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A NEW US MILITARY SPACE MISSION

ANTHONY KENDEN

1. INTRODUCTION

THE TITAN 3B BOOSTER was introduced in July 1966, and by the end of 1981 61 of the vehicles had been launched, 57 of them reaching orbit. In all that time, though, it had been used for only two applications, both of them classified military programmes. Fifty two of the launches were for the "close look" high resolution photographic reconnaissance programme, and the remaining nine were for the Satellite Data System (SDS) communications and data relay programme.

Satellites from these two programmes use highly distinctive orbits; a look at the orbital parameters of a particular satellite reveals its programme. Close look satellite orbits are typified by low perigees; usually about 125 km, with apogees in the 260 to 300 km range. However, their most distinctive features are their inclinations; in the early years of the programme these were in the 92° to 112° range, but since 1975 they have always been at 96.4°, to produce synchronism with the annual movement of the Sun. SDS satellite orbits are always highly eccentric with periods near 12 hours, and their inclinations are always 63.4°, to produce zero rotation of perigee around the orbit.

It was therefore not surprising that when a Titan 3B placed a payload in a 143 by 537 km orbit, inclined at 97.32°, on 21 January 1982 that it was immediately classified by observers of the US space programme as a routine close look reconnaissance satellite. Within the next few days, however, it showed itself to be something completely different and apparently quite new.

2. FIRST PHASE OF THE FLIGHT

The launch of 21 January was given the international designation 1982-06, with two objects in orbit, A and B. They were inserted into similar orbits, but object B's orbit was greatly affected by atmospheric drag, and it decayed about 11 hours after launch. The high rate of decay indicates that it had a large cross-sectional area in comparison to its mass, and so it was probably a fairing or shroud rather than the Agena stage of the launcher. This implies that the payload and Agena did not separate, appearing together in orbit as object A, in the same manner as the close look satellites.

About 12 hours after launch 1982-06A made a small change to its orbit but then, nearly 24 hours after launch, a major two-burn manoeuvre was carried out. The orbit was raised from 174 by 543 km to 553 by 645 km and the inclination reduced to 97.25°. A velocity increment of 136 metres per second was required, and as a result the orbital period was increased from 91.77 to 96.73 minutes.

Up to this point, 1982-06A had all the appearances of a close look satellite. The initial apogee was a little higher than normal, but previous missions had used a "settling" period of a few days following orbital insertion before starting operational activities. For example, the most recent close look satellite before 1982-06A was 1981-19A, which entered a 135 by 348 km orbit. It did not start operations for seven days, by which time the orbit had decayed down to its normal operational altitude of 128 by 253 km.

At its new altitude of around 600 km, 1982-06A experienced negligible atmospheric drag, so it appeared that the aim of the manoeuvre could have been to place the satellite in a parking orbit, putting it into "cold storage," to be called down to operational use when the need arose. This would certainly have added a considerable degree of flexibility to reconnaissance satellite operations. This theory was shown to be incorrect when, on 29 January, seven days after the large orbit-raising manoeuvre, another manoeuvre was made. The perigee was raised to 582 km, and this was to be the start of a regular series of manoeuvres. In the next 39 days 1982-06A adjusted its orbit a further six times, until it was in an orbit of 622 by 655 km, with a period of 97.55 minutes.

3. SECOND PHASE OF THE FLIGHT

1982-06A remained in its 622 by 655 km orbit for a week, from 9 to 16 March. It then again manoeuvred, but this time its orbit was *lowered*, to 620 by 648 km. After successively raising its orbit this came as rather a surprise, but a bigger surprise was soon to follow. On 21 March three objects, designated C, D and E, were released. Object C entered a 621 by 646 km orbit, object D entered a 615 by 663 km orbit, and object E entered a 620 by 649 km orbit. As time went on none of these objects performed any manoeuvres, but while objects C and E experienced virtually no decay, object D decayed noticeably – a month after its release its orbit had dropped to 611 x 656 km. A second difference between object D and objects C and E was the fact that D's orbit differed considerably from that of the main satellite, while those of objects C and E were quite similar (this can be seen from the perigees and apogees listed above, and from the inclinations, which were 97.24°, 97.25°, 97.21° and 97.24° respectively for objects A, C, D and E). A possible explanation for this is that objects C and E were subsatellite payloads, while object D was some form of fairing or support structure.

