LETTERS

Weather Satellites and Climate Research

M. Mitchell Waldrop, in his article, "What price privatizing Landsat?" (News and Comment, 11 Feb., p. 752) discusses the government's intent to commercialize the earth resources satellite, Landsat, and the National Oceanic and Atmospheric Administration's (NOAA's) operational weather satellites. He does not, however, point out the potential of the operational weather satellites for climate research, something that also appears to have gone unnoticed by those seeking to commercialize the satellites.

This potential for climate research stems from a growing history of fairly routine observations. Observations began in the 1970's with the scanning radiometer (SR) and the vertical temperature profile radiometer (VTPR) on NOAA-2 through NOAA-5. If not squelched, they will continue through the 1980's with the advanced very high resolution radiometer (AVHRR) and the high resolution infrared radiation sounder (HIRS/2) on the TIROS(N) series. These satellites provide fairly standardized observations for the entire Earth.

Aside from rudimentary studies of time and space average, the data have yet to be exploited for climate studies. They are primarily used for preparing weather forecasts. The problem facing the climate research community is that the volume of data is enormous—approximately 5000 tapes each year for AVHRR and 500 for HIRS/2. Because of this volume, researchers must learn to design efficient, automated algorithms to extract the desired signals. Because of the complexity of the earth's atmosphere and surface, such automated algorithms are akin to pattern recognition schemes and have proved difficult to construct.

One envisions, however, that just as we now turn to carefully preserved temperature and pressure records, future generations will turn to the satellite data now being collected to gain further insight into the dynamics of climate and climate change. With added experience and new technology, researchers will be able to gain the skill and ability to process the large volume of data. The value of these data, however, rests on three conditions: (i) that the observations continue; (ii) that they are carefully collected in archives; and (iii) that researchers are encouraged to develop the complex tools needed to explore the wealth of information provided by the data.

Inasmuch as the government contributes to the well-being of its people, its job is to maintain standardized observations, to collect and preserve these observations, and to support research focused on their use. I see no reason for giving this task to industry. It is unlikely that industry would always be able to maintain the standards required of a useful climatological data set.

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Nuclear Plant Performance

George Huhn (Letters, 25 Mar., p. 1377) writes that I stated that the average capacity factor of U.S. reactors ranged from 50 percent to 62 percent from 1975 through 1980. This was the range for reactors with a capacity greater than 800 megawatts. The all-reactor average was about 5 percentage points higher.

In answering Huhn, Eliot Marshall cites nuclear plant "availability" factors. Availability is a power-industry buzz-word denoting the percentage of time a generating unit is "available to operate" without netting out inability to maintain full power. For nuclear units, what matters economically is capacity factor, and that is typically 10 to 15 percentage points less than availability, because of equipment failure, on-line inspection, and safety-related restrictions.

For the record, the U.S. nuclear capacity factor average was 56 percent in 1982 and 59 percent for all years through 1982 (*1*).

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Note

1. Calculated with original reactor design electrical ratings, based on net generation, for all units 400 megawatts or larger, omitting any operation before the first New Year's Day of commercial service.

Cancer Chemotherapy

In his article about the National Cancer Chemotherapy Program (13 Aug., p. 600), Emil Frei III reviews the progress since 1955. He points out that certain types of cancer now can often be cured, thanks to advances in radiotherapy and chemotherapy. He then says that these advances were responsible for the 20 to 40 percent drop in cancer mortality recently seen in people under 45, and he states that each year in the United States more than 40,000 patients are being cured of cancer by chemotherapy.

