A Vast Machine

Paul Edwards

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"For every complex problem, there is an answer that is clear, simple—and wrong." Edwards explains complexity well.

The quote is from Twain, who would have enjoyed a couple of wonderful coinages which characterize this book. The "Apocalypse Gap" is the void which must be filled by somebody scaring us to death. An "issue entrepreneur" is somebody who successfully exploits that gap and sells newspapers by scaring us. Global warming as a concept has to fight against our inherent skepticism. We have been blasted with the population bomb, numbed by global winter, piqued by peak oil, and generally jerked around by every manner of scaremonger with a book to sell. Edwards convinces me it’s real this time.

Edwards’ field, he tells us in his final chapter, is "science and technology studies." The sociology of science and scientists. It is a good background, because in the field as complex as climate studies, before you can even decide what you know, you have to decide how you know what you know. Gone are the days when a single scientist in the lab could have a "Eureka" moment and prove something profoundly new about the climate. No, everything we know about weather and climate is the result of an immense and collaborative effort.

Because we can never make a meaningful number of observations on our own, the question of how we know things is of paramount importance. Individually, we can anecdotally note that it was a hot summer in Russia and that there were an exceptional number of forest fires perhaps in Wyoming. We might guess that the world is getting warmer. But no individual would ever have the resources to monitor thermometers in 1000 stations throughout the world, much less do so over any meaningful period of time, such as daily for forty or fifty years. Even making the impossibly simple assumption that you measure global warming by thermometers alone, one can immediately see that whatever you know depends on other people.

Depending on other people, it depends on systems and standards on which all those people agree. Where to put thermometers; how to shield them from the wind; what time of day to read them; what manufacturers to use… And 1000 other questions. Then: how to send the thermometer readings to some central site, correct errors, and translate into universally agreed geographic coordinates and times.

This is my poor introduction to a vastly more complex problem. The things that are measured, the devices that measure them, and the data translations are vastly more complex. A key observation that Edwards makes early on is that "it is models all the way down." For data to be useful, they have applied to standardized three-dimensional grid points. Of course weather stations are not conveniently placed at the intersections of longitude and latitude lines, and they certainly cannot be stacked twenty kilometers up in space. Useful readings have to be interpolated from actual readings into estimated readings for the points in a regular grid. They have to be corrected for any systematic errors known to be associated with the instruments, and interpolated for time. It is all modeling.

A key distinction is that weather forecasting and climate measurement are different enterprises. The first must be done on very short process cycles, is eminently pragmatic in its orientation, and is uninterested in data after the forecast is done. Climatologists have all the time in the world, love nothing more than long sequences of commensurable data, and are interested in many more types of data than weather forecasters. What they have in common is that they both depend on models.

Computer models are based on physical principles from a large number of disciplines: fluid dynamics for wind and ocean movements; thermodynamics for the exchange of radiant energy among all components of the atmosphere, ocean and earth; biology, for the physiology of living things; chemistry, for the interaction of chemicals in the atmosphere. Add to these physical principles a number of given parameters, such digitized topographic maps of the Earth, observed ice and snow cover, locations of rivers, and so forth.

Some physical interactions are well understood and can be quite accurately modeled, such as the absorption of sunlight by carbon dioxide in the atmosphere. Some are vastly more difficult and problematic, such as the way in which soot in the air precipitates the formation of clouds, or clouds reflect sunlight back out into space.

No model can possibly describe every characteristic of the earth; fine details have to be rolled into gross parameters. Edwards' example is rain; you cannot model individual raindrops, you have to talk about average precipitation over one of your grid squares, typically several hundred kilometers on a side. In the end, you are left with the following realizations: it is impossible to model everything – whatever model you make will be shot through with simplifying assumptions. However, a model is absolutely the only way to visualize either weather or climate on a global scale. Any claim that we don't understand global warming because it is "just a model" misses the point. A model is absolutely the only way we can understand global climate or global weather. Edwards does a great job of leading us through the history of both data collection and modeling. His argument is that today's models are fairly good because (1) they do a pretty good job of explaining past climate and (2) a vast number of models, more or less independent of one another, converge on more or less the same predictions. His word, a nice usage, is shimmering models. The images of the past and the future that they create are not fixed – each one is slightly different from the others, which you can visualize as shimmering – but they converge fairly well.

He introduces the UN's Intergovernmental Panel on Climate Control late in the book, and he published before last year's major controversies over the Himalayan glaciers and the East Anglia e-mails which tarnished the IPCC. Nevertheless, he does an exceptionally good job of describing the political environment in which the IPCC operates.

He might have mentioned, but does not, that the IPCC has three working groups: the science of global warming, the projected effects of global warming, and proposed policy to combat global warming. This book addresses the work of only the first of them, perhaps the least controversial. While there is a consensus that the world will warm by perhaps three degrees Celsius when carbon dioxide doubles to 560ppm, it is much harder to project, or get a consensus, on whether that will be harmful or beneficial to any given country, and harder yet to conclude, as the Kyoto protocol attempted, that the world must bite the bullet to the tune of 100 trillion dollars to combat CO2 immediately. In summary, Edwards' sticks with the science, and does an extremely good job of presenting the case for believing the model, and also that there nothing else in which one could believe but the model. Having established that global warming is almost certainly real, he leaves what to do about it to the politicians. But he dedicates the book to his children and the world they will inherit.

I add that Edwards has an excellent web site, http://pne.people.si.umich.edu/vastmachine/index.html in support of the book.