tinued manoeuvring, progressively lowering its orbit. On 22 April it made its fifth manoeuvre since the release, reducing its orbit to 601 by 613 km, with a period of 96.90 minutes. After five days in this path the spacecraft made a relatively large orbital adjustment, requiring a velocity change of 17 metres per second, once again reversing its previous trend by raising its orbit, to 633 by 645 km, with a period of 97.56 minutes.

Six days later, on 3 May, another project appeared, 1982-06F. Object F's orbit ranged from 602 to 612 km, with a period of 96.89 minutes. This was significantly lower than 1982-06A's orbit at that time, but very similar to its orbit before its latest manoeuvre, suggesting that object F may have been released prior to 27 April, but was not detected by NORAD's tracking radars until 3 May.

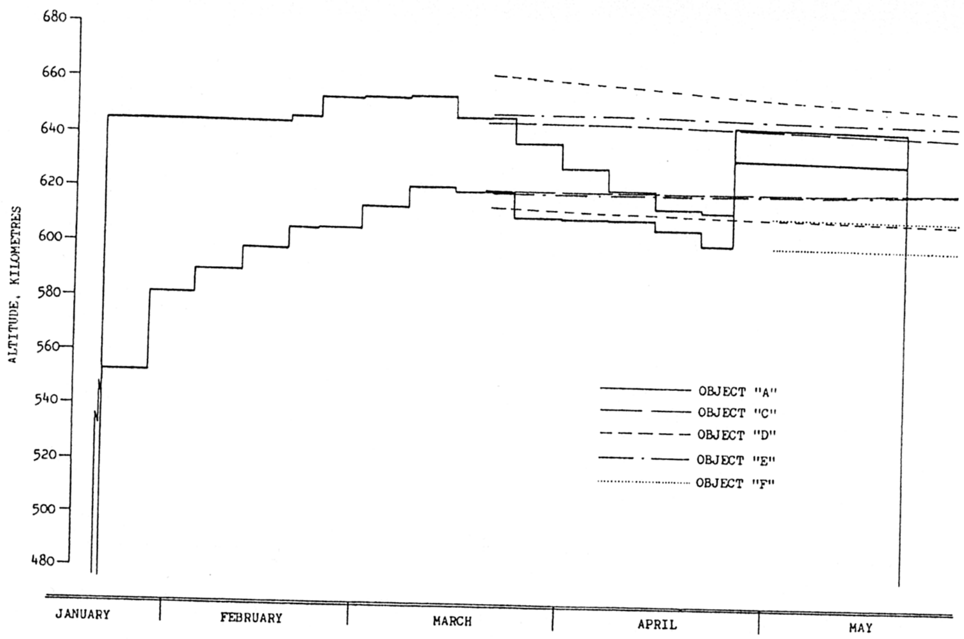

Fig 1: The orbital history of 1982-06.

Fig.1. The orbital history of 1982-06.

Once in its new high orbit, 1982-06A seems to have become inactive. The previous longest spell between manoeuvres was nine days, but this was exceeded with no signs of any activity, and its inclusion in the *Two Line Orbital Elements* became much less frequent. The *Two Line Orbital Elements* are issued daily, and most operational low orbit satellites are included each day, often more than once. During its active period 1982-06A was listed regularly every day, with more than one element set per day at times just after manoeuvres. From the end of April, however, it appeared much less frequently, typically once a week.

Finally, on 23 May, 1982-06A was de-orbited. It had spent 122 days in space, manoeuvred 17 times, with a total ΔV of almost 400 metres per second (including the de-orbit burn). Figure 1 shows the values of perigee and apogee through its life.

