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Feature

Goodbye sunshine

Each year less light reaches the surface of the Earth. No one is sure what's causing 'global dimming' - or what it means for the future. In fact most scientists have never heard of it. By David Adam

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In 1985, a geography researcher called Atsumu Ohmura at the Swiss Federal Institute of Technology got the shock of his life. As part of his studies into climate and atmospheric radiation, Ohmura was checking levels of sunlight recorded around Europe when he made an astonishing discovery. It was too dark. Compared to similar measurements recorded by his predecessors in the 1960s, Ohmura's results suggested that levels of solar radiation striking the Earth's surface had declined by more than 10% in three decades. Sunshine, it seemed, was on the way out.

The finding went against all scientific thinking. By the mid-80s there was undeniable evidence that our planet was getting hotter, so the idea of reduced solar radiation - the Earth's only external source of heat - just didn't fit. And a massive 10% shift in only 30 years? Ohmura himself had a hard time accepting it. "I was shocked. The difference was so big that I just could not believe it," he says. Neither could anyone else. When Ohmura eventually published his discovery in 1989 the science world was distinctly unimpressed. "It was ignored," he says.

It turns out that Ohmura was the first to document a dramatic effect that scientists are now calling "global dimming". Records show that over the past 50 years the average amount of sunlight reaching the ground has gone down by almost 3% a decade. It's too small an effect to see with the naked eye, but it has implications for everything from climate change to solar power and even the future sustainability of plant photosynthesis. In fact, global dimming seems to be so important that you're probably wondering why you've never heard of it before. Well don't worry, you're in good company. Many climate experts haven't heard of it either, the media has not picked up on it, and it doesn't even appear in the reports of the Intergovernmental Panel on Climate Change (IPCC).

"It's an extraordinary thing that for some reason this hasn't penetrated even into the thinking of the people looking at global climate change," says Graham Farquhar, a climate scientist at the Australian National University in Canberra. "It's actually quite a big deal and I think you'll see a lot more people referring to it."

That's not to say that the effect has gone unnoticed. Although Ohmura was the first to report global dimming, he wasn't alone. In fact, the scientific record now shows several other research papers published during the 1990s on the subject, all finding that light levels were falling significantly. Among them they reported that sunshine in Ireland was on the wane, that both the Arctic and the Antarctic were getting darker and that light in Japan, the supposed land of the rising sun, was actually falling. Most startling of all was the discovery that levels of solar radiation reaching parts of the former Soviet Union had gone down almost 20% between 1960 and 1987.

The problem is that most of the climate scientists who saw the reports simply didn't believe them.

"It's an uncomfortable one," says Gerald Stanhill, who published many of these early papers and coined the phrase global dimming. "The first reaction has always been that the effect is much too big, I don't believe it and if it's true then why has nobody reported it before."

That began to change in 2001, when Stanhill and his colleague Shabtai Cohen at the Volcani Centre in Bet Dagan, Israel collected all the available evidence together and proved that, on average, records showed that the amount of solar radiation reaching the Earth's surface had gone down by between 0.23 and 0.32% each year from 1958 to 1992.

This forced more scientists to sit up and take notice, though some still refused to accept the change was real, and instead blamed it on inaccurate recording equipment.

Solar radiation is measured by seeing how much the side of a black plate warms up when exposed to the sun, compared with its flip side, which is shaded. It's a relatively crude device, and we have no way of proving how accurate measurements made 30 years ago really are. "To detect temporal changes you must have very good data otherwise you're just analysing the difference between data retrieval systems," says Ohmura.

Stanhill says the dimming effect is much greater than the possible errors (which anyway would make the light levels go up as well as down), but what was really needed was an independent way to prove global dimming was real. Last year Farquhar and his group in Australia provided it.

The 2001 article written by Stanhill and Cohen sparked Farquhar's interest and he made some inquiries. The

reaction was not always positive and when he mentioned the idea to one high-ranking climate scientist (whose name he is reluctant to reveal) he was told: "That's bullshit, Graham. If that was the case then we'd all be freezing to death."

But Farquhar had realised that the idea of global dimming could explain one of the most puzzling mysteries of climate science. As the Earth warms, you would expect the rate at which water evaporates to increase. But in fact, study after study using metal pans filled with water has shown that the rate of evaporation has gone down in recent years. When Farquhar compared evaporation data with the global dimming records he got a perfect match. The reduced evaporation was down to less sunlight shining on the water surface. And while Stanhill and Cohen's 2001 report appeared in a relatively obscure agricultural journal, Farquhar and his colleague Michael Roderick published their solution to the evaporation paradox in the high-profile American magazine Science. Almost 20 years after it was first noticed, global dimming was finally in the mainstream. "I think over the past couple of years it's become clear that the solar irradiance at the Earth's surface has decreased," says Jim Hansen, a leading climate modeller with Nasa's Goddard Institute for Space Studies in New York.

