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Project Zion Podcast

Josh Mangelson
Welcome to the Project Zion Podcast. This podcast explores the unique spiritual and theological gifts Community of Christ offers for today's world.

Rod Downing 00:00
Welcome to Project Zion Podcast. I'm your host, Rod Downing from Vancouver, Canada. This is the series Climate Brewing, where we interview the world class scientists and other experts who gave presentations as part of the Community of Christ North American zoom series, All of Creation, from Crises to Transformation. Today, we kick off this series with an interview of the very first presenter from this series, Dr. Richard Gammon. For me, he was a dream team person to start our series. I like to aim big, and so thought it would be great to have someone from the IPCC, which is the UN's Intergovernmental Panel on Climate Change. When the media is talking about those 1000s of climate scientists saying this or that it's the IPCC. That's the umbrella organization for those 1000s of scientists. Further, I thought it would be even better to have someone who chaired one of those committees, or authored one of their reports. And in fact, Dr. Gammon co authored the very first IPCC report in 1990, on the carbon cycle. In terms of background, he studied chemistry at Princeton, and then at Harvard, where he got his PhD. Later along the line, he was the head of the carbon dioxide program, from or for NOAA, the US National Oceanic and Atmospheric Administration. That's a bit of a mouthful. Currently as professor emeritus at the University of Washington. So it was a delight when Dr. Gammon not only agreed to do our first session, which was on the basic science of climate change, but also our second one, he came back and focused on the solutions, either in terms of mitigating or helping us to adapt to the climate changes. And then as a bonus, at the end of the second session, and definitely worth listening to, on our website. He had a dialogue with Community of Christ President, Steve Veazey. So Dr. Gammon, it is again, a great pleasure to welcome you this time to the podcast.

Richard Gammon 03:09
Thank you very much, Rod, it's an honor to have taken part in this series.

Rod Downing 03:14
And we're delighted to have you. Now, when you started the series, it was a surprise to me to hear that you didn't start out focused on our climate. So could you briefly share how you started? And more particularly what caused you to change your focus?

Richard Gammon 03:39
Well, I've, I've always loved being in nature. I was a boy scout, Cub Scout, Boy Scout, explorer Scout, enjoyed hiking the Appalachian Trail in Virginia. And this led me in my science, to seek to try to understand the science of the natural world. In a way of deep curiosity about how nature works. And how we got here, science is pretty good at answering "what" questions and how questions but not very good at answering "why" questions and actually felt that, in doing research about the natural world, it's a kind of a way of discovery, a way of knowing, and for religious people, maybe even a way of worship.

If you're trying to understand nature, and how things came to be you you're trying to understand the creation as a process, and that can be a spiritual experience. So I started out as a lover of nature, I majored in chemistry and got a advanced degree in physical chemistry. I didn't want to do physics because my older brother was in physics and I did not want to compete with him, so I was a chemist. But I always was wanting to be a chemist of the natural world. And so my advisor, my PhD advisor said, Okay, go be a chemist in space. So I became an astro chemist or cosmo chemist, looking for molecules in interstellar space; molecules needed for the origin of life. And then I, that actually led my wife and me to two years in Brazil. I found that although radio astronomy in Brazil was very interesting, I saw the problems, the environmental problems around me. And I said, when you get back to the US, I'm going to try to transition from astro chemistry, chemical atmospheric chemistry into into something that that has more social relevance. So it was not immediate. I mean, my transition from just loving nature and trying to understand it, to becoming a climate scientists was a gradual process. In a sense, I think that climate change chose me, I didn't choose climate science. It just became the thing that I had to do.

Rod Downing 06:00
Well, we're sure glad you made the change, though things I guess can be pretty exciting out there. The Mars rover just landed.

Richard Gammon 06:11
Lovely! Oh, yeah, I'm following that as much as I can. What a wonderful thing. And I hope that we do this, that we make these explorations as a world, not as individual nations, I'd like to see both Moon and Mars become truly international efforts, not just the US versus other countries.

Rod Downing 06:28
Right? Yes. In in many ways, that would be a wonderful step forward. And hopefully, we can get there someday. Now, when we started the series, you started with showing a picture of your grandson, and it was pretty apparent, there was a lot of affection there. And at the same time, you stated that the basic science is pretty grim. So firstly, what is it about the basic science that, quote, keeps you up at night, when you think of your grandson? What are the primary implications that concerns you?

