appendix A

List of analyzed literature

Following is a list of items that were included in our content analysis.

- American Petroleum Institute: url http://www.api.org/globalclimate: "The Big Picture", "The Science", "The Costs", "API's Position", "Voluntary Actions", "Other Views"

- Competitive Enterprise Institute: Cooler Heads newsletter, vol. III, no. 16-17. url http://www.cei.org/chn.asp

- Global Climate Coalition:a Booklet: The Global Warming Experiment, published by the Marshall Institute, Washington, D.C. copyright 1995.

- Greening Earth Society: issues 5.3 and 5.4 of the World Climate Report. url http://www.greeningearthsociety.org

- Heartland Institute: Newsletter from 11/98 and 9/99. url http://www.heartland.org.

- Marshall Institute: "The Global Warming "Crisis"" (formerly http://www.marshall.org/globa and "Can Effect Come Before Cause in Global Warming (url http://www.marshall.org/can%2C

- Oregon Institute of Science and Medicine: The Petition Project. url http://www.oism.org/ppr

- Science and Environmental Policy Project: Booklet: The Scientific Case Against the Global Climate Treaty, by Fred Singer, published by SEPP. Video: Against Nature, aired December, 1997, London, channel 4.

Appendix B

Sample content analysis

In this appendix, we are providing a sample of our content analysis. The sample we are using is from the OISM's petition project (url http://www.oism.org/pproject/s33p36.htm). When we found an argument, we placed the relevant text in brackets with the number of the argument in braces at the end.

Environmental Effects of Increased Atmospheric Carbon Dioxide

ARTHUR B. ROBINSON, SALLIE L. BALIUNAS, WILLIE SOON, AND ZACHARY
W.   ROBINSON

Oregon Institute of Science and Medicine, 2251 Dick George Rd.,
Cave Junction, Oregon 97523   info@oism.org

81

George C. Marshall Institute, 1730 K St., NW, Ste 905, Washington, DC 20006 info@marshall.org January 1998

ABSTRACT

[A review of the research literature concerning the environmental consequences of increased levels of atmospheric carbon dioxide leads to the conclusion that increases during the 20th Century have produced no deleterious effects upon global weather, climate, or temperature. {4a}] [Increased carbon dioxide has, however, markedly increased plant growth rates.{4b}] [Predictions of harmful climatic effects due to future increases in minor greenhouse gases like CO2 are in error and do not conform to current experimental knowledge. {2g}]

Summary

World leaders gathered in Kyoto, Japan, in December 1997 to consider a world treaty restricting emissions of ''greenhouse gases,'' chiefly carbon dioxide (CO_2), that are thought to cause ''global warming'' severe increases in Earth's atmospheric and surface temperatures, with disastrous environmental consequences.

Predictions of global warming are based on computer climate modeling, a branch of science still in its infancy. [The empirical evidence actual measurements of Earth's temperature shows no man-made warming trend.{2e}] [Indeed, over the past two decades, when CO2 levels have been at their highest, global average temperatures have actually cooled slightly. {2f}]

To be sure, CO2 levels have increased substantially since the Industrial Revolution, and are expected to continue doing so. It is reasonable to believe that humans have been responsible for much of this increase. [But the effect on the environment is likely to be benign. Greenhouse gases cause plant life, and the animal life that depends upon it, to thrive. {4b}] What mankind is doing is liberating carbon from beneath the Earth's surface and putting it into the atmosphere, where it is available for conversion into living organisms.

Rise In Atmospheric Carbon Dioxide

The concentration of CO2 in Earth's atmosphere has increased during the past century, as shown in figure 1 (1).

Figure 1: Atmospheric CO2 concentrations in parts per million by volume, ppm, at Mauna Loa, Hawaii. These measurements agree well with those at other locations (1). Periodic cycle is caused by seasonal variations in CO2 absorption by plants. Approximate global level of atmospheric CO2 in 1900 and 1940 is also displayed (2).

