

# Climate, Energy and Community: Vermont 2009

Alan K. Betts  
 Atmospheric Research, Pittsford, VT 05763  
[akbetts@aol.com](mailto:akbetts@aol.com)  
<http://alanbetts.com/writings>

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## Abstract:

This is a compilation of my 2009 Weekly Planet articles from the Sunday Environment page in the Rutland Herald and Barre/Montpelier Time Argus. The corresponding set for 2008 includes an introductory narrative, discussing how this Environment page was set up, and my perception of my responsibility as a climate scientist to contribute to the public discussion.

These columns go through the seasons, dealing with weather, climate, climate change, energy and policy issues. They blend science with a systems perspective, and encourage the reader to explore alternative and hopeful paths for themselves, their families and society. They are written them so that a scientist will perceive them as accurate (although simplified); while the public can relate their tangible experience of the weather to the much broader issues of climate and climate change.

*Footnote: All my articles can be freely reused under a Creative Commons license. The old Herald web references have not been maintained. You can find articles at <http://rutlandherald.com/section/archives>. However, they charge for access.*

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**a) Winter reflections, one year on.****(January 18, 2009)**

<http://rutlandherald.com/article/20090118/ENVIRONMENT/901180350/>

It has been one year since my first Weekly Planet column in this section, so this is a good time for some reflection. Like our human world, the weather and climate of this planet are full of unusual events, and our understanding is always incomplete. We can never generalize from a single year, and we tend to notice the extremes!

The northern ice cap didn't melt quite as much in 2008 as in 2007, but clearly it is a bellwether for our warming planet. In the Caribbean, there were five major hurricanes, including an unusually strong one in November – a week after the official end of hurricane season. Cuba was battered by many storms. Here in Vermont we had one of the wettest summers on record, with more than 20 inches of rain over much of the state. Rutland and Montpelier both set new summer rainfall records.

More recently, December brought alternating ice storms, deep snow and rain from a series of powerful storms at the boundaries between very cold air from the north and warm moist air from the oceans to the south and east. What a difference the rain-ice-snow boundary makes to our lives! If it is far south of us, we get light powdery snow, and the ski resorts smile. But if we are near the edge and rain falls from warmer air aloft into cooler air and onto frozen ground, then ice accumulates on roads and on trees until branches break under the weight – and our lives are made difficult. Since our electrical transmission is on above-ground poles, falling trees caused widespread loss of power in December. And now in January, the deep chill of winter is here.

Extremes of weather seem to be increasing as the climate warms, but the details are not yet fully clear. At our northern latitude, stronger temperature gradients from northwest to southeast produce more intense winter storms. In the transition from fall to winter when the sun is lowest in the sky, the land cools much faster than the ocean (the ocean stores much more heat from the summer). And as the climate warms, more water evaporates from the warmer ocean. This transfers extra heat from the ocean to fuel winter storms, when the water condenses in clouds and falls as rain or snow.

It has been a transformative year for the United States, but not at all as anticipated. The year was dominated first by election politics and a speculative bubble in the oil and commodity markets – and then by the financial crash.

The burning of fossil fuels has increased levels of carbon dioxide in the atmosphere by about 35 percent since the industrial revolution. Global emissions of CO<sub>2</sub> slowed in the 1990s but accelerated since then, along with the exuberant growth of global economies. In the United States, debt and leverage on many levels – along with fossil fuels – fueled consumer growth.

Many had argued from studying natural ecosystems that our economic model, based on limitless growth, was unsustainable and dangerous for the planet. But when the crash came in 2008, it didn't come from the collapse of the real economy of goods and services, nor from our dependence on fossil fuels. Instead it came from the unregulated shadow economy. Without information and oversight, we had let this virtual leveraged economy become so large and opaque that its inevitable collapse overwhelmed and paralyzed the banking and credit system. The government is now trying to borrow enough money to rescue the real economy. But it is improbable that a crisis created by borrowing too many trillions of dollars can be solved by borrowing trillions more. We hope that the new government will be willing to think through the consequences with more care.

