The Carrington Event

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**Sam Evans-Brown: So here I am, Sam Evans-Brown reporting from closet studio I think it’s like 4.0?**

**Taylor Quimby: Nice.**

**Sam Evans-Brown: And with me, virtually, on Zoom, like the entire world for some reason despite privacy concerns is producer Taylor Quimby.  Where does our story begin?**

**Taylor Quimby: Well, it begins as many stories like this do… a long long time ago…with an old amateur scientist.**

[mux]

Richard Carrington: While engaged in the forenoon of Thursday, September the first, in taking my customary observation of the forms and positions of the solar spots, an appearance was witnessed which I believe to be exceedingly rare…

**Taylor Quimby: So these are the words of 19th century amateur astronomer and Charles Darwin beard impersonator Richard Carrington. Now Carrington was, as EVERYBODY knows, the author of “**[**Catalogue of 3735 Circumpolar Stars**](https://archive.org/details/catalogueof3735c00carrrich)**”.**

**Sam Evans-Brown: A classic.**

**Taylor Quimby: But we’re here to talk about an event that happened In late summer of 1859, when he witnessed history whilst observing the sun.**

Richard Carrington: I had secured diagrams of all the groups and detached spots, and was engaged at the time in counting from a chronometer… when with the area of the great north group, two patches of intensely bright and white light broke out.

[SFX]

**Taylor Quimby: Now it may seem that a bright spot on the sun is of little consequence - uhhhh so to translate why this was such a big dealio is Noe Lugaz - research associate professor at the Space Science Center at the University of New Hampshire.**

Noe Lugaz: 11 - Typically, there are flares, large emission of light from the sun - every day. But they are mostly visible in the UV and X-ray vision so unless you have an extra filter, which at the time people didn’t have, you wouldn’t see that.  But this one was so bright that you actually see it in the emission of the sun just like imagine a lightbulb exploding, so it’s something you can see with the naked eye without any equipment.

**Taylor Quimby: And what’s more Carrington wasn’t the only one to see it. Another observer, independent of him, saw the same bright flash and jotted down his findings.**

12 - And then I guess that was it for that day… but then the next night…

**Taylor Quimby The Northern Lights… go crazy.**

Noe Lugaz: 15 - Some people think it’s actually daylight starting… and report from newspaper is that people could read newspaper at 1am in the middle of the night. So just imagine how bright this aurora is that it’s pretty much as bright as sunlight.

**Sam Evans-Brown: Northern lights as bright as the sun? How have I not heard of this before? People must have thought the world was ending.**

**Taylor Quimby: But also another big weird thing here… these Northern LIghts were not entirely Northern. So yes, there are recorded sightings in the more typical latitudes… where auroras are more common, like Toronto, Canada..**

Observer [Jason]: The whole night sky was covered with a brilliant mass of streamers, patches and luminous bands.

**Taylor Quimby: And Lewiston, Maine.**

Observer [Emily]: Long brushes of pale white light were shooting up from the west… and also the east.

**Taylor Quimby: But the sightings are also coming from places like Indiana...**

Observer [Nick] : The most extraordinary display of the Aurora Borealis I have ever witnessed”

**Taylor Quimby: There are reports from newspapers in Mississippi.**

**Sam Evans-Brown: Missississippi?!**

Observer [Jason] : A belt of white light tinged with pink shot up from the northern horizon to the height of twenty or twenty-five degrees.”

**Taylor Quimby: And even the Director of an observatory in HAVANA CUBA.**

Observer [Daniela] : At the second hour the Aurora had attained its highest magnificence. The heavens then appeared stained with blood and in a state of complete conflagration.

Noe Lugaz: As far as Mexico, Cuba, all of the United States, part of Japan and China, and so on and so forth.