The annual cycles in figure 1 are the result of seasonal variations in plant use of carbon dioxide. Solid horizontal lines show the levels that prevailed in 1900 and 1940 (2). The magnitude of this atmospheric increase during the 1980s was about 3 gigatons of carbon (Gt C) per year (3). Total human CO2 emissions primarily from use of coal, oil, and natural gas and the production of cement are currently about 5.5 GT C per year.

To put these figures in perspective, it is estimated that the atmosphere contains 750 Gt C; the surface ocean contains 1,000 Gt C; vegetation, soils, and detritus contain 2,200 Gt C; and the intermediate and deep oceans contain 38,000 Gt C (3). Each year, the surface ocean and atmosphere exchange an estimated 90 Gt C; vegetation and the atmosphere, 60 Gt C; marine biota and the surface ocean, 50 Gt C; and the surface ocean and the intermediate and deep oceans, 100 Gt C (3).

Figure 2: Surface temperatures in the Sargasso Sea (with time resolution of about 50 years) ending in 1975 as determined by isotope ratios of marine organism remains in sediment at the bottom of the sea (7). The horizontal line is the average temperature for this 3,000 year period. [The Little Ice Age and Medieval Climate Optimum were naturally occurring, extended intervals of climate departures from the mean. {2a}]

So great are the magnitudes of these reservoirs, the rates of exchange between them, and the uncertainties with which these numbers are estimated that [the source of the recent rise in atmospheric carbon dioxide has not been determined with certainty (4). {2h}] [Atmospheric concentrations of CO2 are reported to have varied widely over geological time, with peaks, according to some estimates, some 20-fold higher than at present and lows at approximately 18th-Century levels (5). {4a}]

The current increase in carbon dioxide follows a 300-year warming trend: Surface and atmospheric temperatures have been recovering from an unusually cold period known as the Little Ice Age. [The observed increases are of a magnitude that can, for example, be explained by oceans giving off gases naturally as temperatures rise. {2a}] [Indeed, recent carbon dioxide rises have shown a tendency to follow rather than lead global temperature increases (6). {2g}]

85

There is, however, a widely believed hypothesis that the 3 Gt C per year rise in atmospheric carbon dioxide is the result of the 5.5 Gt C per year release of carbon dioxide from human activities. This hypothesis is reasonable, since the magnitudes of human release and atmospheric rise are comparable, and the atmospheric rise has occurred contemporaneously with the increase in production of CO2 from human activities since the Industrial Revolution.

Figure 3: Moving 11-year average of terrestrial Northern Hemisphere peratures as deviations in C from the 1951-1970 mean left axis and darker line (8,9). Solar magnetic cycle lengths right axis and lighter line (10). The shorter the magnetic cycle length, the more active, and hence brighter, the sun.

Atmospheric And Surface Temperatures

In any case, what effect is the rise in CO2 having upon the global environment? [The temperature of the Earth varies naturally over a

wide range. {2a}] Figure 2 summarizes, for example, surface

temperatures in the Sargasso Sea (a region of the Atlantic Ocean)

during the past 3,000 years (7). Sea surface temperatures at this

location have varied over a range of about 3.6 degrees Celsius (C)

during the past 3,000 years. Trends in these data correspond to

similar features that are known from the historical record.

Figure 4: Annual mean surface temperatures in the contiguous

United States between 1895 and 1997, as compiled by the National

Climate Data Center (12). Horizontal line is the 103-year mean. [The

trend line for this 103-year period has a slope of 0.022 C per

decade or 0.22 C per century. The trend line for 1940 to 1997 has a

slope of 0.008 C per decade or 0.08 C per century. {2e}]

For example, about 300 years ago, the Earth was experiencing the

''Little Ice Age.'' It had descended into this relatively cool period

from a warm interval about 1,000 years ago known as the ''Medieval

Climate Optimum.'' [During the Medieval Climate Optimum, temperatures

were warm enough to allow the colonization of Greenland. These

colonies were abandoned after the onset of colder temperatures. {4b}]

For the past 300 years, global temperatures have been gradually

recovering (11). As shown in figure 2, they are still a little below

the average for the past 3,000 years. [The human historical record

does not report ''global warming'' catastrophes, even though temperatures have been far higher during much of the last three millennia. {4a}]