In computer jargon, the system needs rebooting and we need a new sustainable operating system. This

is our task for this winter, while it is snowing outside. Yes, we need to keep warm and consider where our food will come from this year. (Plan a vegetable garden, or support local farms and community-supported-agriculture projects.) But our larger task is to reconstruct a well-regulated, real economy that is less vulnerable to global speculation and in tune with the natural ecosystems of the Earth.

Computers are great for constructing virtual fantasy worlds and idealized models. But we must remember that we live in a real material world, subject to finite resources and real physical laws. We depend on the natural world for food, fresh water and renewable energy supplies – so it is critical that we try to understand the rules that govern the regulation of the natural world.

It is deeply ironic that right-wing economists and politicians criticized the science of global climate modeling by claiming that the computer models are a poor approximation of the real world. Climate models are only approximate, but they are based on the physical laws governing the atmosphere and oceans. In contrast, the financial models that were the basis of our unregulated economic system contain many unjustified assumptions and much wishful thinking. The collapse of the financial system illustrates the folly of coupling a virtual fantasy world to our real economy.

The beauty of relocalization is that knowing our neighbors and producers, we can once again act responsibly towards each other and our world. The foolishness of our global economy, both real and shadow, is that we cannot see the consequences of our choices; so responsibility is lost. No amount of virtual wealth can compensate if actions become irresponsible, as in the past few years.

So take heart, put doctrine aside and ask if a proposal makes sense in the long term for your community and for the Earth. Every year brings a new dawn. Look for the light that shines through the darkness and reflects in the snow and ice of our winter. Will we care for the poor or bail out the rich? Will we create an economy – "right livelihood" — that employs people? Or will we again allow our wealth to be sucked away into the hands of speculators – in the name of a "free economy"? And will we be prepared for the spring that is coming?

*Alan Betts is Vermont's leading climate scientist and the past president of the Vermont Academy of Science and Engineering. He lives in Pittsford and can be reached at [akbetts@aol.com](mailto:akbetts@aol.com).*

Meteorological summer of 2008:

[www.erh.noaa.gov/btv/climo/Summer08Rainfall.php](http://www.erh.noaa.gov/btv/climo/Summer08Rainfall.php)

Local communities, global connections:

[www.relocalize.net/](http://www.relocalize.net/)

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**b) Snow's Global Impact.****(March 1, 2009)**

<http://rutlandherald.com/article/20090301/ENVIRONMENT/903010335/>

It has been quite a snowy winter, but in March the sun is rapidly getting higher in the sky and the days are growing longer. In just three weeks it will be the spring equinox, when the sun is over the equator at noon, and both our days and nights are just twelve hours long. But let's think about the winter snow one more time before we forget! Snow and ice on our roads create a nuisance to us, but they matter a lot to the earth. Snow insulates the earth, stores water and reflects the sun.

On cold winter days when the temperature is far below freezing, the crystals of snow are light and powdery - even a foot of snow may contain only one inch of water, and the rest is just air. You can easily check this by filling a large saucepan with snow and melting it on the stove. Because it is mostly air trapped within the snow, this blanket of snow insulates the ground, and protects mice and moles from the bitter cold. But after a few days and particularly if the temperature rises closer to freezing, the snow settles, becoming much denser. With melting and refreezing it can turn to ice, which has a density that is 90 percent of that of water (that is why ice floats on water).

The snowpack in the forest or on the hills stores a lot of water from winter to spring. Here in Vermont when spring melt comes, the ground becomes saturated with water and the rest runs off into the rivers, which are prone to flooding. We have to wait several weeks till a lot of the water drains out of the soil, before we can dig over our gardens in spring.

Here in Vermont, spring flooding is mostly an annoyance, but in the mountains in the western United States and in South Asia, the snowpack can store a foot or more of water - equivalent to several months of rain. The spring melt provides critical irrigation water in spring and early summer. As our climate warms, this snowpack is shrinking. Snowmelt is coming earlier. Many areas will run short of fresh water.