Richard Gammon 07:29
Well, going back to my days, and boy scouts, we were told to leave the campsite better than you found it. And I want us to leave a world better than the world that we found it, that we found ourselves and we're not heading in that direction. So there's, there's a moral imperative to halt the damage and begin the healing. And the healing will go on for generations. So when I show a picture of Jesse, he's almost five now on the beach in California, there's a possibility that one third to one half of all those beaches in California will be underwater with sea level rise. That's a horrible thought. And I'd love to snorkel on coral reefs lay in Hawaii. And to think that we may lose, essentially all the coral reefs in the tropical world. It's just that keeps me up at night. Yeah, losing that. And some of this will come back. Of course, the extinction of species is forever. They don't come back. So let's save as much as we can. Let's, let's stop the damage and start the healing. And it'll go on for many generations, maybe as native indigenous people say seven generations? Well, that's a couple 100 years some of these problems are going to like ocean acidification, they're going to be with us for 1000s of years. 1000s of years.

Rod Downing 08:45
And, yes, so there are a lot of troubling signs you've already alluded to them. And for sure it is this going to become this intergenerational thing. What I'd like to do then is is kind of take a step back even further to the basic science behind all of these troubling signs that again, neither the newspapers are talking about or TV or wherever one, again, we just had, or I guess Texas is still, we're this is being recorded in in February of 2021. And Texas is still I think, in the grips of this freeze, because the polar vortex dropped so low. So there are lots of these troubling signs. But I'd like to, especially because you know this stuff so well is in your bones, I'm sure. Go back to the basic science. That is where does this all come from? What's the dynamic that that's bringing this all about? Can you can you just briefly explore to us in in sort of layman's terms?

Richard Gammon 10:28
Sure, this idea that gases in the Earth's atmosphere can capture heat and redirect it back down to the surface, the greenhouse effect is not a new idea. It's almost 200 years old. And in fact, more than 150 years ago, the English scientist Tyndall actually made laboratory experiments and he showed which gases are greenhouse gases and which gases are not, he showed that nitrogen and oxygen are not greenhouse gases, but that ozone, water, ozone, water vapor and carbon dioxide are greenhouse gases. He showed that by direct measurement 150 years ago. And so you can say any, any molecule that has more than two atoms, tri atomic molecule will have some vibrations in the infrared, and will resonate with that infrared radiation and recapture it and send some of it back. So we know this is basic, very basic science. And nitrogen and oxygen are diatomic gases, they, they don't have that property, and they don't interact with with heat coming back up from the earth. Now, we think that in the early days that Mars had a habitable environment. And that's what the this perseverance rover is going to look for signs of ancient life on Mars, very exciting. And the greenhouse effect on Mars is very tiny now. It's got a 1% of our atmosphere. And that's mainly carbon dioxide. So there's a very tiny greenhouse effect. Not enough to warm it, not enough to keep it keep water and frozen. On the other hand, the planet closer to the sun than us, Venus has many, many times more gas in the atmosphere than we do. And that gases, carbon dioxide, it has a hellish atmosphere, super greenhouse effect. So we're kind of the Goldilocks in the middle, not too much, just right. And we've been just right for billions of years, as life has, has originated and evolved.

Rod Downing 12:32
Right. And, and, and I just wanted to be clear, you're talking, he said the infrared light, or sorry, infrared.

Richard Gammon 12:41
Sorry, visible light is what you see with your eyes. and beyond. At shorter wavelength, higher energy than that is ultraviolet. And that can be damaging. And most of the ultraviolet light is actually captured by ozone in the stratosphere. And we're glad that that form of oxygen, read oxygen atoms together, ozone is up there and protects us from the solar UV. At the other end of the spectrum for wavelengths longer than red, infrared. You can't see it, but you can feel it, it's like heat. And it goes out all the way out to radio and microwave at the other end. So there's this long spectrum, what we're talking about mainly, is in the infrared, its wavelength we can't see. But that that can be captured by these molecules and re emitted as heat. So some of the Earth's imbalance, the incoming sunlight is turned into heat, infrared and goes back to space. Some of that is captured and sent back down to the surface. That's

the natural greenhouse effect. And the problem is we're putting more of this infrared capturing gas in the atmosphere, the carbon dioxide and recapping too much of that outgoing heat. That's why the earth is warming up. Their natural greenhouse effect is there we need it, but we're doing too much of a good thing.

Rod Downing 13:59
Right good. Okay, that's good. That's got a pretty clear in my head now. Now, you mentioned carbon dioxide and and what would you claim are the other critical gases of significance that we need to be paying attention to and you know, carbon dioxide is always the one.