[What causes such variations in Earth's temperature? The answer may be fluctuations in solar activity. Figure 3 shows the period of warming from the Little Ice Age in greater detail by means of an 11-year moving average of surface temperatures in the Northern Hemisphere (10). Also shown are solar magnetic cycle lengths for the same period. It is clear that even relatively short, half-century-long fluctuations in temperature correlate well with variations in solar activity. When the cycles are short, the sun is more active, hence brighter; and the Earth is warmer. {2a}] These variations in the activity of the sun are typical of stars close in mass and age to the sun (13).

Figure 4 shows the annual average temperatures of the United States as compiled by the National Climate Data Center (12). The most recent upward temperature fluctuation from the Little Ice Age (between 1900 and 1940), as shown in the Northern Hemisphere record of figure 3, is also evident in this record of U.S. temperatures. [These temperatures are now near average for the past 103 years, with 1996 and 1997 having been the 42nd and 60th coolest years. {2f}],

Figure 5: Radiosonde balloon station measurements of global lower tropospheric temperatures at 63 stations between latitudes 90 N and 90 S from 1958 to 1996 (15). Temperatures are three-month averages and are graphed as deviations from the mean temperature for 1979 to 1996. Linear trend line for 1979 to 1996 is shown. [The slope is minus 0.060 C per decade. {2f}]

Especially important in considering the effect of changes in atmospheric composition upon Earth temperatures are temperatures in the lower troposphere at an altitude of roughly 4 km. In the troposphere, greenhouse-gas-induced temperature changes are expected to be at least as large as at the surface (14). Figure 5 shows global tropospheric temperatures measured by weather balloons between 1958 and 1996. [They are currently near their 40-year mean (15), and have been trending slightly downward since 1979. {2f}]

Figure 6: Satellite Microwave Sounding Unit, MSU, measurements of global lower tropospheric temperatures between latitudes 83 N and 83 S from 1979 to 1997 (17,18). Temperatures are monthly averages and are graphed as deviations from the mean temperature for 1979 to 1996. Linear trend line for 1979 to 1997 is shown. [The slope of this line is minus 0.047 C per decade. {2f}] This record of measurements began

89

in 1979.

Figure 7: Global radiosonde balloon temperature (light line) (15) and global satellite MSU temperature (dark line) (17,18) from figures 5 and 6 plotted with   6-month smoothing. Both sets of data are graphed as deviations from their respective means for 1979 to 1996. [The 1979 to 1996 slopes of the trend lines are   minus 0.060 C per decade for balloon and minus 0.045 for satellite. {2f}]

Since 1979, lower-tropospheric temperature measurements have also been made by means of microwave sounding units (MSUs) on orbiting satellites (16). Figure 6 shows the average global tropospheric satellite measurements (17,18) the most reliable measurements, and the most relevant to the question of climate change.

Figure 7 shows the satellite data from figure 6 superimposed upon the weather balloon data from figure 5. The agreement of the two sets of data, collected with completely independent methods of measurement, verifies their precision. This agreement has been shown rigorously by extensive analysis (19, 20).

[While tropospheric temperatures have trended downward during the past 19 years by about 0.05 C per decade {2f}], it has been reported

that global surface temperatures trended upward by about 0.1 C per

decade (21, 22). In contrast to tropospheric temperatures, however,

surface temperatures are subject to large uncertainties for several

reasons, including the urban heat island effect (illustrated below).

During the past 10 years, U.S. surface temperatures have trended

downward by minus 0.08 C per decade (12) while global surface

temperatures are reported increased by plus 0.03 C per decade (23).

[The corresponding weather-balloon and satellite tropospheric 10-year

trends are minus 0.4 C and minus 0.3 C per decade, respectively.

{2f}]

Figure 8: Tropospheric temperature measurements by satellite MSU

for North America between 30 to 70 N and 75 to 125 W (dark line)

(17, 18)   compared with the surface record for this same region

(light line) (24), both plotted with 12-month smoothing and graphed

as deviations from their means for   1979 to 1996. The slope of

the satellite MSU trend line is minus 0.01 C per decade, while that

for the surface trend line is plus 0.07 C per decade. The

correlation coefficient for the unsmoothed monthly data in the two

sets is 0.92.