4. 1982-06A's GROUNDTRACK PATTERN

The Earth's daily rotation and the precession of a satellite's orbital plane combine to shift the satellite's groundtrack progressively westwards. The amount of westward shift experienced during one orbit, that is the difference in longitude between successive northbound or southbound equatorial crossings, is referred to as the track separation. When a satellite's track separation is such that a whole number of track separations equals a multiple of 360° the groundtrack will repeat itself.

During its flight, 1982-06A's track separation varied from 24.186° to 24.395°, not counting its first day in space (when it was in its initial low orbit). Figure 2 shows the observed pattern of its northbound equatorial crossings for a typical four week period, in this case from 14 February to 13 March. It shows the longitudes of the first two crossings west of the Greenwich Meridian made each day, with the orbit numbers listed next to the plotted points. For any particular crossing, a near repeat was made 15 orbits later, about 5° further west (at a latitude of 45°, a difference in longitude of 5° corresponds to 394 km on the ground). The arrowed lines show how crossings made 74 orbits and five days apart repeated much more closely. The slopes of these

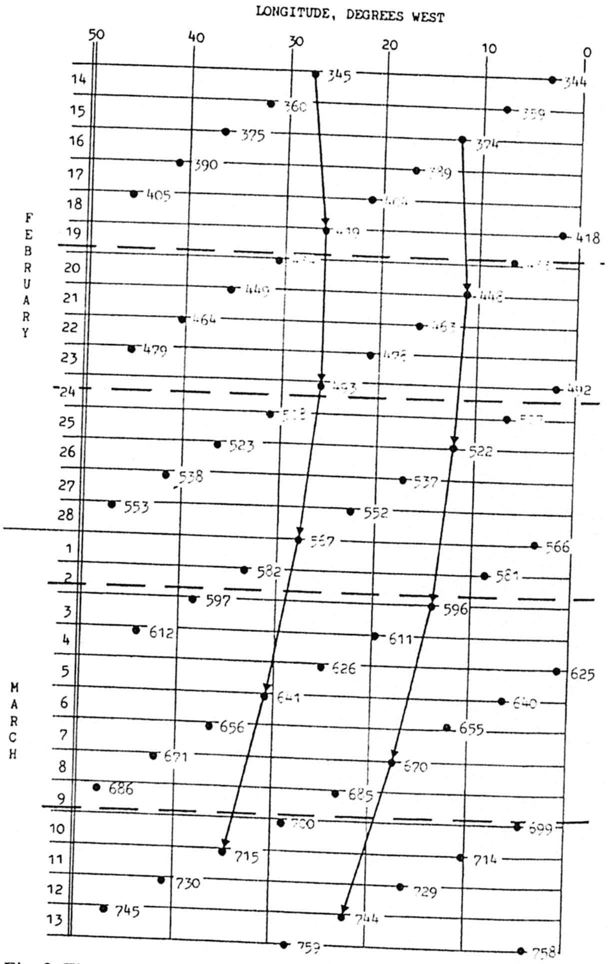

Fig. 2. The first two northbound equatorial crossings west of the Greenwich Meridian made each day by 1982-06A.

lines vary due to the changing value of track separation, which in turn was caused by orbital manoeuvres. The occurrences of manoeuvres are marked on the diagram as dotted lines. During the period shown the track separation increased from 24.305° to 24.394°, while the value for an exact repeat after 74 orbits is 24.324°. The diagram clearly illustrates how small changes in track separation can cause significant changes in the groundtrack pattern.

5. SYNCHRONISM WITH THE SUN

Like all US photo reconnaissance and weather satellites, 1982-06A was placed in a Sun synchronous orbit, with its southbound passes occurring in daylight. This means that the local time, as measured by Sun angle, of all northbound or southbound equatorial crossings remains constant throughout the mission. This type of orbit is generally chosen so that viewing conditions, in particular the ratio between the height of an object on the ground and the length of its shadow, are more or less the same for all regions of observation.