Richard Gammon 14:30
From the burning of fossil fuels coal oil natural gas, is the primary gas which is increasing in the Earth's atmosphere. When I was responsible for the measurement by the US government of carbon dioxide in the remote Earth's atmosphere, Mauna Loa Hawaii, Barrow, Alaska, American Samoa and the South Pole. Those four sites were making continuous minute by minute measurements and have been since the late 1970s. Back then, the value was 340 parts per million .034%. 340 parts per million, and now the number is 415 and running away, it was going up about one and a half per year, when I was in charge of the network. Now it's going up two and a half or three parts per million per year. And half of all the Co2 that we've ever put in in the air has been put up since I was in charge of the network in 1983. It's probably not, so in those in those 40 years, we've doubled the problem.

Rod Downing 15:26
Yes.

Richard Gammon 15:27
Oh, and other gases, sorry, methane, is probably the second most important greenhouse gas. Now, it has a shorter atmospheric lifetime than CO2. So all these gases are measured relative to the warming effect of CO2 in that scale, methane, over a 10 year lifetime is 80 times more potent than CO2. But it mainly is destroyed by chemical reactions within 10 years. So average over 100 year lifetime, it's about 30 times more potent than CO2 per molecule. The next gas further down the list is nitrous oxide laughing gas, some people have had that. But if you put nitrate fertilizer on your field, your agricultural field, some of that nitrate gets reduced to nitric oxide. So a good part of the nitrous oxide in the atmosphere today is from agricultural use of nitrate fertilizer and fields, but we have to put nitrate on the field to grow our food. So there's a problem there. Can we can we use more organic fertilizers? Can we use less of this inorganic nitrate, that's something to think about. And then finally, there's a class of molecules, we got rid of the chlorocarbons, and the chlorofluorocarbons, which were damaging the ozone layer.

Rod Downing 16:39
Yeah, I remember those from years ago.

Richard Gammon 16:41
Yeah, we got rid of those through the Montreal Protocol, which was a first international successful treaty of the global atmosphere, it's got a lot of lessons for us. Now we're CO2. But we went to some

substitute compounds are in there called the hydrofluorocarbons. Now they don't have any chlorine, so they don't chew up the ozone layer. But they're tremendously potent greenhouse gases, 10,000 times per molecule more effective than CO2. Now, the little bit of them leaking out of your air conditioner, your home heating system, etc. So we need to move to some other refrigerant compounds. And there's an effort underway to ban these compounds, these hydrofluorocarbons and to move as quickly as we can, to different fluids, gases that we can use in our heating and air conditioning system. So those are the main characters CO2, methane, nitrous oxide and hydrofluorocarbons. Now, on the other side, if you put up smoke and dust in the atmosphere, like from a volcano, or from a forest fire, that actually sends some of the sunlight back to space and has a cooling effect. So a part of the pollution is not just from CO2, it's from the smog and smoke that we put up, that counters maybe a third of the warming. So as we clean up the atmosphere, we put less of this smog, aerosol in the atmosphere, and the earth gets warmer. Although we need to do that, because this smog pollution kills millions of people every year. So it's a complicated problem. The first thing we should do is stop burning, stop burning coal, oil and natural gas move as quickly as we can to renewable energy systems that don't rely on combustion of fossil fuels.

Rod Downing 18:17
Right. Yes. Well, I really appreciate that explanation for a number of reasons. One is because, you know, as soon as you start going up and looking at something, you you've you find the numbers varying, you know, the co2 got 30 times or at times and things like that, but that, that clarifies. that clarifies why, and and the reason why I wanted to start at that sort of the basics is because that sort of can help us point us in the right direction. And and your example of the, excuse me, the refrigerant is a great example. Such potency in the leaking of yeah, an air conditioner, something like that, that you wouldn't think, you know, what's the big, yeah, what, how big a deal can that be? Well, whoa, 1000s of times! So, yes, that sure gives lots of room for directions, how we can start cleaning up some of this stuff. Now, before proceeding, I want to acknowledge that pushback still exists. Some is intentional distortion. But some is simply the consequence of short news cycles or whatever that oversimplify what is in this case, very complex systems. For instance, there is the classic hockey stick graph, though perhaps we can use the wrong notion that things are getting warmer due to solar flares or cycles of the sun. In your November 15th talk, you gave a single slide that clearly showed why such simple solutions fail. Necessary set of criteria. Oh, and for the audience, I went back to the archive video on the website. And it is right at the 30 minute mark, if you want to go see the visual. Anyway, Could you briefly go over that? Briefly share.

Richard Gammon 20:51
The first thing I'll say is the climate scientists, those people actually doing this work and publishing in Science Nature Journal of Geophysical Research, they are fully convinced that it's real, and that people are responsible for it. There is no debate among the climate scientists. Now the general public probably thinks that scientists are still arguing. We're not, we're not arguing. It's more than 97 98%. That's done.

Rod Downing 21:16
Right.