The National Cancer Institute has just published the assembled statistics for cancer mortality in the United States between 1950 and 1977 (*1*). These figures show exactly which cancers have been the main contributors to the overall decline in cancer mortality among the young (Table 1). Numerically the most important change has been in cervical cancer; in 1977, there were more than 1000 fewer deaths in women under 45 than would have occurred in 1950. Next in the list come leukemia and colorectal cancer (each about 800 fewer deaths), followed by Hodgkin's disease, breast cancer, and stomach cancer (each 200 to 400 fewer deaths). It is hard to determine how much these numbers really represent the successes of treatment and how much they reflect the decline in incidence that is now being seen in younger age groups (*2*). The reduction in deaths from leukemia could be entirely attributed to treatment if we are prepared to believe that all children with leukemia are now being looked after as well as the children in clinical trials (*3*), which is somewhat doubtful (*4*). But the fall in deaths from cervical and colorectal cancer cannot be due to treatment; in each case, the decline has been going on steadily for 30 years, despite the absence of any conspicuous advances in treatment. Deaths from cancer of the cervix have gone down threefold, and colorectal cancer deaths have been halved. As a result, between 1950 and 1977 the chance that an infant's mother might die of cancer has decreased much more than the chance that the infant itself will die of cancer. In other words, more benefit has come to young families as the result of certain unexpected changes in cancer incidence than has come, so far, from the National Cancer Chemotherapy Program.

Frei estimates that each year in the United States more than 40,000 patients are being cured by chemotherapy. He does not say how he arrives at that figure, but it seems too high by a factor of about 10. Recently, de Vita *et al.* (*5*) calculated that 11,000 patients could be cured by chemotherapy each year, assuming that survival for 5 years can be counted as a cure (which is not always true) and that the results of the best available treatment can be extrapolated to the nation as a whole (which is too optimistic for even a simple procedure, let alone something as hazardous as treatment with the cytotoxic agents used

Table 1. Recent reductions in cancer mortality in people under 45; the difference between the expected number of deaths from cancer (calculated for the population in 1977 on the basis of death rates observed in 1950) and the actual number that occurred in the United States in 1977, with main contributing types of cancer and number of deaths fewer than expected for each type (*1*).

	Ages	Difference (all cancers combined)	Main contributors (number of deaths fewer than expected)
White males	0–14	678	Leukemia (354); kidney (78); Hodgkin's (22)
	15–29	418	Hodgkin's (145); colorectal (108); leukemia (41)
	30–44	427*	Stomach (238); colorectal (203); Hodgkin's (131)
White females	0–14	710	Leukemia (344); kidney (101); nervous system (43)
	15–29	878	Cervix (117); leukemia (108); Hodgkin's (88)
	30–44	2803	Cervix (1069); colorectal (427); breast (388)

*Owing to the increase in death rate from lung cancer, the total reduction in mortality for this group was not as great as the sum of the three main contributors to this reduction.

in cancer chemotherapy). Therefore, even that number is likely to be too high. We can try to arrive at the answer another way. Each year, in the nation as a whole, there are now about 1000 fewer deaths from Hodgkin's disease, and, as mentioned earlier, about 1000 fewer deaths from childhood leukemia. The other cancers, which used to be fatal and are listed by Frei as regularly curable by chemotherapy, are not common and collectively cause fewer than 2000 deaths a year. Last, there are certain common cancers (breast and ovarian cancer, and non-Hodgkin's lymphoma) that sometimes respond to chemotherapy; each is now causing 200 to 400 fewer deaths in people under the age of 45, although there has been little change at older ages. In short, it is hard to see how the total of cancers actually being cured by chemotherapy could be much higher than 5000 a year.

Anyone engaged in the care of cancer patients tries to present the statistics in the best possible light, so a level of optimism that entails an error of a factor of 10 might seem perfectly reasonable. But when the time comes to pass judgment on a program that consumes more than $100 million a year, something more is required. During the period that the Chemotherapy Program has been using these vast sums of money to find out how to cure a few thousand patients each year, we have gradually reached the point where, each year, about 70,000 extra deaths from lung cancer are being added (*1*). Given numbers like these, it seems likely that some of the money spent on treating patients would have been better spent on a campaign to prevent cancer.