[Disregarding uncertainties in surface measurements and giving equal

weight to reported atmospheric and surface data and to 10 and 19 year averages, the mean global trend is minus 0.07 C per decade. {2f}]

In North America, the atmospheric and surface records partly agree (20 and figure 8). Even there, however, the atmospheric trend is minus 0.01 per decade, while the surface trend is plus 0.07 C per decade. The satellite record, with uniform and better sampling, ismuch more reliable.

The computer models on which forecasts of global warming are based predict that tropospheric temperatures will rise at least as much as surface temperatures (14). Because of this, and because these temperatures can be accurately measured without confusion by complicated effects in the surface record, these are the temperatures of greatest interest. The global trend shown in figures 5, 6 and 7 provides a definitive means of testing the validity of the global warming hypothesis.

Figure 9: Qualitative illustration of greenhouse warming. Present: the current greenhouse effect from all atmospheric phenomena. Radiative effect of CO2:   added greenhouse radiative effect from doubling CO2 without consideration of other atmospheric components. Hypothesis 1 IPCC: hypothetical amplification   effect

assumed by IPCC. Hypothesis 2: hypothetical moderation effect.

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The Global Warming Hypothesis

There is such a thing as the greenhouse effect. Greenhouse gases such
as H2O and CO2 in the Earth's atmosphere decrease the escape of
terrestrial thermal infrared radiation. Increasing CO2, therefore,
effectively increases radiative energy input to the Earth. But what
happens to this radiative input is complex: It is redistributed, both
vertically and horizontally, by various physical processes, including
advection, convection, and diffusion in the atmosphere and ocean.

When an increase in CO2 increases the radiative input to the
atmosphere, how and in which direction does the atmosphere respond?
Hypotheses about this response differ and are schematically shown in
figure 9. Without the greenhouse effect, the Earth would be about 14
C cooler (25). [The radiative contribution of doubling atmospheric
CO2 is minor {4a}], but this radiative greenhouse effect is treated
quite differently by different climate hypotheses. The hypotheses
that the IPCC has chosen to adopt predict that the effect

of CO2 is amplified by the atmosphere (especially water vapor) to produce a large temperature increase (14). Other hypotheses, shown as hypothesis 2, predict the opposite that the atmospheric response will counteract the CO2 increase and result in insignificant changes in global temperature (25-27). The empirical evidence of figures 5-7 favors hypothesis 2. [While CO2 has increased substantially, the large temperature increase predicted by the IPCC models has not occurred (see figure 11). {2c}]

The hypothesis of a large atmospheric temperature increase from greenhouse gases (GHGs), and further hypotheses that temperature increases will lead to flooding, increases in storm activity, and catastrophic world-wide climatological changes have come to be known as ''global warming'' a phenomenon claimed to be so dangerous that it makes necessary a dramatic reduction in world energy use and a severe program of international rationing of technology (29).

Figure 10: The radiative greenhouse effect of doubling the concentration of atmospheric CO2 (right bar) as compared with four of the uncertainties in the   computer climate models (14, 28).

[The computer climate models upon which ''global warming'' is based have substantial uncertainties. {2h}] This is not surprising, since

94

the climate is a coupled, non-linear dynamical system in layman's
terms, a very complex one. Figure 10 summarizes some of the
difficulties by comparing the radiative CO2 greenhouse effect with
correction factors and uncertainties in some of the parameters in the
computer climate calculations. [Other factors, too, such as the
effects of volcanoes, cannot now be reliably computer modeled. {2h}]

Figure 11 compares the trend in atmospheric temperatures predicted by
computer models adopted by the IPCC with that actually observed
during the past 19 years those years in which the highest atmospheric
concentrations of CO2 and other GHGs have occurred.