Richard Gammon 21:16

Let's go on to what we do about it. So that's the first point. The second point is go to go to the reliable sources. And, of course, the Intergovernmental Panel on Climate Change, issues a report about every five years. It's slipped a little bit because of the pandemic. But this this fall, there will be the Conference of the Parties will meet in Glasgow, Scotland, and there should be a new IPCC report. Part One of that is the physical climate science basis. Two is impacts and adaptations. And part three is possible policy responses. So for sure, be on the lookout for the next IPCC. They come out about every five or seven years. Next, the US government, every four years issues, the National Climate Assessment. We had one in 2018. So again, next year, we will have another National Climate Assessment. And in my slideshow, the first of my presentations to this this group, I showed a mini figures from that, and it shows that the the trapping of greenhouse infrared heat by greenhouse gases is the cause is the primary cause solar variability is tiny. The sun, there's a solar variability 10 year sun cycle, but it's, you know, five or 10%. And we're actually in a low time right now. And you can't say that the warming this past year, so it was due to El Nino, we're actually we're in a lot Nino phase, the opposite phase, which normally is associated with cooling 2016. It was really we this year in 2020 18 2016, for the warmest year in the historical record. But it wasn't solar. And it wasn't volcanoes. It was manmade greenhouse gases. I did want to say that there's some new books coming out so on my reading list, and I've not read these books yet, our new books by Michael Mann he have the hockey stick fame. So Michael Mann has a new book coming out. I don't have a title, but you can look it up. Michael Mann. Elizabeth Kolbert writes for The New Yorker, I think, magazine, New Yorker also has a new book coming out. And that one will include some topics about geoengineering, she talks about the end of blue sky, white sky, instead of blue skies, we put stuff in the stratosphere to scatter sunlight back to space. Scary. Whose mission do we ask to end blue sky? That's a horrible thought. And then finally, there's a Bill Gates has also got a new book out, and he's a strong proponent of nuclear power. So these are three books, none of which I've read, but they're on my reading list. Anyway. Other good sources realclimate.org is very good, realclimate.org. And you mentioned Skeptical Science. So these are some of the sources that you can go to, in in between these reports, like the National Climate Assessment, and IPCC. And here in the northwest, the climate impacts group at the University of Washington issues, regular reports, as does California and Oregon. So we have some West Coast sources I don't know about British Columbia, but I'm sure they have climate reports as well. Maybe Rod, you know.

Rod Downing 24:08
Yes, but I couldn't name them off the top of my head like yourself. But yes, they're UBC and SFU. Oh, two more, sorry, two more people.

Richard Gammon 24:20
Two more! Sorry, Jim Hanson has written some books and publishes regular updates on the climate science. He's very good. And then one, a good climate scientists who speaks to Christian evangelical groups, it gets Katharine Hayhoe in Texas.

Rod Downing 24:37
Is I saw one of her TED Talks. Yes, she's quite good. Yeah. Yeah. Let's then moves in, so it's clear. There simply is no doubt with the scientists on climate change at this point. So that's clear. And it's it's from my perspective, I mean, I come from a science background. That's, that's reassuring that we are to that point. So let's move then, well, first of all, I I mentioned, you know, one of the implications is

polar vortex that. I mean, I was trying to think of when I first heard that word polar vortex, it's definitely been within the last five to 10 years or so I don't definitely growing up. I never heard heard of that term. So yes, I always take note when new words come in to our vocabulary, because because they're definitely saying something. And it isn't obvious, necessarily obvious, like, but I wanted to take a look then just at some of the other implications. You You talked about coral reefs, you talked about the sea rise, could you give a couple more examples of just some of these large scale? Because when people think global warming, you can often think, well, everything gets hotter, which is often going to be the case. But there are lots of other implications. Could you just name a couple more of the more critical ones that have at least happened in in recent times.

