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Computers, Physics and Our World FREE

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Computers, Physics and Our World

BY ROBERT R. BORCHERS

As usual, when I think about a subject, I look back to an early involvement. In the case of computing and the planet, the place and the time are well defined. The place, as usual, is Madison, Wisconsin and the time is the early 1960s. Picture a nuclear physics graduate student, rolls of paper tape under his arm, waiting for his turn at the UW's new Seymour Cray-designed CDC 1604. The goal is analysis of neutron time-of-flight data from the Van de Graaf accelerator. The impediment is a meteorology graduate student with reels of magnetic tape. Where did the tape come from? It was the result of one of the first attempts to use a satellite to apply one of the basic laws of physics (energy balance) to Earth.

To be less cryptic, even though I am not a scholar in the field of modern meteorology, I can say that I know one, and I will always remember the person who introduced me to the subject: Verner Suomi. The graduate student "impediment" mentioned in the last paragraph was working on an experiment conceived by Suomi that was brilliantly simple. Two hemispheres, one black and one white, (known as "Suomi's balls") were mounted on the outside of the satellite Explorer VII. A pair of thermocouples measured the temperature differential between the balls (remember how good thermocouples are at measuring delta T) and modulated a carrier. The carrier frequency correlation to the satellite position should be used to infer the radiation balance of the Earth. Suomi's concept was basic and elegant, appropriate to a person whose Ph.D. thesis had to do with the energy balance of a cornfield!

An amusing aspect of the Explorer VII satellite was its longevity. Long after it was supposed to have "died" it would receive an infusion of solar energy, wake up, and resume transmitting data from its faded and yellowed "balls." I assume another graduate student would then appear in the queue at the computer center.

Out of all this came the famed Space Science and Engineering Center (SSEC) at UW Madison, directed for many years by Vern Suomi. The satellite became more complex and the data returned more sophisticated, but Suomi's insightful approach was always present. My involvement with the Center became less vicarious when my colleagues and I helped develop one of the first "bit-mapped" graphics displays for the Man Computer Interactive Data Analysis System (McIDAS) which allowed use of satellite photos to measure wind velocities by the elegantly simple trick of following individual clouds. Clearly, a computer helper was needed and McIDAS was the answer.

In these days of satellite photos on the evening news, we tend to forget the tremendous amount of information they deliver. Yet, understanding these and other data is the key to understanding the Earth's operation and our potential effect on it.

From a computing point of view, numerical simulations of the planetary systems (atmosphere, ocean and land) are critical. Environment and astrophysics are two areas where one would prefer not to do large-scale experiments! The compromise is use of large-scale numerical models, which, when validated, allow tame experimentation and prediction. One of the goals of the inventor of modern computer architecture, John von Neumann, was weather prediction.

Understanding of long-term climatic effects may be attainable with numerical models. The subject of global warming due to carbon dioxide concentration in the atmosphere has recently become a "hot" topic. The thesis is that increasing amounts of CO_2 can trap radiation and lead to spectacular effects like the melting of the polar ice caps (check the average height above sea level of your Florida real estate).

Many of the results of the models come from trying to include detailed understanding of energy balance (à la Vern Suomi) and other physical factors. A problem is that different models give different answers. Those of us who occasionally like to refer to computational science as being on an equal footing with experimental and theoretical science tend to overlook one of the basic rules: consistency. It should be possible to reproduce a computational result using the same physics assumptions even though the code used different algorithms and even a different language and operating system. Fortunately, in the important area of global warming, the U.S. Department of Energy has embarked on an ambitious program of trying to intercalibrate a number of the most important weather and climate codes. Additional effort is going into improved understanding of the interaction of the atmosphere and the oceans, an important unknown in the CO_2 equation.

Meanwhile, as you have read in *CIP*, we expect new satellites providing new data, better means of utilizing the data, better models, and faster computers. All of these factors come together at a critical time since they could drive important policy decisions about energy options. ■

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