1982-06A was launched at 11:30 PST, and the vehicle followed a course slightly west of due south, making its first southbound crossing of the equator at 11:13 local time. Following the large manoeuvre a day after launch, its inclination was slightly less than that required for exact Sun synchronism. As a result, the equator crossings occurred about 19 seconds earlier each day, until by the time of its de-orbit burn it was crossing the equator at 10:34 local time. This change, amounting to only 39 minutes, may not appear significant, but in fact it would have had a marked effect on any observations. An object 1 m high at the equator would cast a shadow 21 cm long at 11:13 local time, while at 10:34 its shadow would be 39 cm long, virtually double the value.

To make the orbit exactly Sun synchronous without altering its altitude would have required increasing the inclination by 0.63°; presumably the launch vehicle guidance errors were considerably less than this figure and, if they were not, a plane change of this magnitude was certainly within the capabilities of the onboard manoeuvring system, so one must conclude that the lack of exact synchronism was intentional.

6. THE MISSION OF 1982-06

Having considered the orbital behaviour of the launch of 21 January, the question arises as to the nature of its mission. There are no obvious clues, either from the orbital data or from press reports, so one can only start by examining all the current US military space activities to see if 1982-06 fits into any of these. Current activities can be classified as follows:

- photo reconnaissance
- missile early warning
- electronic intelligence and monitoring ("elint/ferret")
- ocean surveillance
- navigation and position fixing
- communications and data relay
- weather observation
- research and development

We can immediately eliminate missile early warning, navigation and position fixing, communications and data relay, and weather observation on the grounds that the current and near future programmes in all these areas have been well publicised, and do not include anything like 1982-06. Research and development missions, which here includes such work as geodetic flights and radiation measuring experiments, are now all flown under the auspices of the Space Test Program (STP), and since 1980 all STP flights have been planned to be carried on the Space Shuttle. This leaves photo reconnaissance, elint/ferret and ocean surveillance as possible candidates.

Photo reconnaissance is currently carried out by three classes of satellite; KH-11, Big Bird and close look. KH-11 provides routine low resolution coverage, with all year round operation of two satellites. Big Bird provides moderate resolution coverage, averaging one six-month flight a year. Close look provides high resolution coverage, averaging one three-month flight a year. However, both Big Bird and close look programmes are being phased out, with only a couple of spacecraft in each programme remaining to be flown. For the future, an advanced version of KH-11, providing both long life and high resolution imagery, is under development and is scheduled to enter service in 1984.

Clearly 1982-06 does not fit into any of these programmes, but its use of a Sun synchronous orbit does suggest some kind of Earth observation role. Its orbit was considerably higher than is normally used for reconnaissance, but it could have been a flight to test components of the advanced KH-11, in particular the new camera system and possibly a new manoeuvring system. Possible corroboration of this comes from the long life of KH-11 satellites; the last one that completed its mission did so after a life of 38 months. The two KH-11s currently in service were launched in February 1980 and September 1981; possibly the first advanced KH-11, planned for launch in 1984, will be the *next* KH-11. If this is the case, there would be good reason to test some of the components before going to a full operational mission.

The elint/ferret effort is one of the most secret of the US's space activities. Since 1972 the mission has been carried out by small subsatellites ejected from Big Bird photo reconnaissance flights. These subsatellites use two types of circular orbit: one type was originally at an altitude of 1,440 km but recently has changed to 1,330 km, and the second type started at 490 km but from 1976 has been at 630 km. The orbital elements of 1982-06A bear a striking resemblance to the lower altitude elint/ferret subsatellites, suggesting that it may be a new type of elint/ferret craft. However, if 1982-06A were an elint/ferret mission, why did it use the high orbital inclination? The Big Birds use an inclination which makes them Sun synchronous for observational reasons but, as a consequence, the subsatellites appear at the same inclination, although their mission does not require this high an inclination. Indeed, the original dedicated elint/ferret satellites, which were in use from 1962 to 1971, flew at inclinations of 70° to 82°.

