A Silver Lining for the Weather Satellites?

The weather satellites have become a budgetary and ideological football; can a new consensus be reached?

After years of budgetary brinksmanship, the national weather satellite program may be approaching a major decision point. At the request of Congress, the National Oceanic and Atmospheric Administration (NOAA) will spend the next 9 months on a study that could shape the system for the rest of the century.

The basic problem is simple: NOAA is an operations agency within an administration that is philosophically opposed to the government's operating much of anything (*Science*, 7 December, p. 1172). The weather satellites, as one of NOAA's most expensive activities, have thus become a battleground.

There have been attempts to sell the weather satellites to private industry. Budget cuts and delays in the procurement of satellites have put the system on a knife edge, with little redundancy and potential gaps in the years ahead. And there has been a bitter struggle between the Administration and Congress over the number of satellites needed for adequate coverage. NOAA's study is thus an attempt to produce some much-needed consensus and to end this ceaseless buffeting. Some examples:

• The attempt to sell the weather satellites to a private operator (*Science*, 11 February 1983, p. 752). This idea originated in 1981 with the Communications Satellite Corporation (COMSAT), which wanted the weather satellites as part of a package deal for commercializing NOAA's Landsats. OMB and top Department of Commerce officials embraced it immediately. Although the commercialization effort did not directly affect the day-to-day operation of the weather system and although Congress eventually put a stop to it, it did consume an enormous amount of the program managers' time, energy, and attention—not to mention keeping the staff in a demoralizing state of limbo. Moreover, internal Commerce memorandums suggest that by late 1981, the department was coming under heavy pressure from COMSAT lobbyist James Lynn, who was pushing for deep cuts in the weather satellite budget. COMSAT's apparent motive was to have the system cut so deeply that it would *have* to be spun off to the private sector. For whatever reason, by late 1981, top Commerce officials and the OMB were targeting the weather satellites for serious cuts.

• The attempt to cut back on the polar-orbiters. NOAA's series of polar-orbiting satellites—which are known as NOAA-7, NOAA-8, and so forth—occupy an 850-kilometer orbit that takes them over almost any given spot on the earth once a day. Their primary mission is to provide a vertical profile of atmospheric temperature and humidity. For redundancy and for more frequent coverage, NOAA currently tries to keep two functional spacecraft in orbit at all times, one passing overhead in the morning, and one in the afternoon.

For 3 years running, however, OMB has tried to cut the system back from two satellites to one as a cost-saving measure. The argument is that NOAA's system duplicates a pair of polar orbiters operated by the Pentagon. As OMB director David Stockman wrote in a letter to Commerce Secretary Malcolm Baldrige on 26 July 1984, "Eliminating the second polar satellite (actually the fourth U.S. polar) saves over $300 million from 1985 to 1989."

John H. McElroy

Will Envirosat 2000 *be the basis of a new consensus?*

Congress, however, has put the second polar orbiter right back in every time. The immediate concern has been with the quality of forecasts and services in a one polar-orbiter system. As it was expressed in the 1983 NOAA authorization report from the House Committee on Science and Technology: "Long-range forecasts will suffer, as will short-range forecasts in tropical areas, in the Southern Hemisphere, and in oceanic areas such as Alaska and Hawaii. . . ."

An even greater concern has been the fact that, except for the Soviet Union, the United States currently operates the only system of polar-orbiting weather satellites in the world. With more than 120 nations depending on the American satellites for data, the international repercussions of downgrading the system would be considerable—especially in the tropical areas of the Third World, where frequent data updates are essential for a decent job of forecasting.

In an emergency the data can indeed be obtained from the Defense Department's satellites, as Stockman suggests. The information itself is not classified; in fact it is routinely shared with NOAA. However, the transmissions are encrypted, whereas NOAA's satellites transmit direct to anyone who has a ground station to receive it. Any long-term dependence on the military satellites would thus be awkward at best.