Richard Gammon 26:40
I realized I didn't quite finish the answer to your previous question, which is if you take a picture of the temperature of the globe, like a 10 year average of the last 10 years, and then compare it to an earlier period, the pattern of warming, which can only be explained by greenhouse gases, the pattern of warming is the warming is greater in the Northern Hemisphere than the southern, the woman is greater on the land than over the ocean, the warming is greater at high latitude than low latitude. The warming is greater in the wintertime than in the summertime, the warming is greater at night than during the day and only greenhouse gases meet that meet all those criteria. So I think that's the thing you want me to say before? Yes, that's that's the slide. And and I was quite intrigued by that, that, that all of these criteria, they're there. And only one thing lines them up, which is that co2. So yeah, I mean, I'd like to take a picture and frame that one is going on from there, rather than a sort of a low, slow, gradual warming everywhere, especially at higher latitude in the Northern Hemisphere. We're facing extreme weather events. And now, the climate models are getting good enough and fast enough that after an extreme event like this middle of the US, cold freeze, I have a brother in Houston right now, I talked to him this morning. He was without power and without water. He's kind of immobile in his house. He's not safe. It's a terrible situation in Houston,. The power is coming back on but the water's not there. And people are lining up for food, water, fuel, whatever. So can we say that the extreme weather events like that are will be more probable in the future? Yes, we probably can say that. Now, the science of polar, polar vortex and polar wandering is still debated. There are still people on both sides. One of the early proponents of this theory was Jennifer Francis, at that time at Rutgers, I'm not sure where she is now, maybe Woods Hole and Judah Cohen. And they they argue that yes, what happens basically is, as global warming warms up the high latitude more than the equator, that temperature difference between the equator and the poles is what drives the jetstream. So if you warm up the North Pole more than you want at the equator, that temperature gradient is less, and the jetstream slows down and gets wondering. And because it's slower, and loopy, you can get these outbursts of cold air which come down over continents, and hang around for a while, not just a day or two, but a week or more. So that's that's what's happened and Texas was not prepared for this, they really didn't think it was going to happen again, although it happened 10 years ago. 2011 they had it. And they were they were they were warned back then that they better protect winterize their their power generation systems. And in this time, who knows what they're gonna do as a result of this, but there's a lot of pressure on the state now and the electrical utility to be better prepared in the future. Right now we have to protect those people who were who are suffering in the state and throughout the mid mid part of the United States. So that's one more step more extreme unpredict weather. Another is that when it rains, it's going to rain more. And when hurricanes come in, they're going to drop more rain and they'll stall on the coast, the

strongest hurricanes will be stronger. Maybe not the total number of hurricanes will increase, but the strongest ones will be stronger. They will intensify as they approach the coast, and they'll hang around and drop more rain. Why? Why does global warming mean more rain? Well, because the temperature dependence of water vapor goes up about three 3% per degree Fahrenheit, or six or 7% per degree centigrade. That's called clausius clapeyron relationship. That's known basic physics. So a warmer ocean means more evaporation, the energy of the evaporated water is the energy which drives the storms. So we're going to have stronger storms, that's independent of sea level rise, that's just temperature the ocean. When we talk about impacts on the ocean, I say the oceans are going to be hotter because most of the greenhouse heat is going in the ocean. They're going to be sour because carbon dioxide a third of it is going into the ocean. It's an acid gas, ocean acidification. The oceans are rising. Thermal expansion as well as polar icecaps, there are toxic blooms as well, that are occurring. So all of these things are happening to our ocean, none of them are good. And some of them will take a very long time to heal. So those are just some of the things that are happening, extreme storms, more extreme flooding and rainfall events. And, and again, the energy of hurricanes is derived from the energy of the evaporated water, which is which is greater in a hotter world with warmer surface water fires. Yeah, certainly, hot dry conditions in California in the western United States have led to worse and worse forest fire seasons over the past decade or so longer forest fire season, worse, bigger fires, worse fires, and some people are leaving, some people are saying i'm gonna i'm not gonna stay there. I'm, I'm there's no water in the Colorado River. I don't like these fires in the northwest, I'm going to go to New Hampshire, I'm going to go to Canada, Vancouver. So people will be moving mass migrations that people have already begun. And like the Cascadia rest of the rest of the Cascades and Pacific Northwest. Many more people will come here and I don't think that this region is even beginning to think about that. They're not thinking much about sea level rise, they're certainly not thinking about mass migrations of people that's just within the US. If you live in Central America, or some places in Sub Saharan Africa, where you cannot grow your food, you can't live, you get your children and you leave. You go to the cities you go wherever you have to to live. And this mass migration of people is one of the major climate impacts in the coming decades.

Rod Downing 32:43
Yes, I was fascinated by your well, I guess, I don't actually recall whether it's the first or second session right now where I had never thought about migration within the US itself. I know, for sure, because I sort of have some other global interests. I've recognized some of the global migration patterns that are likely that are already happening that are going to be increasing around the world. But I've never stopped to think gee, even within the US, and probably Canada to that there could come that day when when migration becomes this massive issue to be dealt with within it.

Richard Gammon 33:41
It's not just a few people. I mean, the dustbowl days when the Okies went to California, that was a few 100,000 people. And when Blacks went to northern cities, Detroit, etc. A few million people migrated North then, but we're talking about 10s of millions of people within the US.

