

# CARBON AND OUR CLIMATE

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*Einar Vikingur*

## **The Earth Does Three Waltzes**

What I would like to do is to take you through my own journey from being an acceptor to a resister on the role of carbon in our climate. I did not have a 'Road to Damascus' moment; it came together gradually, and in a sequence. Some stuff was almost incidental, sometimes from way in the past, but it all turned out to be relevant as I pieced the story together. In other words, I am not a bloke who read Professor Ian Plimer's *Heaven + Earth* and converted—no; I did my own work. I am interested in the science and what its conclusions should drive, and that is good policy.

When I became wary of the explanations for climate change (while accepting that something is happening to our climate), I began to wonder about what had occurred as the planet's climate altered in the past. Why had it gone through these wild cycles of hot and icy and back and forth many times? One factor, which immediately appealed to me because the mechanics were real, calculable, and rather majestic, was what the whole Earth did as it moved and rotated and generally carried on its business of being a molten-core metallic rock flying about the Sun. Further, it seemed to me that the Sun itself had a place in one of the Milky Way's spiral arms, and that arm itself was moving around the core of our galaxy. Come to think of it, the whole show was moving through a supposed void, but one actually stuffed with gas clouds, particle streams, dust, and the occasional burst or stream of radiation from supernovas (exploding stars), quasars and pulsars (both intense sources of energy), and various other interfering bits and bodies.

Whilst the picture as a whole is very complicated, what the Earth itself does is quite simple and regular, and it has been worked out with great exactitude. I knew the basics of orbital mechanics, buried somewhere in my education, but I did not know that an engineer from Serbia, called Milankovitch, had spent years around the time of the First World War working out the details of the Earth's orbital journey. What he described is no fantasy, not an issue anyone questions. He showed that the amount of heat delivered to our planet by the Sun varies in three precise cycles, the interaction of which produces a net result which changes constantly and which is affected by the uneven distribution of land between the Earth's two hemispheres.

First, the Earth's orbit moves between being nearly circular to being slightly elliptical—I word it in this odd way because the change is very small. To put it another way: sometimes the circle is squeezed a little about its diameter and it takes about 100,000 years for the orbit to go through an entire cycle of changing shape. As it does so, there is a tiny but constant change in heat delivery to our planet.

Second, the Earth's axis is tilted a little, and the amount of tilt changes in a cycle of about 40,000 years—and it is this tilt which drives the seasons, because it changes the amount of heat delivered to the two hemispheres as the Earth rotates about itself and revolves around the Sun (here the second cycle, tilt, interacts with the first cycle, orbital shape).

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Third, the axis itself wobbles like a spinning toy top—so, not only is the tilt changing its angle, it is also wobbling in a cycle which takes about 20,000 years to complete. So, here is the third cycle acting on the second cycle which is working in the first cycle. Since the three cycles have different lengths, the net result was tricky to compute at first but is now well understood.

The net effect is that heat delivered to the Earth varies in ways which can be calculated. However, this does not mean we know the precise result, and that is because the Earth is not a perfect sphere with a uniform surface. The Earth has land in all sorts of awkward places and shapes and elevations—and it is covered by an atmosphere which is a chicken broth in one place and a pea soup in another (and *vice versa* tomorrow). Further effects are added from numerous and diverse sources such as sunspots, attenuation of solar radiation by interstellar gas clouds, volcanic eruptions, storage of heat and gases by the oceans and glaciers, various long and short cycles in the Sun's energy output, cloud cover, reinforcing or damping feedback loops in the atmosphere—and so on. However, we do know the imprecise result: sometimes it gets very cold for very long and we have ice ages, called interglacials. Sometimes it gets warmer, and we have periods between ice ages. Sometimes it gets colder for a little while, and sometimes it gets warmer for a little while. Now, I am an Icelander, and owe my existence to a warm period because my ancestors were able to settle Iceland at the start of such a period eleven centuries or so ago (and many of them died during a cold period five or six centuries later).

The *Milankovitch Cycles* do not explain everything about our climate, but they do form a very important part of the story. For the layman and the scientist alike, they are a real, explainable, unarguable factor in our climate. For me, in my journey of understanding what lay behind the hyperbole of the excited and the ignorant, they were a milestone of clarity. I did not have to believe in anything other than gravity to accept that they were fundamental truth.