The polar ice-sheets of the earth are also storing water. In Antarctica, some of the ice was evaporated from the oceans and fell as snow (which turned to ice) hundreds of thousands of years ago. This ice-sheet is ten thousand feet thick in places, and a million years old at its base.

At the North Pole, the floating sea-ice used to last all summer, reflecting the sun's energy back into space. This reflection is one of the ways the earth as a whole keeps cool. But now the northern icecap is melting a lot in summer, and so the warming of the north is accelerating.

The brilliant reflection of the low sun by snow is very familiar to us. We have to protect our eyes when driving or skiing. Because the sun's energy mostly is reflected, little goes into melting the snow. The snow lingers, so that it stays cold, until the sun gets high in the sky, or until warm winds from the south melt our snowdrifts.

This is a critical year for us and for the Earth. The United States, as it wakes from a decade of sleep, needs to pass climate change legislation this year, so that we are prepared for the December global climate conference in Copenhagen. If the world community can agree to major reductions in greenhouse gas emissions, the Earth will rejoice next winter and our children's future will gleam much brighter.

UN Climate Change Conference; December 7-18, 2009: <http://en.cop15.dk/>

### **c) Envisioning a sustainable energy future. (April 5, 2009)**

<http://rutlandherald.com/article/20090405/ENVIRONMENT/904050325/>

It was cold but sunny on the first day of spring. My garden was dry enough, so I started turning over my cover crop of winter rye. The previous two winters I had been able to do this in January, but this year in January the ground was frozen hard. It takes a lot of heat to melt the ice, and the soil temperature stays at 32 degrees until all the ground-ice has melted. Seeds won't germinate in cold soil; we have to wait a few more weeks for the ground to warm up as the sun gets higher in the sky. Then we can plant our cool weather crops like peas and lettuce.

As the ground melts, a lot of water drains out of the soil. This leaves a lighter, aerated soil – easy to dig. My vegetable garden plot has a good southern exposure, and the soil warms and dries out early. I have already planted Buttercrunch lettuce, spinach and radishes and protected them with a little glass cold-frame, which is simply an old window sash that we replaced with more efficient double glazing.

In mid-March, I went to the Climate Change Science Congress in Copenhagen that was reviewing new research results since the 2007 Report of the Intergovernmental Panel on Climate Change. Sadly the news isn't good. Sea-level is rising faster than our models predicted – we will likely see a three-foot rise in sea-level this century (with a faster rise for centuries to come), unless we make a very rapid transition away from burning fossil fuels. At the same time, less carbon dioxide is dissolving in the southern oceans than expected, so atmospheric CO<sub>2</sub> is increasing faster. The acidification of the oceans also continues, and this is expected to reduce the marine productivity of the coastal regions.

One of the speakers at the conference was the British economist Lord Stern – famous for his 2006 report to the British government which said the investment cost of the transition away from a fossil fuel economy would be tiny compared with the cost of ignoring the issue. He pointed to the financial meltdown and explained it offers a profound lesson in risk. Because the market failed to price risk correctly, unregulated financial institutions took huge risks for profit – until the global system collapsed. His sobering conclusion was this: Unless we properly price the huge climate risk from burning fossil fuels (through a carbon tax and other measures), a climate catastrophe is certain, and it will last for centuries.

On a more hopeful note, Denmark has the highest energy efficiency in Europe. Denmark understands the long-term effort necessary for making the transition to a truly sustainable energy system. The country now gets about 20 percent of its electricity from wind power (both on-land and off-shore turbines). As you cross the bridge from Denmark to Sweden you can see rows of turbines in the sound quietly generating power. Every fifteen minutes, swift electric trains link Denmark's towns together. The new metro system in Copenhagen has a futuristic feel – the rail cars are fully automatic and driverless. The country is planning a transition to more efficient electric cars using surplus wind-power. Denmark has also created an efficient distributed power system, connected by a smart grid.