Rod Downing 34:02
Wow, that's, that's a stunning number, stunning number in it, at least in my mind. So let's hope we can get things under control before then. And that actually leads exactly into what I wanted to go next,

which is, of course, I have to watch my science side because I could I could stay in this for a long time but let's move to the solution end or solution side of things. That is these even the these IPCC reports and I'm not suggesting you repeat from them. You can just however you feel is is the best response but that there are solutions. It's not like we woke up a few years ago, you know, there you were in 1998. And, and I know, I, the first article I wrote on on this was the yeah, well, it was sometime late 80s. So you know that this has been known. And people have been looking for solutions for a long time. So that's where I want to turn now. So let's start with there, in terms of vocabulary, as I say, new words show up. And one of the words that I think is is now showing up in our vocabulary is the word mitigation. And it gets paired sometimes with adaptation. Now, mitigate, mitigate, you can correct me if I'm wrong, I'll put myself on the hot seat here for a second to mean, mitigation is trying to all of these issues that we've been talking about mitigation is trying to reduce all of these effects. Almost preventative, but it's too late to be preventative, the horse is already out of the barn, we're just trying to slow that horse down, and and maybe get it at least back into the field or something. But it's it's trying to reduce the effects. Whereas adaptation is saying, well, not only is a horse out of the barn, and probably not the right and not great at analogies, so but adaptation is simply saying, it's, it's to rate, the only thing you can do is a dat, that is build a higher date, or you're gonna, you're gonna face flooding, there's no way around one or the other. So adaptation is when it's too late to reduce these effects. So that that is becoming, at least in my world a part of the vocabulary. So mitigation and adaptation. I'd like you to just talk a little about which of course, pretty basic language for you. What do you when when you think then back to your grandson, Jesse, and you say, Well, come on world. Let's get going. Let's do X or Y, what is what are some of those most important things in your mind that we should at least be starting on in terms of getting, getting a handle on this crisis?

Richard Gammon 38:21
Okay, good. This is a big topic and stop me if I go too far. First thing I would say I often show a slide of John Holdren, who was the presidential science advisor for Obama. And he, he laid it out, he said, there's mitigation, there's adaptation and there's suffering. mitigation is avoiding that climate change to which we're not able to adapt, because it's too big. And adaptation is preparing for that climate change we can no longer avoid, because it's built in. It's happening. So that's one way to think about mitigation adaptation. Another way is it takes some examples, let's say and let's take nuclear war. And so adaptation is you've got a two week supply of green beans and water and your fallout shelter. That's adaptation. Mitigation is you are out in the streets protesting trying to establish a Nuclear Test Ban Treaty. That's mitigation. Right. That's one example of annotation versus mitigation. Another is you're driving down the highway and your car. You drive drunk and when you're asleep, and you're you're speeding. Be careful. That's mitigation. You can avoid having the accident. If you're careful how you drive, seatbelts, no, you having the accident, seatbelts go off, that's adaptation. It helps you stay alive, but it doesn't prevent the accident. So those are two different ways to think about adaptation versus mitigation, if that helps it all.

Rod Downing 39:47
Right. So what then in terms of the, these dynamics that we've been talking about how do we slow them down, how do we stop them? How do we reverse them? On the one hand, the mitigation side of things and or for things that are too late, then, you know, what, what should we do? But it's primarily, I guess, the mitigation side that I'm interested in.