### Tectonic Plates, Gobblers of Carbon

Next I began to think about the element carbon, and all those terms bandied about such as the '*carbon cycle*', '*poisonous carbon dioxide*', '*carbon sequestration*', and so on. Once again it was the fundamental long-term stuff which might hold the answers, so I asked myself questions such as: "*What happens to all this stuff pouring out of coal-fired power stations, volcanic vents, rotting trees, Mount Hekla in Iceland, my ridiculously powerful V8 car, and the breathing of six-odd billion people? Does it just bank up and lie in wait? Does it reappear in trees or dissolve in the sea, or what?*" I did find the answer, and it lies in a surprising place. What was generally described as the '*carbon cycle*' was actually just a blippy little sideshow in the bigger picture of how the Earth works. But there is a **real** carbon cycle, and I'll describe it.

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Let's start with Mount Hekla, which erupts every now and again and chucks out enormous amounts of lava and hot gases (including carbon dioxide). The lava cools and becomes rocks, largely made from calcium silicon oxide. Over millions of years, this rock gets broken up and turned into pebbles and sand and eventually the calcium in it gets weathered away and dissolved. In fallen raindrops and lakes and seas the calcium combines with carbon dioxide to form limestone deposits, and the shells of crabs, and coral reefs and so on. Over tens of millions of years, everything becomes sludge on the sea floor; and yet that stuff never seems to build up. Mount Hekla erupts because Iceland sits on a joint between two tectonic plates being driven apart by circulating molten rock kept hot by the radioactive decay of naturally-occurring isotopes in the Earth's interior (also the energy source for geothermal power, incidentally). But the sea floor's sludge finds itself one day at a different type of tectonic joint, where one plate is driven into the Earth (taking the sludge with all this carbon dioxide locked up in limestone with it) and the other one stays on top. In the molten lava, the limestone combines with silicon again to make the same rocks, and then the Earth releases lava and carbon dioxide out of Hekla (or Vesuvius) to do the circuit again for millions of years.

**T**his is the carbon cycle which regulates the amount of carbon dioxide in circulation, but it works on time-scales not easily grasped by a humanity which popped into existence microseconds ago in the geological way of thinking. It is also a cycle in which the quantities of material on the move dwarf anything we can do, including when natural variations such as eruptions occur. The natural variations are a part of the control loop which regulates the level of carbon dioxide in the atmosphere. Control loops are called that because they are systems which can deal with variations, and this one plays a role in regulating temperature over geological time. Variations are a part of how such a process works. The system is driven by tectonic plate movements, the idea of which was ridiculed by most of the scientific community for decades, until eventually it entered the mainstream as an unarguable fact.

The level of carbon dioxide is rising, but it is easy to calculate the number of tonnes required to produce the increase in concentration, and to demonstrate that humans contribute perhaps only as much as a tenth of the increase. There is evidence which indicates some recent rise in average temperatures, except for the past eight years. Humans are unquestionably making a contribution to the rise in carbon dioxide in the atmosphere, and even a 10 per cent contribution would be a very serious issue if carbon dioxide were connected with this temperature rise.

The connection between carbon dioxide and temperature rise is what we will examine in the next part. It is such a simple story that when I first grasped it, I discarded it. However, I dug a bit deeper and made sure I understood the science.

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## What Is This Carbon Dioxide Stuff?

In the first two sections I covered two factors influencing climate, neither of which explain the whole picture. I do not for a moment claim to be able to give you the whole picture; the best I can do is to lay out the things which are proven to be truth, and try and draw some conclusions from those things in aggregate. Having described what happens with heat when the Earth moves about its business, and what happens in part with the regulating of that heat when the tectonic plates move about the Earth's surface, I think we should take a look at what carbon dioxide does in more detail. Since many in the world speak continually about the wretched molecule (although most people know nothing about it) a bit of information might be in order. As governments everywhere rush to implement expensive measures to limit or cap release of the gas, should we not get to know the villain properly?

When sunlight is reradiated off the Earth, some of it is absorbed by the atmosphere. A molecule is hit by a bundle of energy which it can absorb; it wiggles about and bumps into other molecules—and a bunch of excited atoms and molecules is what heat actually is. If the bundle of energy had just passed back out through the atmosphere, no heating would have occurred. This trapping of heat is the greenhouse effect. Gases like oxygen and nitrogen (about 98 per cent of the atmosphere) do not trap heat. Carbon dioxide, methane, water vapour and ozone do—they are examples of greenhouse gases.