**Taylor Quimby: That’s what I mean when I say ‘go crazy’.**

**Sam Evans-Brown: I love this. One of my favorite ways to think about the aurora is as the light show we get when the planetary defenses are all geared up, keeping us safe from the craziness of the sun. So, I have to say, sign me up for this. In my lifetime I would love to see a lightshow of that proportion.**

**Taylor Quimby: Ok, well.. Hold that thought.**

Noe Lugaz: 16 - So at the time the most advanced technology was telegraph. Which we don’t use anymore but the basic idea is that you run some current through a telegraph line to send a message.

**Taylor Quimby: The same night, telegraph machines around the world started spitting sparks, or in some cases - working without being plugged in to a battery, without being attached to a power source.**

**Sam Evans-Brown: Oh terrifying.**

**Taylor Quimby: Yeah.**

[static and telegraph SFX]

Taylor Quimby: 17 - This is the sort of thing you see in a horror movie, where there’s a TV on, and it’s static, and then they pull the plug and it’s still going?

Noe: Lugaz: That’s pretty much what happens, so people turn off the telegraph and they could still send message and receive message, and I’m pretty sure that freaked them out. I think probably some telegraph line burst because of how strong the current was running through them.

**Taylor Quimby: This incident - the lights, the telegraph wires, the whole thing - is now referred to as The Carrington Event - after our friend who witnessed the bright light on the sun just before it started.**

Carrington: (with reverb) My first impression was that, by chance, a ray of light had penetrated...

**Taylor Quimby: Now… if that sounds scary… maybe even a little cool, Sam… I want you to imagine that this didn’t happen in 1859. Imagine that it happened today. And instead of telegraph machines going haywire…. Imagine that it was our electric grid. Imagine no radio.**

[SFX]

**No GPS.**

[SFX]

**No electricity.**

[SFX]

**No music.**

[SFX]

**That’s a catastrophe!**

**Taylor Quimby: It is indeed.**

[theme hits]

**Sam Evans-Brown: This is Outside/In, a show about the natural world and how we use it. I’m Sam Evans-Brown. Today, Taylor tells us the story of an event that changed how humans view the sun… an event, that if it happened today, could wind up being very, very not cool. This is a story that asks… how do you prepare for a disaster that always seems incredibly far away… until it’s not?**

**[mux fade]**

**Have you ever heard of the phrase, “A black swan event?”**

**Sam: Yeah. Because we’re in one. Supposedly.**

**Taylor Quimby: Right - so for listeners who haven’t heard of it, a black swan event is a seemingly improbable and highly disruptive thing that the world isn’t ready for… but that in hindsight, we should have seen it coming.   So back in 1859, people didn’t have the scientific knowledge to totally understand what was happening during the Carrington Event.**

**But that’s not the case anymore. Now, we have the tech… and the scientific understanding… to know what, and how guess at how often these sorts of things happen.**

**Sam Evans-Brown: Because now we know solar science.**

**Taylor Quimby: Right. Speaking of which, do you… you must know what a sunspot is.**

**Sam Evans-Brown: A spot of low solar activity, a dark patch on the sun.**

**Taylor Quimby: Right. And they form because there are these areas where the sun’s magnetic field gets all twisted up, cooling the surface down, and it stores up this… well let’s call it solar fuel.**

[explosive springy SFX]

Noe Lugaz: 27 - And then sometimes you get so much energy into sunspot that they break up and explode.

Taylor Quimby 28: In terms of explosion is this like an explosion you would see from TNT, is it literally blowing up on the surface, like bchhhooey?

Lugaz: Yeah it’s literally blowing up on the surface, except it’s like billions of nuclear bombs kind of level of things.

**Taylor Quimby: When these explosions are big enough to send stuff shooting into space like this, they’re called CMEs - or coronal mass ejections.**

**These CMEs send waves or radiation, and little particles traveling at ridiculously high speeds - and if they hit the earth, well that’s a geomagnetic solar storm, like what we saw during the Carrington Event.**

**Sam Evans-Brown: This is what I was saying… the northern lights are the earth’s defenses… but doesn’t that also tell us this is happening all the time?**

**Taylor Quimby: They do yeah, the sun goes through this cycle where activity goes up and down...**

Noe Lugaz: 30 - One or two eruption a week during solar minimum. And maybe you’re going to have three or four per day during solar maximum.

