

Every month since February 1987 the Olympia Fellowship of Reconciliation has produced one-hour TV programs on issues related to peace, social justice, economics, the environment, and nonviolence. The Olympia FOR's program airs several times every week for the entire month on Thurston Community Television (TCTV), channel 22 for Thurston County's cable TV subscribers. You can see TCTV's schedule at www.tctv.net.

You can also watch the program described below (and many more than 150 of our previous monthly interview programs and also many special programs) at the Olympia FOR's website, www.olympiafor.org. Simply click the TV programs link, scroll down, and click the program you want to watch. Many of our website's TV program listings also include links to documents describing the program in Word and/or .pdf format.

August 2016

“How Science and Art Explain the Carbon Cycle and Climate”

→ *Also see the resource list near the end of this article.*

by Glen Anderson, this TV series' producer and host

The Olympia Fellowship of Reconciliation's TV program for August 2016 helps people understand the climate crisis – and powerful solutions – in fresh ways. Three knowledgeable guests combine easy-to-understand science and visually explicit art to help us explore the carbon cycle as a crucial but often neglected aspect of the climate crisis. We present the carbon cycle in some fresh ways that non-scientists – and people of all ages – can easily understand. We also show how these fresh insights can help us choose practical remedies to reverse the damage and make our climate more sustainable. We hope educators, scientists, and climate advocates will help to publicize this outstanding TV program and the informative description you are reading now.

Three guests provide easy-to-understand information:

Pat Boutin Wald has a Master of Fine Arts degree in textiles. She has exhibited in museums across the US and has taught art in four universities. She was selected as an Artist in Residence by the WA State Arts Commission and National Endowment of the Arts.

Pat also has a strong background in researching and working for human rights. For the U.S.'s nationwide level of Amnesty International she was the Administrative Coordinator of the China Coordination Group and the Tibet coordinator.

Pat is also an educator with a K-12 teaching certificate. She worked for 17 years for our Hands On Children's Museum and retired from her position as Senior Curriculum Advisor.

I've enjoyed working with Pat for a number of years, and when we proceed through this interview you'll see why Pat is so much fun to work with!

Richard Gammon enjoyed a long career as a professional scientist. He is professor emeritus in chemistry and oceanography at the University of Washington in Seattle. He headed up the Pacific Science Center for 1 ½ years and worked with the United Nations' climate body, the Intergovernmental Panel on Climate Change, the IPCC. He was a carbon monitor for 2 years.

In February 2016 Richard gave expert witness testimony as the only climate scientist to testify in the trial of the “Delta Five” – the courageous people who nonviolently blocked an oil train in Everett, Washington. We interviewed one of the defendants during the Olympia FOR's May 2015 TV program about oil trains. You can watch this through www.olympiafor.org Click the “TV Programs” link and scroll down to the May 2015 program.

Heather Taylor Zimmerman is an Olympia artist who has created art for hospitals, clinics, schools, and libraries as well as corporate, city, and state offices. She specializes in environmental murals that bring the “outside in” and reconnect us to the natural world. See her skills in her murals at the Hands On Children's Museum, where art is used to teach children about the environment.

Heather is currently getting a doctoral degree in archetypal psychology, exploring how art can teach us as a means of unconscious communication. She has also trained and worked as a graphic recorder creating visual synthesis and consensus within groups.

Her love for children and the natural world has motivated her to work on carbon sequestration as essential to restoring a homeostatic relationship with the earth.

Heather believes that art and science should be in dialogue because they are different ways to explain the world around us. In the early part of our interview Heather will illustrate Pat's explanation of photosynthesis. Later in our interview she will discuss the use of art to help people understand clearly.

An easy way to understand photosynthesis and the carbon cycle:

Heather shows us an attractive, easy-to-understand illustration of photosynthesis and the carbon cycle while Pat explains how these basic processes work. Together, they explain:

- How the air we breathe is replenished
- Where all food comes from
- How earth's temperature is regulated
- How molecules interact within and across the plants and animals of the past, present and future

Pat says if we were to plant a seed in the ground and a giant tree grows, we might ask, “Where does the mass, the stuff, of the tree come from?” She said that people's most common answer – it comes from the soil – is only a tiny bit right. Actually, Pat explains, what really happens is this: Tree roots suck up water from the ground and send it to the leaf. Molecules of carbon dioxide from the air enter the leaf through holes called stomata. Just two ingredients! Then chlorophyll, the green stuff in the leaf, uses the energy of the sun to break apart the water and carbon dioxide molecules and recombines them to create plant sugar. This sugar is used to build the tree. Most of the dry weight of a tree is carbon that the leaves took in from the air. Yes, trees come mostly out of the thin air! (See the link to Richard Feynman's interview as one of the resources about this specific topic, listed near the end of the summary you are reading now.)