In a box of our air that contained 10,000 molecules, fewer than four of them would be carbon dioxide. It is pretty difficult to excite the others, no matter how much energy you can absorb. So, would it make a difference if we doubled or tripled the number of carbon dioxide molecules? The surprising answer is that it would not, and the reason is that carbon dioxide is very selective in the wavelength of energy it absorbs—it works only in a very narrow band. So, at any given moment, most of the tasty light for carbon dioxide is absorbed by a few lucky ones, and the rest of them just float around the place unexcited. If we add more of the stuff, a bit more energy gets absorbed, but mostly we just have more unexcited carbon dioxide doing nothing more than wait around to be absorbed by plants, or get dissolved in water, or combine forces with calcium to make limestone (and then get dragged into the roiling earth by a tectonic plate in a gazillion years).

The bottom line is that not only is carbon dioxide an uncommon gas, it is a pretty poor absorber of energy. Water vapour is another matter: it is ten times more common than our villain, and it absorbs energy across pretty well the entire spectrum. So, there is not only much more of the stuff, it also works much harder as a greenhouse gas. It also forms clouds and rain (and this action releases heat, too), reflects light back out, back in—does all sorts of stuff carbon dioxide could never hope to do. Clouds and their unruly behaviour are one of the main reasons why climatic computer modelling is so difficult to do beyond a few weeks, incidentally. It is also instructive to note that cloud formation is influenced by solar activity in an

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indirect sense—reduced emission of a wide spectrum of radiation from the Sun permits increased penetration of cosmic rays (mostly particles; it is a historical misnomer) into the atmosphere, increasing cloud formation as water condenses around the particles.

As an aside, the Earth's magnetic field is one of the sentinels which deflect harmful radiation and particles from reaching us. The magnetic field is influenced by the movement of gigantic quantities of molten metal in the Earth, a movement which also drives the tectonic plates. The isotopes which provide the power were formed in nuclear reactions in the guts of stars which then turned supernova and distributed their material—and our own planet collected some as it coalesced out of dust clouds billions of years ago. Everything is connected, and there is rarely a single explanation for anything.

**T**he paragraphs above can be backed up by numbers and calculations and graphs until the cows come home, none of which could be disputed. All the statements about absorption, rarity and heat release are undisputed facts of nature. What these facts scream at us is that it is impossible for carbon dioxide alone to heat up the atmosphere—this is such an important statement that I am going to reiterate a few things. There are not enough carbon dioxide molecules to do the job. The molecule does not absorb heat well, because it is fussy about wavelengths. There is a lot more water vapour than there is of carbon dioxide. Water vapour is many times more effective as a greenhouse gas. Whatever heating is happening cannot be the work of carbon dioxide, except for a small portion. It is physically impossible. The physics does not make sense. Whatever is happening, carbon dioxide cannot be blamed for it. What's more, the gas is actually plant food and having more of it promotes plant growth. Greenhouse growers the world over pump into their greenhouses a carbon dioxide concentration several times that of the atmosphere.

I want to make an important point about cause and effect: if the Earth is heating up and carbon dioxide levels are rising, that does not mean one is the cause of the other. All the spectacular reporting about changes to glaciers and coral reefs only shows that warming is taking place. It does not show what is causing the warming, and all the physics evidence demonstrates that the cause has to be something other than carbon dioxide. I do not say that burning fossil fuels in a profligate manner should continue, far from it. I just say that we cannot blame fossil fuels for climate change (I do wish we would plant more trees, though, for a thousand reasons other than temporarily absorbing carbon dioxide).

### **The Deeds of Carbon Dioxide in the Past**

**I**n the first three segments we started with a Serbian engineer and his slide rule, and worked our way up to the physics of how carbon dioxide behaves in the atmosphere. What I would like to do now is return to geological time and what the gas has been getting up to as the climate has cycled through high and low temperatures. Surely this must be important, as carbon dioxide today is the same

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structure and is bound by the same laws as whatever of the gas was swirling around in the past.

It is possible to reconstruct the temperature and carbon dioxide relationship with startling accuracy for the past half a million years or so, using ice cores drilled out of the glaciers (which therefore have never melted) in Antarctica and Greenland. This work has been done several times, by different people in different places. The data has been analysed several times, in different ways, by different researchers. The conclusion is consistent, and beyond dispute: temperatures rise, and about eight centuries later the level of carbon dioxide rises. The temperature increase precedes the rise in carbon dioxide, and it is therefore not possible for temperature to have been driven up by the gas. As temperatures rise, from whatever cause, the oceans get warmer and this reduces the amount of gas which can be held in solution. The oceans therefore release the gas as a result of more heat—and that is the likeliest explanation as to why carbon dioxide concentration lags temperature increases.