As a teenager, I rode a bicycle around Europe, so while in Denmark I was delighted to see a prototype of the Aerorider – an aerodynamic and fully weatherproof electric-powered tricycle. Designed for commuting, it has a range of 100 miles on a battery charge and a top speed of 30 miles per hour.

Like Denmark, Vermont is rich in wind power, and we also have extensive biomass resources in our forests. Wood-fired cogeneration units that provide heat and electricity can have a 90 percent overall efficiency.

With long-range planning and investment our state could create a sustainable future. As we emerge from winter here in Vermont, it is time to chart a new course. We know in broad outline how to construct an efficient, sustainable society, powered by renewable energy, so let us summon the individual and collective will to do so.

**ON THE NET:**

United Kingdom Office of Climate Change: <http://www.occ.gov.uk/activities/stern.htm>



Danish recumbent electric tricycle: [www.aerorider.dk](http://www.aerorider.dk)

**d) Balancing technology, economics and values. (May 10, 2009)**

<http://rutlandherald.com/article/20090510/ENVIRONMENT/905119989/>

Spring is a time of new beginnings. Nature blossoms with an enthusiasm we can all see and feel. The annual cycle of growth and decay is normal for the natural world. For us, this is a time to look afresh at our lives, plant new seeds and make new choices. Let us start with the intersection of science, technology, economics and values.

Our science and technology have transformed our human world and are in the process of transforming our planet. For better or worse, we must find a way to live with technology. But remarkably we have realized only very recently that our technology must be managed, because it has led to both extraordinary achievements and catastrophic failures. The great achievements we take for granted, but most of the time we avoid connecting catastrophes to the poor management of technology. For an example of a catastrophic use of technology, consider nuclear weapons. Or take the current financial crisis – where amoral, computerized financial creativity was allowed to run amuck until it brought down our global economic system. The climate crisis is yet another impending catastrophe, one that is coming directly from a lack of foresight and constraints on our use of fossil fuel technology.

Our technological society has become vulnerable because we have failed to build in the types of safeguards and controls that every complex system needs for stability. Mostly we manage with the short-term objective of maximizing profit. More money can be made if we ignore some of the costs. The standard business strategy is to let the free market make decisions for us, based on the lowest cost – ignoring or “externalizing” as many of the environmental costs as permitted. Industry is free to move production to countries with the lowest costs, the cheapest labor and the least regulation. But of course

there is no free lunch – workers and the local and global environment, our grandchildren and the Earth itself all pay for the deferred costs.

A market system can only work well if we price all the consequences and risks of production correctly. This is not easy, and most of the time our societies have shirked this responsibility by deferring costs, and often waiting until pollution has become obvious, unhealthy and unavoidable before passing regulations. On a global scale, we are facing a climate crisis because we have not placed a high price on the burning of fossil fuels that add long-lasting greenhouse gases to the atmosphere and warm the planet.

Sound economics is necessary, but economics can only take us so far. It is impossible to estimate the full cost of the damage our technology is doing to the natural world. Despite extraordinary advances in research, we simply do not yet understand natural systems well enough. And the services that ecosystems provide to us and all of life on this planet are truly beyond any price. We need values to shape and restrain our choices. Consider the Native American tradition of looking ahead for the next seven generations when a decision must be made, a practice that recognizes life on the earth as both precious and slow to adapt. This is a value system rooted in deep insight rather than short-term economics.

So how much do we value the beauty of the earth and its creatures this spring? Are we willing to look ahead even two generations to our grandchildren's time? Would we pay to better insulate our houses so we burn less fuel oil? Would we buy a smaller, more efficient car that burns less gas? Will we work with our neighbors and our government to try to create a more energy-efficient society? For electricity, will we weigh the sight of wind turbines on our hills against the inter-generational risks of making plutonium and nuclear waste? There are many choices to make that have long-term consequences, and they all need deeper reflection and public discussion.