**But most of them are either so weak that we’re protected by the Earth’s magnetic field, or they just miss the planet. It’s like a gun being pointed away from the Earth.**

**Sam Evans-Brown: Space is big, and in 360 degrees, and the Earth is small and in just one spot.**

**Taylor Quimby: Right. But when they do hit… the effects can be very weird. Because what they screw up is all of our modern technology.**

**Sam Evans-Brown: Like zoom? Noooooo, not Zoom?!**

**Taylor Quimby: If zoom… zoom would be down everywhere! Can you imagine?**

**Sam Evans-Brown: We’d all be on Skype again.**

**Taylor Quimby: No Skype would be down too!**

**Sam Evans-Brown: Oh my god my brain is broken. But can you imagine Coronavirus and a coronal mass ejection?**

**Taylor Quimby: It’s really not worth thinking about.**

[mux]

**In 1967, a solar storm interrupted surveillance radars and momentarily pushed US forces to scramble for the possibility of nuclear war.**

**In 1972 a solar storm detonated remote magnetically operated sea mines in South Vietnam, they just exploded on their own.**

**Sam Evans-Brown: Oh my god.**

**Taylor Quimby: This storm also struck right in between the last two Apollo missions - and had astronauts been out in open space,  they could have been hit with a lethal dose of radiation.**

**Sam Evans-Brown: God.**

**TQ#: So Sam…  So you want to hear the worst case scenario? What scientists think would happen if a solar storm as big as the Carrington Event hit the US today?**

**Sam Evans-Brown: Do I want to hear about this right now, as I’m in my closet in the midst of a pandemic?**

**Taylor Quimby: [whispers] Yes you do...**

**Sam Evans-Brown: In the same way that I want to see what happened in that car accident that I’m driving by on the highway, yes, hit me with it.**

**Twenty to forty million Americans without power.**

**Sam Evans-Brown: Ok.**

**Taylor Quimby: For somewhere between - this is a big range - 16 days up to 1 or 2 years.**

**Sam Evans-Brown: Two years, Taylor?!**

**Taylor Quimby: I’m not finished. Total economic cost... somewhere between $0.6-2.6 trillion dollars.**

**Sam Evans-Brown: Good… gravy… Wait can I ask why? Like… what actually breaks in the grid that would take it so long to get it going again.**

**Taylor Quimby: Well it’s the biggest transformers that are the problem, those are those big boxes you see in certain spots behind chain link fences that transition between high voltage and lower voltage.**

**In an event like this, the risk is some of the big transformers might just overheat and melt. And it’s very specialized manufacturing. They’re hand-made by specialized electricians that spend a decade as apprentices. If you were to order one today, it would take a year and a half or two years to get it.**

**If this ever goes down, it will be a true Black Swan - where most of us are caught with our pants down, but afterwards the experts will point to reports and science and say… guys, we knew this was coming eventually.**

**[Pause]**

**Sam Evans-Brown: Ok.  I think… I think we need to take a break.**

**Taylor Quimby: yeah… this closet is so uncomfortable.**

BREAK

[SFX of countdown]

**Sam Evans-Brown: Welcome back to Outside/In, I have caught my breath... I’m Sam Evans-Brown.**

**Taylor Quimby: And I’m producer Taylor Quimby.**

**Sam Evans-Brown: Bad news bears Taylor Quimby**

**Taylor Quimby: That’s me. And this… is what it sounds like when a very expensive satellite doesn’t quite make it to orbit.**

Announcer: We have been informed… We have been informed... that we have lost telemetry. We have a slight telemetry loss.

David Wade: 23 - The cost of that satellite was over 400 million dollars. So it was rather an expensive loss that day.  My name is David Wade. I’m a space underwriter for the Atrium Space Insurance Consortium, which is a consortium of Lloyd’s syndicates. I underwrite satellites.