In effect, an experiment has been performed on the Earth during the
past half-century an experiment that includes all of the complex
factors and feedback effects that determine the Earth's temperature
and climate. [Since 1940, atmospheric GHGs have risen substantially.
Yet atmospheric temperatures have not risen. {2c }] [In fact, during
the 19 years with the highest atmospheric levels of CO2 and other
GHGs, temperatures have fallen. {2g}]

Figure 11:

Global annual lower tropospheric temperatures as measured by

satellite MSU between latitudes 83 N and 83 S (17, 18) plotted as deviations from the 1979 value. The trend line of these experimental measurements is compared with the corresponding trend line predicted by International Panel on Climate Change (IPCC) computer climate models (14).

[Not only has the global warming hypothesis failed the experimental test; it is theoretically flawed as well. {2f}] It can reasonably be argued that cooling from negative physical and biological feedbacks to GHGs will nullify the initial temperature rise (26, 30).

The reasons for this failure of the computer climate models are subjects of scientific debate. [For example, water vapor is the largest contributor to the overall greenhouse effect (31). {2d}] It has been suggested that the computer climate models treat feedbacks related to water vapor incorrectly (27, 32).

The global warming hypothesis is not based upon the radiative properties of the GHGs themselves. It is based entirely upon a small initial increase in temperature caused by GHGs and a large theoretical amplification of that temperature change. Any comparable temperature increase from another cause would produce the same outcome from the calculations.

[At present, science does not have comprehensive quantitative knowledge about the Earth's atmosphere. Very few of the relevant parameters are known with enough rigor to permit reliable theoretical calculations. {2h}] Each hypothesis must be judged by empirical results. The global warming hypothesis has been thoroughly evaluated. [It does not agree with the data and is, therefore, not validated. {2f}]

Figure 12: Eleven-year moving average of global surface temperature, as estimated by NASA GISS (23, 33, and 34), plotted as deviation from 1890 (left   axis and light line), as compared with atmospheric CO2 (right axis and dark line) (2). Approximately 82% of the increase in CO2 occurred after the   temperature maximum in 1940, as is shown in figure 1.

[The new high in temperature estimated by NASA GISS after 1940 is not present in the radiosonde balloon measurements or the satellite MSU measurements. It is also not present in surface measurements for regions with comprehensive, high-quality temperature records (35). The United States surface temperature record (see figure 4) gives 1996 and 1997 as the 38th and 56th coolest years in the 20th century. {2f}] Biases and uncertainties, such as that shown in figure 13, account for this difference.

Global Warming Evidence

Aside from computer calculations, two sorts of evidence have been advanced in support of the ''global warming'' hypothesis: temperature compilations and statements about global flooding and weather disruptions. Figure 12 shows the global temperature graph that has been compiled by National Aeronautic and Space Administration's Goddard Institute of Space Studies (NASA GISS) (23, 33, and 34). This compilation, which is shown widely in the press, does not agree with the atmospheric record because [surface records have substantial uncertainties (36). {2e}] Figure 13 illustrates part of the reason.

[The urban heat island effect is only one of several surface effects that can confound compiled records of surface temperature. [2B}] Figure 13 shows the size of this effect in, for example, the surface stations of California and the problems associated with objective sampling. [The East Park station, considered the best situated rural station in the state (37), has a trend since 1940 of minus 0.055 C per decade. {2f}]

Figure 13: Surface temperature trends for the period of 1940 to 1996 from 107 measuring stations in 49 California counties (39, 40). After averaging the   means of the trends in each county, counties of similar population were bined and plotted as closed circles along with the standard errors of their means. The   six measuring stations in Los Angeles County were used to calculate the standard error of that county, which is plotted alone at the county population of 8.9   million. The ''urban heat island effect'' on surface ments is evident. The straight line is a least-squares fit to the closed circles. The points marked ''X'' are the six   unadjusted station records selected by NASA GISS (23, 33, and 34) for use in their estimate of global temperatures as shown in figure 12.

The overall rise of about plus 0.5 C during the 20th century is often cited in support of ''global warming'' (38). [Since, however, 82% of the CO_2 rise during the 20th century occurred after the rise in temperature (see figures 1 and 12), the CO_2 increase cannot have caused the temperature increase. {2g}] The 19th century rise was only 13 ppm (2).