But do not reflect inside your homes and businesses. Go out into the warm spring sun, feel the breeze on your face, listen to the birdsongs and smell the myriad scents that nature uses to communicate. Then plant those seeds, be grateful for the earth and ask what you can do.

### **e) Protecting our forests. (June 21, 2009)**

<http://rutlandherald.com/article/20090621/ENVIRONMENT/906210346/>

Our glorious Vermont summer has arrived, and the first of my sugar snap peas are ready to eat. The forests everywhere are green and lush in their burst of summer growth, which will last only until the leaves turn in late September. This forest growth period is short, but Vermont depends on it for its beauty, its wildlife, fuel wood and tourists. It is at the heart of our identity as a state and a people.

Protecting the forests of the earth is a big issue this year. Forests act as a brake on our warming climate because they take up and store some of the carbon dioxide that comes from the burning of fossil fuels. Here in the Northeast we need a healthy balance, so that our forests continue to grow and store carbon, even as we burn some of that growth each winter as fuel.

The United States and China are the two countries that have the largest emissions of CO<sub>2</sub>. Together they are responsible for about half the global emissions that, because of the greenhouse effect, are driving the earth towards dangerous climate change. The two countries with the next largest emissions

of CO<sub>2</sub> are Brazil and Indonesia, although not much of it comes from burning fossil fuels. Most results from the destruction of their tropical forests as they are converted to agriculture. This returns carbon stored in the trees and soil back to the atmosphere as CO<sub>2</sub>, which accelerates the warming of our planet.

Many schemes are being discussed to try to reverse this dangerous path under the acronym REDD (reducing emissions from deforestation and forest degradation). It is relatively cheap to reduce emissions from deforestation. But it still costs money to protect a rain forest, when it could be cleared to grow soybeans. So the big question is, as always: Who pays?

One proposal is to raise money from carbon markets. For instance, we have the Regional Greenhouse Gas Initiative market here in the Northeast, where CO<sub>2</sub> emission allowances are auctioned to power plants. But presently the money raised is used to fund needed efficiency improvements and renewable energy projects here, rather than to protect tropical forests. There are other offset schemes in which people in richer countries continue to burn fossil fuels but pay "offsets" — payments to protect forests in tropical countries. You can see why this is an attractive idea. Our wasteful lives can go on undisturbed, but we can feel good because we pay a small penance. Unfortunately, humanity needs to do both: reduce our wasteful use of fossil fuels and reduce deforestation.

So the debate about who should pay to save our precious planet from dangerous climate change is not an easy one. The industrial nations are responsible for burning most of the fossil carbon, which will stay in the atmosphere for centuries. And the poorer tropical countries will suffer most from climate change. The current climate bill in Congress does not transfer enough funds to help the poorer nations protect their forests and adapt to climate change.

The industrial countries are the richest, and indirectly fossil fuels have largely powered the creation of our wealth. But right now we don't feel rich because we are in debt in so many different ways. We build roads and bridges, and we then become dependent on them — but we don't put aside money for their repair and replacement. We burn fossil fuels, but don't allocate funds to undo the damage to the global environment later. We build nuclear power plants, but don't save enough money to clean up the radioactive waste later. We refuse to budget the full costs of our choices and actions. But all these debts against the future will have to be repaid — if not by us, then by our children.

It is easy for Vermonters to understand why preserving forests matters to the world. Forests stabilize our climate by storing carbon, they protect watersheds from flooding and they preserve wildlife and biodiversity. We will have to manage our forests carefully, as the pressure mounts to burn more wood as fuel. The principles are the same here and in the tropics: We need working forests with sustainable harvests, a diversity of life and a long-term future.