Congress's final concern has been the lack of back-up capacity in a one-satellite system. If that one satellite were to fail, noted the committee report, then there would be *no* polar orbiter for a period of from 1 to 18 months, until a replacement could be launched.

Stockman's argument has been that the Air Force satellites will serve as backups. However, the instruments on the military spacecraft are somewhat different from NOAA's, which means that the data lead to poorer results in NOAA's forecasting models.

Be that as it may, there is every indication that OMB will once again try to delete the second polar orbiter in the fiscal year 1986 budget, which is now being prepared for submittal to Congress in January.

• The summer of 1984. Congress's concern about backups began to look very prescient indeed last summer when two of NOAA's weather satellites were lost within a month of each other. On 30 June, the attitude control system failed on the polar-orbiting NOAA-8 and left it tumbling out of control, effectively use-

less. Then on 30 July the imaging system failed on the GOES-5 spacecraft, part of a separate series of satellites residing in the 35,900-kilometer geostationary orbit. The United States operates two of the spacecraft, while Japan, India, and the European Space Agency each operate one; their principal mission is to provide global imagery of weather patterns and storm development (not to mention the satellite photographs seen on television weather reports.) Among other things, the breakdown of GOES-5 meant the loss of imagery from the North Atlantic and the hurricane breeding grounds of the Carribean.

What made this situation an inconvenience and not a disaster was redundancy. Not only is the second polar orbiter, NOAA-7, able to fill in for NOAA-8, but it happens that an earlier satellite, NOAA-6, also remains operational (albeit showing its age.) Moreover, several replacement spacecraft are already in the pipeline; the next is currently scheduled for launch on 9 December.

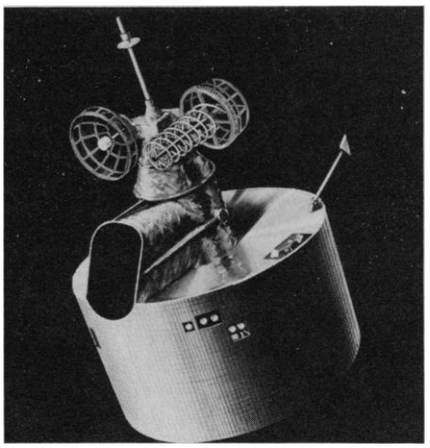
Meanwhile, the second geostationary satellite, GOES-6, has been moved from its westerly position over the Pacific to a more central position due south of Texas. This allows it to maintain coverage over most of continental North and South America; the missing oceanic data on either side is again filled in (partially) by the low-flying NOAA-6 and -7, and by the military polar orbiters.

"What all this illustrates," says a high NOAA official, "is that when you have a system with robustness, you can patch around the problems. If OMB had succeeded [in eliminating the second polar orbiter] then right now we could have been in a one-GOES situation."

Still, he says, no one should underestimate the seriousness of the predicament: "The system is hanging on a weak thread. And we are definitely reducing weather service for Alaska and Hawaii."

• The delay in GOES procurement. In many ways the most worrisome aspect of the current situation is that there is now no backup for the remaining U.S. geostationary satellite, GOES-6. (The Pentagon has nothing of its own in geostationary orbit.) The replacement for the deceased GOES-5 will not be launched until October 1985 at the earliest, and then only if the manufacturer, the Hughes Aircraft Company, can maintain a very tightly paced schedule. The launch could easily slip into the spring of 1986.

The origin of this gap is partly technological. GOES-5 and -6 are the last of a series of three spacecraft ordered in 1977. Their estimated on-orbit lifetime



The GOES satellite

"The system is hanging on a weak thread."

was 5 years, but in fact only GOES-5 even made it to 3 years; the result is that NOAA has simply used up this group of satellites faster than planned. "We've made a lot of changes to increase the lifetime," sighs John McElroy, head of NOAA's satellite service, "but we just keep turning up new problems." (A particularly vexing problem is a little light bulb known as the encoder lamp, which serves as a reference point to orient the optical system. The things keep burning out. The next GOES will carry not one, but three backup lamps.)

