C/E-55
October 1956

File

COMMENTS ON THE SOVIET REQUEST TO OBSERVE THE OCTOBER 1958 SOLAR ECLIPSE FROM THE TOKELAU ISLANDS

I. Summary

A. The Soviets have requested New Zealand to permit a 40-man expedition to occupy a station on Atafu, to observe and photograph the solar eclipse of October 1958.

B. Neither the size of the expedition nor the 6- to 9-week period of observation requested is deemed to be excessive for such a scientific program.

C. Eclipse observations have long been of recognized scientific interest. The current interest in establishing geodetic ties between continents and islands has given the observations an added military significance associated with the reduction of sizeable errors in the relative accuracy in the positioning of points widely separated by vast ocean areas. When a number of eclipses whose paths cross have been observed, ocean areas might be bridged for establishing geodetic connections.

D. The 1958 eclipse will afford little opportunity for establishing long geodetic connections unless the Soviets also attempt to observe the eclipse from the west coast of South America.

E. Nevertheless, the positioning of Atafu would be improved. This would be of value for comparison with the results of position values determined from astro-positions corrected for deflections of the vertical. If the two compare favorably, the Soviets may increase their

capability for establishing a transoceanic test range for a 5,500-mile missile.

F. By utilizing the data to be obtained from a U.S.-sponsored IGY lunar photography program, together with the eclipse data, Atafu might become a key point from which geodetic relationships with the Western Hemisphere could be determined.

G. The correct positioning of Atafu could provide the Soviets with an accurate point for the covert seismic recording of nuclear tests at Eniwetok. This might be coupled with the measure of fallout in this remote area of the globe.

H. If the Soviets are to be granted permission the following technical suggestions are made:

1. They should submit in advance a complete program of their activity for monitoring.

2. A list of personnel and equipment should be provided to facilitate surveillance of activities and intentions.

3. Free access should be available to all areas of operations and activities at all times (during their observations of the Brazil eclipse of 1947, the Soviet camp was closed to non-Soviets).

4. A duplicate copy of all observational data should be supplied to New Zealand.

II. Discussion

A. The New Zealand Government has received a request from the Soviet Government for permission to send a "complex equatorial expedition" to Atafu Island in the Tokelau Group to observe and study the solar eclipse that will take place in October 1958. The Soviets have indicated that

about 40 technical people would occupy a base on Atafu for a period of 6 to 9 weeks. The activities of the expedition would constitute part of the Soviet IGY program.

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C. The path of totality of the October 1958 solar eclipse is indicated on an attached copy of a map provided by the U.S. Naval Observatory. At sunrise the path begins in the Pacific Ocean near the equator and north of the Solomon Islands. It extends a little south of easterly across the Pacific Ocean and ends at sunset in Western Argentina at approximately 34°S latitude. A unique feature of the path of totality of this eclipse is that it does not cross large land masses from which it might be observed under favorable conditions. For the most part the path of totality traverses wide ocean spaces in which there are only very few small islands. The sun will be near setting when the eclipse reaches South America; consequently optical and radio observations in Chile and Argentina would suffer high incidence and long path through the earth's atmosphere.

Atafu is an atoll of the Tokelau Group and has only a small native population. It seems to lie astride the path of totality at a point where the eclipse will occur during the midmorning. If other nations send expeditions to the Pacific to observe this eclipse, it is likely that Atafu or other islands of the Tokelau Group will be selected for observation bases.

Forty scientists and technicians operating for 6 to 9 weeks at the base site would not be excessive for the variety of interest associated with a present-day solar eclipse. In the past a solar eclipse was an occasion for determining accurately the moon's position in its orbit at the instant of totality. Since the moon's orbital motion is now studied by other means, solar-eclipse interest in recent years has shifted to the study of the corona, effects in the ionosphere, radio communication, photometry, spectroscopic analysis, etc.

The variety of these studies is such that 40 men might well be required to fulfill all planned tasks. Whereas some apparatus could be set up and made ready in a week, other more sensitive apparatus could take 6 weeks to get in proper working order. The fact that the Soviet expedition would be included in the IGY program also may have made it easier to get this number of people assigned to the expedition.

U.S. plans for observing the eclipse are unknown at the present time. A U.S. expedition might well involve 100-500 technical people in expeditions covering this eclipse. Therefore, neither the size of personnel nor the duration of the expedition requested by the Soviets seems out of order.

D. In recent years eclipses of the sun have been photographed for the specific purpose of strengthening intercontinental geodetic ties. By determining the moments of totality of the eclipse at successive stations along its path, time differences are related to the geodetic coordinates of the observing stations without regard to local deflection angles. If a number of solar eclipses were observed over a period of years and if the paths of the eclipses crossed, it would be possible

to tie together widely separated stations. The eclipse method thus permits geodetic bridging of the vast ocean areas, which is a matter of great importance to the geodesist. The October 1958 eclipse, however, will afford little opportunity for long geodetic connections since the latter half of the path of totality is remote from land except for a final small segment on South America near sunset. If the Soviets should also request permission of Chile or Argentina to send an eclipse expedition to either of those countries, despite the unfavorable refractive conditions at sunset, it would indicate their intention of attempting such a long geodetic connection.

During their occupation of the Atafu station, the Soviets could make a fairly good determination of the geodetic position of the island. The experience they would gain and the accuracy of their result might serve them to advantage at some future time. At present, the positions of many Pacific islands have the accuracy of astro-observations only, and may be in error by a mile or more. The eclipse might thus serve to check the geodetic position of the island.

