

REFLECTING ON CLIMATE CHANGE AN INTERVIEW WITH PHIL GOODE

INTERVIEWER: SHERYL WEINSTEIN *is public relations director for NJIT.* The dynamics of the Earth's climate and the globalwarming debate are complex, to say the least. NJIT researchers, who are studying many aspects of solar physics and some aspects of climate, recently reported a very surprising finding. Among these researchers is Phil Goode, distinguished professor of physics and director of NJIT's Center for Solar-Terrestrial Research. Goode and several colleagues have determined from measurements of earthshine - light from the Earth reflected to the dark portion of the Moon's disk and back to Earth — that our planet has been reflecting more light back into space over the last few years. In the May 28, 2004 issue of Science, they reported a complete reversal of the decline in reflectance seen in data for more than two decades, until the late 1990s, that may be due to natural variability in the Earth's cloud cover. Goode and his team combined satellite and other data with observations at Big Bear Solar Observatory in California, operated by NJIT since 1997, to reach

conclusions with significant implications for further study of global warming.

Weinstein: What led you to study the Earth's reflectance?

Goode: Before NJIT took over the Big Bear observatory, there had been some experimental observations revitalizing what is really an old and appealing way of measuring light reflected by the Earth. I became interested in refining the technique so that it might be more precise and useful, and I managed to get funding. In some ways, the technique can be more exact than gathering the same data with satellites, and it is much less expensive. That's a very pleasing combination.

Weinstein: How has your work been funded? Goode: We were initially funded by NASA for six years and have been renewed for three more years. We've also applied to the Keck Foundation for money to build a global network of eight automated earthshine monitoring telescopes. These would be small reflecting telescopes smart enough to monitor the weather, decide whether to observe, and then find and track the moon throughout the night and record data. Once a week someone would transfer the data to a CD and send it to us.

Weinstein: Why did your team connect changes in the Earth's reflectance with cloud cover? Goode: A basic climate parameter is the net sunlight reaching the surface of the Earth, which depends on both the Sun's output and the Earth's reflectance. The fluctuations in radiation output from the Sun that have been recorded are too small to matter. So the key factor had to be some change in the Earth's atmosphere or in the planet's reflectance. While any analytical model for studying reflectance has to include cloud-cover data, we made extensive use of what you might say is gold-standard data, from the ISCCP. That's the International Satellite Cloud Climate Project, which started in the 1980s.

Of the more than a hundred cloud parameters in the ISCCP data, we found that the three most significant are cloud amount, cloud thickness, and where the clouds are located. Using these data and our own earthshine observations, we found the hint of a reversal in the trend of declining reflectance that may be attributable to changing clouds. When we have more ISCCP data and more earthshine data, we should be able to get a better insight into the strength and persistence of this reversal. **Weinstein:** What has been your most surprising finding?

Goode: There are two. One is that once you quantify the changes in reflectance over the 80s and 90s it's climatologically very significant. The other is that there seems to be a decadal time-scale variation of the reflectance.

Weinstein: Is there some indication that the Earth has a natural tendency towards equilibrium, a balance between the heat it reflects and retains? Goode: It's still not clear how quickly the Earth would come to a new equilibrium if there are atmospheric changes. But it may not take much longer than a few years, depending on the change. Barring some really large change, which is not what we're talking about, the Earth is pretty close to being in equilibrium now, with the net sunlight reaching us now being approximately five hundred watts per square meter and the net heat leaving amounting to about five hundred watts per square meter.

In the classic picture of greenhouse warming, putting more greenhouse gases into the atmosphere

changes the equilibrium. So for a while there's more radiation being retained than going out — and then the system adjusts by warming up. For each change that makes things warmer, there could be a compensating, cooling change. It's pretty well established that a gradual increase in greenhouse gases has contributed to warming the Earth. But the big question is whether there are critical natural cycles that are just as important.

My primary interest right now is building a new telescope at Big Bear, a very sophisticated instrument that will be the world's largest optical telescope designed for solar research.

The bottom line is that we need more data and more precise observations, such as those involving cloud cover, to know what the truth really is. I guess what we're all saying is that the complexity and uncertainty may be larger than we've imagined up to this point.

Weinstein: Where do you see your research interests taking you over the next decade?

Goode: My primary interest right now is building a new telescope at Big Bear, a very sophisticated instrument that will be the world's largest optical telescope designed for solar research. In addition to being supported by NJIT, we're funded by the National Science Foundation, NASA and the Air Force. We expect to be operational in two or three years.

The earthshine project also continues to fascinate me and I see us going in several new directions. I've already mentioned the global network of robotic telescopes to measure the Earth's reflectance more precisely. We would also like to include a spectrograph in at least some of the telescopes to study the large-scale spectrum of the Earth, which could give us important insights into the effects of greenhouse gases and how the structure of the atmosphere might be changing. No one is measuring that. **Weinstein:** A final question — did you see *The Day After Tomorrow*, the recent film about disastrous climate change?

Goode: I rarely go to the movies, but I did see *The Day After Tomorrow*, mainly because of the subject. I recommend wearing earplugs when you see it. The science is really bad but the special effects are tremendous. ■