

D OVERVIEW - NASA REMOTE SENSING PROGRAMS

Dr. William P. Raney (Assistant Associate Administrator - Space
& Terrestrial Applications - NASA
Headquarters)

My talk this morning is an overview of our present status and applications and what we expect in the future.

There is an essential complication in applying applications in a functional and efficient capacity. We have to encompass different sources of activities. Unless there is a proper scientific base for the applications we are going to apply, we could adapt very expensive systems with people doing a lot of things and then suddenly stand back and ascertain that we are not quite sure what it means. There is a component of science that has to go along with development of the applications. We must work closely with users to make certain that we are not doing things that everyone considers useless. Just standing back and waiting for someone to say I need to do that, completely negates any gains that can be made out of the opportunities that arise from fresh ideas in technology. There must be a balance between technology and applications.

The next process involves how you actually do something with practical technology. You need to create a working system to demonstrate that the system is possible without actually putting it in operation. We have discovered in working through the Landsat program and other programs at NASA, that very often you really do not get the full perspective of what is necessary for an operational system without trying an operational system.

Finally, there is the process which involves transferring the technology into the operations to someone who will carry this on in the future. Transferring technology is the functional process, aside from who spends the money that will be required to do this. We wish to gain knowledge of mineral and geological resources in a systematic way. We start with recognition of a problem, in this case, we then work on various ways of contributing to the solution of the problem technologically. Work out a program plan, work out the details of how we are going to interact with the cooperating agencies and then, finally, develop capabilities to do what we believe will support some improvement in solving the international problem.

In the Earth remote sensing area, we have three functions. One of them is understanding the basic mechanics and behavior of the earth. That

does not have much to do with remote sensing, but is one of the major scientific and practical problems facing everyone in the world. For example, our better understanding of the earth may lead to understanding earthquake phenomenon and prediction, and lead to steps to prepare for earthquakes. It has a great deal to do with understanding where minerals have been formed in the crust. Therefore, in the final analysis, it will provide a better understanding on where to look for minerals that can be extracted with some economical potential.

The second one is a more mature function of evaluating what is available in the way of minerals and hydrocarbons on a general scale. Finally, the third goal is simply the types of things we have been working on in the Landsat program for some years now and to arrange for a scheme that will allow us to manage the national assets.

The tools of the trade are the Landsat series for remote sensing of the land system. I am happy to announce, if you have not heard already, that Landsat 3 is working again, the multispectral scanner is working. Now we have two satellites and the instruments on the satellites are both working. We are looking forward to a successful launch of Landsat 'D', with both its major instruments, in the third quarter of 1982. At this point, we do not see any major impediment in being able to launch that satellite on schedule. The new budget has cut off the series after Landsat 'D'. What eventually happens, of course, depends on the details of our interaction with the private sector in taking over the system and making it run. Our technology development for the next series is multi-linear array and will get started when Landsat 'D' flies, leading into a potential next family of operational satellites. We make no pretense at this point who may be in charge of the operational satellites. We still have it as part of our mission to contribute to technology development. The MLA Program is to develop a push scanner and prove technology throughout resolution with specific emphasis on bands in the short wave infrared which are research and useful in some of the mineral classifications and botanical classifications.

I will give you a brief status of the French and their operational system. They are coming along well and still plan a May 1984 launch, followed by a few months of checkout following the 1984 launch. The SPOT system is different from anything we are flying at the moment. The satellite will have a push broom scanner, align array, and 2 instruments similar to Landsat with high resolution and visible range. It operates in 3 Bands which span the visible and the near infrared parts of the spectrum. The swath determined by two instruments are different from the Landsat swath. It is 60 kilometers on the side, looking straight down, and there are two instruments side by side, with an overlap. You can program each instrument to work separately. They have a mode to provide high resolution

about 10 meter instantaneous field of view resolution and the 20 meter is the standard output. The 20 meter is better than Landsat 'D' can do in terms of nominal resolution, but the resolution by itself is not the end of the story, as many of you who have tried to interpret data understand.