It is, of course, impossible for anyone to predict when chemotherapy will start to have a major impact. But there are some biological reasons for thinking that many of the common cancers of adult life will never be curable by the kinds of cytotoxic drugs discovered so far. To any biologist, it will be significant that the cancers that can be mostly successfully treated by chemotherapy fall into two special classes. First, there are the cancers of the immune system (the lymphocytic leukemias and the lymphomas) arising in cells that, perhaps because of the body's need to control clonal selection, are themselves under a kind of immunological control; second, there are the cancers such as choriocarcinomas, testicular teratocarcinomas, and Wilms' tumors that arise in embryonic cells which are programmed to be destroyed once embryogenesis is complete. Since the body already has mechanisms for killing such cells that could complement any cell destruction started by chemotherapy, it is not surprising that these rather rare cancers can often be cured by somewhat nonspecific cytotoxic agents. Unfortunately, most cancers arise in epithelia where the cells are not programmed to destroy themselves and are not apparently under the kind of controls operating within the immune system. These will presumably require some specific form of chemotherapy.

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Cairns and Boyle take issue with my estimate of the effect of cancer chemotherapy on national cancer mortality statistics. They use baseline data collected in 1950, compare it to the last quantitative collection of mortality data (1977), and use the differences, appropriately corrected for population changes, to evaluate the effect of cancer chemotherapy (*1*). They conclude that very little progress has been made in the curative treatment of cancer with chemotherapy.

The first major curative cancer chemotherapy was developed in the 1960's for the leukemias and lymphomas and, at about the same time, for many of the solid tumors of childhood. Such treatment became widely employed in the community by 1970 or later. Curative chemotherapy for other cancers was developed after 1970. Many forms of cancer represent chronic diseases. Thus curative treatment will not have a full impact on mortality for five or more years. Therefore mortality up to 1977 reflects curative treatment introduced in 1973 or earlier. One would not expect curative treatment developed in cancer centers in the 1960's and disseminated in the early 1970's to affect a major absolute reduction in national mortality by 1977, which is what Cairns and Boyle found. However, we agree that downward trends in mortality for the curable tumors (acute lymphocytic leukemia, Hodgkin's disease, solid tumors of childhood) and for the 0 to 44 age group in which these diseases largely occur were clearly evident by 1977.

Since comprehensive cancer mortality statistics are available only through 1977 (*1*), I calculated the reduction in expected cancer mortality, as of 1982–1983, not observed, as inappropriately implied in my article. The actual (observed) figure would require years of follow-up after 1982. My analysis was deleted because of lack of space, but the conclusion (40,000) remained without adequate explanation. The calculation included the 13 forms of cancer that have been cured by chemotherapy in major, often multiple, clinical trials. Cure on the basis of short-term (5- to 10-year) follow-up is defined as relapse free survival after a relapse risk period (*2*). The absolute incidence of these 13 cancers for 1982–1983 was estimated by the accepted technique (*3*), with the assistance of E. S. Pollack and J. L. Young of the Biometry Branch of the National Cancer Institute. The percent of patients appropriate for curative chemotherapy was determined, for example, by subtracting subsets curable only by surgery, radiotherapy, or both,

Table 1. Curability of cancer by chemotherapy (1982–1983).

Type of cancer	Incidence	(−)*	Potential curability				Reference
			Established		Putative		
			Percent	Number	Percent	Number	
ALL† (pediatric)	2,000	(2,000)	50	1,000	80	1,600	*6*
ALL (adult)	3,600	(3,600)	20	720	40	1,440	*7*
AML‡ (pediatric)	350	(350)	20	70	40	140	*8*
AML (adult)	6,000	(4,500)	10	450	20	900	*8*
Breast (premenopausal)	41,500	(20,750)	10	2,075	15	3,113	*2, 5*
Breast (postmenopausal)	72,500	(26,100)	10	2,600	15	3,915	*2, 5*
Gastric (stage I)	24,500	(8,085)	0	0	15	1,213	*9*
Hodgkin's (stages III and IV)	7,100	(4,260)	40	1,704	80	3,408	*10*
Lung, small cell							
Limited	18,005	(15,188)	10	1,519	20	3,038	*11*
Advanced	18,005	(15,188)	3	450	5	759	*11*
Lymphoma, non-Hodgkin's	23,000	(9,315)	40	3,726	65	6,521	*12*
Pediatric solid tumors§	2,250	(2,135)	25–75	1,074	60–96	1,638	*13*
Testis	5,400	(3,240)	60	1,944	90	2,916	*14*
Trophoblastic disease	1,000	(1,000)	> 80	948	> 80	948	*15*
Total				18,280		31,549	