We call this process photosynthesis. Only plants can do it. This process of photosynthesis produces a waste product, oxygen. The leaf spits oxygen back out into the air. If this was all that happened, after a while we'd have lots of oxygen in the air for us, but no carbon dioxide for plants to breathe.

Fortunately, there's another half of this cycle. When animals (including people) eat plants, our bodies use the glucose and combine it with the oxygen we breathe in. This releases energy, the energy our bodies need to move and grow. We call this process respiration. This produces carbon dioxide and water as waste products.

Notice that these two processes are opposites that balance each other. We take in oxygen and give off carbon dioxide, while plants take in carbon dioxide and give off oxygen. In and out, round and round they go.

Please understand that carbon molecules travel around a lot. This is the “carbon cycle.” Carbon can collect in any of four places: the air, plants and animals, the ground, and water. Sometimes carbon gets stored in one place for a while. We call that “sequestration.”

In our example, the tree takes carbon from the air and makes it into sugars that it stores in its bark, wood and leaves. It also stores some carbon in its roots and mycorrhizal fungi to be stored underground. When we release carbon that has been stored in living plants – or underground as coal, oil or natural gas – it goes into the air and bodies of water. Carbon dioxide (CO₂) in the atmosphere prevents some of the sunlight that reaches the earth from emerging back into space. This tendency to trap carbon dioxide within earth's atmosphere causes it to function like a greenhouse that heats up inside. (This is why CO₂ is called a “greenhouse gas.”) Richard explained that it was way back in 1859 when John Tyndall discovered that carbon dioxide is a greenhouse gas that traps heat close to the earth. Too much carbon in the air can cause temperatures to rise. Too much carbon in the water causes it to become acidic, which chemically prevents sea animals from making their shells strong.

Early in our interview Pat explained this, while Heather pointed to the relevant parts of the artistic display added more to this imagery.

About half of a tree is below ground. When it dies it rots and goes into the air again.

Grass has 4 times the amount of roots compared to the amount above ground. We used to have carbon 12 feet deep in the soil. We have done as much damage with the plow as with the factory.

Therefore, we need to plant more trees in more places, and we need to regrow prairies that had tall grass, because they can sequester enormous amounts of carbon. Even old trees continue photosynthesis. For this reason, the Nisqually Tribe is urging people to leave trees growing much longer before harvesting.

Pat explained – and Heather illustrated – how photosynthesis drives this process, and the carbon cycle supports that. Next Richard explained how things have changed over time.

How the natural carbon cycle evolved in earth's history:

Richard explained that about 3.8 billion years ago – before oxygen became common – the earliest life that appeared on earth did not use oxygen. It was “anaerobic.” The air contained much methane. While bacteria were developing in the ocean, there were no land plants. Over a long period of time different life forms evolved, including some plants that used photosynthesis and produced oxygen. The carbon cycle that we have explained gradually emerged. The carbon cycle allowed for feedback loops and stability.

Earth's atmosphere was relatively stable for millions of years until human beings disrupted it just a few hundred years ago with the Industrial Revolution, when we extracted enormous amounts of carbon (coal, oil, natural gas) that had been stored safely underground for millions of years, burned it, and polluted earth's atmosphere with enormous amounts of carbon dioxide, which – because it is a “greenhouse gas” that traps heat – caused earth's temperatures to rise. Now we have more CO₂ in the earth's atmosphere than had existed at any time in the past 4 million years.

To illustrate a sustainable life system, Richard showed a small visual item – a small glass “Ecosphere” globe containing water, a few brine shrimp, a little plant life, and a balanced system for exchanging oxygen and carbon dioxide, as we have explained:

This is a small physical example illustrating the basic description of the Earth’s natural carbon cycle in mutual benefit of all plant and animal life in self-regulating equilibrium (homeostasis). Basically, this “Ecosphere” is a simplified model of the global carbon cycle, a self-stabilizing ecosystem that does not exchange matter with the external world (just as our Earth is essentially closed to matter exchange with the rest of the solar system and universe), but that does exchange energy (just as our Earth is open to incoming sunlight, in balance with outgoing heat).