The particular orbit for SPOT - about 830 kilometers - is different than anything we are flying. It is a bit higher than Landsat 'D' and lower than Landsat 3. It will have a 26 day repeat cycle. The orbit is a peculiar one and it offers a number of chances because they can tilt instruments and take another look, although not exactly the same look. You acquire the same look every 26 days. They can look at the same areas several times during one of the 26 day cycles, and there are several opportunities where you can get a look at the same area from off the side on 1 day spacing, or 4 or 5 day spacing. There is just a different set of operational capabilities that they have planned. The equator crossing time is different than Landsat. It is 10:30 rather than 9:30 and corresponds to the fact that it is optimized for looking at regions of higher latitude and look at what the sun angle is at the higher latitude. SPOT is optimized for Europe while Landsat is optimized for North America and the United States. There are no resource looks. We have had numerous conversations with the French so that they can attempt to make their data streams compatible with people at the ground stations that have arranged to see Landsat data. They hope to work a number of deals with foreign receiving stations and they plan a processing/distributing system on a semi-commercial basis. There would be some type of corporation set up which will have government agencies and private sector agencies as members. A vigorous promotional campaign was launched to prepare people to buy the products. It is quite clear from the details that the product will not be exactly the same but it will have many interesting characteristics and people will be able to make good use of the data. Since they are going to be able to tilt the instruments on SPOT, there is a possibility of being able to generate some sort of stereo imagery. They are not going to hold the orbit closer than + or -5 kilometers, and the timing of the orbit except for specific points is not going to be closer than + minus 15 minutes. They are trying to put the pairs of imagery available through the SPOT system together into a massive stereo pair.

In the United States we have no capability to offer in stereo imagery. I believe the SPOT people are trying to work out an arrangement with US firms to handle the distribution of SPOT imagery in the United States. They may be doing some talking about trying to arrange for commercial retailing of Landsat 'D' information to their sets of customers.

The French will be offering several levels of processing, pre-processing etc., giving several degrees in quality of radiometric, geometric

correction, including what they call Mobile 4 which involves removing all distortions and then generating photographic products. They have not told us what the prices will be. In fact, I think people who are planning on using either Landsat 'D' information or SPOT information, really ought to recognize that both of these are going to be new systems as far as data handling is concerned. Both systems will take some time to perfect. We discovered quite painfully over the eight or nine years of Landsat operation, that there are many details that have to proceed smoothly to get regular and easy access to satellite information.

In both cases, Landsat 'D' and SPOT, the rate at which data will be provided, and the complications in processing must be worked out in detail. We hope to provide good quality products from Landsat 'D' within a few months after the launch and SPOT is programming a few months to solve any discrepancies in their system.

In the remote sensing program we will continue to work on renewable resource activities. The AgRISTARS program will continue, although at a reduced level. We have made considerable progress in learning how to separate and distinguish between confusion crops. You need to measure at the right time during the growing season to distinguish various pairs of crops that look similar from the satellite. At some time during the growing season, the methods used to distinguish crops are a hopeless mess, but there is a window there, where if you look at the right time, you can get a clear distinction and make an accurate classification, for areas where you are unable to get in on the ground and do the classification. If you wait too late, you can not do it so the timing is critical.

As we look forward to the future, and the R&D Program, we will be investigating the utility of other sorts of observations that can eventually be combined with observing systems. We are going to try and look a great deal more at the use of fluorescence. There are certain areas where microwave measurements can display certain characteristics which do not show up in the normal visible spectrum. We have other programs in hand. We will be flying Synthetic Aperture Radar on the shuttle to give us our first opportunity to make repetitive data measurements. I am aware of a vigorous and valuable business in flying radars on aircraft, but if you must pay for sending an aircraft in for repetitive measurements or if in some places you cannot send an aircraft in without having an unfriendly reaction, there is still some value in finding out the limits of what you can do with radars of this sort from a satellite.