Richard Gammon 40:18
Okay. Well, your primary problem, the number one problem is increasing carbon dioxide in the atmosphere. So how do you slow and stop the emission of CO2 to the atmosphere? You move as quickly as you can, to non fossil fuel sources of energy, green energy, if we can, if we can green our whole electrical grid by 2035. That's a wonderful goal. And if we can actually have net zero carbon emissions for the world, by the middle of this century, even better, China may be a little slower than that. But if we can have a world that is carbon neutral, by 2050, that's, that's not the end. Because they're we're sitting, we're sitting at this very high co2 level, we got to get it back down, after probably tree planning will help might be 10 to 15%, of what we need to do plant a trillion trees, good, good. They have to live they have to grow, and 10 to 20 years, they can begin to soak up some CO2. They won't do much of saplings, though. So we're gonna have to have direct air capture, we're gonna have to mechanically remove CO2 from the atmosphere, compress it and put it underground in geologically gas tight formations. Is anybody doing that now? Some people are experiencing experimenting with it.Nobody's paying you to do it. There's no price on carbon. So we need a price on carbon. We need to pay people to suck CO2 out of the air and put it underground. If you're active with basalt formations. Like in Iceland, it actually becomes rock in a year or two. So it's going to stay down. So that's a good solution. And two people who are doing as Klaus Lackner, I think, is it Arizona now, and David Keith, US Canadian. And now he teaches at Harvard, they both have active businesses, not just the research, but businesses that have prototypes, removing CO2 from the air, compressing it and putting it underground. No, it's not happening on a wide scale, it's going to have to have millions of these machines, we're talking about billions of tons of CO2, we got to get out, we're putting 40 billion tons of CO2 into the air every year, about 15% of that from the US. So there's another whole nother area, what can I do as an individual, but I'm talking about policy. So set set very high goals, like a carbon free, fossil fuel free electricity by 2035, a carbon neutral world by 2050. So our goals, invest in infrastructure. And in research, that means batteries for electric vehicles, for example. Those are things we can do at a policy level. Now, we can talk about cap and trade or price on carbon. My own view is that yes, we need a price on carbon. I think we need a price on carbon. Again, another story is say you don't want to pay for sewage and and your dog and your toddler, you put their their poop in a bag and you throw it over the fence and your neighbor's yard. After a while this is piling up, your neighbor's children get sick. And they call the Public Health Department on you and they come out. And they say you have to stop that. And not only have to stop that we're finding you and you got to go clean it all up. So that's kind of way to think about the garbage that we're putting in the sky, we're not paying a penny for it. It's think it's free. It's not free, we're just not paying the cost. We got to pay to take it back out. Now the social cost of carbon is that $50 a ton. Previous President Trump reduced that to a few dollars per ton. He said, I'm not going to consider impacts on anybody else, just to us. And I'm going to discount the future so much that it's basically free. Obama had something like $50 a ton. And the latest research is going to come out later this year. Probably we need a cost on carbon at about $100 a ton or more. That's where we have to go. It's not free. We got to begin to pay the cost of putting carbon in the air. That's again, this these are policy level things not not what you as an individual can do. That's another maybe that's your next question.

Rod Downing 44:12

Oh boy, I better not get into Star Trek. But yeah, getting some vibes there. Cuz we seem to be in sync on this. That's exactly where I wanted to go. So I appreciate the answer as one of the top systemic or policy level changes needed, of course, say that we're tax and vape results as it should in a democracy. But I sit in a living example we're here in BC we were the first North American area to institute a carbon tax in 2008. And the biggest concern was how it might negatively affect the economy and jobs. But 12 years later, and we had the strongest economy in Canada for most of that time. Now granted, other factors were at play, and this is all pre COVID. But in broad brushstrokes it works, one can transition to a greener economy. That said, to me, it had an even effects as it rose each year now to about $35 a ton. And we still have a long way to go. But 12 years later, there are now more equitable models to be used. So anyway, that's an example of the systemic side. Now, let's move to the other aspect, the personal things we can do.

Richard Gammon 46:08
First thing, I would say the kind of makes a transition from being from the political level to the personal level. There's an effort here in the United States in each state. And we have it here on Whidbey Island and northwest, called the citizens climate lobby. And they are trying to get a bill through Congress, and that's sort of like Noah's Ark, they're getting one republican and one democrat to buy to get on the boat. And, and the gold is a fee and dividend. So yes, it is kind of like a carbon fee. But use of carbon goes with wealth. Wealthier people have private boats and extra homes, and they they have a bigger carbon footprint. So if everyone is charged for the carbon that they use, and then everybody gets a check back the same check, regardless of what they've used, it's actually progressive. Most people 60-70% of the people will actually make money under discipline. So it's a fee and dividend, you get it back, right. And if you're really rich, and you're flying your private jet, oh, you pay more but you know, you probably don't feel it that much. But most people would benefit from a carbon fee and dividend system like that. So it's chugging along and Congress slowly. But that's that's one effort at another level. Just like you manage your own budget, your own money. You can only manage what you measure until you measure your own carbon emissions. You won't be able to reduce them. And so they're a program that started over in Jefferson County. With retired NOAA glaciologist Robert Bindschadler was done there. And then done in Seattle and Edmonds. And then here in South Whidbey, we did it two years ago. It's called Taming Bigfoot, you can go on the website and look up taming Bigfoot, reducing your carbon footprint. So we had teams of people, we got 60 or 70 people in teams to for a month, the base, they track their baseline data, they weighed their garbage, they looked at their miles driven and the power and all of that, and they they assessed their baseline carbon emissions. And over the next two months, they worked to reduce the emissions of their team. The team could be a family or a group of families. And then we had a party and gave away prizes for people or people or teams that had made the largest percentage reduction in their carbon footprint, or the largest absolute reduction in the carbon footprint. It was very revealing. And some people have continued that they have the baseline data, they know what they're emitting. And they know if they drive less, or they try to have an electric car instead of a gasoline powered car. I found that I'm driving a Chevy Bolt now electric car and I charge it with panels on my roof and set an example. So I have several friends who say, Richard, you have an electric car? How do you do that? And the panels with the panels on the roof, who'd you talk to you? So if you do something like that, not only do you reduce your carbon footprint, you set an example for people in your community, your neighbors even and some of those may come around. That's one way that that solar panels happen. That people say oh, where'd you get those? What are you doing?