Union of Concerned Scientists, forest solutions  
[www.ucsusa.org/global\\_warming/solutions/forest\\_solutions/](http://www.ucsusa.org/global_warming/solutions/forest_solutions/)

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## **f) The choices we face. (August 2, 2009)**

<http://rutlandherald.com/article/20090802/ENVIRONMENT/908020316/>

So far it has been another rainy summer. The springs on my hillside have not dried up as they usually do by this time of year, and the weeds in my garden are hard to control. Walking down past the hayfields to the covered bridge in the early morning, I often see fog blowing off the forested hills and



evaporating in the sun. Water on the trees and grass evaporates as well, forming more clouds and on many afternoons more thunderstorms — returning the water to the earth in a nearly continuous cycle. With all this cloud cover, which reflects the sunlight back into space, afternoon temperatures in June and July have been 6 degrees cooler than normal — until this past week.

Last month the U.S. government published a report on the impacts of global climate change in this country. Based on research by thousands of scientists, this report has taken many years to complete. It's long — but readable with excellent graphics — and presents two basic scenarios that our children and grandchildren will face. The first is likely if we ignore the problem and continue to burn fossil fuel as our main energy supply. And it is a grim prospect. The second scenario, more hopeful but still very troubling, is possible if we push through legislation nationally and draft global treaties to move towards an efficient global society, powered by renewable energy. This report is well worth reading because we all need to understand the possible futures we face. Then the crucial decisions we make as individuals, or our towns and governments make for us, will be better informed and wiser.

Clearly a different strategy is required. The growth of human population, energy use and consumerism have all been encouraged — to the point where humanity is now using or polluting an unsustainable fraction of the earth's natural resources. The oceans are filling with plastic waste, and the atmosphere with greenhouse gases. Mercury from burning coal accumulates in fish, and nuclear waste simply piles up.

All human activity uses energy and materials and produces waste. When we make or use things, we need to ask two basic questions: “Does this use the least amount of materials and energy?” and “Do the waste products have a short lifetime in the natural environment?”

The first question speaks to the need for greater energy efficiency in both manufacturing and use. And it also addresses the importance of minimizing waste itself by redesigning things so that they can be recycled or remanufactured easily and cheaply when their useful life is over. This “sustainable engineering” is the kind of challenge that engineers enjoy. The benefits from remanufacturing are huge — large reductions in energy use and raw materials, and a much smaller waste stream. But legislation is required to ensure products are built to be remanufactured or recycled at the end of their life. Such laws are already in place in the European Union.

Minimizing the lifetime of wastes in the biosphere is the second big issue. The invention of plastics was amazing, but plastic products last so long that they must be recycled. And we've had to redesign all our refrigeration to reduce the damage to the ozone layer from the long-lived chlorofluorocarbons that were used as refrigerants. Now we must shift away from burning fossil fuels that increase the burden of long-lived greenhouse gases in the air that are transforming the earth's climate.

We have a long way to go — but at least we know what direction to take. We can all be grateful that the era of throwaway consumerism is coming to an end!

U.S. Global Change Research Program

[www.globalchange.gov/usimpacts](http://www.globalchange.gov/usimpacts)

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## **g) The Transition into Fall. (September 13, 2009)**

<http://rutlandherald.com/article/20090913/ENVIRONMENT/909130341/>

Fall is approaching, so let's take a look at what is happening to our climate. I live in Pittsford at a low elevation of 450 feet, on a west-facing hillside overlooking the flood plain of the Otter Creek. My garden has seen only one killing frost before October in the past 12 years — on September 29, 2000. During this period, the last spring frost has come in late April or the first week of May, earlier than in previous decades. So the growing season between frosts is now about 150 days long, several weeks longer than when I started gardening in Vermont 32 years ago. Our winters have also been getting significantly milder, so now I expect to have hardy crops like brussels sprouts for Thanksgiving and Christmas. In recent winters, protected by a covering of leaves, I have been able to harvest frozen sprouts even in February.

The fall transition that occurs with the first hard frost illustrates neatly how life and climate are linked together. The first hard frost kills some plants and tells maple trees to shut down photosynthesis for winter. But as long as plants are alive, their transpiration puts water vapor into the air. Water vapor is a powerful greenhouse gas, which traps heat radiation and prevents the ground from cooling rapidly to space at night. More water vapor in the air also produces more clouds, which also trap heat at night. So transpiration from our forests delays that first frost in the fall — until one night, cool dry air sinks down from the north and the temperature falls enough that frost forms by sunrise.