The geological applications program is attempting to put together information derived from a number of sensors and a number of wavelengths

that will eventually allow us to interpret this information and generate geological maps. These maps have to be put together using a certain amount of theory about the way the crust develops, as well as sub-surface features, for the first approximation unless you can do field measurements. You can not read below the surface of the earth. You need to acquire all information to understand the geological applications, so the capability eventually has to come from satellite observations from the surface, and various wavelength bands combined with a vigorous program of modeling. In this way, you can infer from the surface measurements as to what lies below, and, therefore, eventually get to resource evaluation.

Related to the solid earth observation, are observations of the oceans and atmosphere. They have a good deal of commonality in instrument type but are looking at different sorts of things. There is radiation coming in from the sun, radiation going out from the cooling of the earth. This radiation emitted back and forth, establishes balances or imbalances, and drives the chemistry in the atmosphere. There are heat inputs, winds, circulatory motions. All that has to be understood to determine how it interacts with the troposphere and eventually, the surface of the earth.

There are several general thrusts in the environmental quality business. We are working closely with people and instruments. We receive observations from the NIMBUS Program, which provides data, plus new theoretical interpretations to try out new instruments and provide research demonstrations. The major component we are working on will ultimately give us some handle on environmental quality. We are trying to understand the chemistry of the atmospheric constituents and the dynamics of chemical species movements throughout the atmosphere.

The national climate office is attached to NOAA, and NASA has a congressional mandate for contributing to the understanding of climate. It comes in 2 parts. One is the influence of climate on man's activities and the other is the influence of man's activities on the climate. This gets us into the long term effects of things such as chlorophyll methane. Man's dumping of particular matter into the atmosphere.

Our major experimental activity in this area at the moment is still the radiation budget experiment which is coming along nicely. They expect to be able to fly a pair of satellites in a few years, which will provide one of the major components we need to understand the climate. The details of the interaction of the incoming radiation from the sun and the outgoing radiation from the cooling of the Earth.

Finally, we have been reminded during the last few years that handling the flood of satellite data is a major problem. We can do it, waste the federal investment and miss opportunities if an adequate system is not in place to capture the data, massage it, and deliver it to the people who actually need it. We have found that a single source of satellite information is seldom exactly what is wanted or needed, but that it almost always has to be put together with information from other sources.

We are trying to do a better job of understanding how you put together data from a number of satellite sources and get it registered properly so it can be overlaid, used and put together into analysis needed to make proper decisions.

To that end, we have a data systems program. We are trying very hard to understand what people's requirements are for data and how they insist the data be available and put together. Our hope is to be able to get an investigator who needs data from any source, draw the data out, get it in a form that can be used and then processed and managed in a way that will be useful. That means a fair amount of new technology in the system that connects among the various data sources.

The danger of course is that all that lovely technology is missing the point. It is fun to play with, but does not wind up doing useful things with the data. That means there is a lot of philosophy and software, and there is a lot of very careful planning that has to be carried out to work out the systems in a way that will end up being useful. We decided some years ago on a global information system and everyone choked. We dropped back to a national information system and everyone still choked. We dropped back to a NASA information system and then to an applications office system. That was still too general and we decided to do the thing that technical people always do and break it down to a simple problem. We developed some pilot systems, which function in each of three major areas. We think we have an over-arching way of thinking about the problem that will allow us to develop practical working systems in each area and get it ready to provide essential ground work in putting together at least an application office-wide system. Judging on that success, we will then be able to determine whether we have learned something, and then spread it out to a broader application for all of NASA, as well as some major segments of national interest.

We are going ahead with the revised budget cuts, because I think everyone recognizes that this is where the payoff is of remote sensing systems. This is a choke point to the benefits from remote sensing systems.

Unless we solve the data handling problems, most of it is going to be a wasted investment.

That gives you a picture of what we have going. Very few new hardware starts will occur. The major ones that are important for land observing are going forward on schedule. Landsat 'D' is headed for a successful completion. The downstream replication of Landsat 'D' satellites is very much in doubt, depending upon our future relations with the private sector. The essential parts of the atmospheric observations and ocean observation systems are still alive and going forward in a reasonable fashion. The applications data system is coming along with a substantial effort in trying to solve continuing problems on how not to waste the space investment.