One explanation of the use of the high inclination, and possibly of the regular orbital manoeuvres that 1982-06A made, could be that it was to keep a particular plane separation from elint/ferret subsatellites already in orbit. However, an examination of their orbital elements belies this. The last two subsatellites launched were 1978-29B and 1979-25B, and their orbits are sufficiently different, both from each other and from 1982-06A's, that the rates of precession of their orbital planes differ significantly. It is possible, of course, that the subsatellites released by 1982-06A were standard elint/ferret craft, particularly as the proceeding one ejected from a Big Bird had by then been in operation for two years, and was presumably nearing the end of its life. However, 12 days before 1982-06A's de-orbit, a new Big Bird was launched and released an elint/ferret subsatellite. An interesting point to note about this craft is that its orbital altitude was greater than its predecessors, having a perigee of 699 km and an apogee of 704 km.

The third possible mission for 1982-06 is ocean surveillance, but this must be regarded as rather a "long shot." The current ocean surveillance system, which has the code name White Cloud, consists of clusters of spacecraft in 1,100 km, 63.4° orbits. The full system is formed by three clusters with their orbital planes 120° apart. Each cluster contains a main "parent" satellite and three small subsatellites which are dispensed from the parent soon after orbital insertion. Full operational status was achieved in March 1980 following the third launch in the programme, and since then there has been only one White Cloud flight. This came in December 1980, and from the time of lift-off it is clear that this was intended to replace the first cluster, which had by then been in orbit for four and a half years. Seven minutes after lift-off the booster veered off course and was destroyed by the Range Safety Officer.

Why a backup has not been launched is something of a mystery, but it is possible that the original form of White Cloud has been abandoned, and a replacement in the shape of 1982-06 has been developed. 1982-06's inclination was certainly very different from those of the White Clouds, but its use of a relatively non-decaying orbit and the release of subsatellites bears some resemblance to a White Cloud flight. There is one difference, however, between the use of subsatellites by 1982-06A and by the White Clouds. The separations between the White Cloud subsatellites and their parent are kept to distances of the order of tens of kilometres, implying that either the subsatellites are able to carry out small station-keeping manoeuvres or that they are physically connected to their parents, for example by fine wires. 1982-06A's subsatellites, on the other hand, entered slightly different orbits and over periods of weeks drifted far apart.

7. CONCLUSIONS

1982-06 operated in space for four months; it manoeuvred repeatedly, first raising its orbit, then lowering it, then raising it again, and finally de-orbiting itself. On two occasions it released objects into independent orbits. Just what it was doing is still a puzzle. Some possible explanations have been considered here, but a definitive answer is still awaited.

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The orbital data used in this article are all derived from NASA's *Two Line Orbital Elements*. The descriptions of current military space programmes presented in the section discussing 1982-06's possible mission were drawn from two previous works by the author:

"U.S. Reconnaissance Satellite Programmes," *Spaceflight*, July 1978.

"Recent Developments in U.S. Reconnaissance Satellite Programmes," *JBIS*, 35, January 1982.

CORRESPONDENCE

Gemini Assignments

Sir, While reading D. J. Shayler and T. Avery's paper "Astronaut Assignments in the Mercury and Gemini Programmes (1959-1966)" [1] I was rather intrigued to come across the description of astronaut Ed Givens death in a jet crash in October 1964. Givens was, in fact, alive and well unitil 6 June 1967 when he died in a car crash.

M. WEST
Nottingham

REFERENCE

1. *JBIS*, 35, 6, p. 275(1982).

The authors' reply:

Mr. West is, of course, correct. The astronaut death in 1964 was Ted Freeman: subsequent comments concerning Givens should refer to Freeman. This was a slip of the typewriter that went unspotted at later stages! In fact, the correct information had already been published in the "Where Are They Now?" series in *Spaceflight* – written by one of the above authors!