But the GOES gap is also the result of managerial delays. It happened that the successors to the 1977 series—a group of three satellites starting with the one to be launched next October—had to be ordered in the midst of the Reagan Administration's attempts to slash the federal budget in 1981–82. This was not exactly a happy time for any program. But GOES faced an additional complication: the new purchase had been budgeted at $115 million, based on a cost estimate by National Aeronautics and Space Administration (NASA), the original developer of the satellites; the figure now being quoted by Hughes for the new group was $143 million, nearly 30 percent higher.

NOAA officials warned that time was of the essence: even then it was apparent that the system might be down to one GOES as early as 1984 or 1985. But their bosses at Commerce and OMB nonetheless spent another 6 months in a futile effort to force the new satellites back within the budget. NOAA is paying for that delay now with its scramble to get GOES-6 ready for launch in 1985.

Furthermore, it was decided in the end to order only *two* new GOES. NOAA officials are now worried that they may be paying for that decision with an even worse gap in the late 1980's. (OMB has subsequently rejected every NOAA request to put the third satellite back in.)

• The SARSAT fight. Last summer, in a side skirmish to the one-polar/two-polar battle, Stockman tried to keep NOAA and NASA officials from renewing an international agreement on search-and-rescue satellites, or SARSATs. (*Science*, 7 September, p. 999). The SARSAT transponders are provided jointly by Canada and France and fly on the U.S. polar-orbiting weather satellites; the Soviet Union meanwhile flies compatible transponders on its own polar orbiters. Stockman's problem was that the agreements called for each nation to fly *two* SARSATs, which would implicitly commit the United States to a two-polar system.

When it became obvious that reneging on the agreement would be a major international embarrassment to the United States, Stockman was forced to back down. However, such is OMB's opposition to the two-polar system that it has suggested flying the second SARSAT on its own dedicated satellite, despite the fact that the savings would be minimal. (The military weather satellites do not carry foreign instruments.)

Looking back over all this, it seems painfully clear that NOAA, Congress, and the OMB have worked themselves into a state of conceptual gridlock on this issue. It is equally clear that the only way out is to reestablish some consensus on what the weather satellite program should be and where it is going.

While this is easier said than done, an optimist could point to a glimmer of hope. On 10 August, in the wake of the satellite failures and the SARSAT imbroglio, Representative Don Fuqua (D–Fla.), chairman of the House Science and Technology Committee, and Representative James H. Scheuer (D–N.Y.), chairman of the subcommittee on natural resources, asked NOAA to prepare a comprehensive report on "the purposes, goals, needs and future organization of the Environmental Satellite Service."

McElroy saw his opportunity. With the committee's approval, he has now taken the original request, added in some parallel studies requested by the OMB, coupled them with some in-house activities of his own, and assembled it all into a single master study to be called *Envirosat 2000*. "We felt that if we didn't do a thorough, objective study of the whole system," says McElroy, "we'd be swamped again."

The hope is that the exercise will provide the basis for a new consensus. The technical portions of the study will be released over the next 9 months as a coordinated series of conference reports;

Envirosat 2000 itself will then be released as a policy document in August 1985. Some issues:

• The military/civilian relationship. Quite aside from the one-polar/two-polar debate, OMB has asked NOAA to look at ways to eliminate wasteful duplication between the two systems. NOAA and the Pentagon already use the same basic spacecraft, for example, and they are already planning a joint system of data analysis. What else might be done? So far as NOAA is concerned, this is an utterly sensible thing to think about.

• The NOAA/NASA relationship. NASA withdrew from advanced remote sensing research in 1981, when it was under budget pressures of its own. NOAA, of course, has had no funds to pick it up. The Land Remote Sensing Commercialization Act of 1984 requires NOAA and NASA to prepare a joint agenda for future research by July 1985.