In addition, incomplete regional temperature records have been used to support ''global warming.'' Figure 14 shows an example of this, in

which a partial record was used in an attempt to confirm computer climate model predictions of temperature increases from green-house gases (41). A more complete record refuted this attempt (42).

[Not one of the temperature graphs shown in figures 4 to 7, which include the most accurate and reliable surface and atmospheric temperature measurements available, both global and regional, shows any warming whatever that can be attributed to increases in green-house gases. Moreover, these data show that present day temperatures are not at all unusual compared with natural variability, nor are they changing in any unusual way. {2e}]

Figure 14: The solid circles in the oval are tropospheric temperatures for the Southern Hemisphere between latitudes 30 S and 60 S, published in 1996 (41) in   support of computer-model-projected warming. Later in 1996, the study was refuted by a longer set of data, as shown by the open circles (42).

Sea Levels And Storms

The computer climate models do not make any reliable predictions whatever concerning global flooding, storm variability, and other catastrophes that have come to be a part of the popular definition of ''global warming.'' (See Chapter 6, section 6-5 of reference 14.) Yet several scenarios of impending global catastrophe have arisen separately. One of these hypothesizes that rising sea levels will flood large areas of coastal land. Figure 15 shows satellite measurements of global sea level between 1993 and 1997 (43). [The reported current global rate of rise amounts to only about plus 2 mm per year, or plus 8 inches per century, and even this estimate is probably high (43). The trends in rise and fall of sea level in various regions have a wide range of about 100 mm per year with most of the globe showing downward trends (43). {2e}]

Figure 15: Global sea level measurements from the Topex/Poseidon satellite altimeter for 1993 to 1997 (43). [The instrument record gives a rate of change of   minus 0.2 mm per year (43). {2f}] However, it has been reported that 50-year tide gauge measurements give plus 1.8 mm per year. A correction of plus 2.3 mm   per year was added to the satellite data based on comparison to selected tide gauges to get a value of plus 2.1 mm per year or 8 inches per century (43).

Historical records show no acceleration in sea level rise in the 20th century (44). Moreover, claims that global warming will cause the Antarctic ice cap to melt and sharply increase this rate are not consistent with experiment or with theory (45).

Similarly, claims that hurricane frequencies and intensities have been increasing are also inconsistent with the data. Figure 16 shows the number of severe Atlantic hurricanes per year and also the maximum wind intensities of those hurricanes. Both of these values have been decreasing with time.

Figure 16: Annual numbers of violent hurricanes and maximum attained wind speeds during those hurricanes in the Atlantic Ocean (46). Slopes of the trend   lines are minus 0.25 hurricanes per decade and minus 0.33 meters per second maximum attained wind speed per decade.

[As temperatures recover from the Little Ice Age {2a}], [the more extreme weather patterns that characterized that period may be trending slowly toward the milder conditions that prevailed during the Middle Ages, which enjoyed average temperatures about 1 C higher than those of today. {4b}] Concomitant changes are also taking place,

102

such as the receding of glaciers in Montana's Glacier National Park.

Fertilization Of Plants

How high will the carbon dioxide concentration of the atmosphere ultimately rise if mankind continues to use coal, oil, and natural gas? Since total current estimates of hydrocarbon reserves are approximately 2,000 times annual use (47), doubled human release could, over a thousand years, ultimately be 10,000 GT C or 25% of the amount now sequestered in the oceans. If 90% of this 10,000 GT C were absorbed by oceans and other reservoirs, atmospheric levels would approximately double, rising to about 600 parts per million. (This assumes that new technologies will not supplant the use of hydrocarbons during the next 1,000 years, a pessimistic estimate of technological advance.)

One reservoir that would moderate the increase is especially important. Plant life provides a large sink for CO2. Using current knowledge about the increased growth rates of plants and assuming a doubling of CO2 release as compared to current emissions, it has been

103

estimated that atmospheric CO2 levels will rise by only about 300 ppm before leveling off (2). At that level, CO2 absorption by increased Earth biomass is able to absorb about 10 GT C per year.

