

## WEATHER FACTORS IN SATELLITE RECONNAISSANCE

The effect of weather on photo reconnaissance has been known since aerial reconnaissance was first tried, but a set of new elements is brought about by the use of satellites.

- 1) Since satellites are outside the atmosphere, clouds at all altitudes can prevent photo reconnaissance thereby increasing the "effective" cloud cover.
- 2) Surveillance from one polar satellite at about 300 miles gives successive looks of the same location at roughly 24 hour interval. The relation between this interval and the "correlation interval" for cloud cover is not too well known, but plays an essential part in operational plans for photo surveillance.
- 3) The usual weather computations for satellite photo surveillance define a necessary satellite - day figure. The implication that the same probability of obtaining photo coverage is obtainable by using one satellite and trying for 15 days, or using 15 satellites and trying for one day, is obviously false. Here the satellite - day figure is optimistic because of the observation made under 2) above.
- 4) Generally speaking, at higher latitudes the weather gets worse but the overlap between orbits is high; the two effects tend to compensate each other and to equalize at all latitudes the number of satellite - days required to give a certain probability of success for photo reconnaissance.

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5) In some parts of the world, the weather is so bad that statistical success in photo surveillance becomes so unlikely as to destroy the usefulness of the photo mission. In this case, all-weather sensors and directed reconnaissance, rather than surveillance, become the only possible solutions.

6) The reliability life of the system becomes an absolutely fundamental parameter in deciding the practicability of surveillance.

For instance, assume the following -

- a. Target: Moscow in Summer.
- b. Camera swath 100 miles.
- c. Surveillance required with 90% probability of success once every 24 hours.
- d. Polar orbit.
- e. No correlation between cloud cover at different times.
- f. Reliability of satellite in orbit = 85% satellites launched.
- g. Reliability of the vehicle equipment.

MTBF = Meantime between failures = 1 month

With these assumptions, we find (see Appendix) that we need 12 satellite - days. Because of note 2) above, this is a conservative estimate.

I am not sure that we know how to achieve an MTBF of one month. The requirement for 90% probability of daily success implies anyway, 12 satellites simultaneously flying and, 95% equipment reliability. With a MTBF of one month, to get 90% chances of daily success, we would need about 200 satellites launched per year.

The figure of 200 satellites is, of course, very strong function of the assumptions made. A 300 mile swath would reduce the number by about a factor of 2. A swath of 75 miles would require doubling the number of satellites. If the MTBF were a year rather than a month, about 15 - 20 satellites a year would be required to insure daily success on Moscow in the summer.

To cover other regions of the earth, or to cover Moscow in the Winter may require much larger numbers of satellites.

A large number of unknown factors limits the validity of the above conclusions -

- A) How important is the availability of photo coverage of a particular spot within one day?
- B) What is the relation between ground-observed and satellite-observed cloud cover?
- C) What is the effect of the false assumptions made on the statistics of clouds, both because of meteorological considerations (item 2 above), and the effect of particular geographical terrain features?
- D) What is the cost of a satellite in orbit after production techniques have been installed?
- E) What is the relation between resolution and effective cloud cover. Because of items 1), 2) ---6), and notwithstanding the uncertainties A), B), C), D), E), it appears this time that
- I) Weather effects have not been properly included in 117L system planning despite the fact that all the pertinent information is available

in 117L reports.

II) Reconnaissance can be made with a satellite launched in a predetermined orbit when the weather is favorable. It may well be that reconnaissance rather than surveillance will be the best method of using satellites as photo reconnaissance devices.