**Sam Evans-Brown: they really do have insurance for everything, don’t they.**

**Taylor Quimby: They do indeed. So I called David because Coronal Mass Ejections - or CMES - could pose a serious threat to satellites. And so David, who has built satellites, taught people to build satellites, and now insures them - has a real incentive to try and sound the alarm about a possible future Carrington Event. Carrington level Event… I don’t know what you call it, Carrington Event 2.0?**

**Sam Evans-Brown: So this is where we hear about how all the experts have been warning us for years and so that’s why this is a Black Swan is we should have seen it coming.**

 **Taylor Quimby: Right.**

David Wade: Yeah, I’ve always had an interest and a concern about CMEs… Across the space insurance market there’s about 30 billion dollars of exposure in orbit. 26 - No one insurer can afford to take the hit of a satellite failing.

**Taylor Quimby: This is the scene in the movies where the expert comes running in with their arms full of binders and charts and papers and tries to get the politicians to pay attention, but gets laughed out of the room. That’s this scene, in real life.**

David Wade: 31 - In terms of space weather we have two realistic disaster scenarios… considering space weather...

**Taylor Quimby:  He says that contrary to what way maybe your instinct CMEs do have an impact on satellites, but it’s not as bad as you might think. Really what they do is damage the solar panels a little bit… make them less efficient. So if we did have a Carrington Event...**

David Wade: ...but worst case we think that would something like a 5% loss on every satellite that’s in orbit.

**Taylor Quimby: There’s another type of technical malfunction he worries about too that could totally wreck a few big satellites, but in either case we’re only talking about, like  a few billion dollars worth of claims, he tells me.**

**Sam Evans-Brown: Just a few billion. No big deal. There’s like individual humans in the united states that could cover that.**

**Taylor Quimby: Ugh, sad.**

**Taylor Quimby: All in all David is worried about CMES… and he says yes there will be impacts because of the damage to  the satellites**

David Wade: 40 - Is it a major disaster waiting to happen… it’s a difficult question to answer. If it’s not taken seriously, then yes.

[Mux]

David Wade: 41 - We are ever more reliant on the services that satellites provide. And a major event, even if it did not affect the satellite itself, would certainly lead to things like communication signals being knocked out, GPS signals being knocked out. And the more and more reliant on those services means it’s going to be a bigger impact.

**Taylor Quimby: David helped to co-author one of the dire reports that I read for this story. And while David is ostensibly a space guy… the report wound up being mostly about things happening down on Earth. All of the ripple effects caused by the extended loss of electricity**

David Wade: 37 - food wastage, transport systems would be affected, pumping of water supplies, pumping of sewage...

**Taylor Quimby:  And as we’re seeing today, with the coronavirus, everything is connected, right? You cancel schools, well then where do some kids who rely on meal programs eat lunch s . How do health care workers get to the hospital if they don’t have daycare? It’s just one ripple after another.**

David Wade: 43 - What are the consequences of those long blackouts? Do we then start to see shops running out of food? Do we start to see civil unrest? The consequences are enormous.

Taylor Quimby: 45 - Do you struggle in your work generally to convince people that this is stuff that matters?

David Wade:  Well, I’ll say where we’ve struggled is we’ve written these reports for Lloyd’s and they don’t seem to get too much uptake from other underwriting divisions.

**Taylor Quimby: This is the ridiculous hollywood moment where you see we’re not listening to the experts. So basically, David says, he and the other space insurance nerds write up this disaster scenario report… They wanted to warn all of the other insurers, the ones that cover factories and electrical grids - and be like, guys, you need to prepare for this.**

David Wade: But as soon as that report was released it got sent straight away to the space underwriters. It was the ones that wrote the report in the first place!

**Sam Evans-Brown: [laughs] Oh my god so they just literally glanced at the title and were like, “oh space weather!”**

**Taylor Quimby: Sent it back to the people that wrote it… like ‘oh you guys should read this!”**

David Wade: So it is very difficult to get other people interested in a risk that they’ve never paid a claim on. It’s a very reactive industry. And until some people start paying some claims on some of these risks I don’t think it will ever be taken seriously.