• Expanded international cooperation. In June 1984, the Versailles Economic Summit identified satellite remote sensing as a potential area for scientific cooperation. One result has been the creation of the International Polar-Orbiting Meteorological Satellite group (IPOMS), which includes Japan, Australia, Canada, and six European nations. At their first meeting on 19–20 November in Washington, the members unanimously endorsed the need to maintain *two* polar platforms—with an expanded suite of instruments—and indicated a willingness to shoulder a good deal more of the financial responsibility. "The program we have outlined could save [the United States] a *lot* of money," says McElroy.

• NASA's space station. One way to implement an international remote sensing program would be to collect everyone's instruments onto a single polar-orbiting platform. NASA hopes to include such a platform in its space station initiative—in fact, the European Space Agency may very well be willing to build it—and McElroy, for one, hopes to be a big user. At the moment, he says, the failure of a single sensor or even a single light bulb means abandoning a satellite worth $50 to $100 million. With the instruments collected on a platform, however, visiting astronauts could do repair and maintenance on a regular basis. "I can imagine savings of one-third of the budget per year," says McElroy. "That's $30 or $40 million."

At the moment it is hard to say just what opinion OMB has of all this; officials there have consistently declined to talk to the press about the subject. However, it is clear that none of NOAA's efforts are going to mean much unless a consensus on these issues can be reached with OMB and Congress.

—M. MITCHELL WALDROP

NSF Readies New Education Program

Revamped science and engineering education directorate plans switch in emphasis for precollege activities

For the past year, the National Science Foundation's (NSF's) education directorate has been rebuilding its staff, reorganizing its shop and rethinking its policies. The revival is now at the point where the program is finally taking shape; the first big push will be to upgrade science and mathematics teaching at the elementary and junior high school levels.

The rebuilding effort was required because the Reagan Administration abolished the previous education directorate shortly after assuming office in 1981. As a result of pressure from Congress and some second thoughts by the Administration the directorate was reestablished a year ago, but major hiring and policy decisions were, in effect, put on hold and expenditures on programs kept at a low level while NSF searched for someone to head the revived office. The post went to Bassam Z. Shakhashiri, a chemistry professor at the University of Wisconsin with considerable experience in science education. Shakhashiri joined the foundation in late June and has spent the ensuing months working to develop a program while at the same time recruiting for the directorate staff. Things are now far enough along for Shakhashiri to have agreed to discuss developments in an interview with *Science*.

The education directorate has on the books some $82 million appropriated for use this year, plus another $31 million left over from the last fiscal year for a total of $113 million. Some $25 million of this will go to fund graduate fellowships and another $5 million to provide science instrumentation for colleges. Nearly $80 million, however, is earmarked by Congress for use in precollege programs.

In the precollege sector, what Shakhashiri describes as a major thrust will be in programs for elementary schools and middle and junior high schools. The intent is to use up to 50 percent of the precollege funds for projects in this area. Explaining the targeting of elementary and junior high school students Shakhashiri said, "We believe that attitudes develop in that age group, opinions harden. By the time students get to high school their minds are made up" that science is too hard, math is not for them. He said that discussions at the foundation produced agreement that this was an area where a "concentrated effort needed to be made." He added that research findings support this position. Shakhashiri emphasized, however, that NSF is asking for proposals for lower grades "not to the exclusion of programs at the high school level."

In a letter written to Representative Edward P. Boland (D–Mass.), chairman of the House Appropriations subcommittee with authority over the foundation, NSF director Erich Bloch said that the emphasis on elementary and junior high school education "is a major refocusing of the Foundation's efforts on science and mathematics education that was achieved after much discussion with staff, members of the Advisory Committee and others knowledgeable in the field."

Within the education community, a major question brewing since the NSF education program was restored is whether the teacher retraining programs—most familiarly the NSF summer institutes—supported by the foundation in the 1960's and 1970's will be revived. The institutes were popular with teachers and school administrators but have both backers and critics in Congress. NSF expects to resume sponsorship of teacher training programs but not on the scale of former times.

Commenting on the retraining issue, Shakhashiri said that NSF is concerned with "teachers in the field and in training," and that "we need to help teachers maintain their competence. But we can't support the retraining or education of