After a hard frost, transpiration from plants and trees is greatly reduced, and the skies become more clear and dry. October often brings some pleasantly warm and sunny days, with bigger drops of temperature at night. In fact, the daily range between maximum and minimum temperature increases as the atmosphere gets drier with less cloud cover.

It has been a very wet summer. Tropical weather has at times brought very heavy downpours, which flooded downtown Rutland for the second year in succession. Adapting to climate change means rebuilding our infrastructure to cope with a different climate — the past is no longer a reliable guide to the future. Our soils are wetter than usual going into the fall, so evaporation may continue for a little longer and delay the first frost.

Further north, the Arctic sea ice is near the end of its melt season. Once again a large area melted to open water, although not as much as the past 2 years. This open Arctic water in fall, where ten years ago there used to be ice, along with warmer temperatures in Canada, contributes to our later frosts. Closer to home the Great Lakes have also been freezing later. This too means more evaporation from the lakes later into the fall, and stronger lake-effect snows in early winter.

Ice and water, life, CO<sub>2</sub>, weather and climate are all interconnected on this planet. This December in Copenhagen, the nations of the world will meet to draft a new global treaty to slow and then reverse the growth of CO<sub>2</sub> in the atmosphere. Every year that we delay will make it more difficult for us to adapt to a warming climate and rising seas. Yes, it is hard for us to face change, and we cannot do it alone. But it is time to think deeply about our shared common purpose — the preservation of this planet that is our home.

National climate summary: <http://www.ncdc.noaa.gov/sotc/>

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## **h) Climate limits are closing in. (October 25, 2009)**

<http://rutlandherald.com/article/20091025/ENVIRONMENT/910250327>

Yesterday was an international day of climate action. Thousands of actions in over 150 countries around the world were sponsored by 350.org. This group is trying to spread awareness that an atmospheric CO<sub>2</sub> concentration above a threshold of 350 parts per million (ppm) will have a dangerous impact on the earth's climate.

Back in June 1992, 154 nations — including the United States — signed the United Nations Framework Convention on Climate Change to limit greenhouse gas emissions and prevent “dangerous anthropogenic interference with the Earth's climate system.” But turning this agreement into a practical global reality has been difficult.

Several countries have since agreed to limit the average long-term warming of the Earth to 2 C (3.6 F). However, the Earth's climate system is very complex, so it is hard to determine exactly how much CO<sub>2</sub> we can put in the air and still meet this goal. From geological records though the ice ages, we can estimate the CO<sub>2</sub> concentration when global sea levels rise 5 to 10 feet from the melting of ice. With this approach we arrive at the low CO<sub>2</sub> threshold of only 350 ppm. Unfortunately CO<sub>2</sub> in the atmosphere has been rising at about 2 ppm per year and has already passed 385 ppm.

So as readers of these Weekly Planet columns know, our global civilization is on a path to a profound climate crisis. Even with all the commitments that nations have so far made to reduce the emissions of greenhouse gases, especially CO<sub>2</sub>, our best estimate is that the earth will warm on average 7 F by the end of this century — with larger temperature rises over land. On this path, the damage to the earth's ecosystems, on land and in the oceans, will be devastating. In fact, humanity is so dependent on the earth for food that our society could simply unravel. Melting ice will flood our coastal cities, and sea levels will keep rising for centuries to come.

There is still time to reduce this global warming in half to “only” about 3.6 F by the end of this century. Even this will take a large shift in our attitudes here in the United States and a serious commitment to global security. It is unlikely we will get anything like the commitments we really need at this December's climate conference in Copenhagen — but perhaps we will get a consensus on the first steps. Changing direction away from fossil fuels as our main energy source and reducing our huge consumption of energy represent a big transition for our country and for the industrial world. There is a lot of resistance. People, businesses and politicians wish to avoid accepting responsibility for the transformation of our planet that is being driven by modern industrial society. There is a widespread belief that limits are unnecessary or simply unacceptable. This may be a relic of the old frontier ethic on which the United States was built. But whether we like it or not, we have reached limits in many areas.