Soviet Remote Sensing

Sir, Not infrequently we read references to the remote sensing of Earth resources conducted by Soviet manned and unmanned spacecraft. Most recently, for example, Julian Popescu wrote on the subject in "Space Chronicle" [1]. A lengthy document, the Russian National Paper surveying the country's accomplishments in remote sensing from space over the past ten years, was presented to the Unispace '82 UN Conference in Vienna during August (and available before that in the UK [2]).

How many images has the Soviet Union released to accompany (some might say substantiate) their claimed successes in remote sensing? I have seen only three obtained with the MKF-6 camera unit and these were made available through the courtesy of Carl Zeiss Jena, the manufacturer in East Germany. A very few hand held camera images of the Earth's surface have been released in the past, but compare that with the tens of thousands of such images available from NASA. No one doubts that the Soviet Union has been conducting an energetic remote sensing programme – it would be surprising if they were not – but may we have less talk and words and more 'action' in the form of images?

On a point of detail, I must challenge Mr. Popescu on his claim that the MKF unit's ground resolution from aboard Salyut is 10 m. The unit (which is a battery of film cameras and not a 'scanner') incorporates lenses of 125 mm focal length and while Salyut 6's altitude was lower than that of Skylab – let us say around 350 km compared with around 425 km – the best ground resolution that could be obtained with the highly sophisticated Itek S190A camera battery in the US space station with lenses of greater focal length (152 mm) was 40 m with high resolution black and white film. Moreover, the Skylab S190B Earth terrain camera with a 460 mm focal length lens could only just secure 10 m ground resolution under optimum conditions [3]. I would be surprised if the Soviet multispectral camera unit was obtaining 30 m ground resolution. But, of course, the proof would be in the seeing!

H. J. P. ARNOLD
Havant, Hants.

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2. Published in Newsletter No. 31 of the Remote Sensing Society December 1981.
3. H. J. P. Arnold, "Skylab: New Horizons in Space Photography," *British Journal of Photography*, May 25 and June 1 1973.

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Europe, including TV broadcasting, data transmission and remote sensing. These complications can only be fully appreciated, and hopefully overcome, by realistic trials.

UNUSUAL MILITARY SATELLITE

Earlier this year, on 21 January, the US Air Force launched its 62nd Titan 3B. Its payload entered a 143 by 537 km orbit, with a period of 91.40 minutes and an inclination of 97.32°, writes Anthony Kenden. Most observers of the US military space programme quickly classed it as a routine high resolution "close look" photographic reconnaissance satellite because of its tell-tale low perigee and Sun-synchronous inclination. However, subsequent manoeuvres showed it to be an unusual mission.

The low perigees used by close look satellites mean that they experience considerable atmospheric drag, forcing them to make daily manoeuvres to counter orbital decay. A day after launch, the new satellite (1982-06A) manoeuvred, but the resulting orbit was much higher than those used by close look satellites. It was the first indication that the satellite was not all that it had originally seemed. It was to surprise observers again and again over the next four months.