*Subset appropriate for curative intent chemotherapy (see text) (*3*). †Acute lymphocytic leukemia. ‡Acute myelogenous leukemia. §Includes Wilms', rhabdomyosarcoma, Ewing's, lymphoma, and osteosarcoma.

or elderly patients who might not be appropriate for combination chemotherapy. Curability was expressed as "established" (long accepted cure rates) and "putative" (more recent, but confirmed, studies). The potential absolute cure figures were calculated as the product of the incidence and cure rate. The assumption that clinical trials conducted in centers can be successfully transferred to the community is supported by recent studies (*4*).

I will discuss breast cancer, the most controversial example, and list the remainder in Table 1. An estimated 114,000 women will develop breast cancer in 1983. Of these 41,500 will be premenopausal. Fifty percent of all patients will have invasion of axillary nodes. Adjuvant combination chemotherapy in such patients increases survival in premenopausal and, in most studies, in postmenopausal patients. Breast cancer is an indolent disease, and the risk of relapse continues beyond 10 years. Hence, cure rates cannot be established in the absence of long-term follow-up. In a randomized study adjuvant chemotherapy provided a 15 percent improvement in survival, which was sustained through 15 years of follow-up in both premenopausal and postmenopausal patients. Similar results with shorter follow-up have been achieved by a number of additional studies (*2, 5*). The cure rates and potential numbers for breast cancer and the other 12 diseases are presented in Table 1 (*2, 5–16*). The totals (established, 18,280; putative, 31,549) represent underestimates, in that they are based necessarily on the results of relatively mature studies.

More recently, major advances in terms of the frequency, magnitude, and duration of tumor regression have been achieved in the chemotherapy of head and neck cancer (80 percent response rate), ovarian cancer, esophageal cancer, lung cancer, gastric cancer, bladder cancer, endometrial and cervical cancer, and soft tissue sarcoma (*16*). The incidence and death rate from these tumors is 375,200 and 187,500, respectively. Some multimodality studies (chemotherapy combined with surgery or radiotherapy, or both) produce results compatible with potential cures of more than 10,000 patients. Because the studies are of insufficient duration, secure quantitative data is not available.

Tumors of immunologic and embryologic cell origin are more curable, perhaps for the reasons cited by Cairns and Boyle. However, the implication that epithelial tumors will not respond is not true. Major effectiveness for chemotherapy has been demonstrated against epithelial tumors in culture and transplanted in mice. Many of the tumors included in the table and text are epithelial in origin and chemoresponsive.

The final comment of Cairns and Boyle that the cancer treatment results are hyped for political-fiscal purposes is incorrect and unfortunate. Before 1973, only a few institutions and scientists focused on cancer treatment. Largely as a result of public support, many universities and centers have made significant commitments to cancer treatment. Such a dynamic and important discipline must be evaluated on the basis of current information, albeit tentative, and not on the basis of data from a decade or more ago.

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Erratum: In the article "The new inflationary universe" by M. Mitchell Waldrop (Research News, 28 Jan., p. 375), it was stated incorrectly that, in the standard model, the expanding universe cooled below 10^{27} degrees Kelvin about 10^{35} seconds after the Big Bang. The correct time is 10^{-35} second.