Rod Downing 49:10
Yeah, yes, no, they're they're very prominent. So yes, great. Great example. I have a friend that did that as well, quite recently, and actually got I'm not particularly I mean, I'm not definitely not poovar we're all sitting on top of the world heep, but I've got an electric car and I was thinking, Well, what will be our next movie and I was thinking towards the solar panel, but I'm now thinking I'd rather get off gas or I mean, I'm starting to look at heat pumps as, as, as an option. And I'm finding, originally there was nothing anywhere about it. And now I'm finding ads in the paper about it. So it's sort of interesting to see how societal dynamics can can be altered by, by these things.

Richard Gammon 50:24
Personal choices really matter. They do.

Rod Downing 50:28
Yes. So I appreciate you bringing that aspect up. For sure. And again, on our website, we have some examples of, of, you can go up on your webs on the website and and do these first, there's a variety, then we have them up on our website. And I guess I'll just leave it at that. Or you or people can Google themselves, but doing it as a group and doing it, yeah, having prizes at the end? Yeah. I mean, we're relational beings, let's, let's have some, yeah, let's enjoy it all. So that's great to hear. In the end, then we need to sort of bring this to a close. As much as, again, I could, I could go on and listen, and we could chat for quite a while, but there's a whole series, so I don't need to worry coming coming up. But started coming back then full full circle, that there, there is this what seems to be an which many people have come to me and said, Oh, this is just such an overwhelming issue. I can't get, I just can't even think about it. And I'm glad we've at least touched base with some possibilities. There's lots of entrances in into what can be done. And again, on our website, we're going to be keeping track of some of the more common ones. And, and some of the more valuable ones, like you've just mentioned right now. But I wanted to turn them back to the big picture. And and, and to me, when I hear these people, what I'm hearing is either fear or a lack of hope. And I'm wondering, just as we sort of conclude, where where do you sit you spent then virtually your whole career on this, you've watched as the certainty of the science became clear, and yet the politics started sounding good, but not always did it get far, but sometimes, yeah, it's surprising things might happen. But but we're still way behind where we ought to be. If and when you gave three examples of mitigation, adaptation and suffering. You know, there are already many people on that third, rung the suffering. So where then do you take hope? You take it when you take a step back in in the big picture, or do you or where we're where I should leave it open ended? Where are you in? In all of that?

Richard Gammon 54:15
I think, I think if a climate scientist is honest, there are days of eco despair, for sure, for sure. But you can't stay there. You have to, you have to go through that grieving process, grieve for what's lost and what will be lost. And then say, dammit, I'm gonna, I'm gonna do whatever I can to minimize that loss and to begin to heal the world. So people say, Are you optimistic or pessimistic? I'm hopeful. I'm hopeful in that sense of Vaclav Havel is a wonderful quote about hope. I can't do a justice but he sort of says, hope. Hope is doing the right thing, no matter how it turns out. And there was a young man who was born with HIV AIDS in South Africa and coasties Johnson, who became the face of aids for South

Africa, and before he died, he died at age 10 or 11. He said, do all you can, with what you've got, in the time you have, where you are.

Rod Downing 55:17
Wow, yes, very, very powerful from, again, sort of the mouth of babes or of children. And I suppose that is also maybe one thing, at least, that I take hope, on his, I mean, at least pre pandemic, when people could be out on the streets is it was the youth that were leading a lot of these things, that gratitude verbs and, and such. So, well, this has been a wonderful conversation. Uh, again, I'm sort of chomping at the bit to keep going on a whole variety of areas, but I have to cut it at at this point. And again, just what so much appreciate that your generosity in helping us as we grapple, and it is a grappling process. But nonetheless, it's there, so yes, the alternative to ignore it is, is is devastating, especially, as we think down the future to other generations. But on the positive side, yes! Who knows what the creative and the perseverant capabilities of humanity can do. It almost goes back to that your original, when we're talking about space, wouldn't it be nice if we could come back, you know, internationally and start doing this because these are issues of global commons, and there's no national boundaries, so. But we'll work as that child said, where we are in whatever way we can. So thank you very much, Dr. Gammon. This, this has been extremely valuable, and to the audience. His videos are very much worth watching, and his dialogue with President Veazey, you will find fascinating. So I'll close it at this point. And look forward hopefully, to the rest of you tuning in again. And thanks, again to Dr. Gammon. And thanks to all of you for listening in today. Had a great day everyone. And thanks again. Richard. Bye now.

Josh Mangelson
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