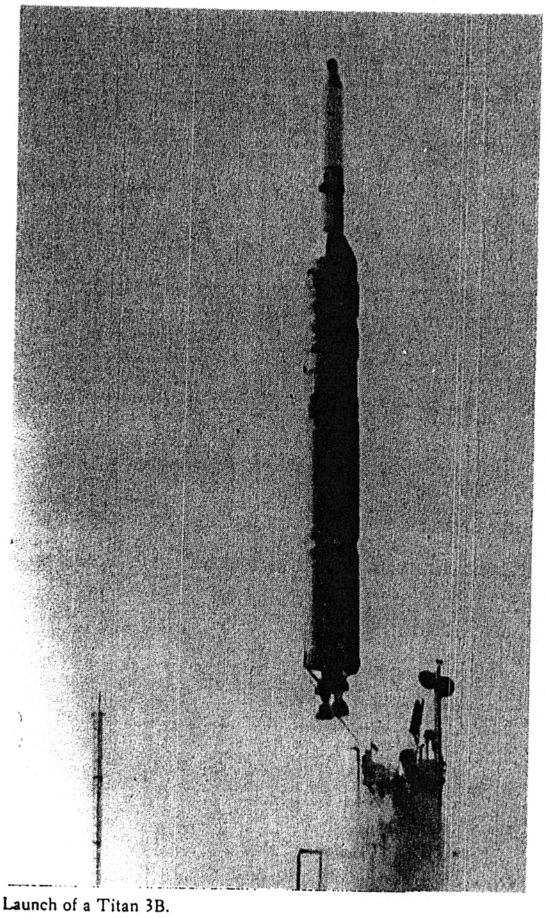
1982-06A's new orbit had a perigee of 553 km and an apogee of 645 km, with a period of 96.73 minutes. At this altitude it showed virtually no atmospheric decay. Was it simply a close look satellite in a parking orbit waiting to be called down to active service when the need arose? The answer was shown to be "no" on 29 January, when 1982-06A manoeuvred again, raising its perigee to 582 km. By 9 March it had raised its orbit a further six times, resulting in a path of 622 by 655 km, with a period of 97.55 minutes.

After a week of this, 1982-06A manoeuvred again, but this time *lowering* its orbit. Five days later it released three objects into their own orbits. The main satellite then continued to lower its path, until by 22 April it ranged from 601 to 613 km. Five days later a second relatively large manoeuvre was made, raising the orbit to 633 by 645 km, and after another six days a fourth object appeared.

Having manoeuvred 16 times in 96 days, 1982-06A now became inactive. For 26 days it stayed in this high orbit, decaying slightly but showing no signs of any manoeuvring. Finally, on 23 May, it fired its engine for the last time and pushed itself out of orbit. It had been in space for 122 days.

There are no obvious clues as to what 1982-06 was actually doing, either from its orbital behaviour or from reports in the press, but it is possible to make some intelligent guesses. Examining all the types of US military space activities and eliminating those for which current and future programmes have been well publicised leaves photo reconnaissance, electronic intelligence and ocean surveillance as possibilities. Of these, the most likely appears to be to test systems for the new advanced KH-11 photo reconnaissance satellite, due to enter service in 1984.

A paper by Anthony Kenden on this unusual satellite appears in the October 1982 "Space Chronicle" issue of JBIS *- Ed.*



Launch of a Titan 3B.

SOLAR SATELLITE RESULTS

An 18-month decrease in the Sun's energy output, recently detected by the Solar Maximum Mission satellite, may have been a factor in this year's unusually harsh winter.

This winter's severe weather conditions in the United States, coupled with the new results, may be the first direct observation of a cause and effect relationship between the Sun's energy output and changes in Earth's weather and climate.

A persistent decrease of a tenth of a percent in the total amount of solar energy reaching Earth (solar irradiance) was detected over an 18-month period from February 1980 to August 1981 by the Active Cavity Radiometer Irradiance Monitor experiment on the satellite.

"This is a small change in the total energy output of the Sun, but has great potential significance for the Earth's fragile ecosystem," according to Dr. Richard C. Willson, principal investigator and designer of the experiment, a physicist at the Jet Propulsion Laboratory.

Climatologists are already studying the results of the experiment which will be correlated with such global climate indicators as average temperatures, ice coverage and sea level to evaluate the effects of the drop in solar irradiance.

A systematic increase or decrease in the Sun's release of energy - as little as one half percent per century - can produce vast changes in the Earth's climate. Scientists believe that a one percent decrease would lower Earth's mean global temperature by more than 1°C. According to some models, a decrease in solar energy of less than 10 per cent could effectively freeze the Earth's entire surface.

Nearly all life forms on Earth exist within the 10 km above and below mean sea level. The temperatures within this thin environmental shell, called the biosphere, are determined by the amount of energy received by the Sun and delicate interactions between the atmosphere, ocean and land masses. The climatic effects of short-term variations in solar irradiance are