The missing radiation is in the region of visible light and infrared - radiation like the ultraviolet light increasingly penetrating the leaky ozone layer is not affected. Stanhill says there is now sufficient interest in the subject for a special session to be held at the joint meeting of the American and Canadian geophysical societies in Montreal next May.

So what causes global dimming? The first thing to say is that it's nothing to do with changes in the amount of radiation arriving from the sun. Although that varies as the sun's activity rises and falls and the Earth moves closer or further away, the global dimming effect is much, much larger and the opposite of what would be expected given there has been a general increase in overall solar radiation over the past 150 years.

That means something must have happened to the Earth's atmosphere to stop the arriving sunlight penetrating. The few experts who have studied the effect believe it's down to air pollution. Tiny particles of soot or chemical compounds like sulphates reflect sunlight and they also promote the formation of bigger, longer lasting clouds. "The cloudy times are getting darker," says Cohen, at the Volcani Centre. "If it's cloudy then it's darker, but when it's sunny things haven't changed much."

More importantly, what impact could global dimming have? If the effect continues then it's certainly bad news for solar power, as darker, cloudier skies will reduce its meagre efficiency still further. The effect on photosynthesis, and so on plant and tree growth, is more complicated and will probably be different in various parts of the world. In equatorial regions and parts of the southern hemisphere

regularly flooded with light, photosynthesis is likely to be limited by carbon dioxide or water, not sunshine, and light levels would have to fall much further to force a change. In fact, in some cases photosynthesis could paradoxically increase slightly with global dimming as the broken, diffuse light that emerges from clouds can penetrate deep into forest canopies more easily than direct beams of sunlight from a clear blue sky.

But in the cloudy parts of the northern hemisphere, like Britain, it's a different story and if you grow tomatoes in a greenhouse you could be seeing the effects of global dimming already. "In the northern climate everything becomes light limiting and a reduction in solar radiation becomes a reduction in productivity," Cohen says. "In greenhouses in Holland, the rule of thumb is that a 1% decrease in solar radiation equals a 1% drop in productivity. Because they're light limited they're always very busy cleaning the tops of their greenhouses."

The other major impact global dimming will have is on the complex computer simulations climate scientists use to understand what is happening now and to predict what will happen in the future. For them, global dimming is a real sticking point. "All of their models, all the physics and mathematics of solar radiation in the Earth's atmosphere can't explain what we're measuring at the Earth's surface," Stanhill says. Farquhar agrees: "This will drive what the modellers have to do now. They're going to have to account for this."

David Roberts, a climate modeller with the Met Office's Hadley Centre, says that although the issue of global dimming raises some awkward questions, some of the computer simulations do at least address the mechanisms believed to be driving it. "Most of the processes involving aerosols and formation of clouds are already in there, though I accept it's a bit of a work in progress and more work needs to be done," Roberts says.

Another big question yet to be answered is whether the phenomenon will continue. Will our great grandchildren be eating lunch in the dark? Unlikely, though few studies are up to date enough to confirm whether or not global dimming is still with us. "There's been so little done that nobody really understands what's going on," Cohen says. There are some clues though.

O hmura says that satellite images of clouds seem to suggest that the skies have become slightly clearer since the start of the 1990s, and this has been accompanied by a sharp upturn in temperature. Both of these facts could indicate that global dimming has waned, and this would seem to tie in with the general reduction in air pollution caused by the scaling down of heavy industry across parts of the world in recent years. Just last month, Helen Power, a climate scientist at the University of South Carolina published one of the few analyses of up-to-date data for the 1990s and found that global dimming over Germany seemed

to be easing. "But that's just one study and it's impossible to say anything about long-term trends from one study," she cautions.

It's also possible that global dimming is not entirely down to air pollution. "I don't think that aerosols by themselves would be able to produce this amount of global dimming," says Farquhar. Global warming itself might also be playing a role, he suggests, by perhaps forcing more water to be evaporated from the oceans and then blown onshore (although the evidence on land suggests otherwise). "If the greenhouse effect causes global dimming then that really changes the perspective," he says. In other words, while it keeps getting warmer it might keep getting darker. "I'm not saying it definitely is that, I'm just raising the question."

Ultimately, that and other questions will have to be considered by the scientists around the world who are beginning to think about how to prepare the next IPCC assessment report, due out in 2007. "The IPCC is the group that should investigate this and work out if people should be scared of it," says Cohen. Whatever their verdict, at least we are no longer totally in the dark about global dimming.

Further reading

Global Dimming: A Review of the Evidence, G Stanhill and S Cohen Agricultural and Forest Meteorology Volume 107 (2001), pages 255-278

The Cause of Decreased Pan Evaporation Over the Past 50 Years, M Roderick and G Farquhar Science Volume 298 (2002), pages 1410-1411

Observed Reductions of Surface Solar Radiation at Sites in the US and Worldwide, B Liepert Geophysical Research Letters Volume 29 (2002), pages 1421-1433

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