



MORENCI graduate Dr. Ryan Shadbolt, now an instructor at Michigan State University, spoke Feb. 2 at Stair District Library about the science behind climate change. Morenci Area High School's Green Earth Club invited Shadbolt to speak.

DAVID GREEN/Observer photo

Climate Change

MSU instructor talks at library about causes of changing climate

By DAVID GREEN

Symptoms, science and solutions.

Those are the three aspects of climate change that Dr. Ryan Shadbolt uses to explain the changing environment.

Shadbolt, a Morenci graduate who now teaches at Michigan State University, spoke Feb. 1 at Stair District Library at the invitation of the Morenci Area High School Green Earth Club.

Shadbolt said that one of his goals as a teacher was to develop a climate change primer for freshman science students—an audience that doesn't have a background in mathematics and physics. He squeezed that class into a morning presentation at the library.

Symptoms

Shadbolt started his talk by describing the symptoms of climate change. What is nature telling us? What does it say is going on?

What's known as the hockey stick graph, due to its shape, shows the changes in temperature through the past thousand years. The rise in global averages in recent decades produces the

blade of the hockey stick.

A red area of the graph represents the uncertainties of the future, with a projection showing the business-as-usual forecast if no changes are made to slow the increase in rising temperatures.

"The Northern Hemisphere has warmed more," Shadbolt said, and that's why the changing climate is more noticeable in Alaska than in Michigan.

Land and water heat up and cool down at different rates, and there's more land in the Northern Hemisphere. Antarctica, on the other hand, is surrounded by water.

In addition, most of the world's population is in the Northern Hemisphere and this is where most of the carbon dioxide emissions take place.

Back in the 1950s, Shadbolt said, the number of hot and cold temperature records set was nearly even. The globe cooled some in the 1960s and more cold records were broken.

Since the 1980s, there have been far more warm records than cold records broken.

"In a typical year, we are now seeing nearly double the num-

ber of warm records vs. cold records," Shadbolt said. "Cold records are still happening, but they're becoming less and less frequent."

As the planet warms, there are consequences—the symptoms that Shadbolt spoke of.

The extent of sea ice in the north is easily monitored through satellite imagery. There's variability—some years with an increase—but in general there's a decrease in ice.

Shadbolt asked his audience how many remember learning the equation for a line: $y=a(x+b)$. It can be used to project changes forward in time.

"With that one equation, you're doing climate modeling," he said. "You can use that to project a future value."

Nature doesn't always follow a linear pattern, he cautioned, but data from recent decades shows that it's been close.

Shadbolt said that he does have a problem with the graph because ice isn't two



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dimensional. The volume of the ice should also be considered, although data is not as easy to obtain.

“If we continue on the same trend for ice loss,” he said, “this tells me that all of the Arctic ice will be gone probably within the next few decades.”

Global sea level has risen 3.2 millimeters per year since 1990, and eventually coastal flooding will result.

Other consequences of a warming planet include the precipitation rate. The amount of water on Earth stays the same—the conservation of mass in the atmosphere—but shifts in the location of moisture is changing along with its physical state.

“As the ice melts, we gain liquid and we gain vapor,” Shadbolt explained. “Extreme heat and vapor can lead to changes in the weather. Generally what we’re seeing now is not so much a change in the frequency of tropical cyclones [hurricanes], but rather their intensity and size is changing.”

Category 5 storms were very infrequent when the scale for hurricanes was developed, and that scale is only based on wind speed.

There are also impacts on species of plants and animals, with many species extinct or on the brink.

“In many cases there are behavioral changes,” he said.

Studies of lilacs, for example, are showing earlier and earlier bloom dates, with spring arriving earlier. Species are also moving up-slope in mountainous areas as temperatures in the lower region rise.

The oceans are acidifying as more carbon dioxide is stored in the water—the reason for shrinking coral reefs. The ranges of insects capable of spreading disease to humans are expected to increase.

Science

The study of “greenhouse gases” is nothing new, Shadbolt said. “We’ve known about this for more than a century.”

About 30 percent of sunlight is reflected back up into space from the Earth’s surface, but the molecules in greenhouse gases absorb a lot of that energy and hold it in the atmosphere, often for a long time.

Carbon dioxide accounts for about 64 percent of the greenhouse gas impact, followed by methane at 17 percent. The concentration of carbon dioxide is growing.

Shadbolt explains several factors relating to climate change.

- Astronomical—The tilt of the Earth is responsible for the seasons as the planet revolves around the Sun. The tilt is not constant and follows a cycle of about 40,000 years. Another astronomical cycle follows a 23,000-year cycle and another is pegged at 26,000 years.

“Cycles can explain long-term changes,” Shadbolt said, but not year-to-year changes.

- Plate tectonics—The slow movement of continents has occurred for eons, and this can move a land mass into a different climate zone.

Michigan’s state rock, the Petoskey stone, is a coral that once grew in a tropical ocean.

Plate tectonics can also lead to volcanic eruptions in which enormous quantities of material are emitted into the atmosphere, leading to cooling through less sunlight.

- Oscillations—Short-term changes in large-scale weather patterns known as La Niña and El Niño change air and water patterns that affect weather over large areas, including this region.

- Feedbacks—One simple change can affect other factors and amplify a change. An increase in air temperature leads to an increase in water evaporation. More water vapor in the air is in itself a short-term greenhouse gas that leads to more energy in the atmosphere. That, in turn, warms the surface of the Earth and leads back to a further increase in air temperature.