**Sam Evans-Brown: So is anybody out there doing anything to prevent or mitigate this possible disaster?**

**Taylor Quimby: Yeah, the government has a lot of especially military reasons to really care about this sort of thing. There is this Space Weather Action plan the trump administration has put out. I looked through it, it is largely a to-do list of like figure out what to do. The plan is like come up with a plan, that’s what it says right now.**

**Sam Evans-Brown: right.**

**Taylor Quimby: There are some new standards for transformers and we might start getting transformers that are better prepared sometime in 2020s… And there’s a lot of people working on and trying to figure out how we can have better forecasting - so that we have more advanced notice of when a CME is going to hit.**

**Sam Evans-Brown:  So how long of a head’s up do we have now.**

**Taylor Quimby: Well, it’s not good. It’s not good.**

Noe Lugaz:7 - I can give you a forecast with maybe half an hour warning that is almost perfect. Scientifically we can be good enough, with new missions, in a decade give you 30 minutes, a few hours warning almost perfectly, so you can make a decision on this… to get one day or two day advance warning, that’s probably not going to happen in my lifetime. What’s going to happen is people are going to ride the storm, if I may say.

David Wade: Is it a major disaster waiting to happen? That’s a difficult question to answer. If it’s not taken seriously, yes.

[mux swell and fade]

**Sam Evans-Brown: Can I just say… as much as this seems to meet the criteria of a black swan — a blind spot that we should be paying attention to but aren’t — aren’t there a lot of things in this category? You know… the massive earthquake we’re due for in the Pacific Northwest… mega droughts in the midwest… like… Pandemics… Aren’t we told all the time that we’re on the cusp of disaster. And I guess… part of me just doesn’t want to believe this, but is this just fundamental to the human condition that we just can’t grapple with risks that seem remote and unlikely?**

**Taylor Quimby: Yeah, I know… and this is why, especially given current circumstances I wanted some good news. I wanted to know what it would look like to be better.**

Ilan Kellman: 7- So it’s all very well to say I’ve only seen white swans, so therefore black swans or blue swans or pink swans don’t exist. But where’s our creativity? Where’s our imagination? Where’s our innovation?

**Taylor Quimby: So this is Ilan Kellman, who works at two very relevant organizations right now…**

Ilan Kellman: 2 - The Institute for Risk and Disaster Reduction and the Institute for Global Health.

**And Ilan, is basically like even if we do get hit by an event that is truly unpredictable…aliens attacking. We should and can build our communities better, so that whatever it is, we can handle it better. Maybe not handle it, but handle it better.**

**Sam Evans-Brown: Ensure that we have heroes like Will Smith ready to pilot the alien spacecraft**

**Taylor Quimby: We should be more like actors...**

Ilan Kellman: 8 - Let’s do away with Black Swans. Let’s not be surprised, but let’s be ready for anything that we create for ourselves or that nature throws at us.

**Sam Evans-Brown: Right - we should be more prepared generally speaking.**

**Taylor Quimby: I’ve heard it called the “all hazards” approach.**

**Taylor Quimby: So basically, having two weeks of food and water, flashlights, some wind up radios, batteries, medications and hygiene stuff - it’s the same sort of stuff we should have had ready before the pandemic sent everybody searching for toilet paper.**

**Sam Evans-Brown:  This is what is supposed to be the good news, Taylor? Two weeks worth of food and water? Aren’t we just telling listeners they should be preppers?**

**Taylor Quimby: Noooo preppers are like ready to be in a bunker by themselves for the rest of their lives, there’s a real difference here.**

Ilan: 23 - I prefer not to call it prepping or surviving, I prefer to call it living.

Ilan Kellman: There’s so many groups out there and phrases, whether it’s prepper or survivalist. 13 - A lot of them are only  individualistic. They’re interested in surviving for themselves, by themselves without linking in to wider society.