Our nation grew rich burning cheap fossil fuel for energy, so now our population has high energy demands. The boom is ending, but the transition to using energy efficiently and replacing fossil fuels with renewable sources of energy will not be easy. Add insulation and button up your house for the winter to reduce the energy you'll need for heating. You will gain comfort and security against rising fuel prices — and you will be contributing to the security of our Earth. It may seem remarkable that there is a link between our actions and the future of our planet, but we are all interconnected.

United Nations Climate Change Conference: <http://en.cop15.dk/>

October 24, 2009: International day of climate action: <http://www.350.org/>

## **i) The Copenhagen Challenge. (December 6, 2009)**

<http://rutlandherald.com/article/20091206/ENVIRONMENT/912060312>

With so much rain this summer, evaporation has continued into the fall — and the clear skies of autumn have been rare. October was rather wet and chilly. November was a little clearer, with a few warmer days. But as the sun drops lower in the sky and we approach the winter solstice, the days get shorter and the nights longer. At our latitude, the earth cools more to space at night than it is warmed by the sun during daytime. Clearer skies just slow this drop of temperature, until the first heavy blanket of snow plunges us into winter by reflecting a lot of the sun's warmth.

As we move towards winter, it's time for some reflection by the fire. There is much we need to rethink before the coming year. The United Nations Climate Change Conference begins tomorrow in Copenhagen. It may be the most important global meeting this century – but will agreement be reached in two weeks on a binding plan to move our global economies away from fossil fuels? Here in the United States, Congress has failed to pass climate change legislation this year. We are now a decade behind other countries in this respect.

Despite all the talk of change, Congress has moved at a glacial pace this year. Our collective worldview has barely changed, while events continue to rush onward around us. We have spent a trillion dollars to rescue the shadow economy of investment banking and insurance derivatives (hiding behind the myths of trickle-down economics and too-big-to-fail), while unemployment steadily grows. Why is it so hard to face uncomfortable truths and start planning for a sustainable and resilient society, rather than lurch from crisis to crisis?

Here in Vermont the situation is brighter. In May, our Legislature passed the far-reaching “Renewable Energy and Energy Efficiency Act” implementing feed-in tariffs for solar, wind and biogas projects. The Public Service Board reviewed and ratified electric rate tariffs for these renewable power sources, and the program was fully subscribed the first day in October that it was open for bid. In fact, for photovoltaic power 170 MW of projects were proposed, but only 14 MW could be accepted, because the entire program has a 50 MW cap spread across all types of renewable power. This is an excellent beginning that will provide local power and productive employment. With a similar effort every year for the next decade, Vermont could become largely self-sufficient with renewable power, and our aging nuclear power plant could be phased out.

It is here in our local communities that we need to look for inspiration this winter. Locally a community planning group is working to reduce the energy needs of 10 percent of the homes in Rutland County by 10 percent in the coming year.

We have yet to build a wind farm on any of the ridges west of Rutland — we will need that electricity on windy nights in winter in the coming decades to recharge our hybrid-electric vehicles and for ground heat pumps (that extract heat from the ground). We will have to look beyond our fears and learn to admire the stark beauty of the turbines as they turn almost silently in the wind to generate renewable power for our homes and businesses. We should build them as community projects, so that our towns and schools benefit financially — as world leaders like Denmark have done for decades.

We need to return to community solutions that root employment in our local economy and environment, where we have some understanding and control and some financial benefit. We have trumpeted individualism and consumerism — and bred alienation. It is living communities that we need and want, where we can find our shared common purpose around a fire in the depths of the Vermont winter.

UN Climate Change Conference: <http://en.cop15.dk/>

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