Figure 17: Standard normal deviates of tree ring widths for (a) bristlecone pine, limber pine, and fox tail pine in the Great Basin of California, Nevada, and   Arizona and (b) bristlecone pine in Colorado (48). The tree ring widths have been normalized so that their means are zero and deviations from the means are   displayed in units of standard deviation.

[As atmospheric CO2 increases, plant growth rates increase. Also, leaves lose less water as CO2 increases, so that plants are able to grow under drier conditions. Animal life, which depends upon plant life for food, increases proportionally. {4b}]

Figures 17 to 22 show examples of experimentally measured increases in the growth of plants. These examples are representative of a very large research literature on this subject (49-55). Since plant response to CO2 fertilization is nearly linear with respect to CO2 concentration over a range of a few hundred ppm, as seen for example in figures 18 and 22, it is easy to normalize experimental measurements at different levels of CO2 enrichment. This has been

done in figure 23 in order to illustrate some CO2 growth enhancements calculated for the atmospheric increase of about 80 ppm that has already taken place, and that expected from a projected total increase of 320 ppm.

[As figure 17 shows, long-lived (1,000- to 2000-year-old) pine trees have shown a sharp increase in growth rate during the past half-century. {4b}]

Figure 18: Young Eldarica pine trees were grown for 23 months under four CO2 concentrations and then cut down and weighed. Each point represents an   individual tree (56). Weights of tree parts are as indicated.

Figure 18 summarizes the increased growth rates of young pine seedlings at four CO2 levels. [Again, the response is remarkable, with an increase of 300 ppm more than tripling the rate of growth. {4b}]

Figure 19: Inventories of standing hardwood and softwood timber in the United States compiled from Forest Statistics of the United States (58).

[Figure 19 shows the 30% increase in the forests of the United States that has taken place since 1950. Much of this increase is likely due to the increase in atmospheric CO2 that has already occurred. {4b}]
In addition, it has been reported that Amazonian rain forests are increasing their vegetation by about 34,000 moles (900 pounds) of carbon per acre per year (57), or about two tons of biomass per acre per year.

Figure 20: Fig. 20. Relative trunk and limb volumes and fine root biomass of young sour orange trees; and trunk and limb volumes and numbers of oranges   produced per mature sour orange tree per year at 400 ppm CO2 (light bars) and 700 ppm CO2 (dark bars) (59, 60). The 400 ppm values were normalized   to 100. The trees were planted in 1987 as one-year-old seedlings. Young trunk and limb volumes and fine root biomass were measured in 1990. Mature trunk and limb volumes are averages for 1991 to 1996. Orange numbers are averages for 1993 to 1997.

Figure 20 shows the effect of CO2 fertilization on sour orange trees. [During the early years of growth, the bark, limbs, and fine roots of sour orange trees growing in an atmosphere with 700 ppm of CO2 exhibited rates of growth more than 170% greater than those at 400

ppm. As the trees matured, this slowed to about 100%. Meanwhile, orange production was 127% higher for the 700 ppm trees. {4b}]

Figure 21: Grain yields from wheat grown under well watered and poorly watered conditions in open field experiments (61, 62). [Average CO_2-induced   increases for the two years were 10% for wet and 23% for dry conditions. {4b}]

Trees respond to CO_2 fertilization more strongly than do most other plants, but all plants respond to some extent. Figure 21 shows the response of wheat grown under wet conditions and when the wheat was stressed by lack of water. These were open-field experiments. Wheat was grown in the usual way, but the atmospheric CO_2 concentrations of circular sections of the fields were increased by means of arrays of computer-controlled equipment that released CO_2 into the air to hold the levels as specified.

[While the results illustrated in figures 17-21 are remarkable, they are typical of those reported in a very large number of studies of the effect of CO_2 concentration upon the growth rates of plants (49-55). {4b}]

Figure 22 summarizes 279 similar experiments in which plants of

various types were raised under CO2-enhanced conditions. Plants under stress from less-than-ideal conditions - a common occurrence in nature - respond more to CO2 fertilization. The selections of species shown in figure 22 were biased toward plants that respond less to CO2 fertilization than does the mixture actually covering the Earth, so figure 22 underestimates the effects of global CO2 enhancement.