This Ecosphere system can continue to thrive in equilibrium for ten years or longer, as the plants make oxygen for the brine shrimp to breathe, and the brine shrimp breathe out carbon dioxide and expel nutrients which fertilize the algae. If the ecosphere gets exposed to too much sunlight, the algae get overstimulated, so they would produce too much CO₂, and this could kill the shrimp by raising the water’s acidity too much. So, it needs indirect light only and a temperature between 60 and 80° F. Self-regulation ends when all the shrimp die.

You can learn more by searching the web for “ecosphere.”

In the past few hundred years humans have disrupted the carbon cycle:

The carbon cycle we described is stable and sustainable. But for the past few hundred years of the Industrial Revolution humans have extracted much carbon from underground (coal, oil and natural gas), burned it, and polluted the atmosphere with an enormous amount of carbon dioxide (CO₂) that is seriously warming earth’s temperatures, acidifying our oceans, and disrupting our climate.

Scientists agree that it is dangerous for our atmosphere to have more than 350 molecules of CO₂ for every million of other molecules in the atmosphere. **This maximum safe level is referred to as “350 parts per million” (350 ppm). However, now we have more than 400 ppm of CO₂, and the level continues to rise at an alarming rate (about 3 ppm/year).** This is the fastest rate of change in the entire geologic record of earth’s history!

About 90% of our CO₂ emissions now are caused by burning fossil fuels, and the other 10% are caused by cutting down tropical forests, especially in Brazil and Indonesia.

This has become extremely dangerous. Already we are seeing record heat waves, more droughts, more storms, etc. The disruption to the climate occurs more than a decade after the time when the greenhouse gas was polluted into the atmosphere, so there is a lag time. The climate disruptions we are experiencing now are the results from carbon pollution from more than a decade ago, and the carbon pollution we are causing right now will start causing climate disruption more than a decade into the future. **So while we must sharply reduce our climate pollution immediately, we must also recognize that some further damage is already baked into the system!**

The climate crisis is already causing severe social disruption – droughts, refugees, etc. – and will cause much more human suffering in coming years:

The climate crisis is already provoking some social disruptions. We mentioned this briefly during our interview. You can see more information about this near the end of the “Climate Crisis” section of www.olympiafor.org. Look for an article titled “The Climate Crisis Is a Peace & Justice Issue” (www.olympiafor.org/The%20Climate%20Crisis%20Is%20a%20Peace%20&%20Justice%20Issue.pdf) and another

article titled, “If you want peace, protect earth’s climate from disruption” (www.olympiafor.org/Sunshine%20Flyer%20--%20Revised%209-18-2013.pdf)

NASA’s amazing 3-minute video shows CO₂ pollution traveling worldwide:

The earth’s atmosphere is actually very thin. The carbon dioxide we generate travels all around the earth trapping heat in this thin atmosphere. We paused our TV studio interview to show the viewers a powerful 3-minute video from NASA that shows how carbon dioxide (CO₂) travels around the earth. Although CO₂ is invisible, this NASA video uses special effects to show it in color. This video shows **all 12 months of 2006 in just 3 minutes**, and the narration explains it clearly. You can watch NASA’s 3-minute video animation of the entire year 2006’s CO₂ emissions and worldwide circulation at <http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=11719>

We must take vigorous actions now to restore earth’s natural carbon cycle:

With the information we’ve accumulated in the past half hour – including Heather’s illustration on the storyboard – we can see how we can restore the natural carbon cycle. We’ll be at 450 ppm or 500 ppm – far beyond the safe limit of 350 ppm – before our remedies can go into effect and return to 350 ppm. Therefore, **we must take very strong actions now** – actions grounded in the science we’ve explored during this interview – to turn things around.

The late 2015 global climate summit in Paris called for reducing CO₂ emissions by at least 80% by 2050. We must completely stopping tropical deforestation and begin massive global efforts to reforest those areas and plant more trees in more locations. We must protect soil from industrial agriculture and strengthen soil’s ability to store carbon.

Of course we must sharply reduce the burning of fossil fuels, promote energy efficiency, and convert to renewable kinds of energy (wind, solar, geothermal, etc.). We can also establish and expand “smart” grid systems for moving electricity around efficiently and storing it efficiently, including with better batteries.