As I worked through the science behind carbon and our climate, the ice-cores data was for me a sort of a *coup de grace* for carbon dioxide being the cause of temperature increases. The data demonstrated, beyond any reasonable doubt, that the major causal link between the two was the reverse of what was the generally accepted one. Heat causes carbon dioxide levels to rise. Carbon dioxide does not cause heat to rise, other than as a minor contributor. I found this situation utterly astonishing, once I became confident that I understood the facts, because entire governments, large bureaucracies, swathes of the scientific establishment, and practically every commentator on the planet seemed not to have understood the facts.

I looked at things from different directions, I checked my logic, and I wondered whether there was something I had missed. However, because I tried to focus on science grounded in proven facts, I always came back to the same thing: carbon dioxide is a minor player, a sideshow in the global warming story. So why were we all being told by so many clever and competent people that we were about to be engulfed by a cataclysm caused by this sideshow? And, incidentally, what was warming us up late last century?

My last part will try and answer those questions. I am not confident about my answers, but I think I am on the right track. The one thing I am certain about is this: carbon dioxide is not the primary cause of global warming, and therefore humanity (whilst there are too many of us) is not to blame. And in any case, should we be blaming or rejoicing? Does it occur to anyone that warmth is good? That we are in an interglacial right now, and should be afraid of cold returning? Haven't humans thrived during warm periods (*Mediæval Warming*) and suffered terribly during cold spells (*The Dark Ages*)?

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### What the World Should Not Do (And What It Might Consider Doing)

Remember the Millennium Bug? In the 1970s some dork (apparently) wrote code using only the last two digits for the year, and the result was supposed to be doomsday when the clock struck midnight on December 31, 1999. Billions of dollars were spent on upgrading equipment and software, thousands of boffins beavered away for years all over the world leading up to the magic moment—and nothing happened! At that time I was the chief information officer for one of the country's biggest corporations, and I swallowed the bait hook, line and sinker. I spent millions of the shareholders' dollars—and nothing happened. Along with everyone else, I had failed to dig until I found the facts. I was a member of the world's biggest unintended con job and groupthink; just an unthinking member of the herd, and I have been ashamed of it ever since. You reckon groupthink could not happen on carbon dioxide and global warming?

Many have staked a lot on climate change and carbon emissions—they have become vested interests, captured by personal or institutional pride, and a certainty born of habit. But the known facts have changed since the game began, and everyone needs to have the courage to change with them. It will be easier for most than for the thousands of climate scientists who are now earning both a good living and a place in the sun (sorry...). Worse still, the politicians and their bureaucrats are thick into this, and many of them would find it extremely difficult to reverse positions even if they understood the facts and wanted to recant. And much worse still, financial institutions the world over are sniffing out the money to be made out of carbon credits, permits trading, you name it, and they'll think of a fancier name still (something like *'leveraged derivatives twice bonded and once removed'*)—and these institutions therefore have every reason to believe in and encourage what is happening. This is what they are designed to do; it is their primary motive, unfettered by neither kindness nor malice.

Let's get this straight: some warming has happened over recent decades—even though the measuring is dodgy and disputed, and the last eight years have been on a cooling trend. The population is large, and we are making a real mess of our home—and the solution to over-population lies not in coercion of anyone but in the emancipation and education of women. We have chopped down too many trees (I love trees). We are not investing enough in renewable energy, specifically on how to harness in a distributed way the ultimate source of all energy, the Sun. We are using up resources fast. We should allow fish stocks to recover (I love marine creatures of all kinds), and stop dumping so much rubbish into the oceans and into landfill. We need to work against religious bigotry and the resulting violence, and we need to feed and govern and protect all people properly, on the basis of liberty and compassion. What we should not be doing is wasting huge resources on reducing carbon dioxide emissions, because it would be on a problem which does not exist. The other problems do exist.

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So, the world's climate is changing yet again. We have a choice between homing in on a non-existent carbon problem, and thereby condemning half of the world's people to continued poverty as they are forced to pay for expensive energy (the rich world's prosperity is based on cheap fossil fuels), or we can adapt as the world changes its climate of its own accord. As we adapt, the cost and effort of a carbon focus and the economic dislocation it would cause could be redirected towards solving the problems we know to be real.