[Figure 23 summarizes the wheat, orange tree, and young pine tree enhancements shown in figures 21, 20, and 18 with two atmospheric CO2 increases - that which has occurred since 1800 and is believed to be the result of the Industrial Revolution and that which is projected for the next two centuries. {4b}] The relative growth enhancement of trees by CO2 diminishes with age. Figure 23 shows young trees.

[Clearly, the green revolution in agriculture has already benefited from CO2 fertilization; and benefits in the future will likely be spectacular. Animal life will increase proportionally as shown by studies of 51 terrestrial (63) and 22 aquatic ecosystems (64). {4b}] Moreover, as shown by a study of 94 terrestrial ecosystems on all continents except Antarctica (65), species richness (biodiversity) is more positively correlated with productivity - the total quantity of plant life per acre - than with anything else.

Discussion

[There are no experimental data to support the hypothesis that increases in carbon dioxide and other greenhouse gases are causing or can be expected to cause catastrophic changes in global temperatures or weather. {2f}] [To the contrary, during the 20 years with the highest carbon dioxide levels, atmospheric temperatures have decreased. {2f}]

[We also need not worry about environmental calamities, {4a}] [even if the current long-term natural warming trend continues. {2a}] [The Earth has been much warmer during the past 3,000 years without catastrophic effects. {4a}] [Warmer weather extends growing seasons and generally improves the habitability of colder regions. {4b}] [''Global warming,'' an invalidated hypothesis, {2f}] provides no reason to limit human production of CO2, CH4, N2O, HFCs, PFCs, and SF6 as has been proposed (29).

Figure 22: Summary data from 279 published experiments in which plants of all types were grown under paired stressed (open circles)

109

and unstressed (closed circles) conditions (66). There were 208, 50, and 21 sets at 300, 600, and an average of about 1350 ppm CO_2, respectively. The plant mixture in the 279 studies was slightly biased toward plant types that respond less to CO_2 fertilization than does the actual global mixture and therefore underestimates the expected global response. [CO_2 enrichment also allows plants to grow in drier regions, further increasing the expected global response. {4b}]

[Human use of coal, oil, and natural gas has not measurably warmed the atmosphere, and the extrapolation of current trends shows that it will not significantly do so in the foreseeable future. {2e}] [It does, however, release CO_2, which accelerates the growth rates of plants and also permits plants to grow in drier regions. Animal life, which depends upon plants, also flourishes. {4b}]

[As coal, oil, and natural gas are used to feed and lift from poverty vast numbers of people across the globe, more CO_2 will be released into the atmosphere. {1b} [This will help to maintain and improve the health, longevity, prosperity, and productivity of all people. {4b}]

Human activities are believed to be responsible for the rise in CO_2 level of the atmosphere. Mankind is moving the carbon in coal, oil,

and natural gas from below ground to the atmosphere and surface, where it is available for conversion into living things. [We are living in an increasingly lush environment of plants and animals as a result of the CO2 increase. Our children will enjoy an Earth with far more plant and animal life as that with which we now are blessed. This is a wonderful and unexpected gift from the Industrial Revolution. {4b}]

Figure 23(a): and

Figure 23(b): Calculated growth rate enhancement of wheat, young orange and very young pine trees already taking place as a result of atmospheric   enrichment by CO2 during the past two centuries (a) and expected to take place as a result of atmospheric enrichment by CO2 to a level of 600 ppm (b).   In this case, these values apply to pine trees during their first two years of growth and orange trees during their 4th through 10th years of growth. As is shown   in figure 20, the effect of increased CO2 gradually diminishes with tree age, so these values should not be interpreted as applicable over the entire tree   lifespans. There are no longer-running controlled CO2 tree experiments. Yet, even 2,000 year old trees still respond significantly as is shown in figure 17.

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