We began this interview with Pat and Heather showing how photosynthesis works. They explained that carbon can move around and be stored in air, water, earth, or plants and animals. We have too much carbon in the air (atmospheric CO₂ pollution) and too much in the ocean (where it increases acid that hurts animals with shells). To restore a sustainable climate we must sharply **reduce the sources of carbon pollution and also increase the “carbon sinks” where we can store excess carbon. We must move much of that carbon out of the air and the ocean, and into the ground and living things.** Photosynthesis and the carbon cycle are Mother Nature’s biological solution to our problem. Let’s stop interfering with them and start cooperating with Mother Nature’s sustainable processes.

A number of scientists also recommend that – in addition to supporting forests, tall-grass prairie grasses, and soils – we should protect and restore estuaries, the natural areas where rivers and streams flow into salt water, and where high tides bring salt water back into those areas. They are rich sources of biological activity and can support marsh grasses, carbon-enriched soils, and other remedies.

Soil can be a good “carbon sink”:

Increasingly powerful scientific evidence shows that soil has great ability to sequester carbon – to be what is called a “carbon sink.” Industrial agriculture with monoculture crops and too much plowing and pesticide use has sharply reduced soil’s ability to store carbon. Industrial agriculture kills the life that should exist in soil – including the latticework of underground fungi – depriving soil of the carbon that could reduce the CO₂ in the air. We need to reverse those practices: rotate crops, plow less or not at all, use few or no pesticides, etc. Using better farming methods could help farm land protect our climate.

Nature wants to do this. In fact, nature needs to do this. See www.thecarbonunderground.org

Another remedy is to put a price on carbon, so Initiative 732 will be on Washington State's election ballot for November 2016:

More and more people across the political spectrum are saying that in order to reduce carbon pollution we should put a price on carbon fuels. This would induce people to burn less. In November 2016 Washington State's voters will be able to vote on Initiative 732, which would put a tax on carbon and reduce some of our state's unfair taxes so it would be revenue-neutral. British Columbia, Canada passed a similar tax that went into effect in July 2008. It successfully reduced fossil fuel use and is perceived as fair and workable.

Store carbon underground in geologically stable basalt:

New technology can store carbon in underground basalt, where it would be geologically stable and would not leak into the atmosphere. This has been used in Norway and Iceland. The Pacific Northwest also has underground basalt where we could do this.

To make progress we must bring more people into the climate movement:

The climate crisis has gotten as bad as it is because of several reasons, including the power of the fossil fuel industries and the politicians who are stuck in the status quo. Therefore, in order to accomplish the remedies our TV guests are recommending, we will need a lot of "people-power" to overcome the status quo. We talked a bit about how to expand and strengthen the grassroots climate movement.

We need to acknowledge that the climate crisis is a difficult – and frightening – topic. But research shows that frightening people does not work. People are not motivated by hearing bad news. People need a positive, empowering message in order to get them to act. We need to explain the science clearly, and in several ways. For example, this TV program uses Heather's artistic skills along with Pat's and Richard's carefully crafted messaging. Skillful art can illustrate invisible things to help people understand. Heather and Pat said they want art and sciences to be in dialogue because they are different ways to explain things.

Art can explain and empower:

Our interview briefly discussed how art can help people learn about things that are not tangible and not even visible. When Heather's art makes the invisible visible, people can understand what happens in the environment. This makes it real for people. She has performed professional quality "graphic illustration" all over the nation at conferences about "systems thinking" and other topics.

Heather is working on a doctoral dissertation in "archetypal psychology," drawing upon insights from Carl Jung and using art to communicate insights.

Sources of information specifically on this topic:

→ See the very interesting resources listed immediately below, and resources about the broader climate issue after the end of this list:

- You can watch NASA's 3-minute video animation of the entire year 2006's CO₂ emissions and world-wide circulation at <http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=11719>