“It self perpetuates without us adding

anything,” Shadbolt said.

Warmer temperatures lead to more rain and less snow and ice. This means that less sunlight is reflected back into space and more sunlight is absorbed into the earth. That means warmer temperatures and, again, back to less snow and ice.

In the far north, warmer land masses are leading to the melting of permafrost.

“We are not in a run-away situation where the planet’s just warming, warming, warming indefinitely,” Shadbolt said. “There are some countering feedbacks to even things out a little bit.”

As the Earth emits more infrared radiation, it loses energy and the temperature

That does not happen naturally. It’s a very rapid change.

— Ryan Shadbolt

decreases. Cloud cover is another factor under study.

- People—Humans contribute by changing land cover—from forests to concrete, for example—and by increasing greenhouse gas emissions through heating, generating electricity and transportation.

How do we know climate from past centuries if instrumentation was available only since the mid-1800s? That’s a question often heard from those who are skeptical about climate change, Shadbolt said, and added, “Nature has its way of telling us what happened.”

The most critical source of information comes from ice cores. Layers of ice show a record of the past, much as tree rings, and ice also preserves ancient history by trapping bubbles of air. Was there more carbon dioxide? Was there a volcanic eruption? Are oxygen isotopes changing?

Surface observations of temperature show variability from year to year, but overall there’s a steady increase.

Skeptics point to a cooling period from 1998 to 2013 referred to as the climate change hiatus or pause.

“The hiatus, if it existed at all, is clearly gone now,” Shadbolt said. “There’s more to the story than what you see in the news. Even while temperatures were stable for a while on land, ocean temperatures were still increasing. If you ask me, there was no hiatus.”

Climate modeling is much different than weather forecasting, he said. Climate modeling looks at general trends rather than whether it’s going to rain tomorrow in a particular location.

When a climate model using only natural factors is compared to what actually occurred, the two give similar results until about 1970. After that, temperatures are much warmer than what would be expected from the natural factors listed above.

“What that tells us is that if humans didn’t exist on the planet, Earth would be cooling now,” Shadbolt said. “Factor in human activity—land cover change and emissions—and it now fits very well with the observations.

“This is the smoking gun for climate scientists and why we can confidently say that at least since the 1970s, human activity is the driving force in warming since that time.”

With business-as-usual, the Earth will likely warm by 4°C in a century.

“That does not happen naturally on Earth,” he said. “It’s a very rapid change.”

The rate at which the change is happening is what alarms climate scientists, he said.

Solutions

People with no knowledge of climate science often tell Shadbolt something they heard or read that negates climate change science.

“I follow the evidence,” he said. “I am a practitioner of science. We have choices to make and we have to live with the consequences of these choices.”

He also hears that alternative energy costs a lot of money and is heavily subsidized.

“We heavily subsidize fossil fuel energy as well and no one has questioned that,” Shadbolt said.

Governments around the world spend hundreds of billions of dollars annually to make fossil fuels cheaper, so why not help with the production of wind generators and solar panels?

Shadbolt said that when he was younger, he thought temperatures would even out, and he really wishes they were.

“I share that with you to let you know that scientists are not out to cherry-pick the data,” he said. “We’re not trying to steer this in any particular direction. I am simply following the evidence.”

Consensus by climate scientists is nearly 100 percent, he added.

Shadbolt asks his students if they would be willing to make a life-style change to slow climate change if there was no financial burden. Most say that they would.

But what if there was some financial burden, such as a small tax increase?

“What’s discouraging to me is that even with the knowledge that they gain over the 16 weeks of my class, most of the students say they are not willing to pay money to contribute toward mitigating climate change,” Shadbolt said.

That tells him that personal change is probably not going to help us through the current century.

“I know people don’t like big government, but it’s probably going to have to be from a government-down change,” he said, such as the Paris Agreements. “Cities and states are trying to do their own agreements to help us along.”

The Paris Agreements, organized through the United Nations, involves pledges from countries around the world to find ways to reduce carbon emissions and increase renewable energy in an effort to limit the global temperature rise. President Donald Trump announced last year that the United States will withdraw from the pact.

Many communities are making their own effort to reduce carbon emissions through efficiency measures and changes in public transportation.

“In East Lansing where I live, a former landfill has been converted to a solar park,” Shadbolt said.

Residents can choose to lease panels and get a pay-back from electricity generated.

A lot of misinformation about climate change is presented by television forecasters. They’re specialists in day-to-day variability and they aren’t seeing long-range changes, Shadbolt said, although many are slowly coming around.

“Weather is not climate,” he said. “Just because it’s snowing today does not refute climate change.”

Sen. James Inhofe from Kansas once brought a snowball onto the floor of the U.S. Senate as a confirmation that global warming was a hoax.

People can continue to learn about climate change through many sources, Shadbolt said. He recommends short YouTube videos by Katherine Hayhoe that break climate science down into smaller pieces for understanding, and he mentioned the book “The Thinking Person’s Guide to Climate Change” by Robert Henson.

Climate change has become a political issue, Shadbolt said, but it should go beyond that. Members of any party should be able to support changes in environmental policy regarding changing climate.

“Let your voice be heard via the voting booth,” he said. “You can be pro-life and be pro-gun and also be pro-environment.”