[mux swell]

What we’re advocating for is people take responsibility as much as they can for their own lives. And where they can’t that they create the structures to help others. 12 - So disaster preparedness is about community.

**Taylor Quimby: If you think about it… two weeks is not a HUGE amount of time to be ready for… this is not like advocating for people to be ready to completely cut themselves off from society. So the rest of the picture is to build up  communities... create connections between folks who have the power and privilege to be independent, and vulnerable populations who don’t have that luxury. Things that just make communities better places to live in the first place.**

Anita Chandra: 8 - And so rather than having emergency preparedness be this siloed effort that’s individually funded and separately organized, how do we bring that into closer contact with the routine social service and economic operations of a community.

**Taylor Quimby: this is Anita Chandra - VP and director of Social and Economic Well-Being at the Rand corporation. She’s watching this whole pandemic play out, and is seeing all of the ways that people and communities are adapting, or failing to adapt… and she’s watching to see what happens after.**

Anita Chandra: 14 - The question will be what do we take into our plans and policies going forward, so these innovations aren ‘t fleeting… they’re actually baked in. Because we will be in this situation again.  Can you make sure that you’re a learning system. Can you take the lessons from Covid-19.

**[sfx]**

**Sam Evans-Brown: hmm… can I express some cynicism that perhaps we won’t actually take the right lessons away from the pandemic? Or at least that we’ll forget them relatively quickly? I mean the spanish flu was a just a century ago and yet, did anybody remember that before this all started?**

**Taylor Quimby: Well, here’s my one last attempt to convince you that we might just stand a chance of averting this particular disaster. Because some places… have already had a brush with it.**

Gilbert Sybille: 23 - It happened during the night at 2 hours and 44 minutes AM. The 13th of March, 89.

**Taylor Quimby: Sort of like what happened in Canada in 1989.**

Gilbert Sybille: 22 - So when I wake up in the morning there was no electricity.

**Taylor Quimby: This is Gilbert Sybille.**

**Taylor Quimby: A research engineer that has worked for Hydroquebec since 1978.  People who remember our Powerline series will recall that Hydroquebec is the massive public utility that supplies power to the entirety of Quebec, and exports to the United States. Now in 1989, a huge solar storm hit Canada and knocked out power to all of Quebec for 9 hours.**

Gilbert Sybille: 24 - And the media was very let’s say skeptical about that because it had never happened before. We were the first power utility to experience a blackout due to a geomagnetic storm.

**Taylor Quimby: But since then…**

John Kappenman: They spent something on the order of one and a half billion dollars.

**Taylor Quimby: That’s John Kappenman, an electrical engineer who’s been authoring big government reports trying to get the US to get take the threat of Geomagnetic storms seriously since the early 2000s.**

**He says they installed these things called series capacitors…**

John Kappenman: They went the expensive route, yeah they didn’t really have an option back in the early nineties.

**Taylor Quimby: And now… according to both Gilbert and John… Quebec is ready.**

[mux]

Gilbert Sybille: 31 - People are asking if this could happen again, sure it could happen again and we have simulated that phenomenon. So we can only work with probability but we have to be prepared for the worst case.

**Taylor Quimby: And get this - John says, for the US to install the 300 Carrington proof transformers we would need to defend ourselves against a big solar storm… it would only cost the entire country a billion dollars.**

**Which… when you divide it out through all the electricity customers in the US.**

John Kappenman: It’s the equivalent of an extra fifty-cents per year… about the cost of a postage stamp.

**Sam Evans-Brown: What??? This is all it would take? Ok, now for real, sign me up. I will chip in my fifty cents a year so that we can have a fantastic light show and not have a catastrophic societal collapse afterward.**

**Taylor Quimby: Yeah… well… and if there ever were a moment in which spending a little bit up front to avoid spending a lot down the line was going to be really really appealing… it’s now…**

**Sam Evans-Brown: ok everyone now that you’re thinking about the fragility of society, let’s talk about readiness for cyber attacks, for supervolcanoes, for megadroughts…**