- Watch Rachel Lodge’s interesting 5- minute illustrated video about the carbon cycle, “**Carbon Meditation**” and her slightly longer and much more explicitly illustrated and narrated video, “**Biocarbon: Mobilizing the Power of Nature to Help Restore our Climate**” Search for each of these titles at www.Vimeo.com The end of this video recommends www.nwbiocarbon.org, which provides more information about this.
- Trees come “from out of air,” said Nobel Laureate Richard Feynman. Watch both of the interesting short videos at this link: www.npr.org/sections/krulwich/2012/09/25/161753383/trees-come-from-out-of-the-air-says-nobel-laureate-richard-feynman-really
- Read the article “How the World’s Most Fertile Soil Can Help Reverse Climate Change” at www.eco-watch.com/how-the-worlds-most-fertile-soil-can-help-reverse-climate-change-1906689975.html or more simply at www.tinyurl.com/grtjcbv
- To learn more about soil as a carbon sink, see various parts of www.thecarbonunderground.org and some of the resources it recommends.
- This TV interview briefly mentioned that the climate crisis is already causing social disruption. We posted two very short articles about this at the Olympia FOR’s website, www.olympiafor.org. Click the “Climate Crisis” link and scroll most of the way down to see an article titled “**The Climate Crisis Is a Peace & Justice Issue**” (www.olympiafor.org/The%20Climate%20Crisis%20Is%20a%20Peace%20&%20Justice%20Issue.pdf) and another article titled, “**If you want peace, protect earth’s climate from disruption**” (www.olympiafor.org/Sunshine%20Flyer%20--%20Revised%209-18-2013.pdf)

Sources of information on other aspects of the climate crisis:

Many, many sources of information are available for anyone who cares about the climate crisis’s dangers and remedies, photosynthesis and the carbon cycle. Many, many **non-profit organizations** not only provide information but also create opportunities for people to get involved in solving the problems.

The Olympia Fellowship of Reconciliation’s website lists some good information sources and some good non-profit organizations. See the “Climate Crisis” part of www.olympiafor.org Some of that information is grouped by topic, and some was posted at various times over the past few years, so you will discover interesting information if you scroll through the website’s “Climate Crisis part.

For example, if you want to understand the late 2015 global climate summit in Paris, read information I compiled from dozens of the best articles about it, including links to the original sources. It’s posted on the “Climate Crisis” part of Olympia FOR’s website. See [What the COP21 Paris Climate Summit Accomplished, What it Failed to Do, And Our Next Steps](#) - Glen Anderson-December 2015

Near the end of our website’s climate section you’ll see links to two lists of other organizations. You’ll find some information at each of these, and some of these can help you find other organizations:

[Organizations \(NATIONWIDE and WORLDWIDE\)](#)

[Organizations \(LOCAL and REGIONAL\)](#)

Also, the Direct Action Group of Olympia FOR’s “Confronting the Climate Crisis” created its own website, www.olyccc.org. Check it out.

The Olympia FOR's TV series had produced several other climate-related programs. You can watch them through www.olympiafor.org. Visit the "TV Programs" section and scroll down to watch:

- [May 2015 Stop the Dangerous Oil Trains. Protect Our Communities and Climate \(Word\) \(pdf\)](#)
- [January 2015 Climate Change From Despair and Denial to Courage and Action \(Word\) \(pdf\)](#)
- [February 2012 Climate Change: Updates and Next Strategies \(pdf info\)](#)

Below the chronological listing, scroll down to see these relevant **SPECIAL PROGRAMS**:

- ["Climate Change 911: The Health Effects of Climate Change"](#)(video)
- [Confronting the Climate Crisis](#) January 14, 2013, Demonstration at the Washington State Capitol in Olympia WA

Further encouragement:

This one-hour interview looked deeply into the workings of the earth as a system. Our world is a marvelous and sustainable system **if** we respect it and work with it, not against it.

Someone in South America expressed this wise thought: "To become human one must make room in oneself for the wonders of the universe."

The science we have discussed during this hour also reflects the wisdom of the Roman poet and philosopher Lucretius, who wrote this more than 2,000 years ago: "We are a bit of everything and then we go on to become something else."

Our three guests and I hope you will experience the excitement about learning more and more about the amazing science, including artistic ways of understanding it.

We hope you will also share these insights with other people. You can offer them the link for watching this TV program through the Olympia Fellowship of Reconciliation's website, www.olympiafor.org. Visit the website's "TV Programs" part and scroll down to August 2016 to see the link for watching this program ([August 2016 "How Science and Art Explain the Carbon Cycle and Climate"](#)) and also the descriptive summary you are reading now, which is posted next to the link for watching the TV program.

You can get information about a wide variety of issues related to peace, social justice and nonviolence by contacting the Olympia Fellowship of Reconciliation at (360) 491-9093 or info@olympiafor.org or www.olympiafor.org