E. Stellar photography and observations over the period of their occupancy would give the Soviets good astro-coordinates. Concurrently, they could make gravity observations on the islands, on the submerged shelves, and in the surrounding waters. Enough gravity values might be obtained to permit the calculation of the deflection angle at Atafu. This is the station error or correction which, when applied to astro-coordinates, gives the desired geodetic coordinates of position. Until an attempt of this kind is actually made, the Soviets can only estimate the probable error in positioning a remote island. The eclipse would

provide an additional and independent check on the final result which, we believe, might be accurate to within a few seconds of arc, or a few hundred feet on the earth's surface. The result might serve the Soviets in the future in several ways.

F. During the IGY, the U.S. and many other countries will operate about 21 lunar photographic stations at observatories widely dispersed over the earth, except in the Soviet Union. Over the 1½-year period of the IGY, the moon will be photographed against a background of stars at these stations. From measurements of the photos of the moon's position with respect to the stars, the orbital motion of the moon can be ascertained with great accuracy for the period. The problem is then reversed, and from many photographs the space coordinates of any station can be determined from the moon's position with respect to the stars. Time must be measured very precisely when taking the photographs in order to achieve success by this method of geodetic positioning. Since the observations by the U.S. and other collaborating nations will be published and disseminated freely, the raw data will automatically become available to the Soviets — to whom the matter of computing the geodetic relationships between stations will be no serious obstacle.

The Soviet station at Atafu could eventually be tied in with the network of stations that will participate in the general IGY lunar photographic program. Thus, even though they do not participate in the lunar photographic program, the Soviets would have access to the geodetic benefits derived from it. The nearest lunar photographic stations to Atafu are at Wellington in New Zealand and in Hawaii. Atafu could provide an initial step in a program by which the Soviets might

ascertain the geodetic relationship of Asia to the horizontal control of the Western Hemisphere via the Pacific Ocean.

G. The accurate geodetic positioning of Atafu might indicate a Soviet intention to establish a remote Pacific listening post directed toward U.S. nuclear tests at Eniwetok. From Asia the Tokelau Islands lie more than 2,000 miles beyond Eniwetok. A covert seismic station operated on one of the less frequented islands (and serviced by submarines) could pick up seismic recordings of the nuclear tests at closer range than any other Asiatic station. Fallout and increase in the atmospheric radioactivity could also be detected. The advantage of having Asiatic detection stations augmented by a station on the beyond side of Eniwetok might be considered by the Soviets as great enough to warrant the preliminary steps toward achieving it.

H. Another Soviet objective in determining Atafu's position accurately is suggested when we consider the Soviet need for a missile-testing range approximately 5,500 miles in extent. The following reasoning is based on the assumption that the Soviets are planning to use ballistic missiles of such range in possible future warfare against the U.S. Intercontinental warfare between the U.S. and the USSR would require that missiles have a range of at least such lengths in order to be effective against principal targets on either side.

The longest arc between two points lying entirely within the USSR is approximately 5,000 miles in length. One point of this arc is in the Black Sea area near Odessa and the other at the tip of the Kamchatka Peninsula. If for reasons of security or protection of the population, the launching point were moved farther inland from the border — to

Kapustin Yar, for example — the range would be shortened by about 500 miles. No attempt will be made here to discuss the many other pertinent factors that affect the selection of a launching site. We simply state the conclusion that the physical and political boundaries of the USSR, together with several obvious security precautions, limit to about 4,500 miles the extent of any possible "all-USSR" missile range for the testing of ballistic missiles.

The question then arises, would the Soviets settle for a 4,500 mile testing range when many desirable U.S. targets lie in the next 500 miles of range from launching points in areas behind either Murmansk or Tikal? Suppose the Soviet ballistic missile has a 5,000 mile range. Would the Soviets be satisfied with the results of tests at only 4,500 miles? How would they feel about using a missile at 5,000 miles if it had been tested at only 4,500 miles? It seems consistent with the concept of selective bombing that the test range should be as long as the planned operational range of the missile.

If, as hypothesized, the Soviets are preparing long-range ballistic missiles for possible use against the U.S., they are of necessity confronted with decisions concerning (1) the maximum operational range of their missiles as indicated by developments to date, (2) the preparation of a test range of comparable length, (3) the selection of launching sites suitable for attack against the U.S., and (4) many interrelated questions of logistics.

The suggestion made here is that the Soviets may have just realized the necessity of going outside the limits of the USSR for a test range that will match the capabilities of their ballistic missiles. They

may wish to emulate the pattern of U.S. planning, which for several years has had Ascension Island as its goal for the terminus of one of its ranges. Ascension is very nearly 5,000 miles from Cape Canaveral. Thus, Atafu may be simply a "feeler" directed toward establishing a Pacific test range. Without any mid-Pacific Ocean islands of their own, the Soviets could utilize the 1958 eclipse as an opportunity for geodetically positioning Atafu in order to see what degree of accuracy is possible using a gravity approach to the problem.

III. Technical Suggestions

To insure the most effective watchfulness over Soviet activities in connection with the eclipse, if permission is granted by New Zealand, the following recommendations are made:

1. The Soviets should submit in advance a complete program of all the activities and observations they plan to make during their occupancy of the Atafu station.

2. They should submit a list of all scientific personnel on the expedition, their respective fields of interest, and a list of instruments to be used by the expedition.

3. Guest observers from New Zealand should be allowed freedom to be present and inspect the scientific activities of the Soviet expedition at all times. Such surveillance would provide an indication as to whether astronomic and gravity observations are being made. The Soviet camp observing the eclipse in Brazil in 1947 was closed to non-Soviet nations.

4. All observations made on Atafu by the Soviets should be published openly, whether a part of the IGY program or not.