Incidentally, why has the globe warmed (a little) since about 1850? First, that was the end of the *Little Ice Age*, so it is hardly surprising a bit of warmth has been returning. We know that the climate has fluctuated in the big sense (ice ages) many times, but it also fluctuates in a smaller sense, in that it has warmed and cooled appreciably often, even during recorded history. What we are seeing now is such a fluctuation, and the cause is a combination of things—a net warming as a result of the *Milankovitch Cycle* interactions, the Solar System is perhaps coming slowly out of a very wispy interstellar gas or dust cloud which has been attenuating sunlight slightly, the Sun is in a different part of its radiation cycles—and a myriad of other factors quite beyond our ken as yet are just lining up in a particular way for a little while. This sort of thing has happened many times before, and will happen again.

### The Likely Future

I have focussed on the role of carbon dioxide and have not spent much time on what is likely to happen, but I think it is possible to describe the next few decades. We can all relax, actually, because the planet itself will answer the questions most emphatically by continuing the cooling which has been occurring since 2002. By 2030 we should be at the lowest point of the next sunspot cycle (and it will most probably be an unusually low one) a process that began in 2002. I say “lowest point” in the context of the effects on Earth, as there is a lag of several years as the planet digests the energy delivery and translates it into climate.

The Sun has many interacting cycles of activity (one of them cycles every 1500 years)—the eleven-year *Schwabe* radiation intensity cycle is the simplest one, and the one that people focus on. The irradiance variation is thought of as quite small—perhaps only about 0.1 per cent variation, but that is a great deal of energy in absolute terms. However, there is a twist or three, and I love the way they work.

First, the *Schwabe Cycle* oscillates in length, and can go a year or so either way. If you plot the length over a couple of thousand years (there are various kinds of observational records of sunspots that far back) against intensity of magnetic disturbance, and then do some mathematical transformation of the graph, it emerges that intensity is proportional to length and varies in a 166-year cycle, called the *Gleissberg Cycle*—there is a weak period followed by an intense period every eighty-three years.

The second twist is that sometimes there is a phase shift in the *Gleissberg Cycle*, which means that a weak magnetic cycle is followed by another weak one (instead of weak

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and intense alternating)—but it happens eleven years apart (amazing—I cannot work out whether it is just a coincidence). The middle of the *Little Ice Age* about three centuries ago saw two weak periods in sequence—reduced irradiance coupled with more cosmic rays, resulting in more cloud cover, with a net cooling. The predictability of phase shifts is based on orbital mechanics, and therefore has a fairly high degree of certainty.

The third twist is that there is a lag of several years (about four to eight) as the Earth works out how to translate energy delivery into climate. This is where it gets complicated, and where computer modelling of climate cannot work beyond a few weeks.

When sunspots are active (and they are gigantic magnetic storms, about 40,000 kilometres across) the Sun's magnetic field deflects cosmic rays (which are particles) entering the Solar System and reduces the amount which enters the Earth's atmosphere. Since water condenses around the nuclei, fewer particles mean fewer clouds, reducing reflection of radiation back out to Space. The net result is warming, which is amplified as there is also more radiation and magnetic energy available for the planet. The ozone in the upper atmosphere absorbs more ultra violet radiation, and that energy eventually circulates down. There is also direct energisation of particles in the atmosphere from solar eruptions and storms during strong sunspot activity. This effect is an amplifier: more energy gets transferred to the planet than might be expected from increased irradiance alone.

When sunspots are inactive, the opposite happens—more particles from cosmic rays are available for cloud formation, more reflection occurs, and there is also less radiation, and less transfer of energy from solar magnetic fields into the atmosphere. The net result is cooling. This is a phase we are well into now.

The sunspots are driven by orbital mechanics, those lovely and predictable dances—the four gas giants shift the Solar System's centre of mass from the centre of the Sun in a regular pattern, one which is well understood. The Sun therefore revolves around the centre of mass as well as rotating (the centre of mass can move as much as two to three solar radii from the Sun's centre). The Sun has a metallic structure (this comes as a surprise to most people, but any element other than hydrogen for astrophysicists is a metal) and therefore movements of gigantic masses of metal generate sunspots (magnetic storms, remember) via the solar dynamo effect.

These are the reasons why it is possible to predict with a high degree of confidence that we will be in another *Little Ice Age* (not very cold actually) by 2030. I think it is a most beautiful symmetry, an exquisite demonstration of how a small part of the universe works.

*Einar Vikingur has a BSc with First Class Honours in organic chemistry, an MSc in guided weapons engineering, and a Bachelor of Modern Languages in Russian. He has worked in the mining industry for many years. He lives in Perth.*